Neutron Imaging Facilities Survey

Jointly Prepared and Conducted by the ISNR and IAEA

13 June 2019, Vienna (Austria)

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1. Algeria, CRNB, 15 MW

1. General information

Country	ALGERIA
Region, Place/Closest Town	Djelfa
Institution	Nuclear Research Center of Birine (CRNB)
Facility manager (full name, position, phone, e-mail, web)	BOUKERDJA Layachi. +21327872921 boukerdjal@yahoo.fr
Type of neutron source	Research Reactor
Source power [MW]	15
Source intensity [n/s or cm^{-2} s^{-1}]	~10^{14} cm^{-2} s^{-1}
Availability (hours/year)	384

2. Beam qualification

Beam line alignment (radial, tangential)	radial
Neutron spectrum (qualitative: fast, thermal, cold)	thermal
Curved beam guide (monochromator)	
Neutron spectrum at sample position (qualitative: fast, thermal, cold)	Not measured
Maximal beam intensity at sample position [cm^{-2} s^{-1}]	2.25 x 10^{7}
Polarization (yes/no)	no
Neutron/gamma ratio (n cm^{-2} per mGy)	
Cd ratio (foil material)	

3. Beam line layout

	Setting 1	**Setting 2**
Inlet aperture [mm]	20	
Filter options (e.g. Bi, Be, Si, sapphire,)		
Aperture - detector distance [cm]	300	
Resulting L/D (measured or estimated)	~125(effective)	
Effective beam size [mm]	210 to 240	
Flux uniformity (e.g. flat, gaussian, other)		
Corresponding intensity [cm^{-2} s^{-1}]	1.6 x 10^{6} (at 1 MW)	

4. Detectors* for neutron imaging

	Availability – yes/no
Film based detector (converter material)	yes
Digital camera based detector (scintilator material)	Yes (short exposure time)
Imaging plate detector	no
Amorphous Si flat panel detector	no
Other	Solid state Neutron track detector (SSNTD)

**Specification of the individual performance parameters on a separate sheet*

5. Advanced neutron imaging features

	Availability – yes/no
Tomography	no
Time sequences	/
Grating interferometer	/
Energy selection	/
Polarizer	/
Others	/

6. Involved manpower

	Number
Scientists	03
Students	02 students per year
Engineers	/
Technicians	01

7. Applications*

Research topics	1. Non-destructive testing on different kind of objects 2. Flow visualization and characterization 3. Development of neutron imaging system quality metric procedures
Services for industry	/
Methodical developments	/

**Provide the list for a multiple answer*

8. Revenue generation/recovery

	Yes/No
Presently	NO
Future plans	YES

9. Plans for future upgrades

Expected Year	Type of Upgrade
2012-2015	Implementation of long exposure time dynamic neutron radiography
	Implementation of Neutron Tomography

10. Other relevant information

2. Algeria, CRND, 1MW

1. General information

Country	ALGERIA
Region, Place/Closet Town	DRARIA
Institution	Nuclear Research Centre of Draria
Facility manager (full name, position, phone, e-mail, web)	ALLEK Mouloud. +213 21 31 0357/61, allek_md@yahoo.fr
Type of Source	MTR Pool Reactor
Source power [mw]	1
Source Intensity [n/s or $cm^{-2}s^{-1}$]	
Availability (hours/years)	360 h/y

2. Beam qualification

Beam line alignment (radial, tangential)	Tangential
Neutron spectrum (qualitative: fast, thermal, cold)	Thermal
Curved beam guide (monochromator)	
Neutron spectrum at sample position (qualitative: fast, thermal, cold)	
Maximal beam intensity at sample position [$cm^{-2}s^{-1}$]	$6.\ 10^{6}$
Polarization (yes/no)	No
Neutron/gamma ratio (n cm^{-2} per mGy)	
Cd ratio (foil material)	

3. Beam line layout

	Setting 1	**Setting 2**
Inlet aperture [mm]	30	
Filter options (e.g. Bi, Be, Si, sapphire,)		
Aperture-detector distance[cm]	340	
Resulting L/D (measured or estimated)	113	
Effective beam size [mm]	ø340	
Flux uniformity (e.g. flat, gaussian, other)		
Corresponding intensity [$cm^{-2}s^{-1}$]		

4. Detectors* for imaging system

	Availability-yes/no
Film based detector (converter material)	yes
Digital camera based detector (scintilator material)	no
Imaging plate detector	no
Amorphous Si flat plate detector	no
Other	no

**Specification of individual performance on separate sheet*

5. Advanced neutron imaging features

	Availability
Tomography	no
Time sequences	/
Grating interferometer	/
Energy selection	/
Polarizer	/
Others	/

6. Involved manpower

	Number
Scientists	
Students	
Engineers	/
Technicians	01

7. Applications*

Research Topics	1. Non destructive testing on different kind of objects;
Services for industry	/
Methodical developments	/

**Provide a list for a multiple answer*

8. Revenue generation/recovery

	YES/NO
Presently	NO
Future plans	

9. Plans for future upgrades

Expected Year	Type of Upgrade

10. Other* relevant information

* E.g. facility-instrumentation photos can provided on a separate sheet

For additional information please contact N.Pessoa-Barradas@iaea.org and Eberhard.Lehmann@psi.ch.

3. Argentina, RA-6, 1 MW

1. General information

Country	Argentina
Region, Place/Closest Town	Bariloche, Río Negro, Argentina
Institution	Comisión Nacional de Energía Atómica
Facility manager (full name, position, phone, e-mail, web)	Fernando Ariel Sánchez, researcher Phone: 54-294-4445976 - sanchezf@cab.cnea.gov.ar
Type of neutron source	Research reactor
Source power [MW]	1
Source intensity [n/s or cm^{-2} s^{-1}]	2 x 10^{13} cm^{-2} s^{-1} (thermal neutrons at the core)
Availability (hours/year)	3740

2. Beam qualification

Beam line alignment (radial, tangential)	Radial
Neutron spectrum (qualitative: fast, thermal, cold)	Thermal
Curved beam guide (monochromator)	No
Neutron spectrum at sample position (qualitative: fast, thermal, cold)	Thermal
Maximal beam intensity at sample position [cm^{-2} s^{-1}]	5 x 10^{6}
Polarization (yes/no)	No
Neutron/gamma ratio (n cm^{-2} per mGy)	-
Cd ratio (foil material)	-

3. Beam line layout

	Setting 1	**Setting 2**
Inlet aperture [mm]	40	
Filter options (e.g. Bi, Be, Si, sapphire,)	Sapphire	
Aperture - detector distance [cm]	400	
Resulting L/D (measured or estimated)	100	
Effective beam size [mm]	200 x 200	
Flux uniformity (e.g. flat, gaussian, other)	Flat	
Corresponding intensity [cm^{-2} s^{-1}]	2.4 x 10^{6}	

4. Detectors* for neutron imaging

	Availability – yes/no
Film based detector (converter material)	No
Digital camera based detector (scintilator material)	Yes (^{6}LiF/ZnS(Ag))
Imaging plate detector	No
Amorphous Si flat panel detector	No
Other	No

**Specification of the individual performance parameters on a separate sheet*

5. Advanced neutron imaging features

	Availability – yes/no
Tomography	Yes
Time sequences	No
Grating interferometer	No
Energy selection	No
Polarizer	No
Others	No

6. Involved manpower

	Number
Scientists	1
Students	1
Engineers	1
Technicians	1

7. Applications*

Research topics	Hydrogen technology, cultural heritage
Services for industry	Aerospace industry
Methodical developments	-

**Provide the list for a multiple answer*

8. Revenue generation/recovery

	Yes/No
Presently	No
Future plans	Yes

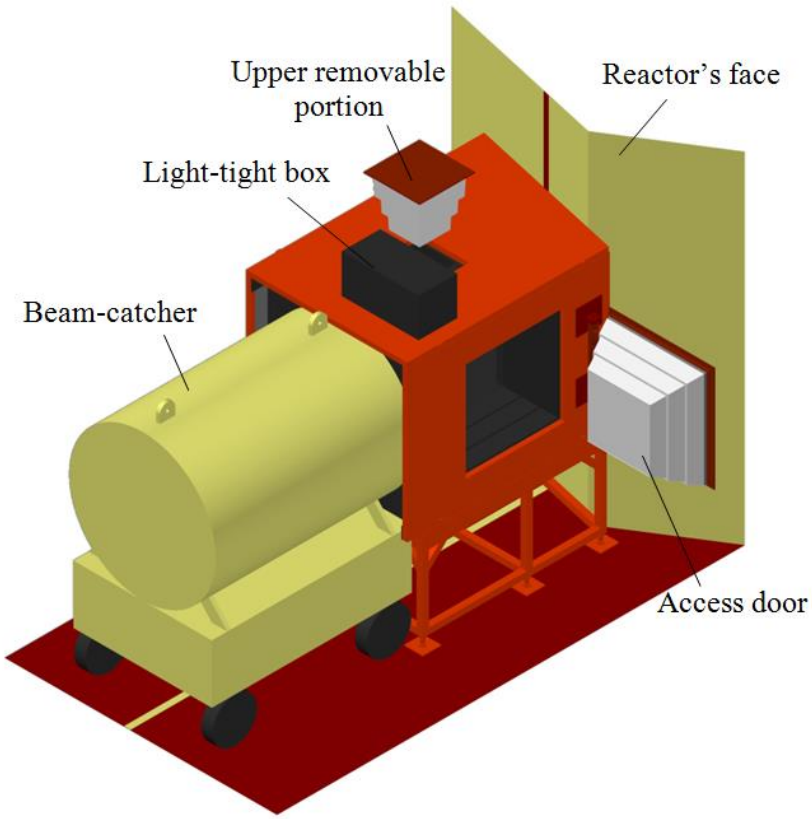
9. Plans for future upgrades

Expected Year	Type of Upgrade
2014	Incorporate a tomographic system

10. Other* relevant information

**E.g. facility-instrumentation photos can be provided on a separate sheet*

Instrumentation:	^{6}LiF/ZnS(Ag) scintillating screen double mirror configuration CCD camera, Pixera 600CLM
Collimation:	double conic collimator
Filtering:	15 cm of sapphire
Useful space:	40 x 40 x 40 cm^3 with two removable portions at top and bottom, for analyzing long objects



Beam facility. Scheme and picture of radiation facility

For additional information please contact N.Pessoa-Barradas@iaea.org and Eberhard.Lehmann@psi.ch.

4. Australia, OPAL, 20 MW

1. General information

Country	Australia
Region, Place/Closest Town	Sydney
Institution	ANSTO
Facility manager (full name, position, phone, e-mail, web)	Ulf Garbe, instrument scientist (DINGO) +61 2 9717 7217 ulg@ansto.gov.au
Type of neutron source	OPAL pool reactor
Source power [MW]	20
Source intensity [n/s or cm^{-2} s^{-1}]	
Availability (hours/year)	6000

2. Beam qualification

Beam line alignment (radial, tangential)	
Neutron spectrum (qualitative: fast, thermal, cold)	
Curved beam guide (monochromator)	
Neutron spectrum at sample position (qualitative: fast, thermal, cold)	
Maximal beam intensity at sample position [cm^{-2} s^{-1}]	
Polarization (yes/no)	
Neutron/gamma ratio (n cm^{-2} per mGy)	
Cd ratio (foil material)	

3. Beam line layout

	Setting 1
Inlet aperture [mm]	
Filter options (e.g. Bi, Be, Si, sapphire,)	
Aperture - detector distance [cm]	
Resulting L/D (measured or estimated)	
Effective beam size [mm]	
Flux uniformity (e.g. flat, gaussian, other)	
Corresponding intensity [cm^{-2} s^{-1}]	

4. Detectors* for neutron imaging

	Availability – yes/no
Film based detector (converter material)	
Digital camera based detector (scintilator material)	
Imaging plate detector	
Amorphous Si flat panel detector	
Other	

**Specification of the individual performance parameters on a separate sheet*

5. Advanced neutron imaging features

	Availability – yes/no
Tomography	
Time sequences	
Grating interferometer	
Energy selection	
Polarizer	
Others	

6. Involved manpower

	Number
Scientists	
Students	
Engineers	
Technicians	

7. Applications*

Research topics	Y
Services for industry	Y
Methodical developments	Y

**Provide the list for a multiple answer*

8. Revenue generation/recovery

	Yes/No
Presently	No
Future plans	Y

For additional information please contact N.Pessoa-Barradas@iaea.org and Eberhard.Lehmann@psi.ch.

9. Plans for future upgrades

Expected Year	Type of Upgrade
2013	Commissioning

10. Other* relevant information

**E.g. facility-instrumentation photos can be provided on a separate sheet*

5. Austria, TRIGA II Vienna, 0.25 MW

1. General information

Country	Austria
Region, Place/Closest Town	Vienna
Institution	Vienna University of Technology
Facility manager (full name, position, phone, e-mail, web)	Ass. Prof. Dr. M. Zawisky +43 1 58801 141470, zawisky@ati.ac.at
Type of neutron source	TRIGA reactor
Source power [MW]	0.25
Source intensity [n/s or $cm^{-2}s^{-1}$]	$7x10^{12}$ cm^{-2} s^{-1}
Availability (hours/year)	1200

2. Beam qualification

Beam line alignment (radial, tangential)	radial
Neutron spectrum (qualitative: fast, thermal, cold)	thermal
Curved beam guide (monochromator)	
Neutron spectrum at sample position (qualitative: fast, thermal, cold)	Maxwellian (thermal)
Maximal beam intensity at sample position [cm^{-2} s^{-1}]	$1.3x10^5$
Polarization (yes/no)	no
Neutron/gamma ratio (n cm^{-2} per mGy)	
Cd ratio (foil material)	

3. Beam line layout

	Setting 1	**Setting 2**
Inlet aperture [mm]	20	
Filter options (e.g. Bi, Be, Si, sapphire,)		
Aperture - detector distance [cm]	270	
Resulting L/D (measured or estimated)	135	
Effective beam size [mm]	90	
Flux uniformity (e.g. flat, gaussian, other)		
Corresponding intensity [cm^{-2} s^{-1}]	$1.3x10^5$	

4. Detectors* for neutron imaging

	Availability – yes/no
Film based detector (converter material)	yes
Digital camera based detector (scintilator material)	yes
Imaging plate detector	yes
Amorphous Si flat panel detector	no
Other	Gas detectors

**Specification of the individual performance parameters on a separate sheet*

5. Advanced neutron imaging features

	Availability – yes/no
Tomography	yes
Time sequences	yes
Grating interferometer	no
Energy selection	no
Polarizer	no
Others	Perfect crystal optics (interferometry, USANS)

6. Involved manpower

	Number
Scientists	1
Students	2
Engineers	-
Technicians	1

7. Applications*

Research topics	Absorber inhomogeneities, hydrogen detection
Services for industry	Investigation of steels, borated materials, fuel cells, building materials
Methodical developments	Systematic study of secondary effects in neutron transmission, beam hardening correction, NR and NT with weak beams

**Provide the list for a multiple answer*

8. Revenue generation/recovery

	Yes/No
Presently	yes
Future plans	yes

9. Plans for future upgrades

Expected Year	Type of Upgrade
2016	Very-thin plate scintillators or NIST detector (?)
	Neutron imaging with mobile Cf-source (?)

10. Other* relevant information

**E.g. facility-instrumentation photos can be provided on a separate sheet*

6. Bangladesh, TRIGA MARK II, 3MW

1. General information

Country	Bangladesh
Region, Place/Closest Town	Dhaka
Institution	Bangladesh Atomic Energy Commission
Facility manager (full name, position, phone, e-mail, web)	Sudipta Saha, SSO, Contact: +8801913467587 E-mail: sudipta.sust@baec.gov.bd
Type of neutron source	BAEC TRIGA Research Reactor (BTRR)
Source power [MW]	3
Source intensity [n/s or cm^{-2} s^{-1}]	5.6×10^{13} cm^{-2} s^{-1}
Availability (hours/year)	750 (average)

2. Beam qualification

Beam line alignment (radial, tangential)	tangential
Neutron spectrum (qualitative: fast, thermal, cold)	thermal
Curved beam guide (monochromator)	
Neutron spectrum at sample position (qualitative: fast, thermal, cold)	-
Maximal beam intensity at sample position [cm^{-2} s^{-1}]	1.06×10^{7}
Polarization (yes/no)	no
Neutron/gamma ratio (n cm^{-2} per mGy)	2.23×10^{6} n cm^{-2} mR^{-1}
Cd ratio (foil material)	10.51

3. Beam line layout

	Setting 1	**Setting 2**
Inlet aperture [mm]	50	
Filter options (e.g. Bi, Be, Si, sapphire,)	Bi	
Aperture - detector distance [cm]	301	
Resulting L/D (measured or estimated)	60	
Effective beam size [mm]	ϕ300	
Flux uniformity (e.g. flat, gaussian, other)	Divergent Beam	
Corresponding intensity [cm^{-2} s^{-1}]	1.32×10^{7}	

4. Detectors* for neutron imaging

	Availability – yes/no
Film based detector (converter material)	yes
Digital camera based detector (scintilator material)	Yes (on test)
Imaging plate detector	no
Amorphous Si flat panel detector	no
Other	no

**Specification of the individual performance parameters on a separate sheet*

5. Advanced neutron imaging features

	Availability – yes/no
Tomography	No
Time sequences	No
Grating interferometer	No
Energy selection	No
Polarizer	No
Others	No

6. Involved manpower

	Number
Scientists	2
Students	2
Engineers	-
Technicians	1

7. Applications*

Research topics	Non-destructive testing to study the internal defects and water absorption behaviour of different kind of objects
Services for industry	R & D collaboration with other industry/organization
Methodical developments	no

**Provide the list for a multiple answer*

8. Revenue generation/recovery

	Yes/No
Presently	**no**
Future plans	**yes**

9. Plans for future upgrades

Expected Year	Type of Upgrade
2015	Neutron beam shutter automation system

10. Other* relevant information

**E.g. facility-instrumentation photos can be provided on a separate sheet*

7. Belgium, BR1, 4 MW

1. General information

Country	Belgium
Region, Place/Closest Town	Mol
Institution	SCK•CEN
Facility manager (full name, position, phone, e-mail, web)	Guido Vittiglio, 0032/14.33.21.95, gvittigl@sckcen.be Bart Van Houdt, 0032/14.33.22.58, bvhoudt@sckcen.be SCK•CEN, BR1 facility, Boeretang 200, 2400 Mol, Belgium www.sckcen.be
Type of neutron source	Research Reactor BR1
Source power [MW]	0.7
Source intensity [n/s or cm^{-2} s^{-1}]	2 x 10 ^{12} cm^{-2} s^{-1}
Availability (hours/year)	800 hours (the reactor, not the NIF)

2. Beam qualification

Beam line alignment (radial, tangential)	tangential
Neutron spectrum (qualitative: fast, thermal, cold)	thermal
Curved beam guide (monochromator)	
Neutron spectrum at sample position (qualitative: fast, thermal, cold)	0.04 eV
Maximal beam intensity at sample position [cm^{-2} s^{-1}]	4.2 x 10^5
Polarization (yes/no)	No
Neutron/gamma ratio (n cm^{-2} per mGy)	
Cd ratio (foil material)	

3. Beam line layout

	Setting 1	**Setting 2**
Inlet aperture [mm]	30	
Filter options (e.g. Bi, Be, Si, sapphire,)		
Aperture - detector distance [cm]	225	
Resulting L/D (measured or estimated)	75	
Effective beam size [mm]	200	
Flux uniformity (e.g. flat, gaussian, other)		
Corresponding intensity [cm^{-2} s^{-1}]	4.2 x 10^5	

4. Detectors* for neutron imaging

	Availability – yes/no
Film based detector (converter material)	Yes, Structurix D4 or Curix Ultra UV6 (Agfa)
Digital camera based detector (scintilator material)	No
Imaging plate detector	No
Amorphous Si flat panel detector	No
Other	No

**Specification of the individual performance parameters on a separate sheet*

5. Advanced neutron imaging features

	Availability – yes/no
Tomography	No
Time sequences	No
Grating interferometer	No
Energy selection	No
Polarizer	No
Others	No

6. Involved manpower

	Number
Scientists	
Students	
Engineers	1
Technicians	1

7. Applications*

Research topics	Occasional internal use
Services for industry	No
Methodical developments	No

**Provide the list for a multiple answer*

8. Revenue generation/recovery

	Yes/No
Presently	No
Future plans	No

9. Plans for future upgrades

Expected Year	Type of Upgrade
	No

10. Other* relevant information

**E.g. facility-instrumentation photos can be provided on a separate sheet*

For additional information please contact N.Pessoa-Barradas@iaea.org and Eberhard.Lehmann@psi.ch.

NIF at channel X25 of the BR1 reactor

Al cassette with film and Gd cover

8. Brazil, Argonauta, 0 MW

1. General information

Country	Brazil, Federative Republic of
Region, Place/Closest Town	Rio de Janeiro
Institution	Instituto de Engenharia Nuclear
Facility manager (full name, position, phone, e-mail, web)	Carlos Alberto Curi Renke Phone: 55 21 2173 3885 e-mail: renke@ien.gov.br web address: www.ien.gov.br
Type of neutron source	Facility: ARGONAUTA, BR-0003 Type: Argonaut reactor
Source power [MW]	0.0002
Source intensity [n/s or $cm^{-2}s^{-1}$]	4.4E09 $cm^{-2}s^{-1}$ (maximum thermal flux)
Availability (hours/year)	310:00 hs (2010)

2. Beam qualification

Beam line alignment (radial, tangential)	radial
Neutron spectrum (qualitative: fast, thermal, cold)	thermal
Curved beam guide (monochromator)	
Neutron spectrum at sample position (qualitative: fast, thermal, cold)	0.025 eV
Maximal beam intensity at sample position [cm^{-2} s^{-1}]	4.46E05
Polarization (yes/no)	no
Neutron/gamma ratio (n cm^{-2} per mGy)	
Cd ratio (foil material)	

3. Beam line layout

	Setting 1	**Setting 2**
Inlet aperture [mm]	4 cm	
Filter options (e.g. Bi, Be, Si, sapphire,)		
Aperture - detector distance [cm]	253 cm	
Resulting L/D (measured or estimated)	63.25	
Effective beam size [mm]	10 mm x 10 mm	
Flux uniformity (e.g. flat, gaussian, other)		
Corresponding intensity [cm^{-2} s^{-1}]	4.46 E05	

4. Detectors* for neutron imaging

	Availability – yes/no
Film based detector (converter material)	yes
Digital camera based detector (scintilator material)	yes
Imaging plate detector	yes
Amorphous Si flat panel detector	no
Other	no

**Specification of the individual performance parameters on a separate sheet*

5. Advanced neutron imaging features

	Availability – yes/no
Tomography	yes
Time sequences	
Grating interferometer	
Energy selection	
Polarizer	
Others	

6. Involved manpower

	Number
Scientists	5
Students	1
Engineers	2
Technicians	3

7. Applications*

Research topics	see list
Services for industry	
Methodical developments	

**Provide the list for a multiple answer*

8. Revenue generation/recovery

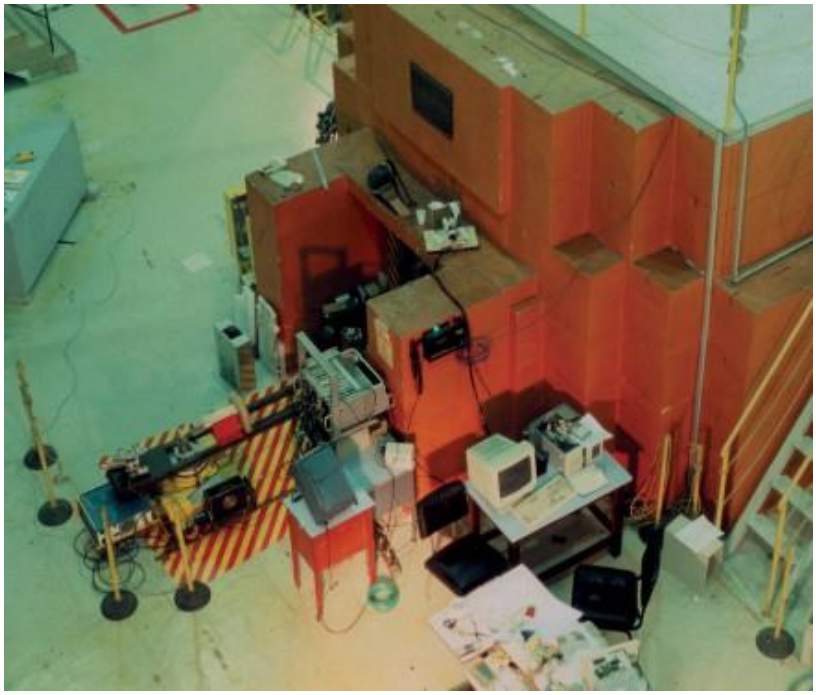
	Yes/No
Presently	no
Future plans	yes

9. Plans for future upgrades

Expected Year	Type of Upgrade
systems with X ray	deploy a system using x ray tubes

10. Other* relevant information

**E.g. facility-instrumentation photos can be provided on a separate sheet*



Argonauta Reactor

Applications

Research Topics:

Develop and apply nuclear techniques to the Argonauta reactor:

- Deploy and optimize image acquisition systems with thermal neutron in real time for analysis and non-destructive testing of dynamic systems
- Develop image acquisition systems with X ray using scintillators screens and imaging plate
- Develop and apply algorithms and software for the acquisition and processing of images – radiographic and tomographic.
- Develop image acquisition systems – radiographic and tomographic -with gamma rays, employing reactor produced radioisotopes

9. Brazil, IAE-R1, 5 MW

1. General information

Country	Brazil
Region, Place/Closest Town	Sao Paulo
Institution	Instituto de Pesquisas Energeticas e Nucleares
Facility manager (full name, position, phone, e-mail, web)	Reynaldo Pugliesi, Researcher, phone +55 11 31339993, pugliesi@ipen.br
Type of neutron source	Research Nuclear Reactor – IEA-R1 research reactor
Source power [MW]	5
Source intensity [n/s or $cm^{-2}s^{-1}$]	10^{13} $cm^{-2}s^{-1}$in the core
Availability (hours/year)	24 h/day, 3 days a week

2. Beam qualification

Beam line alignment (radial, tangential)	Radial
Neutron spectrum (qualitative: fast, thermal, cold)	Thermal/cold
Curved beam guide (monochromator)	
Neutron spectrum at sample position (qualitative: fast, thermal, cold)	7 meV
Maximal beam intensity at sample position [cm^{-2} s^{-1}]	5.10^{6}
Polarization (yes/no)	No
Neutron/gamma ratio (n cm^{-2} per mGy)	
Cd ratio (Au method)	~5

3. Beam line layout

	Setting 1	Setting 2
Inlet aperture [mm]	100	
Filter options (e.g. Bi, Be, Si, sapphire,)	Bi	
Aperture - detector distance [cm]	300	
Resulting L/D (measured or estimated)	~90	
Effective beam size [mm]	Diam. Max. 130	
Flux uniformity (e.g. flat, gaussian, other)		
Corresponding intensity [cm^{-2} s^{-1}]		

4. Detectors* for neutron imaging

	Availability – yes/no
Film based detector (converter material)	Yes
Digital camera based detector (scintilator material)	Yes
Imaging plate detector	No
Amorphous Si flat panel detector	No
Other	Track etch foils

**Specification of the individual performance parameters on a separate sheet*

5. Advanced neutron imaging features

	Availability – yes/no
Tomography	Yes
Time sequences	Yes
Grating interferometer	No
Energy selection	No
Polarizer	No
Others	Beam limiters and filters

6. Involved manpower

	Number
Scientists	2
Students	2
Engineers	1
Technicians	

7. Applications*

Research topics	Archeology, anthropology, engineering, aerospace, medicine
Services for industry	
Methodical developments	Research and development of tomography

**Provide the list for a multiple answer*

8. Revenue generation/recovery

	Yes/No
Presently	Probably
Future plans	Search for new applications and parallel beam

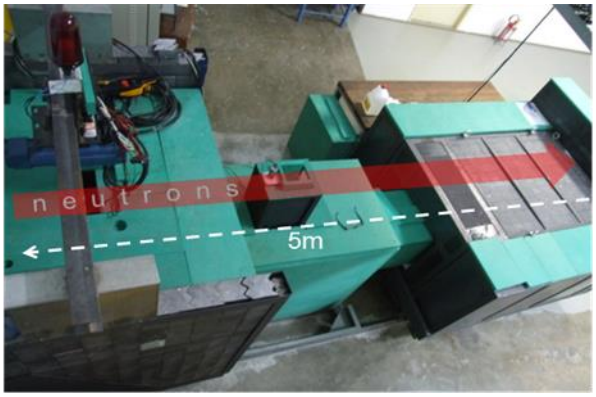
9. Plans for future upgrades

Expected Year	Type of Upgrade
2013	Improve the new facility

10. Other* relevant information

**E.g. facility-instrumentation photos can be provided on a separate sheet*

For additional information please contact N.Pessoa-Barradas@iaea.org and Eberhard.Lehmann@psi.ch.



Top view of the new tomography facility

10. Canada, MNR McMaster Univ., 5MW

11. General information

Country	Canada
Region, Place/Closest Town	Ontario, Hamilton
Institution	Nray Services Inc. (McMaster Nuclear Reactor)
Facility manager (full name, position, phone, e-mail, web)	Rankin MacGillivray, President, 905-627-1302, rankinm@nray.ca, www.nray.ca
Type of neutron source	5MW Material Test Reactor (MTR)
Source power [MW]	5MW (typically operated at 3MW)
Source intensity [n/s or cm^{-2} s^{-1}]	~1 $\times 10^{14}$
Availability (hours/year)	3500h/year

12. Beam qualification

Beam line alignment (radial, tangential)	Radial
Neutron spectrum (qualitative: fast, thermal, cold)	Thermal
Curved beam guide (monochromator)	
Neutron spectrum at sample position (qualitative: fast, thermal, cold)	
Maximal beam intensity at sample position [cm^{-2} s^{-1}]	3.9×10^6 (at 3MW)
Polarization (yes/no)	No
Neutron/gamma ratio (n cm^{-2} per mGy)	
Cd ratio (foil material)	BP1 = 2.95 (Au) BP2 = 3.55(Au)

13. Beam line layout

	Beam Port 1	Beam Port 2
Inlet aperture [mm]	26.5	
Filter options (e.g. Bi, Be, Si, sapphire,)	Polycrystalline Bismuth (gamma filter), sapphire	Polycrystalline Bismuth (gamma filter)
Aperture - detector distance [cm]	194	
Resulting L/D (measured or estimated)	208 (measured)	147 (measured)
Effective beam size [mm]	360mmx440mm	360mmx440mm
Flux uniformity (e.g. flat, gaussian, other)		
Corresponding intensity [cm^{-2} s^{-1}]	$3.4x10^6$	$3.9x10^6$

14. Detectors* for neutron imaging

	Availability – yes/no
Film based detector (converter material)	Yes (Gd conversion screen)
Digital camera based detector (scintilator material)	No
Imaging plate detector	No
Amorphous Si flat panel detector	No
Other	No

**Specification of the individual performance parameters on a separate sheet*

15. Advanced neutron imaging features

	Availability – yes/no
Tomography	No
Time sequences	No
Grating interferometer	No
Energy selection	No
Polarizer	No
Others	No

16. Involved manpower

	Number
Scientists	0
Students	0
Engineers	1
Technicians	12

17. Applications*

Research topics	
Services for industry	Turbine Blades and jet engine component inspection
Methodical developments	Standardization (ASTM)

**Provide the list for a multiple answer*

18. Revenue generation/recovery

	Yes/No
Presently	YES
Future plans	YES

19. Plans for future upgrades

Expected Year	Type of Upgrade

20. Other* relevant information

**E.g. facility-instrumentation photos can be provided on a separate sheet*

11. China, CARR, 60MW

1. General information

Country	China
Region, Place/Closest Town	Xinzhen Town, Fangshan Distr., Beijing
Institution	China Institute of Atomic Energy
Facility manager (full name, position, phone, e-mail, web)	Dongfeng CHEN, Leader of the Department of Nuclear Physics of CIAE, 86-10-69358015, dongfeng@ciae.ac.cn, www.ciae.ac.cn
Type of neutron source	Reactor
Source power [MW]	60
Source intensity [n/s or cm^{-2} s^{-1}]	8×10^{14}
Availability (hours/year)	

2. Beam qualification

Beam line alignment (radial, tangential)	Tangential
Neutron spectrum (qualitative: fast, thermal, cold)	thermal, cold
Curved beam guide (monochromator)	Yes
Neutron spectrum at sample position (qualitative: fast, thermal, cold)	thermal, cold
Maximal beam intensity at sample position [cm^{-2} s^{-1}]	thermal 2.93×10^{8}; cold 7.67×10^{7}(design)
Polarization (yes/no)	No
Neutron/gamma ratio (n cm^{-2} per mGy)	
Cd ratio (foil material)	5.26

3. Beam line layout (Thermal)

	Setting 1	**Setting 2**	**Setting 3**	**Setting 4**	**Setting 5**
Inlet aperture [mm]	6	4	2	1	0.5
Filter options (e.g. Bi, Be, Si, sapphire,)	MgO+Bi				
Aperture - detector distance [cm]	1050	1000	1000	1000	1000
Resulting L/D (measured or estimated)	175	250	500	1000	2000
Effective beam size [mm]	6.7×22	8×24.8	14.8×31.6	18.2×35.1	20×36.7
Flux uniformity (e.g. flat, gaussian, other)	flat	flat	flat	flat	flat
Corresponding	6.6×10^{8}	2.9×10^{8}	7.4×10^{7}	1.8×10^{7}	4.6×10^{6}

intensity [cm^{-2} s^{-1}]					

4. Detectors* for neutron imaging

	Availability – yes/no
Film based detector (converter material)	Yes
Digital camera based detector (scintilator material)	Yes
Imaging plate detector	Yes
Amorphous Si flat panel detector	No
Other	No

**Specification of the individual performance parameters on a separate sheet*

5. Advanced neutron imaging features

	Availability – yes/no
Tomography	Yes
Time sequences	Yes
Grating interferometer	No
Energy selection	Yes
Polarizer	No
Others	No

6. Involved manpower

	Number
Scientists	5
Students	1
Engineers	1
Technicians	2

7. Applications*

Research topics	
Services for industry	Nuclear Industry, Aerospace, Fuel Cell，Two phase flow
Methodical developments	Scintillator, real-time tomography

**Provide the list for a multiple answer*

8. Revenue generation/recovery

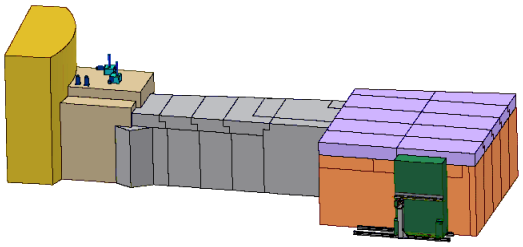
	Yes/No
Presently	No
Future plans	Yes

9. Plans for future upgrades

Expected Year	Type of Upgrade
2014-2017	Under construction

10. Other* relevant information

**E.g. facility-instrumentation photos can be provided on a separate sheet*



Thermal Neutron Imaging Facility at CARR (Under Construction)

Cold Neutron Imaging Facility at CARR (Under Construction)

12. China, Sichuan RR, 20MW

1. General information

Country	China
Region, Place/Closest Town	Sichuan
Institution	INSTITUTE OF NUCLEAR PHYSICS AND CHEMISTRY, CHINA ACADEMY OF ENGINEERING PHYSICS
Facility manager (full name, position, phone, e-mail, web)	Bin Tang, Director, 0086 0816-2492596, Tangbin_e@163.com
Type of neutron source	Reactor
Source power [MW]	20
Source intensity [n/s]	2.4×10^{14}(Thermal neutron)
Availability (hours/year)	2000

2. Beam qualification

Beam line alignment (radial, tangential)	Tangential
Neutron spectrum (qualitative: fast, thermal, cold)	Thermal/Cold
Neutron spectrum (mean energy)	0.025eV(thermal)/2.6Å(cold)
Maximal beam intensity at sample position [cm^{-2} s^{-1}]	8×10^{7}(thermal)/ 8×10^{6}(cold)
Polarization (yes/no)	no

3. Beam line layout

	Setting 1	Setting 2	Setting 3	Setting 4	Setting 5
Inlet aperture [mm]	4~150	1~40			
Aperture - detector distance [cm]	800	1500			
Resulting L/D	200~2000	>400			

Effective beam size [mm]	230*230	200*200			
Corresponding intensity [cm^{-2} s^{-1}]	8×10^{7}	8×10^{6}			

4. Detectors* for neutron imaging

	Availability – yes/no
Film based detector	yes
CCD-camera based detector	yes
Imaging plate detector	yes
Amorphous Si flat panel detector	no
Others	no

**Specification of the individual performance parameters on a separate sheet*

	parameters
Film based detector	Gd screen/^{6}LiZnS(Ag)screen + Kodak film
CCD-camera based detector	^{6}LiZnS(Ag)screen + CCD camera (2048×2048pixels)
Imaging plate detector	FUJI imaging plate (20×25cm/20×40cm)

5. Advanced neutron imaging features

	Availability – yes/no
Tomography	yes
Time sequences	no
Grating interferometer	no
Energy selection	no
Polarizer	no
Others	no

6. Involved manpower

	Number
Scientists	8
Students	
Engineers	1
Technicians	1

7. Applications*

Research topics	Aerial/industrial products NDT; neutron imaging method
Industrial projects	Turbine blade residua detection
Methodical developments	Polarized neutron imaging, neutron holographic imaging, neutron resonance imaging, MCP, coded neutron imaging

**Provide the list for a multiple answer*

8. Commercial activities

	Yes/No
Presently	no
Future plans	yes

9. Plans for future upgrades

Expected Year	Type of Upgrade
2020	Polarized neutron imaging instrument
2022	Energy selection neutron imaging

10. Other* relevant information

**E.g. facility-instrumentation photos can be provided on a separate sheet*

Cold neutron imaging facility

For additional information please contact N.Pessoa-Barradas@iaea.org and Eberhard.Lehmann@psi.ch.

For additional information please contact N.Pessoa-Barradas@iaea.org and Eberhard.Lehmann@psi.ch.

13. China, Peking University AMS Laboratory, 4.5 MeV deuterons on Be and D

1. General information

Country	China
Region, Place/Closest Town	Beijing
Institution	Peking University
Facility manager (full name, position, phone, e-mail, web)	Zhiyu Guo, Professor, Tel: +86-10-6275 5495, Fax: +86-10-6275 1875, Email: zhyguo@pku.edu.cn
Type of neutron source	Based on a 4.5 MV Van de Graaff, d-Be and d-D
Source power [MW]	
Source intensity [n/s]	~1×10^{10} for d+Be (fast white-spectrum); ~5×10^{8} for d+D (mono energetic)
Availability (hours/year)	300

2. Beam qualification

Beam line alignment (radial, tangential)	Radial
Neutron spectrum (qualitative: fast, thermal, cold)	Thermal and fast
Neutron spectrum (mean energy)	Thermal: 0.025 eV; fast: 2-3 MeV varied with projectile energy for d+Be
Maximal beam intensity at sample position [cm^{-2} s^{-1}]	Thermal: 5×10^{3}; Fast: 1×10^{5}
Polarization (yes/no)	No

3. Beam line layout

	Thermal	**fast**	**Setting 3**	**Setting 4**
Inlet aperture [mm]	30	3 (Target spot)		
Aperture - detector distance [cm]	60	100		
Resulting L/D	20	330		
Effective beam size [mm]	120 × 170*	200 × 200		
Corresponding intensity [cm^{-2} s^{-1}]	5×10^{3}	1×10^{5}		

*** limited by scintillator screen**

4. Detectors* for neutron imaging

	Availability – yes/no
Film based detector	No
CCD-camera based detector	Yes
Imaging plate detector	No
Amorphous Si flat panel detector	No
Others	

**Specification of the individual performance parameters on a separate sheet*

5. Advanced neutron imaging features

	Availability – yes/no
Tomography	No
Time sequences	No
Grating interferometer	No
Energy selection	Yes (fast n with d-D)
Polarizer	No
Others	

6. Involved manpower

	Number
Scientists	2
Students	4
Engineers	1
Technicians	0

7. Applications*

Research topics	Study for the design of future RFQ based NR facility
Industrial projects	
Methodical developments	NDT for materials

**Provide the list for a multiple answer*

8. Commercial activities

	Yes/No
Presently	No
Future plans	Yes (with future RFQ based NR facility)

9. Plans for future upgrades

Expected Year	Type of Upgrade
2012	RFQ based NR facility

10. Other* relevant information

**E.g. facility-instrumentation photos can be provided on a separate sheet*

14. China, Sichuan Reactor, 20MW

1. General information

Country	China
Region, Place/Closest Town	Sichuan
Institution	INSTITUTE OF NUCLEAR PHYSICS AND CHEMISTRY, CHINA ACADEMY OF ENGINEERING PHYSICS
Facility manager (full name, position, phone, e-mail, web)	Bin Tang, Director, 0086 0816-2492596, Tangbin_e@163.com
Type of neutron source	Reactor
Source power [MW]	20
Source intensity [n/s/cm^2]	2.4×10^{14} (Thermal neutron)
Availability (hours/year)	2000

2. Beam qualification

Beam line alignment (radial, tangential)	Tangential
Neutron spectrum (qualitative: fast, thermal, cold)	Thermal/Cold
Neutron spectrum (mean energy)	0.025eV(thermal)/2.6Å(cold)
Maximal beam intensity at sample position [cm^{-2} s^{-1}]	8×10^7(thermal)/ 8×10^6(cold)
Polarization (yes/no)	no

3. Beam line layout

	Setting 1	**Setting 2**	**Setting 3**	**Setting 4**	**Setting 5**
Inlet aperture [mm]	4~150	1~40			
Aperture - detector distance [cm]	800	1500			
Resulting L/D	200~2000	>400			
Effective beam size [mm]	230*230	200*200			
Corresponding intensity [cm^{-2} s^{-1}]	8×10^7	8×10^6			

4. Detectors* for neutron imaging

	Availability – yes/no
Film based detector	yes
CCD-camera based detector	yes
Imaging plate detector	yes
Amorphous Si flat panel detector	no
Others	no

**Specification of the individual performance parameters on a separate sheet*

	parameters
Film based detector	Gd screen/^{6}LiZnS(Ag)screen + Kodak film
CCD-camera based detector	^{6}LiZnS(Ag)screen + CCD camera (2048×2048pixels)
Imaging plate detector	FUJI imaging plate (20×25cm/20×40cm)

5. Advanced neutron imaging features

	Availability – yes/no
Tomography	yes
Time sequences	no
Grating interferometer	no
Energy selection	no
Polarizer	no
Others	no

6. Involved manpower

	Number
Scientists	8
Students	
Engineers	1
Technicians	1

7. Applications*

Research topics	Aerial/industrial products NDT; neutron imaging method
Industrial projects	Turbine blade residua detection
Methodical developments	Polarized neutron imaging, neutron holographic imaging, neutron resonance imaging, MCP, coded neutron imaging

**Provide the list for a multiple answer*

8. Commercial activities

	Yes/No
Presently	no
Future plans	yes

9. Plans for future upgrades

Expected Year	Type of Upgrade
2020	Polarized neutron imaging instrument
2022	Energy selection neutron imaging

10. Other* relevant information

**E.g. facility-instrumentation photos can be provided on a separate sheet*

Cold neutron imaging facility

15. Czech Republic, LVR-15, 10MW, HK1

1. General information

Country	The Czech Republic
Region, Place/Closest Town	Rez near Prague
Institution	Research Centre Řež
Facility manager (full name, position, phone, e-mail, web)	Jaroslav Šoltés, http://cvrez.cz/en/commercial-services/irradiation-services/neutronova-radiografie/
Type of neutron source	Research reactor LVR-15
Source power [MW]	10 MW
Source intensity [n/s or cm^{-2} s^{-1}]	10^{14} $cm^{-2}s^{-1}$
Availability (hours/year)	About 700 hours/year

2. Beam qualification

Beam line alignment (radial, tangential)	radial
Neutron spectrum (qualitative: fast, thermal, cold)	thermal
Curved beam guide (monochromator)	no
Neutron spectrum at sample position (qualitative: fast, thermal, cold)	thermal
Maximal beam intensity at sample position [cm^{-2} s^{-1}]	$5x10^7$
Polarization (yes/no)	no
Neutron/gamma ratio (n cm^{-2} per mGy)	10^9 cm^{-2}/mGy
Cd ratio (foil material)	300 (Au)

3. Beam line layout

	Setting 1	**Setting 2**
Inlet aperture [mm]	50	
Filter options (e.g. Bi, Be, Si, sapphire,)	Si	
Aperture - detector distance [cm]	350	
Resulting L/D (measured or estimated)	70	
Effective beam size [mm]	100	
Flux uniformity (e.g. flat, gaussian, other)	flat	
Corresponding intensity [cm^{-2} s^{-1}]	$5x10^7$	

4. Detectors* for neutron imaging

	Availability – yes/no
Film based detector (converter material)	Yes (Li)
Digital camera based detector (scintilator material)	no
Imaging plate detector	yes
Amorphous Si flat panel detector	no
Other	Medipix pixel detector with ^{6}Li converter

**Specification of the individual performance parameters on a separate sheet*

5. Advanced neutron imaging features

	Availability – yes/no
Tomography	yes
Time sequences	yes
Grating interferometer	no
Energy selection	no
Polarizer	no
Others	

6. Involved manpower

	Number
Scientists	2
Students	0
Engineers	0
Technicians	2

7. Applications*

Research topics	yes
Services for industry	yes
Methodical developments	

**Provide the list for a multiple answer*

8. Revenue generation/recovery

	Yes/No
Presently	yes
Future plans	yes

9. Plans for future upgrades

Expected Year	Type of Upgrade
2019	L/D increasing
2020	New detector

10. Other relevant information

For additional information please contact N.Pessoa-Barradas@iaea.org and Eberhard.Lehmann@psi.ch.

16. Czech Republic, LVR-15, 10MW, HK3

1. General information

Country	The Czech Republic
Region, Place/Closest Town	Rez near Prague
Institution	NPI AS ČR
Facility manager (full name, position, phone, e-mail, web)	Tomandl Ivo, tomandl@ujf.cas.cz
Type of neutron source	Research reactor LWR15
Source power [MW]	10 MW
Source intensity [n/s or cm^{-2} s^{-1}]	10^{14} n cm-2s-1
Availability (hours/year)	About 700 hours/year

2. Beam qualification

Beam line alignment (radial, tangential)	radial
Neutron spectrum (qualitative: fast, thermal, cold)	thermal
Curved beam guide (monochromator)	mirror neutronguide
Neutron spectrum at sample position (qualitative: fast, thermal, cold)	thermal
Maximal beam intensity at sample position [cm^{-2} s^{-1}]	1x 10^{7}
Polarization (yes/no)	no
Neutron/gamma ratio (n cm^{-2} per mGy)	
Cd ratio (foil material)	10^{5}

3. Beam line layout

	Setting 1	**Setting 2**
Inlet aperture [mm]		
Filter options (e.g. Bi, Be, Si, sapphire,)		
Aperture - detector distance [cm]	40	
Resulting L/D (measured or estimated)		
Effective beam size [mm]	6 x 15	
Flux uniformity (e.g. flat, gaussian, other)	flat	
Corresponding intensity [cm^{-2} s^{-1}]	10^{7}	

4. Detectors* for neutron imaging

	Availability – yes/no
Film based detector (converter material)	
Digital camera based detector (scintilator material)	
Imaging plate detector	
Amorphous Si flat panel detector	
Other	Medipix pixel detector with ^{6}Li converter

**Specification of the individual performance parameters on a separate sheet*

5. Advanced neutron imaging features

	Availability – yes/no
Tomography	yes
Time sequences	
Grating interferometer	
Energy selection	
Polarizer	
Others	

6. Involved manpower

	Number
Scientists	2
Students	
Engineers	
Technicians	1

7. Applications*

Research topics	4.
Services for industry	
Methodical developments	

**Provide the list for a multiple answer*

8. Revenue generation/recovery

	Yes/No
Presently	NO
Future plans	YES

9. Plans for future upgrades

Expected Year	Type of Upgrade
2018	new supermirror neutronguide

10. Other relevant information

17. Egypt, ETRR-2, 22 MW

1. General information

Country	Egypt
Region, Place/Closest Town	Abou-Zabal
Institution	Egypt Second Research Reactor (ETRR-2),Egyptian Atomic Energy Authority
Facility manager (full name, position, phone, e-mail, web)	T. Mongy, Facility manager, tmongy@gmail.com Tel: 002 01112247942
Type of neutron source	Research reactor
Source power [MW]	22
Source intensity [n/s or $cm^{-2}s^{-1}$]	$1.2*10^{14}$ $cm^{-2}s^{-1}$
Availability (hours/year)	On request

2. Beam qualification

Beam line alignment (radial, tangential)	Radial
Neutron spectrum (qualitative: fast, thermal, cold)	Fast neutrons ~ 10^8 n/cm^2.sec. Epi-thermal neutrons ~ 10^8 n/cm^2.sec. Thermal neutrons ~ 10^7 n/cm^2.sec.
Curved beam guide (monochromator)	
Neutron spectrum at sample position (qualitative: fast, thermal, cold)	Fast neutrons ~ 10^8 n/cm^2.sec. Epi-thermal neutrons ~ 10^8 n/cm^2.sec. Thermal neutrons ~ 10^7 n/cm^2.sec.
Maximal beam intensity at sample position [cm^{-2} s^{-1}]	Thermal neutrons ~ $1.5*10^7$ n/cm^2.sec.
Polarization (yes/no)	No
Neutron/gamma ratio (n cm^{-2} per mGy)	
Cd ratio (foil material)	10

3. Beam line layout

	Setting 1	Setting 2
Inlet aperture [mm]	3	
Filter options (e.g. Bi, Be, Si, sapphire,)		
Aperture - detector distance [cm]	30	
Resulting L/D (measured or estimated)	117	
Effective beam size [mm]	20	
Flux uniformity (e.g. flat, gaussian, other)	cosine	
Corresponding intensity [cm^{-2} s^{-1}]	~ 10^7 thermal neutrons	

4. Detectors* for neutron imaging

	Availability – yes/no
Film based detector (converter material)	Yes
Digital camera based detector (scintilator material)	Yes
Imaging plate detector	No
Amorphous Si flat panel detector	No
Other	

**Specification of the individual performance parameters on a separate sheet*

5. Advanced neutron imaging features

	Availability – yes/no
Tomography	Yes
Time sequences	Yes
Grating interferometer	No
Energy selection	No
Polarizer	No
Others	No

6. Involved manpower

	Number
Scientists	0
Students	3
Engineers	4
Technicians	1

7. Applications*

Research topics	Main object
Services for industry	Available
Methodical developments	Yes

**Provide the list for a multiple answer*

8. Revenue generation/recovery

	Yes/No
Presently	Yes
Future plans	Yes

9. Plans for future upgrades

Expected Year	Type of Upgrade
2014	Facility resolution enhancement
2015	Commerce the facility

10. Other* relevant information

**E.g. facility-instrumentation photos can be provided on a separate sheet*

18. France, ORPHEE, 14MW

1. General information

Country	FRANCE
Region, Place/Closest Town	PARIS
Institution	CEA/CNRS
Facility manager (full name, position, phone, e-mail, web)	Frédéric OTT, 33 1 69 08 61 21 Frederic.Ott@cea.fr
Type of neutron source	ORPHEE nuclear reactor
Source power [MW]	14
Source intensity [cm^{-2} s^{-1}]	Thermal flux 3E14
Availability (hours/year)	3000

2. Beam qualification

Beam line alignment (radial, tangential)	Cold neutron beam guide
Neutron spectrum (qualitative: fast, thermal, cold)	Cold spectrum (3A° - 20A°)
Curved beam guide (monochromator)	
Neutron spectrum at sample position (qualitative: fast, thermal, cold)	Peak flux at 4A°
Maximal beam intensity at sample position [cm^{-2} s^{-1}]	2E7
Polarization (yes/no)	Yes
Neutron/gamma ratio (n cm^{-2} per mGy)	
Cd ratio (foil material)	

3. Beam line layout

	Setting 1	**Setting 2**	**Setting 3**	**Setting 4**	**Setting 5**
Inlet aperture [mm]	6-25mm				
Filter options (e.g. Bi, Be, Si, sapphire,)	no				
Aperture - detector distance [cm]	Typ. 4m (up to 7m)				
Resulting L/D (measured or estimated)	**250-500**				
Effective beam size [mm]	80x80mm² (at 4m)				
Flux uniformity (e.g. flat, gaussian, other)	15% inhomogeneity over 80mm				
Corresponding intensity [cm^{-2} s^{-1}]	2E7 n/cm²/s				

4. Detectors* for neutron imaging

	Availability – yes/no
Film based detector (converter material)	
Digital camera based detector (scintilator material)	LiF or Gadox scintillator ANDOR NEO camera
Imaging plate detector	FUJI image plate (500x200mm²)
Amorphous Si flat panel detector	
Other	

**Specification of the individual performance parameters on a separate sheet*

5. Advanced neutron imaging features

	Availability – yes/no
Tomography	Yes
Time sequences	Yes
Grating interferometer	No
Energy selection	Yes (velocity selector)
Polarizer	Yes
Others	

6. Involved manpower

	Number
Scientists	1
Students	1
Engineers	1/2
Technicians	1

7. Applications*

Research topics	Food science, geoscience, metallurgy, magnetism
Services for industry	**Occasional**
Methodical developments	

**Provide the list for a multiple answer*

8. Revenue generation/recovery

	Yes/No
Presently	Yes
Future plans	Yes

9. Plans for future upgrades

Expected Year	Type of Upgrade
2016	Microchannel plate detector
2016	Crystal monochromator

10. Other* relevant information

**E.g. facility-instrumentation photos can be provided on a separate sheet*

For additional information please contact N.Pessoa-Barradas@iaea.org **and** Eberhard.Lehmann@psi.ch.

19. Germany, BER II, 10 MW (CONRAD Instrument)

1. General information

Country	Germany
Region, Place/Closest Town	Berlin
Institution	
Facility manager (full name, position, phone, e-mail, web)	Nikolay Kardjilov, instrument responsible, phone: ++4930806242298, email: Kardjilov@helmholtz-berlin.de, https://www.helmholtz-berlin.de/user/neutrons/instrumentation/neutron-instruments/v7/index_en.html
Type of neutron source	Pool type research reactor
Source power [MW]	10
Source intensity [n/s or cm^{-2} s^{-1}]	
Availability (hours/year)	Approximately 5760 h / year (240 days)

2. Beam qualification

Beam line alignment (radial, tangential)	Neutron guide
Neutron spectrum (qualitative: fast, thermal, cold)	Cold spectrum
Curved beam guide (monochromator)	
Neutron spectrum at sample position (qualitative: fast, thermal, cold)	3.1 Å (8.5 meV)
Maximal beam intensity at sample position [cm^{-2} s^{-1}]	2.0×10^8
Polarization (yes/no)	yes
Neutron/gamma ratio (n cm^{-2} per mGy)	
Cd ratio (foil material)	

3. Beam line layout

	Setting 1	**Setting 2**	**Setting 3**	**Setting 4**	**Setting 5**
Inlet aperture [mm]	10	20	30	-	
Filter options (e.g. Bi, Be, Si, sapphire,)					
Aperture - detector distance [cm]	500	500	500	0 Guide end	
Resulting L/D (measured or estimated)	500	250	167	70	
Effective beam size [mm]	100x100	110x110	120x120	30x120	
Flux uniformity (e.g. flat, gaussian, other)					
Corresponding intensity [cm^{-2} s^{-1}]	5.8×10^6	1.6×10^7	2.4×10^7	2.0×10^8	

4. Detectors* for neutron imaging

	Availability – yes/no
Film based detector (converter material)	**no**
Digital camera based detector (scintilator material)	**yes**
Imaging plate detector	**yes**
Amorphous Si flat panel detector	**no**
Other	**no**

**Specification of the individual performance parameters on a separate sheet*

5. Advanced neutron imaging features

	Availability – yes/no
Tomography	**yes**
Time sequences	**yes**
Grating interferometer	**yes**
Energy selection	**yes**
Polarizer	**yes**
Others	**-**

6. Involved manpower

	Number
Scientists	2
Students	1
Engineers	-
Technicians	-

7. Applications*

Research topics	Neutron tomography, Energy-selective imaging, Imaging with polarized neutrons, High-resolution radiography, Grating-interferometry
Services for industry	Fuel cells, Automotive industry, Aircraft industry
Methodical developments	High-resolution, polarized neutrons, Bragg-edge mapping

**Provide the list for a multiple answer*

8. Revenue generation/recovery

	Yes/No
Presently	Yes
Future plans	Yes

9. Plans for future upgrades

Expected Year	Type of Upgrade
2011	Supermirror neutron guide, Larger facility

10. Other* relevant information

**E.g. facility-instrumentation photos can be provided on a separate sheet*

Additional X-ray micro focus CT scanner attached to the neutron imaging facility for complimentary studies.

Parameters:

Cone beam

Max. Voltage: 150 kV

Resolution: 10 – 50 µm

Sample size: 1 – 10 cm

20. Germany, BER II, 10 MW (PONTO Instrument)

1. General information

Country	Germany
Region, Place/Closest Town	Berlin
Institution	Helmholtz Zentrum für Materialien und Energie
Facility manager (full name, position, phone, e-mail, web)	Prof. Dr. Anke Pyzalla, Scientific Head, +49 30 8062-42764, anke.pyzalla@helmholtz-berlin.de
Type of neutron source	Reactor
Source power [MW]	10
Source intensity [n/s or $cm^{-2}s^{-1}$]	
Availability (hours/year)	

2. Beam qualification

Beam line alignment (radial, tangential)	tangential
Neutron spectrum (qualitative: fast, thermal, cold)	cold
Curved beam guide (monochromator)	
Neutron spectrum at sample position (qualitative: fast, thermal, cold)	3.5A ~ 0.0067eV
Maximal beam intensity at sample position [cm^{-2} s^{-1}]	3 x 10^6
Polarization (yes/no)	yes
Neutron/gamma ratio (n cm^{-2} per mGy)	
Cd ratio (foil material)	

3. Beam line layout

	150cm	200cm	250cm	300cm	Setting 5
Inlet aperture [mm]	55x60	55x60	55x60	55x60	
Filter options (e.g. Bi, Be, Si, sapphire,)					
Aperture - detector distance [cm]	150	200	250	300	
Resulting L/D (measured or estimated)	500	500	500	500	
Effective beam size [mm]	73x78	79x84	85x90	91x96	
Flux uniformity (e.g. flat, gaussian, other)					
Corresponding intensity [cm^{-2} s^{-1}]	2.25x10^6	1.5x10^6	1x10^6	7.3x10^5	

4. Detectors* for neutron imaging

	Availability – yes/no
Film based detector (converter material)	yes
Digital camera based detector (scintilator material)	yes
Imaging plate detector	no
Amorphous Si flat panel detector	no
Other	He-3

**Specification of the individual performance parameters on a separate sheet*

5. Advanced neutron imaging features

	Availability – yes/no
Tomography	Yes
Time sequences	Yes
Grating interferometer	No
Energy selection	Yes
Polarizer	Yes
Others	USANS

6. Involved manpower

	Number
Scientists	2-3
Students	2-4
Engineers	1
Technicians	0.5

7. Applications*

Research topics	Superconductrivity, magnetic field investigations phase contrast, fundamental physics
Services for industry	No
Methodical developments	scattering, refraction – and USANS - imaging

**Provide the list for a multiple answer*

8. Revenue generation/recovery

	Yes/No
Presently	no
Future plans	yes

9. Plans for future upgrades

Expected Year	Type of Upgrade
2011	Instrument, optics

10. Other* relevant information

**E.g. facility-instrumentation photos can be provided on a separate sheet*

21. Germany, FRM-II (ANTARES), 20 MW

1. General information

Country	Germany
Region, Place/Closest Town	Garching / Munich
Institution	Technische Universitaet Muenchen, FRM II Maier Leibnitz-Zentrum (MLZ) Beam line ANTARES
Facility manager (full name, position, phone, e-mail, web)	Dr Burkhard Schillinger, instrument responsible, +49 89 289 12185, Burkhard.Schillinger@frm2.tum.de, www.frm2.tum.de Michael Schulz, instrument responsible, +49 89 289 14718 Michael.Schulz@frm2.tum.de
Type of neutron source	Research reactor
Source power [MW]	20
Source intensity [n/s or cm^{-2} s^{-1}]	8x 10^{14} cm^{-2} s^{-1}
Availability (hours/year)	240 days reactor operation

2. Beam qualification

Beam line alignment (radial, tangential)	**tangential**
Neutron spectrum (qualitative: fast, thermal, cold)	cold
Curved beam guide (monochromator)	No guide, but selectable double crystal monochromator, velocity selector and neutron optical periscope
Neutron spectrum at sample position (qualitative: fast, thermal, cold)	cold
Maximal beam intensity at sample position [cm^{-2} s^{-1}]	At 1.8 Angstrom
Polarization (yes/no)	Yes
Neutron/gamma ratio (n cm^{-2} per mGy)	
Cd ratio (foil material)	

3. Beam line layout

	Setting 1	Setting 2	Setting 3	Setting 4	Setting 5	Setting 6
Inlet aperture [mm]	2	4.5	8.9	17.8	35.6	71.32
Filter options (e.g. Bi, Be, Si, sapphire,)	Bi, Be, sapphire	Bi, Be, sapphire	Bi, Be, sapphire	Bi, Be, sapphire	Bi, Be, sapphire	Bi, Be, sapphire
Aperture - detector distance [cm]	1420 710	1420 710	1420 710	1420 710	1420 710	1420 710
Resulting L/D (measured or estimated)	7100 3550	3200 1600	1600 800	800 400	400 200	200 100
Effective beam size, fully illuminated [mm]	290	281	275	235	173	50
Flux uniformity (e.g. flat, gaussian, other)	flat	flat	flat	flat	Flat	flat
Corresponding intensity [cm^{-2} s^{-1}]	4×10^5 - 1.6×10^6	2×10^6 – 8×10^6	8×10^6 - 2.5×10^7	2.5×10^7 - 1×10^8	1×10^8 - 4×10^8	4×10^8 - 1.6×10^9

4. Detectors* for neutron imaging

	Availability – yes/no
Film based detector (converter material)	No
Digital camera based detector (scintilator material)	Yes
Imaging plate detector	Yes
Amorphous Si flat panel detector	No
Other	CMOS-camera

**Specification of the individual performance parameters on a separate sheet*

5. Advanced neutron imaging features

	Availability – yes/no
Tomography	yes
Time sequences	yes
Grating interferometer	yes
Energy selection	yes
Polarizer	yes
Others	In preparation

6. Involved manpower

	Number
Scientists	2
Students	3-5
Engineers	1
Technicians	0

7. Applications*

Research topics	Archaeology, magnetism, superconductivity, batteries, fuel cells
Services for industry	Radiography, CT and advanced techniques
Methodical developments	Magnetic imaging, dark field imaging

**Provide the list for a multiple answer*

8. Revenue generation/recovery

	Yes/No
Presently	yes
Future plans	yes

9. Plans for future upgrades

Expected Year	Type of Upgrade
2013/2014	Double crystal monochromator
2013/2014	Velocity selector
2013/2014	Grating interferometer
2014	One Neutron periscope, one polarizing periscope
2019	Installation of x-ray µ-CT setup perpendicular to neutron beam

10. Other* relevant information

**E.g. facility-instrumentation photos can be provided on a separate sheet*

17. Germany, FRM-II (NECTAR), 20MW, with converter

1. General information

Country	Germany
Region, Place/Closest Town	Bavaria, Garching
Institution	TU München
Facility manager (full name, position, phone, e-mail, web)	Dr. Thomas Bücherl, +49 (0)89-28914328, thomas.buecherl@tum.de, www.frm2.tum.de
Type of neutron source	Reasearch Reactor
Source power [MW]	20MW, with a converter target at 32kW
Source intensity [n/s or cm^{-2} s^{-1}]	8x 1E14 cm^{-2} s^{-1}
Availability (hours/year)	6000

2. Beam qualification

Beam line alignment (radial, tangential)	radial
Neutron spectrum (qualitative: fast, thermal, cold)	fission
Curved beam guide (monochromator)	
Neutron spectrum at sample position (qualitative: fast, thermal, cold)	1.9 MeV
Maximal beam intensity at sample position [cm^{-2} s^{-1}]	max. 1.2 x 10^7
Polarization (yes/no)	
Neutron/gamma ratio (n cm^{-2} per mGy)	
Cd ratio (foil material)	no

3. Beam line layout

	Setting 1	**Setting 2**	**Setting 3**
Inlet aperture [mm]	50	24	
Filter options (e.g. Bi, Be, Si, sapphire,)			
Aperture - detector distance [cm]	940	350	
Resulting L/D (measured or estimated)	132	233	
Effective beam size [mm]	∅ 250	∅ 170	
Flux uniformity (e.g. flat, gaussian, other)			
Corresponding intensity [cm^{-2} s^{-1}]	1.2 x 10^7	5.4 x 10^5	

4. Detectors* for neutron imaging

	Availability – yes/no
Film based detector (converter material)	No
Digital camera based detector (scintilator material)	Yes
Imaging plate detector	Read out unit available
Amorphous Si flat panel detector	No
Other	No

**Specification of the individual performance parameters on a separate sheet*

5. Advanced neutron imaging features

	Availability – yes/no
Tomography	Yes
Time sequences	Yes
Grating interferometer	No
Energy selection	No
Polarizer	No
Others	No

6. Involved manpower

	Number
Scientists	0.1 (+1)
Students	0
Engineers	0
Technicians	0

7. Applications*

Research topics	Various
Services for industry	
Methodical developments	Detector systems

**Provide the list for a multiple answer*

8. Revenue generation/recovery

	Yes/No
Presently	Yes
Future plans	Yes

9. Plans for future upgrades

Expected Year	Type of Upgrade
2013	Detector system

10. Other* relevant information

**E.g. facility-instrumentation photos can be provided on a separate sheet*

18. Germany, PIAF, 12 MeV Deuterium, 20 µA CW, 2 µA pulsed

1. General information

Country	Germany
Region, Place/Closest Town	Braunschweig (ca 200 km west of Berlin)
Institution	Physikalisch-Technische Bundesanstalt
Facility manager (full name, position, phone, e-mail, web)	Volker Dangendorf, , +49 531 5926510, volker.dangendorf@ptb.de
Type of neutron source	Cyclotron, d-Be (thick target), 20 uA CW, 2 uA pulsed
Source power [MW]	n.a.
Source intensity [n/s or cm^{-2} s^{-1}]	d-Be: $5x10^6$ $s^{-1}cm^{-2}$ in 3 m distance (point source)
Availability (hours/year)	200 - 300 h (shared, available by application)

2. Beam qualification

Beam line alignment (radial, tangential)	n.a.
Neutron spectrum (qualitative: fast, thermal, cold)	Fast(broad spectrum 1-17 MeV, av. 5 MeV)
Curved beam guide (monochromator)	n.a., (Energy selection: TOF possible @ reducted flux)
Neutron spectrum at sample position (qualitative: fast, thermal, cold)	Fast
Maximal beam intensity at sample position [cm^{-2} s^{-1}]	CW: $5x10^6$ $s^{-1}cm^{-2}$, short exposures up to $15x10^6$ $s^{-1}cm^{-2}$ (< 1 Min @ <5% duty cycle)- Pulsed:$5x10^5$ $s^{-1}cm^{-2}$
Polarization (yes/no)	no
Neutron/gamma ratio (n cm^{-2} per mGy)	n/g ca 5:1 (in flux)
Cd ratio (foil material)	n.a.

3. Beam line layout

	Setting 1	**Setting 2**
Inlet aperture [mm]	5 mm (source diameter)	Further settings can be obtained by choosing distances between 2 m and 12 m, L/D and flux scale linear or inverse - square to distance /source ratio
Filter options (e.g. Bi, Be, Si, sapphire,)	n.a.	
Aperture - detector distance [cm]	200 cm	
Resulting L/D (measured or estimated)	400	
Effective beam size [mm]	Up to d=30 cm 400 cm^2 square	
Flux uniformity (e.g. flat, gaussian, other)	flat	
Corresponding intensity [cm^{-2} s^{-1}]	CW: $5x10^6$ $s^{-1}cm^{-2}$	

4. Detectors* for neutron imaging

	Availability – yes/no
Film based detector (converter material)	No
Digital camera based detector (scintilator material)	Yes (Fast Framing ICCD (ns-exposure, 8 frames), Fast Framing HiSpeed CCD (ms-exposure 500 frames) Event Counting camera system
Imaging plate detector	No
Amorphous Si flat panel detector	No
Other	

**Specification of the individual performance parameters on a separate sheet*

5. Advanced neutron imaging features

	Availability – yes/no
Tomography	Y (available ca 10.2014)
Time sequences	Y
Grating interferometer	N
Energy selection	Y(TOF, reaction based)
Polarizer	N
Others	

6. Involved manpower

	Number
Scientists	1
Students	0.5
Engineers	0.3
Technicians	1

7. Applications*

Research topics	
Services for industry	
Methodical developments	

**Provide the list for a multiple answer*

8. Revenue generation/recovery

	Yes/No
Presently	no
Future plans	If possible

9. Plans for future upgrades

Expected Year	Type of Upgrade
2014	Tomography

10. Other* relevant information

**E.g. facility-instrumentation photos can be provided on a separate sheet*

19. Hungary, DNR , 10 MW

1. General information – Dynamic Neutron Radiography Station (DNR)

Country	Hungary
Region, Place/Closest Town	Budapest
Institution	Centre for Energy Research, Hungarian Academy of Sciences
Facility manager (full name, position, phone, e-mail, web)	László Zoltán Horváth, instrument responsible +36 1 392 2222 ext. 1434, horvath.laszlo.z@energia.mta.hu
Type of neutron source	Research Reactor
Source power [MW]	10
Source intensity [n/s or $cm^{-2}s^{-1}$]	2.2×10^{14} $cm^{-2}s^{-1}$ (thermal neutron flux in the core)
Availability (hours/year)	~ 3400 h

2. Beam qualification

Beam line alignment (radial, tangential)	Radial beam No. 2 (without filter – gamma intensity: 8.3 Gy/h).
Neutron spectrum (qualitative: fast, thermal, cold)	thermal neutron spectrum
Curved beam guide (monochromator)	No
Neutron spectrum at sample position (qualitative: fast, thermal, cold)	thermal neutron spectrum
Maximal beam intensity at sample position [cm^{-2} s^{-1}]	1.8×10^{8} $n/cm^2/s$ (thermal equivalent neutron flux)
Polarization (yes/no)	No
Neutron/gamma ratio (n cm^{-2} per mGy)	7.82×10^{7}
Cd ratio (foil material)	3.76

3. Beam line layout

	Setting 1	Setting 2	Setting 3	Setting 4	Setting 5
Inlet aperture [mm]	25	25	0.5	1	2
Filter options (e.g. Bi, Be, Si, sapphire,)	no	no	no	no	no
Aperture - detector distance [cm]	425	500	300	300	300
Resulting L/D (measured or estimated)	170	200	600	300	150
Effective beam size [mm]	Diameter: ~ 155	Diameter: ~ 220	Diameter: ~ 10	Diameter: ~ 20	Diameter: ~ 40
Flux uniformity (e.g. flat, gaussian, other)	flat	flat	flat	flat	flat
Corresponding intensity [cm^{-2} s^{-1}]	6×10^{7}	5×10^{7}	1.7×10^{3}	7×10^{3}	2.7×10^{4}

4. Detectors* for neutron imaging

	Availability – yes/no
Film based detector (converter material)	No
Digital camera based detector (scintilator material)	CCD camera (756×580 px, 10 bit)
Imaging plate detector	BAS 2500 image plate reader
Amorphous Si flat panel detector	No
Other	LLL TV camera with vidicon (10^{-4} lux)

**Specification of the individual performance parameters on a separate sheet*

5. Advanced neutron imaging features

	Availability – yes/no
Tomography	No
Time sequences	Yes
Grating interferometer	No
Energy selection	Yes - by Bi, Cd and In filter
Polarizer	No
Others	Simultaneous Dynamic Neutron- and Gamma Radiography

6. Involved manpower

	Number
Scientists	1
Students	-
Engineers	1
Technicians	1

7. Applications*

Research topics	Study of the supercritical water. Investigation of Fuel Cells in operation.
Services for industry	Inspection of refrigerators. Test of helicopter rotor blades.
Methodical developments	In-situ imaging of dynamic processes

**Provide the list for a multiple answer*

8. Revenue generation/recovery

	Yes/No
Presently	Yes
Future plans	Yes

9. Plans for future upgrades

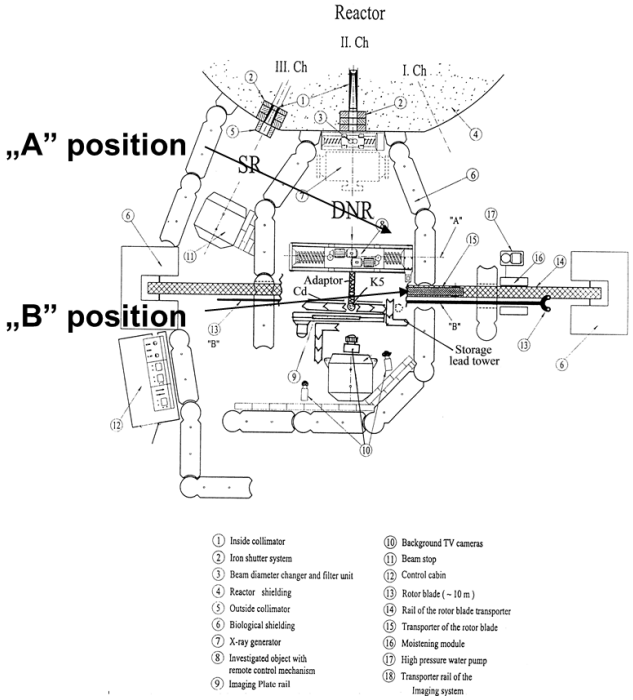
Expected Year	Type of Upgrade
2014	Extending the dimension of the facility
2015	To implement digital neutron, gamma and X-ray tomography

10. Other* relevant information

**E.g. facility-instrumentation photos can be provided on a separate sheet*

The Radiography Station of the Budapest Research Reactor has the following unique features:

1. *Simultaneous Dynamic Neutron and Gamma Radiography – max. dimensions of the investigated object: 800 × 1100 mm² and 300 kg.*
2. *X-ray Radiography (40 – 300 kV; 5 mA).*
3. *It is possible to inspect oversized objects, as a helicopter rotor blade or a refrigerator – max. dimensions of the investigated object: 9800 × 700 mm and 200 kg.*



„A"

Neutron flux: 10^8 n cm^{-2} sec^{-1}

L/D = 170

Beam diameter: 150 mm

Gamma intensity: ~ 8,5 Gy/h

X-ray energy: 50-300 keV; 5 mA

Radiography picture detection:

Low-light-level TV camera and

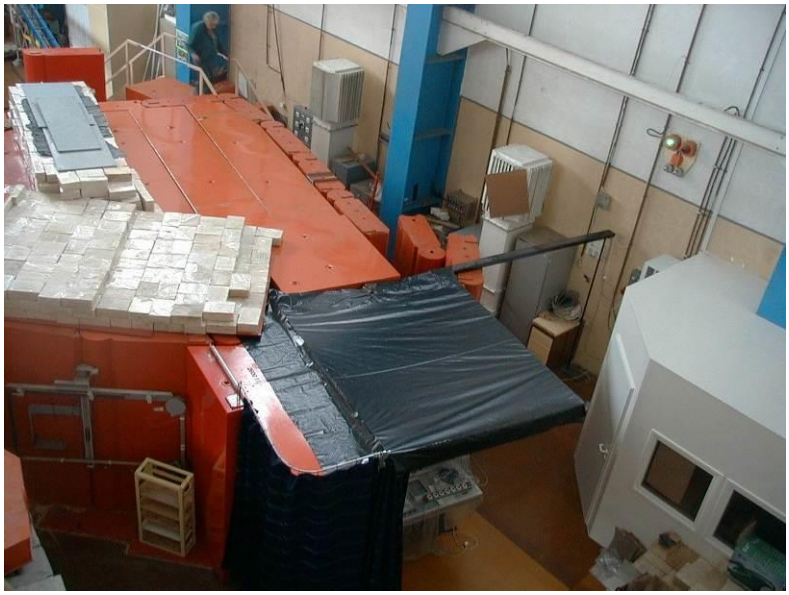
Photo-luminescent Imaging Plate technique

„B"

Neutron flux: 6X10^7 ncm^{-2} sec^{-1}

L/D = 195

Beam diameter: 225 mm



20. Hungary, NORMA, 10 MW

1. General information – Neutron Optics and Radiography for Material Analysis (NORMA)

Country	Hungary
Region, Place/Closest Town	Budapest
Institution	Centre for Energy Research, Hungarian Academy of Sciences
Facility manager (full name, position, phone, e-mail, web)	Zoltán Kis, senior staff scientist László Szentmiklósi, senior staff scientist +36 1 392 2222 ext. 3311 or 3153 kis.zoltan@energia.mta.hu szentmiklosi.laszlo@energia.mta.hu
Type of neutron source	cold source of a research reactor
Source power [MW]	10
Source intensity [n/s or $cm^{-2}s^{-1}$]	~ 10^{10} $cm^{-2}s^{-1}$ (thermal equivalent flux of the cold source)
Availability (hours/year)	~ 3400 h

2. Beam qualification

Beam line alignment (radial, tangential)	Neutron guide facing to the cold source in a tangential channel
Neutron spectrum (qualitative: fast, thermal, cold)	cold
Curved beam guide (monochromator)	yes (no)
Neutron spectrum at sample position (qualitative: fast, thermal, cold)	cold
Maximal beam intensity at sample position [cm^{-2} s^{-1}]	2.7×10^{7} (thermal equivalent neutron flux)
Polarization (yes/no)	No
Neutron/gamma ratio (n cm^{-2} per mGy)	not applicable
Cd ratio (foil material)	no epithermal and fast neutrons at all

3. Beam line layout

	Standard settings
Inlet aperture [mm]	20 × 20 rectangular (at the end of the neutron guide)
Filter options (e.g. Bi, Be, Si, sapphire,)	not needed
Aperture - detector distance [cm]	271
Resulting L/D (measured)	233
Effective beam size [mm]	up to 40 mm rectangular
Flux uniformity (e.g. flat, gaussian, other)	relatively flat
Corresponding intensity [cm^{-2} s^{-1}]	2.7×10^{7}

4. Detectors* for neutron imaging

	Availability – yes/no
Film based detector (converter material)	No
Digital camera based detector (scintilator material)	Andor iKon-M CCD 1024×1024 px, 16 bit, ^{6}Li-ZnS scintillator RC Tritec A.G.
Imaging plate detector	No
Amorphous Si flat panel detector	No
Other	No

**Specification of the individual performance parameters on a separate sheet*

5. Advanced neutron imaging features

	Availability – yes/no
Tomography	Yes
Time sequences	Yes
Grating interferometer	No
Energy selection	No (planned)
Polarizer	No
Others	Coupled to position-sensitive Prompt Gamma Activation Analysis for element composition

6. Involved manpower

	Number
Scientists	2
Students	–
Engineers	–
Technicians	–

7. Applications*

Research topics	• Research related to energy production and conversion • Analysis and imaging of art, geological and material science objects • Homogeneity of materials, coatings
Services for industry	Analysis and imaging of engineering objects
Methodical developments	Combination of Prompt Gamma Activation Imaging and Neutron Tomography

**Provide the list for a multiple answer*

8. Revenue generation/recovery

	Yes/No
Presently	Yes
Future plans	Yes

9. Plans for future upgrades

Expected Year	Type of Upgrade
2013	Image Acquisition Software development

10. Other* relevant information

**E.g. facility-instrumentation photos can be provided on a separate sheet*

The NORMA Station of the Budapest Research Reactor is a unique combination of neutron imaging and position-sensitive element analysis with Prompt Gamma Activation Imaging

Sample chamber:

- *Aluminum house lined with ^{6}Li-polymer sheets, AlMgSi0.5 alloy*
- *inner volume: 20×20×20 cm^3*
- *removable side panels*
- *maximum field of view: about 40 mm*

Computer-controlled sample stage:

- *xyzω movements*
- *maximum load: 5 kg*
- *max. travel distance: 200 mm, depending on the sample dimensions*

Imaging system - CCD-based neutron imaging:

- *100 µm thick ^{6}Li/ZnS scintillator (RC Tritec)*
- *silver-free quartz mirror in 45 degree*
- *ANDOR iKon-M CCD camera (cooled, 16–bit, 1024×1024 pixels)*
- *Typical exposure times: 1.5-2.0 s per projection*
- *Best spatial resolution: 230 µm*

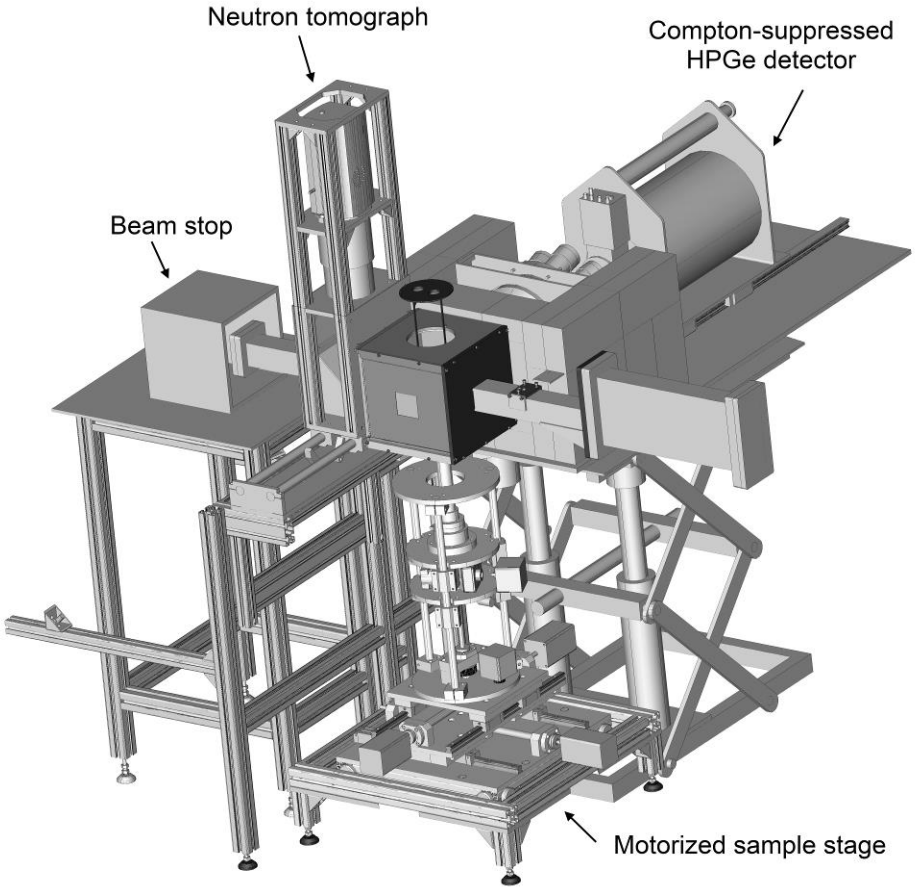
Prompt gamma detection for element analysis - Compton-suppressed HPGe detector:

- *Canberra GR2318/S HPGe detector*
- *surrounded by a Bismuth Germanate (BGO) scintillator*
- *Canberra DSP–2060 digital signal processor*
- *Canberra AIM 556B data acquisition module*
- *10-cm lead shielding with exchangeable gamma collimators*
- *Best spatial resolution: 3-5 mm*

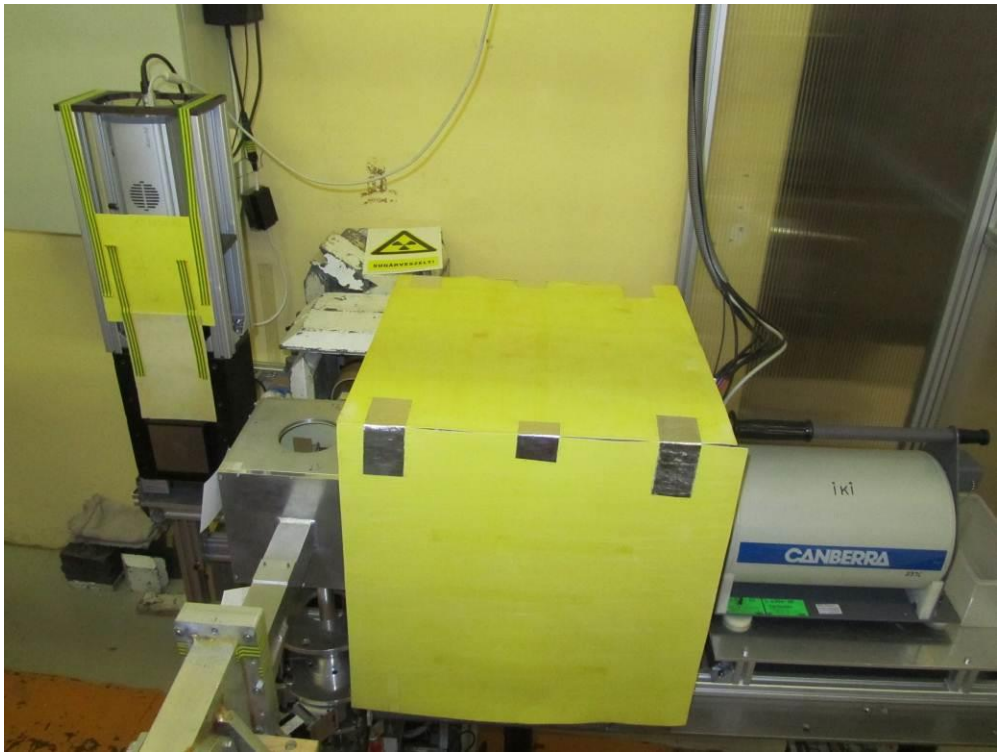
Integrated control software: sample stage, gamma spectrometer and camera

Digital image processing:

- *Tomographic reconstruction: OCTOPUS 8.6*
- *3D Visualization: VG Studio 2.1*



Irradiation facility (model)



Irradiation facility (picture)

For additional information please contact N.Pessoa-Barradas@iaea.org and Eberhard.Lehmann@psi.ch.

21. India, Dhruva, 100 MW

1. General information

Country	India
Region, Place/Closest Town	Mumbai
Institution	Bhabha Atomic Research Centre
Facility manager (full name, position, phone, e-mail, web)	Dr. Tushar Roy Scientific Officer +91 22 2559 5492 tushar@barc.gov.in
Type of neutron source	Dhruva reactor
Source power [MW]	100
Source intensity [n/s or cm^{-2} s^{-1}]	
Availability (hours/year)	>7000 hours/year

2. Beam qualification

Beam line alignment (radial, tangential)	Radial
Neutron spectrum (qualitative: fast, thermal, cold)	Thermal
Curved beam guide (monochromator)	No
Neutron spectrum at sample position (qualitative: fast, thermal, cold)	Thermal
Maximal beam intensity at sample position [cm^{-2} s^{-1}]	4 X 10^7
Polarization (yes/no)	No
Neutron/gamma ratio (n cm^{-2} per mGy)	1.8 X 10^8 n cm^{-2} per mR
Cd ratio (foil material)	250

3. Beam line layout

	Setting 1 (Tomography)	**Setting 2 (Phase Contrast)**
Inlet aperture [mm]	16	1
Filter options (e.g. Bi, Be, Si, saphire,)	Sapphire + Bi	Sapphire + Bi
Aperture - detector distance [cm]	250	250
Resulting L/D (measured or estimated)	160 (estimated)	2500 (estimated)
Effective beam size [mm]	120	
Flux uniformity (e.g. flat, gaussian, other)	Flat	Flat
Corresponding intensity [cm^{-2} s^{-1}]	4 X 10^7	5 X 10^4

4. Detectors* for neutron imaging

	Availability – yes/no
Film based detector (converter material)	No
Digital camera based detector (scintilator material)	Yes (Li^6F:ZnS)
Imaging plate detector	Yes
Amorphous Si flat panel detector	No
Other	

**Specification of the individual performance parameters on a separate sheet*

5. Advanced neutron imaging features

	Availability – yes/no
Tomography	Yes
Time sequences	
Grating interferometer	
Energy selection	
Polarizer	
Others	**Phase Contrast**

6. Involved manpower

	Number
Scientists	4
Students	
Engineers	1
Technicians	1

7. Applications

Research topics	Hydrogen ingression in zirconium alloys
Services for industry	
Methodical developments	

8. Revenue generation/recovery

	Yes/No
Presently	NO
Future plans	

9. Plans for future upgrades

Expected Year	Type of Upgrade

10. Other relevant information

11. Indonesia, GA Siwabessy MTR, 30 MW

1. General information

Country	Indonesia
Region, Place/Closest Town	Serpong-Tangerang Selatan
Institution	BATAN
Facility manager (full name, position, phone, e-mail, web)	Dr. Sutiarso, Head of Neutron Scattering Laboratory, 021-756 6727, sasok@batan.go.id Web: www.batan.go.id/pstbm/info
Type of neutron source	Research Reactor
Source power [MW]	30 MW (max) and operated at 15 MW
Source intensity [n/s or cm^{-2} s^{-1}]	3×10^{14}
Availability (hours/year)	2400

2. Beam qualification

Beam line alignment (radial, tangential)	Tangential
Neutron spectrum (qualitative: fast, thermal, cold)	Thermal neutron
Curved beam guide (monochromator)	n/a
Neutron spectrum at sample position (qualitative: fast, thermal, cold)	Thermal
Maximal beam intensity at sample position [cm^{-2} s^{-1}]	$10^6 – 10^7$
Polarization (yes/no)	n/a
Neutron/gamma ratio (n cm^{-2} per mGy)	$>10^5$ n cm^{-2} per mGy
Cd ratio (foil material)	6.4

3. Beam line layout

	Setting 1	**Setting 2**
Inlet aperture [mm]	65	
Filter options (e.g. Bi, Be, Si, sapphire,)	Lead (HPb_2)	
Aperture - detector distance [cm]	539.5	
Resulting L/D (measured or estimated)	83 (estimated geometry)	
Effective beam size [mm]	200	
Flux uniformity (e.g. flat, gaussian, other)	Gaussian	
Corresponding intensity [cm^{-2} s^{-1}]	$10^6 – 10^7$	

4. Detectors* for neutron imaging

	Availability – yes/no
Film based detector (converter material)	yes
Digital camera based detector (scintilator material)	yes
Imaging plate detector	no
Amorphous Si flat panel detector	no
Other	-

**Specification of the individual performance parameters on a separate sheet*

5. Advanced neutron imaging features

	Availability – yes/no
Tomography	yes
Time sequences	yes
Grating interferometer	no
Energy selection	no
Polarizer	no
Others	-

6. Involved manpower

	Number
Scientists	1
Students	1
Engineers	1
Technicians	2

7. Applications*

Research topics	Neutron radiography for examining automotive components and archaeological objects
Services for industry	N/A
Methodical developments	Neutron tomography

**Provide the list for a multiple answer*

8. Revenue generation/recovery

	Yes/No
Presently	No
Future plans	Yes

9. Plans for future upgrades

Expected Year	Type of Upgrade
2014	Optimization of tomography setup and standardization technique

10. Other* relevant information

**E.g. facility-instrumentation photos can be provided on a separate sheet*

BATAN's neutron radiography facility, RN1

23. Israel, IRR-1, 5MW

1. General information

Country	Israel
Region, Place/Closest Town	Yavne
Institution	Soreq Nuclear Research Center
Facility manager (full name, position, phone, e-mail, web)	Dr. Arie Gayer, Head of NDT Dept. 972-8-9349283, gayer@soreq.gov.il
Type of neutron source	Reactor
Source power [MW]	5
Source intensity [n/s or $cm^{-2}s^{-1}$]	$7x10^{13}$ cm^{-2} s^{-1}
Availability (hours/year)	10 hours/week

2. Beam qualification

Beam line alignment (radial, tangential)	tangential
Neutron spectrum (qualitative: fast, thermal, cold)	thermal
Curved beam guide (monochromator)	
Neutron spectrum at sample position (qualitative: fast, thermal, cold)	0.025 eV
Maximal beam intensity at sample position [cm^{-2} s^{-1}]	$1x10^{6}$
Polarization (yes/no)	no
Neutron/gamma ratio (n cm^{-2} per mGy)	
Cd ratio (foil material)	

3. Beam line layout

	Setting 1	Setting 2
Inlet aperture [mm]	20	
Filter options (e.g. Bi, Be, Si, sapphire,)		
Aperture - detector distance [cm]	500	
Resulting L/D (measured or estimated)	250	
Effective beam size [mm]	600	
Flux uniformity (e.g. flat, gaussian, other)		
Corresponding intensity [cm^{-2} s^{-1}]	$1x10^{6}$	

4. Detectors* for neutron imaging

	Availability – yes/no
Film based detector (converter material)	yes
Digital camera based detector (scintilator material)	no
Imaging plate detector	yes
Amorphous Si flat panel detector	yes
Other	

**Specification of the individual performance parameters on a separate sheet*

5. Advanced neutron imaging features

	Availability – yes/no
Tomography	yes
Time sequences	no
Grating interferometer	no
Energy selection	no
Polarizer	no
Others	

6. Involved manpower

	Number
Scientists	3
Students	
Engineers	2
Technicians	2

7. Applications*

Research topics	Corrosion, Composite materials
Services for industry	bonding
Methodical developments	

**Provide the list for a multiple answer*

8. Revenue generation/recovery

	Yes/No
Presently	yes
Future plans	

9. Plans for future upgrades

Expected Year	Type of Upgrade

10. Other* relevant information

**E.g. facility-instrumentation photos can be provided on a separate sheet*

24. Italy, TRIGA RC-1, 1 MW

1. General information

Country	Italy
Region, Place/Closest Town	Rome
Institution	ENEA
Facility manager (full name, position, phone, e-mail, web)	Emilio SANTORO +39 0630483974 emilio.santoro@enea.it
Type of neutron source	Research Reactor TRIGA Mark II
Source power [MW]	1 MW
Source intensity [n/s or $cm^{-2}s^{-1}$]	
Availability (hours/year)	On demand

2. Beam qualification

Beam line alignment (radial, tangential)	Radial/tangential
Neutron spectrum (qualitative: fast, thermal, cold)	thermal
Curved beam guide (monochromator)	
Neutron spectrum at sample position (qualitative: fast, thermal, cold)	0.025
Maximal beam intensity at sample position [cm^{-2} s^{-1}]	~2.2 x 10^5/~2.5x 10^6
Polarization (yes/no)	No
Neutron/gamma ratio (n cm^{-2} per mGy)	
Cd ratio (foil material)	

3. Beam line layout

	Setting 1	Setting 2	Setting 3
Inlet aperture [mm]	~40	~200	
Filter options (e.g. Bi, Be, Si, sapphire,)			
Aperture - detector distance [cm]	~20	~20	
Resulting L/D (measured or estimated)	116	108	
Effective beam size [mm]	38	180	
Flux uniformity (e.g. flat, gaussian, other)			
Corresponding intensity [cm^{-2} s^{-1}]	~2.2 x 10^5	~2.5 x 10^6	

4. Detectors* for neutron imaging

	Availability – yes/no
Film based detector (converter material)	Yes
Digital camera based detector (scintilator material)	Yes
Imaging plate detector	No
Amorphous Si flat panel detector	No
Other	-

**Specification of the individual performance parameters on a separate sheet*

5. Advanced neutron imaging features

	Availability – yes/no
Tomography	Yes
Time sequences	Yes
Grating interferometer	No
Energy selection	No
Polarizer	No
Others	-

6. Involved manpower

	Number
Scientists	2
Students	1
Engineers	2
Technicians	1

7. Applications*

Research topics	Yes
Services for industry	No
Methodical developments	Yes

**Provide the list for a multiple answer*

8. Revenue generation/recovery

	Yes/No
Presently	no
Future plans	yes

9. Plans for future upgrades

Expected Year	Type of Upgrade
2011	Set-up of facility on the tangential channel (setting 2 - 180mm beam diameter)

10. Other* relevant information

**E.g. facility-instrumentation photos can be provided on a separate sheet*

25. Japan, JRR3, 20MW

1. General information

Country	Japan
Region, Place/Closest Town	Tokai, Naka-gun, Ibaraki
Institution	Japan Atomic Energy Agency
Facility manager (full name, position, phone, e-mail, web)	Hiroshi Iikura, Researcher, +81-29-284-23911, iikura.hiroshi@jaea.go.jp
Type of neutron source	Research reactor
Source power [MW]	20
Source intensity [n/s or $cm^{-2}s^{-1}$]	$3x10^{14}$ $cm^{-2}s^{-1}$
Availability (hours/year)	4200

2. Beam qualification

Beam line alignment (radial, tangential)	Tangential
Neutron spectrum (qualitative: fast, thermal, cold)	Thermal
Curved beam guide (monochromator)	
Neutron spectrum at sample position (qualitative: fast, thermal, cold)	~0.02 eV
Maximal beam intensity at sample position [cm^{-2} s^{-1}]	$1.5\text{-}10^{8}$
Polarization (yes/no)	No
Neutron/gamma ratio (n cm^{-2} per mGy)	
Cd ratio (foil material)	

3. Beam line layout

	Setting 1	**Setting 2**	**Setting 3**
Inlet aperture [mm]	39	48	
Filter options (e.g. Bi, Be, Si, sapphire,)			
Aperture - detector distance [cm]	7286	7357	
Resulting L/D (measured or estimated)	185	154	
Effective beam size [mm]	255	305	
Flux uniformity (e.g. flat, gaussian, other)			
Corresponding intensity [cm^{-2} s^{-1}]	1.5×10^{8}	1.5×10^{8}	

4. Detectors* for neutron imaging

	Availability – yes/no
Film based detector (converter material)	No
Digital camera based detector (scintilator material)	Yes
Imaging plate detector	Yes
Amorphous Si flat panel detector	No
Other	Neutron Color image intensifier

**Specification of the individual performance parameters on a separate sheet*

5. Advanced neutron imaging features

	Availability – yes/no
Tomography	Yes
Time sequences	Yes
Grating interferometer	No
Energy selection	No
Polarizer	No
Others	-

6. Involved manpower

	Number
Scientists	2
Students	0
Engineers	1
Technicians	0

7. Applications*

Research topics	Fuel cell, Architecture, Fluid
Services for industry	Some industrial uses (Fuel cell, Architecture, etc.)
Methodical developments	Improvement of spatial resolution, Noise reduction

**Provide the list for a multiple answer*

8. Revenue generation/recovery

	Yes/No
Presently	no
Future plans	no

9. Plans for future upgrades

Expected Year	Type of Upgrade

10. Other* relevant information

**E.g. facility-instrumentation photos can be provided on a separate sheet*

For additional information please contact N.Pessoa-Barradas@iaea.org and Eberhard.Lehmann@psi.ch.

Thermal Neutron Radiography Facility in JRR-3

26. Japan, J-PARC, <1MW

1. General information

Country	Japan
Region, Place/Closest Town	Ibaraki prefecture , Tokai village
Institution	Japan Atomic Energy Agency (JAEA)
Facility manager (full name, position, phone, e-mail, web)	Kenichi Oikawa (Researcher) TEL:+81-29-284-3211 e-mail: oikawa.kenichi@jaea.go.jp web: http://www.j-parc.jp/MatLife/en/index.html
Type of neutron source	Pulsed Spallation source (J-PARC) 25Hz
Source power [MW]	300kW (2012) 1MW (designed value)
Source intensity [n/s]	$9.5x10^7$[n/s/cm^2] at 10m from moderator
Availability (hours/year)	4800

2. Beam qualification

Beam line alignment (radial, tangential)	radial
Neutron spectrum (qualitative: fast, thermal, cold)	from 0.1meV to keV
Neutron spectrum (mean energy)	Cold neutron spectrum
Maximal beam intensity at sample position [cm^{-2} s^{-1}]	$4.8x10^7$[n/s/cm2] at 1 MW (cold neutron)
Polarization (yes/no)	available

3. Beam line layout

	Setting 1	**Setting 2**	**Setting 3**	**Setting 4**	**Setting 5**
Inlet aperture [mm]	100x100	3.16x3.16	1x1	0.32x0.32	
Aperture - detector distance [cm]	1400	600	600	600	
Resulting L/D	140	190	600	1875	
Effective beam size [mm]	100	100	80	80	
Corresponding intensity [cm^{-2} s^{-1}]	$4.8x10^7$	$1.7x10^7$	$2.0x10^6$	$2.4x10^5$	

4. Detectors* for neutron imaging

	Availability – yes/no
Film based detector	**No**
CCD-camera based detector	**Yes**
Imaging plate detector	**Yes**
Amorphous Si flat panel detector	**No**
Others	**Any detector you have**

**Specification of the individual performance parameters on a separate sheet*

5. Advanced neutron imaging features

	Availability – yes/no
Tomography	Yes
Time sequences	May be
Grating interferometer	No
Energy selection	Yes
Polarizer	May be
Others	

6. Involved manpower

	Number
Scientists	4
Students	0
Engineers	0
Technicians	0

7. Applications*

Research topics	Bragg edge imaging Neutron resonance imaging
Industrial projects	
Methodical developments	Neutron tomography, polarized neutron imaging, Time-of-flight spectroscopic imaging

**Provide the list for a multiple answer*

8. Commercial activities

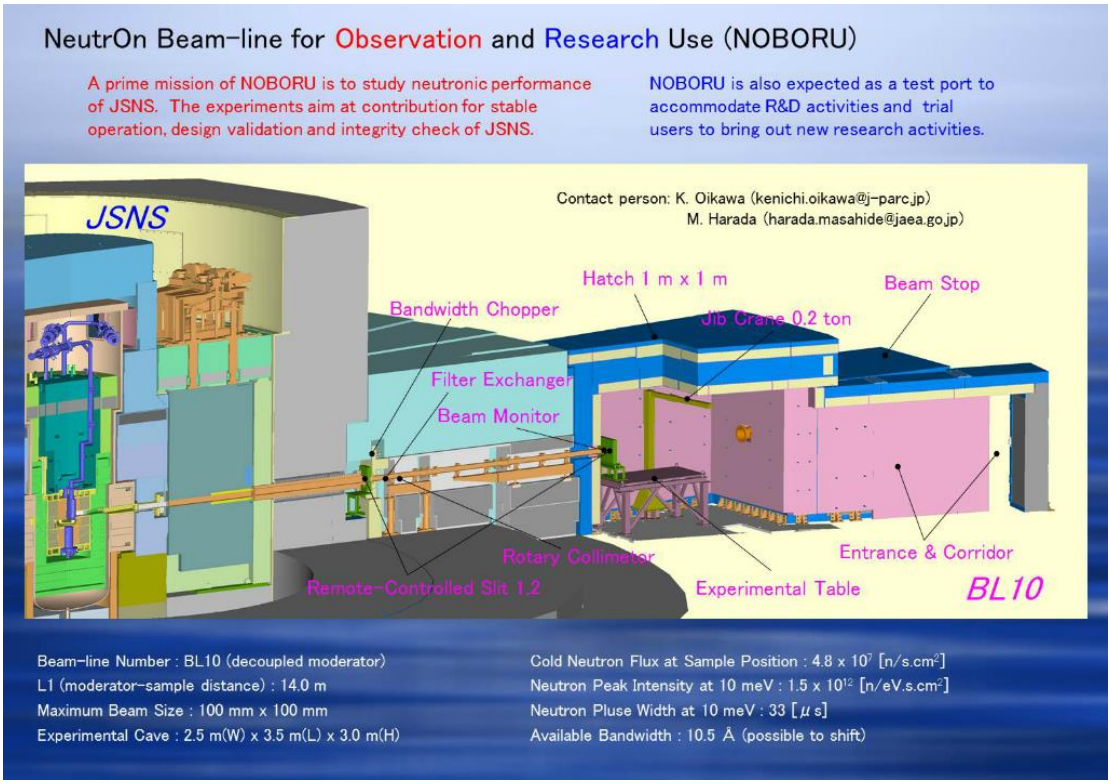
	Yes/No
Presently	**yes**
Future plans	**yes**

9. Plans for future upgrades

Expected Year	Type of Upgrade
2015	A new dedicated beam line for imaging will be operated.

10. Other* relevant information

**E.g. facility-instrumentation photos can be provided on a separate sheet*



27. Kazakhstan, WWR-K Almaty, 6MW

1. General information

Country	Kazakhstan
Region, Place/Closest Town	Almaty
Institution	The Institute of Nuclear Physics
Facility manager (full name, position, phone, e-mail, web)	Mr. Sergey Kislitsin, head of solid state department, 8 (727) 3866800ext.331, skislitsin@mail.ru, www.inp.kz
Type of neutron source	Research reactor
Source power [MW]	6
Source intensity [n/s or cm^{-2} s^{-1}]	$2 \cdot 10^{14}$ cm^{-2} s^{-1}
Availability (hours/year)	4800h/year

2. Beam qualification

Beam line alignment (radial, tangential)	radial
Neutron spectrum (qualitative: fast, thermal, cold)	thermal
Curved beam guide (monochromator)	no
Neutron spectrum at sample position (qualitative: fast, thermal, cold)	thermal
Maximal beam intensity at sample position [cm^{-2} s^{-1}]	~10^8
Polarization (yes/no)	no
Neutron/gamma ratio (n cm^{-2} per mGy)	-
Cd ratio (foil material)	-

3. Beam line layout

	Setting 1	**Setting 2**
Inlet aperture [mm]	200x200	
Filter options (e.g. Bi, Be, Si, sapphire,)	B_4C, paraffin, Pb, Bi	
Aperture - detector distance [cm]	5, 10, 20	
Resulting L/D (measured or estimated)	-	
Effective beam size [mm]	-	
Flux uniformity (e.g. flat, gaussian, other)	Flat	
Corresponding intensity [cm^{-2} s^{-1}]	~10^8	

4. Detectors* for neutron imaging

	Availability – yes/no
Film based detector (converter material)	Gd, Dy, In
Digital camera based detector (scintilator material)	no
Imaging plate detector	X-ray film FT-31 or RT-5
Amorphous Si flat panel detector	no
Other	

**Specification of the individual performance parameters on a separate sheet*

5. Advanced neutron imaging features

	Availability – yes/no
Tomography	no
Time sequences	**yes**
Grating interferometer	**no**
Energy selection	**no**
Polarizer	**no**
Others	

6. Involved manpower

	Number
Scientists	1
Students	1
Engineers	**1**
Technicians	1

7. Applications*

Research topics	5. Nondestructive testing of thermionic reactor-converter elements 6. Nondestructive testing of irradiated fuel elements
Services for industry	**Non-destructive control**
Methodical developments	

**Provide the list for a multiple answer*

8. Revenue generation/recovery

	Yes/No
Presently	NO
Future plans	YES

9. Plans for future upgrades

Expected Year	Type of Upgrade
2020-2022	Partially. Upgrade of detector system for neutron imaging

10. Other relevant information

In 1978 neutron imaging facility was commissioned and named “AGAVA”. On today, facility under extended shutdown.

28. Korea, HANARO, 30 MW

1. General information

Country	Republic of Korea
Region, Place/Closest Town	Daejeon
Institution	Korea Atomic Energy Institute
Facility manager (full name, position, phone, e-mail, web)	TaeJoo Kim, Senior Researcher, +82-42-868-8521, tj@kaeri.re.kr, hanar4u.kaeri.re.kr
Type of neutron source	Pool type research reactor
Source power [MW]	30 MW
Source intensity [n/s or $cm^{-2}s^{-1}$]	~ 3.9 *10^{14} $cm^{-2}s^{-1}$
Availability (hours/year)	Approximately 5280 hr/year(220 days)

2. Beam qualification

Beam line alignment (radial, tangential)	Tangential
Neutron spectrum (qualitative: fast, thermal, cold)	Thermal
Curved beam guide (monochromator)	
Neutron spectrum at sample position (qualitative: fast, thermal, cold)	
Maximal beam intensity at sample position [cm^{-2} s^{-1}]	2 x 10^7
Polarization (yes/no)	No
Neutron/gamma ratio (n cm^{-2} per mGy)	
Cd ratio (foil material)	

3. Beam line layout

	Setting 1	**Setting 2**
Inlet aperture [mm]	25	
Filter options (e.g. Bi, Be, Si, sapphire,)		
Aperture - detector distance [cm]	697	
Resulting L/D (measured or estimated)	278	
Effective beam size [mm]	350 x 450	
Flux uniformity (e.g. flat, gaussian, other)		
Corresponding intensity [cm^{-2} s^{-1}]	2 x 10^7	

4. Detectors* for neutron imaging

	Availability – yes/no
Film based detector (converter material)	Yes
Digital camera based detector (scintilator material)	Yes
Imaging plate detector	No
Amorphous Si flat panel detector	No
Other	No

**Specification of the individual performance parameters on a separate sheet*

5. Advanced neutron imaging features

	Availability – yes/no
Tomography	Yes
Time sequences	
Grating interferometer	No
Energy selection	No
Polarizer	No
Others	No

6. Involved manpower

	Number
Scientists	1
Students	0
Engineers	0
Technicians	1

7. Applications*

Research topics	1.Fuel Cell, Li-Ion Battery 2. Non-destructive Testing for aircraft 3. Dynamic radiography for heat exchanger
Services for industry	Fuel Cell and Li-Ion Battery
Methodical developments	

**Provide the list for a multiple answer*

8. Revenue generation/recovery

	Yes/No
Presently	Yes
Future plans	Yes

9. Plans for future upgrades

Expected Year	Type of Upgrade
No	No

10. Other* relevant information

**E.g. facility-instrumentation photos can be provided on a separate sheet*

29. Malaysia, TRIGA II PUSPATI, 1 MW

1. General information

Country	Malaysia
Region, Place/Closest Town	Selangor, Kajang
Institution	Malaysian Nuclear Agency
Facility manager (full name, position, phone, e-mail, web)	Muhammaad Rawi Mohamed Zin, Senior Researcher +60389250510, muhammad_rawi@nuclearmalaysia.gov.my;
Type of neutron source	Research Reactor (TRIGA)
Source power [MW]	750kW
Source intensity [n/s or $cm^{-2}s^{-1}$]	$1x10^{12}$ cm^{-2} s^{-1} (nom)
Availability (hours/year)	750 (ave.)

2. Beam qualification

Beam line alignment (radial, tangential)	radial
Neutron spectrum (qualitative: fast, thermal, cold)	Fast and Thermal (1:3)
Curved beam guide (monochromator)	N.A
Neutron spectrum at sample position (qualitative: fast, thermal, cold)	200 eV
Maximal beam intensity at sample position [cm^{-2} s^{-1}]	$1x10^{5}$
Polarization (yes/no)	no
Neutron/gamma ratio (n cm^{-2} per mGy)	$1.02x10^{-6}$ $ncm^{-2}mR^{-1}$
Cd ratio (foil material)	-

3. Beam line layout

	Setting 1	Setting 2
Inlet aperture [mm]	50.4	
Filter options (e.g. Bi, Be, Si, sapphire,)	Bi	
Aperture - detector distance [cm]	405	
Resulting L/D (measured or estimated)	75	
Effective beam size [mm]	80 and 150	
Flux uniformity (e.g. flat, gaussian, other)	gaussian	
Corresponding intensity [cm^{-2} s^{-1}]	$1x10^{3}$	

4. Detectors* for neutron imaging

	Availability – yes/no
Film based detector (converter material)	yes
Digital camera based detector (scintilator material)	yes
Imaging plate detector	no
Amorphous Si flat panel detector	no
Other	

**Specification of the individual performance parameters on a separate sheet*

5. Advanced neutron imaging features

	Availability – yes/no
Tomography	Yes (prototype)
Time sequences	no
Grating interferometer	no
Energy selection	no
Polarizer	no
Others	-

6. Involved manpower

	Number
Scientists	2
Students	2
Engineers	1
Technicians	1

7. Applications*

Research topics	Non-metallic materials discontinuities assessment. Cultural heritage objects characterization.
Services for industry	-
Methodical developments	Tomography

**Provide the list for a multiple answer*

8. Revenue generation/recovery

	Yes/No
Presently	no
Future plans	yes

9. Plans for future upgrades

Expected Year	Type of Upgrade
2011-2012	Sample holder and shielding optimisation
2012-2014	1). Install Scanning apparatus within beamline. 2). Improve L/D ratio and increase neutron flux at sample plane.

10. Other* relevant information

**E.g. facility-instrumentation photos can be provided on a separate sheet*

Neutron camera

Exposure room (since 1987)

28. Morocco, MA-R1, 2 MW

1. General information

Country	Morocco
Region, Place/Closest Town	Rabat
Institution	CNESTEN (Centre National De l'Energie des Sciences et Des Techniques Nucléaires).
Facility manager (full name, position, phone, e-mail, web)	OUARDI Afaf, researcher, +212 0537 803 277, ouardi@cnesten.org.ma
Type of neutron source	TRIGA reactor
Source power [MW]	2 MW
Source intensity [n/s or cm^{-2} s^{-1}]	1.03×10^{13}
Availability (hours/year)	1680

2. Beam qualification

Beam line alignment (radial, tangential)	tangential
Neutron spectrum (qualitative: fast, thermal, cold)	thermal
Curved beam guide (monochromator)	
Neutron spectrum at sample position (qualitative: fast, thermal, cold)	0.3 eV
Maximal beam intensity at sample position [cm^{-2} s^{-1}] : (only expected)	$1. \times 10^{6}$
Polarization (yes/no)	No
Neutron/gamma ratio (n cm^{-2} per mGy)	
Cd ratio (foil material)	

3. Beam line layout

	Setting 1	**Setting 2**	**Setting 3**	**Setting 4**
Inlet aperture [mm]	133	133	133	
Filter options (e.g. Bi, Be, Si, sapphire,)	Bi,Sapphire, Be, Cd	Bi,Sapphire, Be, Cd	Bi,Sapphire, Be, Cd	
Aperture - detector distance [cm]	748.3	795.4	812.1	
Resulting L/D (measured or estimated)	748.3	397.6	203.	
Effective beam size [mm]	355 (w_p= 426)	355 (w_p=508)	355 (w_p= 716)	
Flux uniformity (e.g. flat, gaussian, other)	Flat	Flat	Flat	
Corresponding intensity [cm^{-2} s^{-1}]	1.78×10^{6}	1.58×10^{6}	1.51×10^{6}	

4. Detectors* for neutron imaging

	Availability – yes/no
Film based detector (converter material)	Yes
Digital camera based detector (scintilator material)	No
Imaging plate detector	No
Amorphous Si flat panel detector	No
Other	

**Specification of the individual performance parameters on a separate sheet*

5. Advanced neutron imaging features

	Availability – yes/no
Tomography	Yes
Time sequences	Yes
Grating interferometer	
Energy selection	Yes
Polarizer	Yes
Others	

6. Involved manpower

	Number
Scientists	1
Students	1
Engineers	0
Technicians	2

7. Applications*

Research topics	Archaeology, Porous media, fuel pen investigation
Services for industry	Aircraft industry , wood industry
Methodical developments	

**Provide the list for a multiple answer*

8. Revenue generation/recovery

	Yes/No
Presently	No
Future plans	Yes

9. Plans for future upgrades

Expected Year	Type of Upgrade

10. Other* relevant information

**E.g. facility-instrumentation photos can be provided on a separate sheet*

29. Norway, JEEPII, 2MW

1. General information

Country	Norway
Region, Place/Closest Town	Lillestrøm
Institution	Institutt for energiteknikk
Facility manager (full name, position, phone, e-mail, web)	Håkon K. Jenssen,Deputy Head of Dept./Princ. Research Scientist, +4763806089, haakonj@ife.no
Type of neutron source	Heavy Water Reactor (JEEPII)
Source power [MW]	2
Source intensity [n/s or $cm^{-2}s^{-1}$]	2e12 cm^{-2} s^{-1} (thermal)
Availability (hours/year)	1000

2. Beam qualification

Beam line alignment (radial, tangential)	radial
Neutron spectrum (qualitative: fast, thermal, cold)	thermal
Curved beam guide (monochromator)	
Neutron spectrum at sample position (qualitative: fast, thermal, cold)	0.0253 eV
Maximal beam intensity at sample position [cm^{-2} s^{-1}]	~10^7
Polarization (yes/no)	No
Neutron/gamma ratio (n cm^{-2} per mGy)	
Cd ratio (foil material)	

3. Beam line layout

	Setting 1	**Setting 2**
Inlet aperture [mm]	10	
Filter options (e.g. Bi, Be, Si, sapphire,)		
Aperture - detector distance [cm]	238	
Resulting L/D (measured or estimated)	238	
Effective beam size [mm]	210*30	
Flux uniformity (e.g. flat, gaussian, other)		
Corresponding intensity [cm^{-2} s^{-1}]	~10^7	

4. Detectors* for neutron imaging

	Availability – yes/no
Film based detector (converter material)	Yes
Digital camera based detector (scintilator material)	No
Imaging plate detector	No
Amorphous Si flat panel detector	No
Other	No

**Specification of the individual performance parameters on a separate sheet*

5. Advanced neutron imaging features

	Availability – yes/no
Tomography	Yes
Time sequences	Yes
Grating interferometer	No
Energy selection	No
Polarizer	No
Others	No

6. Involved manpower

	Number
Scientists	1
Students	
Engineers	
Technicians	3

7. Applications*

Research topics	Tomography of irradiated rods, hydrogen fuel cell
Services for industry	OECD Halden Reactor Project
Methodical developments	

**Provide the list for a multiple answer*

8. Revenue generation/recovery

	Yes/No
Presently	**Yes**
Future plans	**Yes**

9. Plans for future upgrades

Expected Year	Type of Upgrade
2013	Digital imaging sensor and computerized steering system

10. Other* relevant information

**E.g. facility-instrumentation photos can be provided on a separate sheet*

30. Poland, Maria, 30 MW

1. General information

Country	Poland
Region, Place/Closest Town	Otwock
Institution	Institute of Atomic Energy POLATOM
Facility manager (full name, position, phone, e-mail, web)	Dr. Jacek J. Milczarek, Head of Department, +48605633998, jjmilcz@cyf.gov.pl
Type of neutron source	nuclear research reactor
Source power [MW]	20 MW
Source intensity [n/s or $cm^{-2}s^{-1}$]	4 10^{14} cm^{-2} s^{-1}
Availability (hours/year)	3500 h/y

2. Beam qualification

Beam line alignment (radial, tangential)	radial
Neutron spectrum (qualitative: fast, thermal, cold)	thermal
Curved beam guide (monochromator)	
Neutron spectrum at sample position (qualitative: fast, thermal, cold)	30 meV
Maximal beam intensity at sample position [cm^{-2} s^{-1}]	1.5 x 10^7
Polarization (yes/no)	no
Neutron/gamma ratio (n cm^{-2} per mGy)	
Cd ratio (foil material)	

3. Beam line layout

	Setting 1	**Setting 2**
Inlet aperture [mm]	30	
Filter options (e.g. Bi, Be, Si, sapphire,)		
Aperture - detector distance [cm]	520	
Resulting L/D (measured or estimated)	170	
Effective beam size [mm]	180	
Flux uniformity (e.g. flat, gaussian, other)		
Corresponding intensity [cm^{-2} s^{-1}]	1.1 10^7	

4. Detectors* for neutron imaging

	Availability – yes/no
Film based detector (converter material)	no
Digital camera based detector (scintilator material)	yes
Imaging plate detector	no
Amorphous Si flat panel detector	no
Other	

**Specification of the individual performance parameters on a separate sheet*

5. Advanced neutron imaging features

	Availability – yes/no
Tomography	yes
Time sequences	yes
Grating interferometer	no
Energy selection	no
Polarizer	no
Others	

6. Involved manpower

	Number
Scientists	3
Students	
Engineers	
Technicians	2

7. Applications*

Research topics	Water migration in porous media (imbibition, drying)
Services for industry	Tomography of industrial specimens.
Methodical developments	

**Provide the list for a multiple answer*

8. Revenue generation/recovery

	Yes/No
Presently	Minor
Future plans	Yes

9. Plans for future upgrades

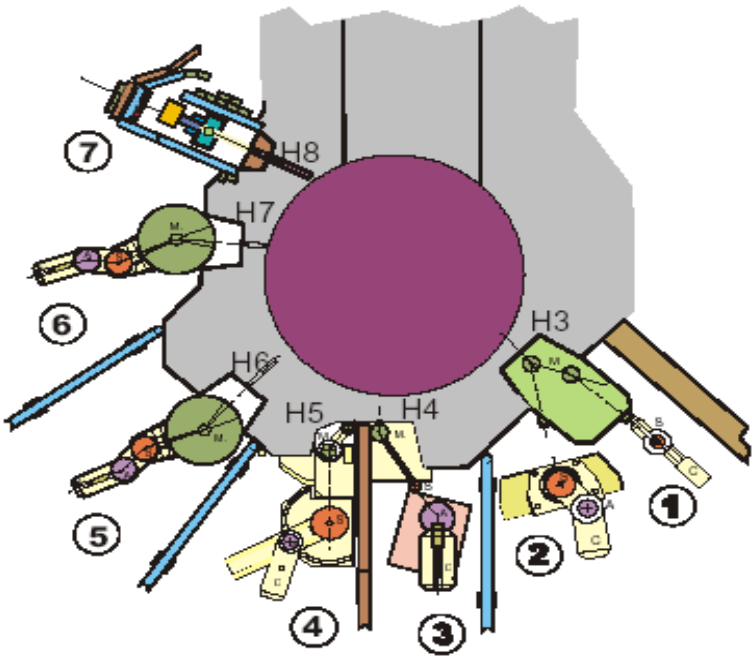
Expected Year	Type of Upgrade
2011	new optical system and image acquisition software
2012	new converter screen

10. Other* relevant information

**E.g. facility-instrumentation photos can be provided on a separate sheet*

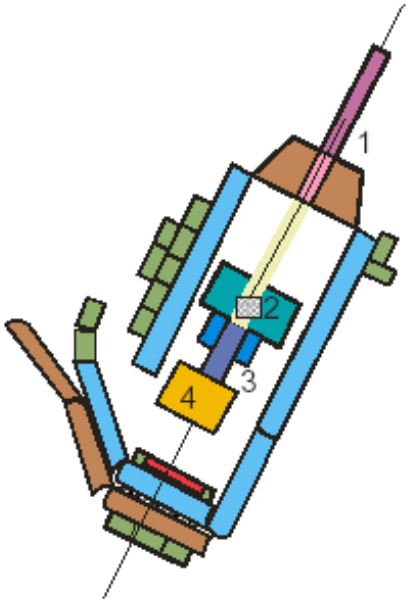
Nuclear research reactor MARIA, Institute of Atomic Energy POLATOM, Poland

Reactor MARIA experimental hall layout



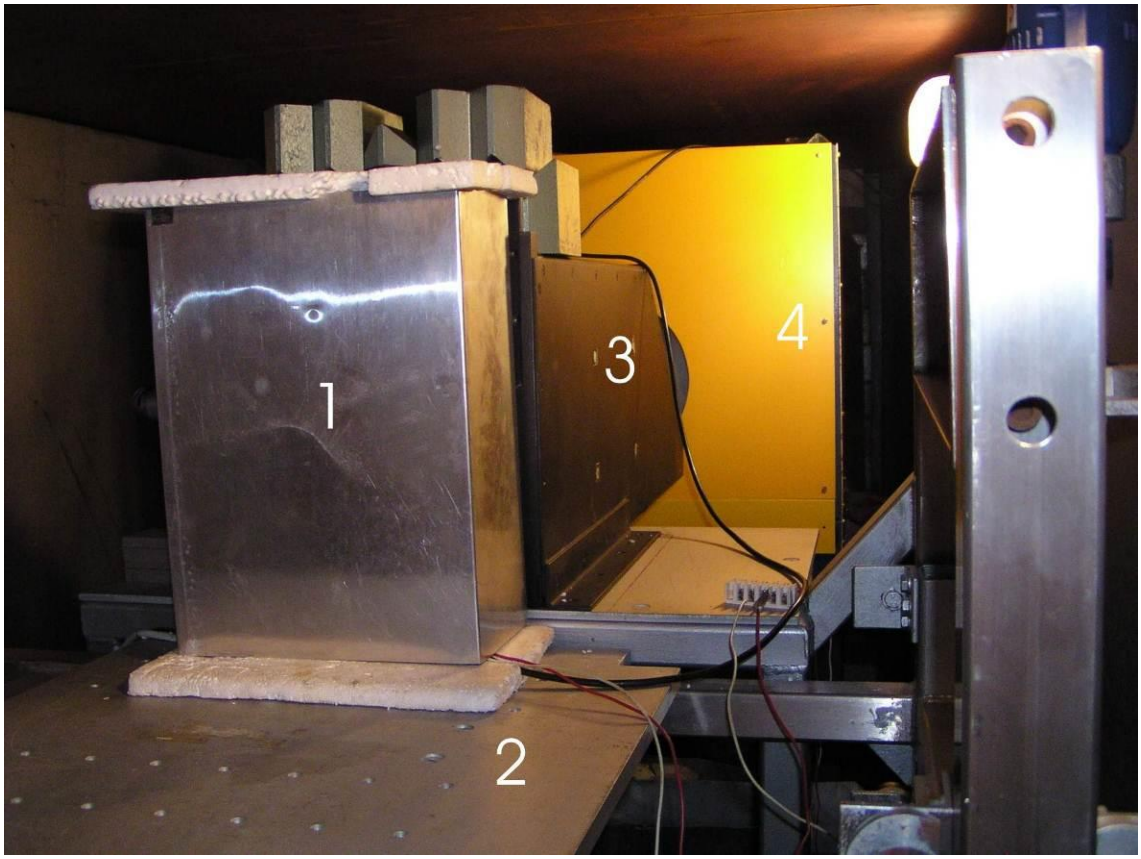
H3	1	small angle neutron scattering diffractometer
	2	neutron diffractometer M
H4	3	double-crystal small angle neutron scattering diffractometer
H5	4	neutron diffractometer P
H6	5	triple-axis spectrometer
H7	6	triple-axis spectrometer
H8	7	neutron and gamma radiography station

NGRS
Neutron and gamma radiography station
at nuclear research reactor MARIA, Institute of Atomic Energy POLATOM, Poland



1. Beam
2. Sample table
3. Optical system
4. Beam trap

Instrument type	Dynamic neutron and gamma radiography facility
Instrument description	Neutron and gamma ray radiography station with separate converter screens for each type of radiation, optical system with digital camera.
Sample environment	Thermal chambers (20 – 80°C) Goniometric table for tomography
Instrument parameters	Cd ratio 20. Fluorescent screens 250 mm × 250 mm. 100<L/D <230. Typical projection ratio ~0.15 mm/pixel neutron flux $1.1 \cdot 10^7 cm^{-2} s^{-1}$ for L/D = 150. Hamamatsu ORCA-ER camera (1280×1024, 12 bit). Typical exposure time 0.6 – 1.6 s.
Field of work	Slow processes (characteristic time ~1 s and length ~1 mm) involving migration of hydrogenous liquids. Temperature and gravitation dependence of water migration in rigid and loose porous media. Drying of porous systems. Nondestructive testing of technical objects.



The inside view of the NGRS neutron and gamma radiography station. The thermal chamber (1) on the object table (2), the optical system box (3) and the beam trap (4) are visible.

31. Romania, TRIGA 14MW, INUS

1. General information

Country	Romania
Region, Place/Closest Town	Arges, Mioveni
Institution	Institute for Nuclear Research
Facility manager (full name, position, phone, e-mail, web)	Marin Dinca, instrument responsible, +40724091052, marin.dinca@nuclear.ro, www.nuclear.ro
Type of neutron source	TRIGA ACPR nuclear reactor
Source power [MW]	0.5 MW in steady state and 20000MW peak pulse
Source intensity [n/s or $cm^{-2}s^{-1}$]	10^{12} $cm^{-2}s^{-1}$
Availability (hours/year)	On request for experiments in steady state

2. Beam qualification

Beam line alignment (radial, tangential)	Tangential
Neutron spectrum (qualitative: fast, thermal, cold)	Thermal
Curved beam guide (monochromator)	
Neutron spectrum at sample position (qualitative: fast, thermal, cold)	0.025 eV
Maximal beam intensity at sample position [cm^{-2} s^{-1}]	3.0E5
Polarization (yes/no)	No
Neutron/gamma ratio (n cm^{-2} per mGy)	
Cd ratio (foil material)	

3. Beam line layout

	Setting 1	**Setting 2**
Inlet aperture [mm]	45	
Filter options (e.g. Bi, Be, Si, sapphire,)		
Aperture - detector distance [cm]	428.8	
Resulting L/D (measured or estimated)	95.29	
Effective beam size [mm]	290	
Flux uniformity (e.g. flat, gaussian, other)		
Corresponding intensity [cm^{-2} s^{-1}]	3.0 x 10^5	

4. Detectors* for neutron imaging

	Availability – yes/no
Film based detector (converter material)	Yes
Digital camera based detector (scintilator material)	Yes
Imaging plate detector	No
Amorphous Si flat panel detector	No
Other	No

**Specification of the individual performance parameters on a separate sheet*

5. Advanced neutron imaging features

	Availability – yes/no
Tomography	Yes
Time sequences	No
Grating interferometer	No
Energy selection	No
Polarizer	No
Others	Gamma tomography

6. Involved manpower

	Number
Scientists	1
Students	-
Engineers	-
Technicians	-

7. Applications*

Research topics	Study of archeological objects
Services for industry	-
Methodical developments	-

**Provide the list for a multiple answer*

8. Revenue generation/recovery

	Yes/No
Presently	No
Future plans	Yes

9. Plans for future upgrades

Expected Year	Type of Upgrade
2013	A new scintillator for neutrons, PGAA involvement

10. Other* relevant information

**E.g. facility-instrumentation photos can be provided on a separate sheet*

32. Romania, TRIGA 14MW, INUM

1. General information

Country	Romania
Region, Place/Closest Town	Arges, Mioveni
Institution	Institute for Nuclear Research
Facility manager (full name, position, phone, e-mail, web)	Marin Dinca, instrument responsible, +40724091052, marin.dinca@nuclear.ro, www.nuclear.ro
Type of neutron source	TRIGA ACPR nuclear reactor
Source power [MW]	0.5 MW in steady state and 20000MW peak pulse
Source intensity [n/s or $cm^{-2}s^{-1}$]	10^{12} $cm^{-2}s^{-1}$
Availability (hours/year)	On request for experiments in steady state

2. Beam qualification

Beam line alignment (radial, tangential)	Underwater facility near TRIGA ACPR
Neutron spectrum (qualitative: fast, thermal, cold)	Thermal
Curved beam guide (monochromator)	
Neutron spectrum at sample position (qualitative: fast, thermal, cold)	0.025 eV
Maximal beam intensity at sample position [cm^{-2} s^{-1}]	5.4E6
Polarization (yes/no)	No
Neutron/gamma ratio (n cm^{-2} per mGy)	
Cd ratio (foil material)	

3. Beam line layout

	Setting 1	**Setting 2**
Inlet aperture [mm]	9	
Filter options (e.g. Bi, Be, Si, sapphire,)		
Aperture - detector distance [cm]	204.3	
Resulting L/D (measured or estimated)	227	
Effective beam size [mm]	385 mm x 100 mm	
Flux uniformity (e.g. flat, gaussian, other)		
Corresponding intensity [cm^{-2} s^{-1}]	5.4 x 10^6	

4. Detectors* for neutron imaging

	Availability – yes/no
Film based detector (converter material)	Yes
Digital camera based detector (scintilator material)	No
Imaging plate detector	No
Amorphous Si flat panel detector	No
Other	Nitrocellulose film

**Specification of the individual performance parameters on a separate sheet*

5. Advanced neutron imaging features

	Availability – yes/no
Tomography	No
Time sequences	No
Grating interferometer	No
Energy selection	No
Polarizer	No
Others	No

6. Involved manpower

	Number
Scientists	1
Students	-
Engineers	-
Technicians	-

7. Applications*

Research topics	Fresh and spent nuclear fuel
Services for industry	-
Methodical developments	-

**Provide the list for a multiple answer*

8. Revenue generation/recovery

	Yes/No
Presently	No
Future plans	No

9. Plans for future upgrades

Expected Year	Type of Upgrade
-	-

10. Other* relevant information

**E.g. facility-instrumentation photos can be provided on a separate sheet*

33. Russian Federation, IBR-2 pulsed, 2MW average

1. General information

Country	Russian Federation
Region, Place/Closest Town	Moscow region, Dubna
Institution	Frank Laboratory of Neutron Physics, Joint Institute for Nuclear Research
Facility manager (full name, position, phone, e-mail, web)	Rutkauskas Anton, Engineer, ranton@nf.jinr.ru
Type of neutron source	pulsed neutron reactor
Source power [MW]	2 MW average (1850 MW in pulse)
Source intensity [n/s or cm^{-2} s^{-1}]	10^{13} n/s or cm^{-2} s^{-1} the time-averaged, 10^{16} n/s or cm^{-2} s^{-1} maximum pulse
Availability (hours/year)	2500 hours/year

2. Beam qualification

Beam line alignment (radial, tangential)	radial
Neutron spectrum (qualitative: fast, thermal, cold)	thermal
Curved beam guide (monochromator)	no
Neutron spectrum at sample position (qualitative: fast, thermal, cold)	thermal
Maximal beam intensity at sample position [cm^{-2} s^{-1}]	5.6×10^6
Polarization (yes/no)	no
Neutron/gamma ratio (n cm^{-2} per mGy)	
Cd ratio (foil material)	

3. Beam line layout

	Setting 1	**Setting 2**
Inlet aperture [mm]	50	
Filter options (e.g. Bi, Be, Si, sapphire,)	Bi	
Aperture - detector distance [cm]	1500	
Resulting L/D (measured or estimated)	194 - 1940	
Effective beam size [mm]	200 x 200	
Flux uniformity (e.g. flat, gaussian, other)	flat	
Corresponding intensity [cm^{-2} s^{-1}]		

4. Detectors* for neutron imaging

	Availability – yes/no
Film based detector (converter material)	no
Digital camera based detector (scintilator material)	yes
Imaging plate detector	no
Amorphous Si flat panel detector	no
Other	no

**Specification of the individual performance parameters on a separate sheet*

5. Advanced neutron imaging features

	Availability – yes/no
Tomography	yes
Time sequences	yes
Grating interferometer	no
Energy selection	no
Polarizer	no
Others	no

6. Involved manpower

	Number
Scientists	3
Students	1
Engineers	1
Technicians	

7. Applications*

Research topics	geology, materials science, planet science
Services for industry	nondestructive testing of various industrial components and products
Methodical developments	Energy dispersive methods, time dependence

**Provide the list for a multiple answer*

8. Revenue generation/recovery

	Yes/No
Presently	Yes
Future plans	Yes

9. Plans for future upgrades

Expected Year	Type of Upgrade
2014 -2015	High frequency camera Andor Neo 5.5 sCMOS
2014 -2015	Digital camera "Videoscan" for routine neutron imaging experiments

10. Other* relevant information

**E.g. facility-instrumentation photos can be provided on a separate sheet*

34. Slovenia, TRIGA Mark II, 0.25 MW

1. General information

Country	Slovenia
Region, Place/Closest Town	Podgorica / broader region of Ljubljana
Institution	Jozef Stefan Institute
Facility manager (full name, position, phone, e-mail, web)	Luka Snoj, +386 1 5885 362, luka.snoj@ijs.si
Type of neutron source	Nuclear reactor
Source power [MW]	250 kW
Source intensity [n/s or $cm^{-2}s^{-1}$]	
Availability (hours/year)	900

2. Beam qualification

Beam line alignment (radial, tangential)	
Neutron spectrum (qualitative: fast, thermal, cold)	Thermal
Curved beam guide (monochromator)	
Neutron spectrum at sample position (qualitative: fast, thermal, cold)	
Maximal beam intensity at sample position [cm^{-2} s^{-1}]	$4.5 \cdot 10^5$
Polarization (yes/no)	no
Neutron/gamma ratio (n cm^{-2} per mGy)	
Cd ratio (foil material)	

3. Beam line layout

	Setting 1	**Setting 2**
Inlet aperture [mm]	50	
Filter options (e.g. Bi, Be, Si, sapphire,)		
Aperture - detector distance [cm]	variable 3m – 5m	
Resulting L/D (measured or estimated)	65 – 80	
Effective beam size [mm]	120	
Flux uniformity (e.g. flat, gaussian, other)		
Corresponding intensity [cm^{-2} s^{-1}]	$4.5 \cdot 10^5$	

4. Detectors* for neutron imaging

	Availability – yes/no
Film based detector (converter material)	Yes
Digital camera based detector (scintilator material)	No
Imaging plate detector	Yes
Amorphous Si flat panel detector	No
Other	No

**Specification of the individual performance parameters on a separate sheet*

5. Advanced neutron imaging features

	Availability – yes/no
Tomography	No
Time sequences	No
Grating interferometer	No
Energy selection	No
Polarizer	No
Others	No

6. Involved manpower

	Number
Scientists	3
Students	2
Engineers	2
Technicians	2

7. Applications*

Research topics	Civil engineering, Archaeology
Services for industry	
Methodical developments	

**Provide the list for a multiple answer*

8. Revenue generation/recovery

	Yes/No
Presently	No
Future plans	Yes

9. Plans for future upgrades

Expected Year	Type of Upgrade

10. Other* relevant information

**E.g. facility-instrumentation photos can be provided on a separate sheet*

35. South Africa, SAFARI-1, 20MW

1. General information

Country	South Africa
Region, Place/Closest Town	Pelindaba, Pretoria
Institution	South African Nuclear Energy Corporation (Necsa)
Facility manager (full name, position, phone, e-mail, web)	Mr Frederik Coenraad de Beer (Frikkie) Section Head: Radiography & Tomography Chief Scientist: Neutron radiography Tel: +27 12 305 5258 Frikkie.debeer@necsa.co.za www.necsa.co.za
Type of neutron source	Nuclear research reactor
Source power [MW]	20
Source intensity [n/s or $cm^{-2}s^{-1}$]	1 x 10^{14} cm^{-2} s^{-1}
Availability (hours/year)	300 days/year = 7200h/y

2. Beam qualification

Beam line alignment (radial, tangential)	Radial
Curved beam guideonochromator)	No
Neutron spectrum at sample position (qualitative: fast, thermal, cold)	Thermal
Curved beam guide (monochromator)	
Neutron spectrum at sample position (qualitative: fast, thermal, cold)	93% Thermal ; 0.025eV
Maximal beam intensity at sample position [cm^{-2} s^{-1}]	1 x 10^{7}
Polarization (yes/no)	No
Neutron/gamma ratio (n cm^{-2} per mGy)	-
Cd ratio (foil material)	-

3. Beam line layout

	Setting 1	**Setting 2**	**Setting 3**	**Setting 4**
Inlet aperture [mm]	5	10	21	
Filter options (e.g. Bi, Be, Si, Sapphire)	Bi	Bi	Bi	
Aperture - detector distance [cm]	2625	2625	2625	
Resulting L/D (Measured or estimated)	525	262	125	
Effective beam size [mm]	~130	~230	~300	
Flux uniformity (Describe profile shape) : (flat; Gaussian; other)	5mm flat	10mm flat	20mm flat	
Corresponding intensity [cm^{-2} s^{-1}]	2.5e6	5e6	1e7	

4. Detectors* for neutron imaging

	Availability – yes/no
Film based detector (Converter material)	Yes (no utilization since 2003) (Direct – Gd) (Transfer – In)
Digital camera based detector (Scintillator)	Yes LiOS GdOS
Imaging plate detector	No
Amorphous Si flat panel detector	No
Other	

**Specification of the individual performance parameters on a separate sheet*

5. Advanced neutron imaging features

	Availability – yes/no
Tomography	Yes (NEUTRA, PSI, Switzerland copy since 2003)
Time sequences	No
Grating interferometer	No
Energy selection	No
Polarizer	No
Others	

6. Involved manpower

	Number
Scientists	4
Students	
Engineers	
Technicians	1

7. Applications*

Research topics	Archaeology Palaeontology Porous media Civil Engineering Reverse Engineering Geosciences
Services for Industry	Yes – Geosciences NDT
Methodical developments	Neutron quantification Porous media Standardization

**Provide the list for a multiple answer*

8. Revenue generation / recovery

	Yes/No
Presently	Ad hoc
Future plans	Ad hoc

9. Plans for future upgrades

Expected Year	Type of Upgrade
2015 Q2	Total upgrade towards new facility on basis of ANTARES, Germany principles - New Shielding - Thermal neutron, Fast neutron & Gamma-Ray radiography/Tomography - Dynamic - Larger flat field (35cm x 35cm) with no gradient in neutron flux
2030	SAFARI-2 with 2 x Radiography beam lines: - Thermal neutron - Cold neutron

10. Other* relevant information

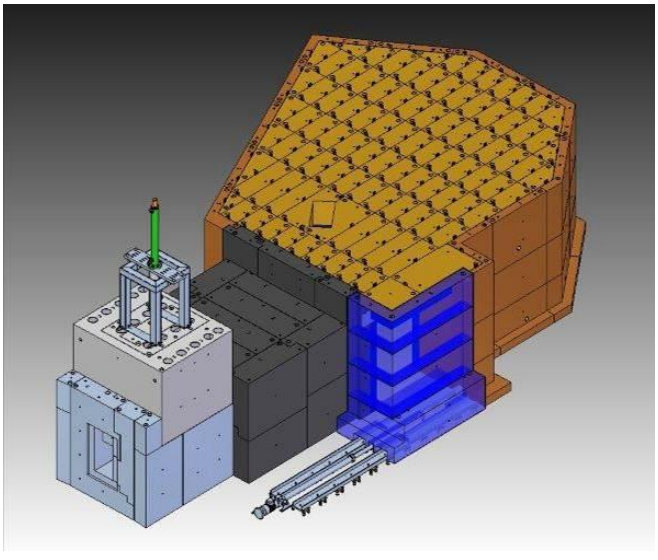
**E.g. facility-instrumentation photos can be provided on a separate sheet*

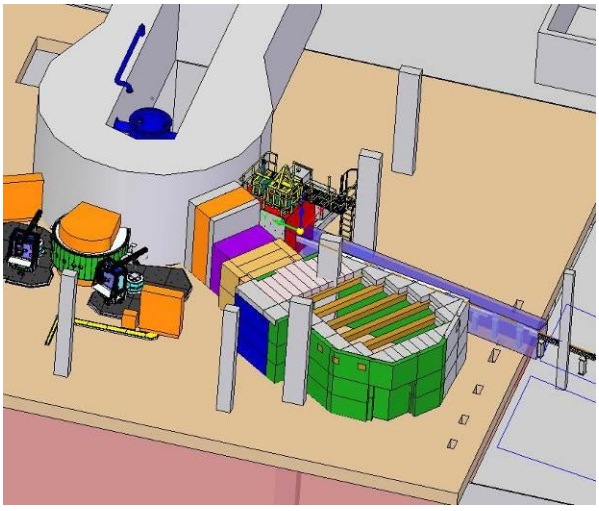
SAFARI-1 NRAD FACILITY IMAGING CHARACTERISTICS

Description	Characteristics
Light tight box	Manufactured by Swiss company
Thermal neutron Scintillator screen	
Model	AST (UK)
Size	25cm x 25cm
Intrinsic resolution	100µm
Spatial resolution	0.4mm
Peak wavelength for thermal neutrons	450nm
Camera:	
Model	DV434 from ANDOR Technology
Pixel array	1024 x 1024
Pixel size	13µm
Cooling	Peltier: Air to ~ -50˚C
Quantum Efficiency at 450nm	~80%
Lenses:	
Types	PENTAX 50 mm, F 1.2 100mm, F2.8 135 mm, F2.8
Field of view	9cm; 13cm 25cm

OLD FACILITY: (Operation from 1999 – Nov 2012)

NEW NRAD FACILITY (SIMULATION) TO BE IN OPERATION FROM FEB 2014





For additional information please contact N.Pessoa-Barradas@iaea.org and Eberhard.Lehmann@psi.ch.

36. Switzerland, ICON, spallation neutron source, 0.8 MW

1. General information

Country	Switzerland
Region, Place/Closest Town	Aargau, Zurich
Institution	Paul Scherrer Institut
Facility manager (full name, position, phone, e-mail, web)	Dr. Anders Kaestner, Beamline scientist, +41563104286, anders.kaestner@psi.ch, http://www.psi.ch
Type of neutron source	Spallation source
Source power [MW]	0.75MW (590MeV proton beam on target)7
Source intensity [n/s or $cm^{-2}s^{-1}$]	3-6x10^{16} n/s (ICON 7.1x10^{8} n/s/mA (aperture 80mm)
Availability (hours/year)	7-8 Months/year

2. Beam qualification

Beam line alignment (radial, tangential)	tangential
Neutron spectrum (qualitative: fast, thermal, cold)	Cold
Curved beam guide (monochromator)	
Neutron spectrum at sample position (qualitative: fast, thermal, cold)	8.53meV/3.1Å
Maximal beam intensity at sample position [cm^{-2} s^{-1}]	1.4x10^{8} n/s/mA
Polarization (yes/no)	No
Neutron/gamma ratio (n cm^{-2} per mGy)	
Cd ratio (foil material)	

3. Beam line layout

Experiment pos 2	**Setting 1**	**Setting 2**	**Setting 3**	**Setting 4**	**Setting 5**
Inlet aperture [mm]	1	10	20	40	80
Filter options (e.g. Bi, Be, Si, sapphire,)					
Aperture - detector distance [cm]	6864	6864	6864	6864	6864
Resulting L/D (measured or estimated)	6864	686	343	172	86
Effective beam size [mm]	150x150	150x150	150x150	150x150	150x150
Flux uniformity (e.g. flat, gaussian, other)					
Corresponding intensity [cm^{-2} s^{-1}]	N/A	3.2x10^{6}	1.3x10^{7}	N/A	1.4x10^{8}

Experiment pos 3	Setting 1	Setting 2	Setting 3	Setting 4	Setting 5
Inlet aperture [mm]	1	10	20	40	80
Filter options (e.g. Bi, Be, Si, sapphire,)					
Aperture - detector distance [cm]	12083	12083	12083	12083	12083
Resulting L/D (measured or estimated)	12083	1208	604	302	151
Effective beam size [mm]	250x300	250x300	250x300	250x300	250x300
Flux uniformity (e.g. flat, gaussian, other)					
Corresponding intensity [cm^{-2} s^{-1}]	N/A	N/A	$3.9x10^6$	N/A	$5.2x10^7$

4. Detectors* for neutron imaging

	Availability – yes/no
Film based detector (converter material)	No
Digital camera based detector (scintilator material)	Yes
Imaging plate detector	Yes
Amorphous Si flat panel detector	Yes
Other	Intensified CCD

**Specification of the individual performance parameters on a separate sheet*

5. Advanced neutron imaging features

	Availability – yes/no
Tomography	Yes
Time sequences	Yes
Grating interferometer	Yes
Energy selection	Yes
Polarizer	No
Others	X ray imaging ability

6. Involved manpower

	Number
Scientists	2
Students	2
Engineers	
Technicians	1

7. Applications*

Research topics	Paleontology, Civil engineering, Energy storage and production. Material science. Porous media in geology and man-made materials.
Services for industry	Combustion engineering, electro chemistry, fault detection
Methodical developments	Grating interferometry, energy selecting imaging

**Provide the list for a multiple answer*

8. Revenue generation/recovery

	Yes/No
Presently	Yes
Future plans	yes

37. Switzerland, NEUTRA, spallation neutron source, 0.8 MW

1. General information

Country	Switzerland
Region, Place/Closest Town	Villigen
Institution	Paul Scherrer Institut
Facility manager (full name, position, phone, e-mail, web)	Dr. Eberhard Lehmann, +41563102963, eberhard.lehmann@psi.ch; www.psi.ch/niag
Type of neutron source	Continuous spallation source
Source power [MW]	0.75 MW
Source intensity [n/s or $cm^{-2}s^{-1}$]	3-6 x 10^{16} n/s
Availability (hours/year)	4800

2. Beam qualification: NEUTRA facility

Beam line alignment (radial, tangential)	tangential
Neutron spectrum (qualitative: fast, thermal, cold)	thermal
Curved beam guide (monochromator)	
Neutron spectrum at sample position (qualitative: fast, thermal, cold)	0.025 eV
Maximal beam intensity at sample position [cm^{-2} s^{-1}]	1.4 10^7 [$n/cm^2/sec$]
Polarization (yes/no)	no
Neutron/gamma ratio (n cm^{-2} per mGy)	
Cd ratio (foil material)	

3. Beam line layout: NEUTRA facility

	Setting 1	**Setting 2**	**Setting 3**
Inlet aperture [mm]	20	20	
Filter options (e.g. Bi, Be, Si, sapphire,)			
Aperture - detector distance [cm]	382	1057	
Resulting L/D (measured or estimated)	350	550	
Effective beam size [mm]	290	400	
Flux uniformity (e.g. flat, gaussian, other)			
Corresponding intensity [cm^{-2} s^{-1}]	1.4 10^7	7.2 10^6	

4. Detectors* for neutron imaging

	Availability – yes/no
Film based detector (converter material)	no
Digital camera based detector (scintilator material)	yes
Imaging plate detector	yes
Amorphous Si flat panel detector	no
Other	

**Specification of the individual performance parameters on a separate sheet*

5. Advanced neutron imaging features: NEUTRA

	Availability – yes/no
Tomography	yes
Time sequences	yes
Grating interferometer	no
Energy selection	no
Polarizer	no
Others	

6. Involved manpower

	Number
Scientists	1
Students	
Engineers	
Technicians	1

7. Applications*

Research topics	Soil physics, plant roots, building materials, nuclear fuel, cultural heritage, etc.
Services for industry	Fuel cell
Methodical developments	Dual modality neutron & X-ray imaging

**Provide the list for a multiple answer*

8. Revenue generation/recovery

	Yes/No
Presently	yes
Future plans	

9. Plans for future upgrades

Expected Year	Type of Upgrade

10. Other* relevant information

Online description of NEUTRA: http://www.psi.ch/sinq/neutra

38. Thailand, TRIGA Mark III, 1 MW

1. General information

Country	Thailand
Region, Place/Closest Town	Bangkok
Institution	Thailand Institute of Nuclear Technology (TINT)
Facility manager (full name, position, phone, e-mail, web)	Wichian Ratanatongchai, Deputy Director of Nuclear Research and Development Division Phone: +66 24019889 ext.5924 e-mail: wichianrt@gmail.com
Type of neutron source	research reactor
Source power [MW]	1
Source intensity [n/s or $cm^{-2}s^{-1}$]	3.1×10^{13} $cm^{-2}s^{-1}$
Availability (hours/year)	700

2. Beam qualification

Beam line alignment (radial, tangential)	tangential
Neutron spectrum (qualitative: fast, thermal, cold)	
Curved beam guide (monochromator)	No
Neutron spectrum at sample position (qualitative: fast, thermal, cold)	
Maximal beam intensity at sample position [cm^{-2} s^{-1}]	1.1×10^{6}
Polarization (yes/no)	No
Neutron/gamma ratio (n cm^{-2} per mGy)	
Cd ratio (foil material)	21

3. Beam line layout

	Setting 1	**Setting 2**
Inlet aperture [mm]	40	
Filter options (e.g. Bi, Be, Si, sapphire,)	Graphite, Pb, Bi	
Aperture - detector distance [cm]	100	
Resulting L/D (measured or estimated)	50	
Effective beam size [mm]	200x200	

4. Detectors* for neutron imaging

	Availability – yes/no
Film based detector	Yes
CCD-camera based detector	Available from July 2014
Imaging plate detector	Yes
Amorphous Si flat panel detector	No
Others (DSLR camera)	

**Specification of the individual performance parameters on a separate sheet*

5. Advanced neutron imaging features

	Availability – yes/no
Tomography	Available soon
Time sequences	No
Grating interferometer	No
Energy selection	No
Polarizer	No
Others	

6. Involved manpower

	Number
Scientists	8
Students	2-4
Engineers	2
Technicians	1

7. Applications*

Research topics	Application of two and three dimensional neutron imaging with focus on cultural heritage research
Services for industry	Design and Installation of Neutron Radiography Beam Control and Radiation Shielding (with Siam City Cement Company)
Methodical developments	- Design and Installation of 3 Dimensions X-ray and Neutron Imaging - Unique application of neutron imaging and other NDT methods in archaeological investigation - Neutron imaging application for growth development determination of biological samples, for example, silk worm and pearl shell

**Provide the list for a multiple answer*

8. Commercial activities

	Yes/No
Presently	No
Future plans	Yes

9. Plans for future upgrades

Expected Year	Type of Upgrade
2014	• Construction upgrade including new shutter, shielding wall and outside containment collimator installation • Making an in-house rotary sample holder and installation • Set up DSLR camera with light tight box and testing for optimized condition for achieving high quality NI
2015	• Adapt in-containment collimator • 3D-NI construction with either DSLR or a specific CCD camera

10. Other* relevant information

**E.g. facility-instrumentation photos can be provided on a separate sheet*

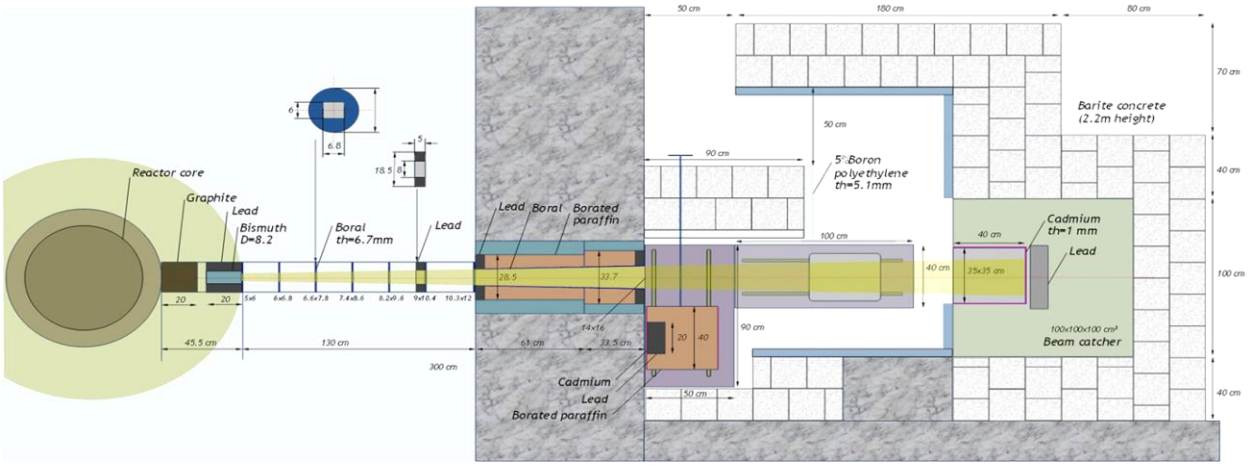


Fig.1 Current NR station at TRR-1/M1 indicated limit working space, small shutter and no behind reactor wall collimator

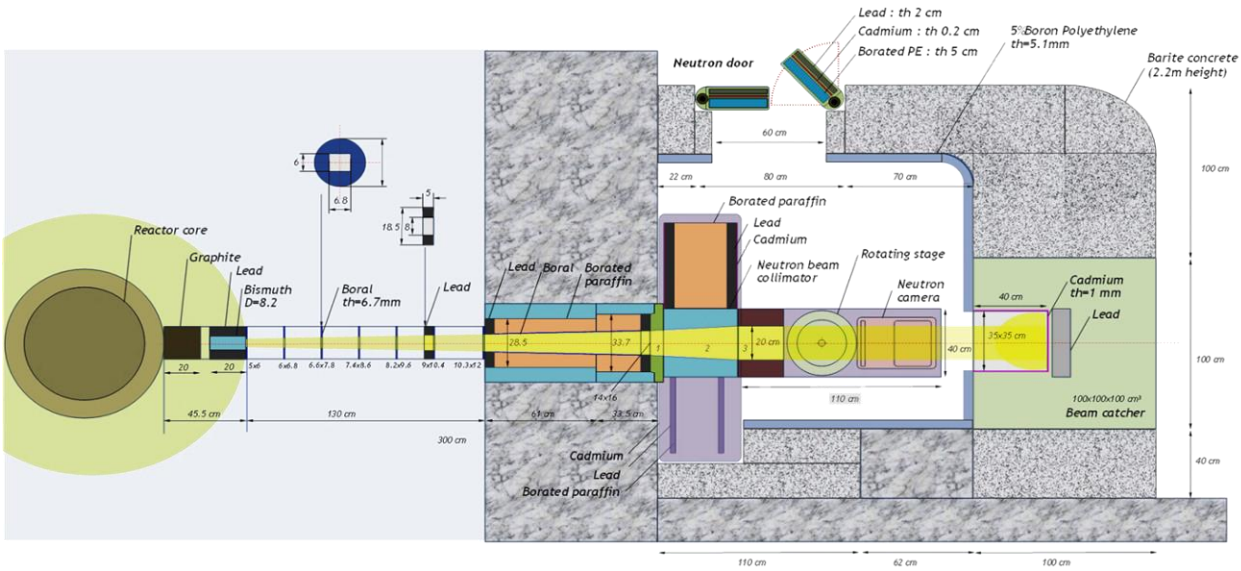


Fig.2 Proposed upgrade NR station at TRR-1/M1 indicated wider working space, more effective shutter, three collimators behind reactor wall and safety

For additional information please contact N.Pessoa-Barradas@iaea.org and Eberhard.Lehmann@psi.ch.

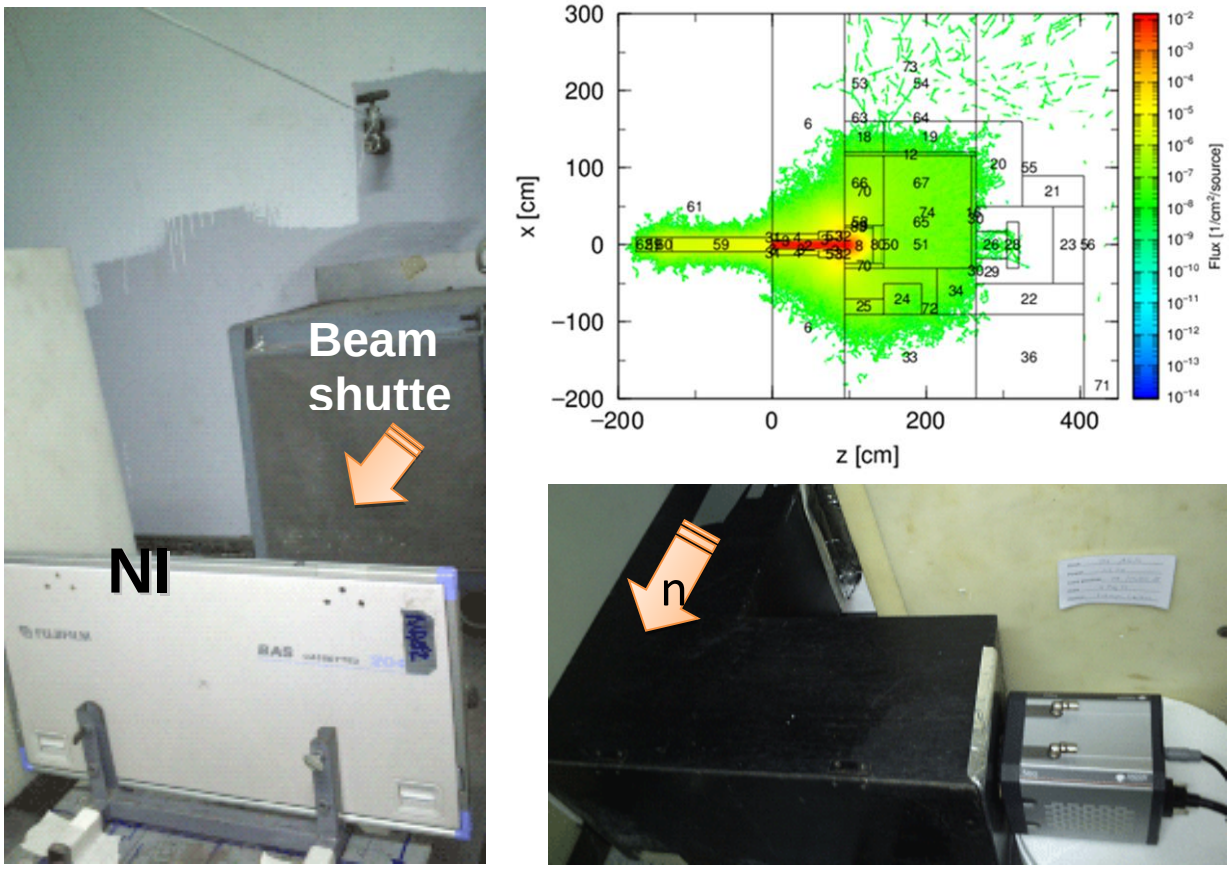


Fig. 3 Beam facility: Photos of the beam facility and simulation of neutron flux

For additional information please contact N.Pessoa-Barradas@iaea.org and Eberhard.Lehmann@psi.ch.

Turkey, Sames T400, 400 keV

1. General information

Country	Turkey
Region, Place/Closest Town	İstanbul/Küçükçekmece
Institution	Çekmece Nuclear Research and Training Centre
Facility manager (full name, position, phone, e-mail, web)	Dr. Recep BIYIK, Head of Department, Work: +90 212 4732600/4100, GSM: +90 533 2482765, recep.biyik@taek.gov.tr
Type of neutron source	Accelerator type
Source power [MW]	400 KeV
Source intensity [n/s or cm^{-2} s^{-1}]	10^{11} (accelerator output)
Availability (hours/year)	No limit

2. Beam qualification

Beam line alignment (radial, tangential)	Radial
Neutron spectrum (qualitative: fast, thermal, cold)	Fast
Curved beam guide (monochromator)	14.1 MeV fast neutron
Neutron spectrum at sample position (qualitative: fast, thermal, cold)	undefined
Maximal beam intensity at sample position [cm^{-2} s^{-1}]	undefined
Polarization (yes/no)	No
Neutron/gamma ratio (n cm^{-2} per mGy)	undefined
Cd ratio (foil material)	undefined

3. Beam line layout

	Setting 1	**Setting 2**
Inlet aperture [mm]		
Filter options (e.g. Bi, Be, Si, sapphire,)	-	
Aperture - detector distance [cm]	100	
Resulting L/D (measured or estimated)	100 (estimated)	
Effective beam size [mm]	270*270	
Flux uniformity (e.g. flat, gaussian, other)	-	
Corresponding intensity [cm^{-2} s^{-1}]	1*10^5	

4. Detectors* for neutron imaging

	Availability – yes/no
Film based detector (converter material)	No
Digital camera based detector (scintilator material)	Yes
Imaging plate detector	No
Amorphous Si flat panel detector	No
Other	

**Specification of the individual performance parameters on a separate sheet*

5. Advanced neutron imaging features

	Availability – yes/no
Tomography	No
Time sequences	No
Grating interferometer	No
Energy selection	No
Polarizer	No
Others	

6. Involved manpower

	Number
Scientists	2
Students	-
Engineers	-
Technicians	-

7. Applications*

Research topics	The FNR facility is a new established so firstly we try to determine the specification of the system and secondly we will start to determine thickness of iron in concrete materials with portable fast neutron generator
Services for industry	No
Methodical developments	

**Provide the list for a multiple answer*

8. Revenue generation/recovery

	Yes/No
Presently	No
Future plans	

9. Plans for future upgrades

Expected Year	Type of Upgrade

10. Other* relevant information

**E.g. facility-instrumentation photos can be provided on a separate sheet*

41. USA, NBSR-NIST, 20 MW

1. General information

Country	United States of America
Region, Place/Closest Town	Gaithersburg, MD
Institution	National Institute of Standards and Technology
Facility manager (full name, position, phone, e-mail, web)	David Jacobson, Physicist, +1-301-975-6207, david.jacobson@nist.gov, http://physics.nist.gov/MajResFac/NIF/index.html
Type of neutron source	Reactor
Source power [MW]	20
Source intensity [n/s or cm^{-2} s^{-1}]	10^{14} cm^{-2} s^{-1}, core flux
Availability (hours/year)	~ 6900 hours / year (recurring reactor cycle: 38 day operation + 10 day maintenance)

2. Beam qualification

Beam line alignment (radial, tangential)	Radial
Neutron spectrum (qualitative: fast, thermal, cold)	Thermal
Curved beam guide (monochromator)	Double monochromator available
Neutron spectrum at sample position (qualitative: fast, thermal, cold)	Thermal
Maximal beam intensity at sample position [cm^{-2} s^{-1}]	~ 3×10^7 (with 10 cm cooled single crystal Bi Filter) ~ 1.2×10^8 (without filter; requires special permission to operate in this mode)
Polarization (yes/no)	Yes (He-3 polarizer)
Neutron/gamma ratio (n cm^{-2} per mGy)	Not yet measured: Due to in beam cooled single crystal Bi filter, gamma and fast neutron contents are expected to be low
Cd ratio (foil material)	>20

3. Beam line layout

	Setting 1	**Setting 2**	**Setting 3**	**Setting 4**	**Setting 5**
Inlet aperture [mm]	20 (Circular)	15 (Circular)	10 (Circular)	2 × 20	1 × 10
Filter options (e.g. Bi, Be, Si, sapphire,)	10 cm Bi	10 cm Bi	10 cm Bi	10 cm Bi	10 cm Bi
Aperture - detector distance [cm]	600	600	600	600	600
Resulting L/D	300	450	600	3000×300	6000×600
Effective beam size [mm]	260	260	260	260	260
Flux uniformity (flat, gaussian, etc.)	Flat	Flat	Flat	Flat	Flat
Corresponding intensity [cm^{-2} s^{-1}]	3×10^7	1.4×10^7	5×10^6	3×10^6	7×10^5

4. Detectors* for neutron imaging

	Availability – yes/no
Film based detector (converter material)	No
Digital camera based detector (scintilator material)	Yes Scintillators: *GadOx (7.6 µm and 20 µm), *LiF:ZnS (150 µm and 300 µm) Cameras: *Andor NEO sCMOS, *Andor iXON *EMCCD, *Andor iKON, Spectral Instruments 1110 (100 MP CCD)
Imaging plate detector	Yes, *Fujifilm BAS-1800 II
Amorphous Si flat panel detector	Yes, *Varian PaxScan 2520
Other	Yes,*40 mm Micro-channel Plate, *100 mm Micro-channel Plate

**Specification of the individual performance parameters on a separate sheet*

5. Advanced neutron imaging features

	Availability – yes/no
Tomography	Yes
Time sequences	Yes
Grating interferometer	Developing
Energy selection	Yes
Polarizer	Yes
Others	Extensive Fuel Cell test and control infrastructure, Hydrogen storage materials testing infrastructure

6. Involved manpower

	Number
Scientists	2
Students	Intermittent
Engineers	Available on Demand
Technicians	1 (higher number on demand)

7. Applications*

Research topics	(*see attached list for details) Neutron focusing optics, neutron detection, proton exchange membrane fuel cells, lithium batteries, two phase flow, porous media, heat pipes, image analysis
Services for industry	Free Collaborative beam time access and Proprietary access available via full cost recovery
Methodical developments	Neutron image forming optics, neutron detectors, image analysis, phase imaging, energy selective imaging, advanced data reduction techniques, nano-fabrication of neutron gratings

**Provide the list for a multiple answer*

8. Revenue generation/recovery

	Yes/No
Presently	Yes: Full cost recovery for proprietary research
Future plans	Yes: Full cost recovery for proprietary research

9. Plans for future upgrades

Expected Year	Type of Upgrade
2014	**Addition of a Cold Imaging Facility in the guide hall**
2014	In situ x-ray radiography

10. Other* relevant information

**E.g. facility-instrumentation photos can be provided on a separate sheet*

(See separate sheet)

Attachments

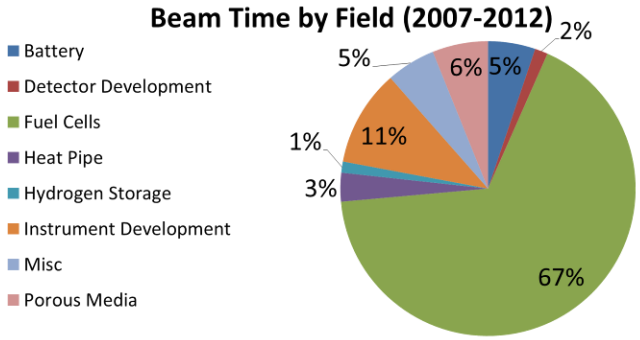
4. Detectors* for neutron imaging (specification list)

Scintillator Material	Substrate	Thickness (µm)	Manufacturer
^{6}LiF/ZnS:Cu,Al,Au	Al	300	Applied Scintillator Technologies
^{6}LiF/ZnS:Cu,Al,Au	Al	150	Applied Scintillator Technologies
Gd_2O_2S(Tb)	Si	7.6	Lexel Imaging Systems, Inc.
Gd_2O_2S(Tb)	Si	20	Lexel Imaging Systems, Inc.

Detector Name	Inventory	Detection Medium	Spatial Resolution	Pixel Pitch	Max (typical) Frame rate	FOV
Amorphous Silicon, Full Resolution (Varian Paxscan)	4	ZnS:LiF scintillator, 300 µm thick	250 µm	127 µm	10 Hz (1 Hz)	25 cm × 20 cm
Amorphous Silicon, Binned Resolution (Varian Paxscan)	(see previous)	ZnS:LiF scintillator, 300 µm thick	500 µm	254 µm	30 Hz	25 cm × 20 cm
XS MCP (Sensor Sciences)	1	Micro-channel plate detector with cross-strip readout anode	10 µm	5 µm	1 Hz (0.01 Hz)	4 cm diameter
EMCCD (Andor iXon)	1	GadOx, 20 µm thick	50 µm	13.6 µm	30 Hz (0.1 Hz)	1.4 cm × 1.4 cm
EMCCD (Andor iXon)	(see previous)	GadOx, 7 µm thick	18 µm	8.5 µm	30 Hz (0.05 Hz)	1.0 cm × 1.0 cm
CCD (Andor iKon-L)	1	GadOx, 20 µm thick	50 µm	21.6 µm	0.2 Hz (0.05 Hz)	4.4 cm × 4.4 cm
sCMOS (Andor NEO)	2	ZnS:LiF scintillator, 300 µm thick	250 µm	120 µm	100 Hz (30 Hz)	25 cm × 25 cm
sCMOS (Andor NEO)	(see previous)	GadOx, 7 µm thick	15 µm	6.5 µm	100 Hz (0.1 Hz)	1.7 cm × 1.4 cm
Large XS MCP (Sensor Sciences)	1	Micro-channel plate detector with cross-strip readout anode	<15 µm	5 µm	1 Hz (0.01 Hz)	9 cm × 9 cm
100 MegaPixel CCD (Spectral Instruments)	1	GadOx, 7 µm thick	<20 µm	9 µm	>0.1 Hz	10 cm × 10 cm
XDL MCP (Sensor Sciences)	2	Micro-channel plate detector with cross-delay line anode	25 µm	13 µm	1 Hz (0.01 Hz)	2 cm diameter
Fujifilm BAS-1800 II	1	BAS-ND2025 Neutron Sensitive, Dysprosium foil tranfer	100 µm	50 µm	0.0001 Hz	20 cm x 25 cm

7. Applications

Research Field	Beam Time by Field
Battery	5%
Detector Development	1%
Fuel Cells	67%
Heat Pipe	3%
Hydrogen Storage	1%
Instrument Development	11%
Misc	5%
Porous Media	6%



- Research topics
  - PEM Fuel Cells
  - Batteries
  - Electrolysis devices
  - Hydrogen storage
  - Heat pipes
  - Archeology
  - Liquid-vapor heat exchangers
  - Geology
  - Porous media: soils, concrete, carbon paper
- Industrial projects
  - Fuel cells
  - Hydrogen storage
  - Batteries
  - Detector development
  - Radiation effects
- Methodical developments
  - High resolution imaging
  - Large format detectors
  - Phase contrast imaging (pinhole)
  - Phase gradient imaging (gratings)
  - Polarized neutron imaging
  - Dynamic tomography
  - Dynamic radiography
  - Energy selective imaging
  - Advanced image processing
  - Neutron focusing optics
  - In situ x-ray imaging

10. Other* relevant information

The National Institute of Standards and Technology (NIST) Neutron Imaging Facility (NNIF) (Figure 1) operates at the NIST Center for Neutron Research (NCNR) located in Gaithersburg, Maryland, U.S.A. This facility provides researchers access to the state-of-the-art in neutron imaging through the long standing NCNR facility user program. The program focuses on advanced imaging methods, advanced high resolution and large format detector development, advanced image analysis and high level technical support to specific program areas: fuel cells, hydrogen storage, and batteries.

Figure 1. View of the NIST Neutron Imaging Facility in the NCNR confinement building.

Accessing the Facility

Beam time at the NNIF is publically accessible through one of two mechanisms. The first is thorough submitting research proposals online during calls for proposals described here (http://www.ncnr.nist.gov/call/current_call.html). Proposals are peer reviewed for merit, and if successful, are assigned beam time at no cost, provided the results are published. The second mechanism is paid proprietary access. This is arranged by directly contacting the facility staff to determine pricing, feasibility and availability. Once appropriate arrangements are made beam time is then assigned.

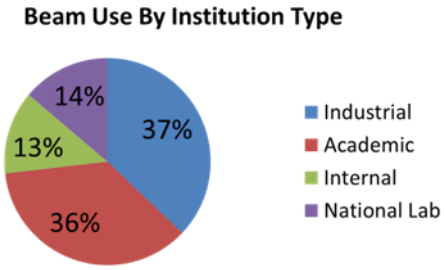


Figure 2. Beam usage by institution type.

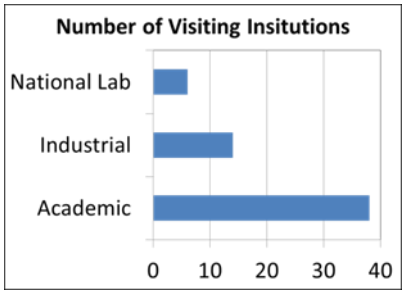


Figure 3. Number of visiting institutions.

Fuel Cell Support

The facility has developed an extensive fuel cell infrastructure due in large part to an ongoing partnership with General Motors. This infrastructure includes 2 test stands: one supports small scale fuel cells up to 50 cm^2 in active area (Figure 4); the other supports cells with large active areas used for commercial fuel cell applications. The detailed list of specifications are as follows:

- Hydrogen Generator (**Figure 5**), max H_2 flow 18.8 slpm
- State of the art Fuel Cell test stand, with GUI
  - Flow control over H2, Air, N2, He, O2:
    - H2: 0-50, 0-500 and 0-3000 sccm
    - N2: 0-2000 sccm
    - Air: 0-50, 0-100, 0-500, 0-2000, 0-8000 sccm
    - O2: 0-500, 0-5000 sccm
    - He: 0-600, 0-6000 sccm
  - 1.5 kW boost power supply allowing Voltage control of the cell to a minimum of 0.01V
  - Heated Inlet gas lines, Built-in humidification
  - 8 T-type thermocouple inputs

Figure 4. Small Scale fuel cell test stand (left) and industrial scale test stand (right).

  - 2 Viasala dew point sensors available[1]
  - Interfaced with facility hydrogen safety system
- Industrial size fuel cell test stand
  - Flow
    - H_2: 0-1,400, 0-11,310 sccm
    - Air: 240-4,200; 240-26,920 sccm
  - Load 12 kW
  - Heated Inlet gas lines, Built-in humidification
  - Liquid coolant D_2O flow up to 2 slpm
  - Interfaced with facility hydrogen safety system
- Freeze Chamber (**Figure 6**) Available to All Users
  - -40 C to +50 C, 1000 kW cooling at -40 C
  - 32" W, 24" H, 18" D sample volume
  - Explosion-proof, and Hydrogen safe
- Zahner IM6eX Electrochemical Workstation available
- All users of the NIST NIF have full access to all fuel cell infrastructure

Figure 5. Nitrogen gas, hydrogen generator and deionized water supply.

Figure 6. Environmental chamber that allows in situ testing from -40 °C to 50 °C.

Hydrogen storage

Up to a maximum of 100 L of hydrogen can be stored and used through a high pressure stainless steel manifold available to users at the beamline. Both ^1H and ^2H isotopes of hydrogen can be used to optimize contrast while studying hydrogen storage vessels. Larger volumes can be accommodated after a safety review.

Battery Support

Battery support is provided through a Zahner IM6 electrochemical workstation.

Figure 7. Varian Paxscan detector, 250 µm spatial resolution.

Detectors

Work at the facility has pursued improving spatial resolution from 250 micrometers to the current spatial resolutions approaching 10 micrometers utilizing both microchannel plate detectors and gadox scintillator based detectors. Efforts are continuing to work towards resolutions as low as 1 micrometer. Current resolutions near 10 micrometers are achieved with both microchannel plate detectors and with thin GadOx screens using both CCD and sCMOS cameras. Large format detectors offering 100 Mega pixel frame sizes allow for near 10 micrometer resolution with large fields of view (10 cm). High frame rate/real time neutron imaging at 30 fps (frames per second) can be achieved using amorphous silicon flat panel detectors (Figure 7). Higher frame rates approaching 90 fps are possible using the sCMOS camera utilizing LiF:ZnS screens.

[1] Certain trade names and company products are mentioned in the text or identified in an illustration in order to adequately specify the experimental procedure and equipment used. In no case does such identification imply recommendation or endorsement by the National Institute of Standards and Technology, nor does it imply that the products are necessarily the best available for the purpose.

Data Analysis

Software written in house is freely distributed to facility users to analyze data offline. Facility staff collaborate with users on data analysis and provide additional support by adding new capabilities as needed. The software is distributed as IDL redistributables and can be run using the IDL Virtual Machine.

In addition to the in house software access to Octopus tomography reconstruction software is available at the facility to allow tomography data sets to be reconstructed. To visually display these data sets Volume Graphics Studio is also available to users of the facility during visits to the facility.

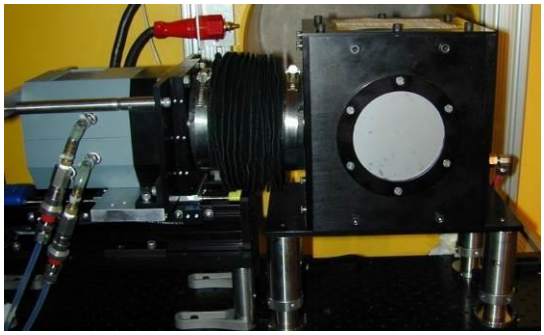


Figure 8. High resolution CCD system, 20 µm spatial resolution.

Data Acquisition Software

All detectors are programmed by facility staff to be tailored to the needs of the facility users and to ensure the reliability of the software.

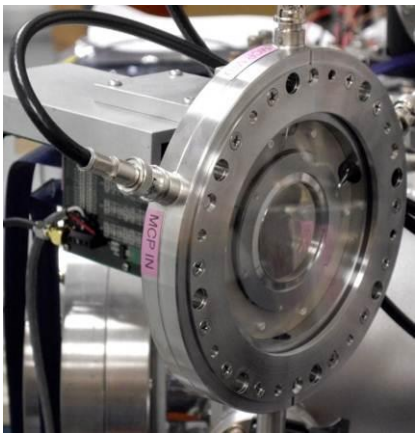


Figure 9. Microchannel plate detector with 10 µm spatial resolution.

Future Facilities Upgrades

A cold imaging facility is designed and is projected to be available near the end of 2014. This new facility will be installed on the end of a cold neutron guide to provide both polychromatic and monochromatic cold neutrons. New neutron focusing Wolter optics will be tested at this facility with a goal to provide a practical neutron microscope for neutron imaging. If successful a neutron microscope could provide both improved spatial and temporal resolution for high resolution neutron imaging. Other novel cold neutron methods like phase contrast imaging will also be available to facility users. In addition to cold neutrons in situ access to x-ray microfocus sources will also be developed and incorporated into the NNIF and the cold imaging facility for applications that need the complimentary information that x-rays can provide.

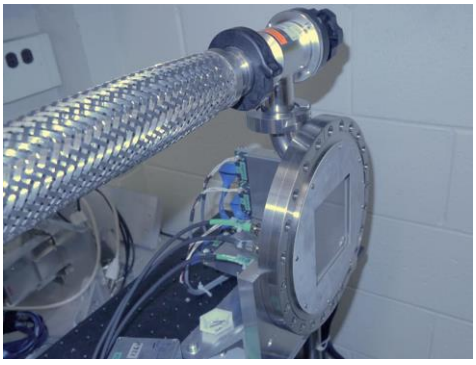


Figure 10. Large microchannel plate detector. FOV 9 cm x 9 cm. Spatial resolution 15 µm.

Facility Users 2010-2013

A123
Automotive Fuel Cell Corporation
Ballard
Chrysler
Dupont
Exxon
Ford
General Motors
Howard University
Los Alamos National Laboratory
Lawrence Berkeley National Laboratory
Louisiana State University
Massachusetts Institute of Technology
NASA, Marshall Space Flight Center
Nissan

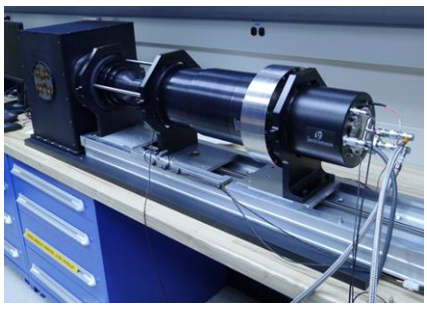


Figure 11. Large CCD, 10 kPixel x 10 kPixel, FOV 10 cm x 10 cm, Scintillator 20 µm Gadox. Overall resolution 20 µm.

NIST
NOVA Scientific
Nuvera
Oak Ridge National Laboratory
Penn State
Purdue
Proctor and Gamble
Rhodia
RMD
Rochester Institute of Technology
Rutgers
Sandia National Laboratory
Sensor Sciences
SUNY, Binghamton
U.S. Army TARDEC
Technology Assessment & Transfer
Thermacore
University of California, Berkeley
University of California, Irvine
University of Connecticut
University of Kansas
University of Maryland
University of Michigan
University of Missouri, Columbia
University of Michigan
University of South Carolina
University of Tennessee, Knoxville
University of Texas, Austin
University of Waterloo
Wayne State University
Wright Patterson Airforce Base

42. USA, OSTR Oregon State, 1.10 MW

1. General information

Country	**USA**
Region, Place/Closest Town	**Corvallis, Oregon**
Institution	**Oregon State University**
Facility manager (full name, position, phone, e-mail, web)	Steve Reese, Director Steve.reese@oregonstate.edu / +1-541-737-2341
Type of neutron source	**GA Mark II TRIGA Reactor**
Source power [MW]	**1.1**
Source intensity [cm^{-2} s^{-1}]	**1.0E13**
Availability (hours/year)	**Normal working hours 0800 to 1700 each day**

2. Beam qualification

Beam line alignment (radial, tangential)	**Tangential**
Neutron spectrum (qualitative: fast, thermal, cold)	**Thermal**
Neutron spectrum (mean energy)	**-**
Maximal beam intensity at sample position [cm^{-2} s^{-1}]	**4.4E6 +/- 2.9E3**
Polarization (yes/no)	**No**

3. Beam line layout

	Setting 1	Setting 2	Setting 3	Setting 4	Setting 5
Inlet aperture [mm]	**152.4X177.8**	**152.4X177.8**	**152.4X177.8**		
Aperture - detector distance [cm]	**30**	**183**	**366**		
Resulting L/D	**86 +/- 4**	**101 +/- 1**	**117 +/- 4**		
Effective beam size [mm]	**44 X 52**	**172 X 229**	**360 X 440**		
Corresponding intensity [cm^{-2} s^{-1}]		**4.4E6 +/- 2.9E3**			

4. Detectors* for neutron imaging

	Availability – yes/no
Film based detector	**No**
CCD-camera based detector	**Yes**
Imaging plate detector	**Yes**
Amorphous Si flat panel detector	**No**
Others	**MCP Based Detector**

Specification of the individual performance parameters on a separate sheet

5. Advanced neutron imaging features

	Availability – yes/no
Tomography	**yes**
Time sequences	**no**
Grating interferometer	**no**
Energy selection	**no**
Polarizer	**no**
Others	

6. Involved manpower

	Number
Scientists	**1**
Students	**1**
Engineers	**1**
Technicians	**1**

7. Applications*

Research topics	**Simulation of spent fuel neutron radiography**
Industrial projects	**Boron content of materials**
Methodical developments	

Provide the list for a multiple answer

8. Commercial activities

	Yes/No
Presently	**No**
Future plans	**No**

9. Plans for future upgrades

Expected Year	**Type of Upgrade**

10. Other* relevant information

E.g. facility-instrumentation photos can be provided on a separate sheet

43. USA, UC Davis, TRIGA Mark III, 1.0 MW

1. General information

Country	USA
Region, Place/Closest Town	Sacramento, California
Institution	Univ. of California, Davis
Facility manager (full name, position, phone, e-mail, web)	Barry M. Klein contact: Michael Lerche, mlerche@ucdavis.edu
Type of neutron source	TRIGA Mark III
Source power [MW]	1 (rated at 2)
Source intensity [n/s or cm^{-2} s^{-1}]	10^{13} n/cm^2s in central core position
Availability (hours/year)	4 Beams at 2000h/year each

2. Beam qualification

Beam line alignment (radial, tangential)	all tangential
Neutron spectrum (qualitative: fast, thermal, cold)	all thermal
Curved beam guide (monochromator)	none
Neutron spectrum at sample position (qualitative: fast, thermal, cold)	all thermal
Maximal beam intensity at sample position [cm^{-2} s^{-1}]	4 Beams: 1.5 $x10^7$/ 1.5 $x10^7$/ 7 $x10^6$/ 6 $x10^6$
Polarization (yes/no)	no
Neutron/gamma ratio (n cm^{-2} per mGy)	4 Beams: 9 $x10^6$ / 9 $x10^6$/ 1.9 $x10^7$/ 5.2 $x10^8$
Cd ratio (foil material)	4 Beams: 6/ 6/ 6/ 30 (Gold)

3. Beam line layout

	Beam 1	**Beam 2**	**Beam 3**	**Beam 4**	**Setting 5**
Inlet aperture [mm]	35.6	35.6	39.6	31.8 (square)	
Filter options (e.g. Bi, Be, Si, sapphire,)	none	none	none	280 mm sapphire permanently installed	
Aperture - detector distance [cm]	710	710	690	950	
Resulting L/D (measured or estimated)	200	200	175	300	
Effective beam size [mm]	600	600	500	450 (square)	
Flux uniformity (e.g. flat, gaussian, other)	flat	flat	flat	flat	
Corresponding intensity [cm^{-2} s^{-1}]	3 $x10^6$	3 $x10^6$	4.7 $x10^6$	2.9 $x10^5$	

4. Detectors* for neutron imaging

	Availability – yes/no
Film based detector (converter material)	yes, all 4 beams, using Gd based converters
Digital camera based detector (scintilator material)	no: Beam 1 and 2 yes: Beam 3 and 4: using LiF based screens
Imaging plate detector	yes all 4 beams
Amorphous Si flat panel detector	no
Other	no

**Specification of the individual performance parameters on a separate sheet*

5. Advanced neutron imaging features

	Availability – yes/no
Tomography	4 Beams: no/no/yes/yes
Time sequences	none
Grating interferometer	none
Energy selection	none
Polarizer	none
Others	none

6. Involved manpower

	Number
Scientists	1
Students	1
Engineers	0
Technicians	4

7. Applications*

Research topics	PEM fuel cell design, Geology
Services for industry	Turbine blades, pyrotechnical devices
Methodical developments	currently none

**Provide the list for a multiple answer*

8. Revenue generation/recovery

	Yes/No
Presently	yes ~50%
Future plans	yes ~50%

9. Plans for future upgrades

Expected Year	Type of Upgrade

10. Other* relevant information

**E.g. facility-instrumentation photos can be provided on a separate sheet*

ad 2: Maximal beam intensity is based on lowest L/D setting possible and 1.5 MW steady state operating power.

44. USA, ORNL, HFIR, 85 MW

1. General information

Country	USA
Region, Place/Closest Town	Oak Ridge, TN
Institution	Oak Ridge National Laboratory
Facility manager (full name, position, phone, e-mail, web)	Hassina Bilheux, Instrument Scientist, (+1) 865-384-9630, bilheuxhn@ornl.gov
Type of neutron source	Reactor
Source power [MW]	85
Source intensity [cm^{-2} s^{-1}]	2.5 x10^{15} thermal
Availability (hours/year)	2700

2. Beam qualification

Beam line alignment (radial, tangential)	Facing cold source
Neutron spectrum (qualitative: fast, thermal, cold)	Cold
Curved beam guide (monochromator)	2 channel curved guide system
Neutron spectrum at sample position (qualitative: fast, thermal, cold)	Cold
Maximal beam intensity at sample position [cm^{-2} s^{-1}]	7.5 x 10^{6}
Polarization (yes/no)	no
Neutron/gamma ratio (n cm^{-2} per mGy)	
Cd ratio (foil material)	

3. Beam line layout

	Setting 1	**Setting 2**	**Setting 3**
Inlet aperture [mm]	12	8	
Filter options (e.g. Bi, Be, Si, sapphire,)	No	No	
Aperture - detector distance [cm]	580	580	
Resulting L/D (measured or estimated)	480	725	
Effective beam size [mm]			
Flux uniformity (e.g. flat, gaussian, other)	other	other	
Corresponding intensity [cm^{-2} s^{-1}]			

4. Detectors* for neutron imaging

	Availability – yes/no
Film based detector (converter material)	No
Digital camera based detector (scintilator material)	Yes
Imaging plate detector	No
Amorphous Si flat panel detector	No
Other	MCP

**Specification of the individual performance parameters on a separate sheet*

5. Advanced neutron imaging features

	Availability – yes/no
Tomography	Yes
Time sequences	Yes
Grating interferometer	No
Energy selection	No
Polarizer	No
Others	-

6. Involved manpower

	Number
Scientists	1.5
Students	0
Engineers	0.2
Technicians	0.5

7. Applications*

Research topics	Energy Storage, Biomedical, Materials Science, Engineering, Geosciences, Cultural Heritage
Services for industry	Yes
Methodical developments	

**Provide the list for a multiple answer*

8. Revenue generation/recovery

	Yes/No
Presently	
Future plans	

9. Plans for future upgrades

Expected Year	Type of Upgrade
2013	New MCP detector
2013	New aperture/diffuser set

10. Other* relevant information

**E.g. facility-instrumentation photos can be provided on a separate sheet*

45. USA, PSBR PENN ST. UNIV., TRIGA, 1MW

1. General information

Country	USA
Region, Place/Closest Town	University Park, Pennsylvania
Institution	Pennsylvania State University
Name of the Facility	Radiation Science and Engineering Center
Facility manager (full name, position, phone, e-mail, web)	Dr. Kenan Unlu, Director, 814-865-6351, k-unlu@psu.edu
Type of neutron source	Research Reactor
Source power [MW]	1
Source intensity [cm^{-2} s^{-1}]	10^{13} in the core
Availability (hours/year)	2000

2. Beam qualification

Beam line alignment (radial, tangential)	Tangential
Neutron spectrum (qualitative: fast, thermal, cold)	Thermal
Neutron spectrum (mean energy)	0.025 eV
Maximal beam intensity at sample position [cm^{-2} s^{-1}]	2 x10^{7}
Polarization (yes/no)	No

3. Beam line layout

	Setting 1	**Setting 2**
Inlet aperture [mm]	32 mm	
Aperture - detector distance [cm]	4900 mm	
Resulting L/D	150	
Effective beam size [mm]	300 mm	
Corresponding intensity [cm^{-2} s^{-1}]	2 x10^{7}	

4. Detectors* for neutron imaging

	Availability – yes/no
Film based detector	Yes
CCD-camera based detector	Yes
Imaging plate detector	Yes
Amorphous Si flat panel detector	No
Others	No

**Specification of the individual performance parameters on a separate sheet*

5. Advanced neutron imaging features

	Availability – yes/no
Tomography	Yes
Time sequences	Yes
Grating interferometer	No
Energy selection	No
Polarizer	No
Others	No

6. Involved manpower

	Number
Scientists	0
Students	2
Engineers	3
Technicians	1

7. Applications*

Research topics	Fuel cells, water movement in porous materials
Industrial projects	Boron distribution
Methodical developments	Image quality devices/indicators

**Provide the list for a multiple answer*

8. Commercial activities

	Yes/No
Presently	Yes
Future plans	Yes

9. Plans for future upgrades

Expected Year	Type of Upgrade
2012	Collimator upgrade
Undetermined	Beam hall expansion

10. Other* relevant information

**e.g. facility-instrumentation photos can be provided on a separate sheet*

46. USA, LANL, LANSCE spallation, 0.08 MW

1. General information

Country	**U.S.A.**
Region, Place/Closest Town	**Los Alamos, New Mexico**
Institution	**Los Alamos National Laboratory**
Facility manager (full name, position, phone, e-mail, web)	**Sven Vogel, Instrument Scientist for imaging, 505-667-7016, sven@lanl.gov, lansce.lanl.gov**
Type of neutron source	**Spallation**
Source power [MW]	**0.08**
Source intensity [n/s]	**10^{15}**
Availability (hours/year)	**2000-4000, depending on accelerator schedule**

2. Beam qualification

Beam line alignment (radial, tangential)	**radial**
Neutron spectrum (qualitative: fast, thermal, cold)	**100 eV to 1 meV, energy resolved**
Curved beam guide (monochromator)	
Neutron spectrum at sample position (qualitative: fast, thermal, cold)	**Maxwellian at 60 meV**
Maximal beam intensity at sample position [cm^{-2} s^{-1}]	**$2x10^7$**
Polarization (yes/no)	**no**
Neutron/gamma ratio (n cm^{-2} per mGy)	
Cd ratio (foil material)	

3. Beam line layout

	Setting 1	Setting 2	Setting 3	Setting 4	Setting 5
Inlet aperture [mm]	**25**	**60**			
Filter options (e.g. Bi, Be, Si, sapphire,)					
Aperture - detector distance [cm]	**500**	**5400**			
Resulting L/D (measured or estimated)	**200**	**900**			
Effective beam size [mm]	**28x28**	**800**			
Flux uniformity (e.g. flat, gaussian, other)					
Corresponding intensity [cm^{-2} s^{-1}]	**$2x10^7$**	**~10^5**			

4. Detectors* for neutron imaging

	Availability – yes/no
Film based detector (converter material)	
Digital camera based detector (scintilator material)	Yes
Imaging plate detector	Yes
Amorphous Si flat panel detector	
Other	Tremsin-type detector

**Specification of the individual performance parameters on a separate sheet*

5. Advanced neutron imaging features

	Availability – yes/no
Tomography	Yes
Time sequences	Yes
Grating interferometer	No
Energy selection	Yes
Polarizer	no
Others	Combination with diffraction

6. Involved manpower

	Number
Scientists	0.5
Students	1
Engineers	
Technicians	

7. Applications*

Research topics	Characterization of nuclear fuels (ceramic, metallic) with the goal to characterize irradiated fuels Characterization of gamma scintillator detector single crystals Water distribution in roots Geosciences
Services for industry	
Methodical developments	Energy resolved neutron tomography/imaging using neutron absorption resonances Utilization of MCPs for resolution enhancement and scatter rejection Combination of imaging and diffraction

**Provide the list for a multiple answer*

8. **Revenue generation/recovery**

	Yes/No
Presently	**No**
Future plans	**Yes**

9. **Plans for future upgrades**

Expected Year	Type of Upgrade
2015	**Installation of optimized collimator and background reduction for efficient epi-thermal neutron imaging**
2016	**Further explore capabilities of high energy (>1 MeV) neutron imaging at the WNR facility, included energy resolved imaging**

10. **Other* relevant information**

E.g. facility-instrumentation photos can be provided on a separate sheet

47. USA, NRAD, 250 kW (East Radiography Station)

1. General information

Country	United States of America
Region, Place/Closest Town	Idaho Falls, ID
Institution	Idaho National Laboratory (INL)
Facility manager (full name, position, phone, e-mail, web)	Aaron Craft, R&D Scientist, 1-208-533-7673, aaron.craft@inl.gov
Type of neutron source	TRIGA Reactor
Source power [MW]	0.250 MW (250 kW)
Source intensity [n/s or cm^{-2} s^{-1}]	5×10^{12} $cm^{-2}s^{-1}$
Availability (hours/year)	2000 hrs/year

2. Beam qualification

Beam line alignment (radial, tangential)	Radial
Neutron spectrum (qualitative: fast, thermal, cold)	Thermal, epithermal and fast
Curved beam guide (monochromator)	No
Neutron spectrum at sample position (qualitative: fast, thermal, cold)	Thermal, epithermal and fast
Maximal beam intensity at sample position [cm^{-2} s^{-1}]	9.5×10^{6}
Polarization (yes/no)	No
Neutron/gamma ratio (n cm^{-2} per mGy)	4750
Cd ratio (foil material)	2.1 (gold foil)

3. Beam line layout

	Setting 1	**Setting 2**	**Setting 3**
Inlet aperture [mm]	88.9	35.4	14.7
Filter options (e.g. Bi, Be, Si, sapphire,)	None	None	None
Aperture - detector distance [cm]	444.5	444.5	444.5
Resulting L/D (measured or estimated)	50	125	300
Effective beam size [mm]	178×432	178×432	178×432
Flux uniformity (e.g. flat, gaussian, other)	<5% deviation	<5% deviation	<5% deviation
Corresponding intensity [cm^{-2} s^{-1}]	5.9×10^{7}	9.5×10^{6}	1.6×10^{6}

4. Detectors* for neutron imaging

	Availability – yes/no
Film based detector (converter material)	Indirect method – Dysprosium and indium foil converter foils. Films used include Agfa D3SC and Kodak Industrex T200.
Digital camera based detector (scintilator material)	In development.
Imaging plate detector	Indirect method using x-ray image plates ScanX-HR scanner.
Amorphous Si flat panel detector	
Other	

**Specification of the individual performance parameters on a separate sheet*

5. Advanced neutron imaging features

	Availability – yes/no
Tomography	Yes - performed using film
Time sequences	No
Grating interferometer	No
Energy selection	No
Polarizer	No
Others	-

6. Involved manpower

	Number
Scientists	3
Students	1
Engineers	3
Technicians	5

7. Applications*

Research topics	Examination of irradiated nuclear fuel and other reactor components.
Services for industry	Nuclear industry: Inspection of highly radioactive objects.
Methodical developments	

**Provide the list for a multiple answer*

8. Revenue generation/recovery

	Yes/No
Presently	No
Future plans	No

9. Plans for future upgrades

Expected Year	Type of Upgrade
2019	Develop initial camera-based imaging system in ERS.
2020	Add a pre-collimator to collimate fast and epithermal neutrons and reduce gamma content in the beam.
2022	Automate neutron tomography

10. Other* relevant information

48. USA, NRAD, 250 kW (North Radiography Station)

1. General information

Country	United States of America
Region, Place/Closest Town	Idaho Falls, ID
Institution	Idaho National Laboratory (INL)
Facility manager (full name, position, phone, e-mail, web)	Aaron Craft, R&D Scientist, 1-208-533-7673, aaron.craft@inl.gov
Type of neutron source	TRIGA Reactor
Source power [MW]	0.250 MW (250 kW)
Source intensity [n/s or cm^{-2} s^{-1}]	5×10^{12} $cm^{-2}s^{-1}$
Availability (hours/year)	2000 hrs/year

2. Beam qualification

Beam line alignment (radial, tangential)	Radial
Neutron spectrum (qualitative: fast, thermal, cold)	Thermal, epithermal and fast
Curved beam guide (monochromator)	No
Neutron spectrum at sample position (qualitative: fast, thermal, cold)	Thermal, epithermal and fast
Maximal beam intensity at sample position [cm^{-2} s^{-1}]	4.5×10^{6}
Polarization (yes/no)	No
Neutron/gamma ratio (n cm^{-2} per mGy)	5000
Cd ratio (foil material)	2.1 (gold foil)

3. Beam line layout

	Setting 1	**Setting 2**	**Setting 3**
Inlet aperture [mm]	88.9	55.12	23.62
Filter options (e.g. Bi, Be, Si, sapphire,)	bismuth	bismuth	bismuth
Aperture - detector distance [cm]	1654	1654	1654
Resulting L/D (measured or estimated)	185	300	700
Effective beam size [mm]	550 (diameter)	550 (diameter)	550 (diameter)
Flux uniformity (e.g. flat, gaussian, other)	<5% deviation	<5% deviation	<5% deviation
Corresponding intensity [cm^{-2} s^{-1}]	4.5×10^{6}	1.8×10^{6}	3.8×10^{5}

4. Detectors* for neutron imaging

	Availability – yes/no
Film based detector (converter material)	Direct method – gadolinium Indirect method – dysprosium, indium Films used include Agfa D3SC and Kodak Industrex T200.
Digital camera based detector (scintilator material)	LiF/ZnS:Cu thermal neutron screen GOS:Tb thermal neutron screen PP/ZnS:Cu fast neutron screen
Imaging plate detector	Gadolinium-doped image plates Indirect method using x-ray image plates ScanX-HR scanner
Amorphous Si flat panel detector	
Other	

**Specification of the individual performance parameters on a separate sheet*

5. Advanced neutron imaging features

	Availability – yes/no
Tomography	Yes
Time sequences	Yes
Grating interferometer	No
Energy selection	No
Polarizer	No
Others	-

6. Involved manpower

	Number
Scientists	3
Students	1
Engineers	3
Technicians	5

7. Applications*

Research topics	1. Examination of irradiated nuclear fuel and other reactor components 2. Battery R&D, other energy-related materials 3. Fossils
Services for industry	Nuclear industry: Inspection of highly radioactive objects.
Methodical developments	

**Provide the list for a multiple answer*

8. Revenue generation/recovery

	Yes/No
Presently	No
Future plans	No

9. Plans for future upgrades

Expected Year	Type of Upgrade
2019	Capture epithermal and fast neutron imaging capabilities
2020	Add a pre-collimator to collimate fast and epithermal neutrons and reduce gamma content in the beam.
2020	Automate neutron tomography
2021	Add monochromator option to the neutron beam

10. Other* relevant information

49. USA, Transient Test Reactor (TREAT), 80 kW

1. General information

Country	United States of America
Region, Place/Closest Town	Idaho Falls, ID
Institution	Idaho National Laboratory (INL)
Facility manager (full name, position, phone, e-mail, web)	Aaron Craft, R&D Scientist, 1-208-533-7673, aaron.craft@inl.gov
Type of neutron source	Nuclear Reactor (Graphite-Based Fuel)
Source power [MW]	80 kW for radiography 19000 MW pulsing capability
Source intensity [n/s or cm^{-2} s^{-1}]	1×10^{12} $cm^{-2}s^{-1}$
Availability (hours/year)	1000 hrs/year

2. Beam qualification

Beam line alignment (radial, tangential)	Radial
Neutron spectrum (qualitative: fast, thermal, cold)	Thermal and epithermal
Curved beam guide (monochromator)	None
Neutron spectrum at sample position (qualitative: fast, thermal, cold)	Thermal and epithermal
Maximal beam intensity at sample position [cm^{-2} s^{-1}]	8.25×10^{6}
Polarization (yes/no)	No
Neutron/gamma ratio (n cm^{-2} per mGy)	10000
Cd ratio (foil material)	10 (gold foil)

3. Beam line layout

	Setting 1
Inlet aperture [mm]	44.5 wide 94.8 tall
Filter options (e.g. Bi, Be, Si, sapphire,)	none
Aperture - detector distance [cm]	284.5
Resulting L/D (measured or estimated)	64 horizontally 30 vertically
Effective beam size [mm]	108 wide 432 tall
Flux uniformity (e.g. flat, gaussian, other)	<5% variation
Corresponding intensity [cm^{-2} s^{-1}]	8.25×10^{6}

4. Detectors* for neutron imaging

	Availability – yes/no
Film based detector (converter material)	No
Digital camera based detector (scintilator material)	No
Imaging plate detector	Indirect method using dysprosium with x-ray image plates. Carestream HPX-1 scanner
Amorphous Si flat panel detector	No
Other	

**Specification of the individual performance parameters on a separate sheet*

5. Advanced neutron imaging features

	Availability – yes/no
Tomography	No
Time sequences	No
Grating interferometer	No
Energy selection	No
Polarizer	No
Others	Fast neutron hodoscope

6. Involved manpower

	Number
Scientists	1
Engineers	2
Technicians	2

7. Applications*

Research topics	1. Examination of irradiated nuclear fuel and other reactor components. 2. Examination of transient nuclear experiments.
Services for industry	Nuclear industry: Inspection of highly radioactive objects.
Methodical developments	

**Provide the list for a multiple answer*

8. Revenue generation/recovery

	Yes/No
Presently	No
Future plans	No

9. Plans for future upgrades

Expected Year	Type of Upgrade
2020	Upgrade aperture and collimator to improve the L/D of the beam
2021	Upgrade radiography stand to allow space for digital imaging systems
2022	Add digital camera-based neutron imaging systems at TREAT
2023	Capture and automate neutron tomography at TREAT

10. Other* relevant information

This reactor also has a fast neutron hodoscope capable of imaging irradiated in real time (1000 Hz frame rate) during a transient test. There are a few papers in WCNR-1 that describe this capability

50. Viet Nam, Dalat RR, 0.5 MW

1. General information

Country	Vietnam
Region, Place/Closest Town	Asian, Dalat City
Institution	Nuclear Research Institute
Facility manager (full name, position, phone, e-mail, web)	Nguyen Canh Hai, Deputy Head of Nuclear Physics Department, +84 63 3 829436, nchai@hcm.vnn.vn;
Type of neutron source	Research Reactor
Source power [MW]	0.5
Source intensity [$cm^{-2}s^{-1}$]	2.8×10^{12}
Availability (hours/year)	1300

2. Beam qualification

Beam line alignment (radial, tangential)	Tangential
Neutron spectrum (qualitative: fast, thermal, cold)	Thermal
Curved beam guide (monochromator)	
Neutron spectrum at sample position (qualitative: fast, thermal, cold)	Thermal
Maximal beam intensity at sample position [cm^{-2} s^{-1}]	2.5×10^{6}
Polarization (yes/no)	No
Neutron/gamma ratio (n cm^{-2} per mGy)	190 mR/h
Cd ratio (foil material)	75.5 (Au foil)

3. Beam line layout

	Setting 1	**Setting 2**
Inlet aperture [mm]		
Filter options (e.g. Bi, Be, Si, sapphire,)	Si filter	
Aperture - detector distance [cm]		
Resulting L/D (measured or estimated)	52	
Effective beam size [mm]	180	
Flux uniformity (e.g. flat, gaussian, other)	flat	
Corresponding intensity [cm^{-2} s^{-1}]		

4. Detectors* for neutron imaging

	Availability – yes/no
Film based detector (converter material)	Yes
Digital camera based detector (scintilator material)	No
Imaging plate detector	No
Amorphous Si flat panel detector	No
Other	No

**Specification of the individual performance parameters on a separate sheet*

5. Advanced neutron imaging features

	Availability – yes/no
Tomography	No
Time sequences	No
Grating interferometer	No
Energy selection	No
Polarizer	No
Others	No

6. Involved manpower

	Number
Scientists	2
Students	1
Engineers	2
Technicians	1

7. Applications*

Research topics	
Services for industry	The facility has been used to test: control rod, electrical and electronics products, mechanical details, biological samples
Methodical developments	Film method, Track-etch method

**Provide the list for a multiple answer*

8. Revenue generation/recovery

	Yes/No
Presently	Yes
Future plans	Yes

9. Plans for future upgrades

Expected Year	Type of Upgrade
2015	Development a new neutron imaging facility at Dalat Research reactor

10. Other* relevant information

**E.g. facility-instrumentation photos can be provided on a separate sheet*

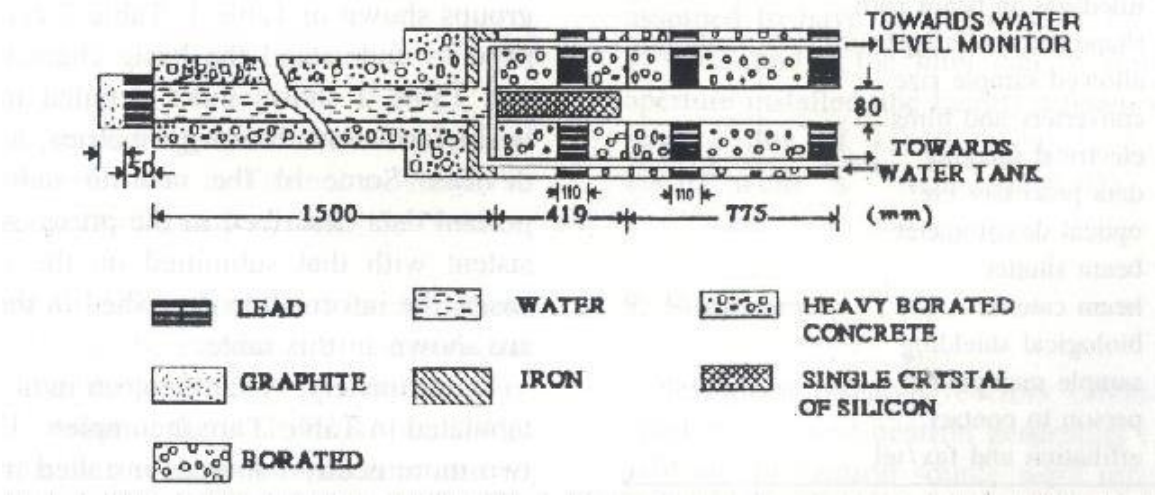


Fig. 1. Sectional view of neutron beam facility in the tangential beam port at Dalat Research Reactor.