The CoSAXS Beamline at MAX IV:
A Small Angle X-Ray Scattering Beamline to Study Structure and Dynamics

SAS Sample Environment workshop, September 10-11th, 2015- Lund

MAX IV LABORATORY

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Aims

Take FULL Advantage

- **Unique source properties**
- **Strong and broad Scandinavian Users Community**

➔ State of the art multipurpose **SAXS** beamline with modular operation.

➔ Multiple techniques to be developed through the commissioning and consolidation phases

- SAXS - BioSAXS
- Microfocus SAXS
- SAXS/WAXS
- Anomalous X-ray Scattering techniques

➔ Possibilities for **Coherent** hard x-ray scattering experiments (XPCS priority).

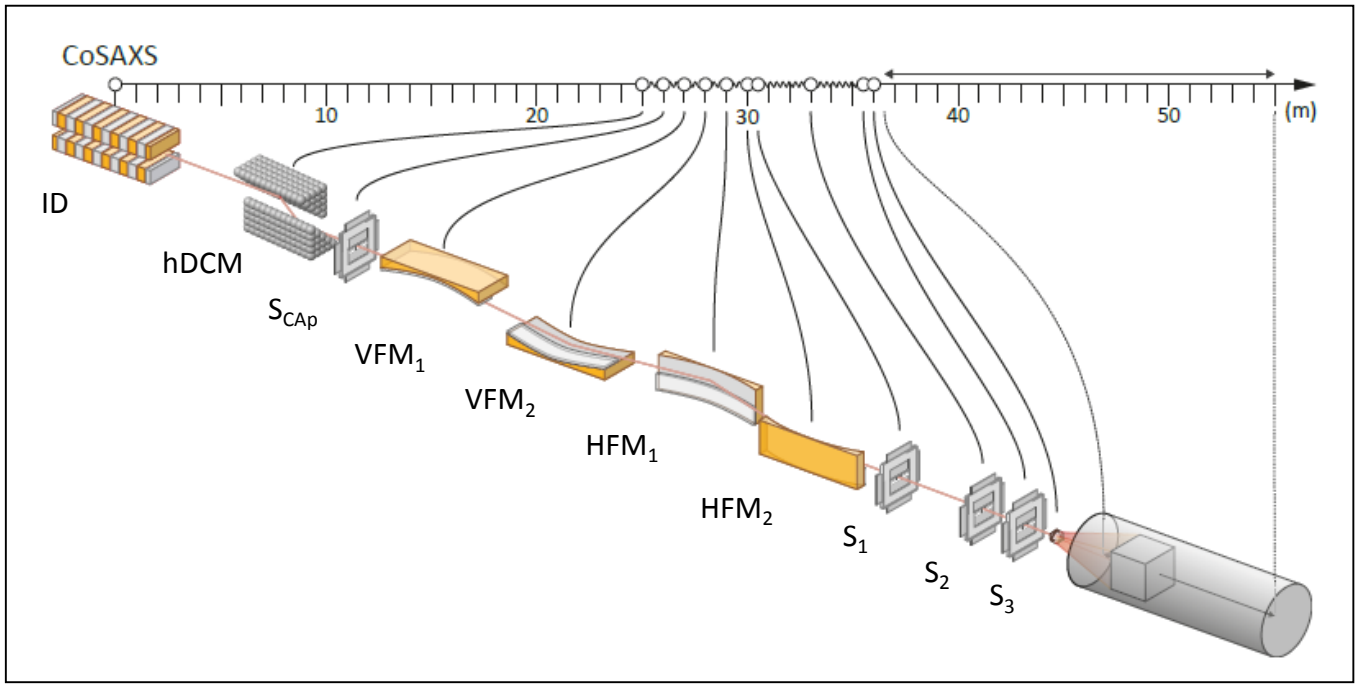
➔ Friendly users, Autumn 2017

➔ Regular users, 2018

Beamline Design targets

- Photon flux, 10^{12}-10^{13} ph/s, with variable and independent Horizontal and Vertical focalization.
- Scattering vector q-range: $6x10^{-4}$ – 6 $Å^{-1}$ at 12.4 keV with simultaneous 2D SAXS/WAXS detection.
- Energy range: 4 -20 keV and Energy resolution: $\Delta E/E$, 2×10^{-4}.
- Possibilities of spot sizes at the sample down to ~10 µm.
- Coherent photon flux of about 10^{12} ph/s with adjustable aperture collimation.

CoSAXS Beamline optics



X-ray source (IVU)	In-vacuum undulator (IVU), 1.85 cm period, 108 periods, 4.2 mm minimal gap, 2 m magnetic length
Monochromator (hDCM)	At 25 m, Si (111), double crystal monochromator, horizontally deflecting, inclined crystals . LN_2 side-cooling.
Focusing optics	Dual Kirkpatrick-Baez (KB) mirror pair (VFMs, HFMs) . 350-400 mm length each mirror
Vertical mirrors pair (VFMs)	At 27 and 28 m, bendable flat mirrors. VFMs can be retracted from the beam.
Horizontal mirrors pair (HFMs)	At 29 and 30 m, bendable flat mirrors.
Slits	3pairs collimation system
Flight tube/ Detection	18m flight tube. In vacuum 2D pixel detectors

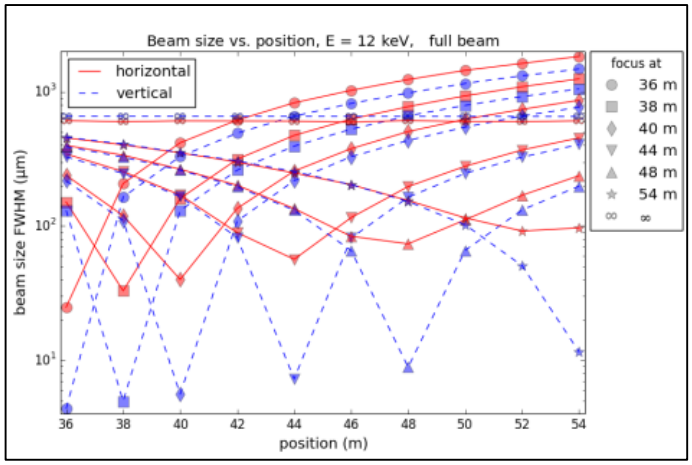
Expected Beam properties

Beam sizes at the sample and the detector, q_{min} and photon flux.

Beam stop size: 2 mm diameter

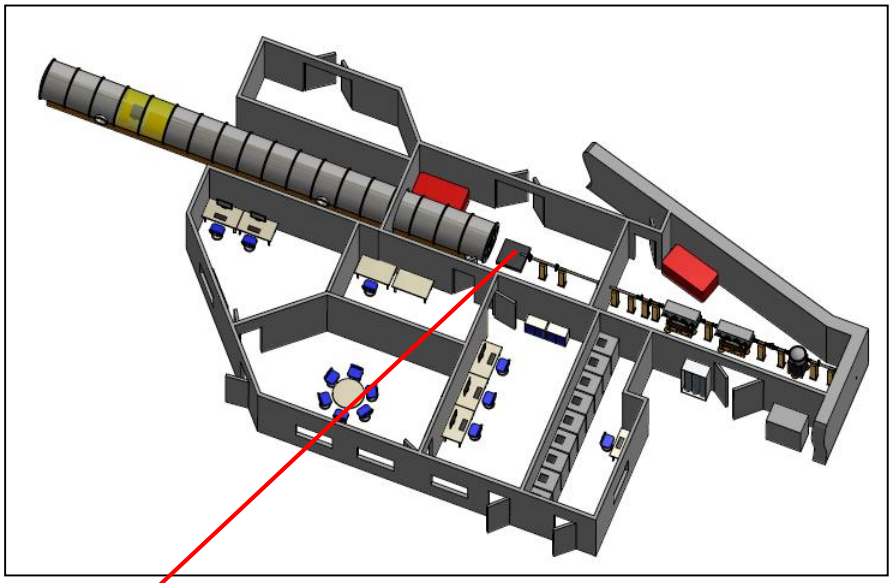
Case I-Focusing at the detector

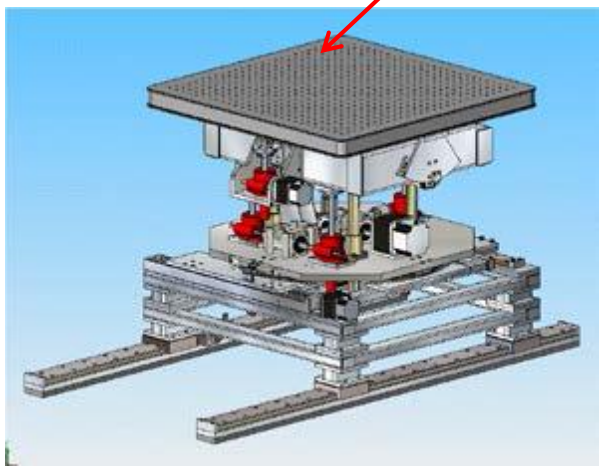
Energy (keV)	Sample-detector distance (m)	Focus at detector HxV (μm^2)	Beam size at sample HxV (μm^2)	q_{min} ($Å^{-1}$)	Photon Flux (ph/s)
12.4	2	33 x 5	151 x 130	3×10^{-3}	2.9×10^{13}
	6	47 x 6.2	108 x 118	1×10^{-3}	4.1×10^{12}
	12	67 x 9	75 x 64	5.2×10^{-4}	8.3×10^{11}
4	2	33 x 6.2	166 x 114	1×10^{-3}	1.6×10^{13}
	4	40 x 7.3	132 x 110	5.1×10^{-4}	3.8×10^{12}



Beam size at variable focalization as observed at positions between 36 and 54 m from the source.

End station: sample environments (under evaluation)

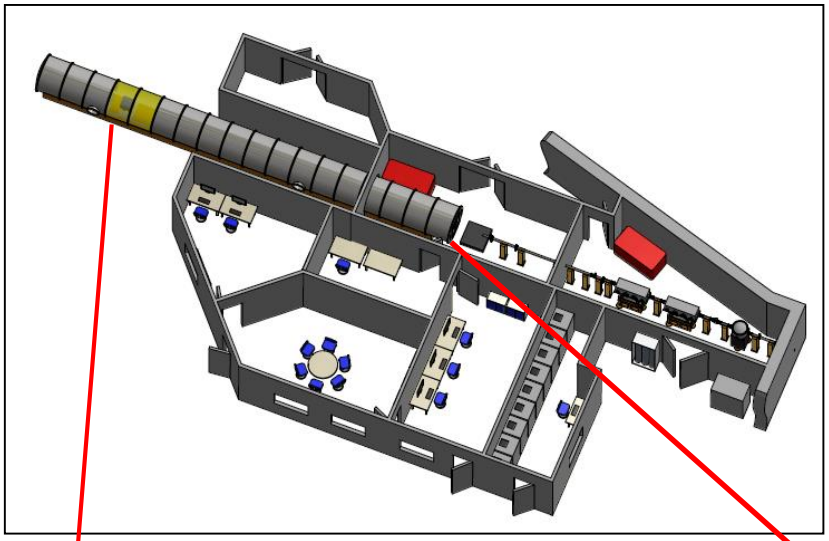




Sample-table: x-y-z, pitch, yaw
(I22@ Diamond sample table)

Travel range	200mm
pitch	±5°
yaw	±10°
Max dimensions	300^3 mm^3
Mounting area	750 x 750 mm
Weight	Up to 100 kg

End station: detectors (under evaluation)



Detector properties	SAXS	WAXS	XPCS
Active area (mm x mm)	160 x 160	~ 60 x 100	~ 50 x 50
Spatial resolution (FWHM, µm)	< 100	≤170	< 30
Dynamic range	$>10^5$	$>10^5$	$>10^4$
Noise	< single X photon	< single X photon	< single X photon
Frame rate [Hz]	>100	>100	>100
Integration time (read out,ms)	≤1	≤1	<1
Count rate (ph/s/pixel)	10^6	10^6	10^6

Ex: Eiger 4M (Dectris)

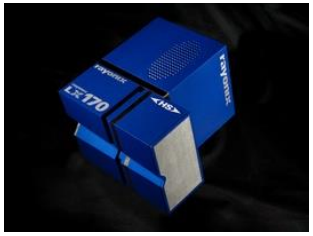
SAXS

- *2D Pixel detector*
- *In vacuum compatible*

WAXS

- *2D detector*
- *Direct beam through the detector*

L-2M , I22@Diamond



LX170 , ID02@ESRF

PI-LCX, P10@DESY

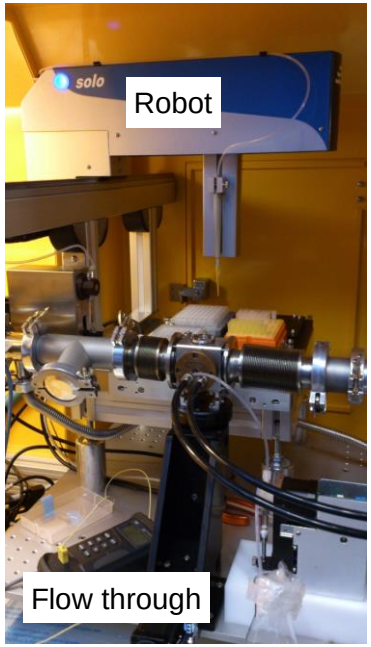
XPCS

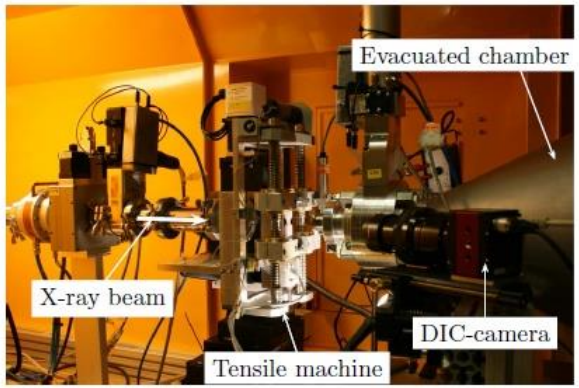
- *??*

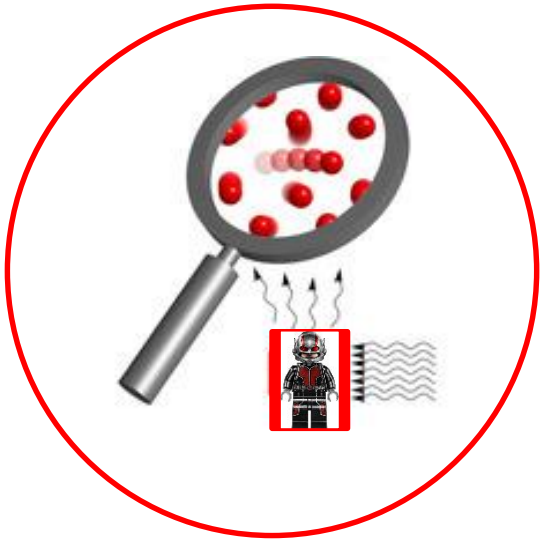
1 to 2 detectors in commissioning phase (2017-2018)

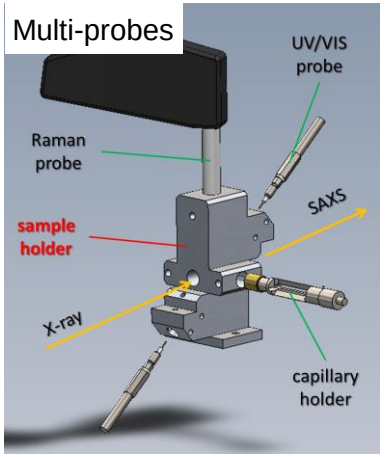
3 to 4 detectors in consolidation phase (2019-2020)

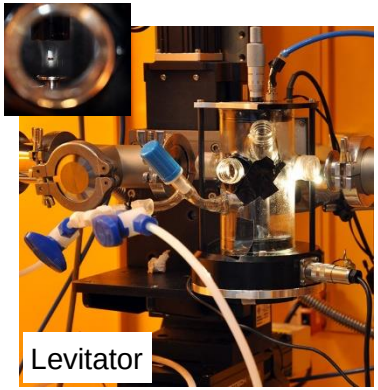
I911-SAXS Experience: commercial, in house or by the users

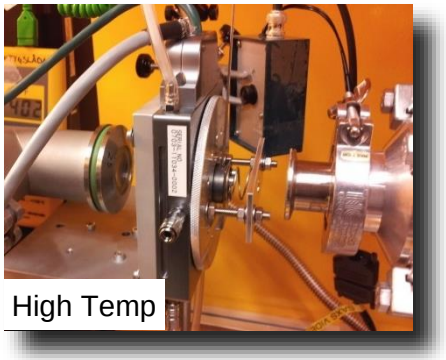












Everything works after some thoughts….

A **significant portfolio of sample environments** will be present at CoSAXS.

- Some dedicated set-ups will exist at CoSAXS based on *our current experience* in the past (in house development).
- New set-ups will be established in collaboration with the user community (*open discussion….*).

Rough timeplan → serial development

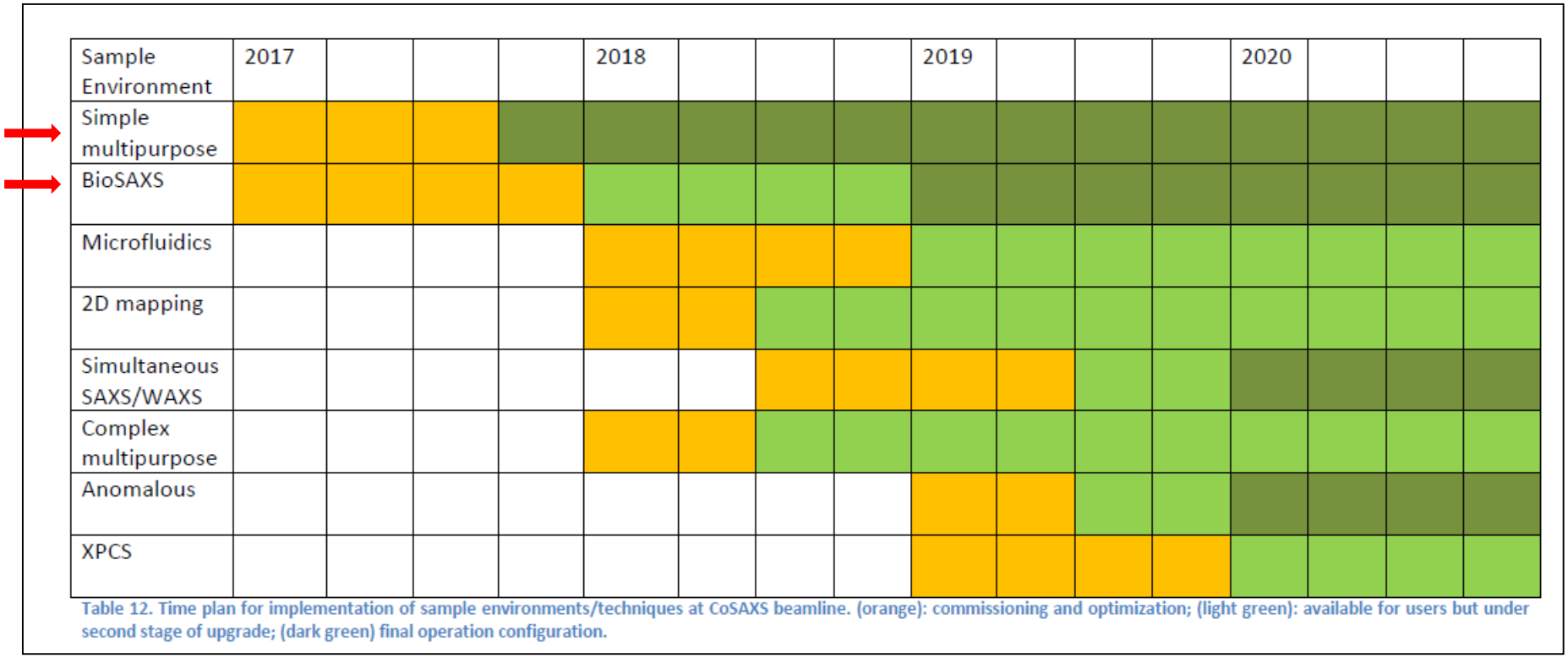


Table 12. Time plan for implementation of sample environments/techniques at CoSAXS beamline. (orange): commissioning and optimization; (light green): available for users but under second stage of upgrade; (dark green) final operation configuration.

“Working team”

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