JCNS – Forschungszentrum Jülich

ACCESS Activity presentation by Thomas Gutberlet

General Assembly in Villigen, CH

March 31, 2009

Jülich Centre for Neutron Science

Exploring the Nano-World

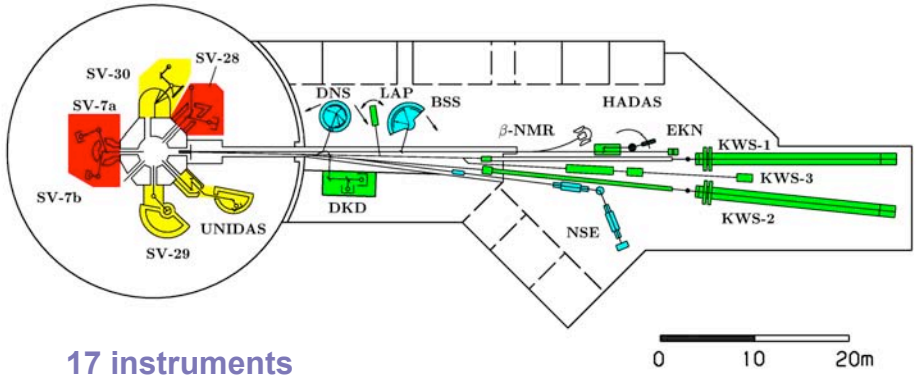
***Jülich Centre for Neutron Science* (JCNS)** - funded 2006 by the Forschungszentrum Jülich GmbH - operates state-of-the-art neutron scattering instruments at the most modern and highest flux neutron sources world wide.

JCNS offers:

- a suite of world class neutron instruments based on science driven in-house method developments
- specialized and unique sample environment
- sophisticated data treatment and modeling
- experienced local contacts with established scientific profiles
- modern laboratory facilities for sample preparation

www.jcns.info

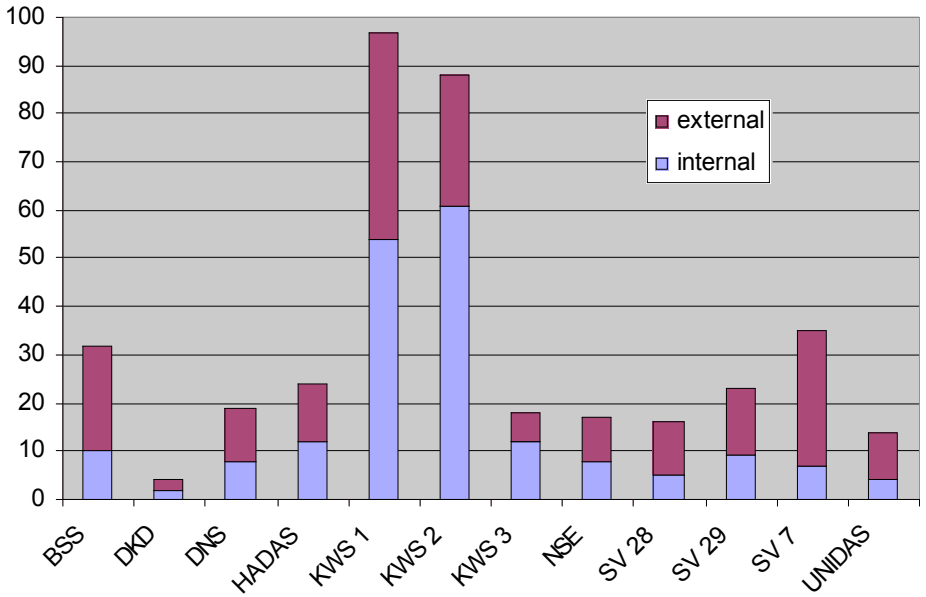
DIDO research reactor FRJ-2 at Forschungszentrum Jülich

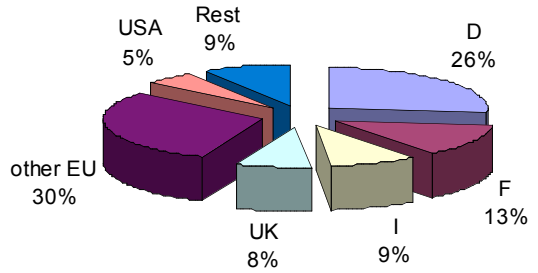


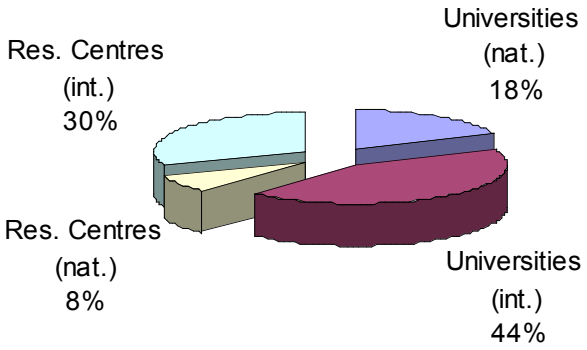
17 instruments

User Operation at FRJ-2 (FP6)

258 reactor operation days, 387 individual experiments



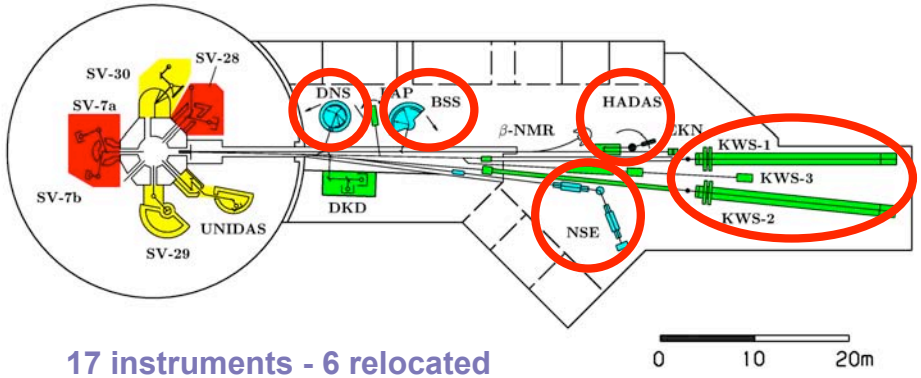




Experiments performed in the year 2005 and 2006 on the neutron scattering instruments at FRJ-2

DIDO research reactor FRJ-2 at Forschungszentrum Jülich

Shut down May 2nd 2006

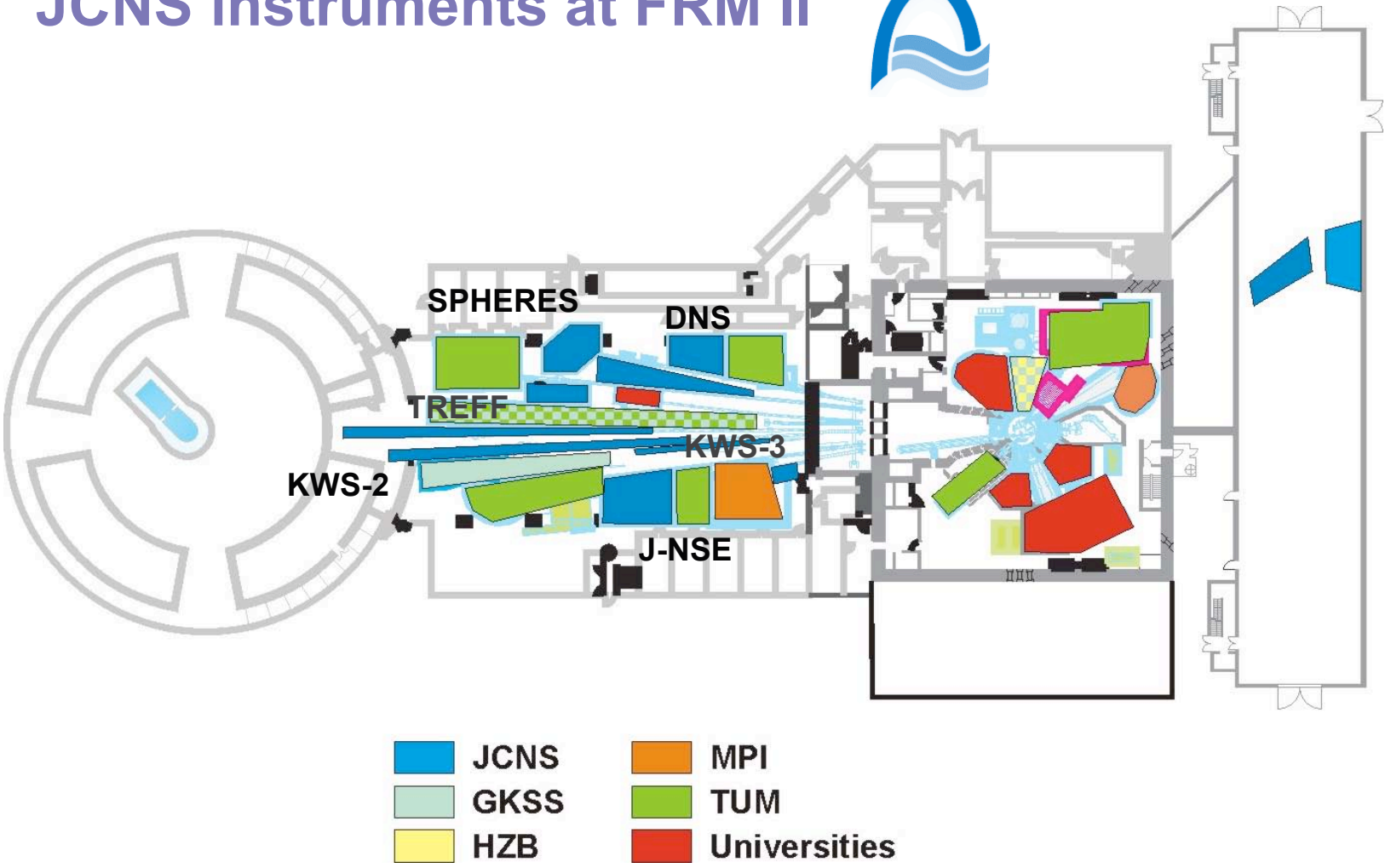


17 instruments - 6 relocated

Relocation of instruments to FRM II

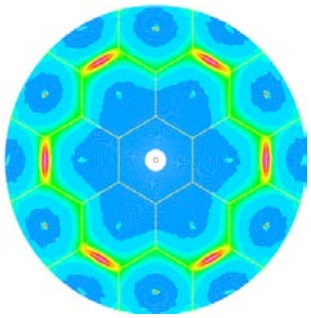
JCNS instruments at FRM II

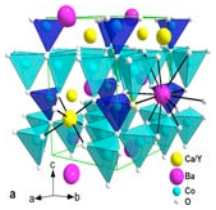
JCNS instruments at FRM II



JCNS instruments at FRM II

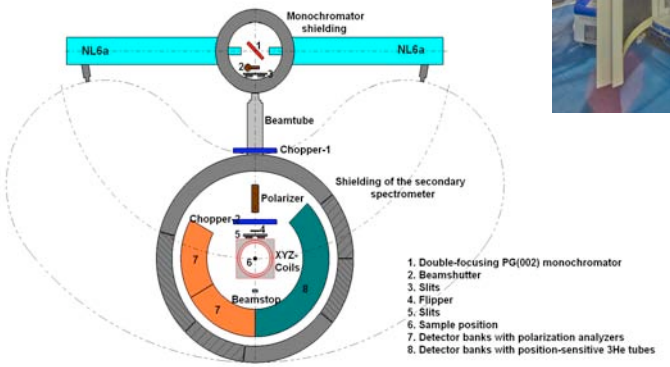
DNS @ FRM II - *High intensity, medium resolution and polarization analysis*





Magnetic diffuse scattering at 30 mK (Θ_{CW}>1000K)
in-plane spin-components as determined by spin-flip scattering of initial P_z polarization

(Cologne/Juelich)

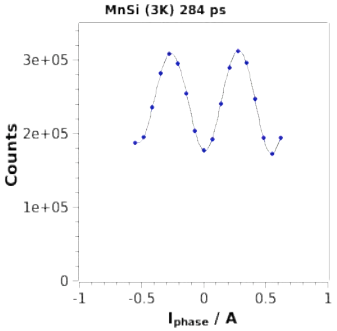


Instrument parameters

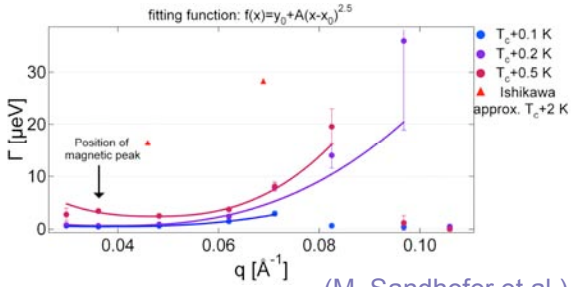
Monochromator	horizontal- and vertically adjustable double-focusing	PG(002) d = 3.355 Å
	crystal dimensions	2.5 x 2.5 cm^2 5 x 7 crystals
	wavelengths	2.4 Å$\leq \lambda \leq$ 6 Å
Double-chopper system	chopper frequency	$<$ 300 Hz
	repetition rate	$<$ 900 Hz
	chopper discs	Titanium, 3 slits Φ = 420 mm
Expected flux at sample (n/cm^{2}s)	non-polarized	$\sim 10^8$, λ=3Å
	polarized	$\sim 10^7$, λ=3Å
Detector banks for non-polarized neutrons	position-sensitive ^{3}He detector tubes	128 units, height 101 cm Φ = 1.27 cm
	total solid angle covered	1.9 sr
	covered scattering angles	$0° < 2\Phi < 135°$
Detector banks for polarized neutrons	polariztion analyzers	24 units, m=3 supermirrors
	^{3}He detector tubes	24 units, height 15cm Φ = 2.54 cm
	convered scattering angles	$0° < 2\Theta < 120°$
Qmax	λ_i = 2.4 Å , E_i = 14.2 meV	4.84 Å^{-1}
	λ_i = 6 Å , E_i = 2.28 meV	1.93 Å^{-1}
Expected energy resolution	λ_i = 2.4 Å , E_i = 14.2 meV	1 meV
	λ_i = 6 Å , E_i = 2.28 meV	0.1meV
Suitable samples	single crystal, powder, soft matter (e.g. polymer, liquid etc.)	
Sample environments	closed-cycle cryostat, Orange-type L-He cryostat, furnace , dilution cryomagnet and cryomagnet up to 4T	

JCNS instruments at FRM II

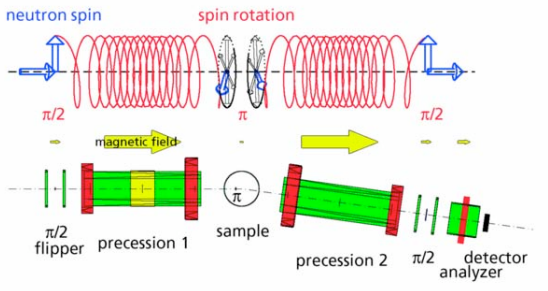
J-NSE – *The Jülich neutron spin echo spectrometer*



Spin-echo of a paramagnetic MnSi sample at 3 K.

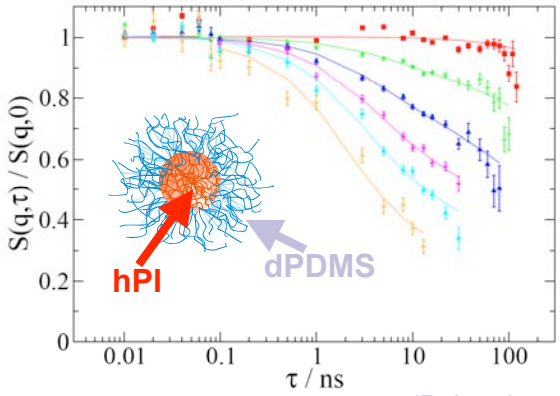


(M. Sandhofer et al.)



J-NSE parameters	Detailed description
Beam tube	NLA1-o
Monochromators	Short wavelength: bent section with FeSi m=3 remanent supermirror coating. Long wavelengths: FeSi polarizer at entrance of spectrometer
Polarized neutron flux: (Sample position)	7 Å: 1 x 10^7 n/cm^2/s 12 Å: 6.8 x 10^6 n/cm^2/s
Momentum transfer range:	0.02 - 1.5 Å^{-1}
Fourier time range:	2 ps (4.5 Å) < τ < 350 ns (16 Å)
Wavelength:	4.5 - 18 Å
Incoming beam: Cross section of guide: sample size:	6 cm x 6 cm 3 cm x 3 cm (max.)
Collimation:	By source and sample size or wire collimators 0.5° x 0.5°
Max. field integral:	0.5 Tm
Analyzer:	30 cm x 30 cm CoTi supermirror Venetian blind
Detector:	32 x 32 1 cm^2 cells ^{3}He multidetector

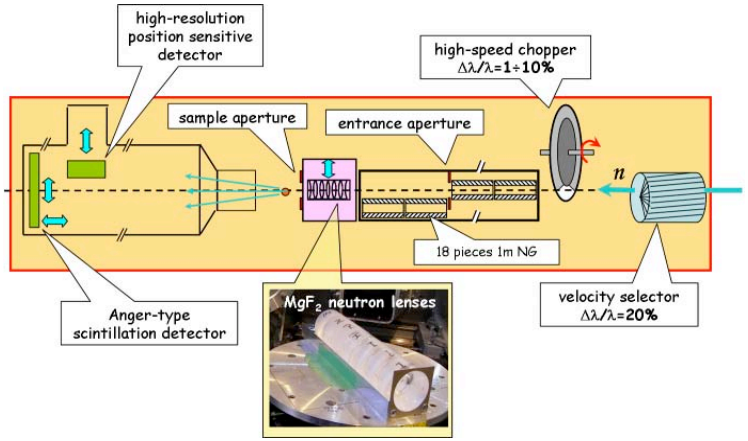
Diblock copolymers

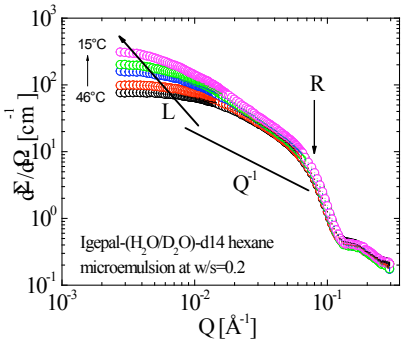


(R. Lund et al.)

JCNS instruments at FRM II

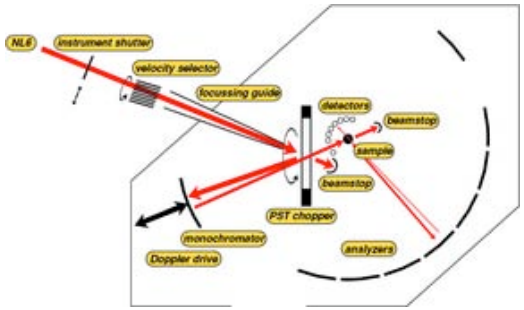
KWS-2 – *High intensity wide Q-range SANS*



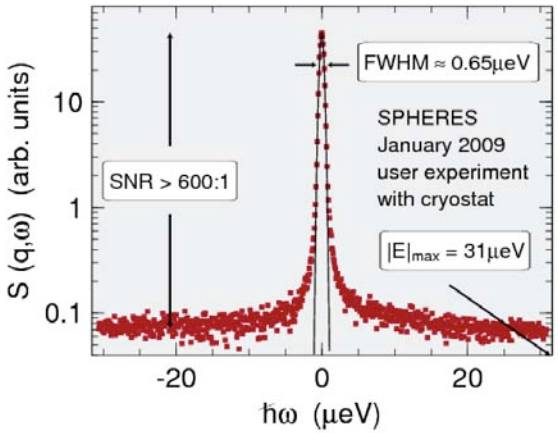


Beam tube	NL3-a-o 5 x 5 cm^2, m = 1.3
Monochromator 1	Astrium velocity selector, $\Delta\lambda / \lambda = 0.2$
Monochromator 2	Chopper (ZAT, FZ Jülich) – in concert with velocity selector, $\Delta\lambda / \lambda = 0.01$ (typical, lower values possible)
Neutron flux at the sample	4.5 x 10^6 to 3 x 10^8 n/cm^2 s Depending on collimation (20m … 2m) λ = 4.5Å
Entrance aperture Sample aperture	5 x 5 cm^2 (collimation length: 2 .. 20m) 1 x 1 cm^2 (suggested without lenses) Ø = 5cm (with lenses)
Detector 1	Active area: 60 x 60 cm^2, 128 x 128 channels Scintillator: ^{6}Li glass, 1mm thickness Spatial resolution: 0.525 x 0.525 cm^2 Max. pulse rate: ca. 1MHz (T_{dead} = 1µs) Detection probability: 95% for 7Å neutrons γ-sensitivity: 2 x 10^{-4} (1MeV) Detection range (z-axis): 2 .. 20m
Detector 2 (high resolution)	Active area: Ø = 8.7cm (~200 channels) Scintillator: ^{6}Li glass, 1mm thickness Spatial resolution: 0.1 x 0.1 cm^2
Wavelength	4.5 … 20 Å
Momentum transfer	2 x 10^{-3} … 0.2 $Å^{-1}$ for 7Å neutrons Down to 10^{-4} $Å^{-1}$ with neutron lenses and small detector

JCNS instruments at FRM II

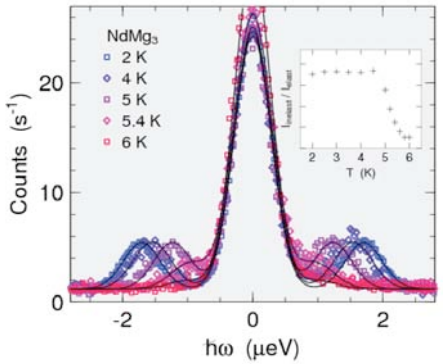


SPHERES – *The neutron backscattering spectrometer*

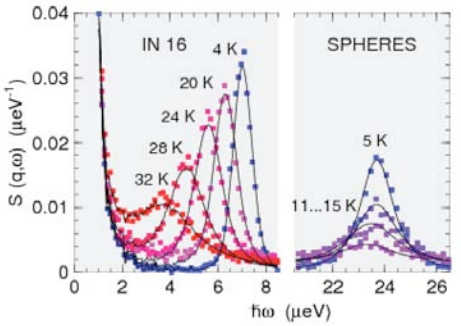


neutron wavelength	$\lambda_f = 6.271$ Å
neutron energy	$E_f = 2.080$ meV
scattering angles	$2\theta = 9.5° .. 134°$
scattering wavenumbers	$q = 0.17 .. 2$ Å^{-1}
flux at end of guide	ca. 1 x 10^{10} n/s
flux at sample (unpolished Si111)	ca. 7 x 10^5 n/s
count rate in elastic channel (10% scatterer)	ca. 100 n/detector/s
energy resolution (unpolished Si111)	0.65 μeV
energy range	±31 μeV
signal-to-noise ratio (without sample environment)	> 300:1, further improvements imminent
signal-to-noise ratio (with cryostat)	ca. 200:1

Hyperfine splitting in ferroelectric and antiferromagnetic Nd compounds.
(Chatterji et al., Phys. Rev. B 78, 012411 (2008)



Rotational spectra of diaminodurene
L. Sobczyk et al, J. Phys. Chem. (in revision)



JCNS instruments at FRM II

JCNS Sample Environment , equipment overview at Instruments

SPHERES	DNS	NSE	MARIA	KWS1/2
Orange Cryo 1.5 K – 330 K, Sample stick, Press Cell	Thermostats -40 °C - 140°C	Cold head, Pr. Cells		Thermostats -40°C – 140C Pr. Cells up to 500 MPa Tensile/shear Furnace
Cryo 3 – 700 K		Cryo 3 – 700 K		
Variox & Dilution T-Range 0.03 K – 300 K				
2 of FRM 2-type Bio-furnace -40°C - 140°C , Julabo driven				
	SHI-Cold head T - Range 2 K – 300 K			
Orange LHe Cryostat T-Range 1.5 - 330 K				

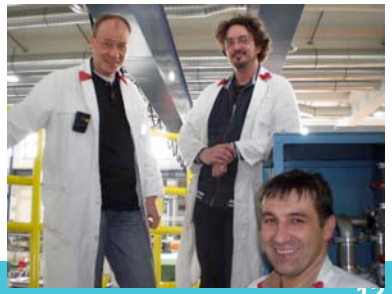
Sample environment

Soft matter and biology

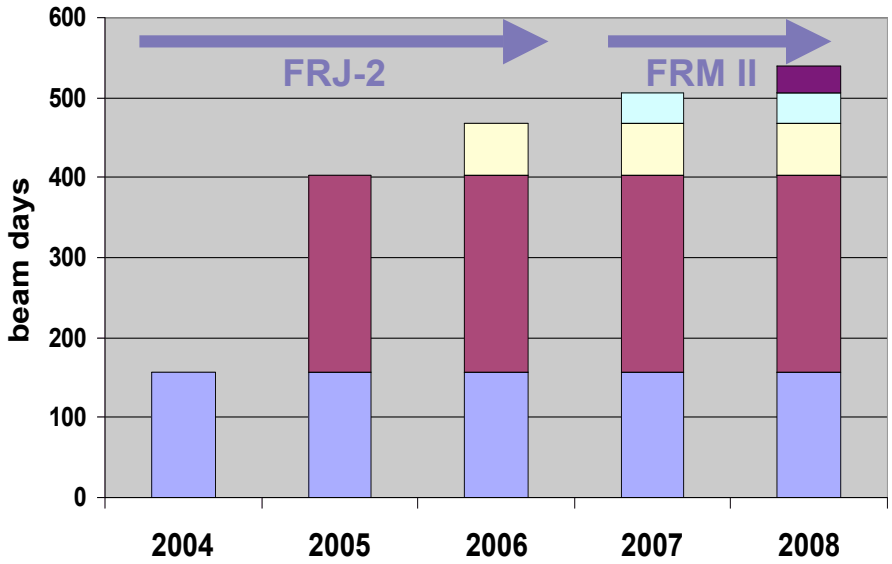
Sample environment devices	Range
Julabo thermostat with small oven	-25 - 120 °C ±0.5 °C
Julabo thermostat with big oven	0 - 120 °C ±0.5 °C
Julabo thermostat with high precession oven	0 - 120 °C ±0.01 °C
Eurotherm thermostat with small oven	25 - 200 °C ±0.5 °C (200 °C in vacuum)
Pressure cell	up to 500 bar
Pressure cell	up to 2000 bar
Orange 65 cryostat	1.5 - 320 K
Si GISANS cell	
Rheometer	

Condensed matter and magnetism

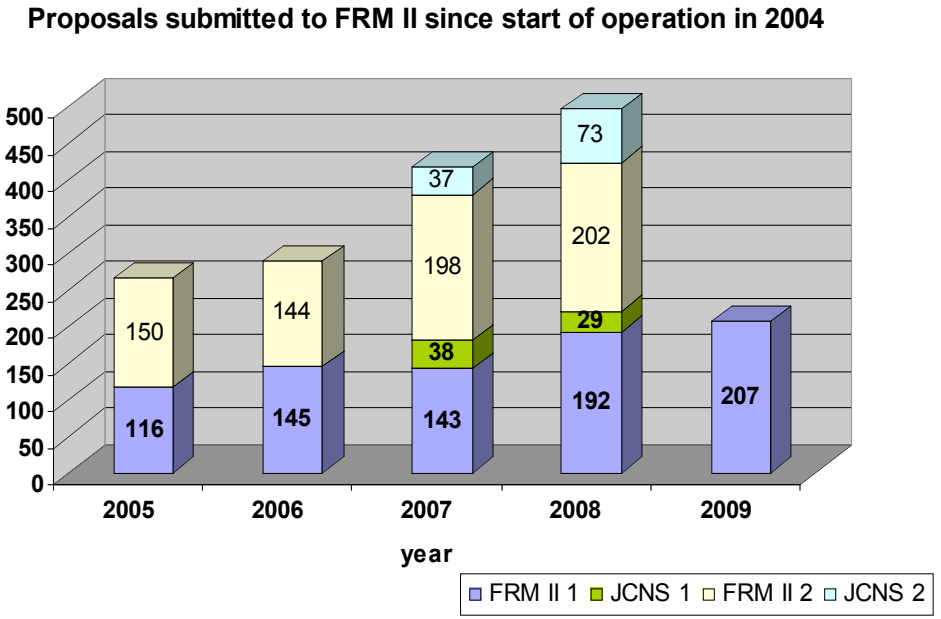
Sample environment devices	Range
Julabo thermostasts	-30 - 120 °C
SHI-CCR Cold head	3 - 300 K
Janis cryo furnace	3 - 700 K
Orange 50 cryostat	4.2 - 320 K
Orange 65 cryostat	1.5 - 320 K
Variox cryostat	1.4 - 300 K
Kelvinox cryostat	0.03 - 300 K
High temperature furnace	up to 1800 K
Mini furnace	up to 1400 K



User Operation at FRJ-2 (FP6) and JCNS (FP6/FP7)

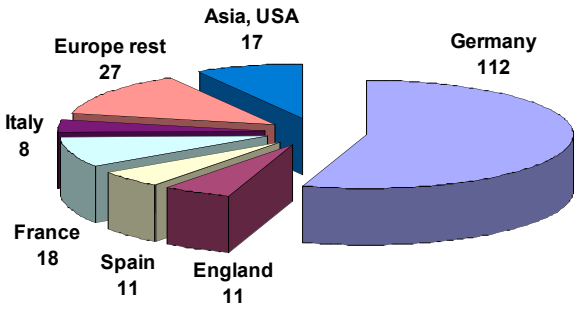


Number of beam days delivered by JCNS for user experiments supported by NMI3 during FP6.
- till 2006 beam days were delivered at FRJ-2 in Jülich (469 days)
- in 2007 and 2008 at FRM II in Garching (76 days)
- 545 beam days in total (contract: 525 days)

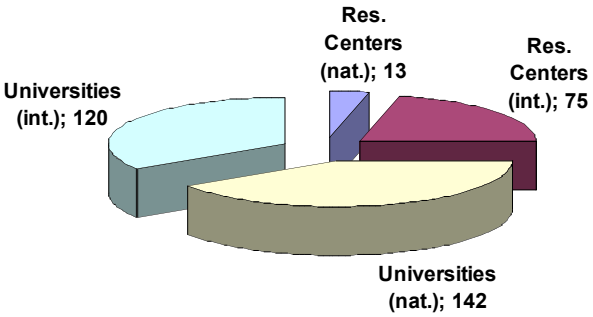


Current JCNS User Statistics

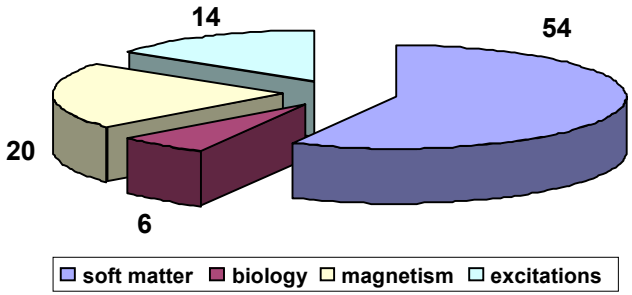
Proposals by Country to JCNS 2007/2008



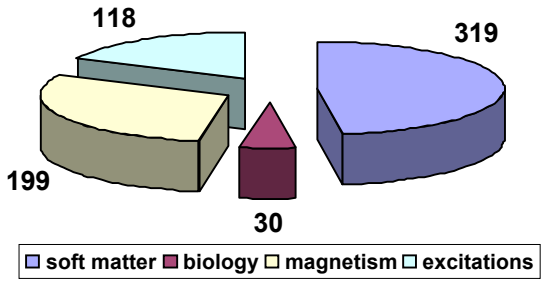
JCNS allocated beam days 2007/2008



JCNS proposals submitted 2008-II



JCNS beam time requested 2008-II



*Institutions marked by an asterisk have used FRJ-2

Institutes which performed measurements in 2007/2008 at JCNS

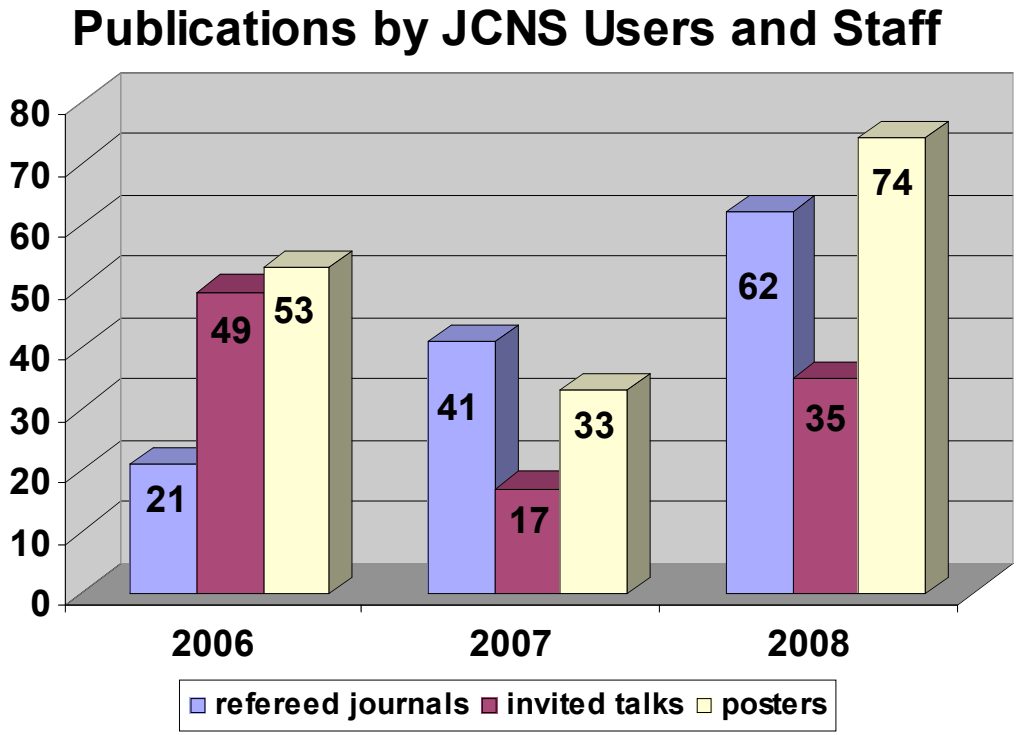
Universities (national)
RWTH Aachen*
Universität Bayreuth*
Universität Köln*
Universität Tübingen
Technische Universität Berlin*
Technische Universität München*

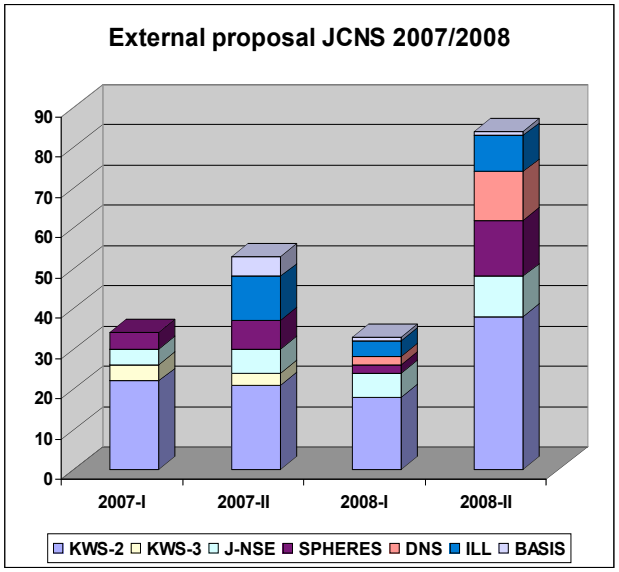
Universities (international)
University College Dublin, Ireland
University Wageningen, Netherlands*
University of Basque Country, San Sebastian, Spain*
University of Tokyo, Japan
University of Kopenhagen, Denmark
University of Naples, Italy*
Universite Montpellier II, Montpellier, France*
University of Cyprus, Cyprus
Warwick University, Warwick, England*
Lerner Research Institute, Cleveland, USA

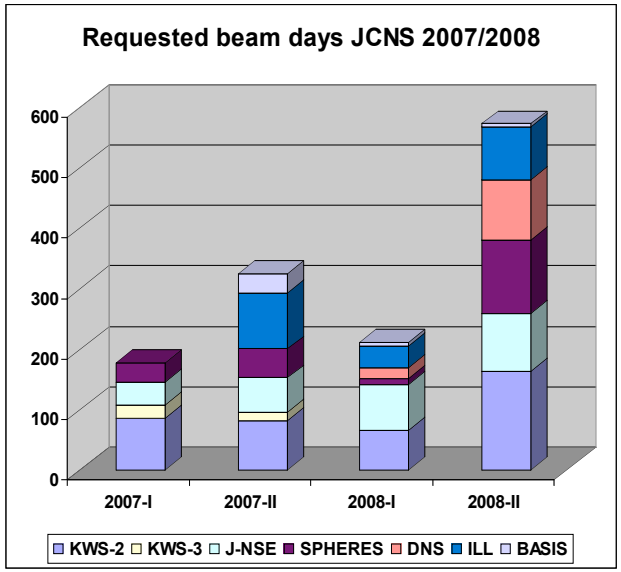
Research Institues (national)
Hahn Meitner Institut Berlin*
Forschungszentrum Karlsruhe*

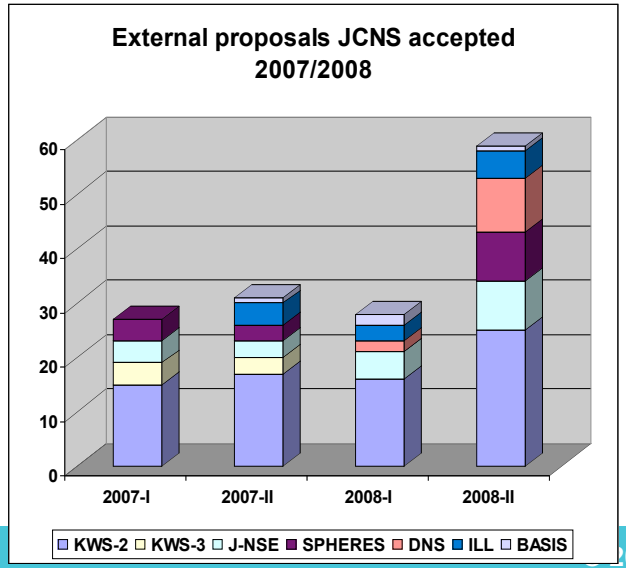
Research institutes (international)
Laboratoire Léon Brillouin, Saclay, France*
Institute Laue Langevin, Grenoble, France*
Technion - Israel Institute of Technology, Haifa, Israel*
Risø National Laboratory, Risø, Denmark*
ANSTO, Lucas Heights, Australia
Paul Scherrer Institut, Villigen, Switzerland*
ISIS, Didcot, England*
Petersburg Nuclear Physics Institute, Gatchina, Russia*
Institute of Atomic Energy, Swierk-Otwock, Poland

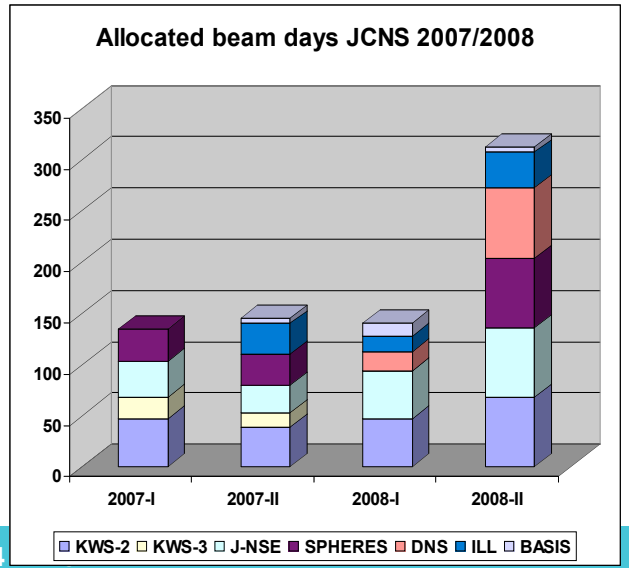
Current JCNS User Statistics

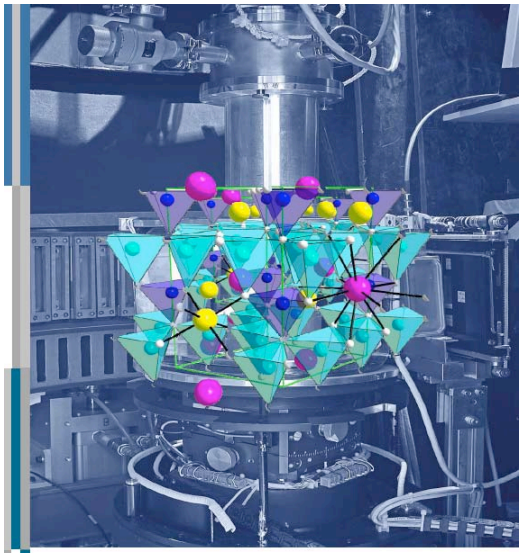










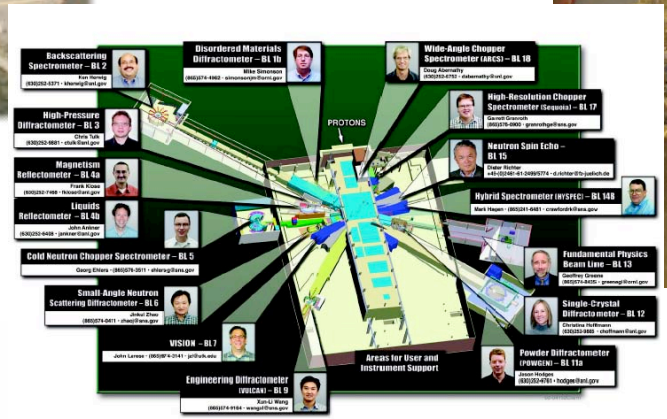


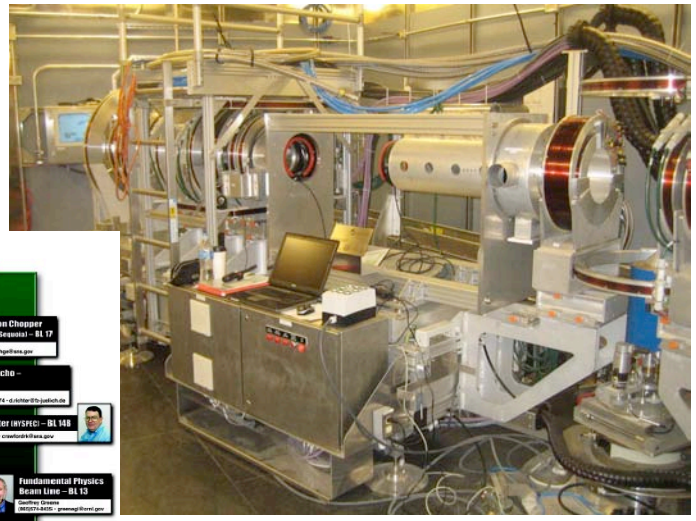
JCNS Experimental Reports 2007/2008

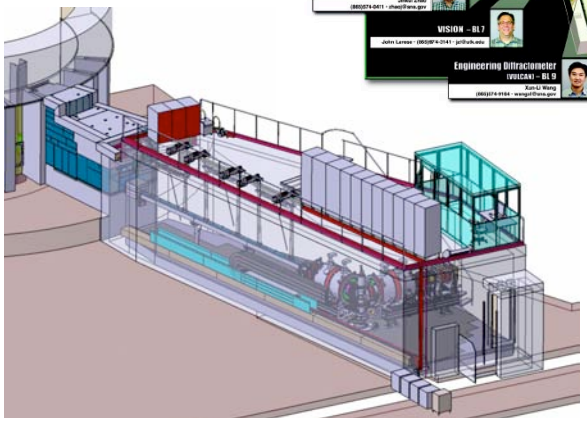
JÜLICH FORSCHUNGSZENTRUM

JCNS at SNS

SNS-NSE – *Spin echo spectrometer*



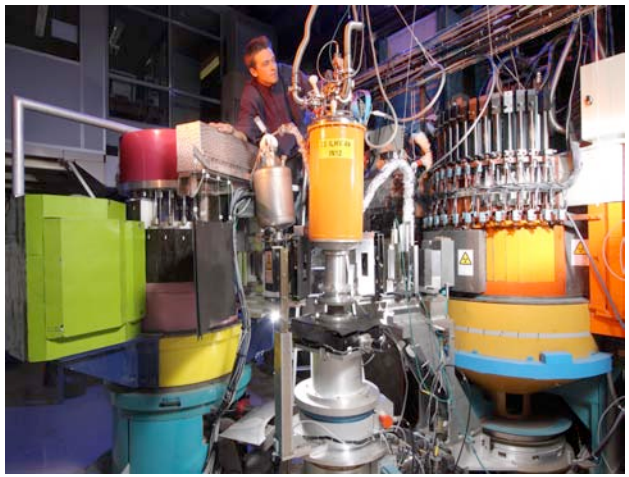




SNS-NSE
wide dynamic range: 1ps … 1μs
and wavevector Q: 0.02 …3.2 Å-1
TOF λ-labelling: $\Delta\lambda(t)/\lambda(t) < 1\%$
Cooperation:

JCNS at ILL

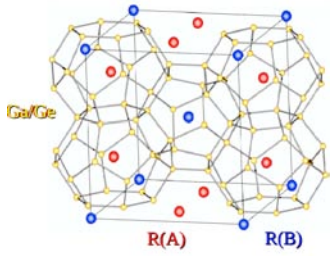
IN12 – Cold Neutron Three Axis Spectrometer



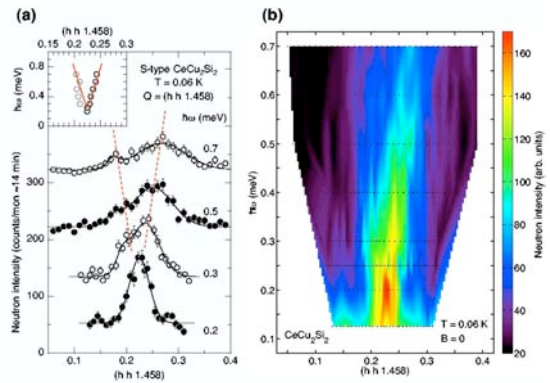
Cold guide H142, Guide hall ILL7	108m from source Beam dimensions: 12x3cm^2
Monochromator Analyzer	Vertically foc. PG(002) Variable horiz. foc. PG(002)
Polarization analysis Polarizer	Heusler (111) Supermirror bender
Incident wavelengths, energies, and wavevectors	$2.3 < \lambda/Å < 6.0$ $2.3 < E_i/meV < 14$ $1.05 < k_i/Å^{-1} < 2.6$
Energy resolution (60' collimation)	30 - 150μeV (FWHM) For E_i = 2.3 and 5 meV
Flux (60' collimation)	$1.4x10^7 ncm^{-2}s^{-1}$

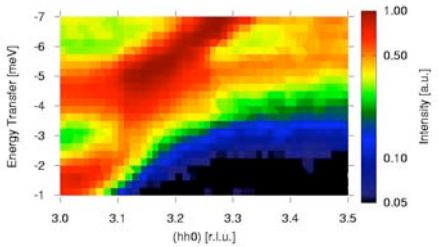
- excitations in low dimensions
- spin waves in localised magnets
- magnetic correlations in heavy-fermion systems
- magnetic multilayers and thin films
- low lying phonons
- critical scattering and phase transition phenomena
- glasses and liquids at low momentum transfer
- dynamics of model membranes

Lattice dynamics in the clathrate $Sr_8Ga_{16}Ge_{30}$ (R. Hermann et al.)



Interplay magnetism and superconductivity in $CeCu_2Si_2$ (O. Stockert et al.)



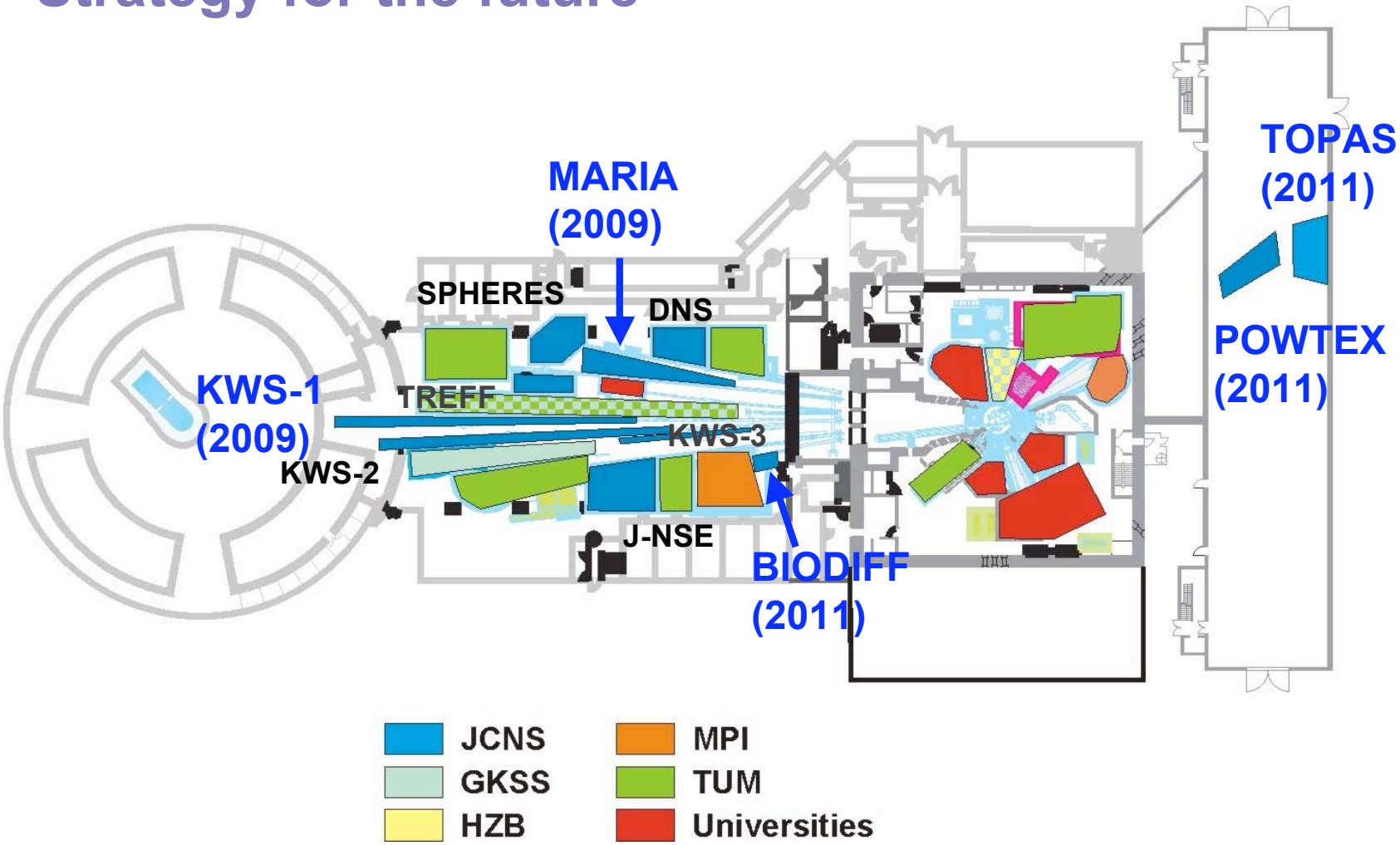


IN12 operated by JCNS in collaboration with CEA Grenoble as a CRG-B instrument at ILL

Strategy for the future

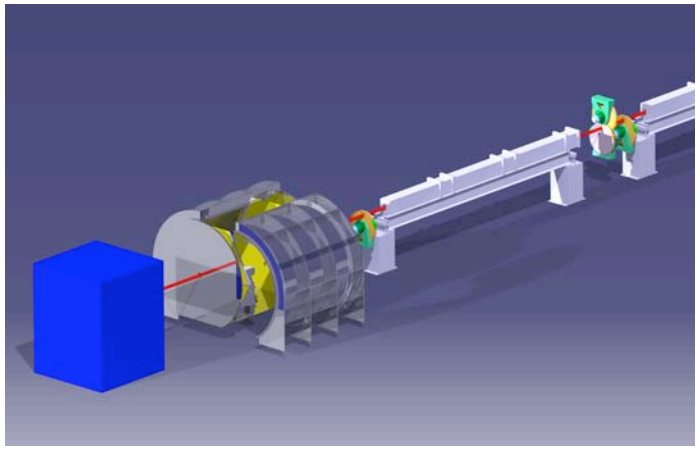
View into neutron guide hall of FRM II with location of running and planned JCNS instruments (Jan.09)

Strategy for the future



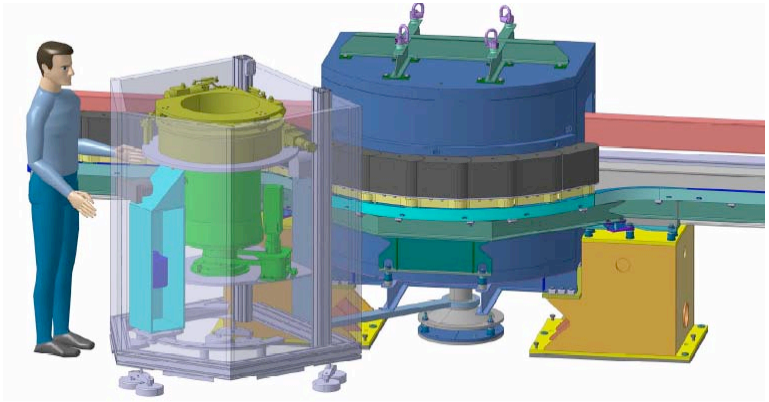
Strategy for the future

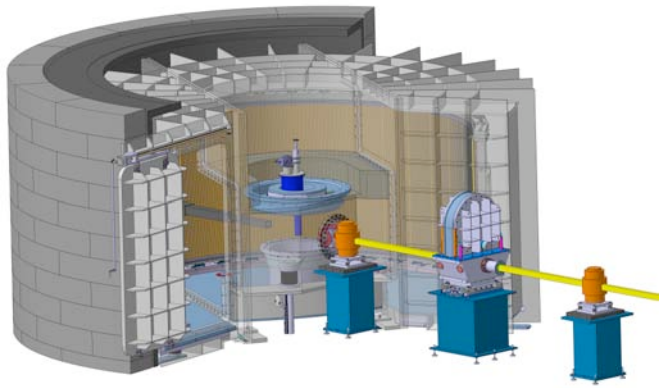
Future instruments to attract new user communities!!



POWTEX:
POWder & **TEX**ture diffractometer @ FRM II (geosciences and solid state chemistry)

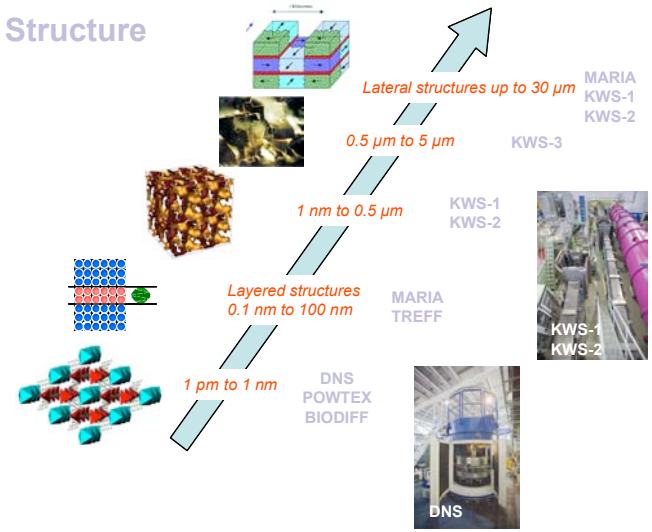
BIO-DIFFractometer @ FRM II (biology)

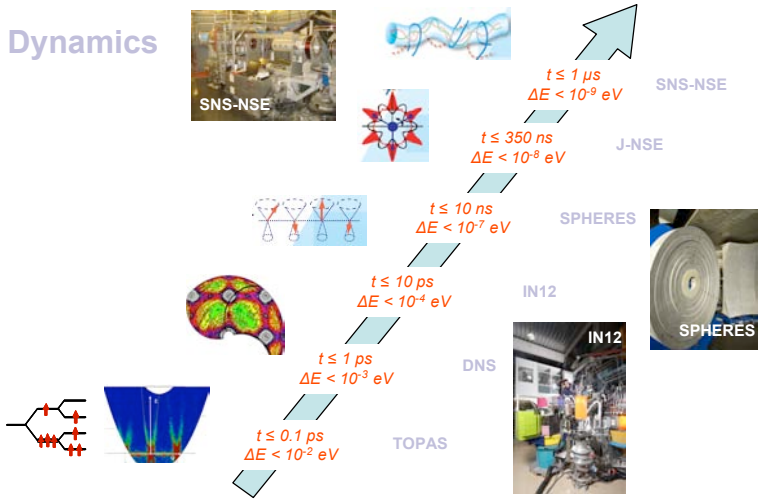




TOPAS:
Thermal time **o**f flight Spectrometer with **p**olarization **a**nalysi**s** @ FRM II

Strategy for the future





JCNS will offer access to 12 instruments plus additional access to 4 instruments for German users at

Dissemination and Education

- annual JCNS Laboratory Course Neutron Scattering
  (50 participants, 1 week lectures, 1 week on-site training)
- annual IFF Spring School
  (2 week lectures on dedicated scientific topic)
- participation in TUM practica
  (1 week on-site training of master students)
- annual JCNS Workshop
  (topical scientific workshop,
  2008 "Modern Trends in Neutron Scattering Instrumentation"
  2009 "Trends and Perspectives in Neutron Scattering on Soft Matter"
- support of scientific workshops
  (e.g. Neutron Scattering Workshop on Biomolecular Dynamics
  and Protein-Water Interactions
  Sept. 24-26 2008 in Feldafing/Munich, co-organized with FRM II)
- training day for users for scheduled experiments

Your place in Europe

Strategy for the future

- Is there a possibility to reinforce the strength of your facility through a common strategy ?
- Would a topical focus make sense ?
- Your point of view regarding integration with other fields (eg. laser).
- Common user data management (eg. ISIS, PSI, ILL) ?
- Neutron & Muon community management (eg. study on publications) ?