

PAUL SCHERRER INSTITUT



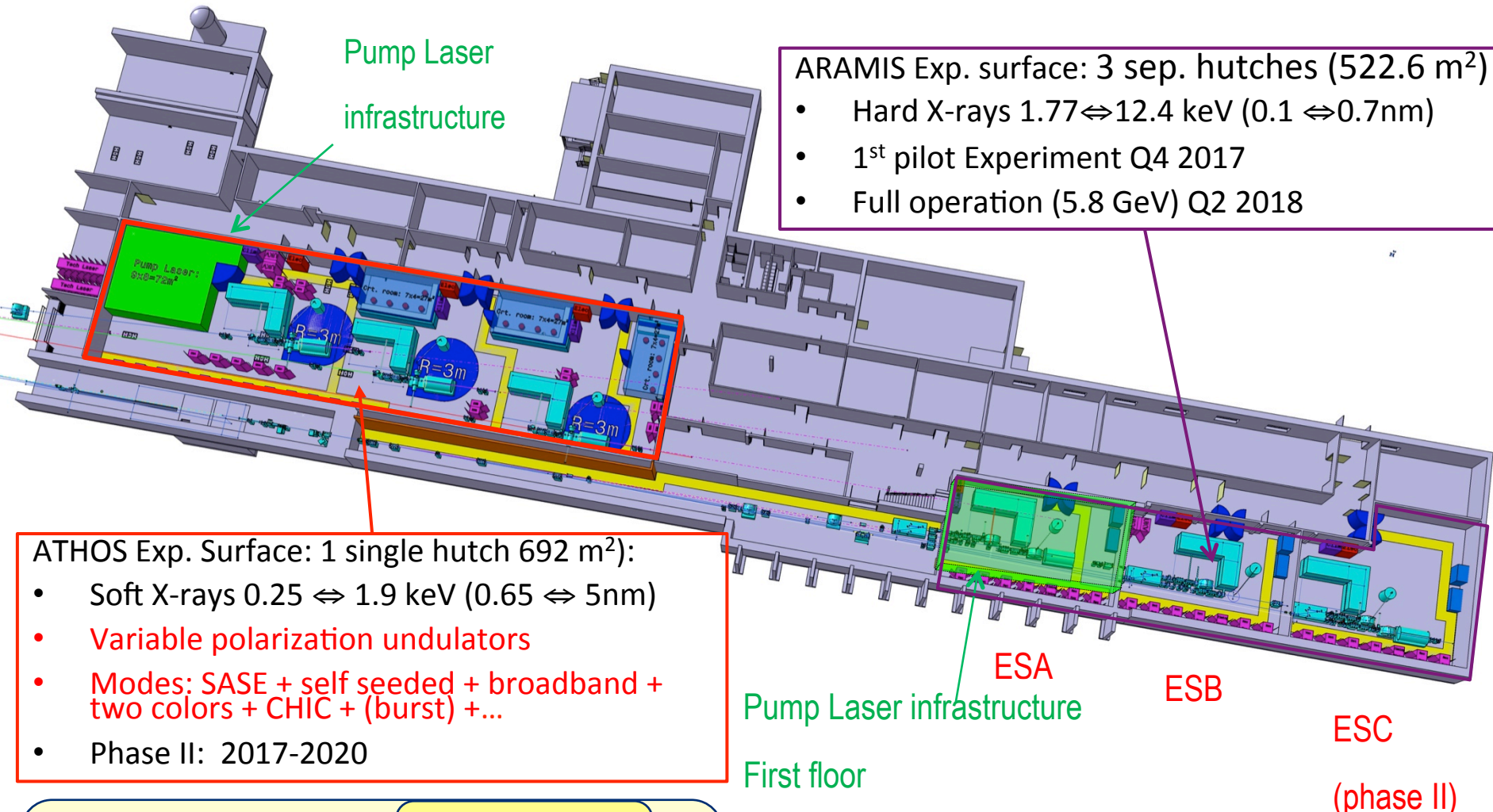
Luc Patthey:: SwissFEL Photonics :: Paul Scherrer Institut

First Experiments & User Operation (Concept)

8th Hard X-ray FEL Collaboration Meeting, October 24 - 26 , 2016

- First Experiments
@ ARAMIS beamline (and ATHOS beamline)
- User Operation (Concept)

ATHOS and ARAMIS Experimental Area



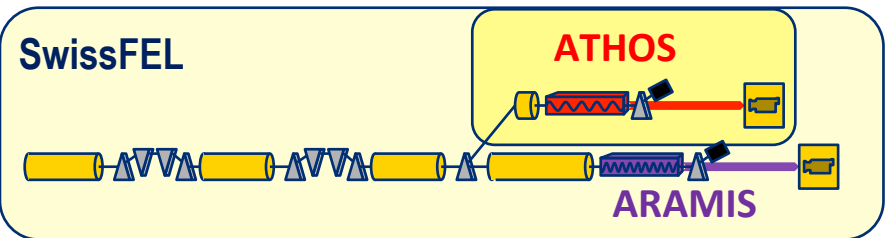
ARAMIS Exp. surface: 3 sep. hutches (522.6 m²)

- Hard X-rays 1.77 ⇔ 12.4 keV (0.1 ⇔ 0.7nm)
- 1st pilot Experiment Q4 2017
- Full operation (5.8 GeV) Q2 2018

ATHOS Exp. Surface: 1 single hutch 692 m²:

- Soft X-rays 0.25 ⇔ 1.9 keV (0.65 ⇔ 5nm)
- Variable polarization undulators
- Modes: SASE + self seeded + broadband + two colors + CHIC + (burst) +...
- Phase II: 2017-2020

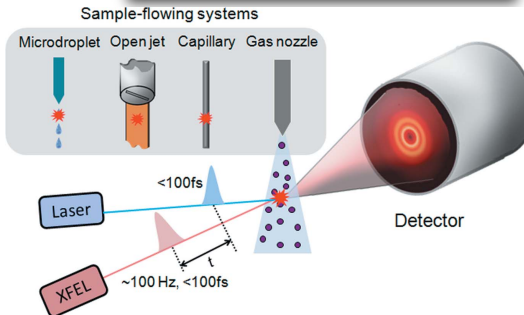
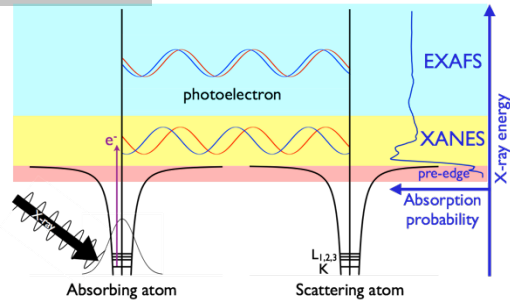
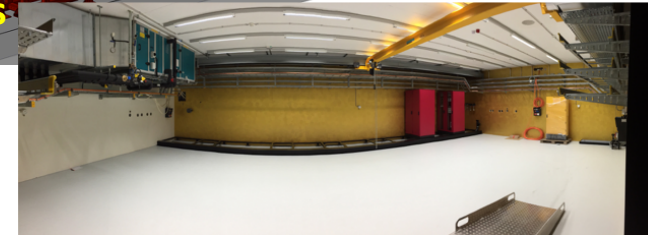
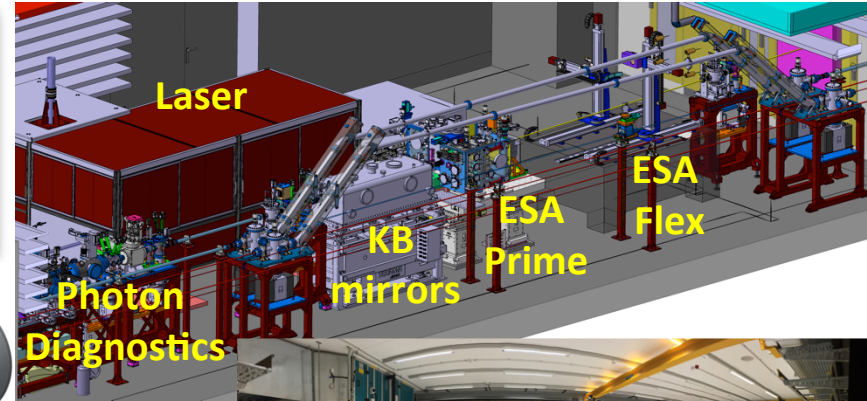
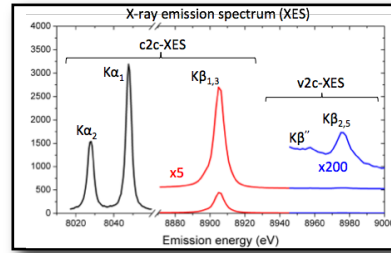
ESA
Pump Laser infrastructure
ESB
ESC
(phase II)



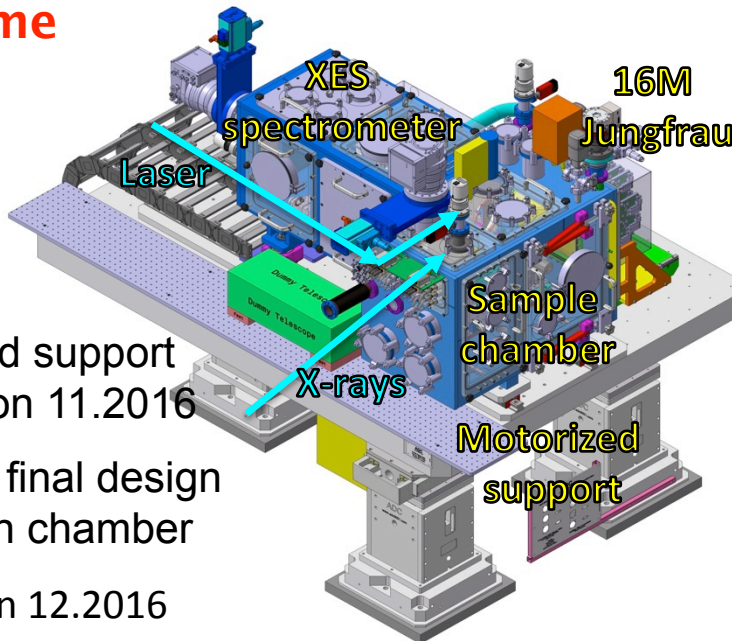
Pulse duration:	1 – 20 fs
e ⁻ Energy	5.8 GeV
e ⁻ Bunch charge	10 – 200 pC
Repetition rate	100 Hz

ESA:

Ultrafast photochemistry
and photobiology

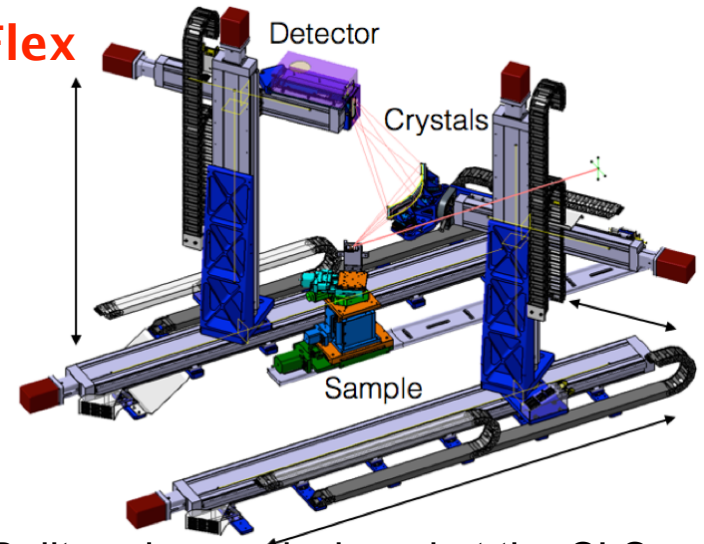


ESA Prime



- Motorized support installation 11.2016
- Awaiting final design review on chamber
- Delivery in 12.2016

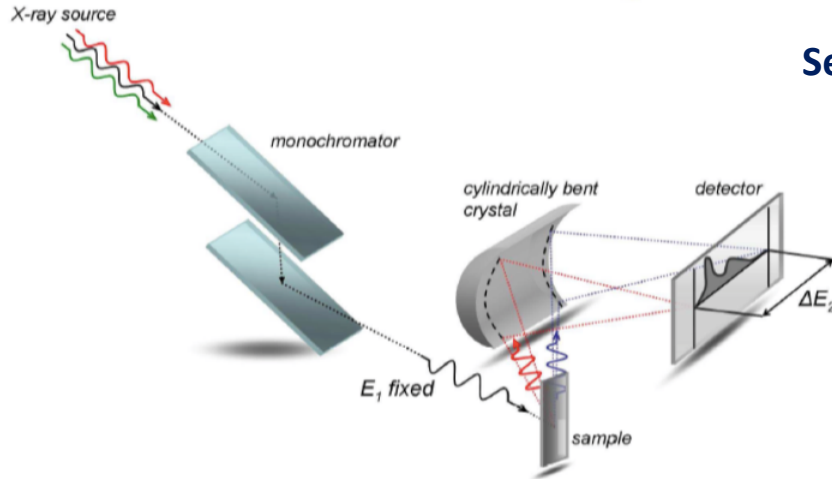
ESA Flex



- Built and commissioned at the SLS
- Ready for installation at SwissFEL

ESA – spectrometer crystals development

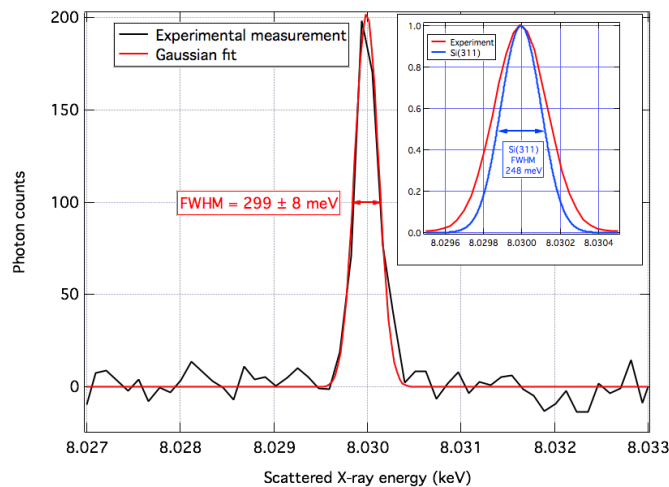
courtesy Chris Milne & Jakub Szlachetko



Segmented-crystals for X-ray emission spectroscopy



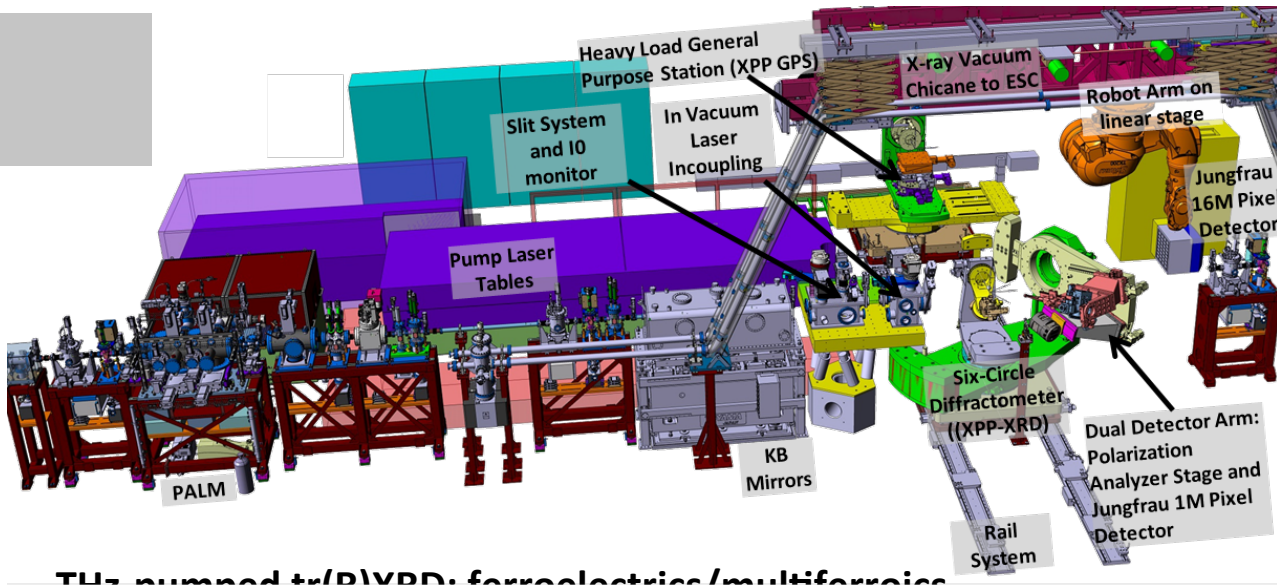
Segment Res.: 100 meV @ 8keV
 $\Delta E/E = 1.25 \times 10^{-5}$



Crystals manufacturing:

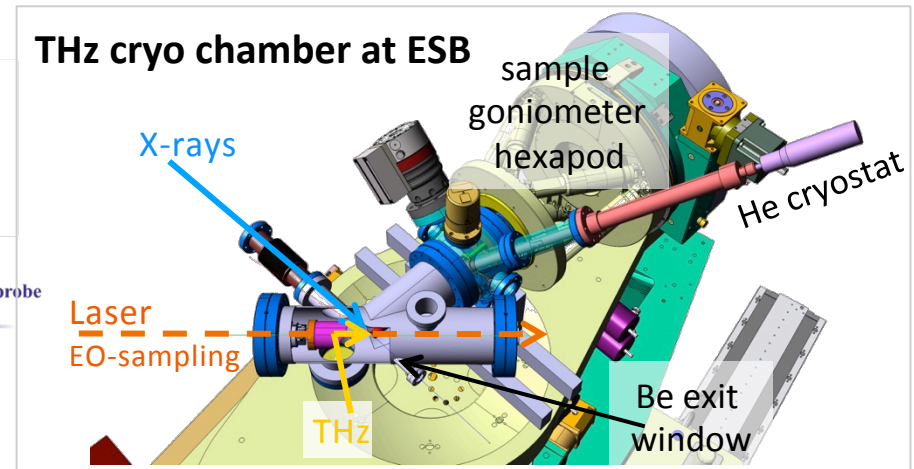
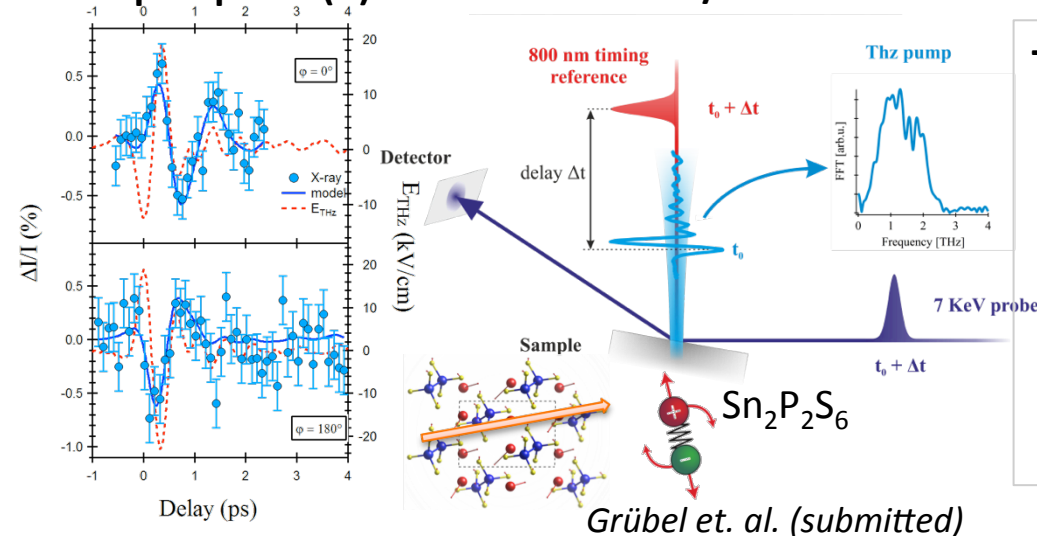
- Process is now reliable and reproducible:
by Jorg Schnieder (ESA) & Konrad Vogelsand (LMN)
- Production of all available Si cuts (1xx, 3xx...)
- In collaboration with PSI Technology Transfer, ESA supplies crystals to external customers (EuXFEL, MaxPlanck, Uni. Fribourg, Brasil Synchrotron....)

Laser/THz-Pumped Diffraction and Scattering: Cond. Mat. & Mat. Sci.



- Installation schedule:**
- PALM prototype ready
 - Pump laser delivered
 - KB optics Nov 2016
 - Laser incoupling Feb 2017
 - GPS station Dec 2016
 - XRD station March 2017
 - THz cryo chamber under design
 - Robot detector arm Sept 2016 & Feb 2017

THz-pumped tr(R)XRD: ferroelectrics/multiferroics



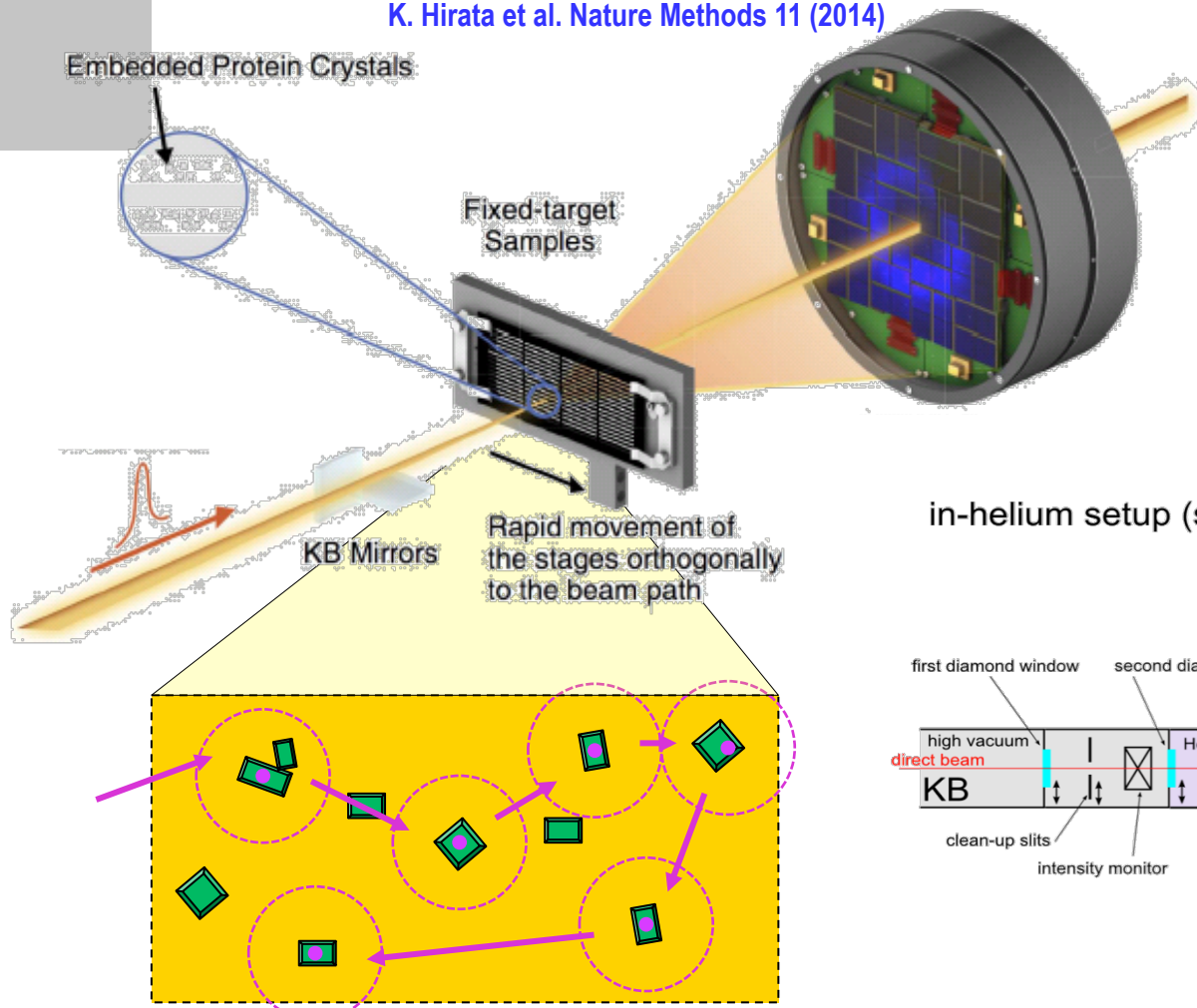
Fixed Target Serial PX in ESB

courtesy Bill Pedrini

M. Hunter et al. Scientific Reports 4 (2014)
K. Hirata et al. Nature Methods 11 (2014)

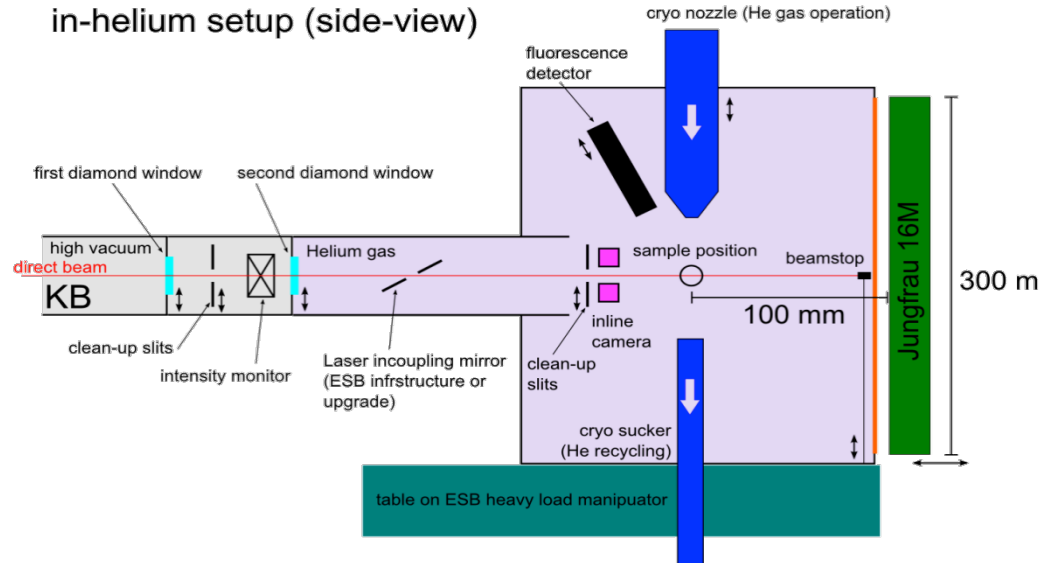
- Project **start**: Jun. 2015
- **Commissioning** at ESB: Nov. 2017
- Project **end**: Feb. 2018

movable PX Sample module:



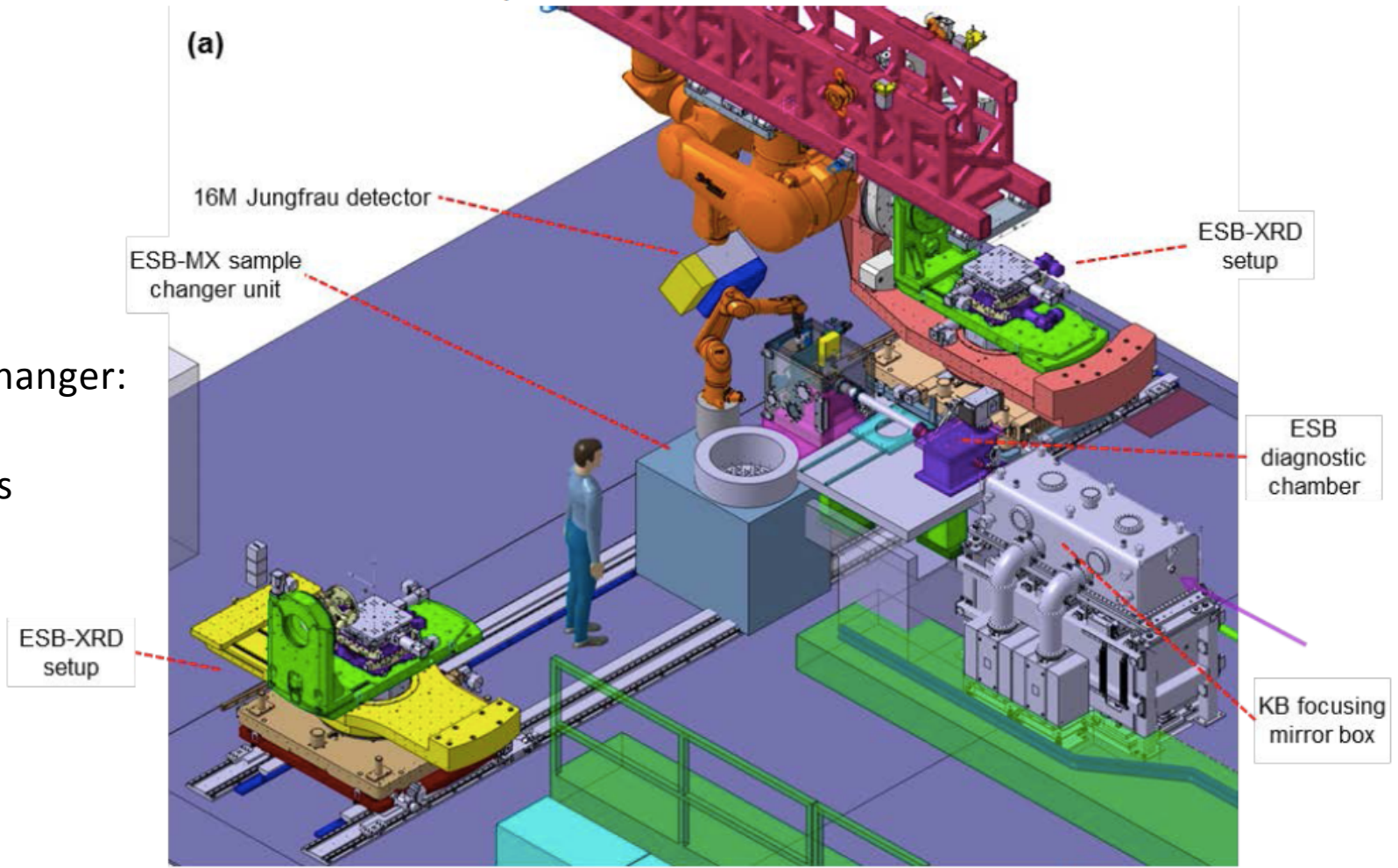
Slalom trajectory: 1.2 μm / 100 μm @100Hz

in-helium setup (side-view)



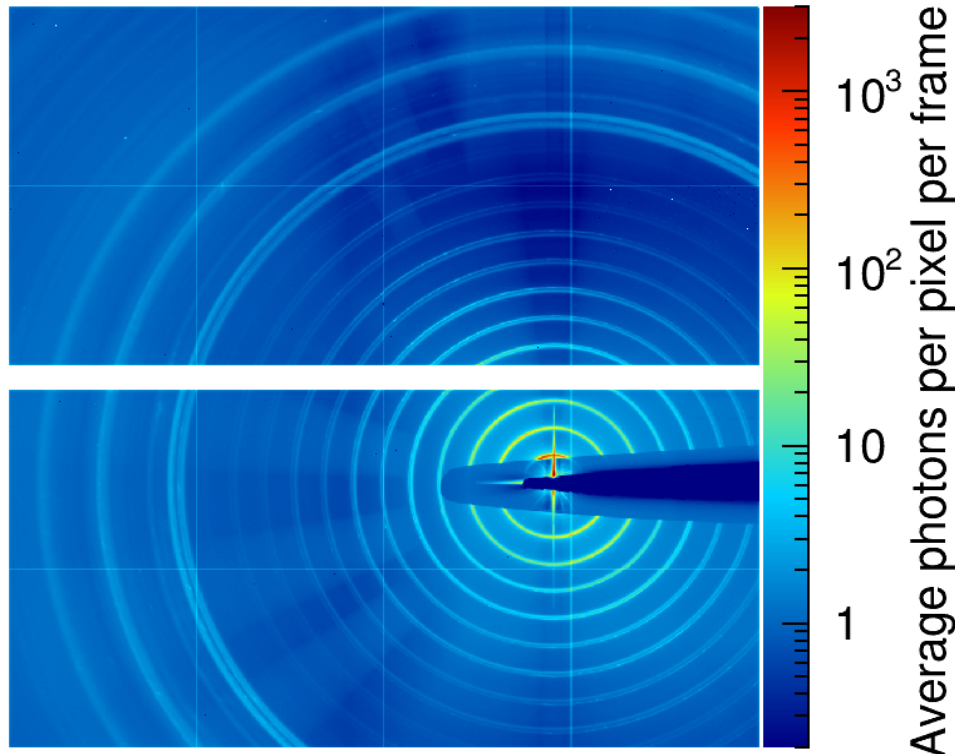
ESB-MX end-station

Sample Changer:
-200 sec
-1000 pins



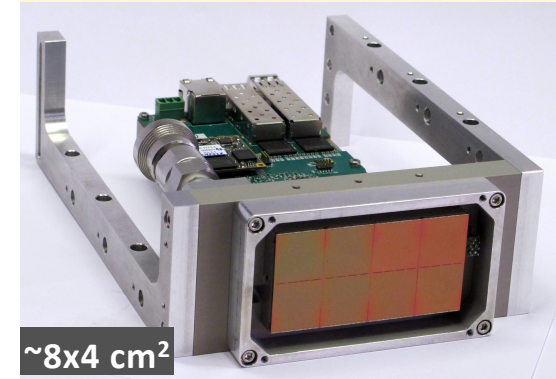
JUNGFRAU – Modules Test at LCLS

Single module: 4x2 chips = 0.5 Mpixel
Number of frames: ~1000 Frames
Corrections applied: Pedestal subtraction
 Offline photon discrimination
 (5 keV equivalent threshold)



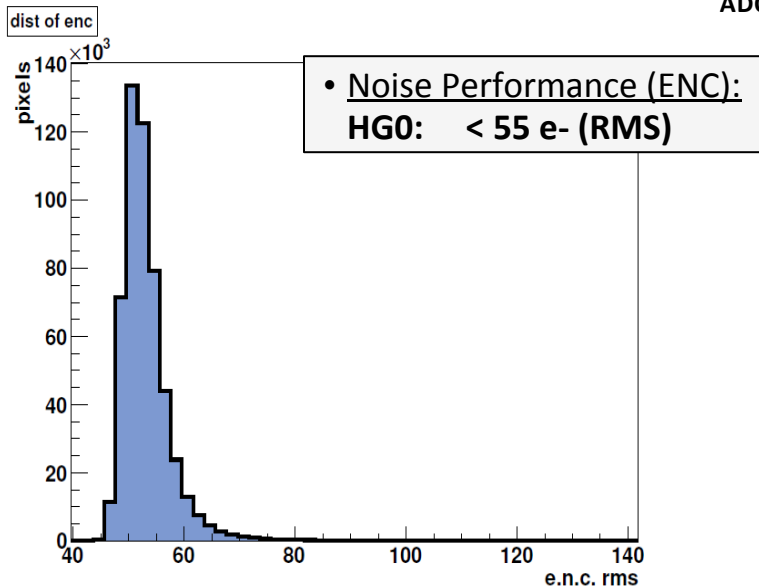
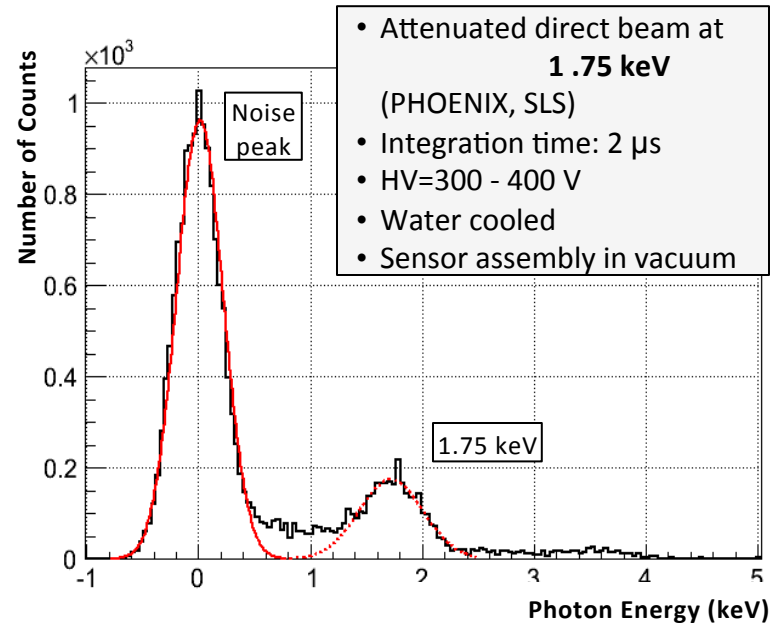
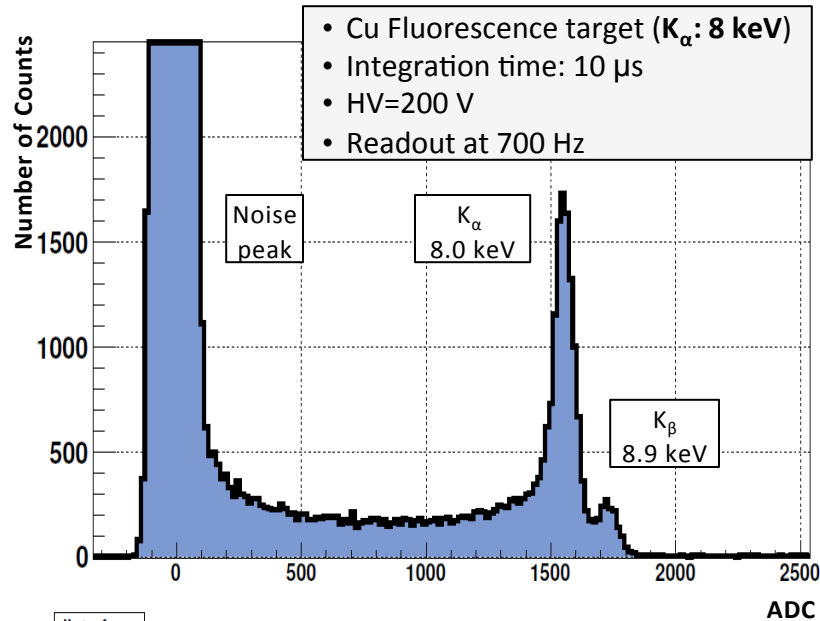
Single Module

500 kPixel



Powder diffraction from calibration standard (Silver Behenate)

JUNGFRAU – Gain and Noise



Different operation conditions:

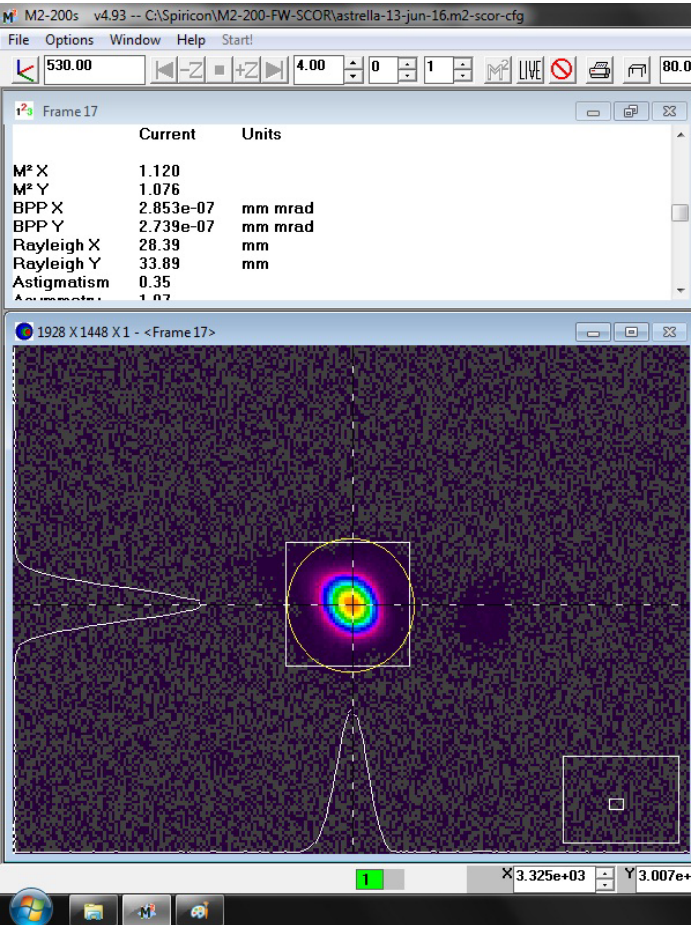
- **High Gain Mode (HG0):**
 - + Noise performance: <55 e⁻ ENC
 - + Minimum photon energy: < 1.5 keV
 - (- Slightly Less Dynamic Range)
- **Standard Gain (G0):**
 - + Noise performance: <100 e⁻ ENC
 - + Dynamic Range: <1·10⁴ x12.4 keV

Pulse energy @ 800nm: 21mJ

Pulse duration: 27fs

M^2 is around 1.1

Focus spot size is around 100 μ m with 1m focus lens



ATHOS experiments from 2020

Low energy

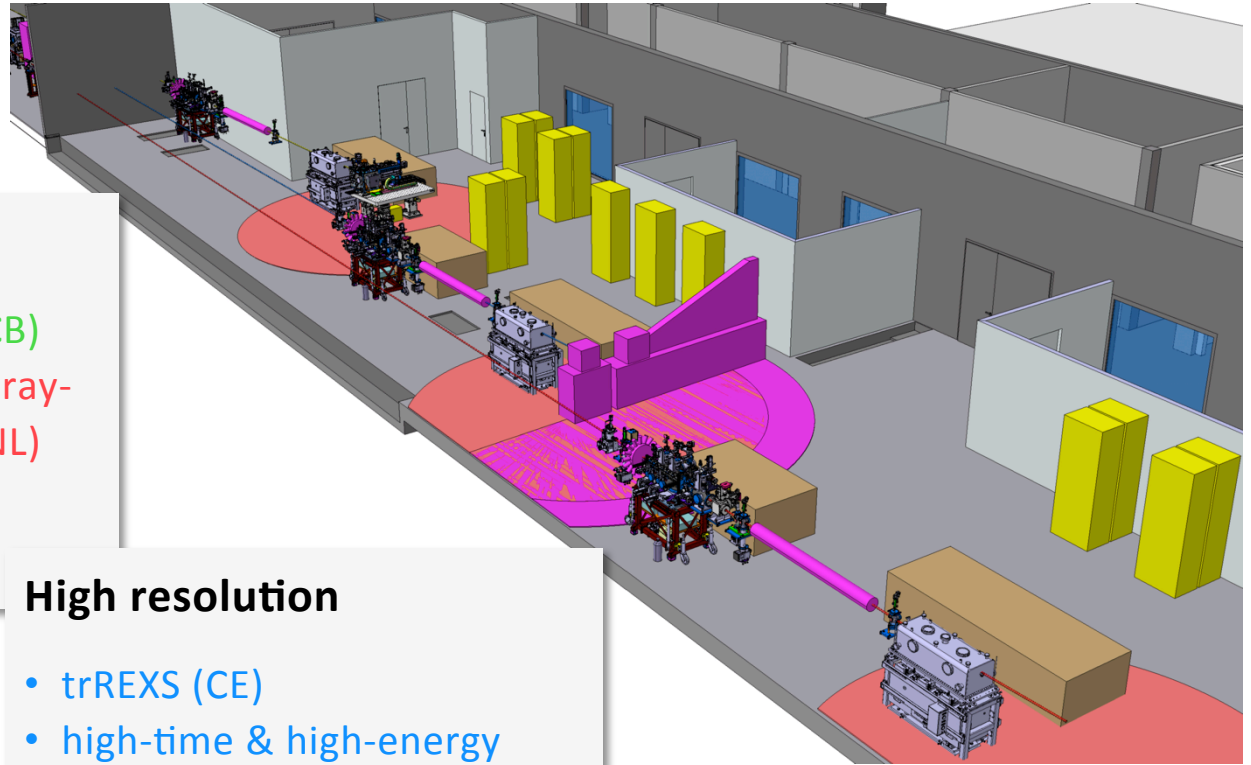
- trXAS, trXES & trRIXS (CB)
- X-ray pump – optical/x-ray-probe 4-wave mixing (NL)

High resolution

- trREXS (CE)
- high-time & high-energy resolution trRIXS (CE)
- Single-shot trXAS & trXMCD (MD)

Small focus

- Split-pulse XPCS (CE)
- tr magn. holography (MD)
- Stimulated Raman/RIXS (NL)



Users Operation: Considerations

The first years of user operation at SwissFEL are built up regarding following issues:

- Improving the **performance of ARAMIS** accelerator, beamlines and stations
- Installation and commissioning of **ATHOS**
- Building up operation and exploitation **experience**

Distribution of beamtime will be split between
accelerator/beamlines development and consolidation,
„FEL production“ for users
and installation work.

This distribution will change according to the „maturity“ of SwissFEL.

Beamtime dedicated for „FEL production“ will be split up :

- | | |
|---|-----|
| ▪ Users time | 70% |
| ▪ Exp station commissioning and in-house research | 25% |
| ▪ Discretionary „directors time“ | 5% |

Scheduling: general considerations

The general yearly schedule is coordinated with all large scale facilities at PSI HIPA, SINQ, SLS to avoid peak load of the staff responsible to maintain and run.

Start of SwissFEL operation: Second week of January

Shut downs: Two weeks in April/May
Six weeks in August/September

End of Operation Third week in December

Start of regular Users Operation May 2018

Call for proposals September 2017 using PSI DUO

OPERATION Mode: 5.8 GeV, 200 pC, 30 fs

All diagnostic in Front End and Optics ready

Timing tools : THz Streaking and Spectral Encoding ready

Two Experimental Stations commissioned:

ESA: Prime and FLEX

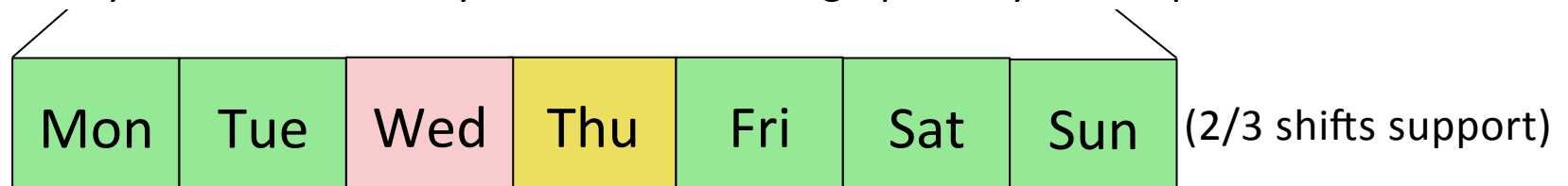
ESB: General Purpose System and Diffractometer

Scheduling 2018 (2019)

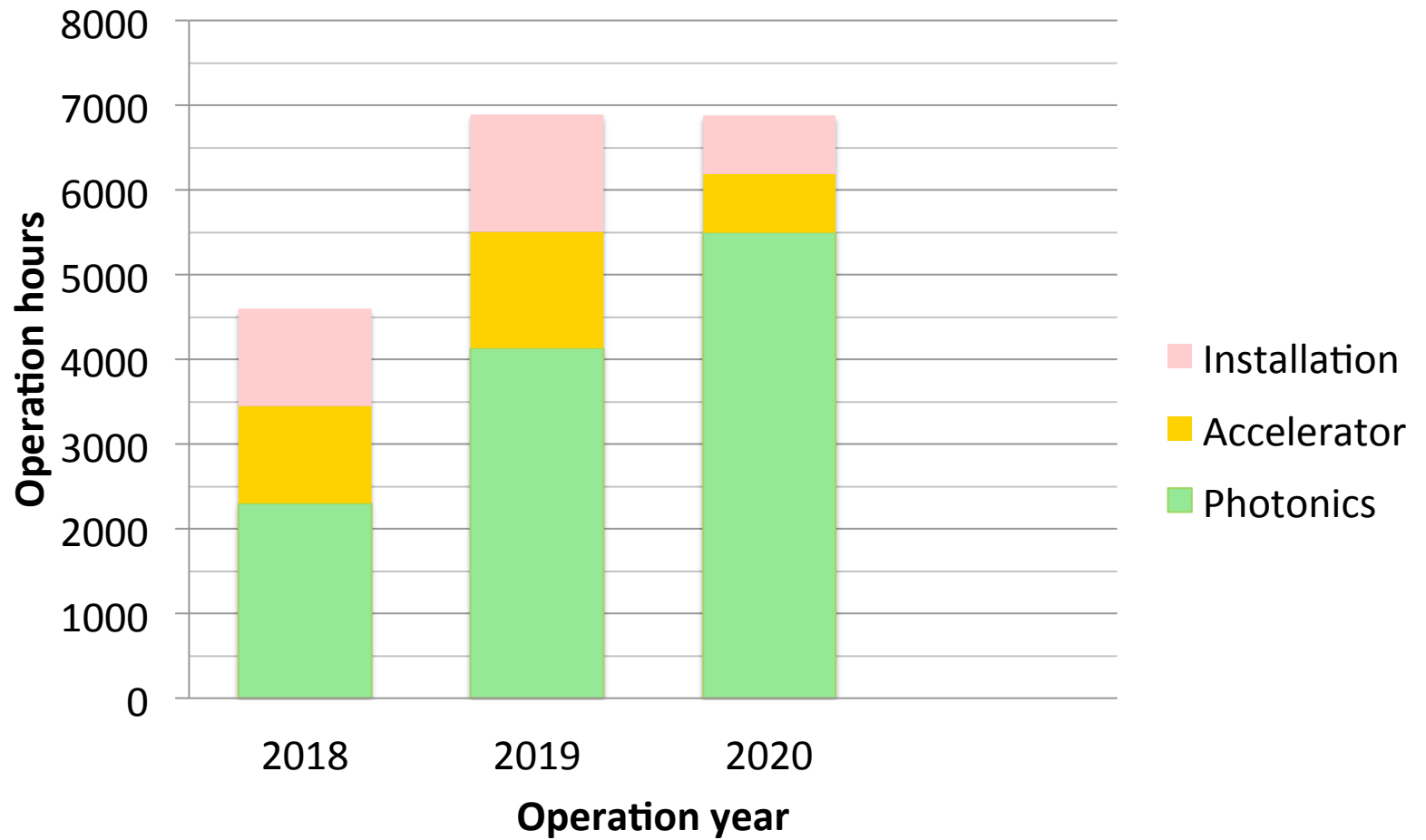
Beam time will be distributed in blocks of 4 weeks:



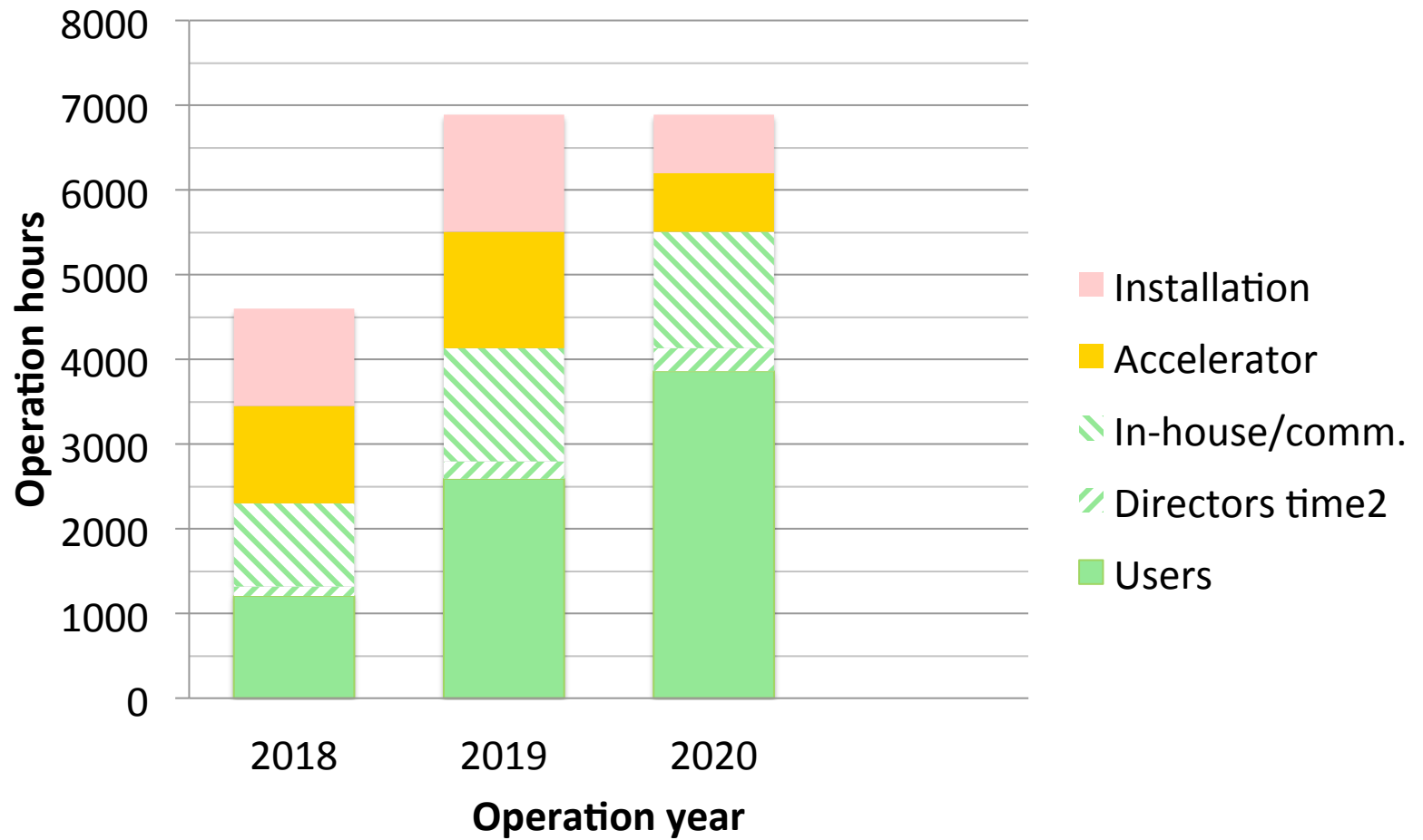
The week dedicated to experiments will be distributed in 1 day installation, 1 day accelerator setting up, 5 days for experiment.



Beamtime Distribution



Beamtime Distribution (detailed)



PSI with SwissFEL, Aare and Alps



1.06.2016 "Longest Tunnel"



5.12.2016

"Finest Source"



6.12.2016

Kick-off User's Meeting