

Photon Science at DESY

Report on the Photon Science Activities at DESY



Edgar Weckert

HASYLAB Users' Meeting
Hamburg, 28 January 2011



Outline

- News and Events 2010
- Operation and User Statistics
- Facility Reports
 - DORIS III
 - PETRA III
 - FLASH
 - European XFEL
- Transition DORIS III to PETRA III
- Research Platforms for Photon Science
- Photon Science at DESY: Deadlines
- HUC



Events in 2010: DESY 50 main celebration, 19 May 2010



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Events in 2010: Honorary Doctor for Helmut Dosch



Helmut Dosch receives Honorary Doctorate from the Kurchatov Institute (25 November 2010)

The chairman of the Board of Directors of DESY, Professor Helmut Dosch, received an honorary doctorate from the Kurchatov Institute. In a ceremony at the Russian institute, Dosch was honoured for his outstanding contribution to the development of X-ray techniques of condensed matter investigation, including phase transitions, and for strengthening the German-Russian collaboration in the field of utilisation of synchrotron radiation for a wide range of scientific problems. Dosch is the first foreigner becoming a honorary doctor of the Kurchatov Institute.

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Workshops and conferences in 2010: I

Peak Brightness Collaboration Meeting, 26.1.2010

European XFEL Users' Meeting 2010 - HASYLAB Users' Meeting 2010,
27.1.2010 - 29.1.2010

IX. Research Course on New X-Ray Sciences, 17.2.2010 - 19.2.2010

Synchrotron Radiation for Bio-Imaging at PETRA III, 29.3.2010 - 30.3.2010

COHERENCE 2010, 8.6.2010 - 11.6.2010

X-ray micro-fluorescence spectroscopy at the PETRA III extension: First user workshop, 9.6.2010 - 10.6.2010

EXAFS beamlines at the PETRA III extension: User workshop, 10.6.2010 - 11.6.2010

Workshop: Chemical Crystallography Beamline at the PETRA III Extension,
17.6.2010 - 18.6.2010

PETRA III Extension Workshop on X-Ray Small Angle Scattering,
24.6.2010 - 25.6.2010



Workshops and conferences in 2010: II

EuroFEL Workshop on Photon Beamlines & Diagnostics, 28.6.2010 - 30.6.2010

Colloquium: Nuclear Resonant Scattering at DESY – Past, Present, Future, 2.7.2010

High-Energy X-Ray Beamlines at the PETRA III Extension, 8.9.2010 - 9.9.2010

Science with FLASH, 27.9.2010 - 9.9.2010

Peak Brightness Collaboration Meeting, 29.9.2010

Workshop for Extreme Conditions Research in a Large Volume Press at PETRA III,
14.10.2010 - 15.10.2010

TANGO Meeting, 25.10.2010 - 26.10.2010

Standard Data Formats for Experiments with Photons, Neutrons, and Ions,
27.10.2010 - 29.10.2010

2nd TUM-HASYLAB Colloquium "The metal-polymer interface",
2.11.2010 - 3.11.2010



Workshops and Conferences in 2010 III

Bio-imaging



Science at FLASH



Coherence 2010



Extreme condition research in LVPs

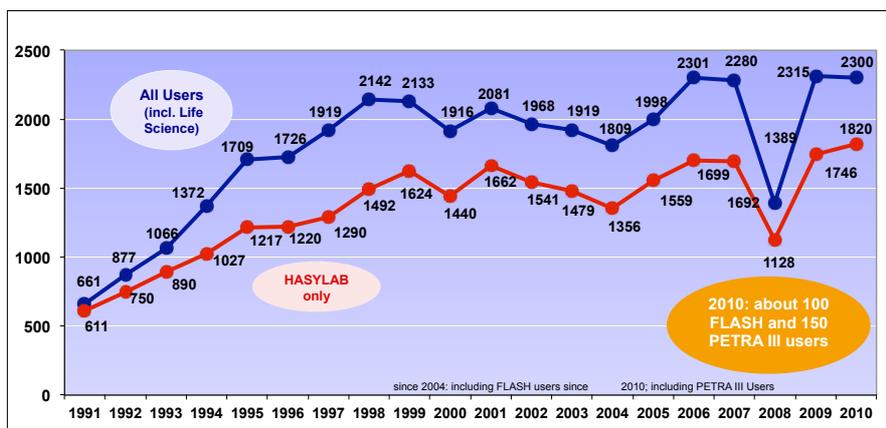


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DORIS III: Run and User Statistics

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
User beamtime	4538 h	4761 h	5100 h	5990 h	5660 h	1873 h	5409 h	4600 h	(5376 h)	(4888 h)
MTBF	41.6 h	61.8 h	45 h	56.5 h	53.9 h	75 h	56.3 h	44.4 h		
availability	96.90%	93%	95%	95.70%	95%	97.20%	95.60%	84.10%		

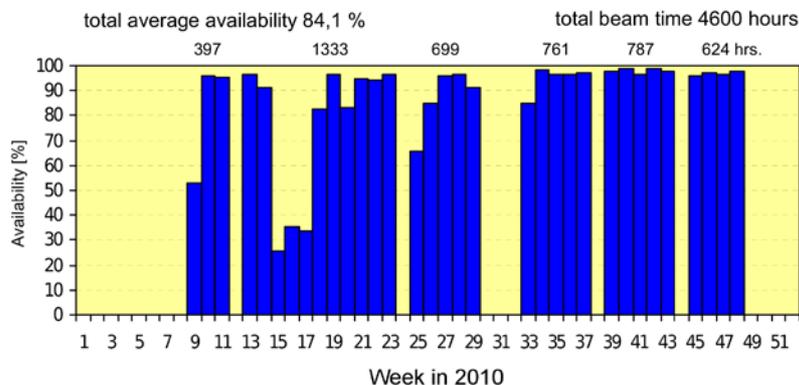


2008: 9 months shutdown DORIS III; 2010: 8 months FLASH shutdown

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DORIS III: availability



Several uncorrelated technical problems in Q1 and Q2 of 2010

Q3, Q4 2010: 96.4% availability

Again:
Record number of new proposals 2010:
(without EMBL, MPG)

cat I	204
cat II	57
total	261

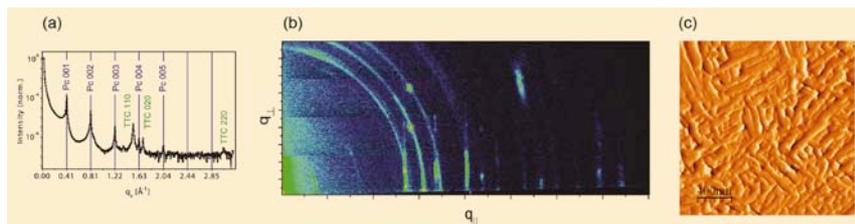
No cat. II proposals at DORIS III anymore !!

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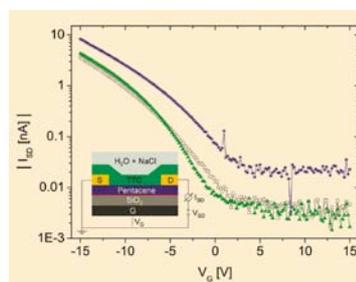
DORIS III: Science examples

Aquatic – paraffin coated – pentacene transistors for bio-sensing



Exploring tetratetracontane (TTC) cap layers on pentacene organic thin film transistors by GIXD.

Göllner et al.,
Advanced Materials 22, 4350–4354 (2010)



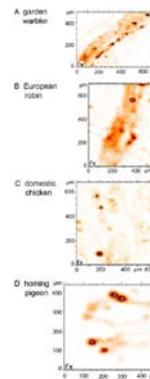
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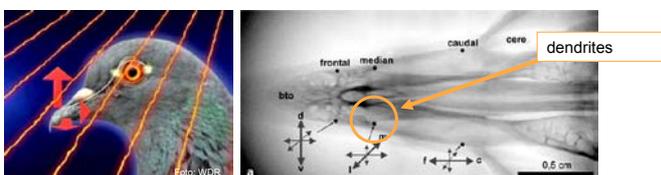
DORIS III: All birds use the same navigation system



Short nerve branches containing iron –so-called dendrites – located in the upper beak of homing pigeons had been discovered by the Frankfurt neurobiologists Dr. Gerta Fleissner and Professor Günther Fleissner together with DESY physicist Dr. Gerald Falkenberg. The decisive iron oxides had been characterised at DORIS. They locally intensify the earth’s magnetic field in the pigeon’s beak and stimulate the dendrites of the nerve cells that are responsible for the pigeon’s navigation. Meanwhile, the scientists’ team found the same structures in many other bird species. With the detection possibilities of X-ray spectroscopy at DESY, it became evident that the iron oxides in the dendrites are identical in all samples. These results were published in the interdisciplinary online journal PLoS ONE.



The X-ray fluorescence picture shows the iron distribution in the dendrites of different bird’s beaks (from top: garden warbler, European robin, domestic chicken, homing pigeon)



Original Article: G. Falkenberg, G. Fleissner, et al., *Avian Magnetoreception: Elaborate Iron Mineral Containing Dendrites in the Upper Beak Seem to Be a Common Feature of Birds.* PLoS ONE 5(2): e9231. doi:10.1371/journal.pone.0009231 (2010)



PETRA III: Overview



03'2010: real top up operation

**08'2010: last lead hutch finished
begin of official user op.**

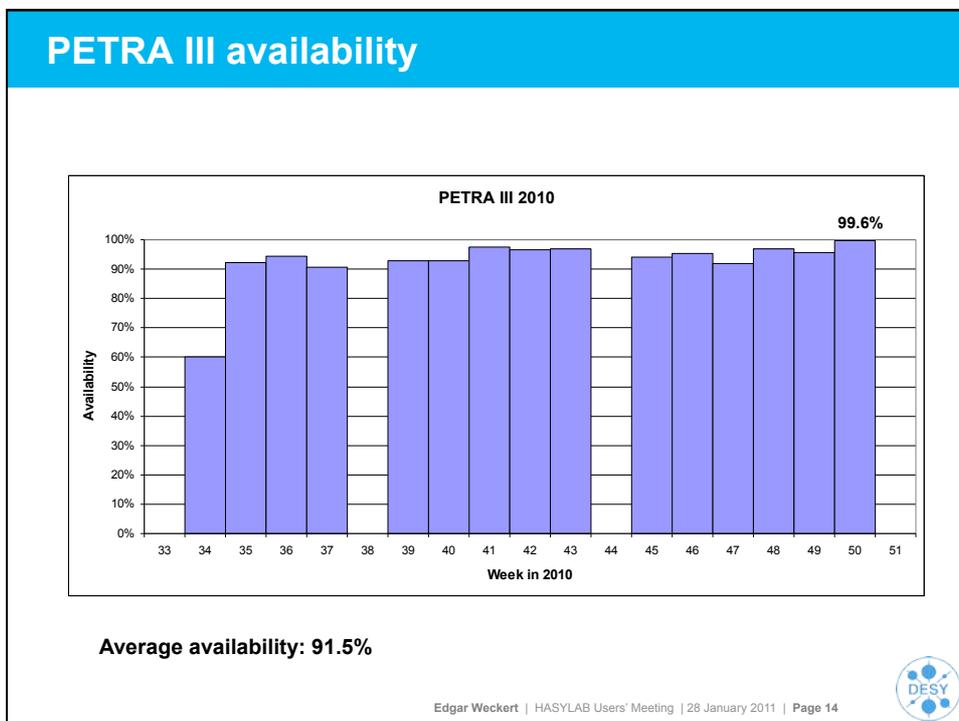
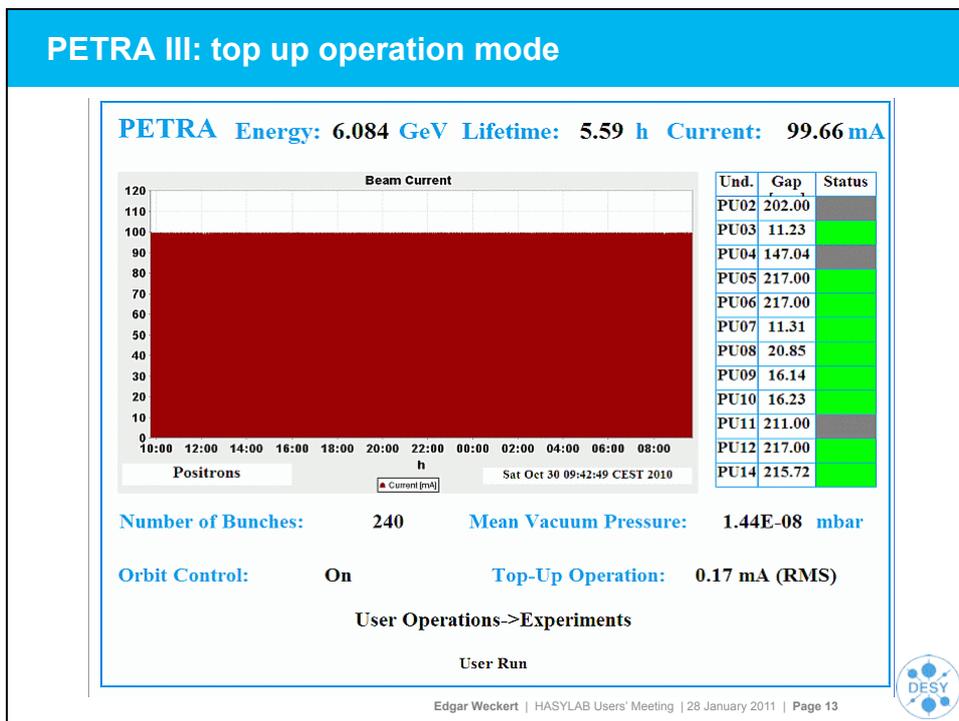
12'2010: end of project phase

Runs:
I_2010 (commissioning) 2000 h
II_2010 (1. user run) 2216 h

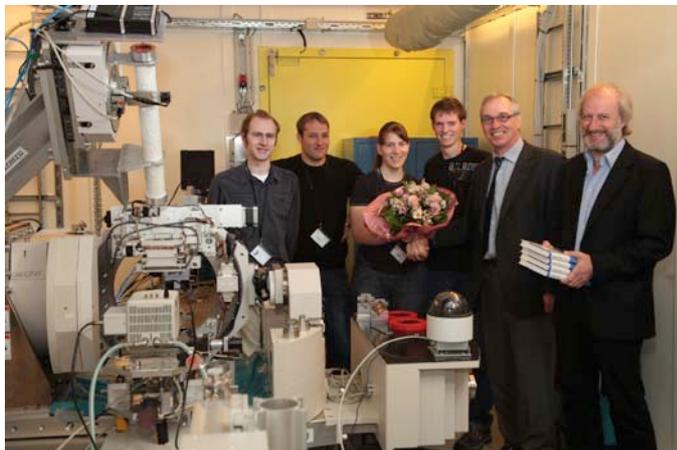
2011 scheduled:
 - 4000 h user operation
 - 1000 h in-house + commissioning
 - ~100 h contingency

Proposal calls:
 - 03'2010: P08, P09, P10
 - 09'2010: P03, P07
 - 03'2011: P01, P02, P06





PETRA III: First external users



First external users in September 2010.

From a total of 54 applications for beam time, 32 scientific workgroups were selected in an international peer review process.

First users: B. Schuster et al. (GSI)



PETRA III: Current beamline status

	Technique	first light on optics	first light on sample	2nd half 2010	1st half 2011
P01	NRS, ps-time resolved, IXS	May 17, 2010	June 10, 2010	friendly users	friendly users
P02	Hard X-ray powder diff./ extreme conditions	November 15, 2010	December 17, 2010		friendly users
P03	Micro SAXS/WAXS	March 18, 2010	April 16, 2010	friendly users	reg. users starting easter
P04	Variable Polarization XUV	December 15, 2010			
P05	Micro- and nano-tomography / imaging	December 17, 2009	March-11		
P06	Micro/nano-spectroscopy / fluorescence	December 17, 2009	November 11, 2010	friendly users	friendly users
P07	High energy materials science and diffraction	December 1, 2009	April 20, 2010	friendly users	reg. users starting easter
P08	High resolution diffraction	October 5, 2009	October 20, 2009	regular users	regular users
P09	Resonant scattering / diffraction / HAXPS	July 17, 2009	September 27, 2009	regular users	regular users
P10	Coherence applications	September 18, 2009	December 11, 2009	regular users	regular users
P11	MX-diffraction / biological imaging	July 15, 2010	April-11		
P12	BioSAXS	July 15, 2010	March-11		
P13	Macro molecular crystallography I	December 2, 2010			
P14	Macro molecular crystallography II	September 9, 2010			

high beta section	high-beta	142x5 μm
low beta section	low-beta	35x6 μm

Still some technical problems with few components:

- software: improves continuously
 - vibrations at monochromators affecting some experiments
- ➔ detailed studies underway



PETRA III – P09: Resonant Scattering from $\text{HoFe}_3(\text{BO}_3)_4$

DESY
Shukla et al.

Poincaré-Stokes parameters:

$$P_1 = (I_{\sigma'} - I_{\pi'}) / (I_{\sigma'} + I_{\pi'})$$

Magnetic scattering at the Ho L_3 edge from the (0, 0, 9/2) reflection at 2.5 K

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PETRA III - P06: Nano-CRL focusing, ptychography

15.25 keV, 10-20 nm resolution achieved
C. Schroer et al., TU Dresden
funded by BMBF Verbundforschung

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XRD and XRF of Neolithic Axes at the P07

Incomming X-Ray-Beam

X-Ray-Fluorescence (VORTEX-EM)

Sample

2-D Stage

X-Ray-Diffraction (X-RAY VHR 150mm)

P07 HEMS Beamline
Tunable Energy : 30-200 keV
Focus size : < 1mm²
Flux : 10x10 μm² (with lenses)
Flux : 10¹² Photons/s/0.01% BW

All 20 measured Axes were 3500 to 5500 years old

OH1 13 m EH1 6.6 m OH2 7.2 m EH2 8.5 m OH3 5.6 m EH3 8.5 m EH4 11 m

DCM arb extra ML optics surf diffrac storage long term heavy duty tomography 3D-mapper

mono TEST FACILITY general purpose dedicated
 30 – 300 keV PHYSICS MATERIALS SCIENCE

Helmholtz-Zentrum Geesthacht
 Centre for Materials and Coastal Research

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PETRA III: reflectivity measurements at P08

4) Experiments with the liquid diffractometer LISA @ 22keV
 (B. Murphy, Uni Kiel) (Funding: BMBF 05 KS7Fk3)

a) Test experiment: H₂O reflectivity

Water

b) Hg-Water interface with potential: Is layering of Hg depending on potential?

Water
Hg

Layering peak

- 10 Orders of Magnitude (at 50mA and APD-detector)
- fully reproducible
- Scanning time 2min → at least 10 times faster as compared to standard liquid diffractometers

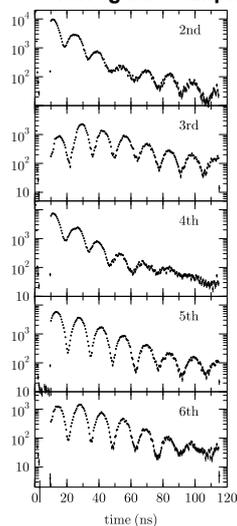
Layering is visible and depends on potential!

→ **Poster P84,85,86**

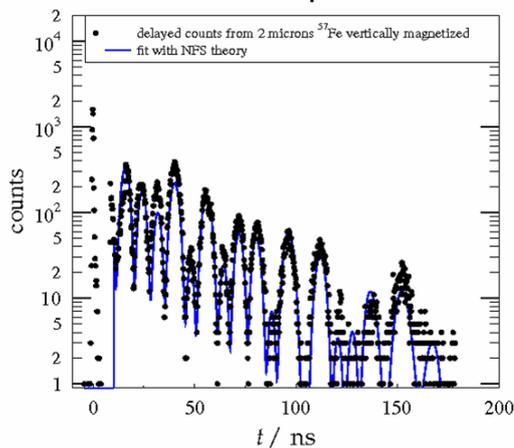
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First test experiments: PETRA III – P01

Double ^{57}Fe
waveguide sample



Standard iron test sample



Bunch purity as good as APS (top up !)

H.C. Wille, K. Schlage, B. Sahoo, F.U. Dill, R. Röhlberger

→ Poster P74



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FLASH: VUV and soft X-ray FEL

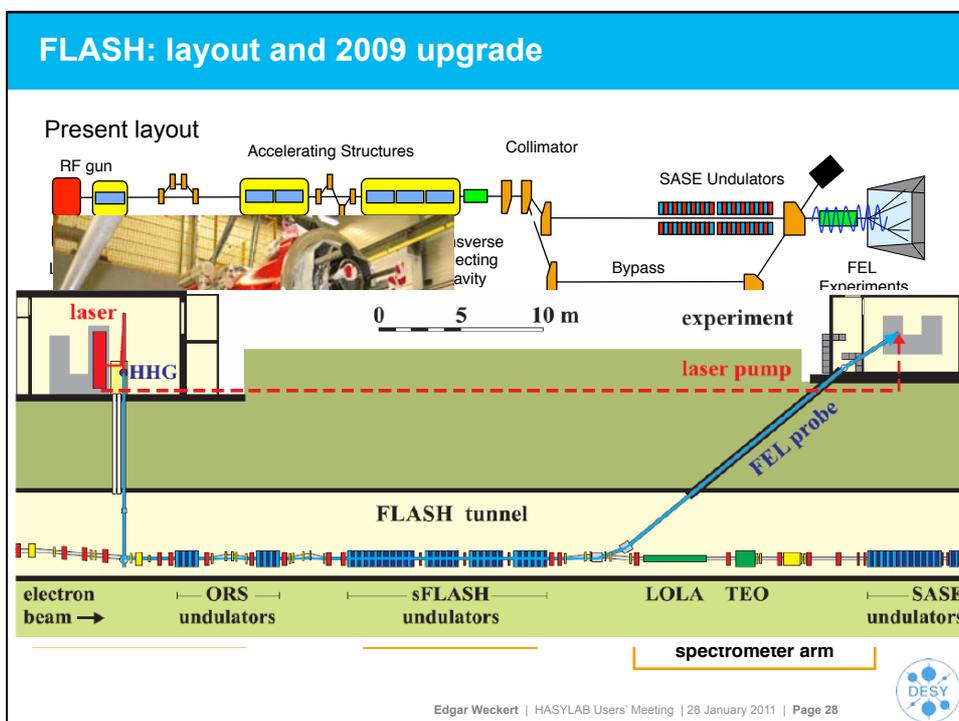
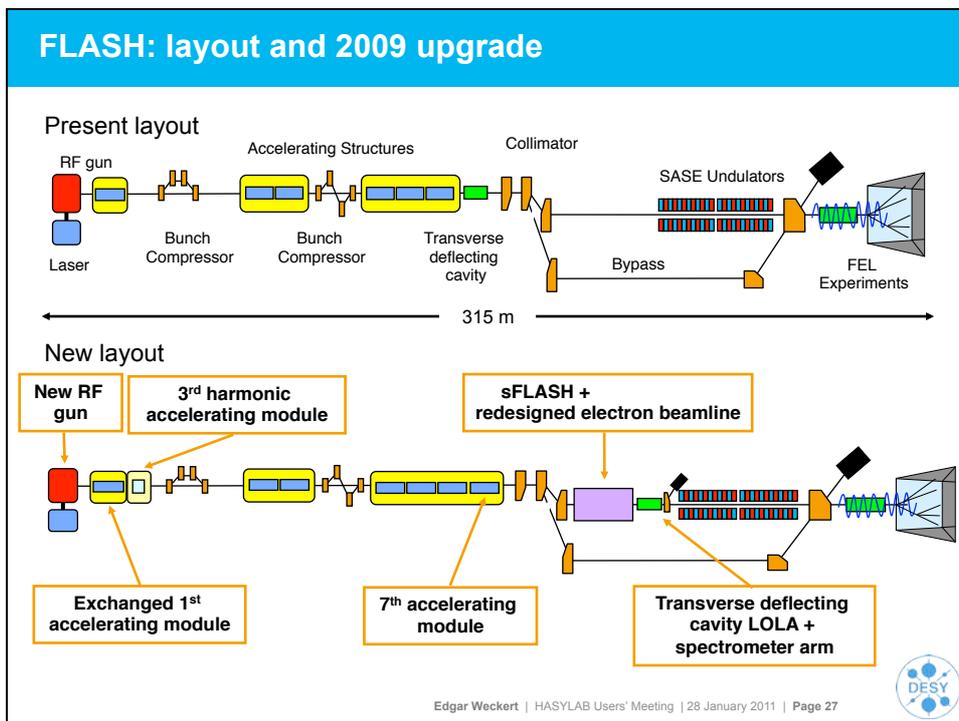
FLASH: VUV free electron laser

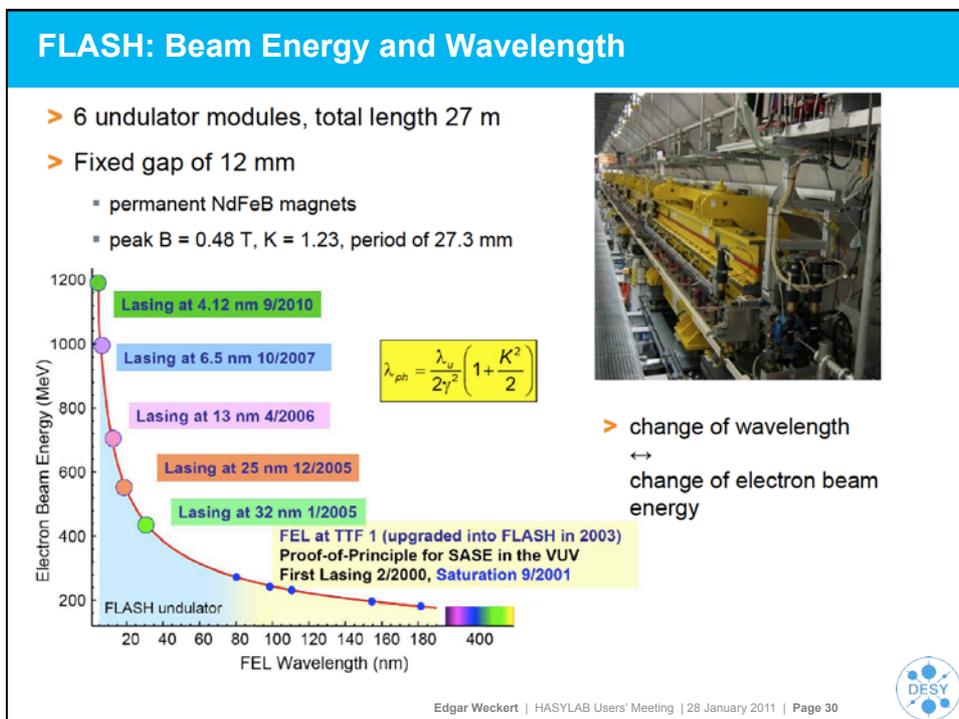
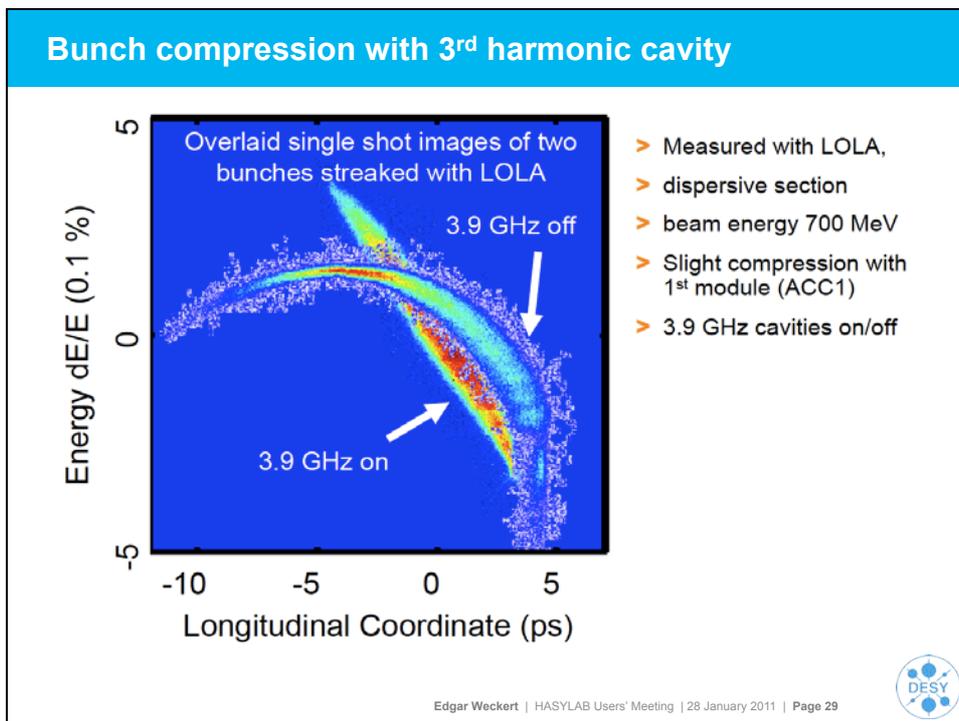
electron energy:	1.25 GeV
wavelength:	4.12-47 nm
average pulse energy:	50-200 μJ
peak pulse energy:	300 μJ
pulse duration:	10-150 fs
average power	
(8000 pulses / s):	~ 1 W
peak power:	3-10 GW
peak brilliance	1-10 $\cdot 10^{29}$
divergence (@13nm):	90 μrad
spectral width:	0.7-1%

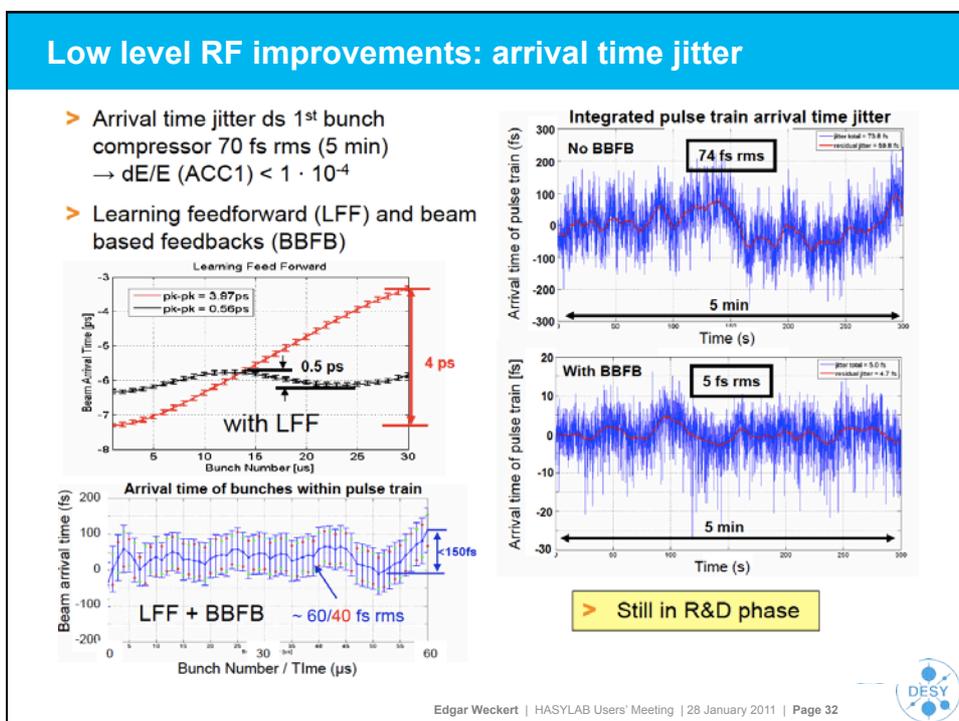
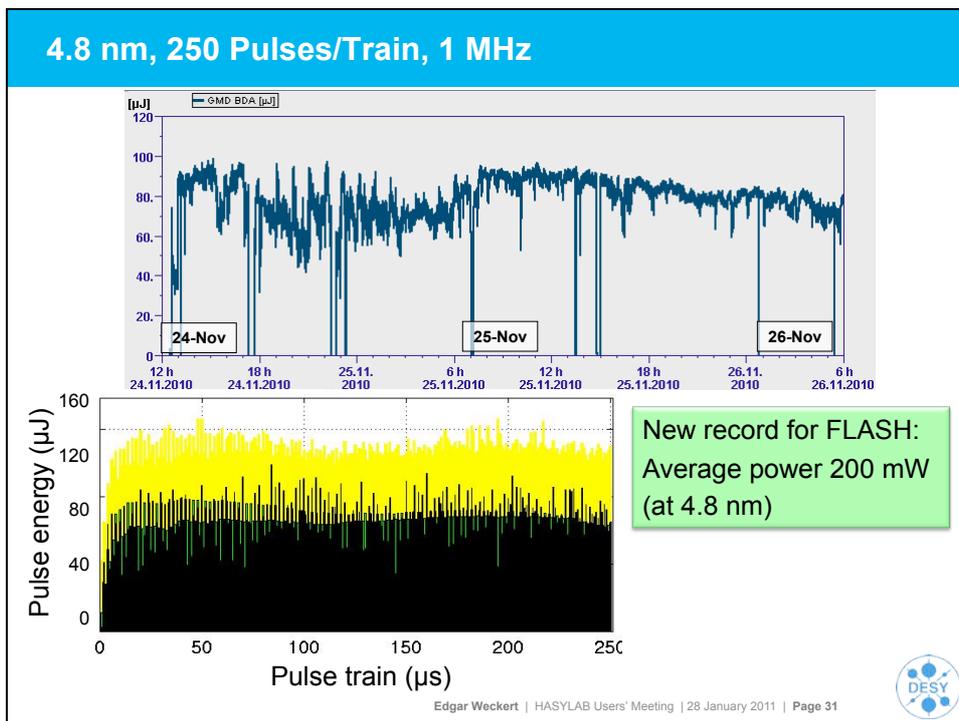


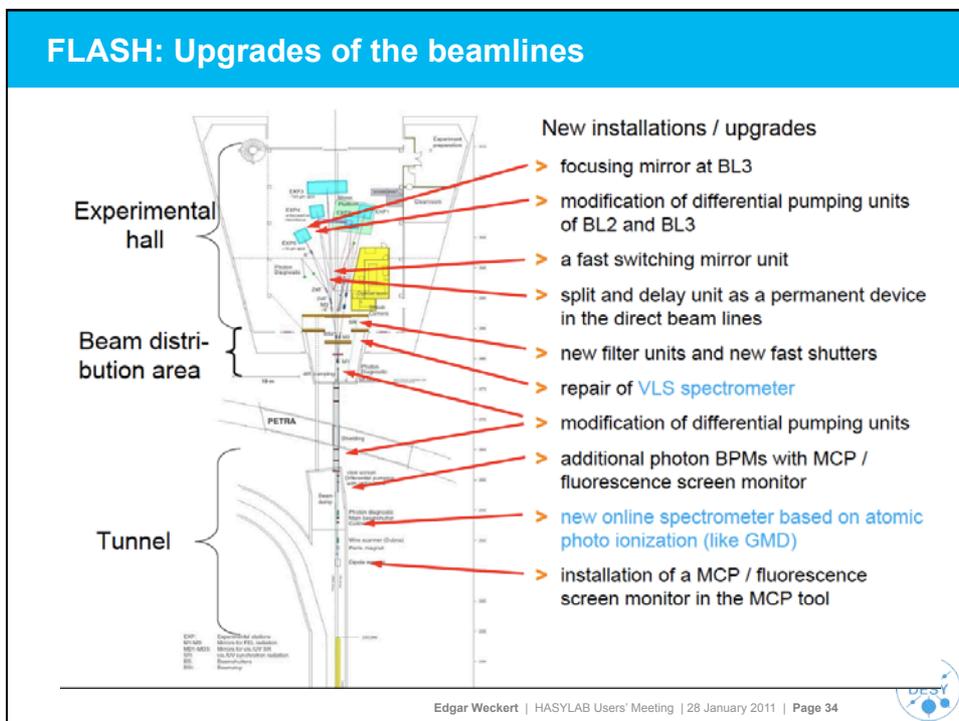
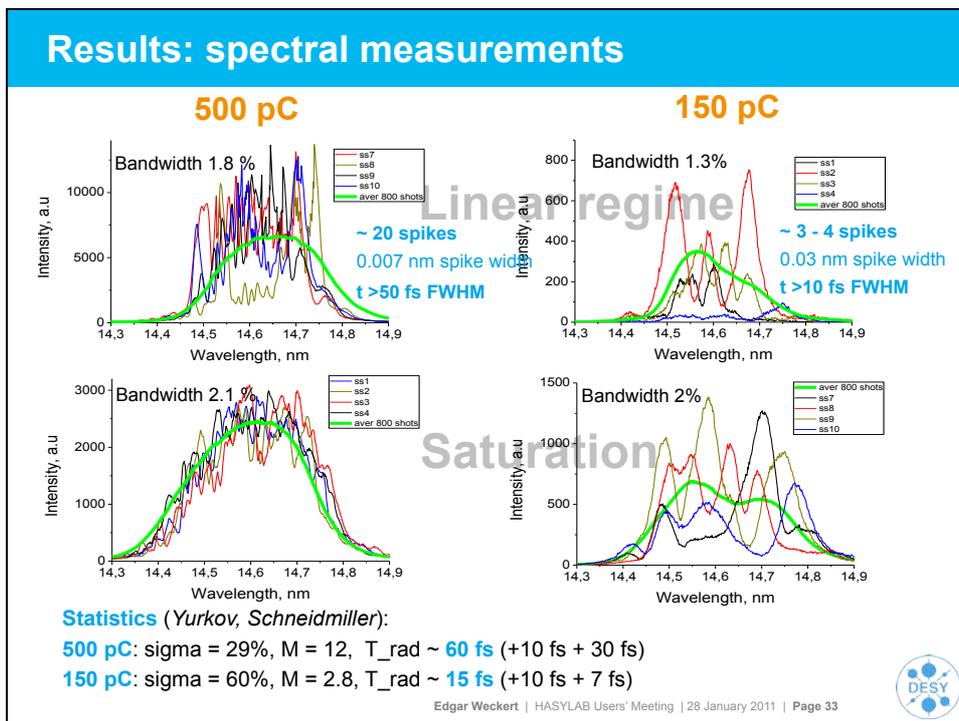
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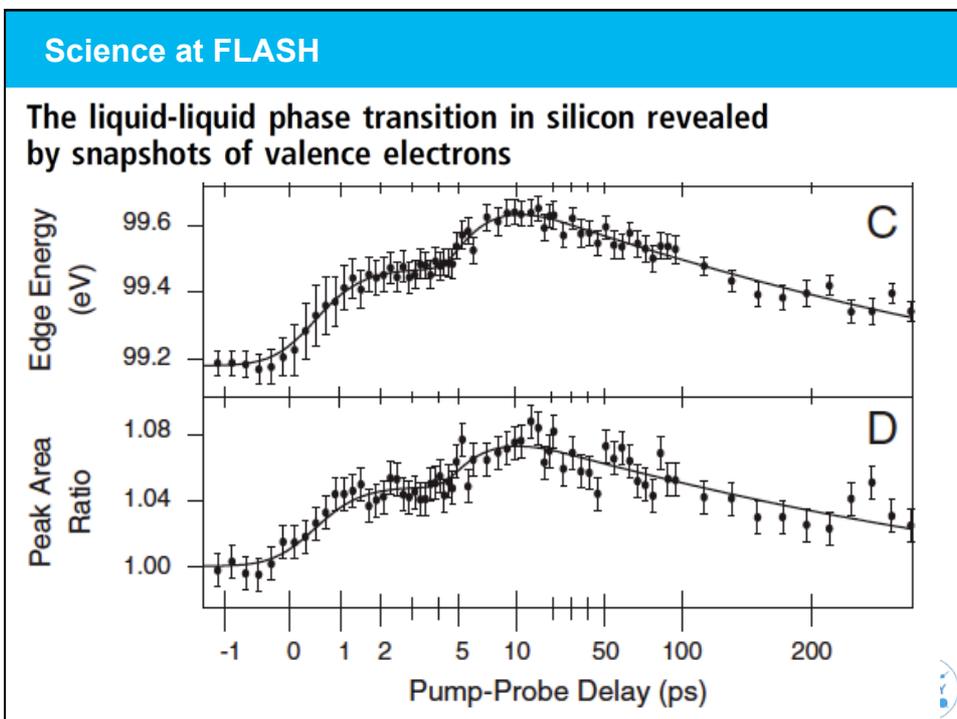
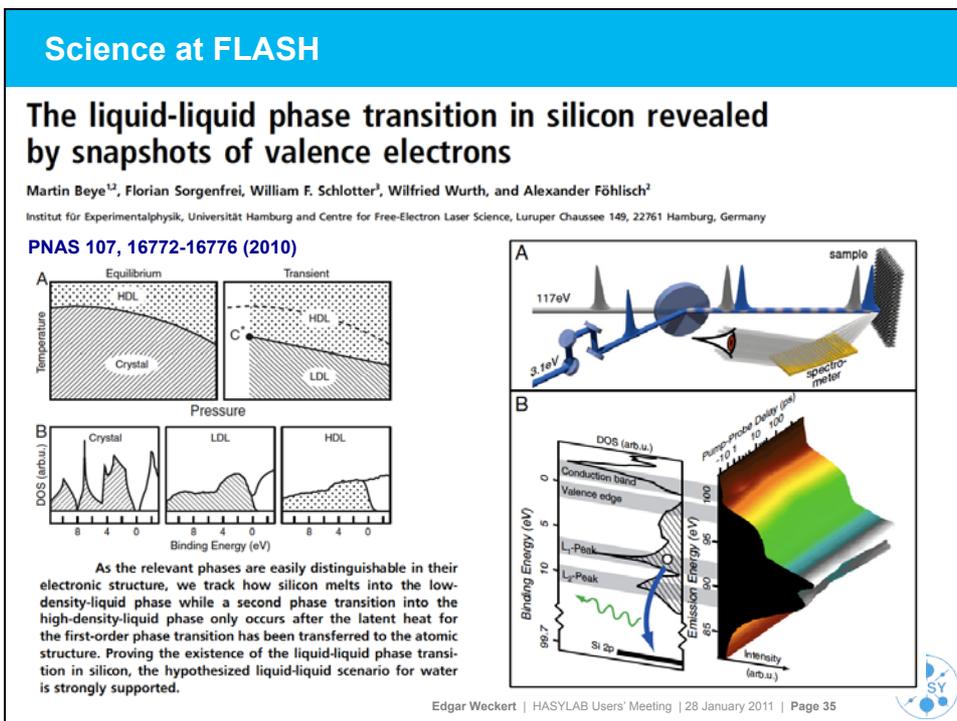












Few-femtosecond timing at FELs

Cross-correlate THz-edge radiation with an external laser

a

b

c

Achievable resolution: ~ 10 fs

Tavella, Stojanovic, Geloni, Gensch, Nature Photonics (2011) in press

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Flash I und Flash II

Experimente Flash II

Experimente Flash I

Layout after upgrade FLASH II

- Enables quasi-simultaneous operation at 2 wavelengths
- Enhances user capacity (almost a factor of 2)
- Application of different seeding schemes (HHG, HGHG) for
 - better timing
 - better spectral control
 - more stable intensity conditions

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Experimental hall layout (schematical)

FLASH I Hall

Opt. Laser
PG1
PG2
BL1
BL2
BL3

20 m

FLASH II Hall

Hutch with Opt. Laser systems

Vacuum/Beamline Electronics and storage space.

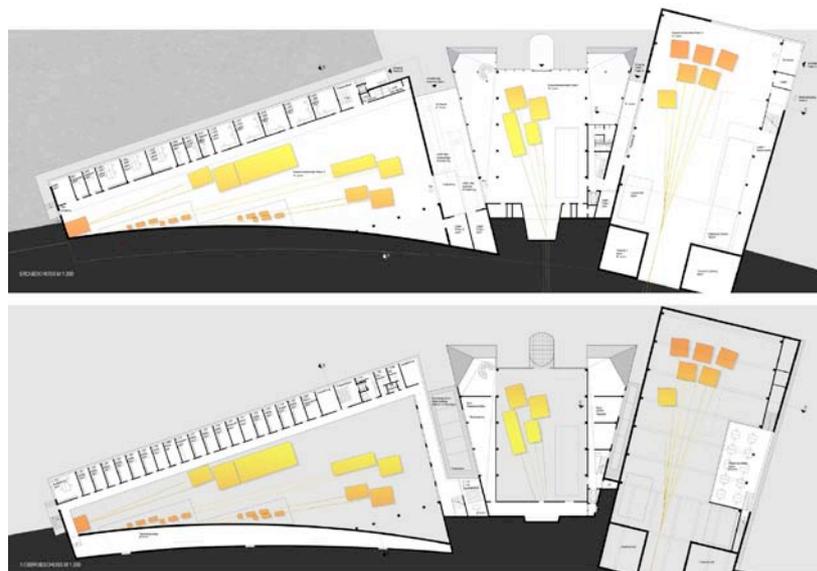
Long wavelengths (>~4 nm at 4 degr. Angle)

Short wavelengths (0.8 nm at 1 degr. angle)

Most beamlines down to 2 nm at 2 degr. angle

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FLASH II and PETRA III extension: architecture



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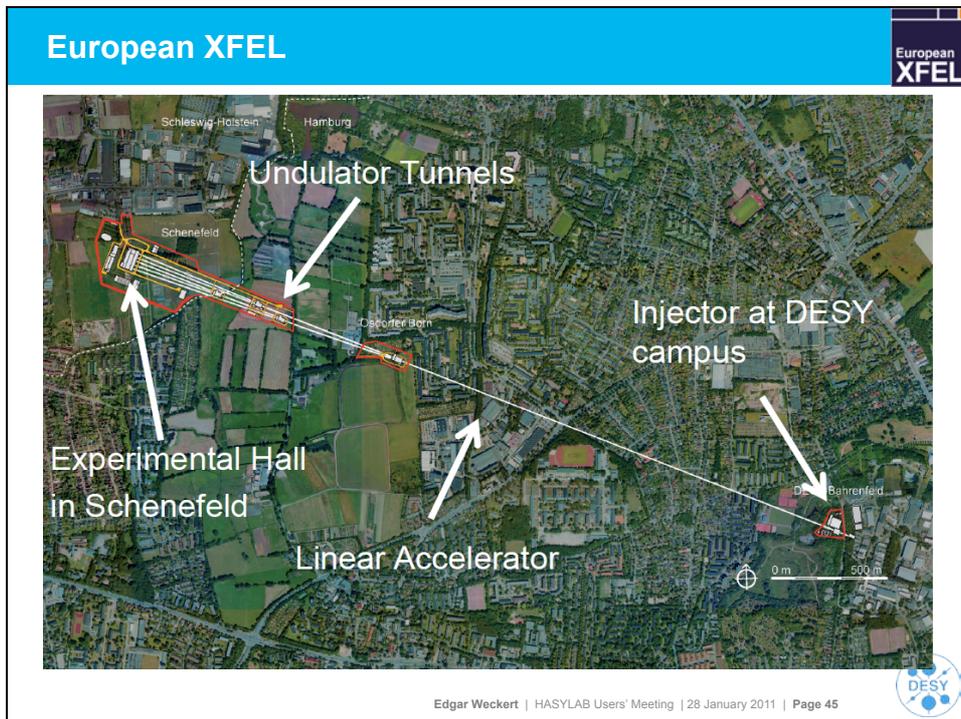


Schedule (tentative)

- Starting now 2011: Removal of Bldg. 47A**
Removal of cables along FLASH
- Sept. 2011: Start of tunnel construction and foundation of experimental hall**
(Needs ~3 months interruption of FLASH operation)
- April-May 2012: Start with technical infrastructure FLASH II tunnel**
- Summer 2012: Start hardware in tunnel**
- Winter 2013: Vacuum connection with FLASH**
- Spring 2013: Start commissioning of FLASH II with beam and seeding**
- Spring 2014(?): Start of user operation FLASH II**
Experimental Hall will be shifted compared to the tunnel by several months

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Transition from DORIS III to PETRA III

DORIS III → PETRA III

- Final shut down of DORIS III by the end of 2012 / begin of 2013
- Extension of PETRA III by those techniques offered at present at DORIS III and not yet present at PETRA III
- 10 new beam ports at PETRA III extension, 12+ experimental stations
- start of extension construction work: 2-3 months before DORIS III shutdown
- all measures will be taken to bring back into operation as fast as possible the most requested techniques like XAFS, SAXS, single crystal XRD, ...



PETRA III extension and possible extensions

two long straights plus the adjacent arcs

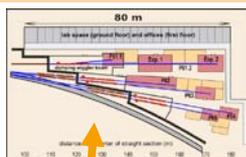
North

- o Damping wiggler straight
- o 4 short straights (2m) in the arc
- o 1 "wundulator"
- o 3 mini-wigglers as BM-like sources

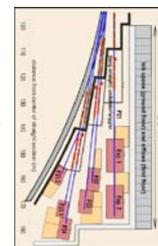
East

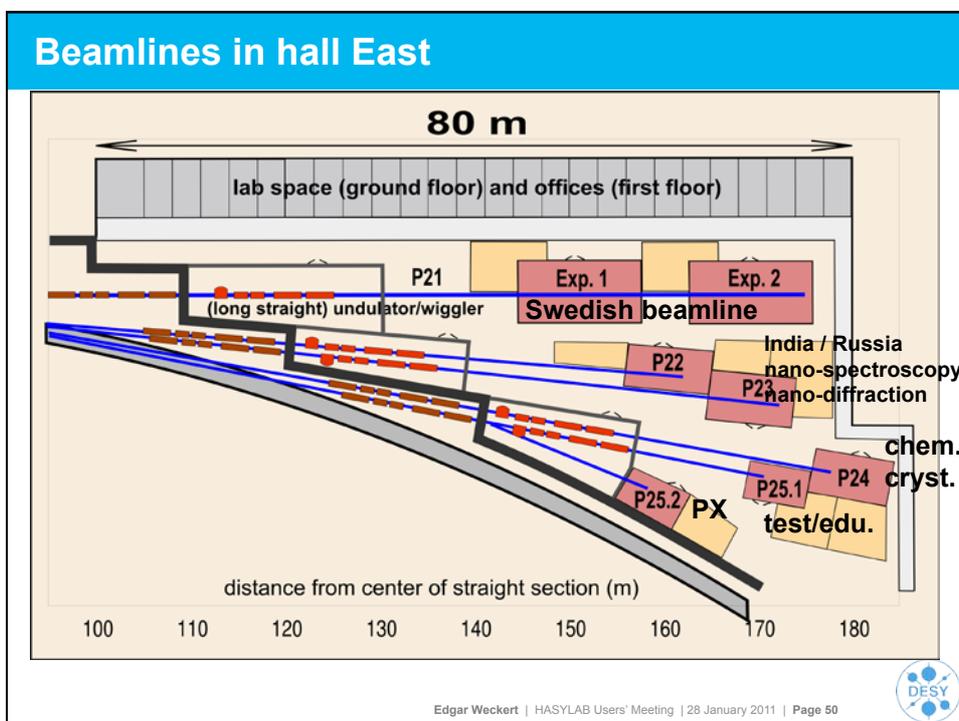
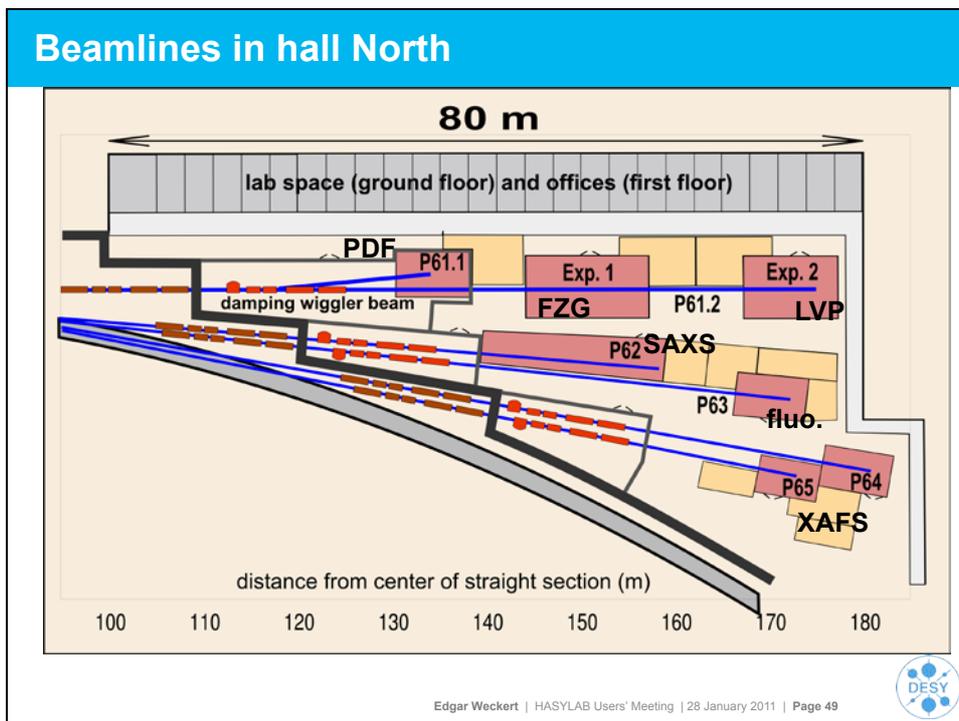
- o Long straight for undulator & wiggler
- o 4 short straights (2m) in the arc
- o 2 undulators
- o 2 mini-wigglers as BM-like sources

North



East





Accelerators | Photon Science | Particle Physics
Deutsches Elektronen-Synchrotron
 A Research Centre of the Helmholtz Association



Tenure track positions for o German-Russian BL "nano-diffraction" o Swedish BL "High-energy materials science"

X-RAY DIFFRACTION .

DESY, Hamburg location, is seeking:
Physicist (m/f)

DESY
 DESY is one of the world's leading centres for the investigation of the structure of matter. DESY develops, runs and uses accelerators and detectors for photon science and particle physics.

Looking back on a long tradition in research with synchrotron radiation DESY is currently developing into one of the leading centres in the field of photon science worldwide. With the storage ring PETRA III and the Free-Electron-Laser FLASH, DESY offers a unique combination of photon sources to the scientific community. PETRA III, one of the most brilliant hard X-ray facilities in the world, has just started operation. A total of 14 new undulator beamlines have been built to utilize its extreme brightness. For the planned extension of PETRA III, DESY is seeking a scientist for the implementation of a German-Russian undulator beamline.

The position

- Lead a team to conceive, design, plan, commission and operate an undulator beamline for nano-diffraction applications
- Develop own independent and collaborative research projects using state-of-the-art synchrotron X-ray diffraction techniques
- Establish and maintain close contacts to the Russian scientific community interested in using the facility
- Work committed in a team oriented environment together with international experts in the field

Requirements

- Ph.D. in physics or a related field
- Record of strong experience with X-ray scattering methods using synchrotron radiation
- Experimental skills and interest in instrumentation development
- Teamwork abilities
- Excellent knowledge of English
- German and/or Russian language skills advantageous

Applications should include CV, list of publications, a statement of research interests and at least two references.

High-energy X-ray material science

Looking back on a long tradition in research with synchrotron radiation DESY is currently developing into one of the leading centres in the field of photon science worldwide. With the storage ring PETRA III and the Free-Electron-Laser FLASH, DESY offers a unique combination of photon sources to the scientific community. PETRA III, one of the most brilliant hard X-ray facilities in the world, has just started operation. A total of 14 new undulator beamlines have been built to utilize its extreme brightness. For the planned extension of PETRA III, DESY is seeking a physicist for the implementation of a Swedish high-energy X-ray material science beamline.

The position

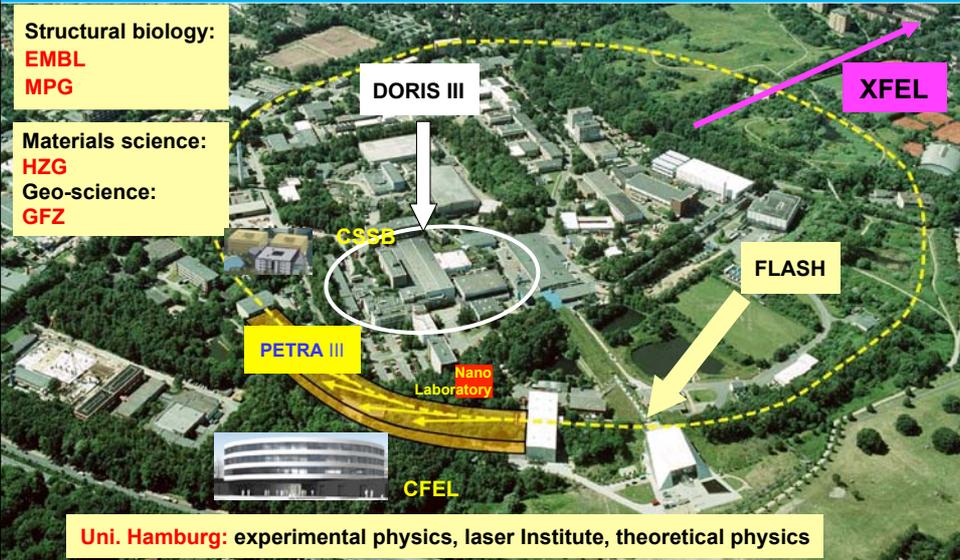
- Lead a team to conceive, design, plan, commission and operate an undulator beamline for materials science applications with high-energy X-rays
- Develop own independent and collaborative research projects using state-of-the-art synchrotron X-ray diffraction techniques
- Establish and maintain close contacts to the Swedish scientific community interested in using the facility
- Work committed in a team oriented environment together with international experts in the field

Requirements

- Ph.D. in physics or a related field
- Record of strong experience with X-ray diffraction techniques using synchrotron radiation
- Experimental skills and interest in instrumentation development
- Teamwork abilities
- Excellent knowledge of English
- German and/or Swedish language skills advantageous

The position is initially limited for 3 years with the possibility of permanent employment (tenure track).

Facilities at DESY: Infrastructure for Science



Structural biology:
EMBL
MPG

Materials science:
HZG

Geo-science:
GFZ

DORIS III

FLASH

PETRA III

Nano Laboratory

CFEL

XFEL

Uni. Hamburg: experimental physics, laser Institute, theoretical physics



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CFEL: Status

Center for Free-Electron Laser Science (CFEL)
 MPG, DESY, and University of Hamburg

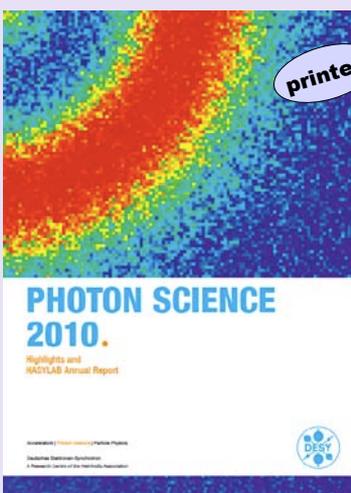
MPG Advanced Study Group I	  	 	Univ. HH Advanced Study Group II
Ullrich Rost Strüder Schlichting Techert	<div style="display: flex; justify-content: space-around;"> <div style="background-color: #90ee90; padding: 2px;">Junior Research Group I</div> <div style="background-color: #90ee90; padding: 2px;">Junior Research Group II</div> <div style="background-color: #90ee90; padding: 2px;">Junior Research Group III</div> </div> <div style="background-color: #cccccc; padding: 2px; text-align: center;"> Max-Planck "Forschungsgruppe" of HH University </div> <div style="display: flex; justify-content: center; gap: 10px;">    </div>	 Wurth Johnson Drescher Klanner Rübhausen Roßbach Khan	

All together about 80 people so far (incl. ASG)
 → Extension of the temporary building necessary
 → New building ready for moving in: **Spring 2012**

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HASYLAB Annual Report 2010; Deadline



Deadline for user reports 2010:

1 March

Please upload of your contributions via DOOR

Link: door.desy.de

Deadline for submission of publications: 15 February 2011

Proposal deadline for DORIS and PETRA:
1 March 2011



Vendor Exhibition 2011.



Agilent Technologies Vacuum Products AXO Dresden GmbH BERTHOLD TECHNOLOGIES GmbH & Co. KG Edwards GmbH Feinmess Dresden GmbH FuG Elektronik GmbH Hiden Analytical Huber Diffractionstechnik GmbH & Co. KG Kleindiek GmbH MDC Vacuum Limited	         	attocube systems AG Beckhoff Automation GmbH CAEN GmbH elspec GmbH FMB Oxford Limited Goodfellow GmbH Hositrad Deutschland Incoatec GmbH Linde Kryotechnik AG MEWASA AG	         
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HUC: HASYLAB User Committee

Ballot for the 2011 Election of the HASYLAB USER COMMITTEE (HUC)

Entitled to nominate and to vote are all users of the DESY photon sources. The main task of the HUC is to act as a link between the users and the management of DESY photon sources. The committee consists of 5 external members. New members are elected during the HASYLAB user meetings for a term of 3 years. A reduction of HUC members is possible.

Candidates	Institute	Research field	Year
<input type="checkbox"/> Hans-Joachim Bräuer	Chemical University of Technology (DE)	Eng. Material Science, Neutron analysis with X-ray and neutron	1999
<input type="checkbox"/> Karen Franke	University of the Basque Country (ES)	Chemical synthesis, organic chemistry/crystallography	1991
<input type="checkbox"/> Andrej Greshchok	University of the Basque Country (ES)	High pressure crystallography, solid state chemistry and physics, materials science	2004
<input type="checkbox"/> Andreas Meyer	Universität Hamburg (DE)	Nanomachined surfaces, Physics, SAXS and EUSAXS	1994
<input type="checkbox"/> Peter Müller-Buschbaum	Technische Universität München (DE)	Soft matter, polymers, EUSAXS	1982
<input type="checkbox"/> Rainer Hübner	Universität Erlangen (DE)	Inorganic materials, nano particles, diffraction, diffraction crystal diffraction scattering	1990
<input type="checkbox"/> Andrej Pavlik	Polish Academy of Sciences (PL)	Polymers (plastics), X-ray structure determination of nanomaterials	2007
<input type="checkbox"/> Guillermo Requena	Vienna University of Technology (AT)	Engineering technical science	2010
<input type="checkbox"/> Luis A. Sanchez de Alamedida Prada	TU Hamburg (DE)	Soft matter, polymers, SAXS	2004
<input type="checkbox"/> Thomas Schneider	Leibniz-Institut für innovative Mikrochemie (DE)	Highly functionalized Si nanoelectronics, "in-situ" studies of working devices	2000
<input type="checkbox"/> Christian Scherer	TU Dresden (DE)	Energy nanotechnology, energy storage, energy conversion, energy analysis, nanotechnology, nanoelectronics, nanophysics, nanomaterials, nanofabrication, nanofabrication	2004
<input type="checkbox"/> Joachim Walschberger	Universität Osnabrück (DE)	Materials science, thin films, surfaces, morphology, x-ray diffraction and reflectometry	1987

2011 Election of the HASYLAB USER COMMITTEE (HUC)

Please drop your ballot in the voting box at the reception desk.

The election for the HUC will be closed at 11:00 (after the coffee break)!



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KFS: Komitee für Synchrotronstrahlung

Election of the new KFS

→ Presentation of U. Pietsch today

→ Please register for being able to vote

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European Light Sources Activities - Synchrotron and Free Electron Lasers : DORIS, PETRA III, FLASH user support
03/2009 – 08/2011



IRUVX-PP the preparatory phase of the ESFRI Roadmap project EuroFEL, a pan-European Research Infrastructure/ Collaboration in FEL science and technology
04/2008 – 03/2011



Network in Advanced Materials and Nanomaterials of industrial interest between Europe and Latin American Countries of MERCOSUR (Argentina-Brazil-Uruguay)
08/2009 – 7/2012



Photon and Neutron Data Infrastructure provides our user communities with data repositories and data management tools
06/2010 – 11/2011

Main new EC-Proposals in 2010 with participation of DESY-Photon Science:
CECILIA continuation of ELISA, **CRISP** collaboration of all physical ESFRI Roadmap projects

Posters & vendors exhibition (Bldg. 72)

DESY Auditorium (Bldg. 5)

European XFEL

Acknowledgement

- BMBF and BWF for financial support for projects and within the Verbundforschung
- Members of the Project Review Panels (PRPs)
- Members of the Photon Science Committee (PSC) and extended Science Council (ESC)
- all DESY staff for their dedication
- all users for their support

**Thank you for
your attention**

