SCS day-one instrumentation & commissioning

Manuel Izquierdo
SCS experiment

Soft X-ray Instruments SQS and SCS satellite workshop
Tuesday 24 January 2017 - DESY - Hamburg

Outline

- Introduction
- SCS baseline experiment
- Day one parameters
- Commissioning tasks
- Timeline
- User program

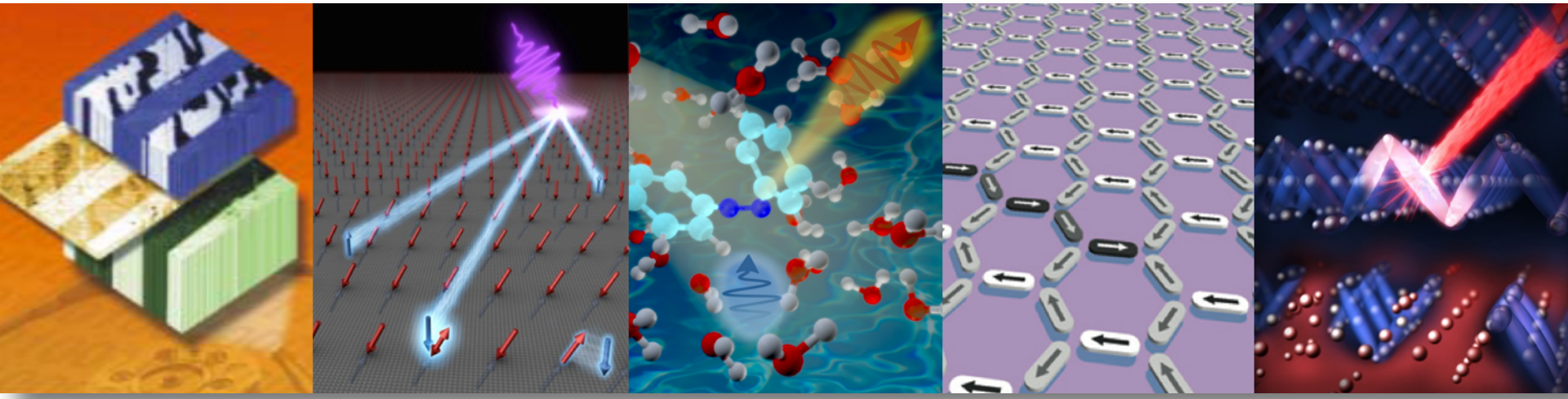
SCS instrument: Science applications and experiment stations

FFT experiment station

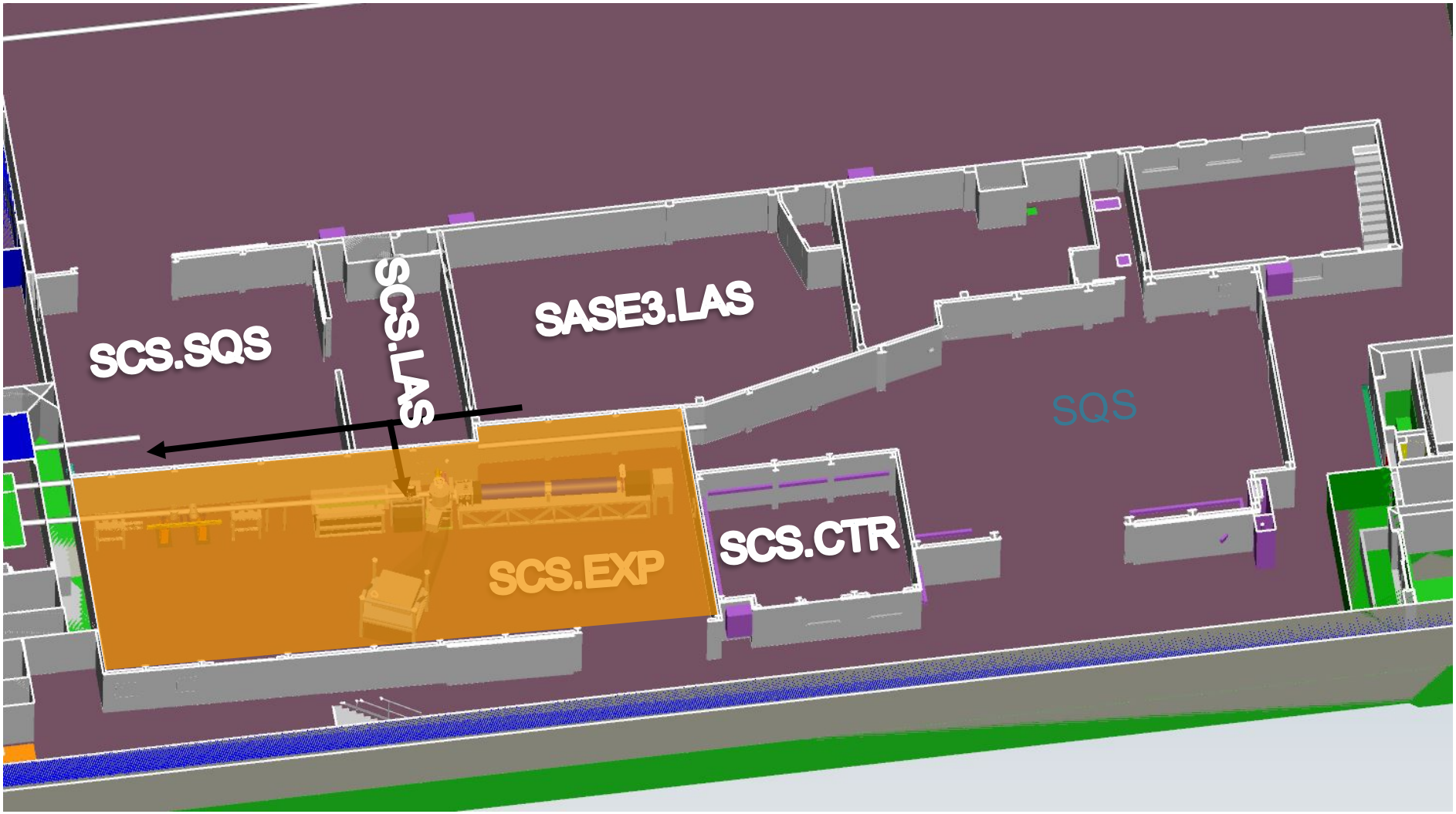
- Time-resolved XAS and resonant SAXS
- Coherent Diffraction Imaging, X-ray Holography

XRD experiment station

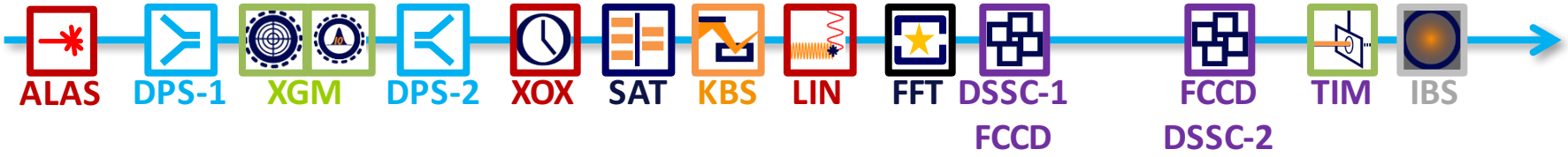
- Time-resolved X-ray Resonant Diffraction and reflection
- Nonlinear X-ray optics, stimulated scattering

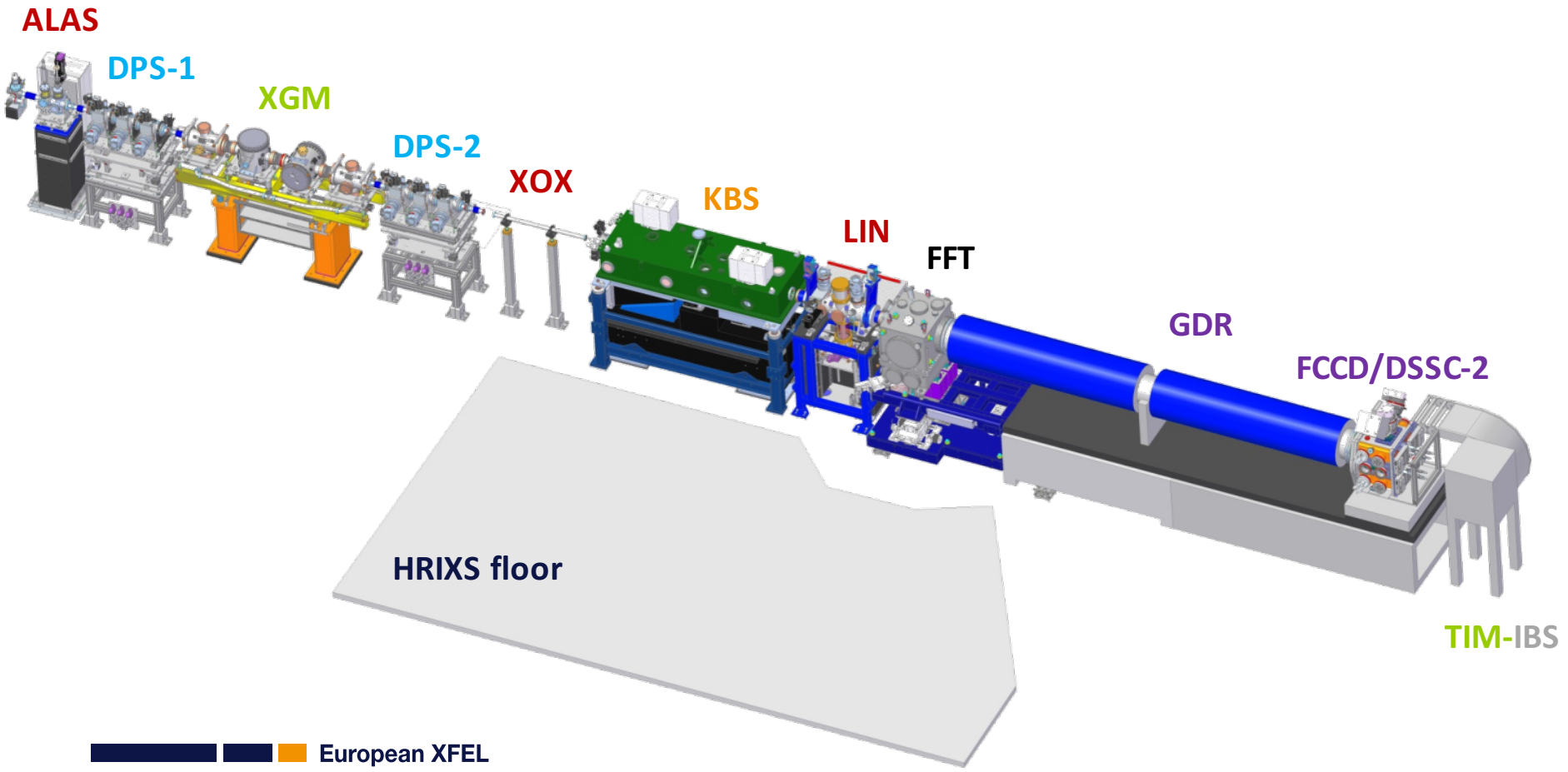


SASE3 hutch infrastructure

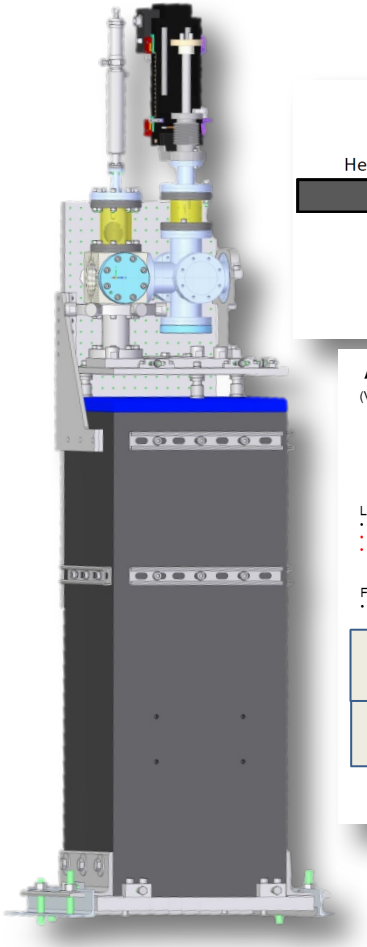


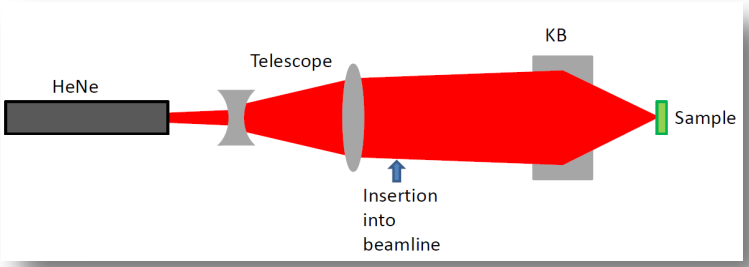
Baseline SCS instrument: FFT experiment station

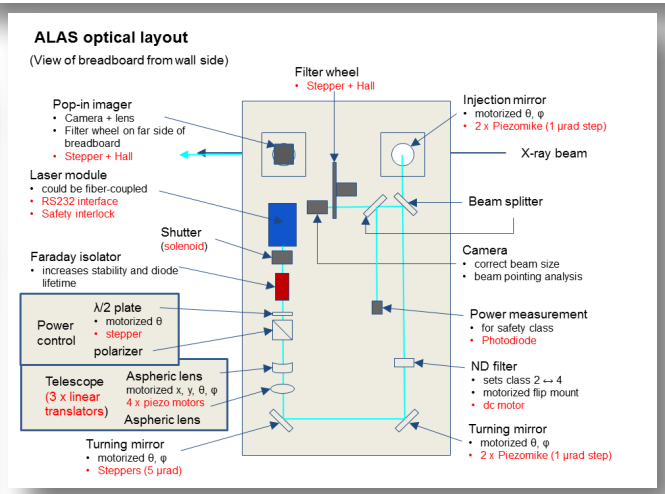


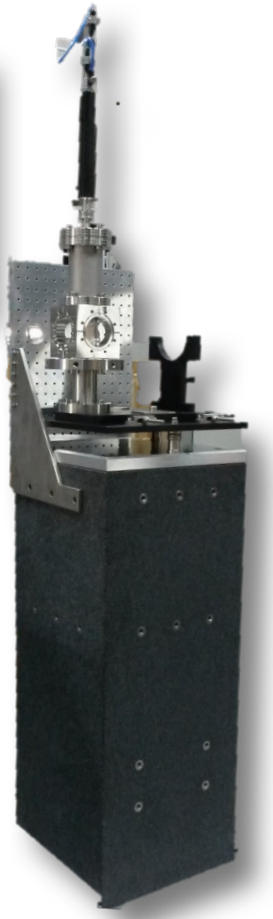


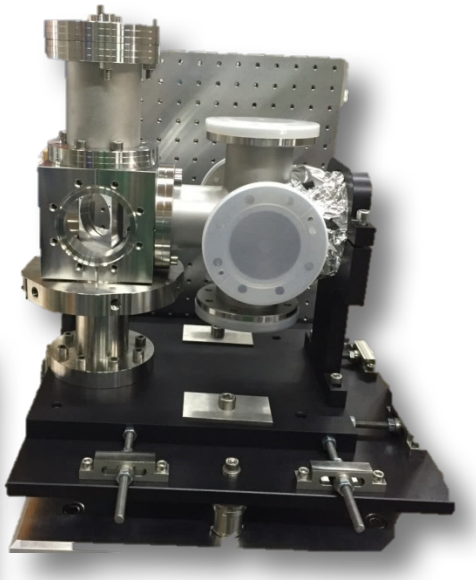
ALAS: Alignment laser



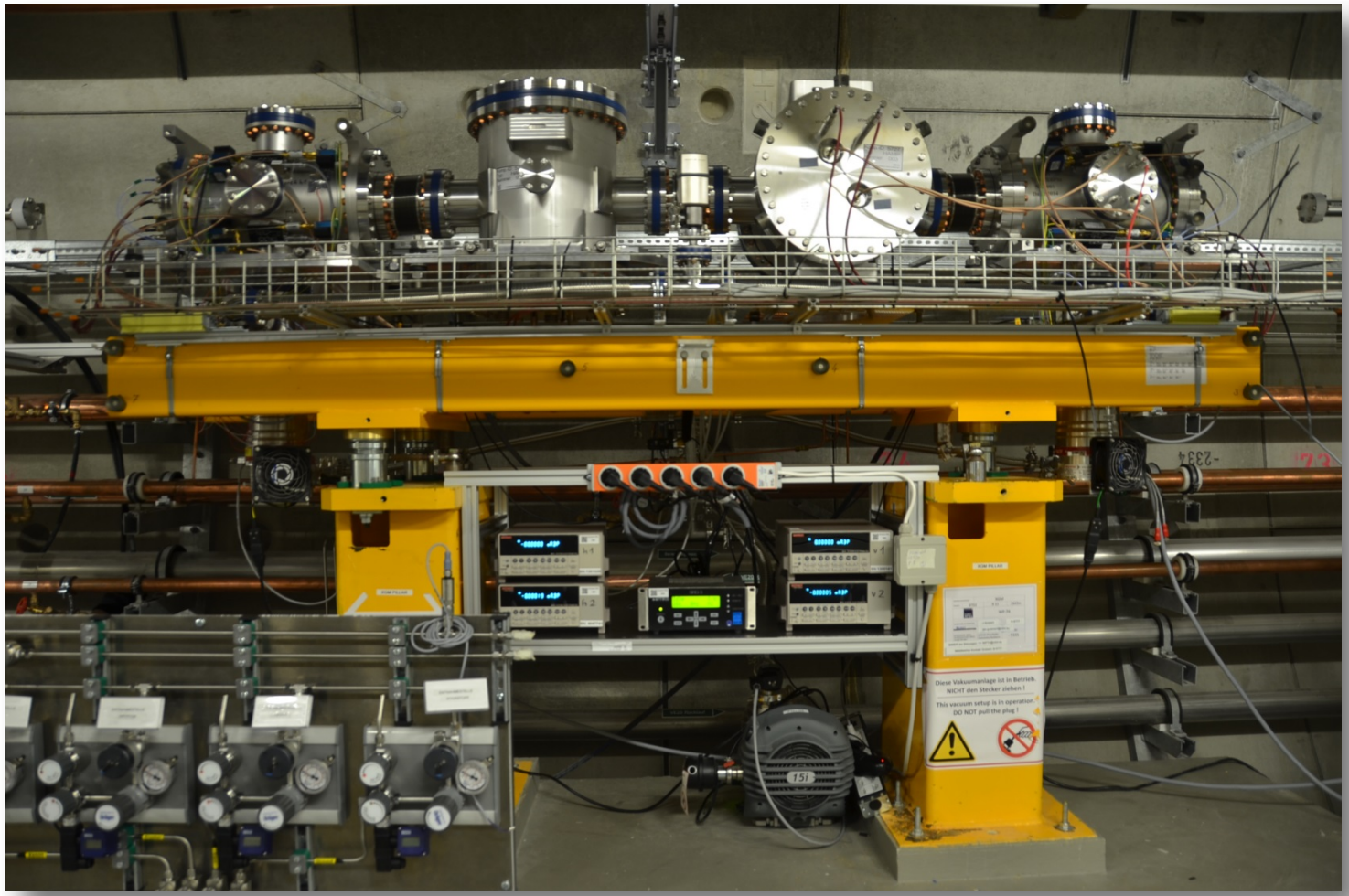






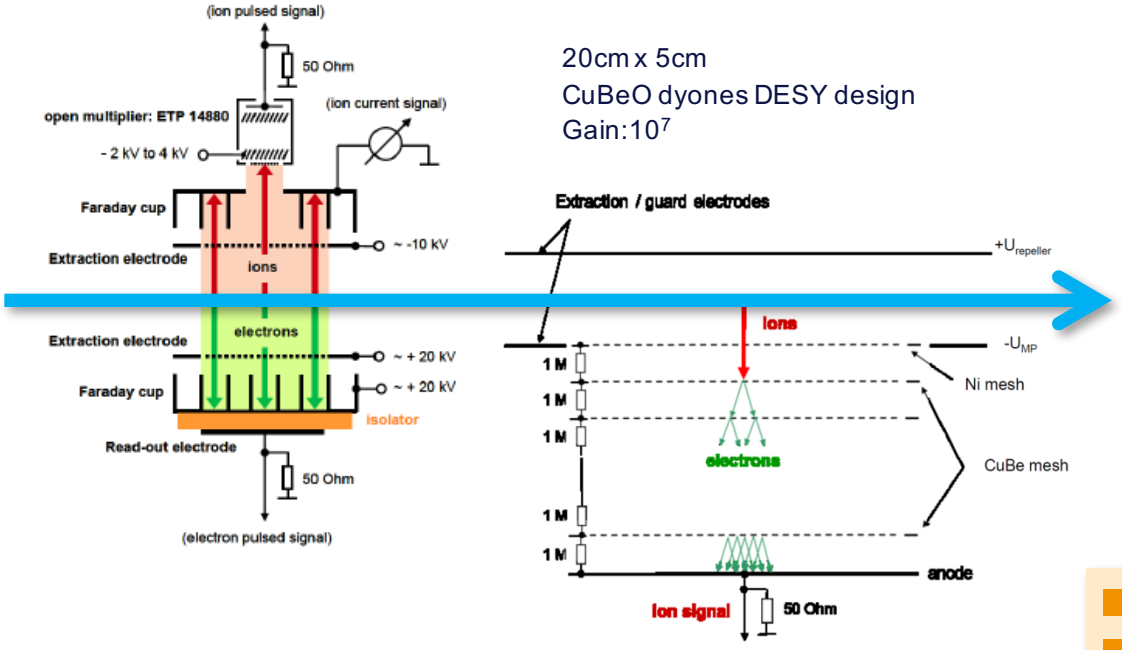


XGM (X-ray gas monitor: WP-74 + DESY (K. Tiedtke)



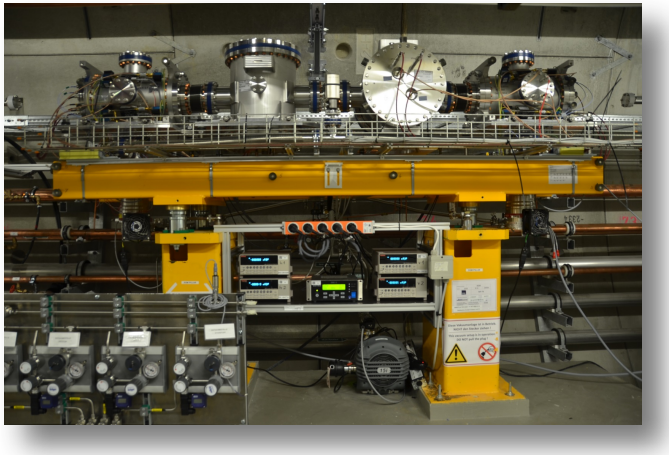
XGM (X-ray gas monitor: WP-74 + DESY (K. Tiedtke)

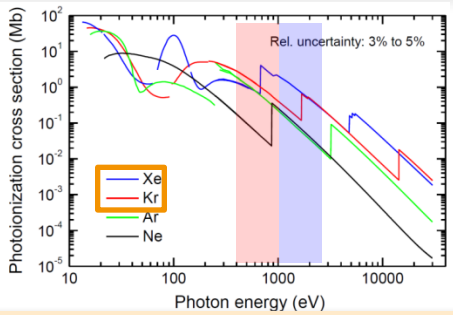
Intensity: Faraday cups
Open multiplier :Y (bunch)



Position: HAMPs
(Huge Area open MultiPlier)

20cm x 5cm
CuBeO dyones DESY design
Gain:10^7

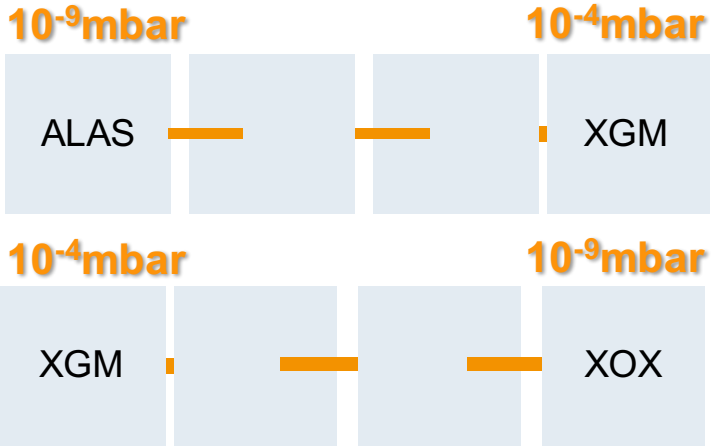




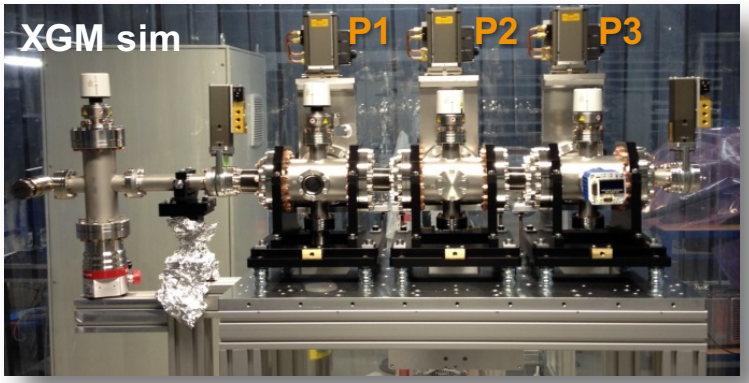
- Full energy range @ XFEL.EU
- Uncertainty per pulse energy < 10%
- Time resolution < 200 ns (bunch resolved)
- Relative intensity (pulse to pulse) < 1%

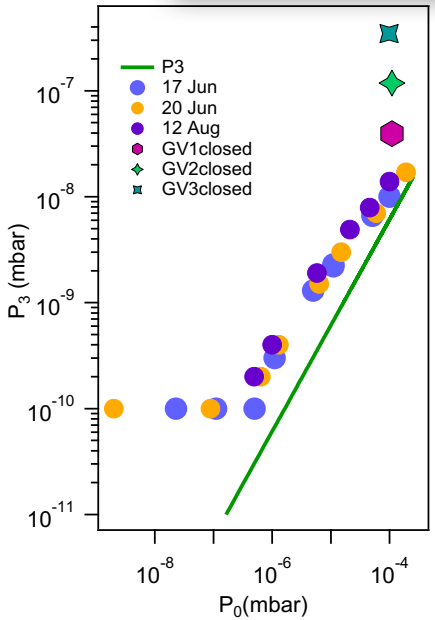
DPS (Differential pumping systems)

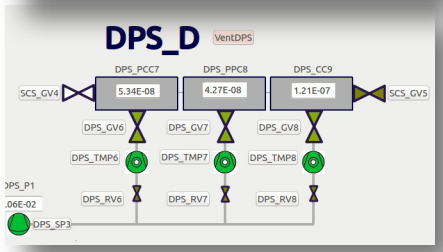
- Compact solution: < 1 m
- Maximum beam size: 7 mm
- Pressure drop:



- 300 l/s pumps
- $D_{01}/D_{12}/D_{23}$= 20/17/17 mm
- $L_{01}/L_{12}/L_{13}$ = 0/100/100 mm

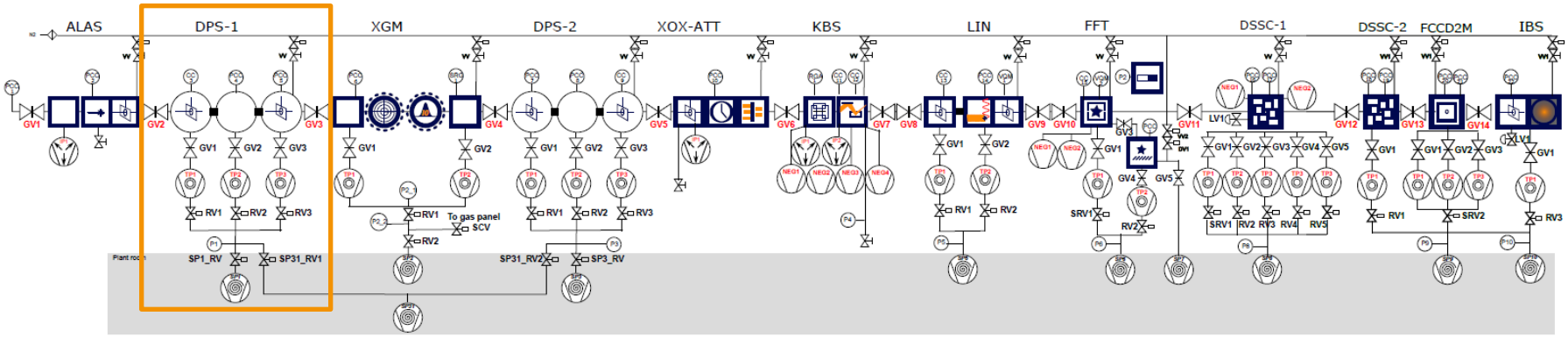






Vacuum layout

European XFEL
SCS Vacuum

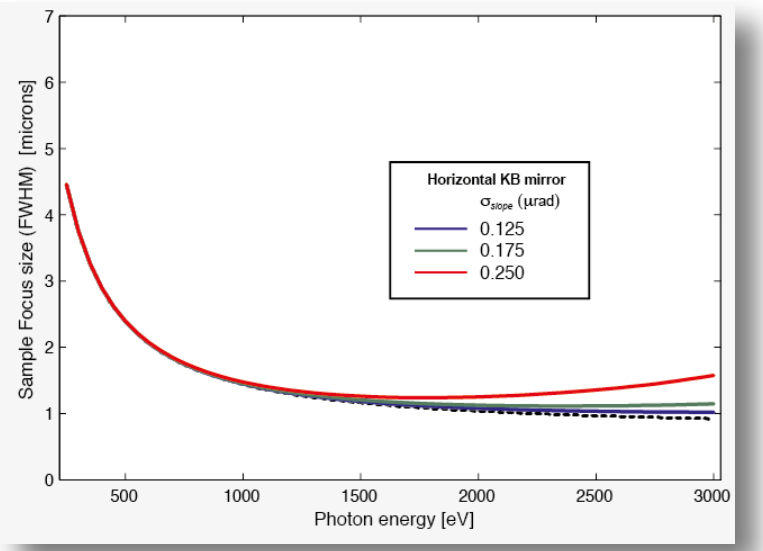


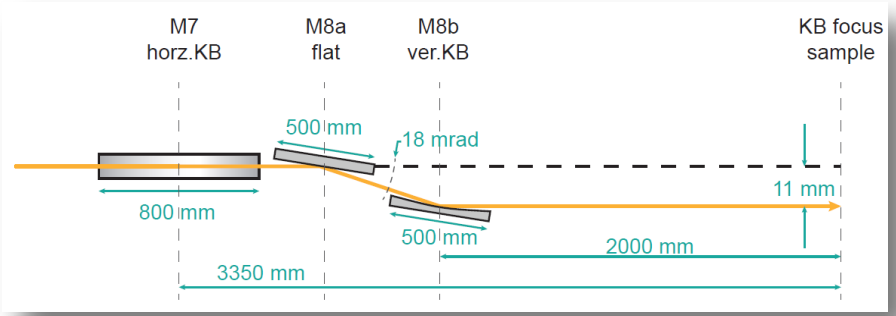
- 12 sections: 11+ GDR vacuum not yet defined..
- 22 Turbo molecular pumps
- 10 scroll pumps
- 36 Gate valves: 14 along beamline
- 25 Gauges, 1 RGA, 2 VQM

KBS: Kirkpatrick-Baez focussing system

Mirror bender allows for changing focus

- nominal focus f_o: slope error 50 nrad (X-ray optics from JTEC)
- $f_o \leq f' \leq f_o + 2m$: slope error <150nrad (FMB mirror bender)
- vertical deflecting mirror: keep beam parallel to the horizontal plane



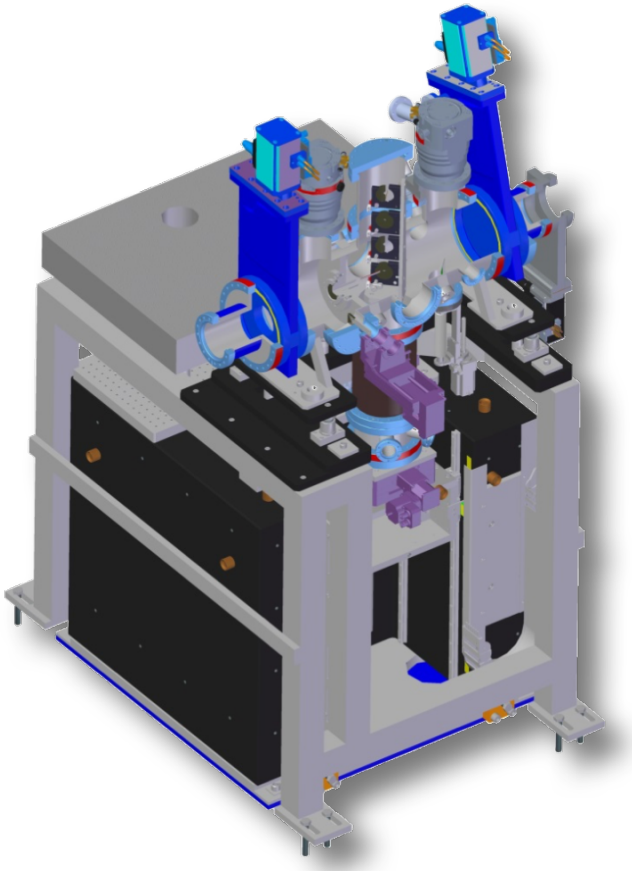


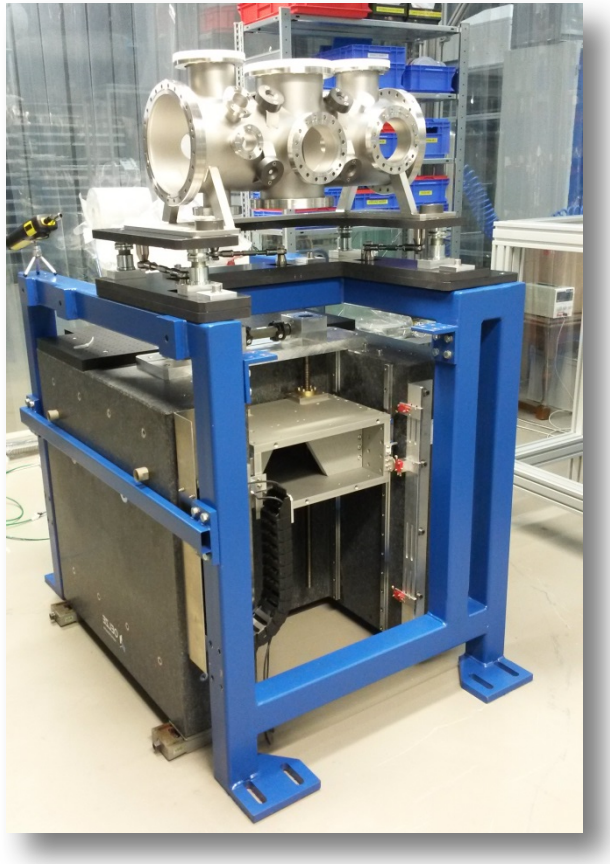
KB best refocusing:
- Minimum beam size: 1.5x1.5 μm²

Near-focus conditions soft x-rays:
- 1.5 - 10μm ⟹ 0 - 1.6 x Rayleigh range

Out-of-focus by bent mechanism:
- Maximum beam size: 1 x 1 mm²

LIN: Laser in-coupling

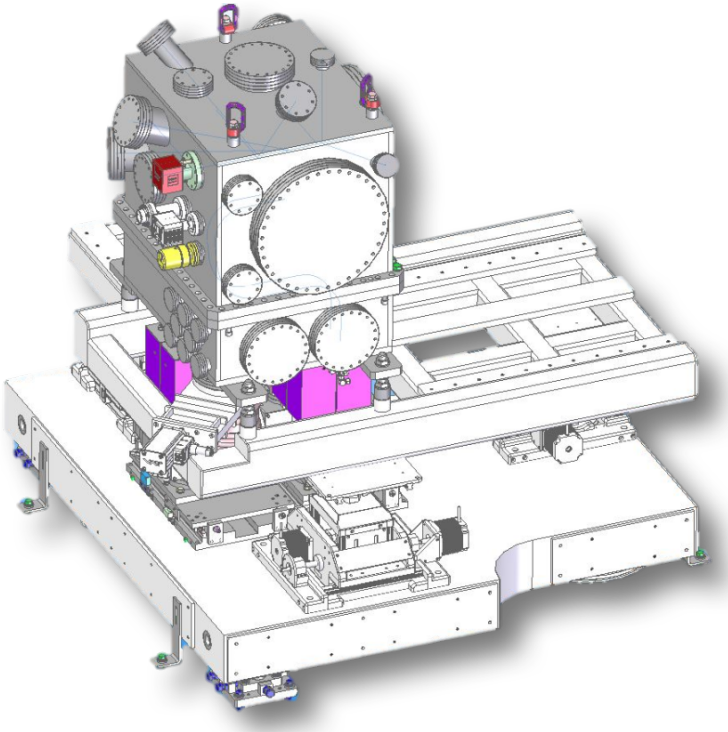


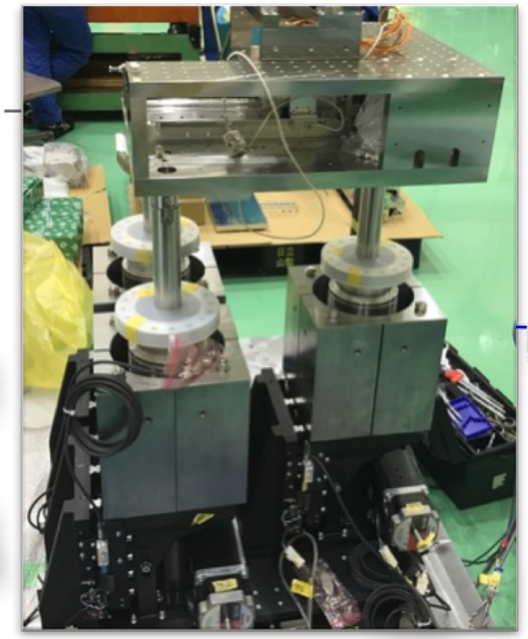


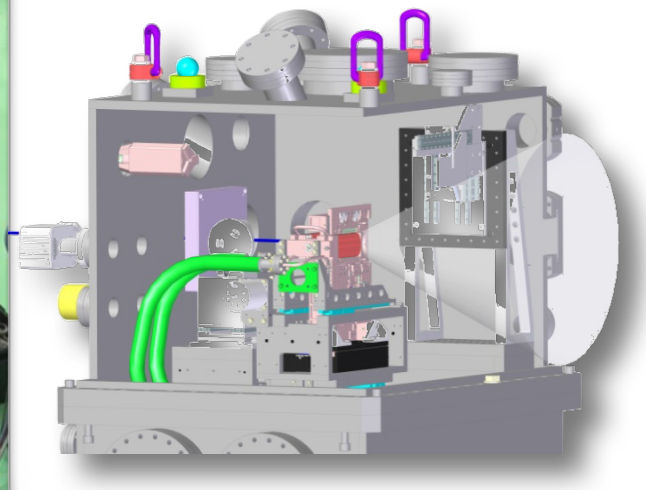
Presentation Robert Carley

FFT: Forward Scattering fixed Target chamber

f_o, f_o+2 m



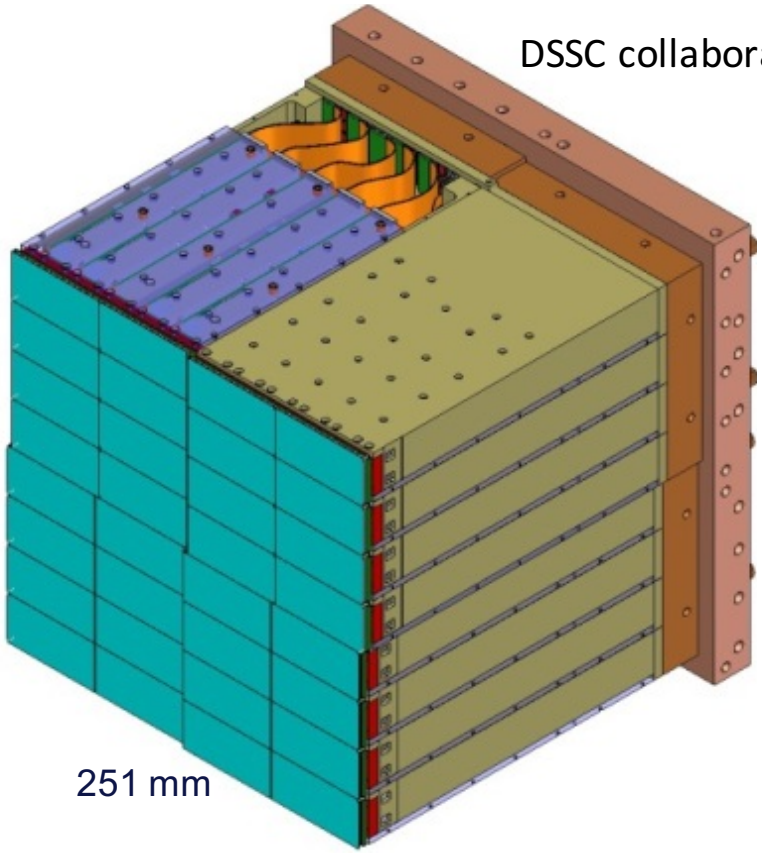


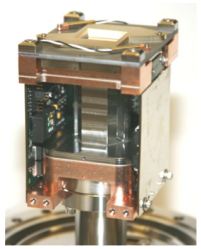


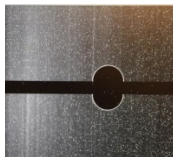
Presentation
James Moore / Carsten Deiter

Soft x-ray detectors

DSSC collaboration (DESY, …)



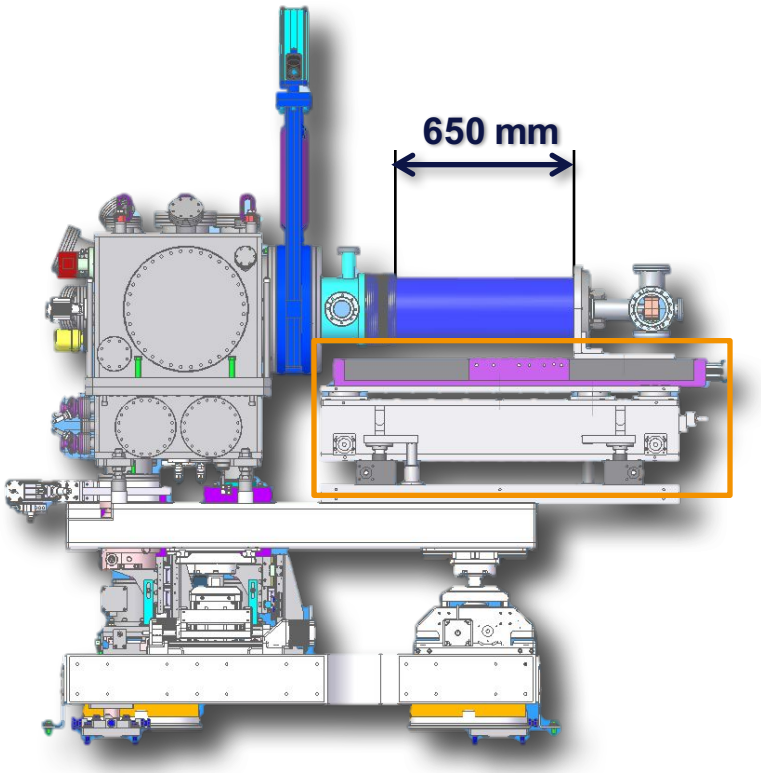


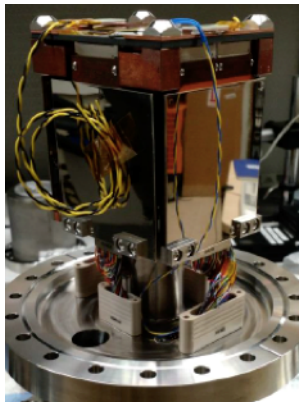


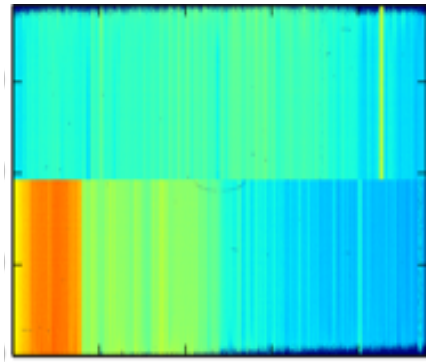
LBNL: 1.8 mm center hole
28.8 mm x 58.8 mm

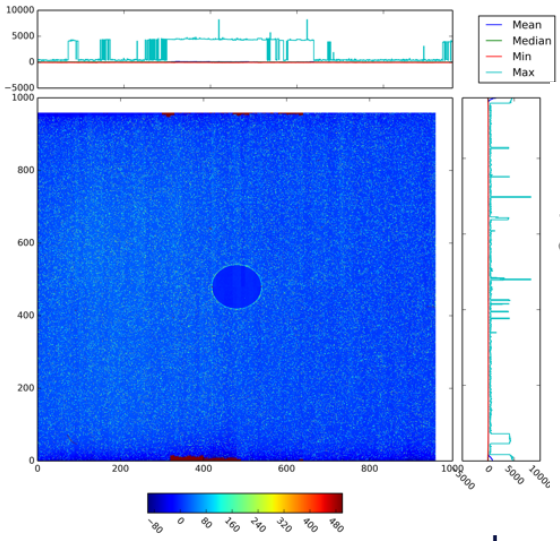
Specification	DSSC	FastCCD
Photon energy range	0.5–6 keV	0.25–6 keV
Number of pixels	1024×1024	1960×960
Pixel coordinates	hexagonal	cartesian
Pixel size	204×236 μm^2	30×30 μm^2
Dynamic range	10^4	10^3 above 0.5 keV
Max frame rate	4.5 MHz	200 Hz

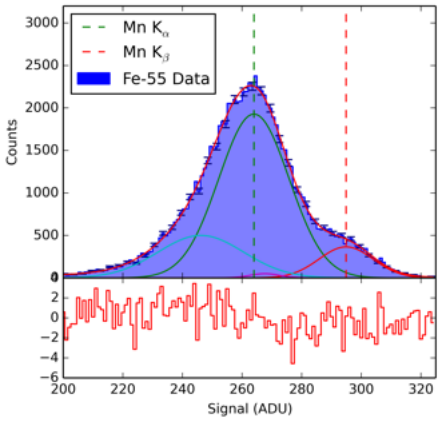
FCCD @ FFT station





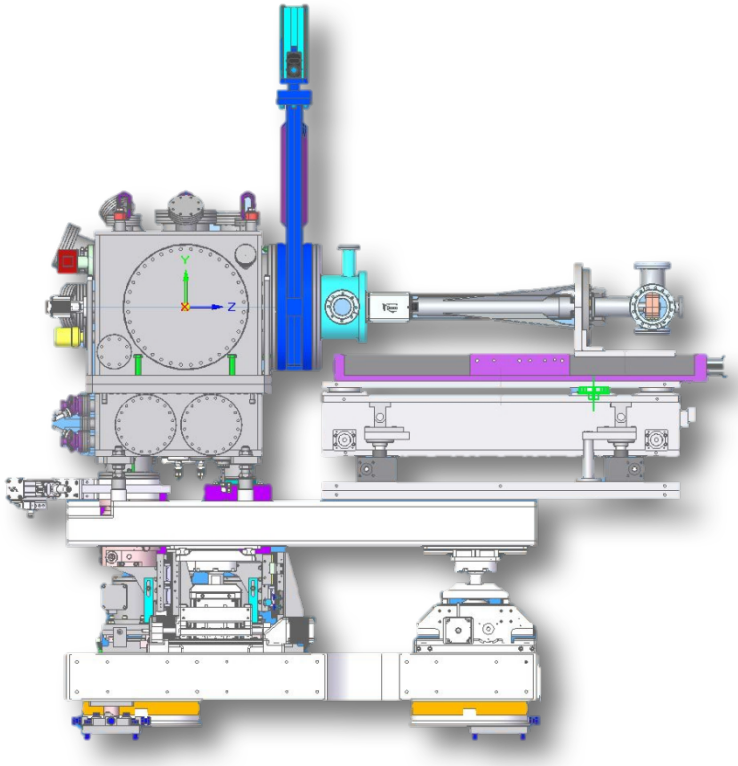


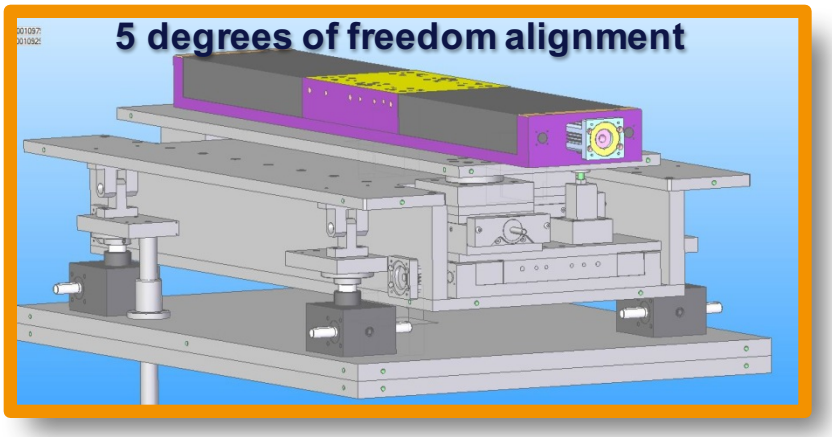




Januschek poster 47 Friday

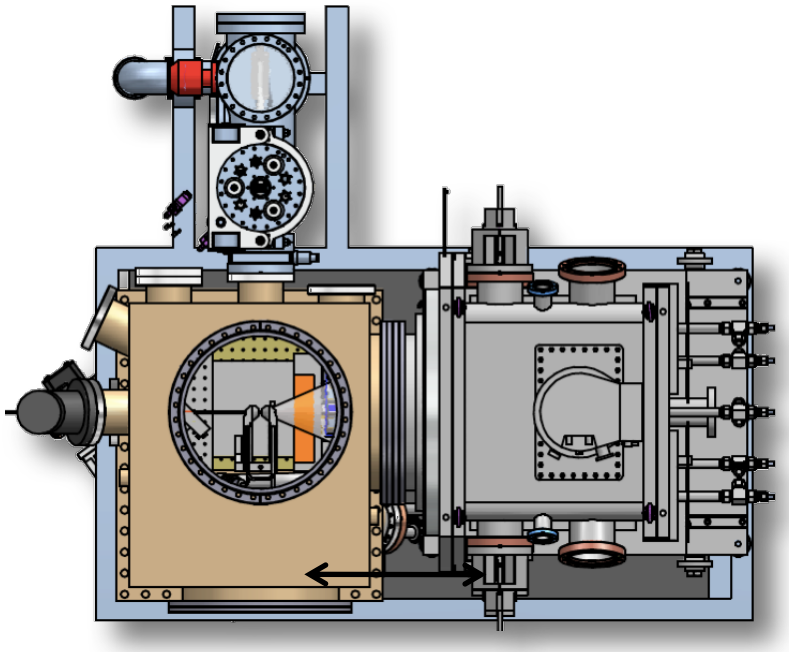
FCCD @ FFT station





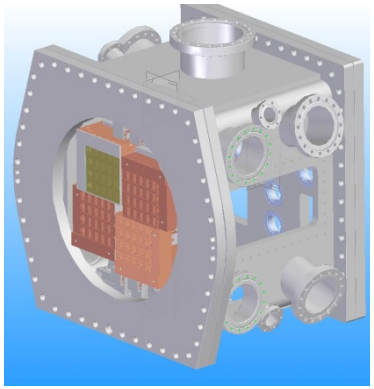
Sample size ϕ_{obj} [µm]	1	3	5	10
FEL diameter [µm]	3	9	15	30
FastCCD distance [mm]				
0.5 keV	48	145	242	484
0.8 keV	77	232	387	774
1.2 keV	116	348	581	1161
2.0 keV	194	581	968	1936
3.0 keV	290	871	1452	2904
Resolution [nm]	4 (2)	13 (6)	21 (10)	42 (21)

DSSC Detector @ FFT station



2- 27 mm Ø hole

Al Filter (500 nm)

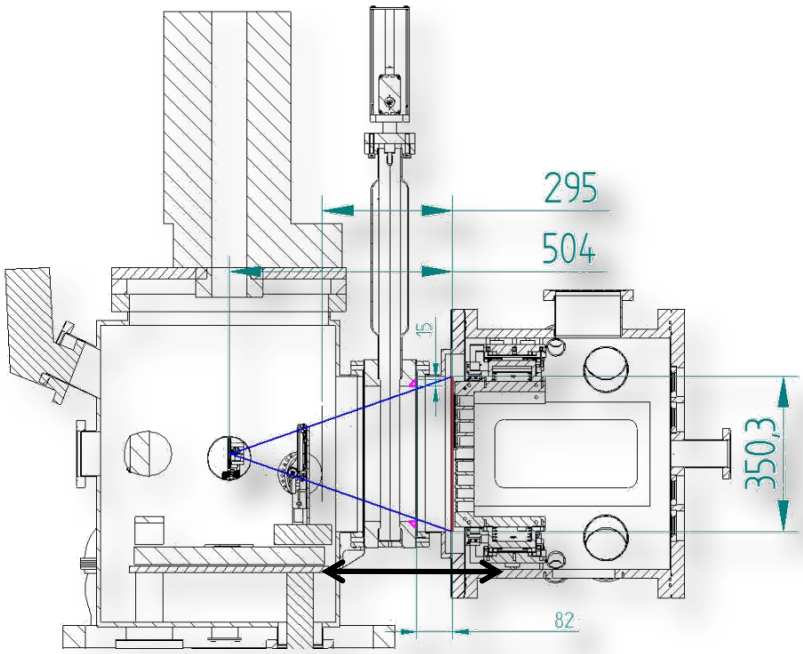


Sample – detector distance: 150 mm

ξ_{min} = 1-4 nm for 1 – 3 keV

Sample size ϕ_{obj} [µm]	1	3	5	10
FEL diameter [µm]	3	9	15	30
DSSC distance [mm]				
0.5 keV	355	1065	1774	3549
0.8 keV	568	1703	2839	5678
1.2 keV	852	2555	4259	–
2.0 keV	1420	4259	–	–
3.0 keV	2129	6388	–	–
Resolution [nm]	4	12	20	39

DSSC Detector @ FFT station



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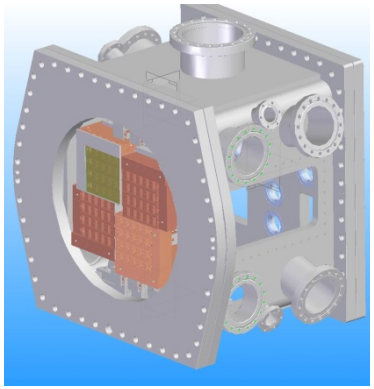

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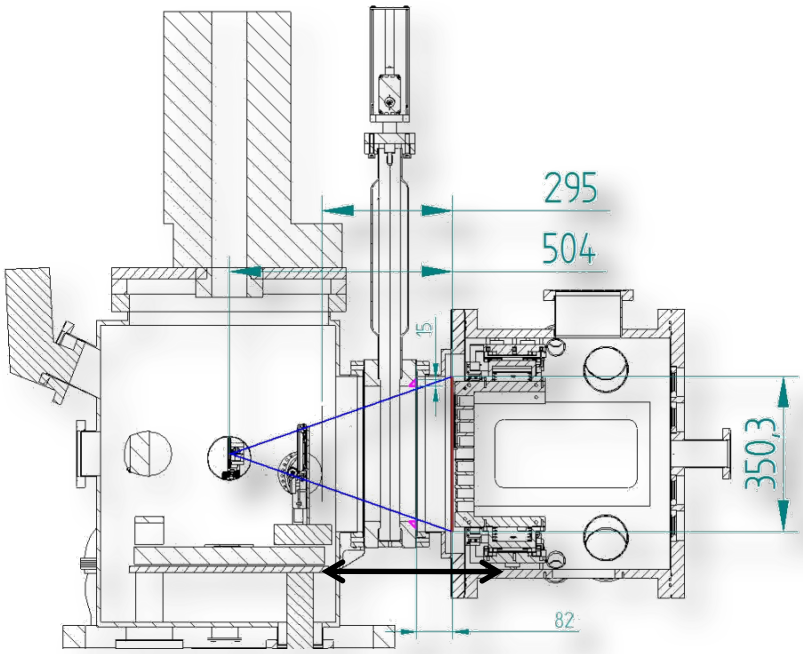

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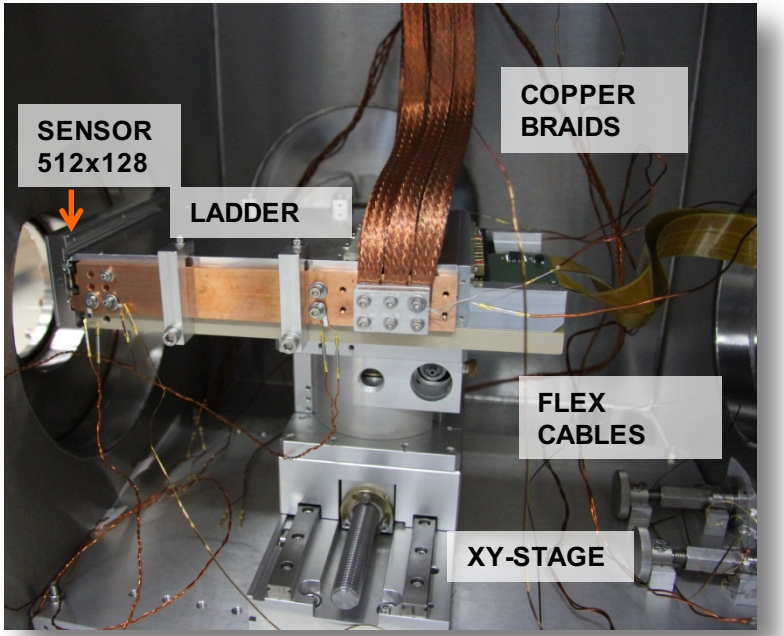
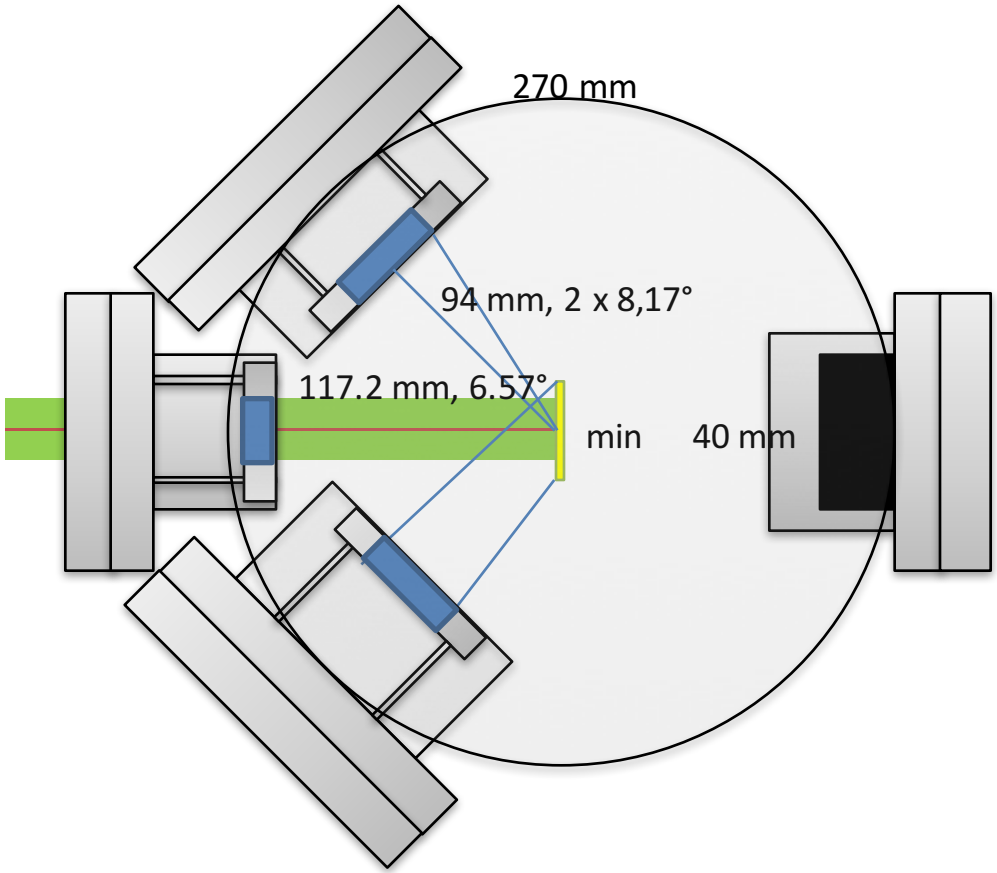
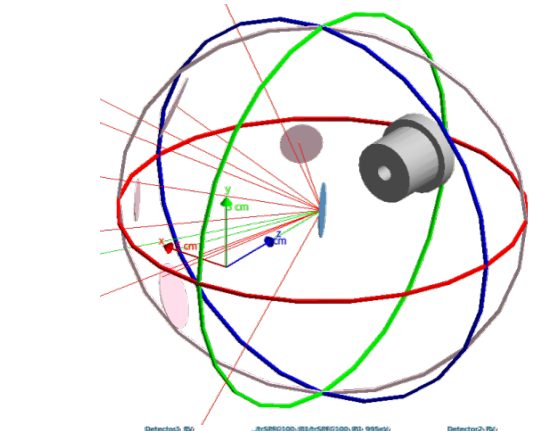


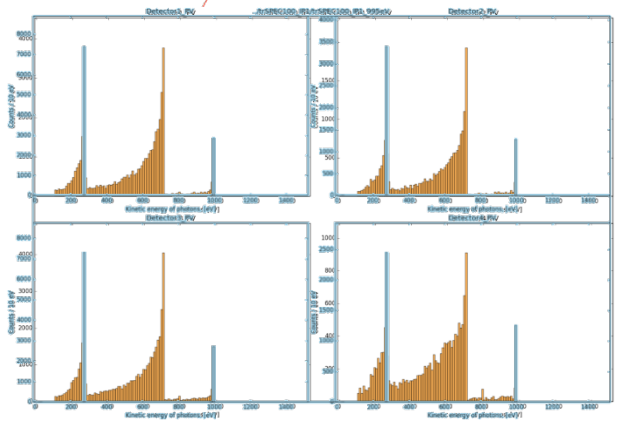
- Successful tests December 2016 at PETRA 4

Donato poster 75 Friday

TIM & IBS: Transmission Intensity Monitor & Instrument Beam Stop





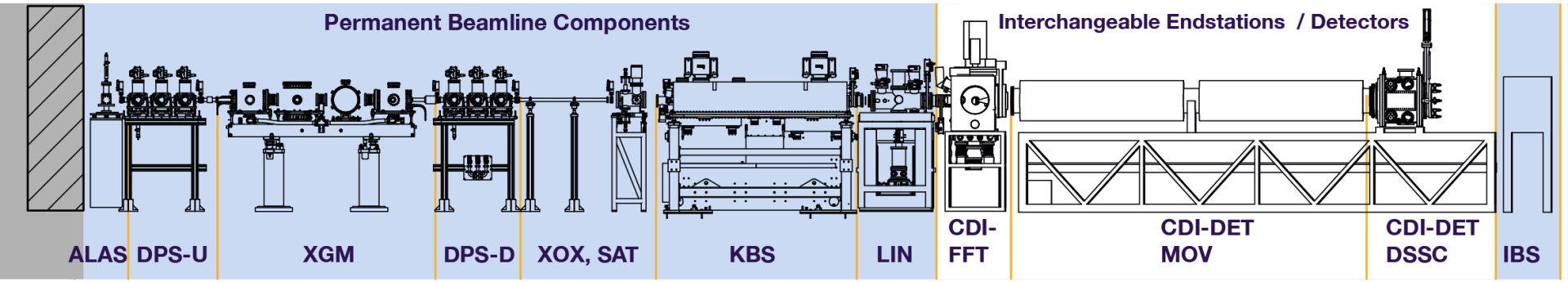


Higley's talk Thurday 12:00
Soft X-ray FEL experiments session

E-beam parameters

Quantity	Value	Day 1	
electron energy	8/12.5/14/17.5	17.5	GeV
macro pulse repetition rate	10	10	Hz
RF pulse length (flat top)	600	600	μs
bunch train length	600 μs	70	μs
bunch repetition frequency within pulse	4.5	1.1/100	MHz/KHz
bunch charge	0.02-1	0.5	nC
electron bunch length after compression (FWHM)	2 – 180	50	fs
Slice emittance	0.4 -1	1.0	mm mrad
beam power	500	5	kW
Variable undulator gap	10-20	14	mm
SASE 3 photon energy	250-3500	>1000	eV

Commissioning Tasks



Commissioning steps (25 shifts) : Bring beam from SQS to SCS up to IBS

- Pre-alignment all component with MEA/ALAS using nominal coordinate system
- Bring beam to IBS:
  - To ALAS
  - To IBS (after re-alignment of component with ALAS new beam axis)
- Soft X-ray Mono commissioning at 1-2 working points for early user program
- XGM commissioning
- FFT instrument diagnostics and detectors
- KB mirror focus / wave front characterization
- Optical laser delivery and timing (end Q2 - 2018)

Time line

- Set-up bunch compression in parallel to LINAC commissioning
- Once Northern Branch ready transport beam to dump after SASE1&3 (April)
- First lasing in SASE1 (May)
- SASE1 photon systems and experiment commissioning follows
- First lasing in SASE3 (June) and following photon systems and experiment commissioning depends on operation priorities and systems readiness

User program

Opening CfP	Mode	Instruments	Allocation period
Q1 2017	Early User Experiments	SPB/SFX, FXE	Q3, Q4 2017
Q3 2017	Early User Experiments	SPB/SFX, FXE, SQS, SCS, (MID, HED)	Q1, Q2 2018
Q1 2018	Early User Experiments	SPB/SFX, FXE, SQS, SCS, MID, HED	Q3, Q4 2018
Q3 2018	Regular Experiments	SPB/SFX, FXE, SQS, SCS, MID, HED	Q1, Q2 2019

Thank you for your attention !