

European Synchrotron Radiation Facility

The Upgrade of the ESRF PHASE I



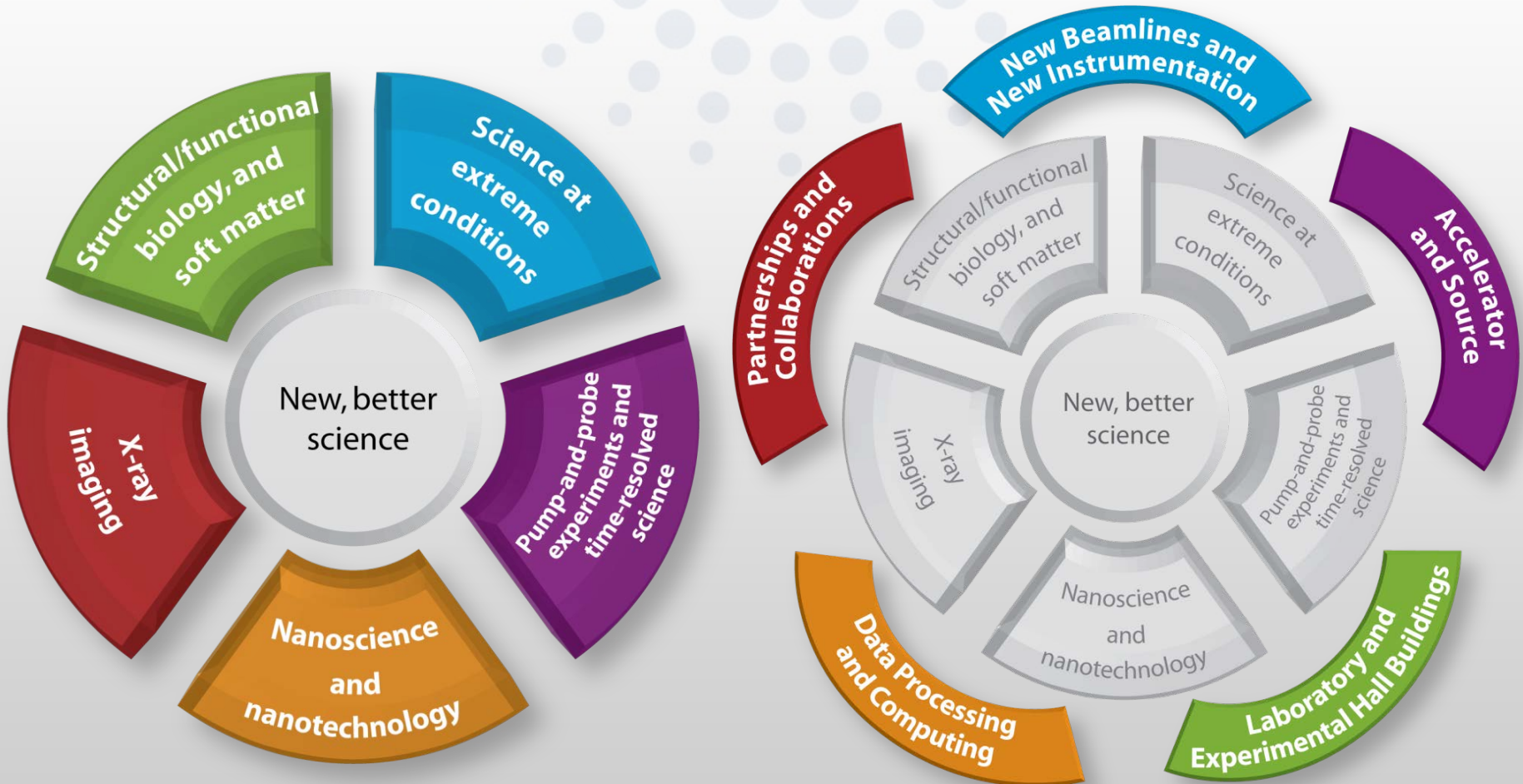
ESRF Upgrade Programme

Purple Book (September 2007)

Key Objectives & Deliverables

- *Eighteen new and upgraded experimental stations (beamlines)*
- *Delivery of enabling technologies*
- *Enhancement of the X-ray source*
- *Construction of 21,000 m² of additional space.*
- *Development of collaborations and partnerships with academia, other synchrotrons, and industry*

Science drivers of the Upgrade Programme of the ESRF



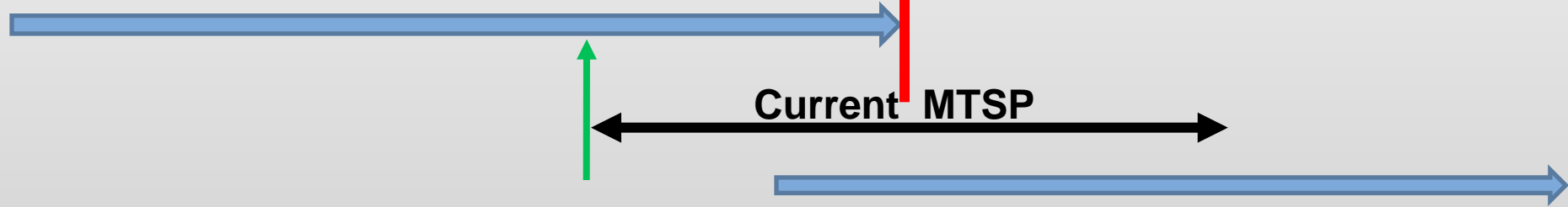
ESRF Upgrade Programme Phase I and Phase II

Phase I

19 upgraded or refurbished BLs
Accelerator and source upgrade
Construction programme

2009

2015



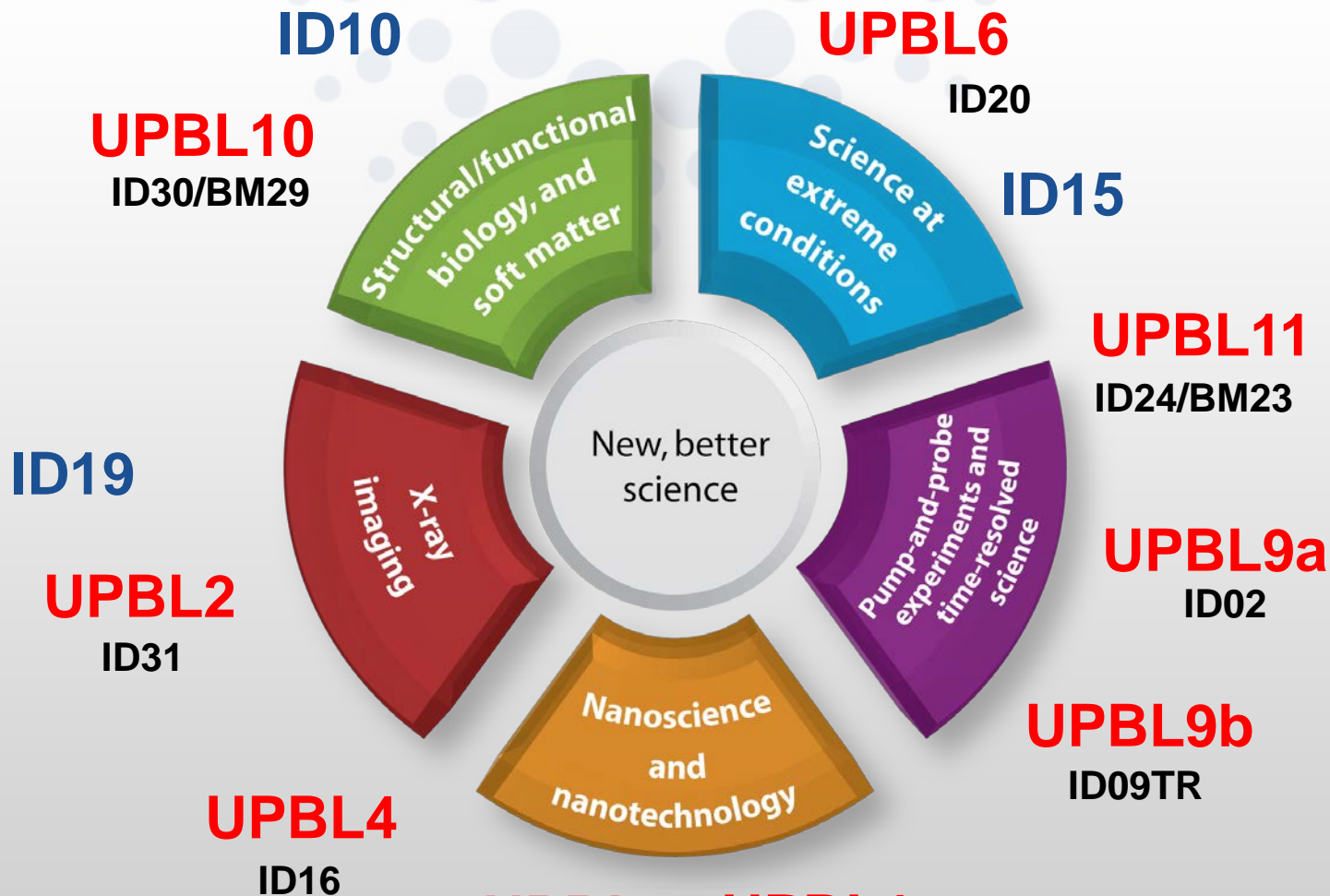
Current MTSP

2015

2020

Phase II

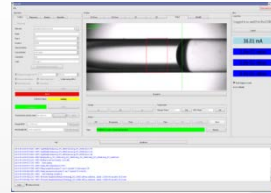
New storage ring
4 new BLs
Enabling technology



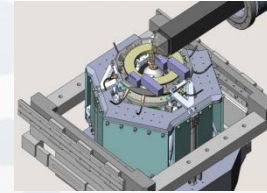
ID09A → ID15B
High pressure

ID31 → ID22
Powder diffraction

Beamline Control & Data Analysis

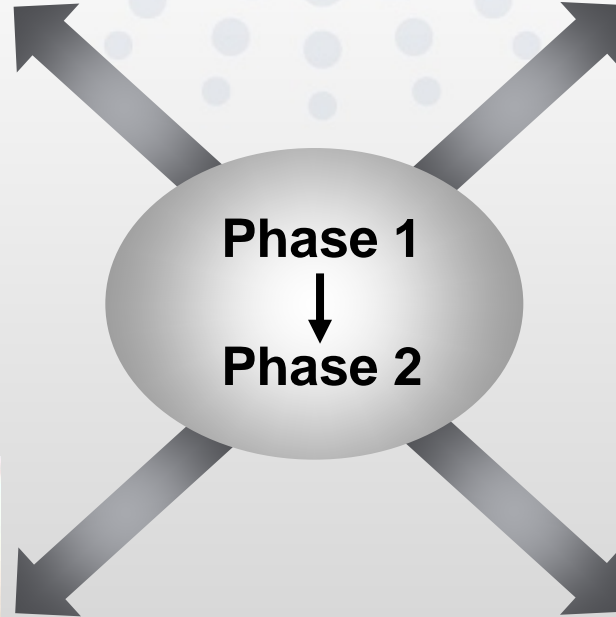


- Modernization of the BL control (long shut-down)
- On-line data Analysis
- Computing infrastructure



High Precision Engineering

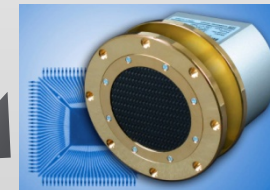
- Consolidation and further developments of expertise in Mechatronics
 - Advanced modeling tools
 - Advanced control methods
 - in-situ metrology



X-Ray Optics








- Preservation of the transverse beam coherence
 - Manufacturing methods
 - New optical metrology tools
 - New simulation tools



X-Ray Detectors

- 2D Detectors combining temporal and spatial resolution
 - Silicon hybrid pixel detectors
 - CMOS Monolithic Active Pixels Sensors (MAPS)

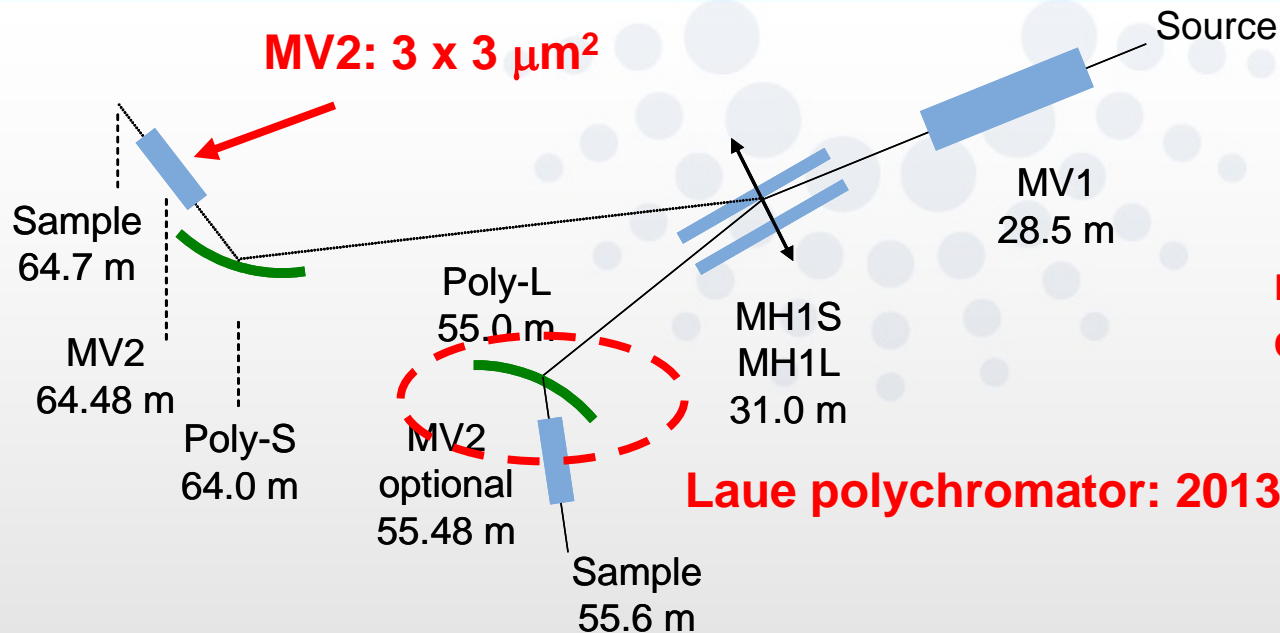
UPBL	Old Sector	New Sector	Application
UPBL1	ID01	ID01	Diffraction for Nano-Analysis 
UPBL2	ID15	ID31	High Energies for interfaces and materials processing
UPBL4	ID22	ID16	Nano-Imaging and Nano-Analysis 
UPBL6	ID16	ID20	Inelastic X-ray Scattering
UPBL7	ID08	ID32	Soft X-rays/nano-magnetic & electronic spectrosc. 
UPBL9a	ID02	ID02	Time-resolved ultra small angle scattering 
UPBL9b	ID09TR	ID09	Pump-probe and time-resolved experiments
UPBL10	ID14	ID30	Massively Automated Sample Selection Integrated Facility 
UPBL11	ID24/BM29	ID24/BM23	Time-resolved and Extreme conditions XAS

+ 2 moving BLs (ID15 complex & ID31) + 2 refurbished BLs (ID10 & ID19)

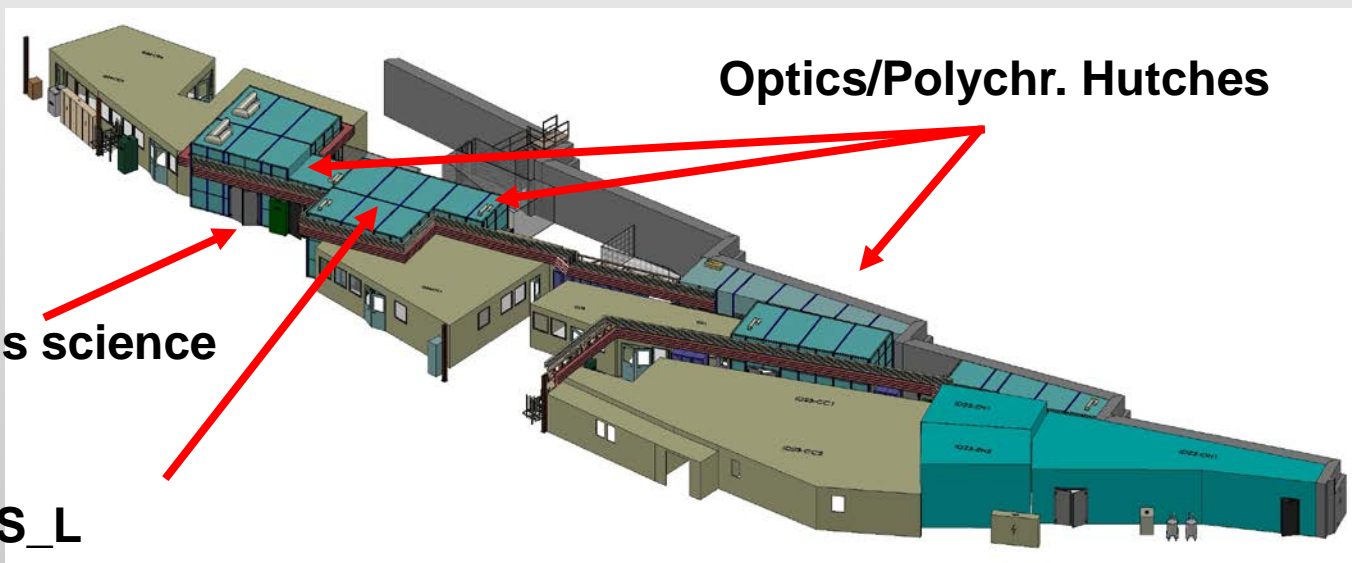
UPBL11 – ID24

Time-resolved and Extreme Conditions XAS





**new XH Ge strip detector
delivery summer 2013**



EDXAS_S
small beam for
extreme conditions science

EDXAS_L
large beam for chemistry program

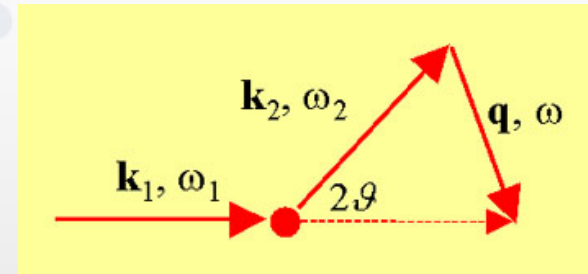
UPBL6 – ID20

Inelastic Scattering



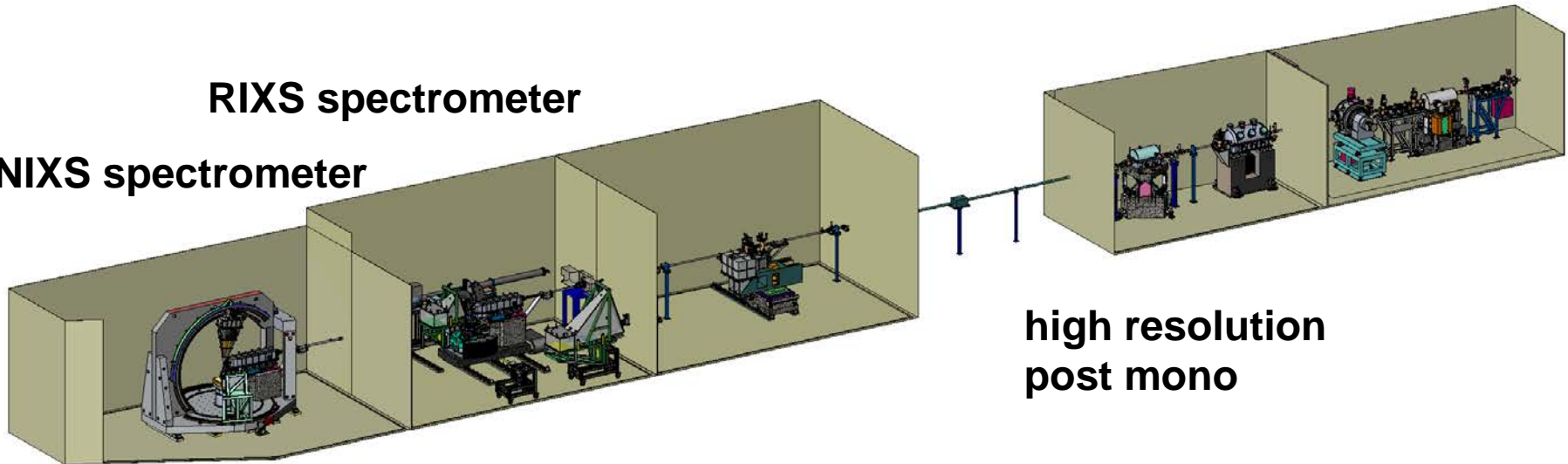
Key Parameters

- ENERGY RANGE : 5 – 20 KeV
- ENERGY RESOLUTION : 1eV to **25 meV**
- FOCAL SPOT SIZE : 8 x 16 μm^2 (VxH FWHM)
- MAXIMISE FLUX AT SAMPLE : use all the beam
- 2 ENDSTATIONS
 - -RIXS (Resonant Inelastic Xray Scattering)
 - -XRS (Xray Raman Spectroscopy)



RIXS spectrometer: target energy resolution reached

RIXS spectrometer
NIXS spectrometer



**high resolution
post mono**

UPBL4 – ID16

Nano-imaging & Nano-analysis



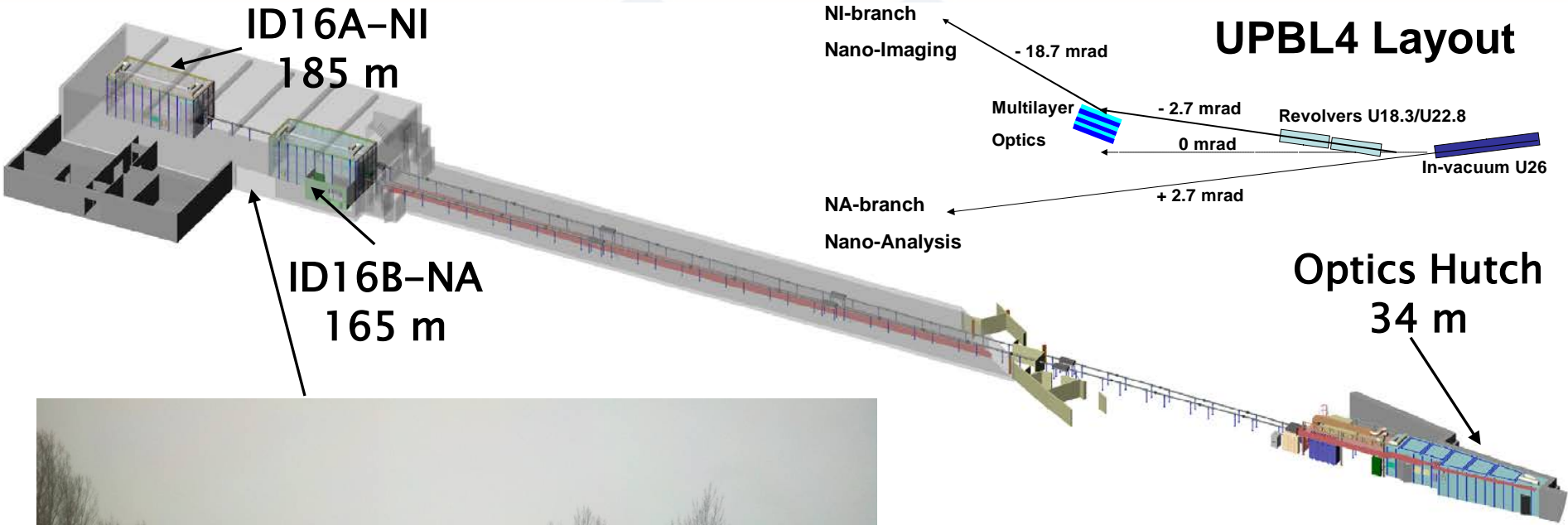
UPBL4 NINA on ID16

UPBL4 is a long, canted, high- β beamline with 2 branches:

- **NI**: ultimate pink beam focus for imaging and XRF
- **NA**: nanofocus monochromatic beam for spectroscopy

X-ray ultra-microscopy and nano-spectroscopy

	NI	NA
Length	185 meters	165 meters
Spatial Res.	10 → 100 nm	50 nm - 1 μ m
DE/E (%)	1	0.01
Energy range	Discrete 11 – 17 – 33 keV	Scanning 5 → 70 keV
Main goals	XRF, coherent XRI-2D/3D Cryo environment	XAS, XRD, XRF, XRI-2D/3D <i>in-situ</i> experiments
Main fields	Biology & Life Sciences Nanotechnology & Nanomedicine	Biology, environmental sciences, geoscience, materials sciences, ...



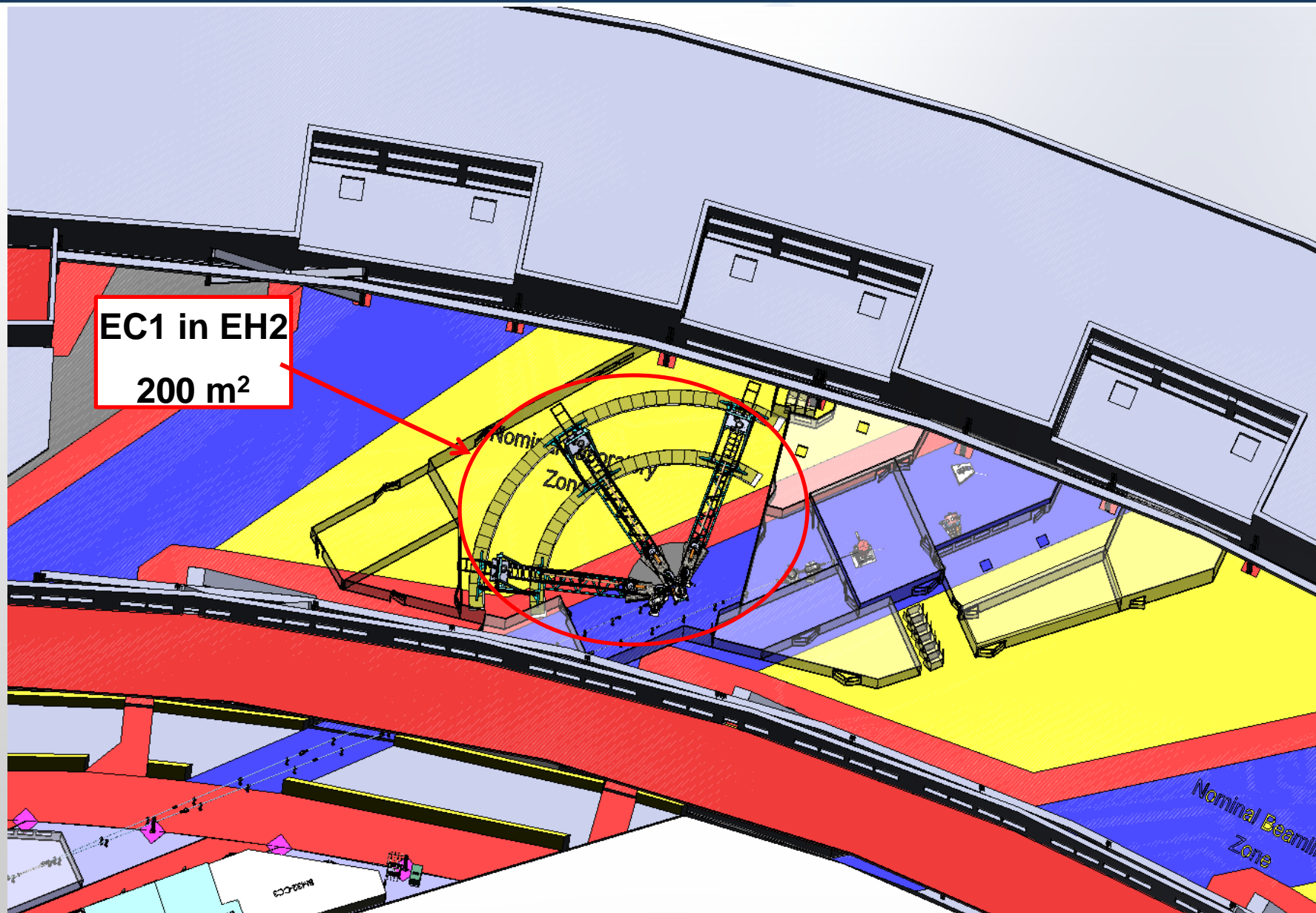
ID16 Satellite Building

UPBL7 – ID32

Soft X-rays: Nano-magnetism & Spectroscopy

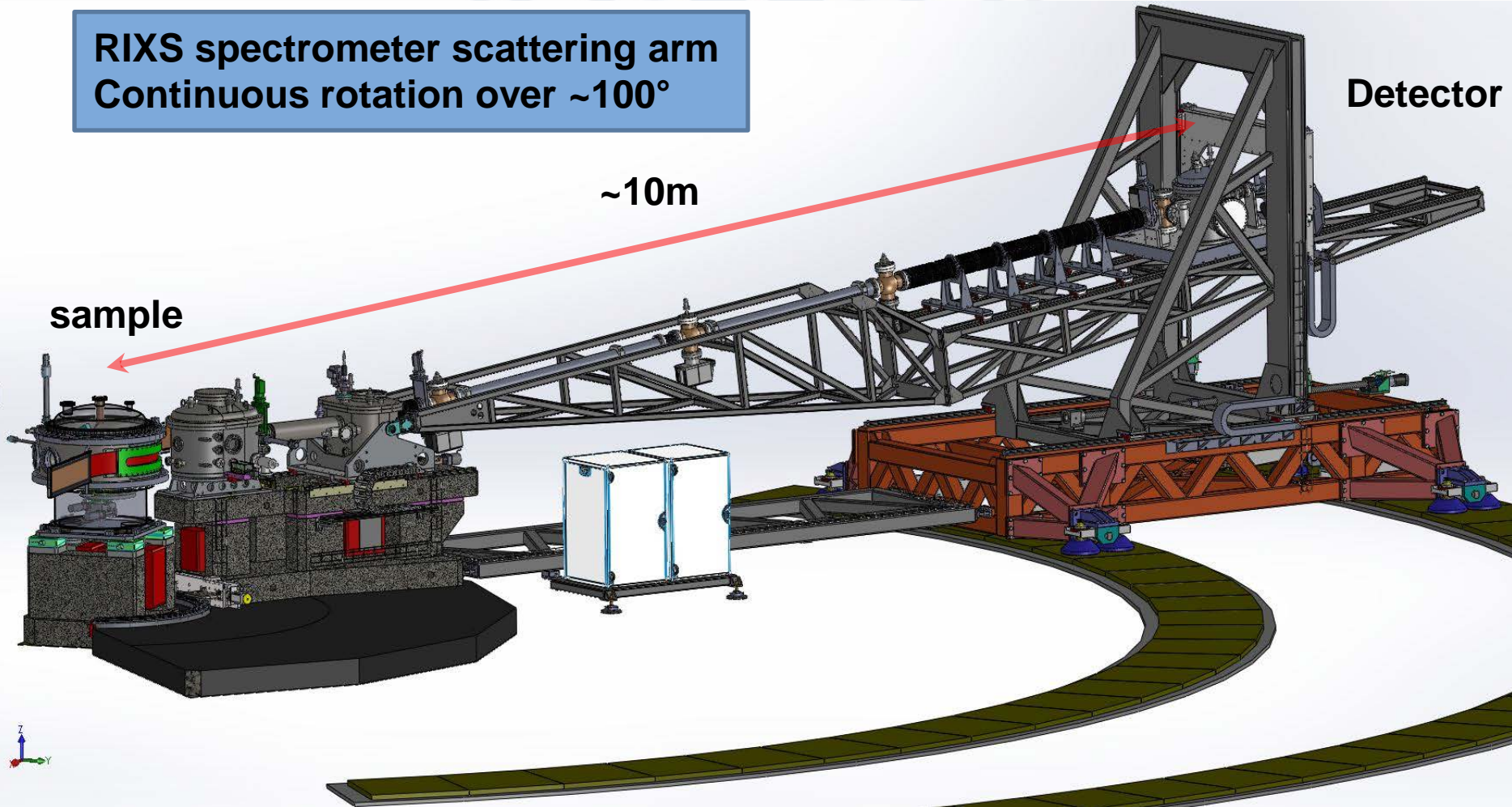
**soft X-ray beamline (300 to 2500 eV) - 2 end stations (RIXS and XMCD)
RIXS spectrometer designed for high energy resolution (25 meV - 900 eV)**



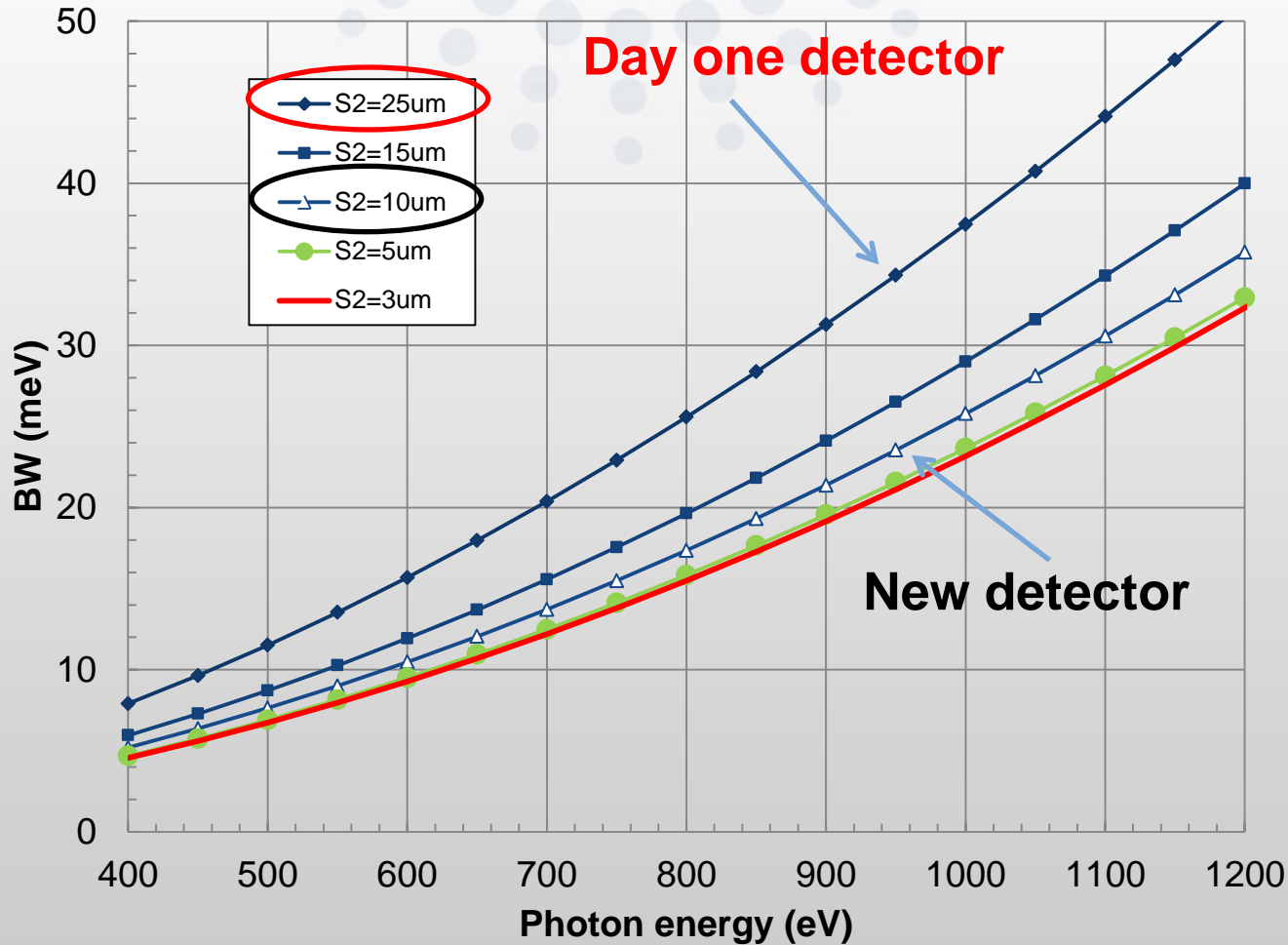


Target combined resolving power ~ 30000 @ Cu L edge = $\sim 35\text{meV}$

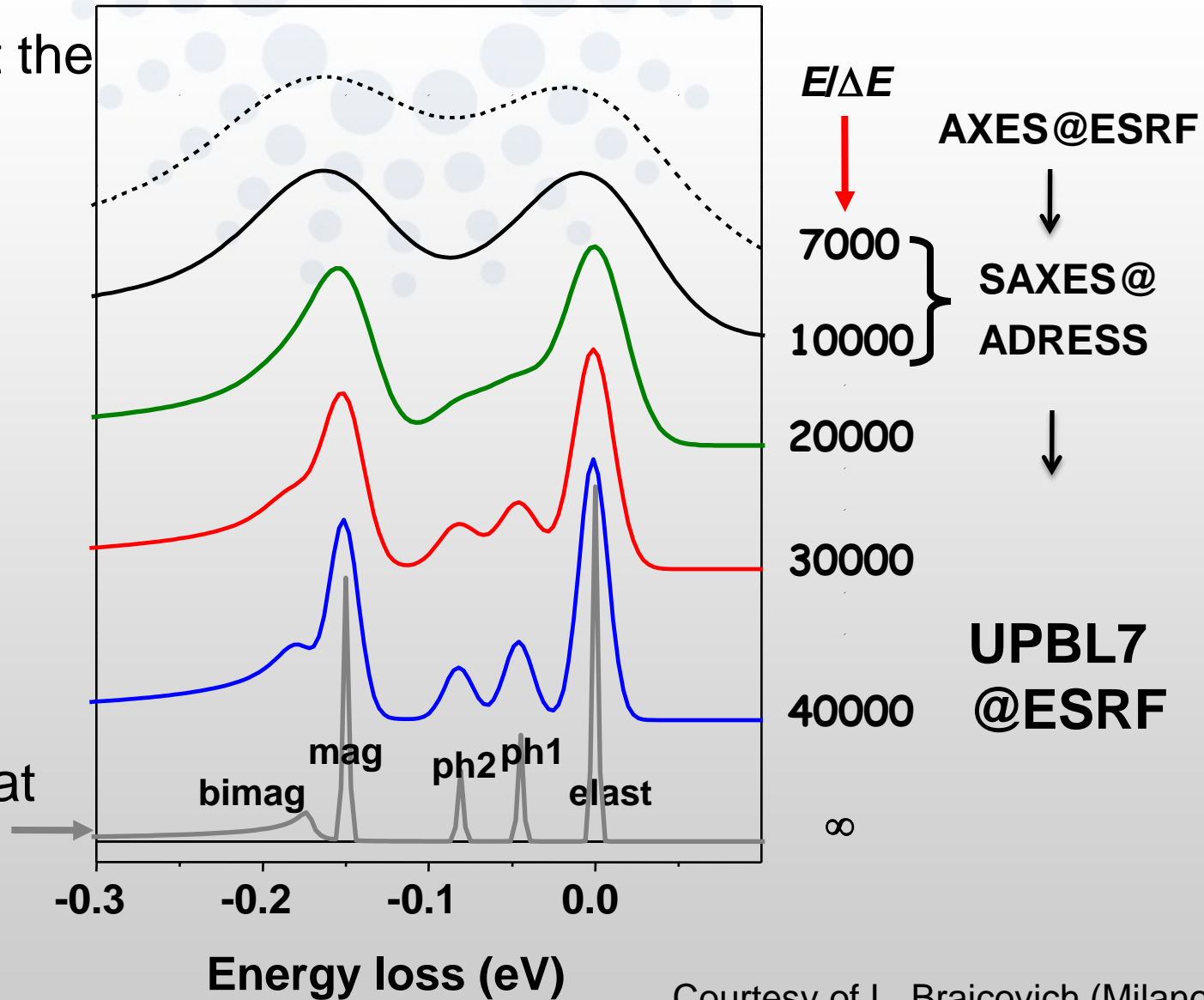
RIXS spectrometer scattering arm
Continuous rotation over $\sim 100^\circ$



High resolution grating 2500 l/mm, total energy BW of the spectrometer vs. actual spatial resolution of the detector at 20deg incidence from CCD surface.



The best data at the SLS today are performed with $E/\Delta E = \sim 8000$



“Ideal” spectrum at Cu L_3

Courtesy of L. Braicovich (Milano)



Off-line commissioning on ID08

- UHV (10^{-10} mbar)
- SC magnet
- cold bore
- split coil
- 450-3K sample T
- 9T along beam (8T/min sweep rate)
- 4T perp. To beam (2T/min sweep rate)

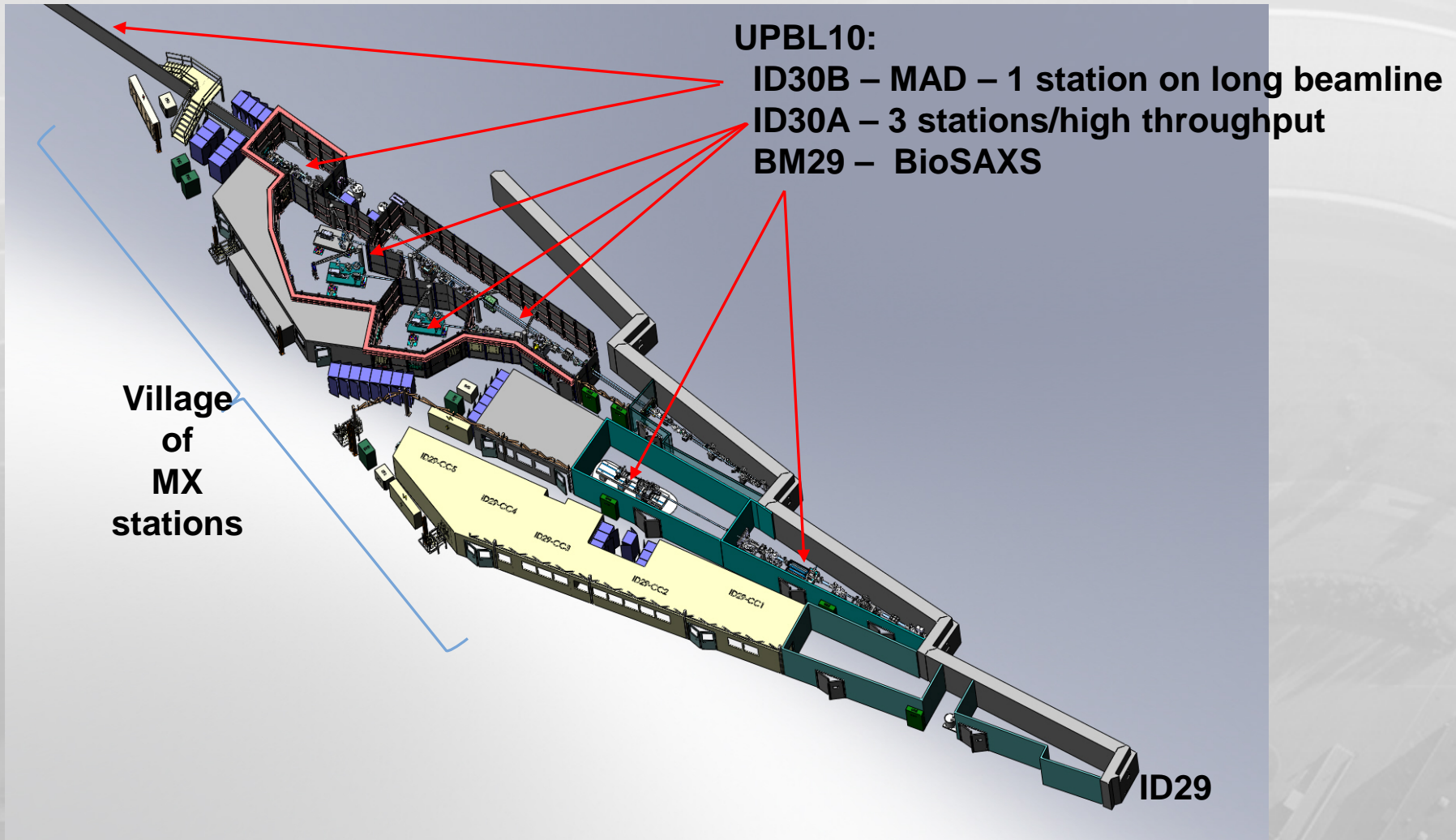
**All specifications have
been reached**

UPBL10 – ID30

MASSIF (Structural Biology)



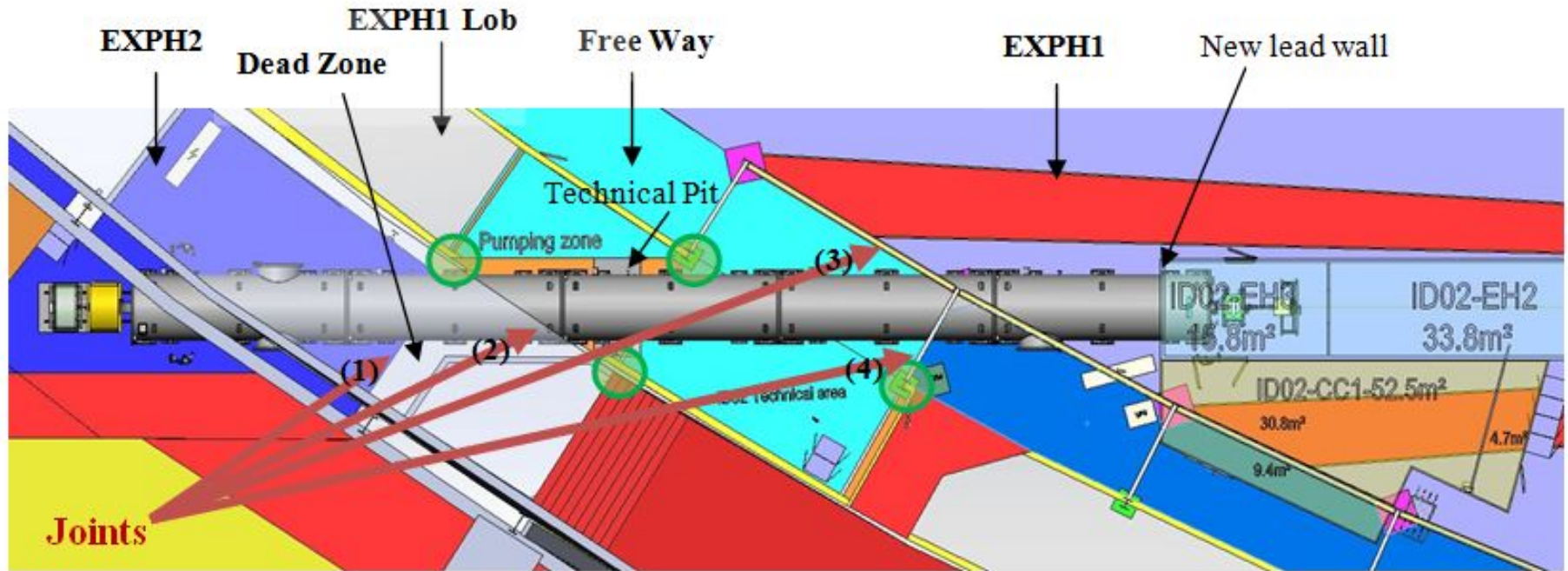
Infrastructure finished – progressive commissioning of new endstations



UPBL9a – ID02

Time-resolved ultra small angle scattering



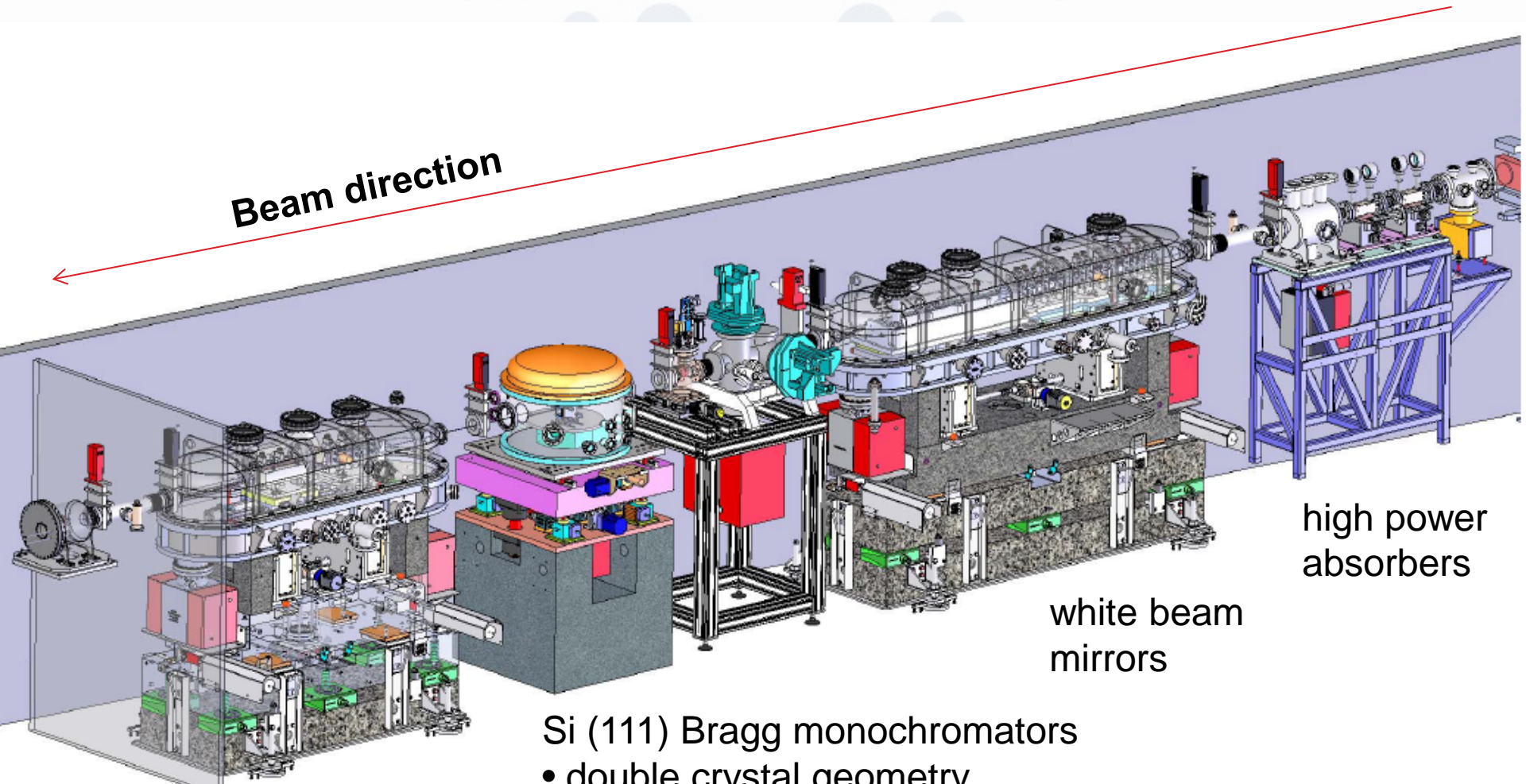


32 m long vacuum tube with 2 m diameter
In-vacuum detector wagon with a selection of 3 2D-detectors

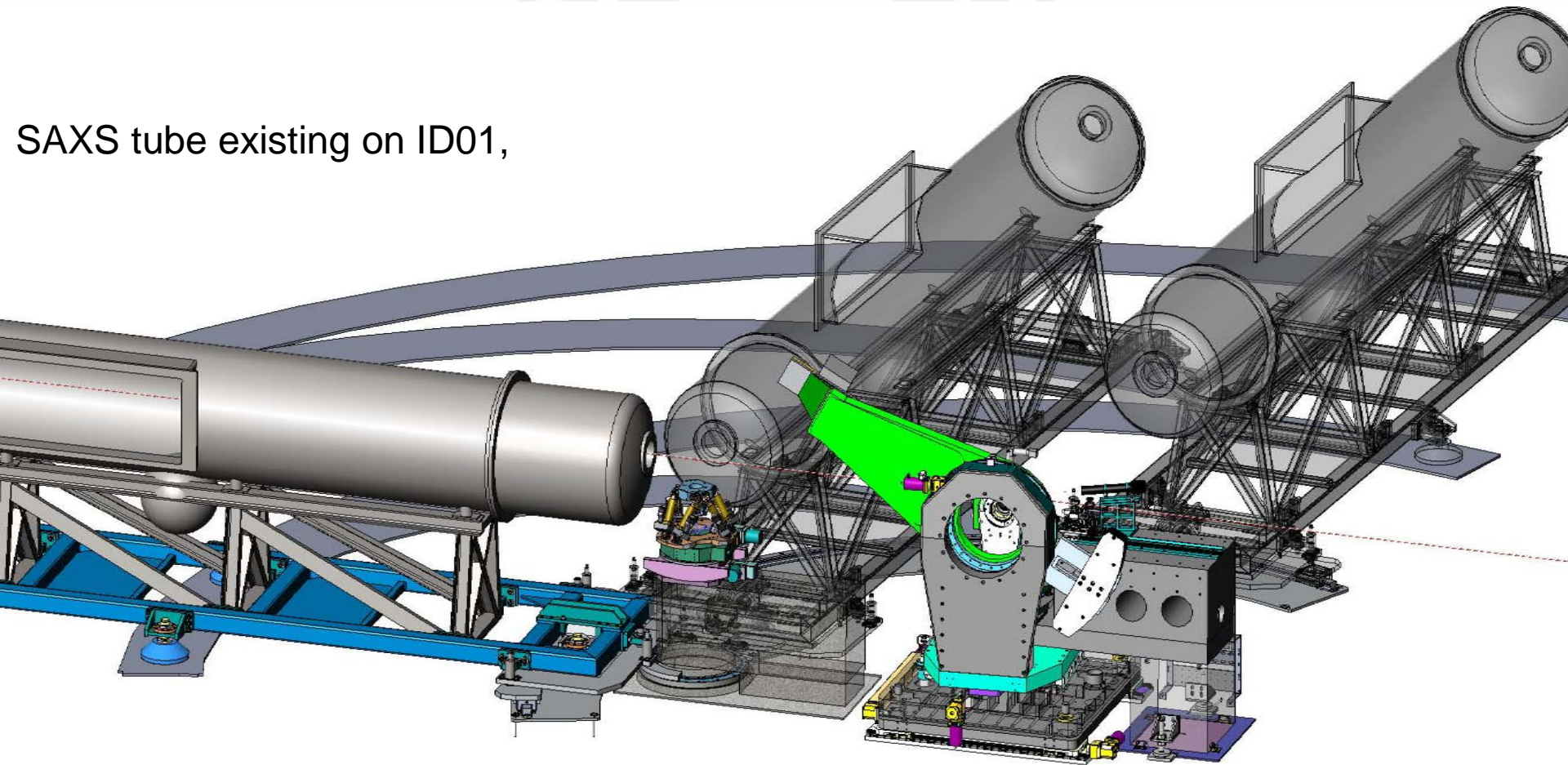
UPBL1 – ID01

Diffraction imaging for nano-analysis





- double crystal geometry
- channel cut geometry

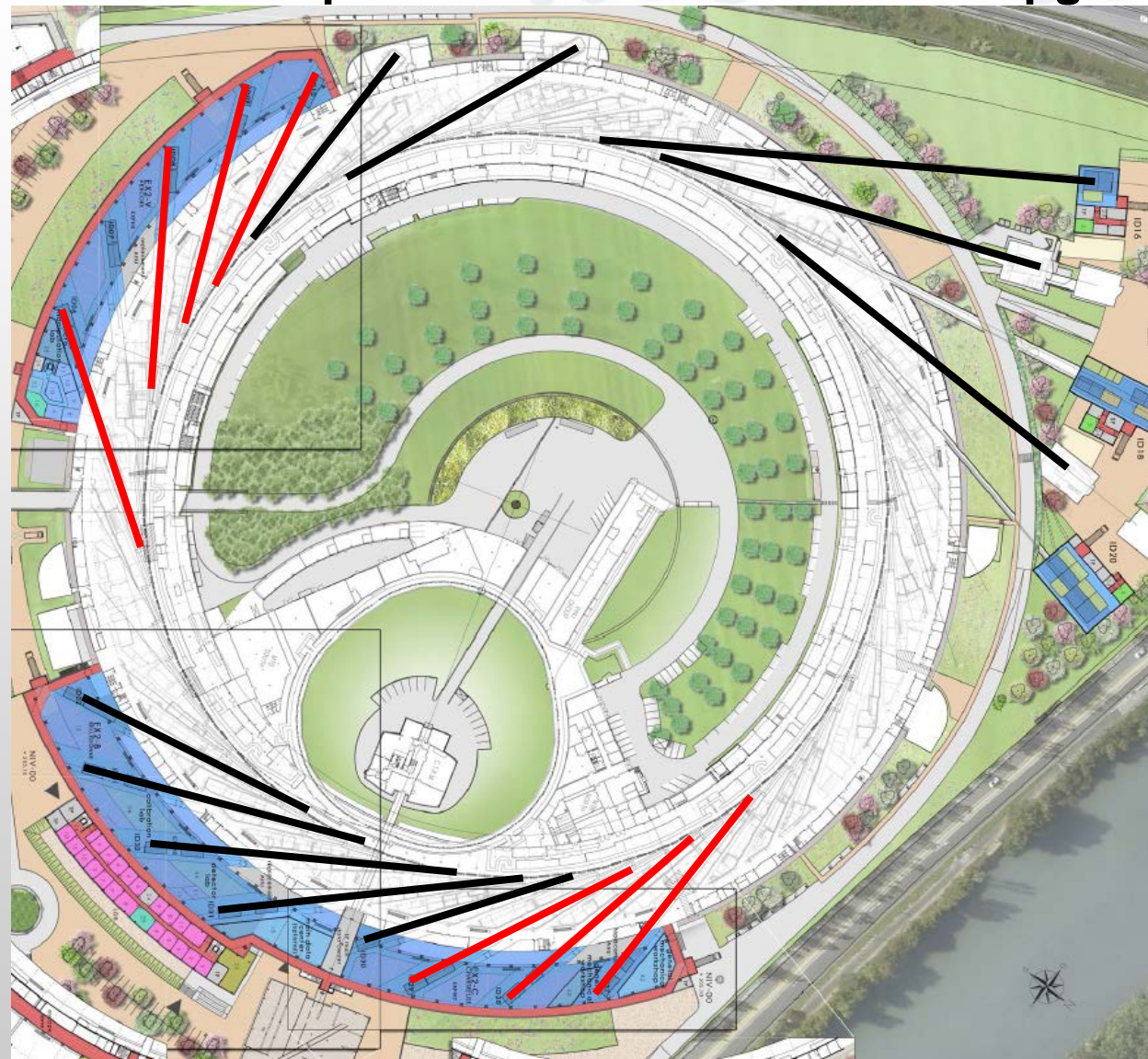


SAXS tube existing on ID01,

SAXS/ GISAXS/ GID/ μ -diff stage,

Nano-diffractometer ,
 CDI, Diffraction, Grazing incidence with
 high precision sample positioning

New floor space – to be filled within the Upgrade Programme Phase II



Existing satellites:

ID11

ID13

ID16

ID17

ID19

Hall extension (EX2):

ID27 – ID02

New Hall extension:

ID06 – ID10

New long beamlines:

ID27 – ID29 (existing)