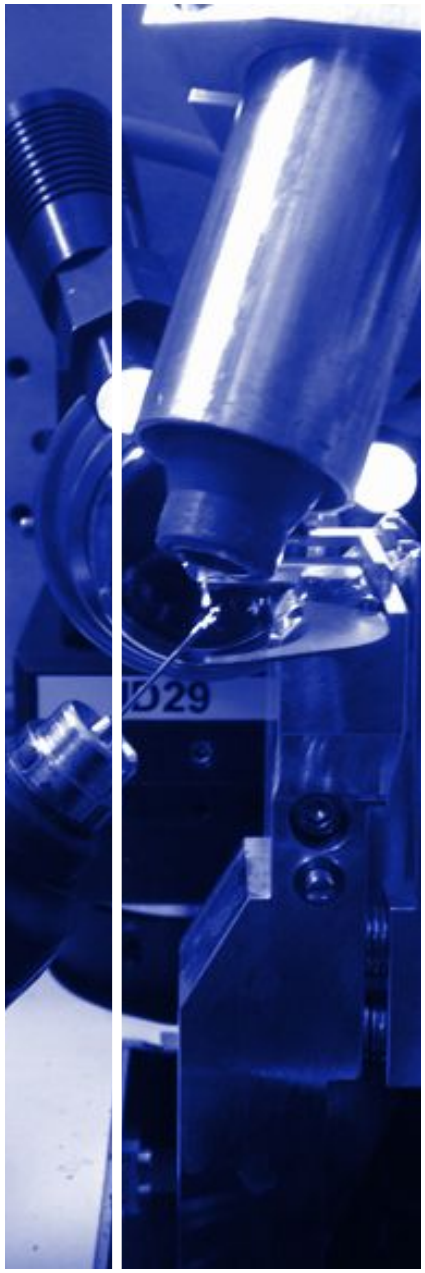
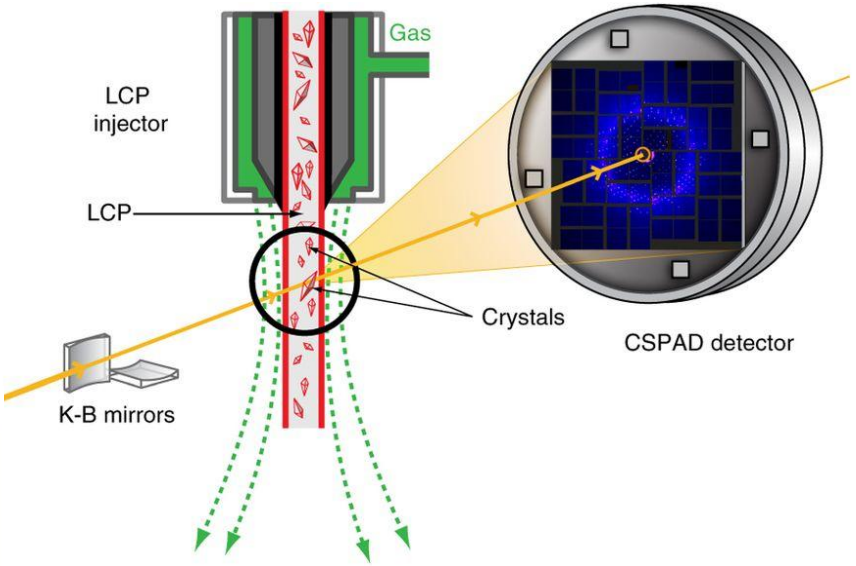
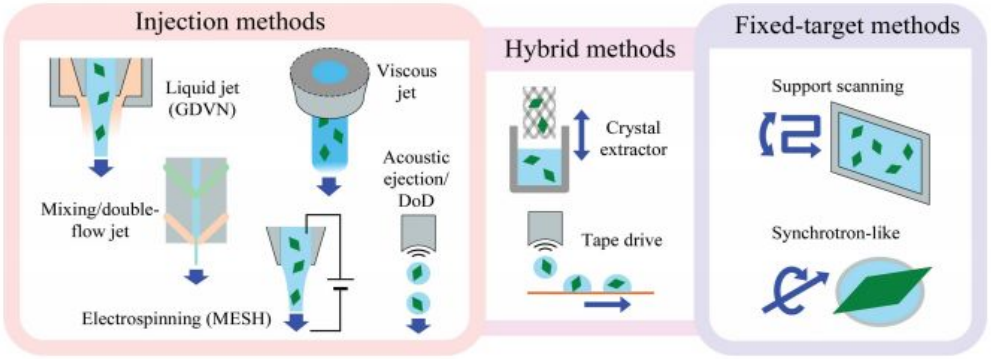


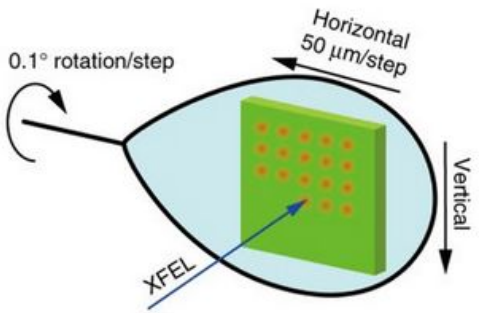
EBSL8
-
The ID29 Upgrade Project

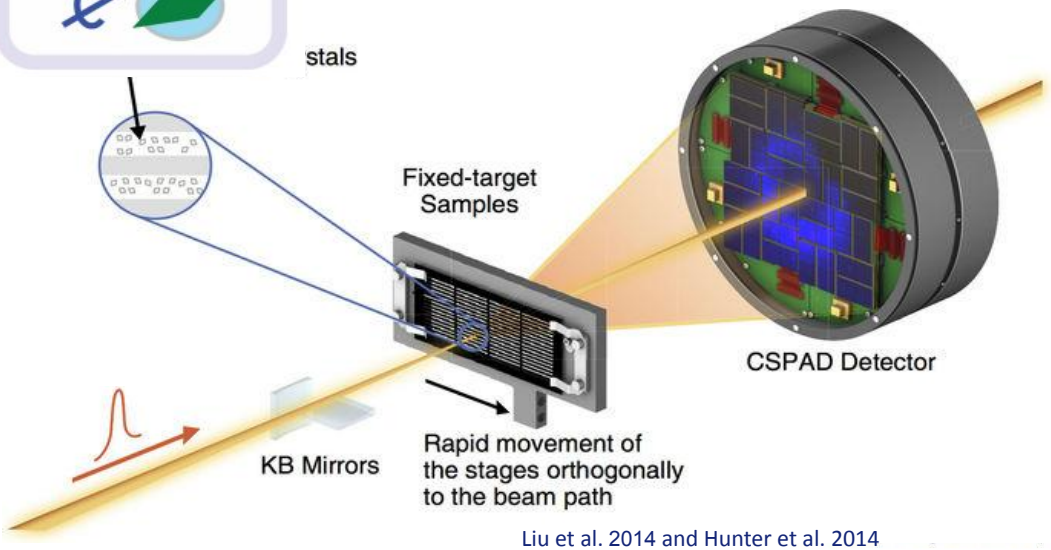
- A beamline dedicated to MX Serial Crystallography
  - Fully exploit Room Temperature data collection
  - Open new perspective for Time resolved studies
  - Adapt different sample environments
  - Minimize exposure time
  - Minimize background
  - Study micron size samples



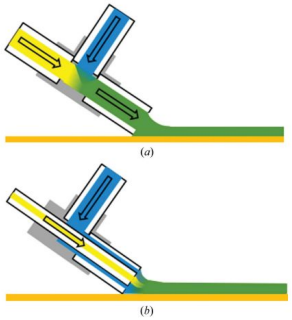


Adapted from Martiel et al 2018

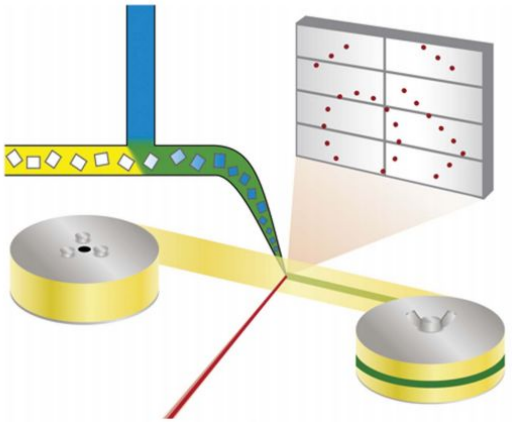


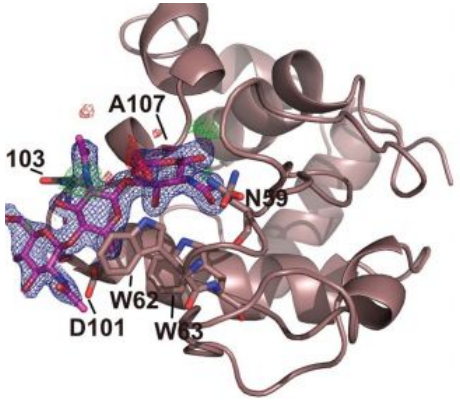


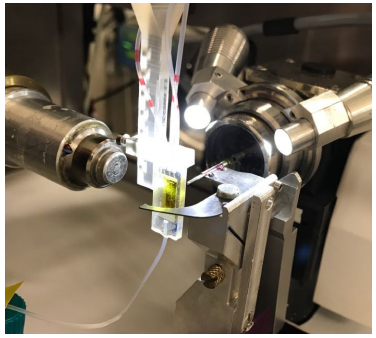
Liu et al. 2014 and Hunter et al. 2014



Beyerlein, et al. 2017.

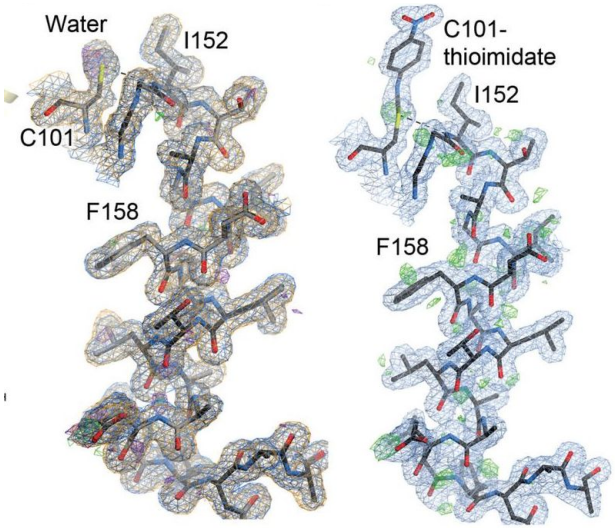




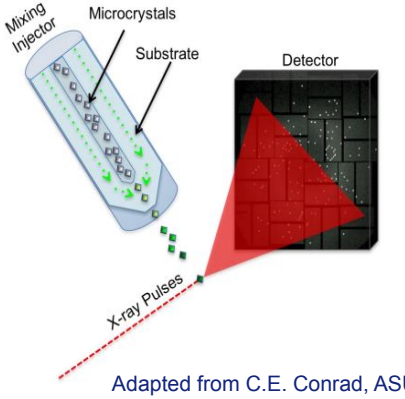


D.Monteiro, et al. 2020

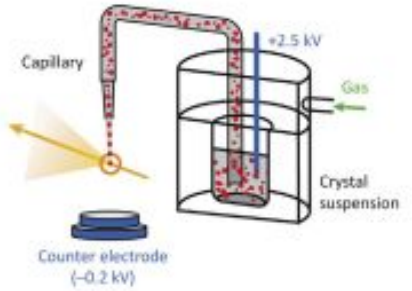
- New perspectives for ligand screening
- Direct soaking in crystal suspension
- On-line mixing (mix and diffuse) prior data collection with injectors, microfludic or tapes
- More efficient diffusion in microcrystals
- Advantage of RT accessible conformations
- Avoid competition with cryoprotectants



Dasgupta, et al. 2019. bioRxiv.

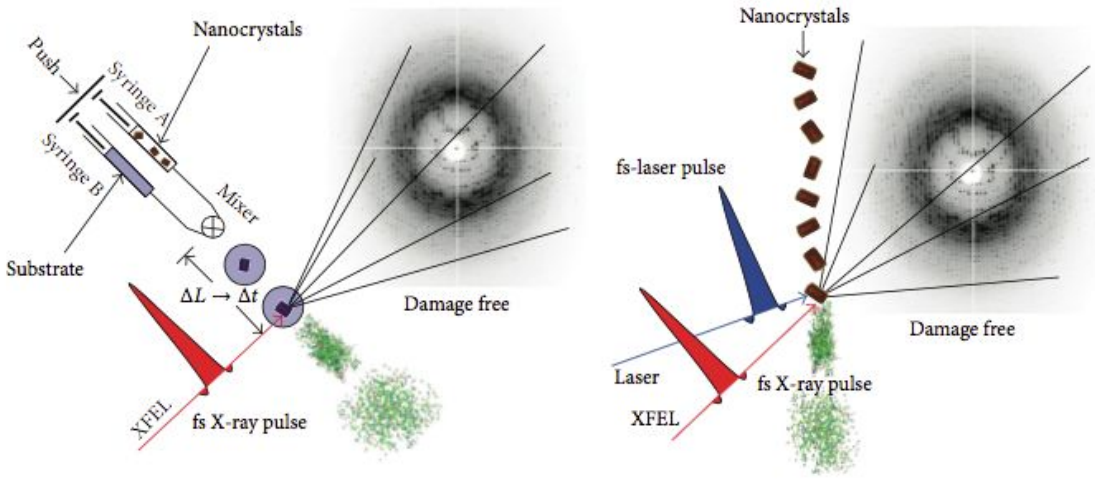


Adapted from C.E. Conrad, ASU, 2016

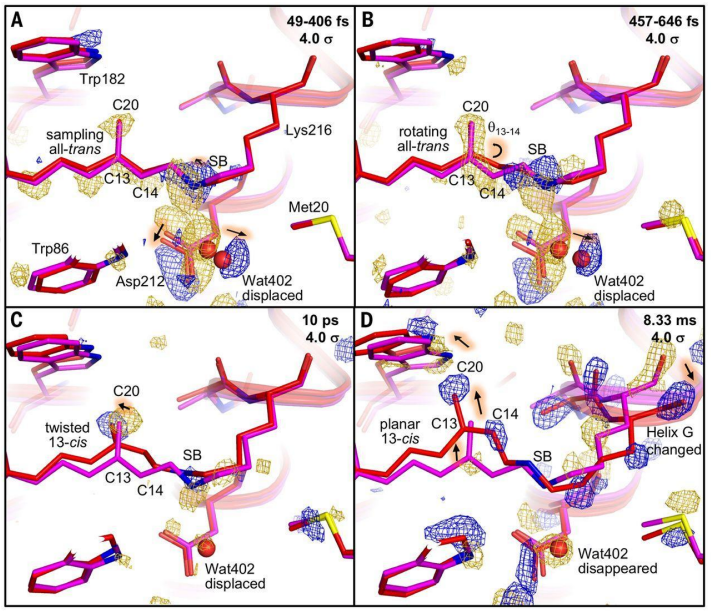


Sierra, et al. 2012.

- Time resolved Serial Crystallography will be more efficient with micro crystals

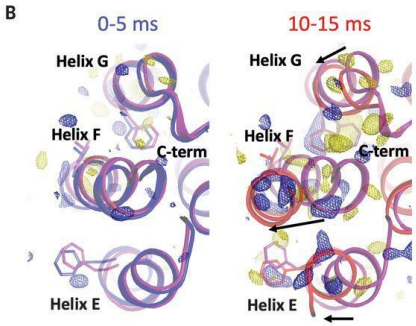


Schmidt, M. (2013). *Advances in Condensed Matter Physics* **2013**, 1-10.

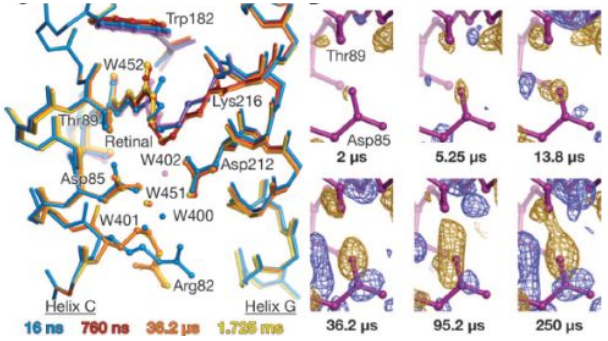


Nogly, et al. 2018. *Science* 361 (6398).

- Pump&probe
  - Use of caged compounds or intrinsic photo activated proteins
  - Time resolution given by convolution of pulses (laser + X-ray) and lag
  - Temperature jumps by IR
  - Other probes
- Mix&Inject
  - More general
  - Mix substrates, ligands
  - pH changes
  - Diffusion is much faster on micro crystals
  - Time resolution may be limited by mixing time



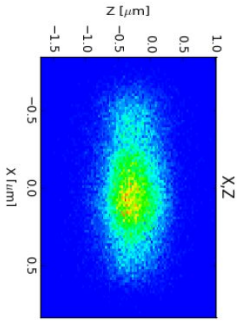
Weinert et al. 2019. *Science* 365 (6448): 61–65.

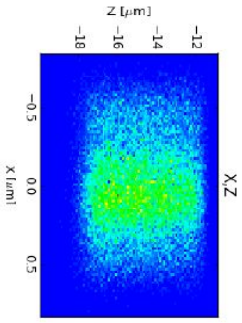


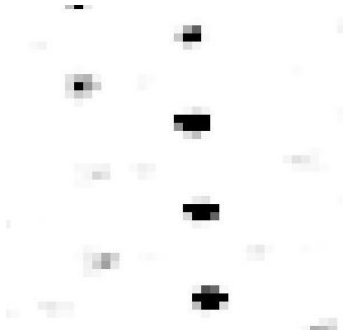
Nango et al. (2016). *Science* **3**, 393 - 401

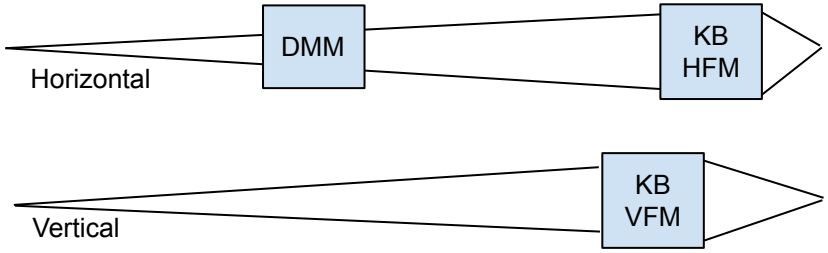
FOCUSING OPTICS

- Sample at 107 m from source
- Working distance to sample 500 mm
- Beam divergence 0.7 x 1.9 mrad (VxH)
- Smallest spot size 0.5 x 0.6 µm (VxH)
- Beam resizing by tuning incident angle

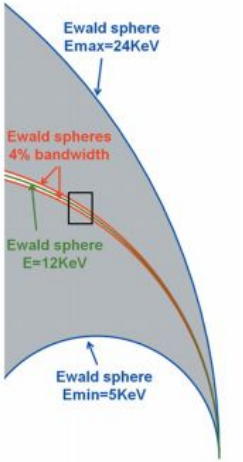


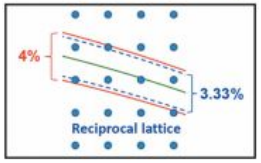




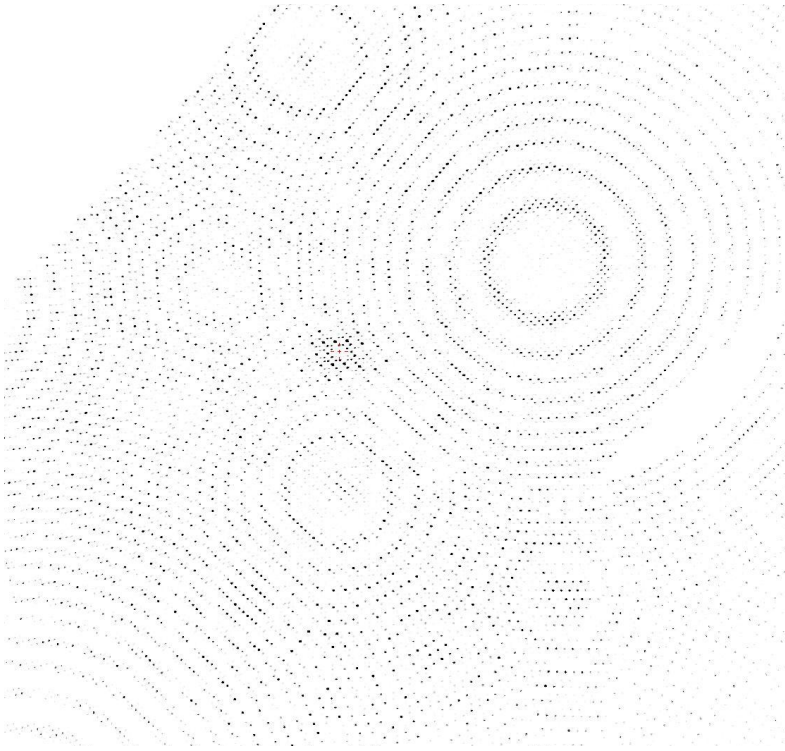


- **Elliptical KB mirrors**
  - HFM slope error < 0.1 µrad
  - VFM slope error < 0.05 µrad





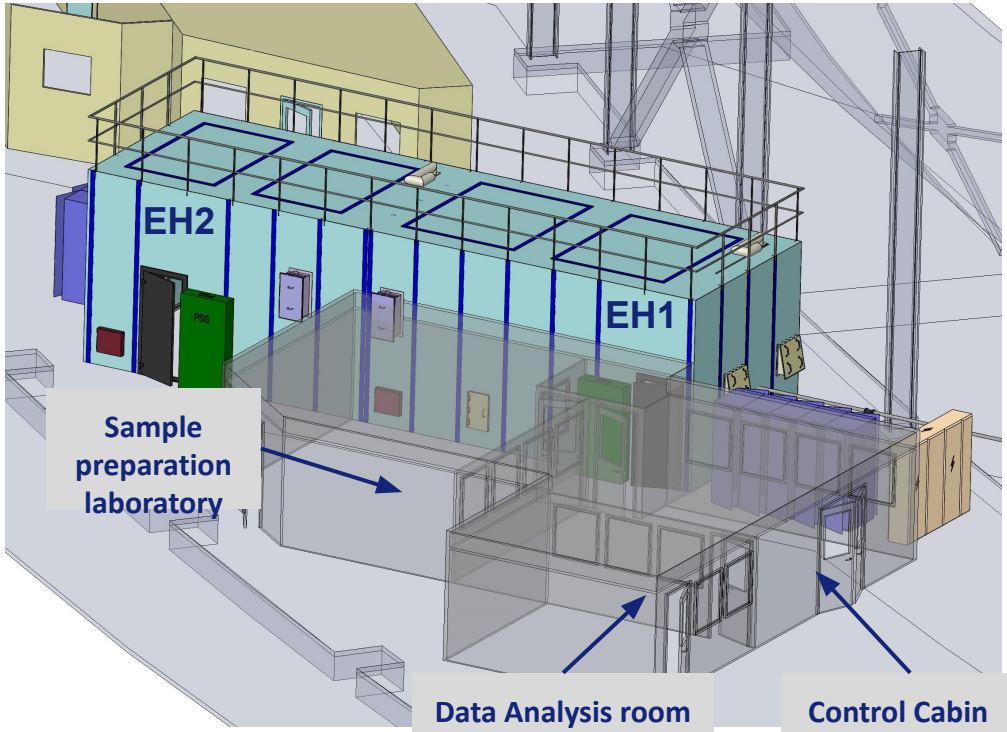
5mqu F23 a = b = c 436.6

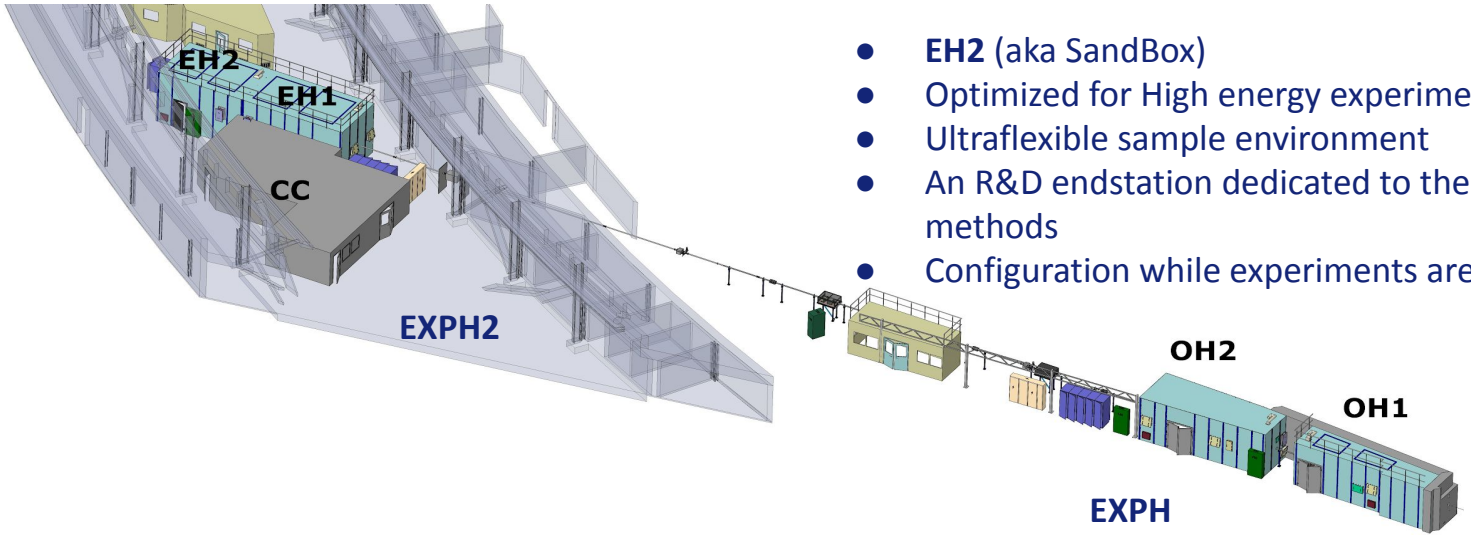


- Larger bandwidth (0.3% and 1%)
  - More flux - up to 10^{16} ph/s
  - More complete spots from stills
  - Reduce exposure time - down to the µs

EBSL8 BEAMLINE

- **EH1** dedicated to Time Resolved-SSX experiments at room temperature
- 10 - 20 keV energy range
- Variable bandwidth (0.3 and 1 %)
- Sub-micron focusing
- Up to **10^{16} ph/s**
- SSX sample environment (jets, microfluidic, fixed targets, etc)
- **New diffractometer** for fast scanning on fixed targets experiments
- New **Jungfrau detector** with 1khz and 1 µs integration time





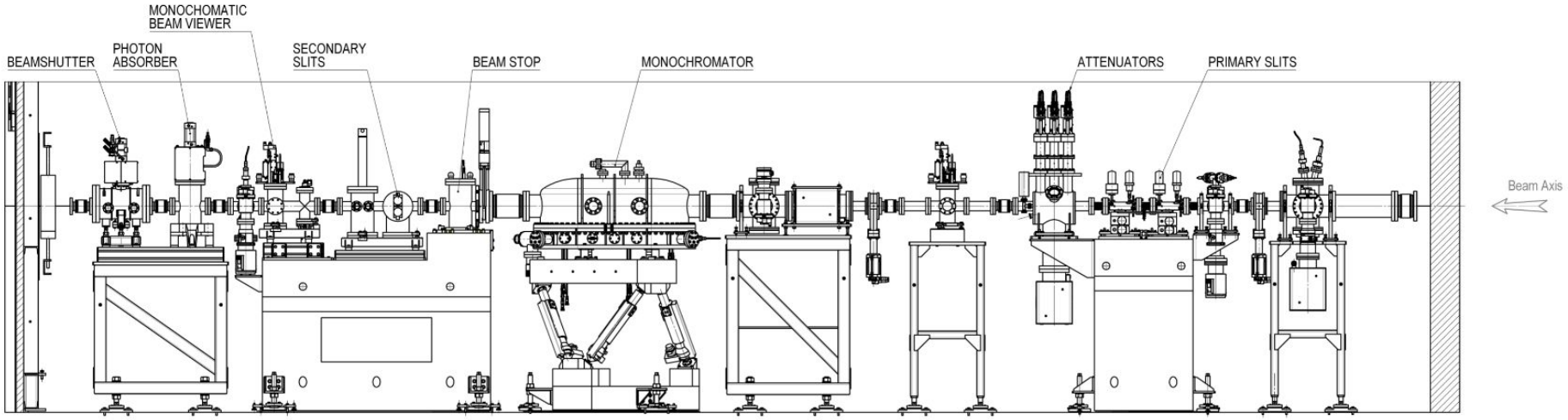
- **EH2** (aka SandBox)
- Optimized for High energy experiments (35 keV)
- Ultraflexible sample environment
- An R&D endstation dedicated to the development of new methods
- Configuration while experiments are running in EH1

SAMPLE PREPARATION LABORATORY

CONTROL CABIN

EXPERIMENTAL HUTCHES

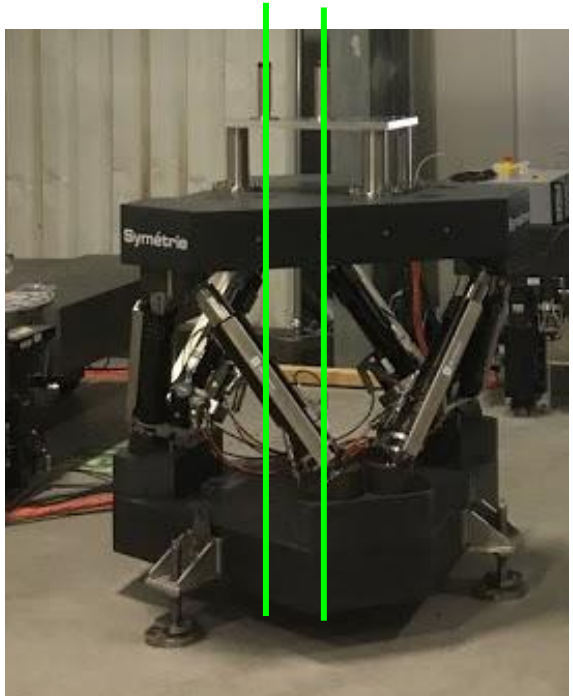
OPTICAL HUTCH 1

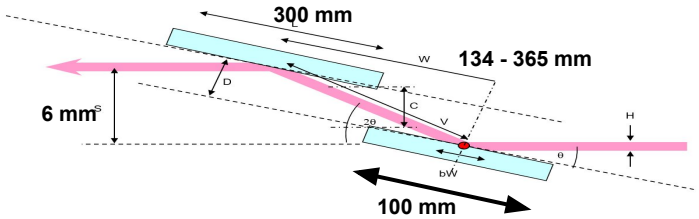


- OH1 construction delayed because of lockdown, completed last December
- Radiation test successful
- Completing cabling to install optical elements

OPTICAL ELEMENTS

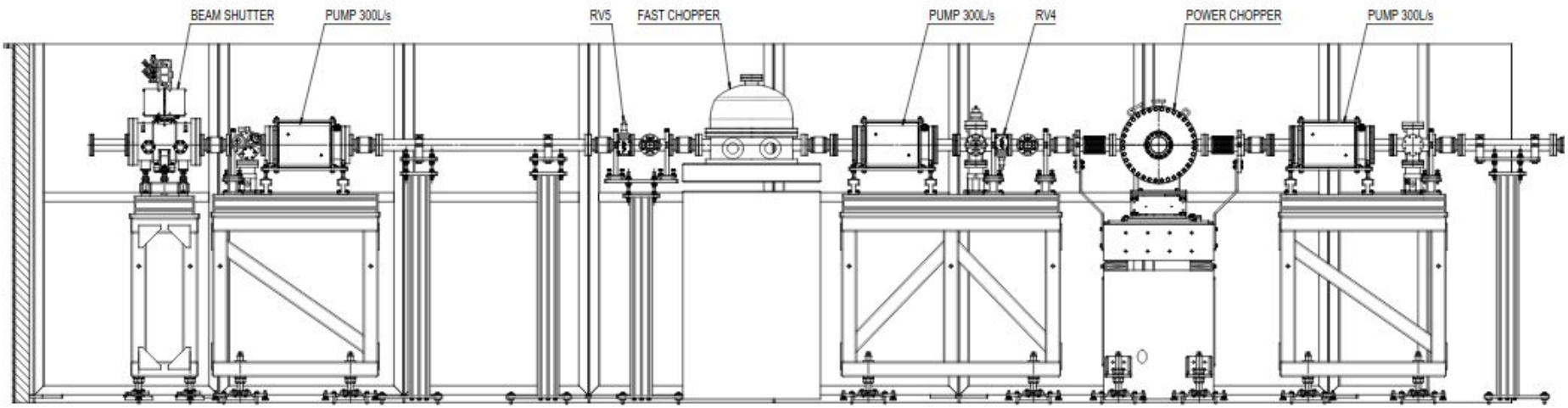
Photon Energy [keV]	10	15	20	25	35
DMM examples					
[Mo/B_4C] d=3.0 nm					
Angle [Mo(1.4)/B_4C(1.6)] [mrad]	21.1	14.0	10.5	8.4	
FWHM beam footprint [Mo(1.4)/B_4C(1.6)] [mm]	35.0	46	57	68	
R^2 [Mo(1.4)/B_4C(1.6)]x200	0.643	0.797	0.711	0.553	
dE/E FWHM peak [Mo(1.4)/B_4C(1.6)]x200	**0.010**	**0.011**	**0.009**	**0.009**	
[Ti/B_4C] d=2.8 nm					
Angle [Ti(1.4)/B_4C(1.6)] [mrad]	22.4	15.0	11.2	9.0	
FWHM beam footprint [Mo(1.4)/B_4C(1.6)] [mm]	33	43	54	63	
R^2 [Mo(1.4)/B_4C(1.6)]x400	0.427	0.650	0.760	0.823	
dE/E FWHM peak [Mo(1.4)/B_4C(1.6)]x400	**0.0037**	**0.0042**	**0.0045**	**0.0046**	
[W/B_4C] d=2.2 nm					
Angle [W(1.1)/B_4C(1.1)] [mrad]					8.2
FWHM beam footprint [W(1.1)/B_4C(1.1)] [mm]					64.8
R^2 [W(1.1)/B_4C(1.1)]x200					0.746
dE/E FWHM peak [W(1.1)/B_4C(1.1)]x200					**0.0119**

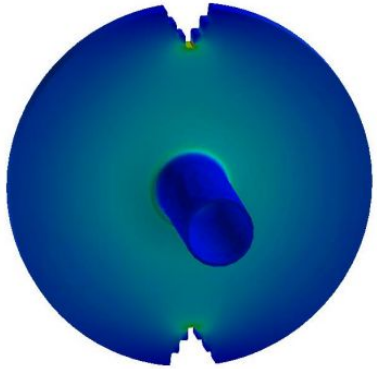




		CDR1	CDR2	CDR1_Z-	CDR2_Z-	
Mvt Rz = ± 50 mrad	Error X	± 3.8 µm	± 6.5 µm	± 3.3 µm	/	± 100 µm
	Error Y	± 20 µm	± 3.8 µm	± 21.5 µm	/	± 20 µm
	Error Z	± 3.3 µm	± 7.5 µm	± 1.8 µm	/	± 20 µm
	Error Rx	± 1.5 µrad	± 2 µrad	± 1.2 µrad	± 1.8 µrad	± 2 µm
	Error Ry	± 2 µrad	± 2.7 µrad	± 2.9 µrad	± 2.6 µrad	± 2 µm
	Error Rz	NA	NA	NA	NA	/

OPTICAL HUTCH 2

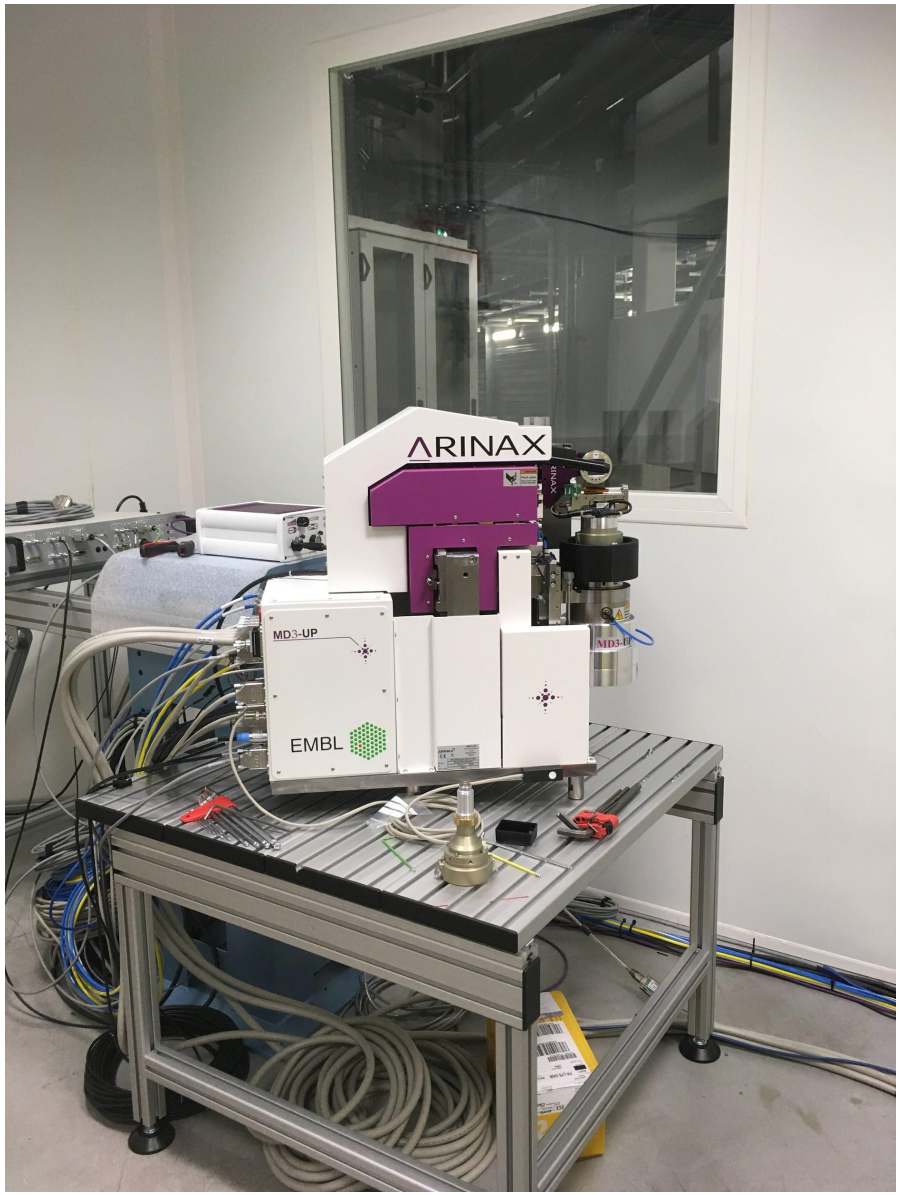


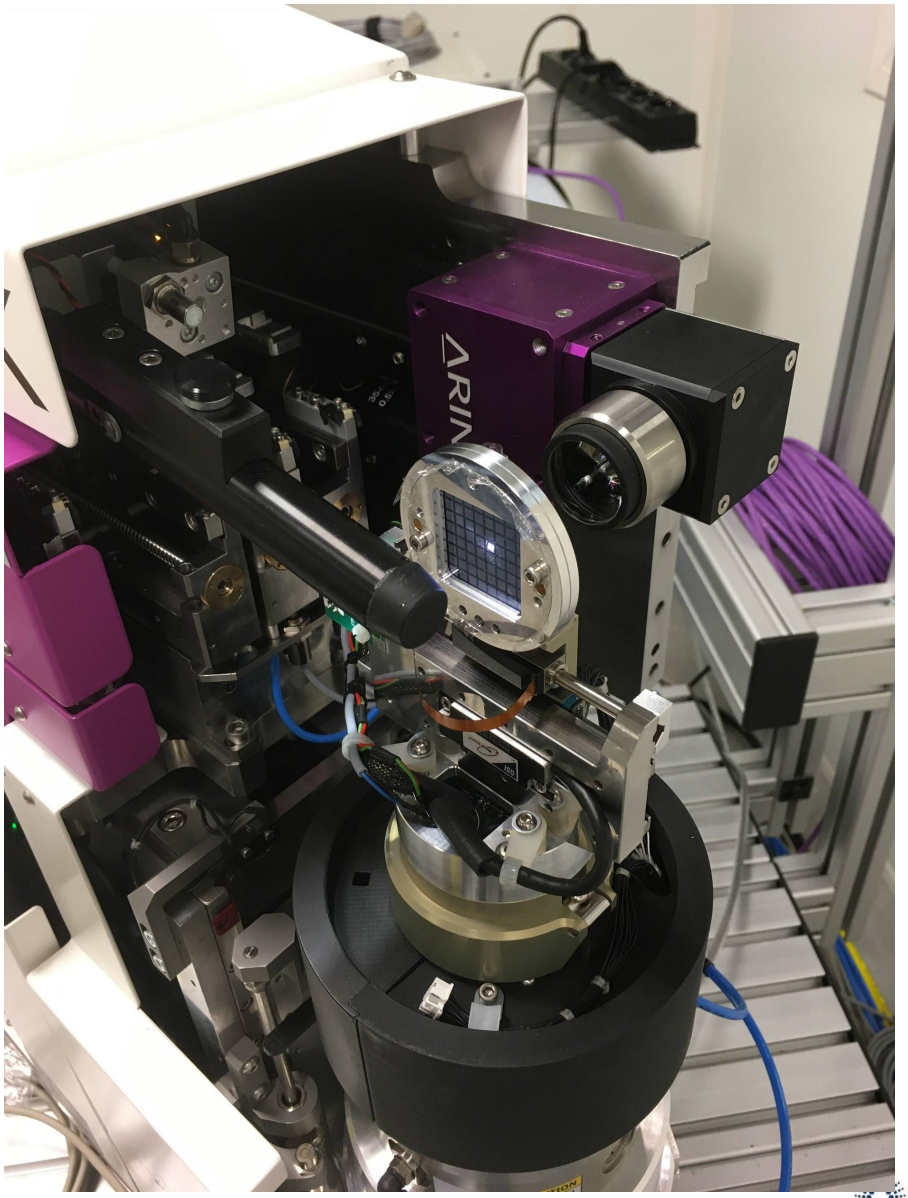


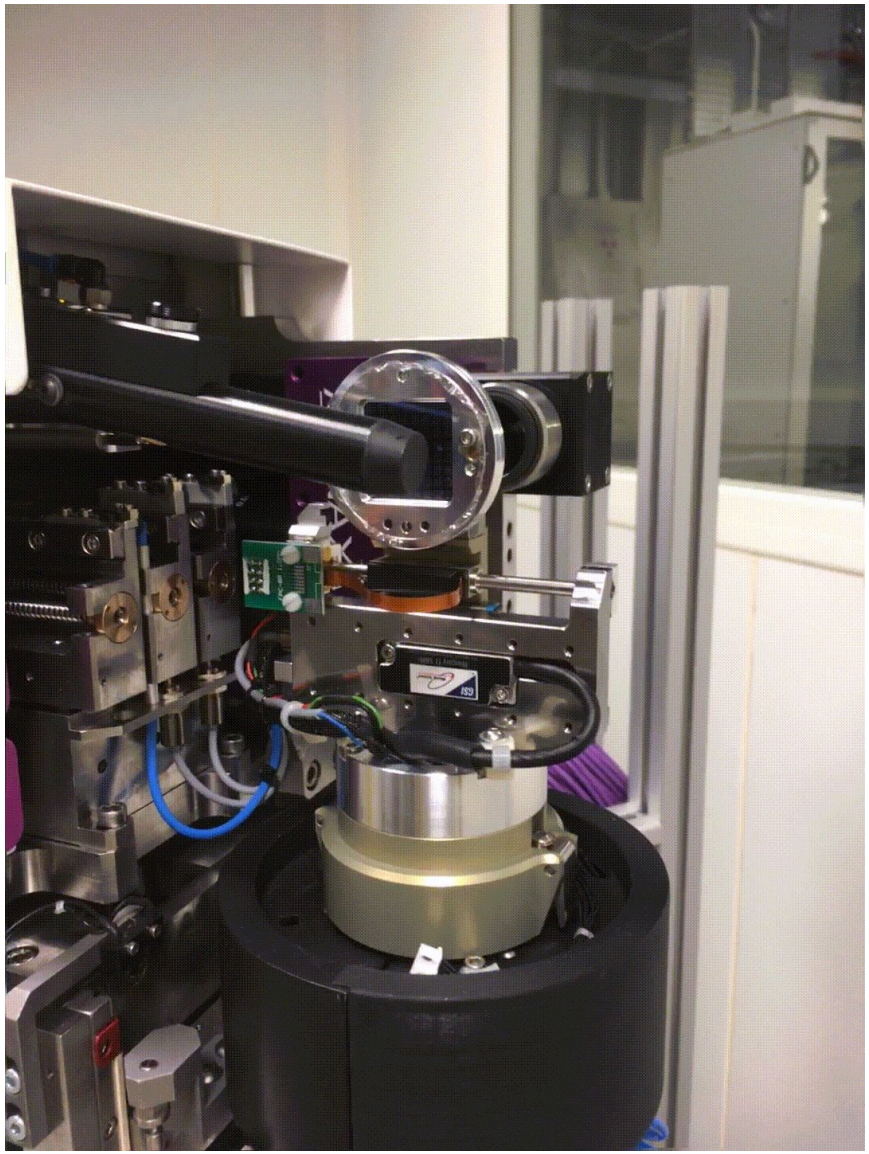
- OH2 reuses old EH1
- Main components are two choppers
  - Power chopper
  - Fast chopper
  - On going development from Celeroton AG
  - Variable exposure time
  - Synchronous opening with machine clock

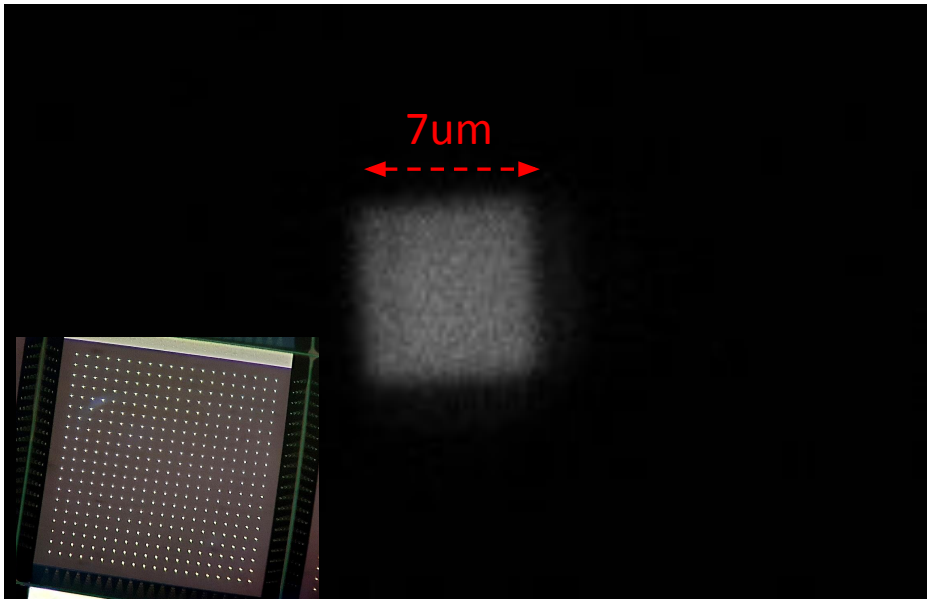
	0.7 mm			0.4 mm		
slots	**@ 17 mm**	**@ 18.5 mm**	**@ 20 mm**	**@ 17 mm**	**@ 18.5 mm**	**@ 20 mm**
1 mm	1.9 / 11.4	1.8 / 10.5	1.6 / 9.7	3.8 / 9.4	3.5 / 8.7	3.3 / 8.0
3 mm	14.7 / 24.9	13.5 / 22.9	12.6 / 21.2	16.6 / 23.0	15.3 / 21.1	14.2 / 19.5
5 mm			23.5 / 32.8			25.2 / 31.0

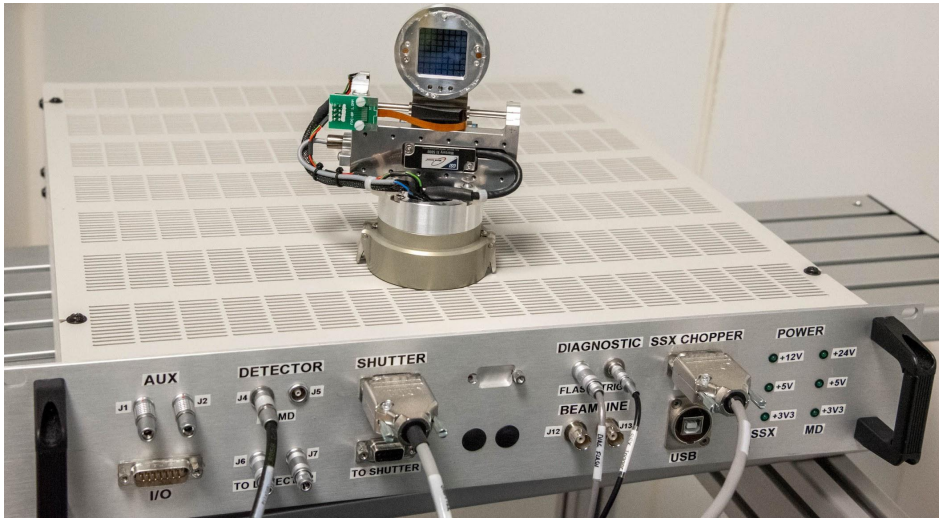
MD3UPSSX



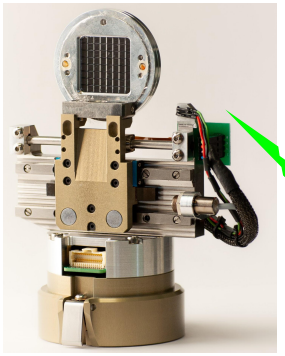


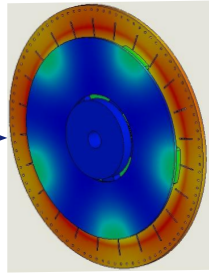


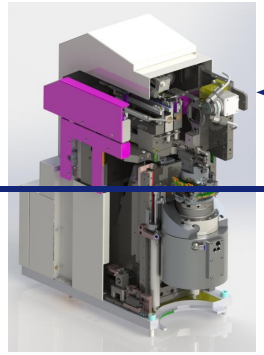

7um


AUX
DETECTOR
SHUTTER
DIAGNOSTIC
SSX CHOPPER
POWER
I/O
TO SHUTTER
USB
SSX
MD

RF





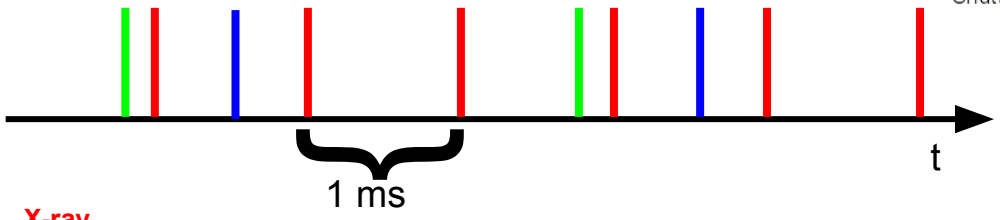


Auxiliary Outputs

Detector

GPIO

Shutter

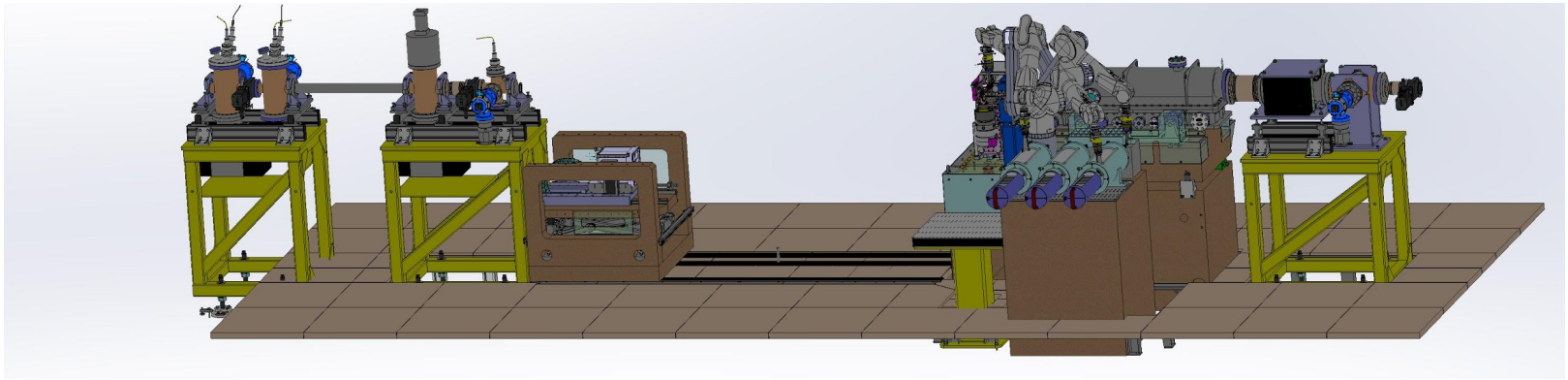


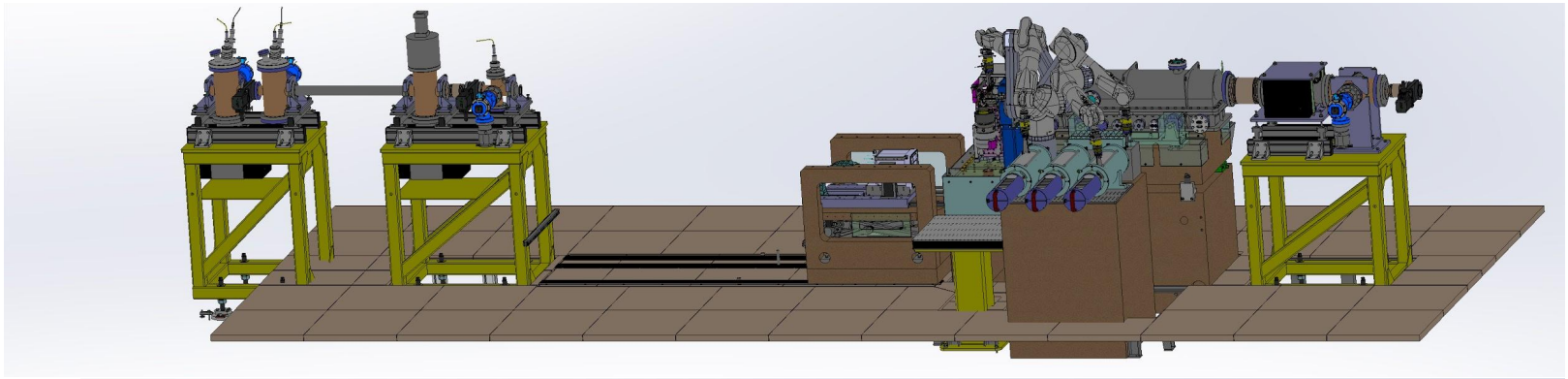
X-ray
Trigger 1
Trigger 2

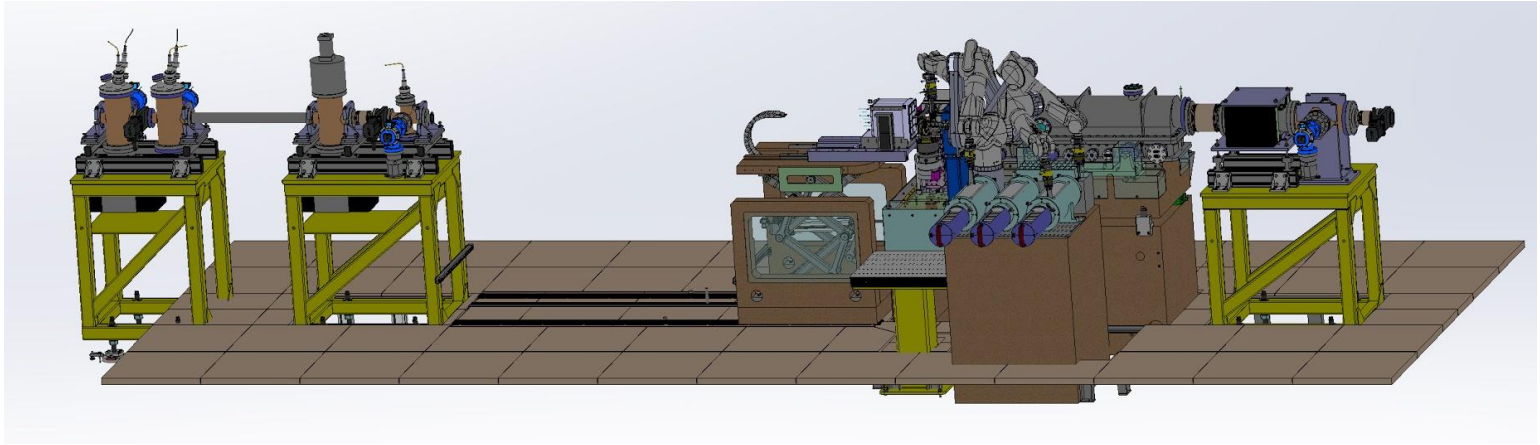
Delays configurables in steps of 20ns

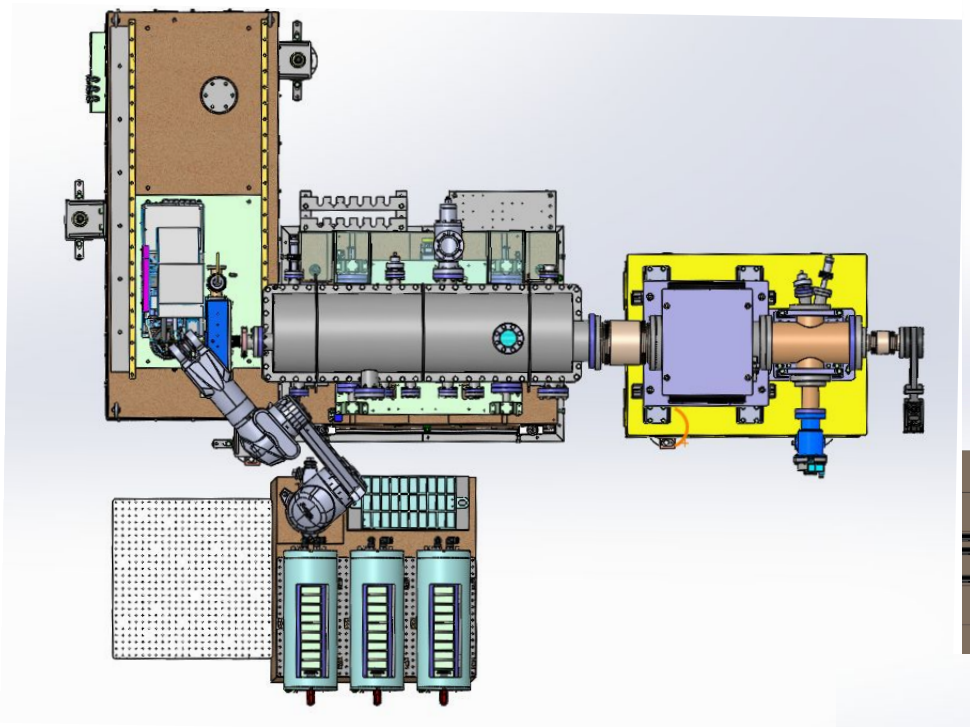
ESRF Electronic Unit
EMBL Instrumentation Team

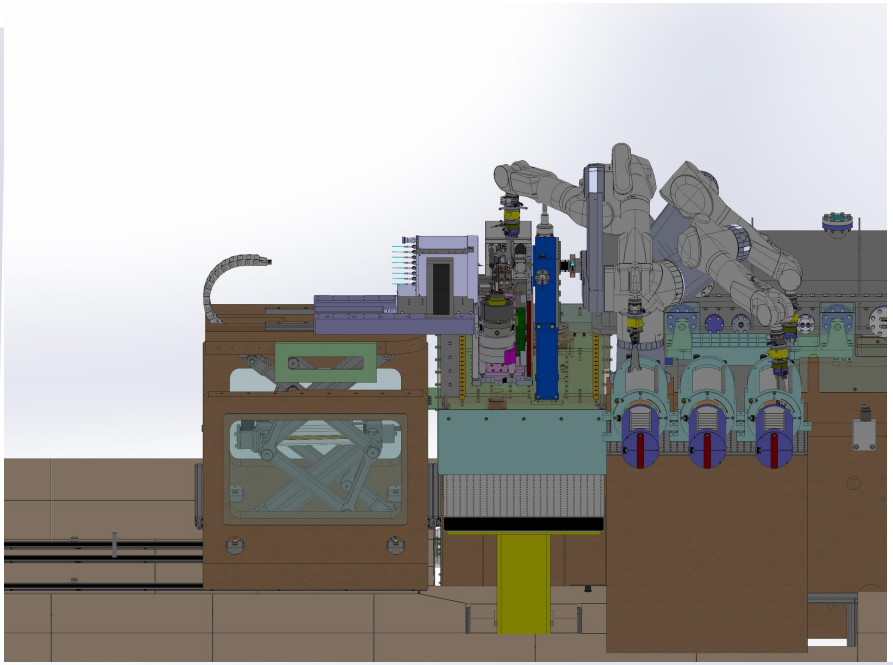
The European Synchrotron | ESRF

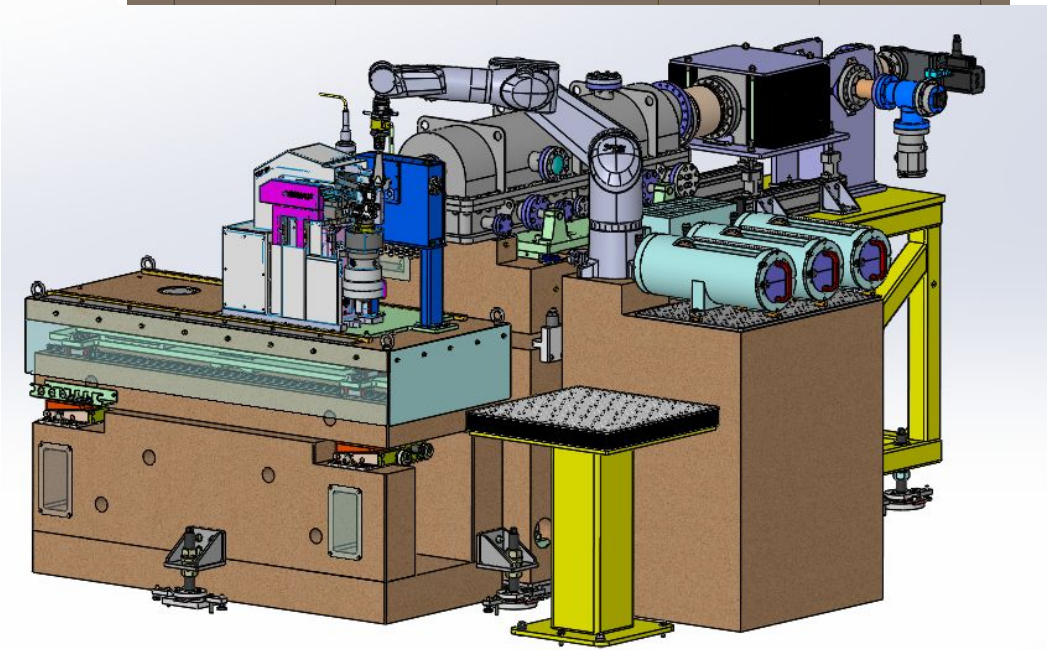












ACKNOWLEDGEMENTS

ESRF Structural Biology Group
Jean Susini
Gordon Leonard
Hugo Caserotto
Fabien Dobias
David Flot
Jonathan Gigmes
Thierry Giraud
Antoine Royant
John Surr

ESRF Mechanical Engineering Group
Pascal Theveneau
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Daphne Lorphevre
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Jerome Kieffer
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Olof Svensson

ESRF Optics Group
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Amparo Vivo
Christian Morawe

ESRF Detector & Electronics Group
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Nicolas Janvier
Herve Gonzalez
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EMBL Synchrotron + Instrumentation Team
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Gergely Papp
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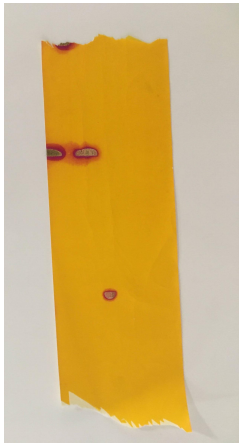

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