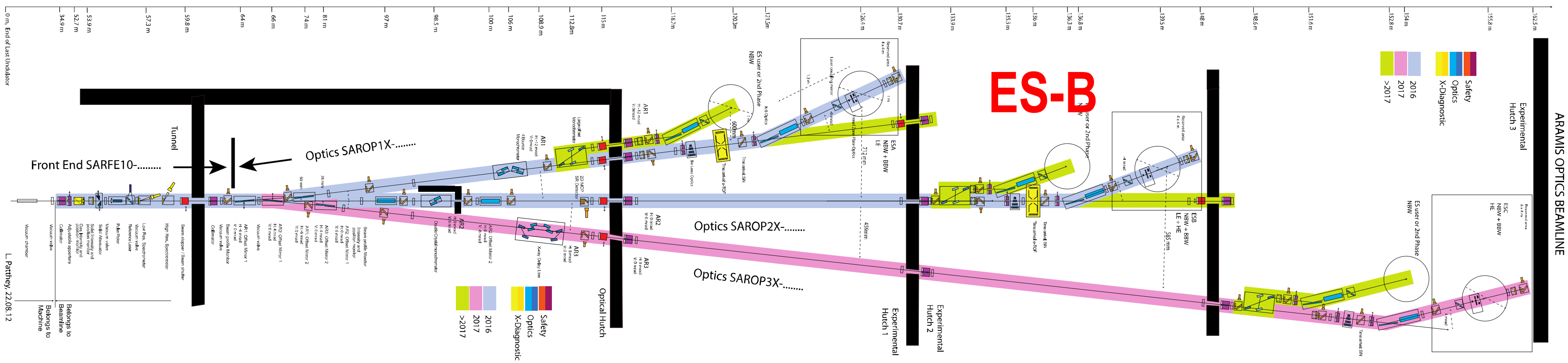
Wir schaffen Wissen – heute für morgen

Paul Scherrer Institut
Paul Beaud

Introduction to ES-B

ES-B: Experimental station B



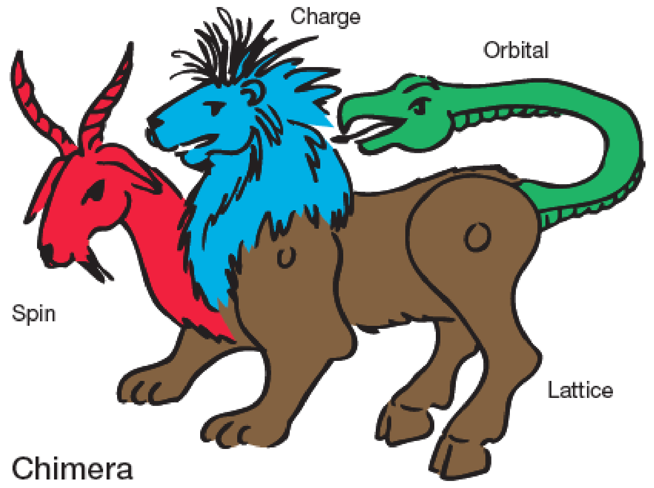
Aramis beamlines currently in design phase (Luc Patthey, Uwe Flechsig)

Endstation-B

– Double crystal monochromator	4 – 12 keV (2 - 14.4 keV)
– Variable Polarization	linear, circular
– KB focusing optics	Ø ~ 5 µm
– Appropriate diagnostics	I_0, *E*-calibration ....
– Timing tools	jitter correction

Pump-probe crystallography

Femtosecond XPP Diffraction and Scattering in Condensed Matter



Scope

Coupled dynamics of cooperative interactions of short-and long-range order in complex materials that exhibit competition between lattice, charge, orbital and spin degrees of freedom.

Method(s)

X-ray pump-probe measurements in the hard X-ray range on solid samples (thin films, crystals) in flexible environement

- Asymmetric diffraction
- Resonant diffraction with polarization analysis
- Diffuse scattering
- Resonant inelastic x-ray scattering (RIXS)

People at ES-B

- FEMTO group at SLS:

Staff: Gerhard Ingold, Paul Beaud, Alex Oggenfuss + ...

Postdocs: Simon Mariager, Jeremy Johnson

PhD students: Andrin Caviezel, Sebastian Grübel

- Time Schedule

Conceptual Design Report (CDR)	Oct 2012 - Feb 2013
Technical Design Report (TDR)	Mar 2013 - Dec 2013
Call For Tender	Jan 2014 - Mar 2014
Component Production	Apr 2014 - Jun 2015
Acceptance Test (at SLS)	Jul 2015 - Jun 2016
Final Installation	Jul 2016 - Dec 2016
Commissioning	Jan 2017 - Jun 2017
Friendly User Operation	1 Jul 2017

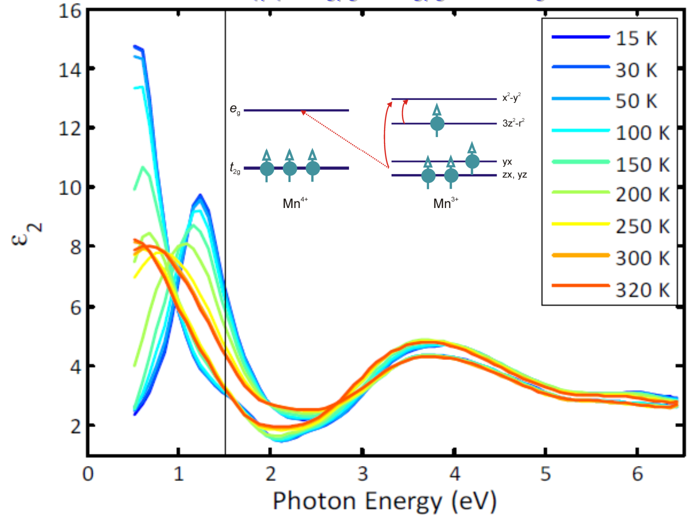
Excitation needed at

Electronic transitions: UV – IR

- τ_L in range 10 -100 fs,
- pp-delay accuracy 20 fs rms

Difficulties:
diagnostics & dispersion control
at arbitrary wavelengths

$La_{1/4}Pr_{3/8}Ca_{3/8}MnO_3$



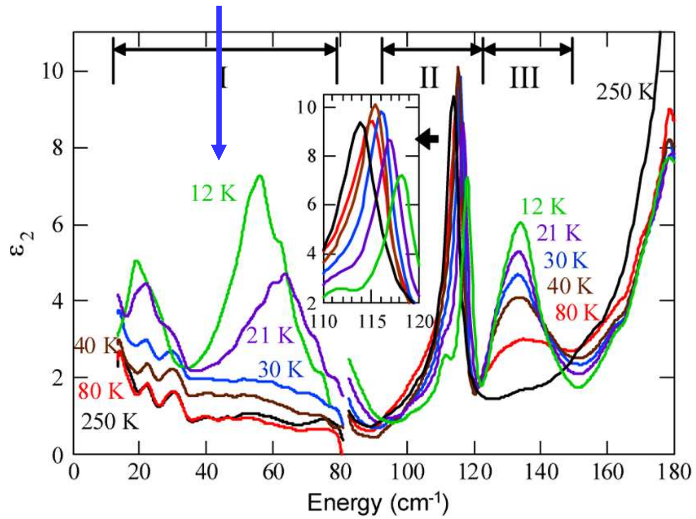
Selective excitation of coherent modes: 1 – 20 THz

- multicycle pulses
- pp-delay accuracy: < 1/10ν

Difficulties:
- inefficient sources
- THz-gap 5 – 15 THz

$TbMnO_3$
electromagnon at 1.8 THz
(spin spiral excitation)

Y. Takahashi et *al.*
PRL **101**, 187201 (2008)



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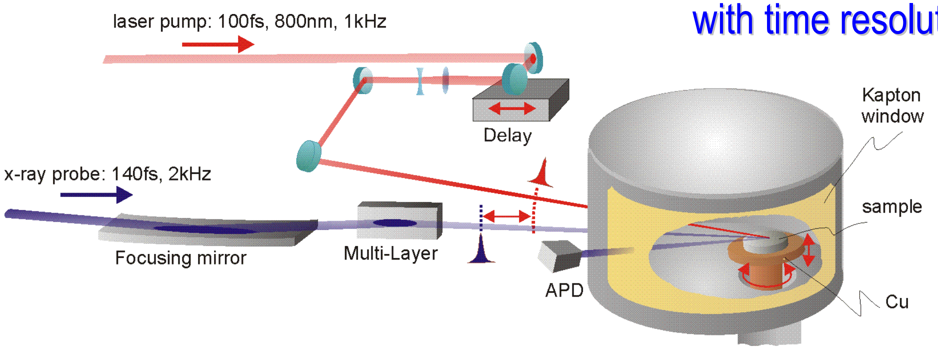
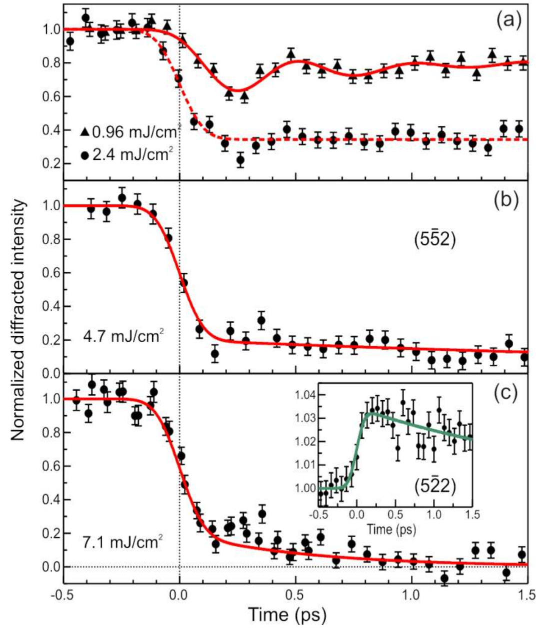
From FEMTO to SwissFEL

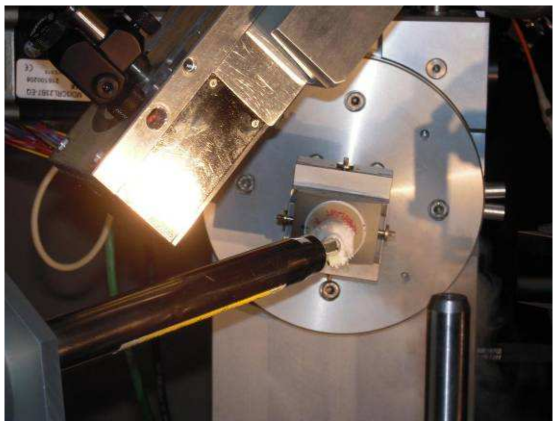
FEMTO limited to study selected Bragg peaks ...
... requires integration over hours or days.

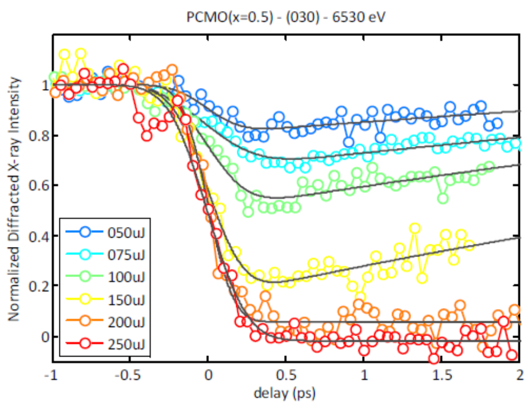


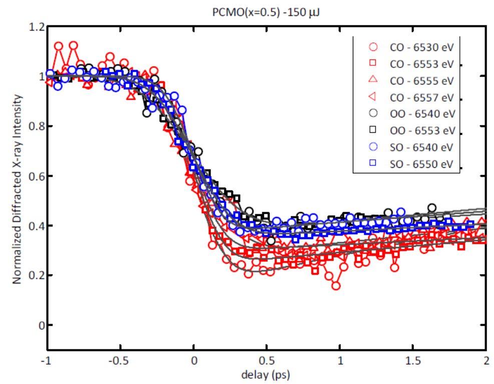
with time resolution ~80 fs rms.



The high FEL photons flux allows exploration
of *q*-space and efficient data collection ...







... in future with time resolution <20 fs rms
and improved flexible sample environment.

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Scanning hard x-ray (R)XRD-Diffractometer

Six axis diffractometer manipulator,
detector arm with polarization analysis

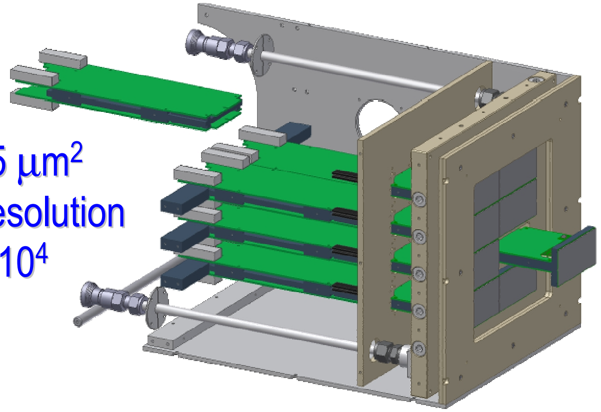
commercial & custom sized
diffractometer (Newport)

Pixel detector development at PSI (Bernd Schmitt):

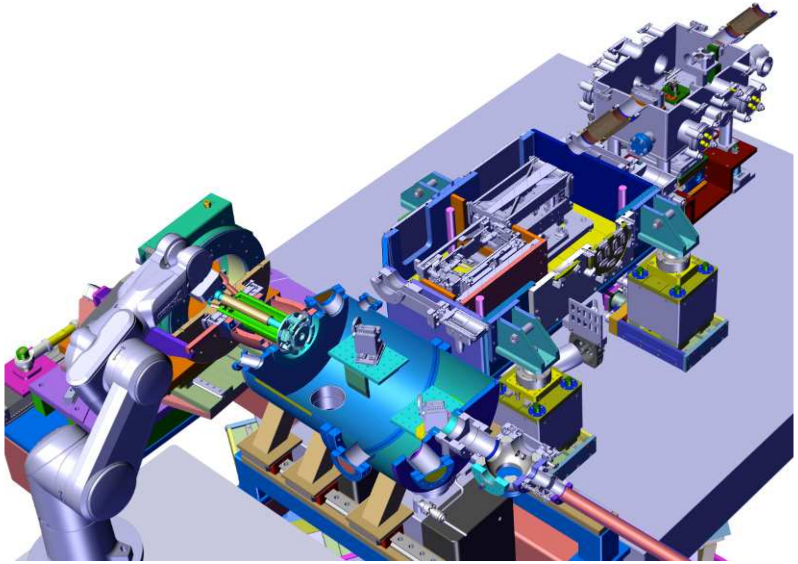
JUNGFRAU

(adJUstiNg Gain detector FoR the Aramis User station)

- modular
- pixel size 75x75 μm^2
- single photon resolution
- dynamic range 10^4



In house design pump-probe UHV chamber



- 10 – 700 K
- static magnetic field ~1 T
  (or SC magnet ~ 10 T in collaboration with NUM)

Possible phase II:
installation of a hard x-ray RIXS spectrometer,
+ seeding operation

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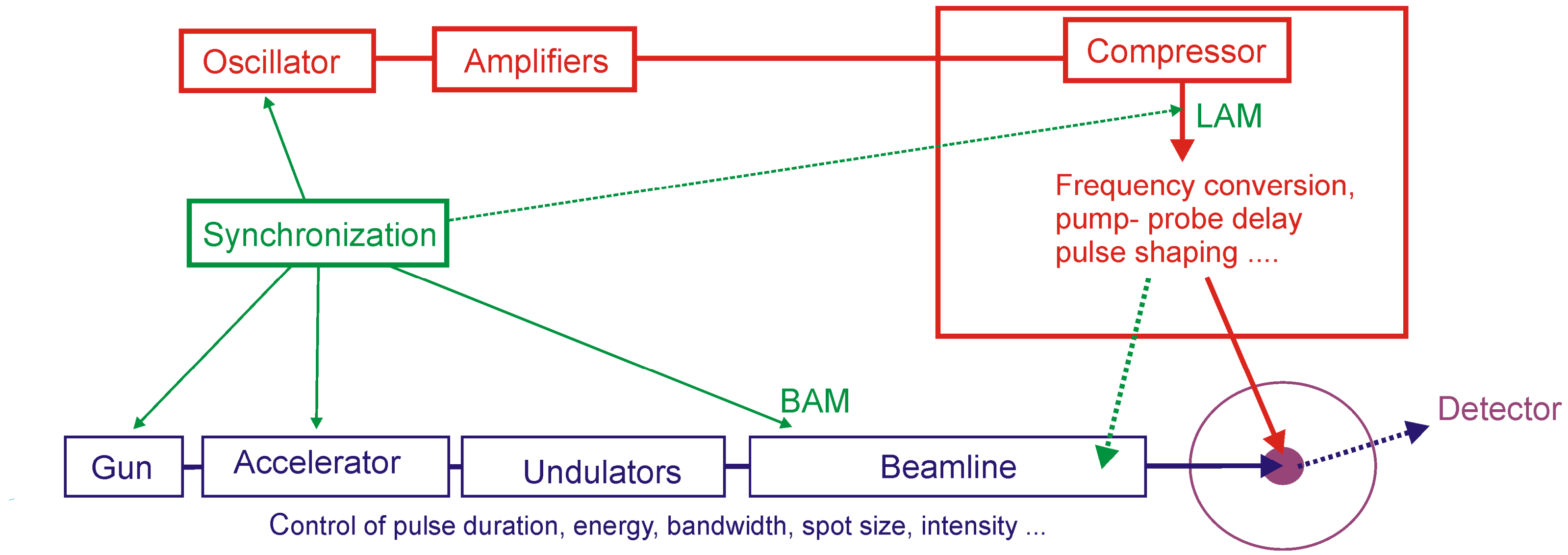
SwissFEL pump laser



1. Pump laser (*work horse*)
   - stable & reliable
   - redundancy

2. Optical table (*taylor pump pulse* τ,ω)
   - driven by experiment
   - close interaction: laser group, beamline & user

3. Synchronization (*minimize pump-probe jitter, accurate jitter measurement)*
   - pulsed optical reference system < 10 fs rms (Volker Schlott, Stefan Hunziker)
   - E-bunch arrival time monitors (BAM)
   - laser arrival monitor proposed (LAM)

Development of 'THz streak camera' for single shot optical/x-ray cross-correlation (Pavel Juranic).

Current at LCLS : transient *R* or *T* < 25 fs rms

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THz Control of Complex Oxides

Michael Först

Condensed Matter Division,
Max Planck Research Department for Structural Dynamics
at the University of Hamburg, CFEL

Ultrafast dynamics in strongly correlated systems: from melting to control

Steven L. Johnson

Ultrafast Dynamics Group, Institut für Quantenelektronik, ETH Zürich

Wrap up: ESA & ESB user demands

ESA / ESB

Excitation wavelength's

Pulse duration

- Pulse shaping?
- CPE stabilization
- PP timing jitter correction

Pulse energy on sample

Online laser diagnostic

Who is responsible for optical setup in ES?

- Laser group, beamline, user or collaboration
- User supplied setups?

How many laser needed for reliable operation?

- Pre-beamtime setup? Redundancy?

Need of separate laser lab for R&D?