

Spectroscopy & Coherent Scattering (SCS) Instrument

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Layout Considerations

Workshop “Soft X-Ray Science and Instrumentation at the European XFEL
Trieste, Dec. 16/17, 2010

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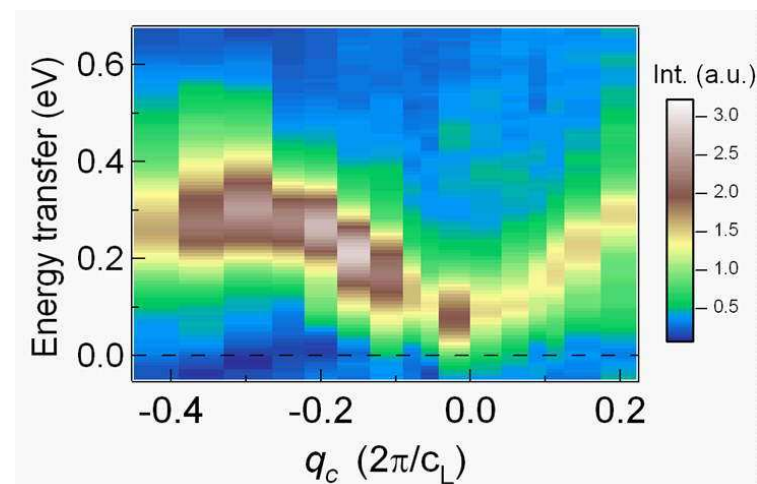
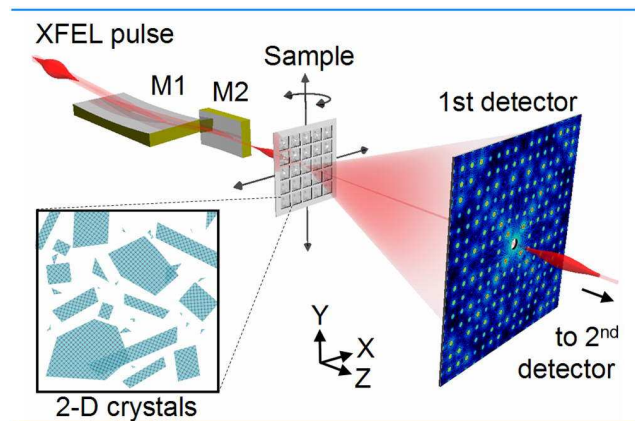
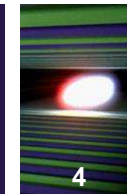


- **TDR instruments (2006)**
- **Startup version (Jan 2008)**
- **Instrument workshops/meetings**
 - Spectroscopy & Coherent Scattering, SCS (Villigen, Jun '09)
- **SASE 3 undulator, beam transport system & SCS (Dec 2010)**



	Description of scientific applications
HED-1	High Energy Density Matter – Investigation of matter under extreme conditions
SQS-1 SQS-2	Small Quantum Systems – Atoms, ions, clusters and nano-domains structural and electronic structure analysis, non-linear processes
PCS-2	X-ray Photon Correlation Spectroscopy – Nanoscale dynamics of disordered systems
XAS-1	X-ray Absorption Spectroscopy – Time-resolved structural dynamics and electronic structure investigations
CXI-1	Coherent X-ray Imaging – Time-resolved structural dynamics investigations

- Two instruments per field correspond to use of monochromatic and high-intensity SASE 3 FEL radiation

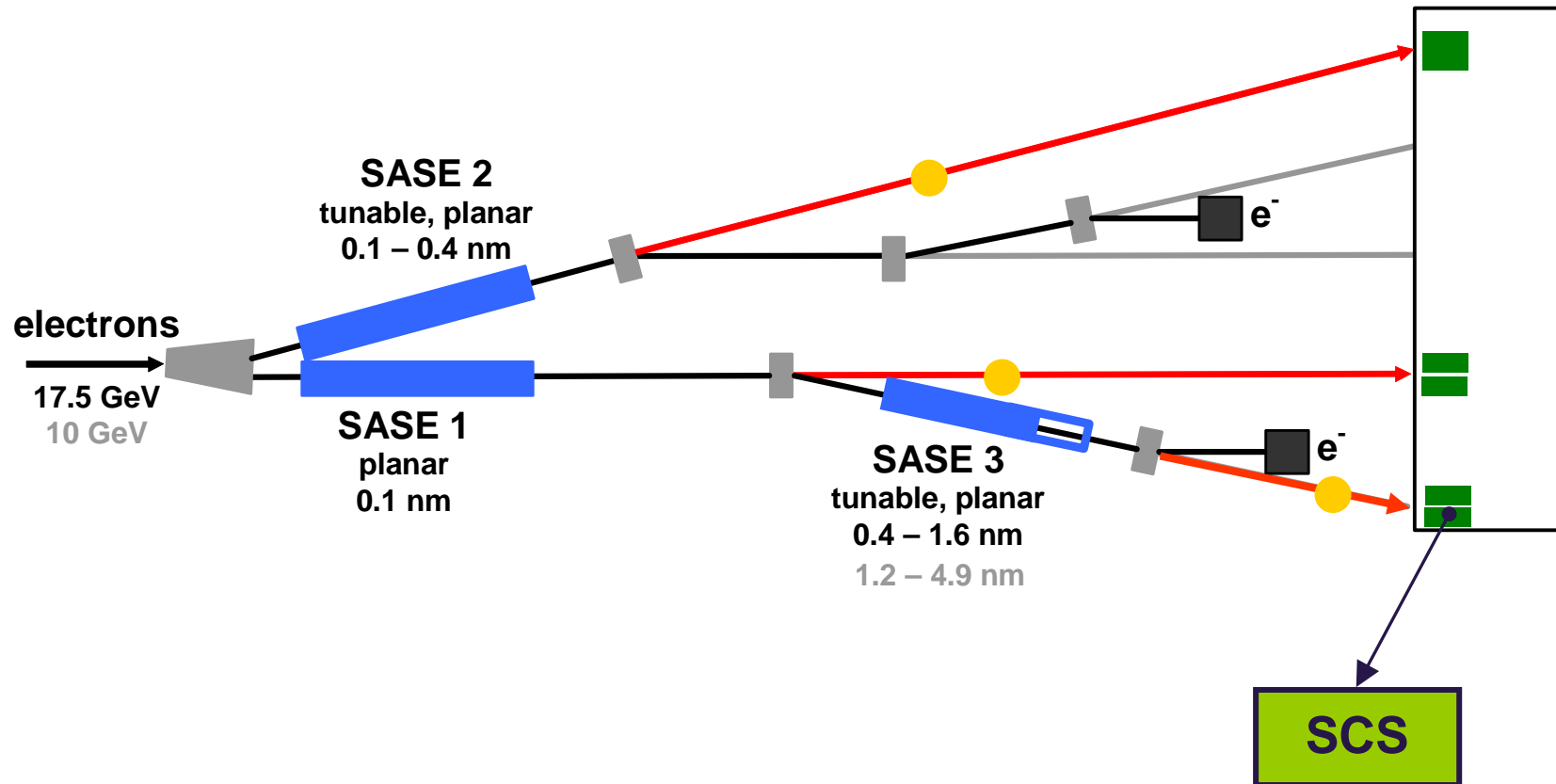
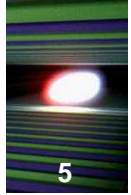


Spectroscopy & Coherent Scattering (SCS)

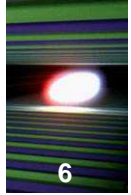
Scientific applications & experimental techniques:

- Electronic and atomic structure and dynamics of nano-systems and of non-reproducible biological objects
- X-ray spectroscopy (XAS, XES, IXS, RIXS, XPS), imaging (holography, CDI, XPCS); Pump-probe experiments

SCS location at SASE 3



Energy range of operation: ~800 eV – 3 keV



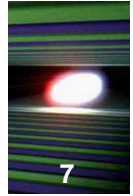
PSI-SLS, Villigen, 2-4 Jun 2009

- Organized by R. Abela, B. Patterson
- Program committee: R. Abela, H. Chapman, G. Faigel, G. Grübel, Z. Hussain, M. Kiskinova, M. Kovalchuk, J. Luning, N. Mårtensson, S. Molodtsov, W. Wurth
- Participants: ~90 scientists, 14 countries

Three working groups (WG):

- Photon-in/photon-out & electron-out spectroscopic experiments (W. Wurth & Z. Hussain)
- Imaging, dynamics & photon correlation spectroscopy: Biological objects (I. Schlichting & I. Vartanians)
- Imaging, dynamics & photon correlation spectroscopy: Magnetic Systems (G. Grübel & J. Luning)





Major applications & instrumentation

- Electronic structure and excitations in solids & liquids
- Magnetism & magnetic structures including their dynamics
- Structure determination of nanosystems and biological units
- Move to low energies, polarization, 2D detection & advanced diagnostics
- Endstation for x-ray spectroscopic studies
- Additional location for user provided equipment

Requirements to x-ray delivery

	Photon energy [keV]	Tunability	Polarization	Beam size [μm]	BW	Rep.rate	OL-PP/ X-PP
Initial	0.8 – 3.0	Yes	Linear	1,10,100	0.01%	4.5 MHz	Yes/Yes
Requested	~0.28 – 3.0	Yes	Variable	1,10,100 unfocus.	0.003%	4.5 MHz, 30 kHz	Yes/Yes
Status / Comments	t.b.e.	✓	t.b.e.	✓	t.b.e.	✓	✓

t.b.e. = to be evaluated



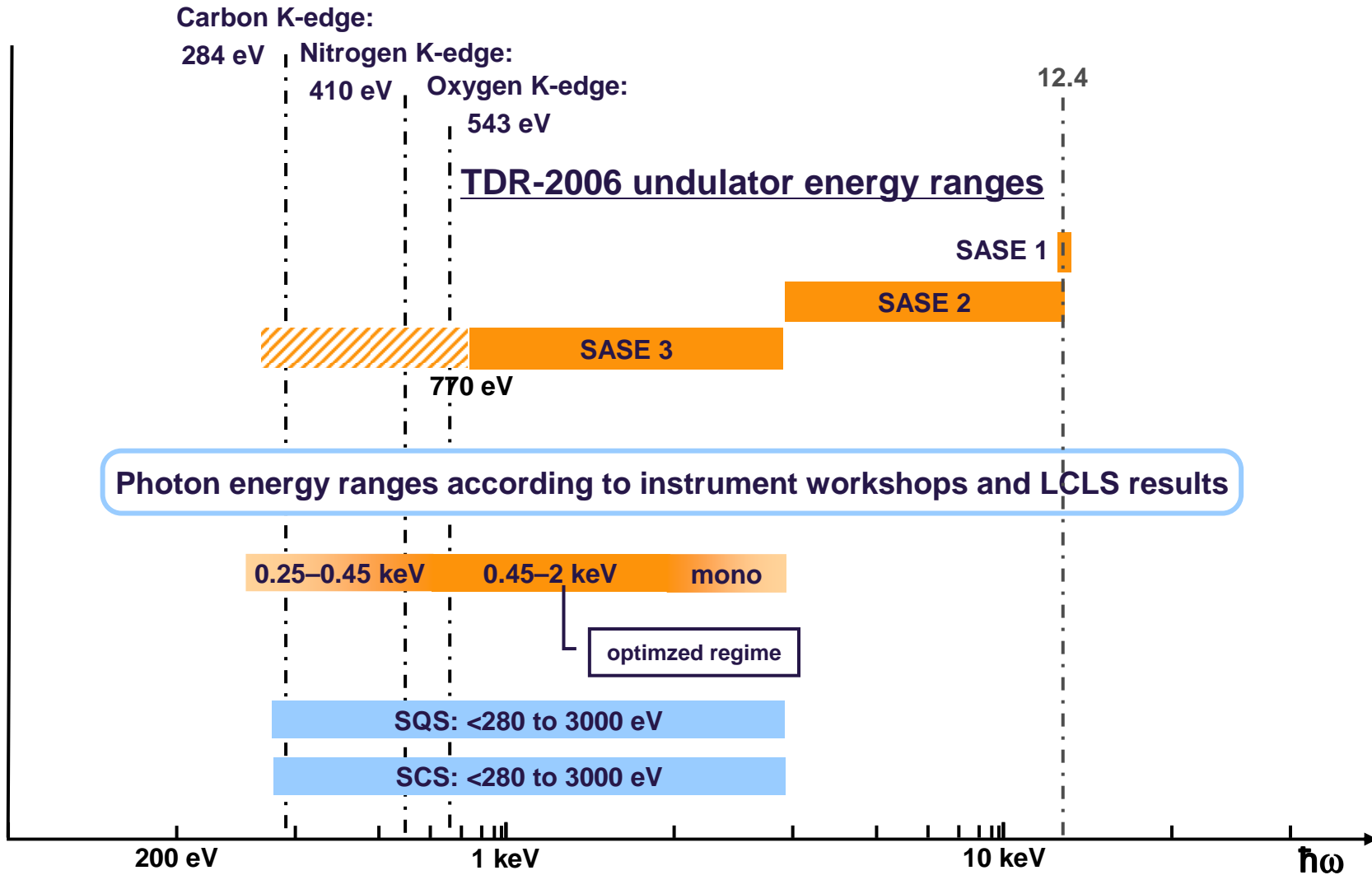
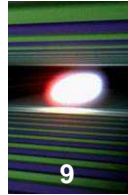
Two main requests coming from the side of the Soft x-ray community are:

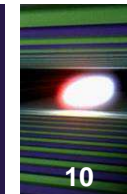
- Extension of the photon energy range if possible below C 1s edge (285 eV)
- Variable light polarization

Based on the recent achievements of LCLS as well as of FLASH and on the R&D results obtained within the other Soft x-ray FEL projects (e.g. FERMI, SwissFEL) the possibility of improvement of the following startup configuration parameters should be evaluated:

- Pulse duration few fs, or even in attosec range
- Monochromatization better 30000
- Synchronisation better 10 fs
- Overall time resolution <10 fs
- Stability positional <10%
 spectral <<0.1%
 temporal <100 fs

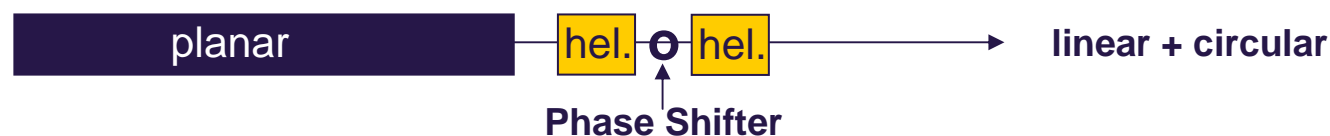
SASE 3 beamline $\hbar\omega$ range (revised, Dec 2010)





Planar undulator & 2 helical “short” afterburners with a phase shifter in between

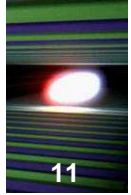
(1) in-line



(2) non-coaxial



- => afterburner operation both at the fundamental (down to C edge) and second (edges of transition and rare-earth metals) harmonics;
- => 100% stable polarization (L. or R.) will be ensured by afterburners, solely;
- => full polarization control (less stability and % of polarization) by phase shifter, additionally.

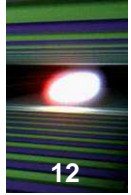


Scope

- Use 0.25-3.0 keV (optimized 0.45 – 2.0 keV) soft x-rays (SASE 3) with varying focus (10 – 100 μm , unfocussed) for studying electronic and magnetic properties and for imaging applications. OL and x-ray pumping & probing

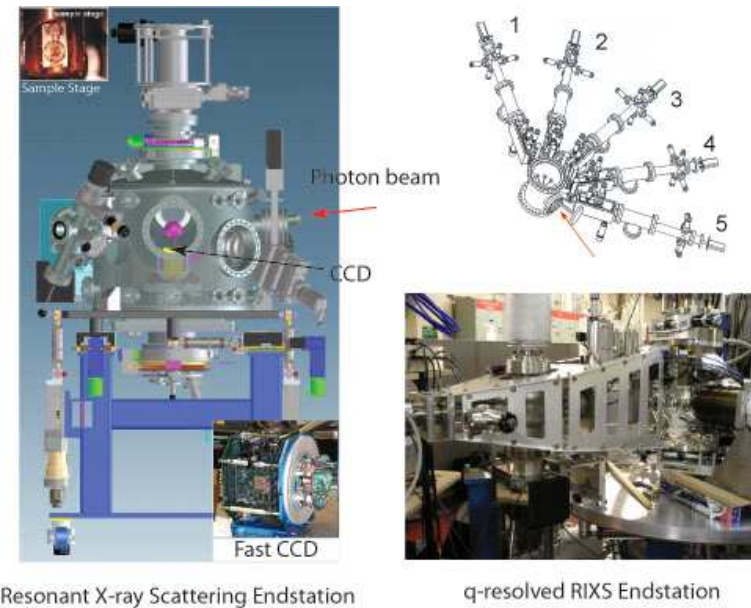
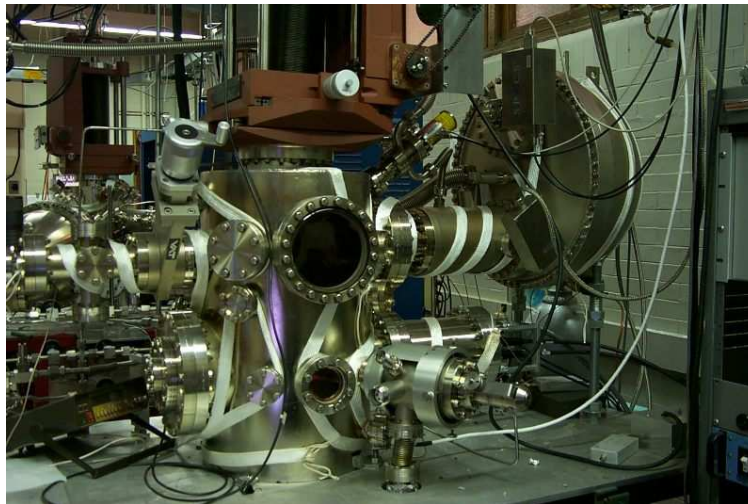
Key techniques & major scientific applications

- Electronic structure and dynamics of correlated materials and nanostructures
- Magnetic structures and dynamics
- 2D and possible 3D structure determination with ‘nm’ resolution of membrane supported cells and similar bio-objects will be of great importance for the investigation and understanding of cellular structure and processes
- The usage of high rep. rates will depend in most cases on the sample-x-ray interaction



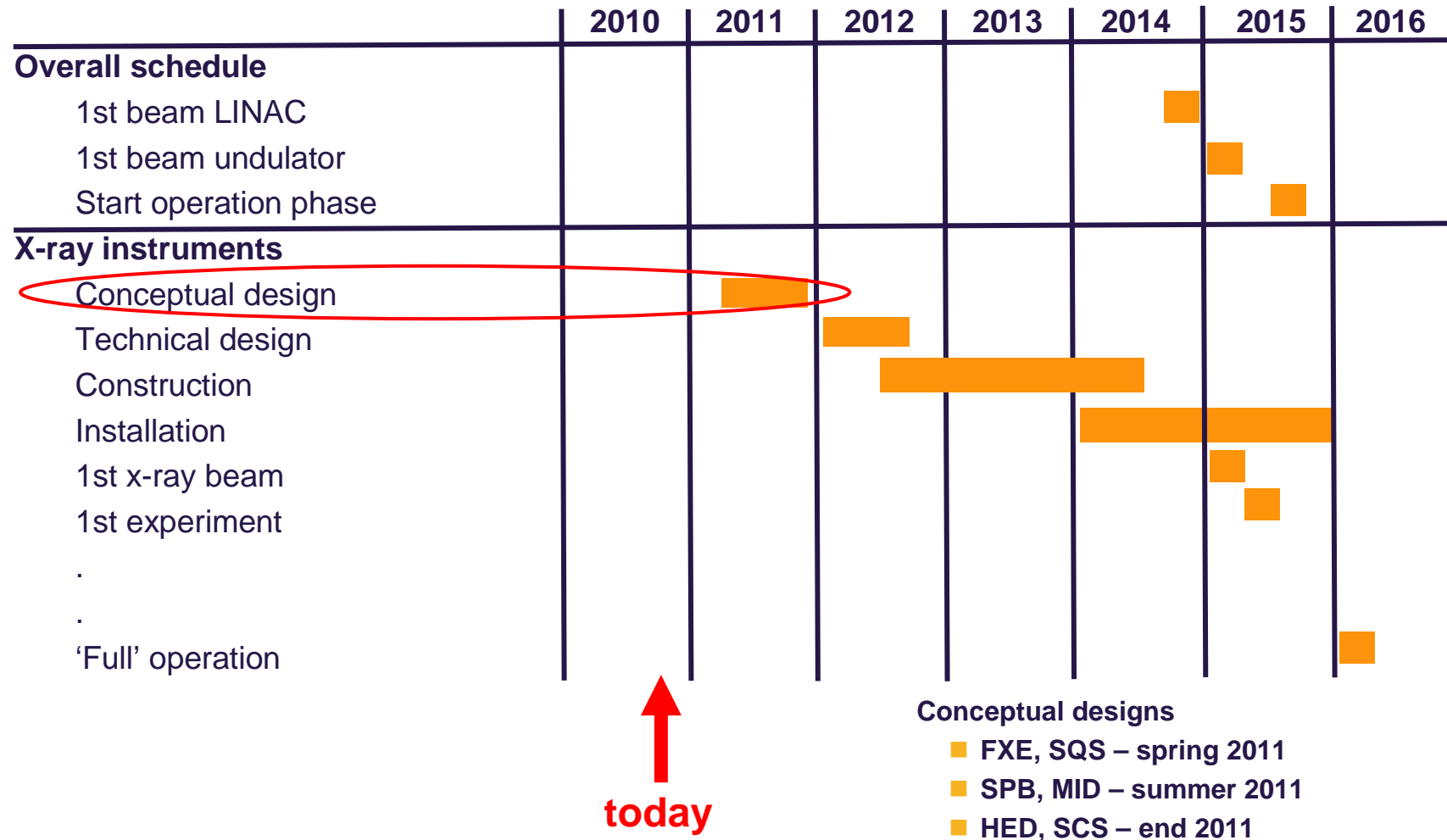
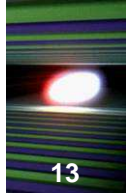
Instrumentation

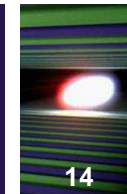
- A UHV setup including photon-in/photon-out spectrometer and forward diffraction/scattering detectors. Photoemission spectrometer is an option provided by users (users' consortia)



- better than 10^{-4} monochromatized variably polarized beam with various, distinct foci, x-ray split & delay
- Access to high rep. rate OL (few fs, 100 μ J, 1 MHz, fully synchronized)
- Pulse resolving diagnostics of X-ray beam properties

SCS: conceptual design





We invite highly qualified scientists to apply for the position as

Leading XFEL research scientist (f/m)

with the two-sided role **to build up a scientific research group and to coordinate the definition, design and construction of the instrument** for soft x-ray spectroscopy and coherent scattering (SCS), both with the purpose to facilitate top-level scientific research programs at the European XFEL. The SCS instrument aims at using fs pulses of soft X-ray coherent radiation for the investigation of structural, electronic and dynamical properties of nanoscale systems. **Candidates are expected to have a proven record in soft X-ray spectroscopy and/or scattering.**

Deadline

15 January 2011

www.xfel.eu



**Thanks you for attention
and
contribution into the definition
of the SCS instrument**