European Synchrotron Radiation Facility

The ESRF Upgrade Programme
&
Opportunities for Industry

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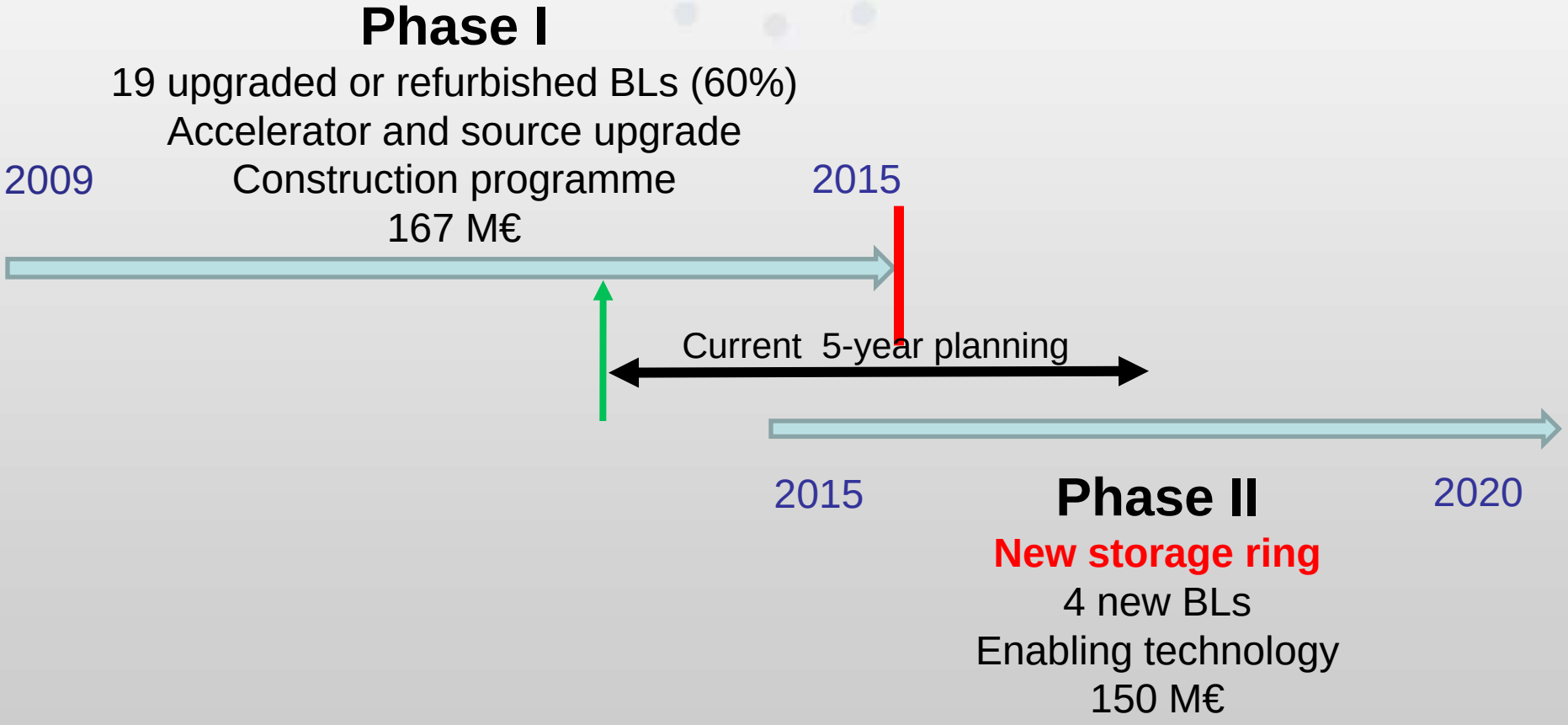
ESRF Upgrade Programme
Purple Book (September 2007)

Key Objectives & Deliverables

- *Eighteen new and upgraded experimental stations (beamlines)*
- *Delivery of enabling technologies*
- *Enhancement of the X-ray source*
- *Construction of 21,000 m^2 of additional space*.
- *Development of collaborations and partnerships with academia, other synchrotrons, and industry*

ESRF Upgrade Programme
Phase I and Phase II (not yet approved)



Upgrade Phase I: 2009-2015
Status

Science drivers of the Upgrade Programme of the ESRF

Accelerator and Source **Phase I**

- SSAs installed for booster; in preparation for SR
- new RF cavities with higher order mode dampers
- introduction of top-up operation in 2013
- 6 and 7 meter straight sections
- new beam position monitoring: Fast Orbit Feedback (FOFB)

New beamlines and new instrumentation

- delivery of 19 upgraded or refurbished beamlines by 2015

Buildings

- delivery of EX2 and LOB in 2013; Science Building in 2013

Data processing and computing

- new data center; continued investment in computing infrastructure

Partnerships and Collaborations

- start of PSCM in 2013 (Science Building)

ESRF
Upgrade Programme

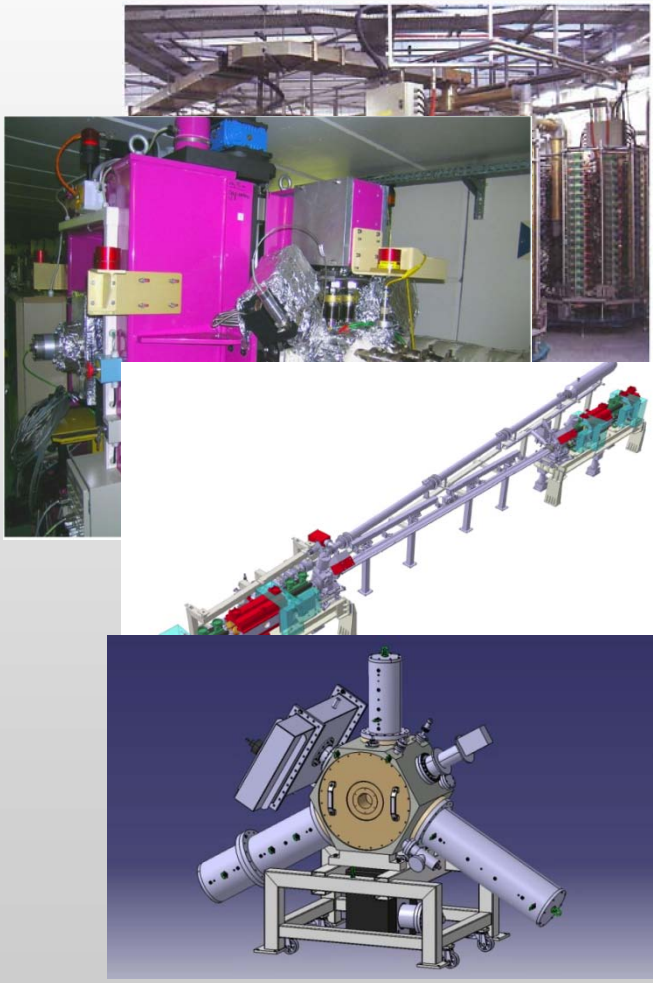
Preparing the Future

Increased Brightness and Improved Stability and Reliability

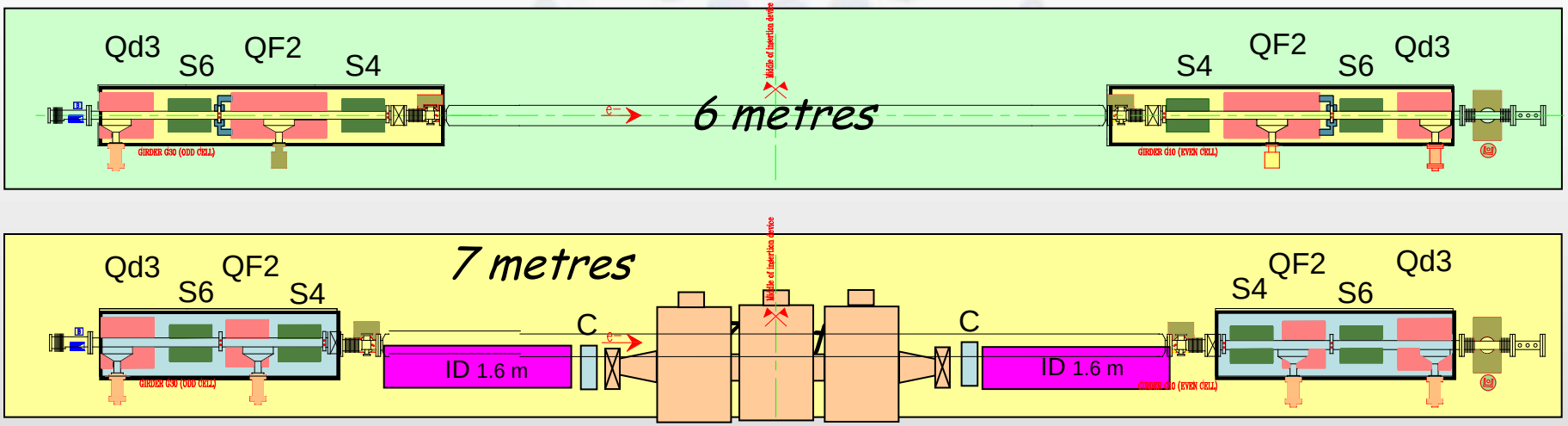
- Solid State Amplifiers based RF Power System
- New Beam Position Monitoring System
- New Cryogenic Undulators

- New 6m ID Vacuum Chambers
- New HOM Damped RF Cavities – Prototypes installed

- Topping-up Capabilities and 300 mA Operation Under Testing and Study
- Canting Options and 7m ID Vacuum Chambers installed



7 m ID straight Sections (end of 2012)

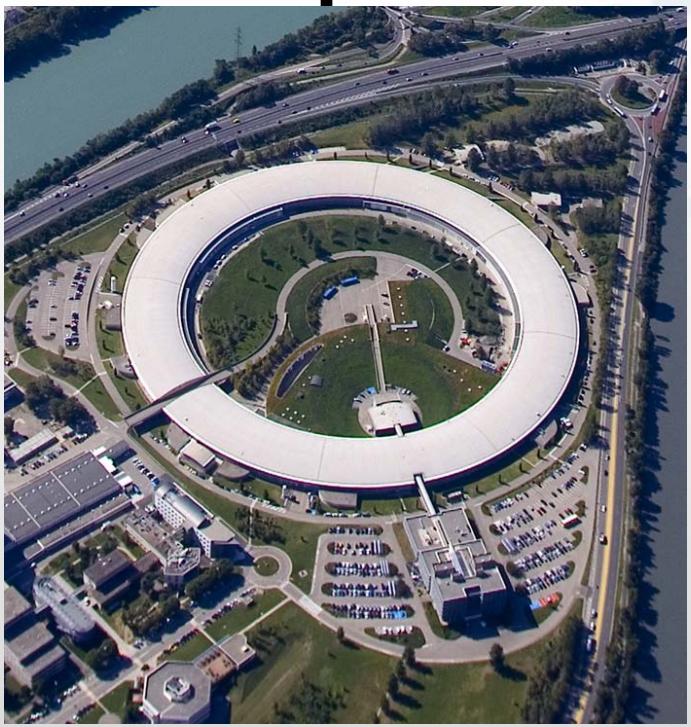


- New girders
- New quadrupoles
- Individual power supplies
- New vacuum chambers
- 1st symmetry breaking

Goal:

- Test low-β_y optics
- Redistribute RF cavities to gain useful straight sections

Experimental Hall Extension (EX2)

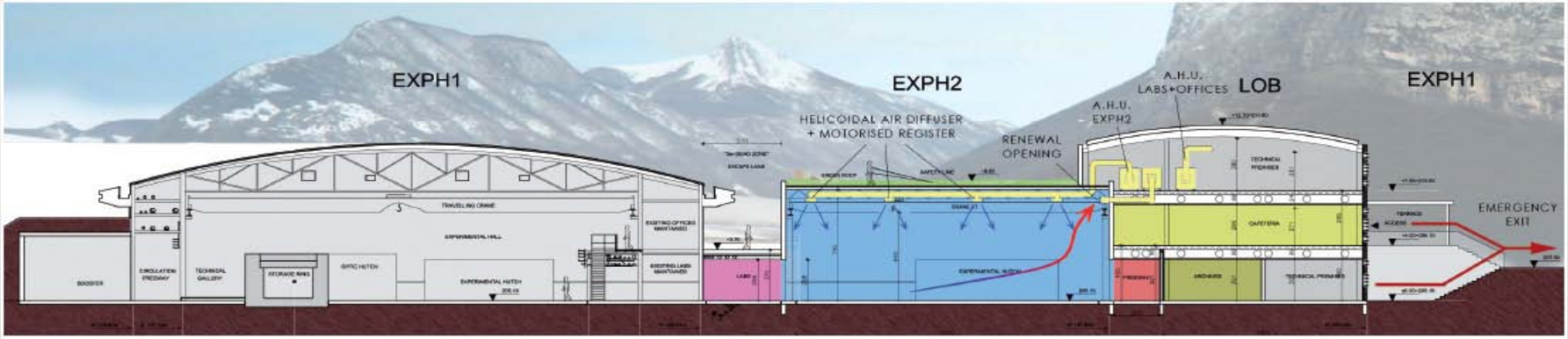


Status February 2013:

- Delivery of satellite building: 10/2012
- Delivery of 1st Hall Extensions & LOB: 6/2013
- Delivery of Science Building: 9/2013
- Start planning for 2nd Hall Extension

MAJOR TECHNICAL CHALLENGES:

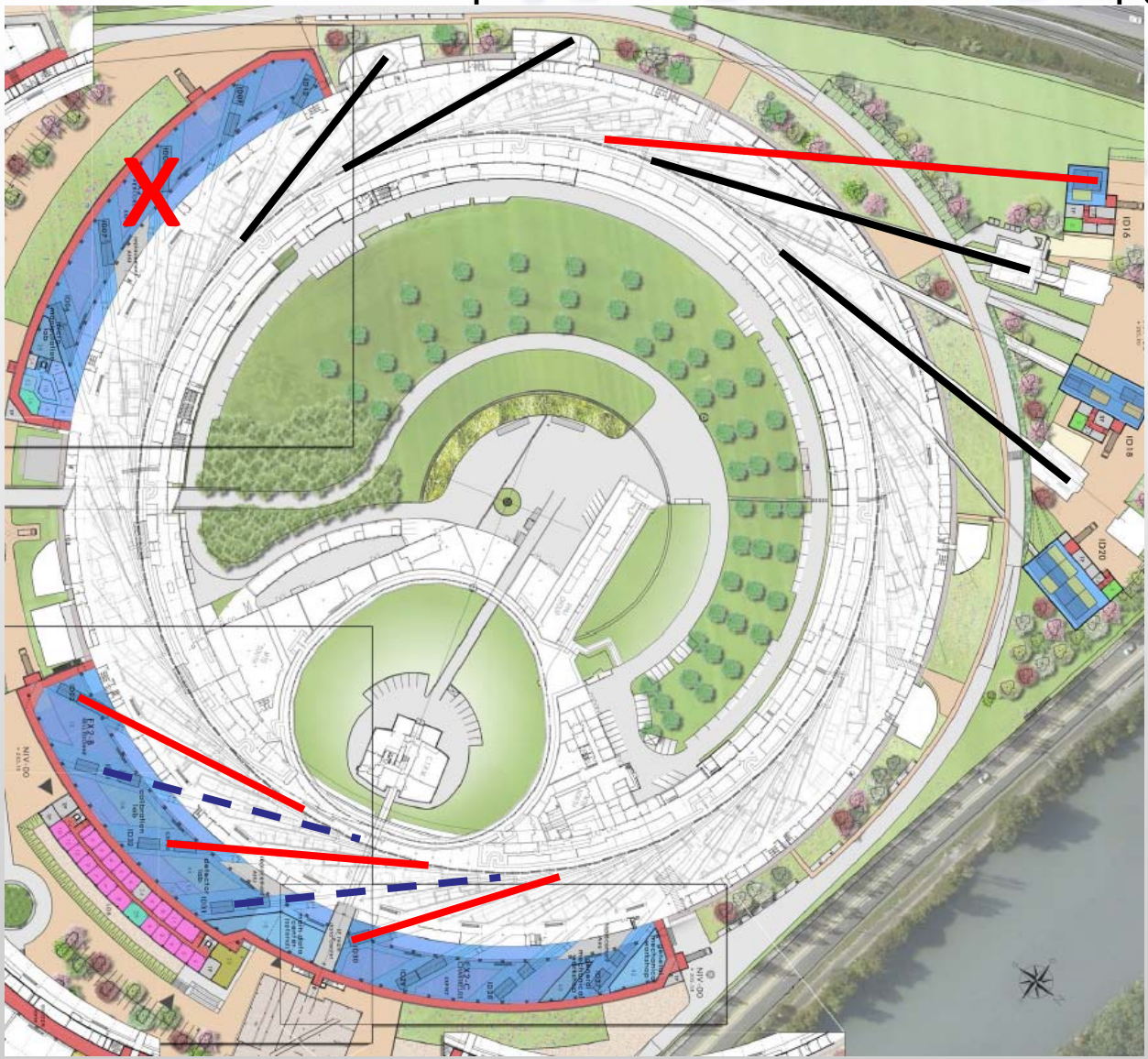
- **Slab design:** Low-level of vibrations
- **T stability:** ±.5°C in the Hall to reach better than ± 0.1°C at the sample.



SOME FIGURES:

- ~7,500m² of high quality slab
- 13 beamlines at 110m/120m.
- ~4,000m² of labs, offices, multi-purpose areas…
- Satellite building for 200m long beamline

New floor space – to be filled within the upgrade programme

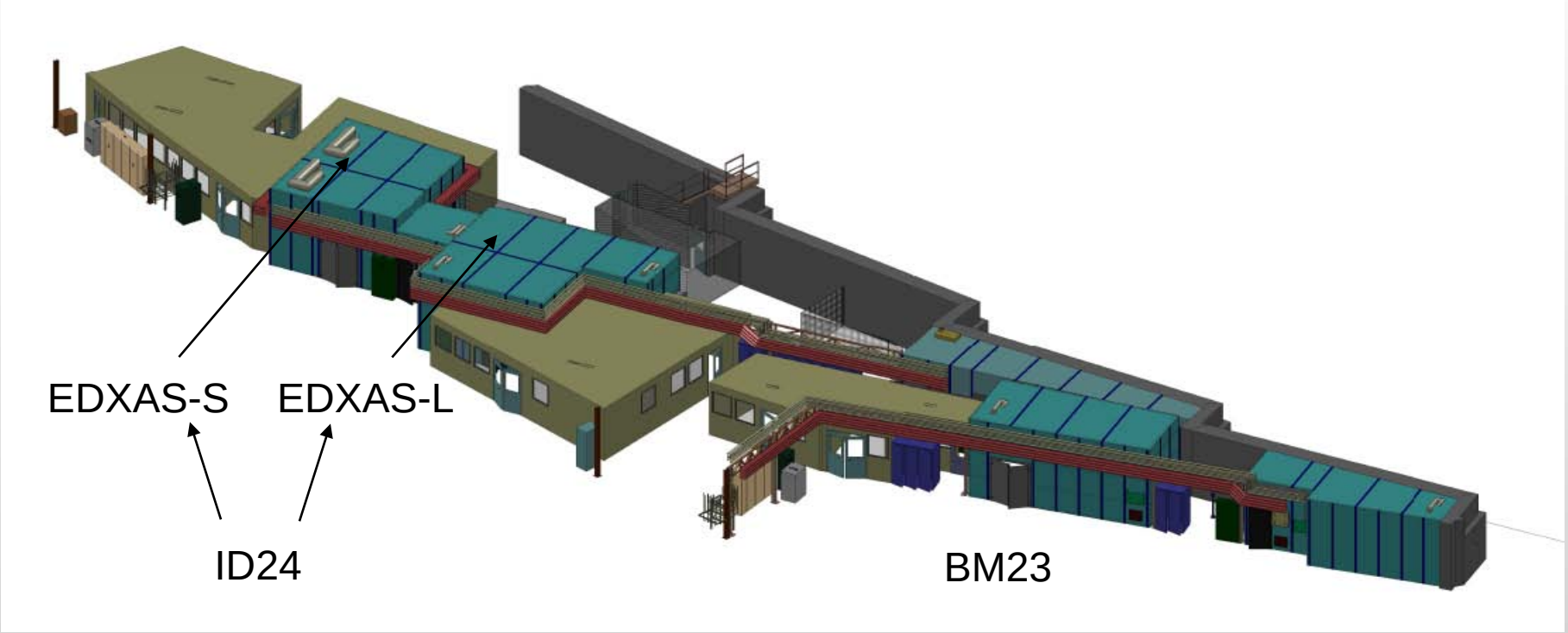


Existing satellites:
ID11
ID13
ID17
ID19

Hall extension:
ID27 – ID02

New satellite:
ID16

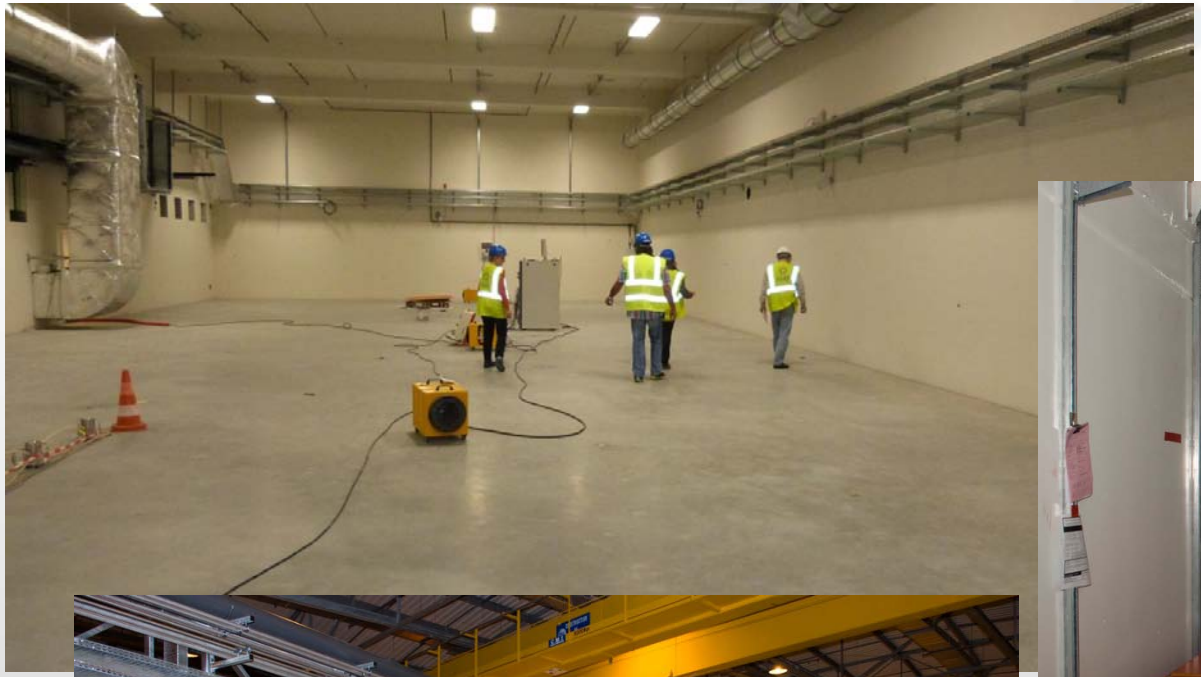
Infrastructure for beamlines



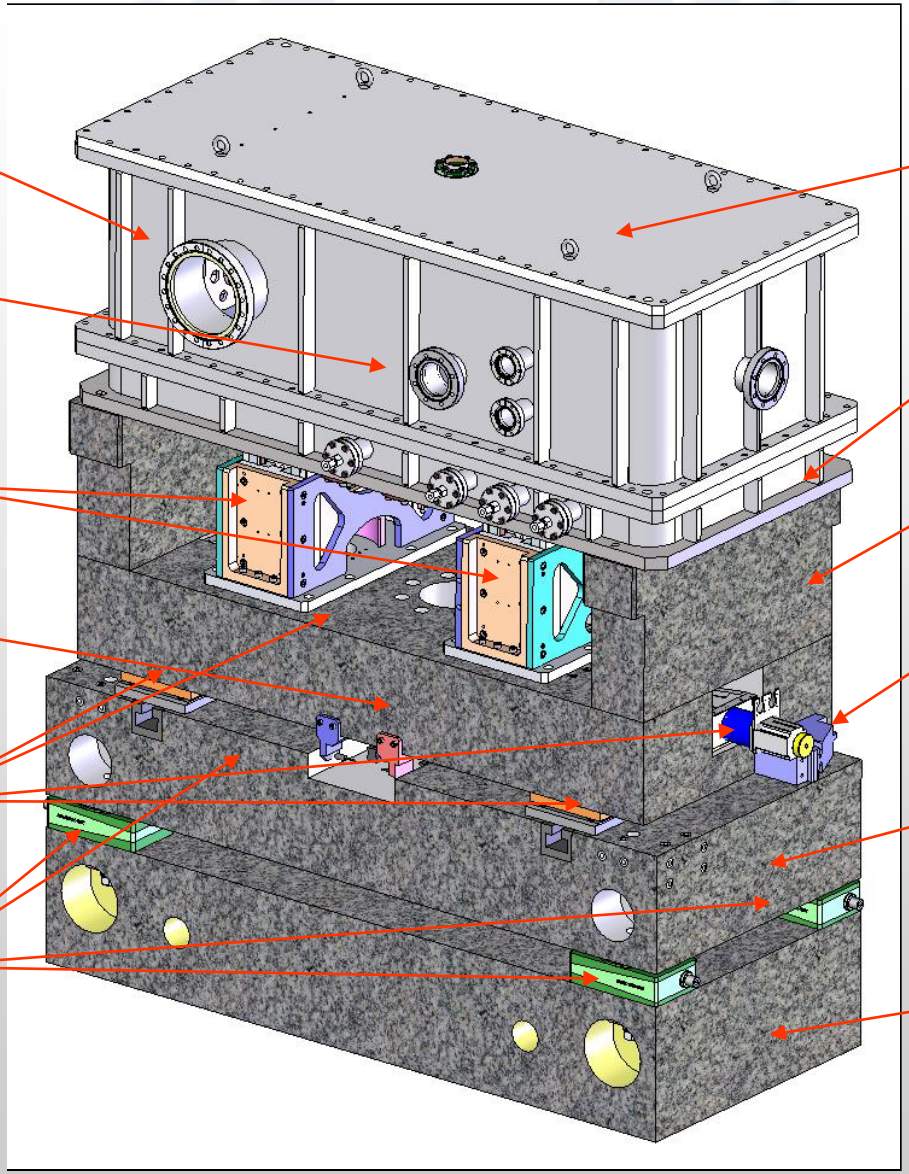
General view of the UPBL11 project

UPBL4 - NINA
Nano-imaging & Nano-analysis

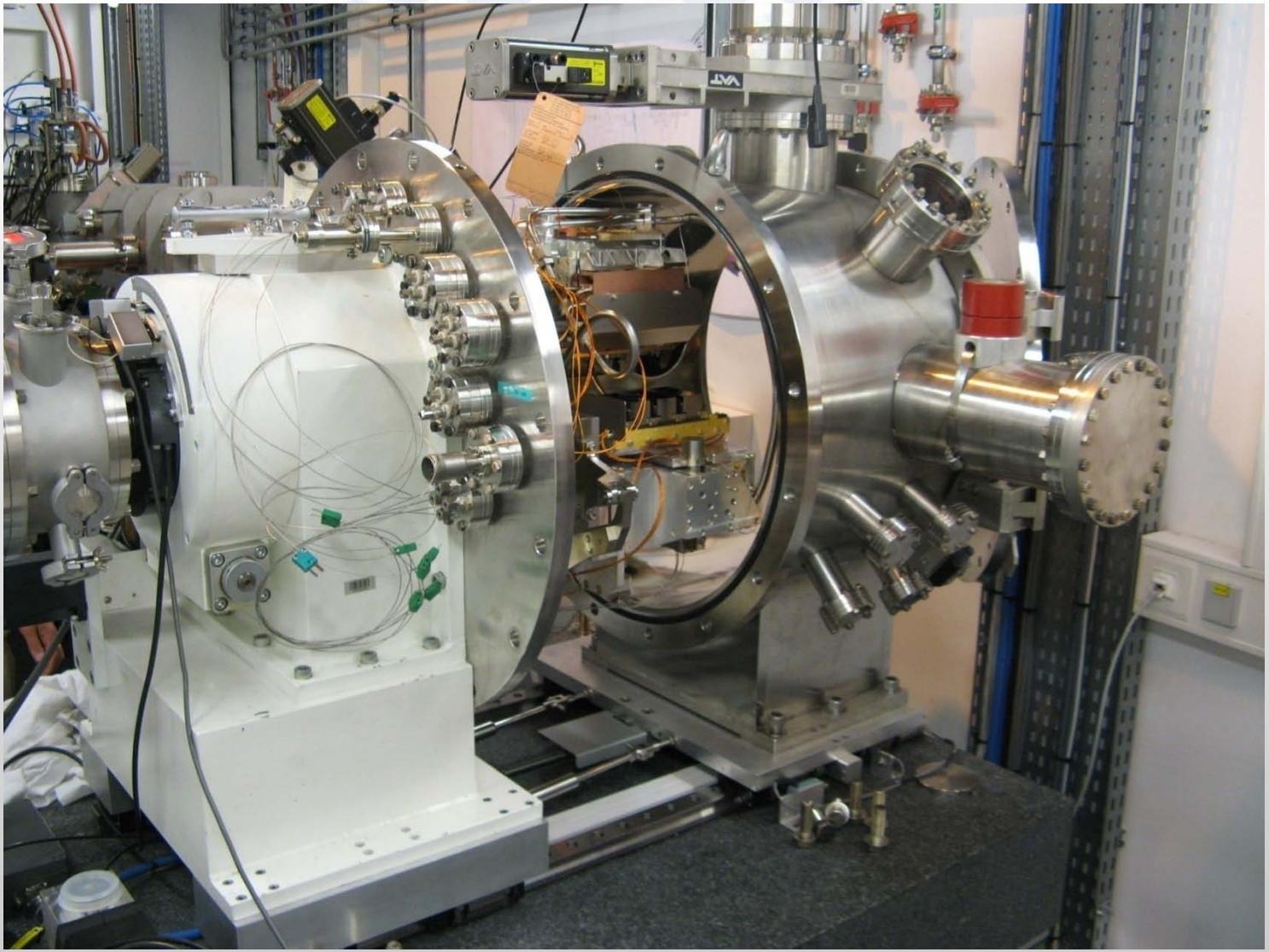
Infrastructure: construction of Pb hutches



New generation of positioning devices for optics



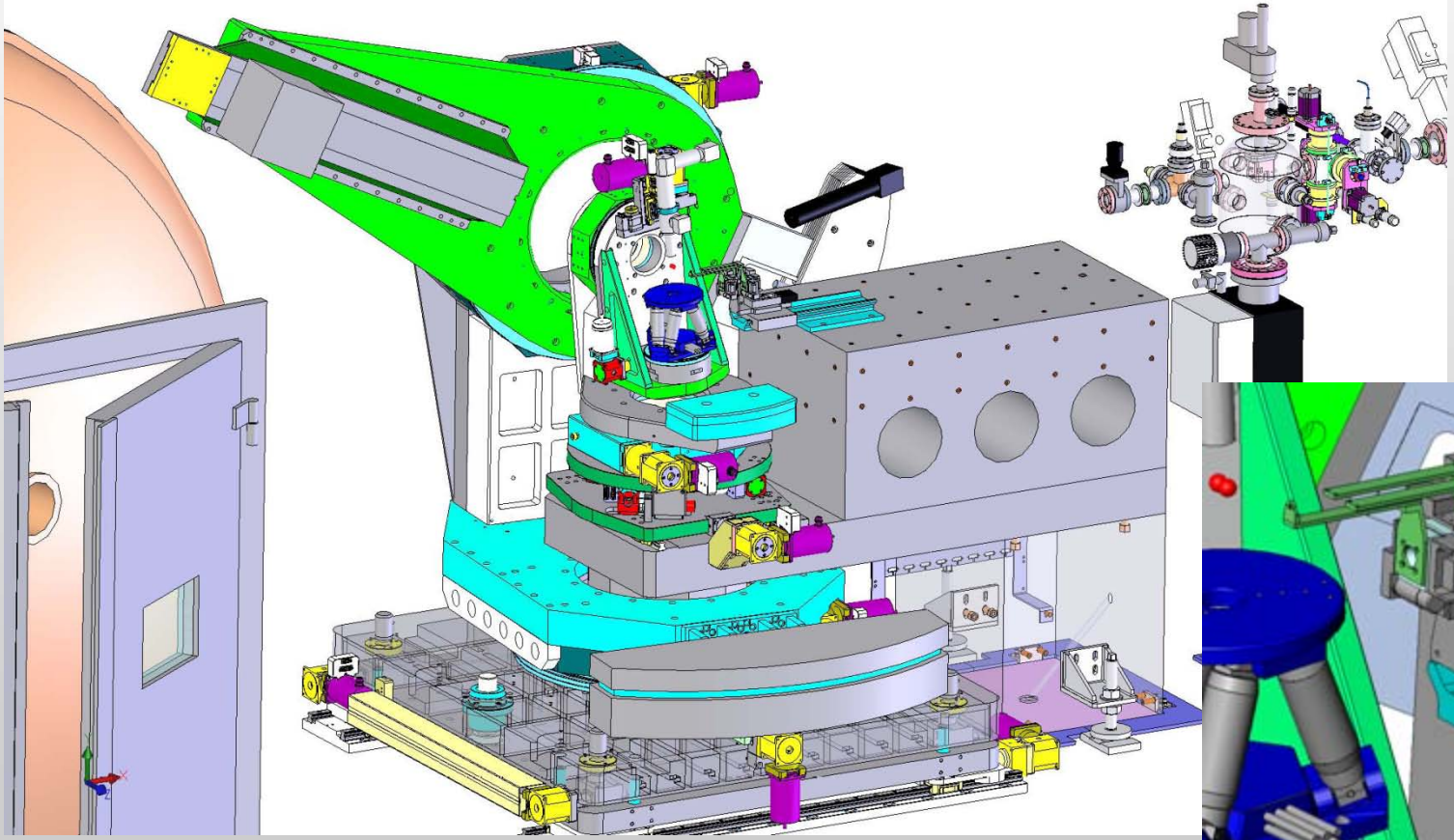
New Optics: Monochromators, Mirrors, Focusing,….

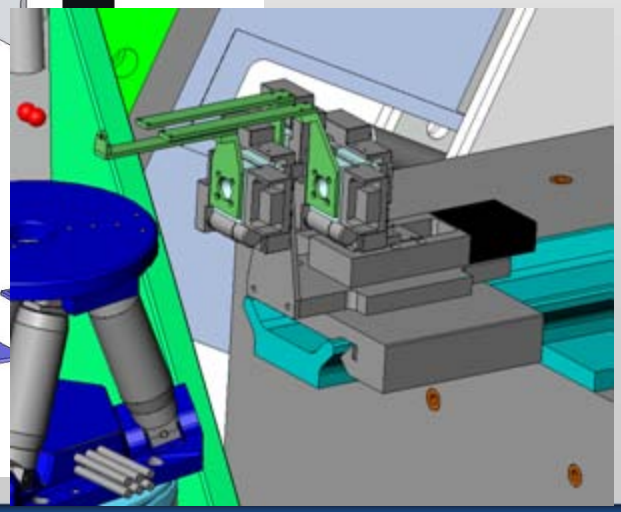


New generation of positioning devices for samples

High precision diffractometer for EH1
UPBL1

beamsize 50 – 100 nm
payload 2…(5) kg
positioning HP ≤ 1 μm
piezo ≤ 20 – 50 μm
SOC ≤ 20 μm (3 axis full)
SOC ≤ 0.2 μm (± 1° for 1 axis)





New generation of detection devices

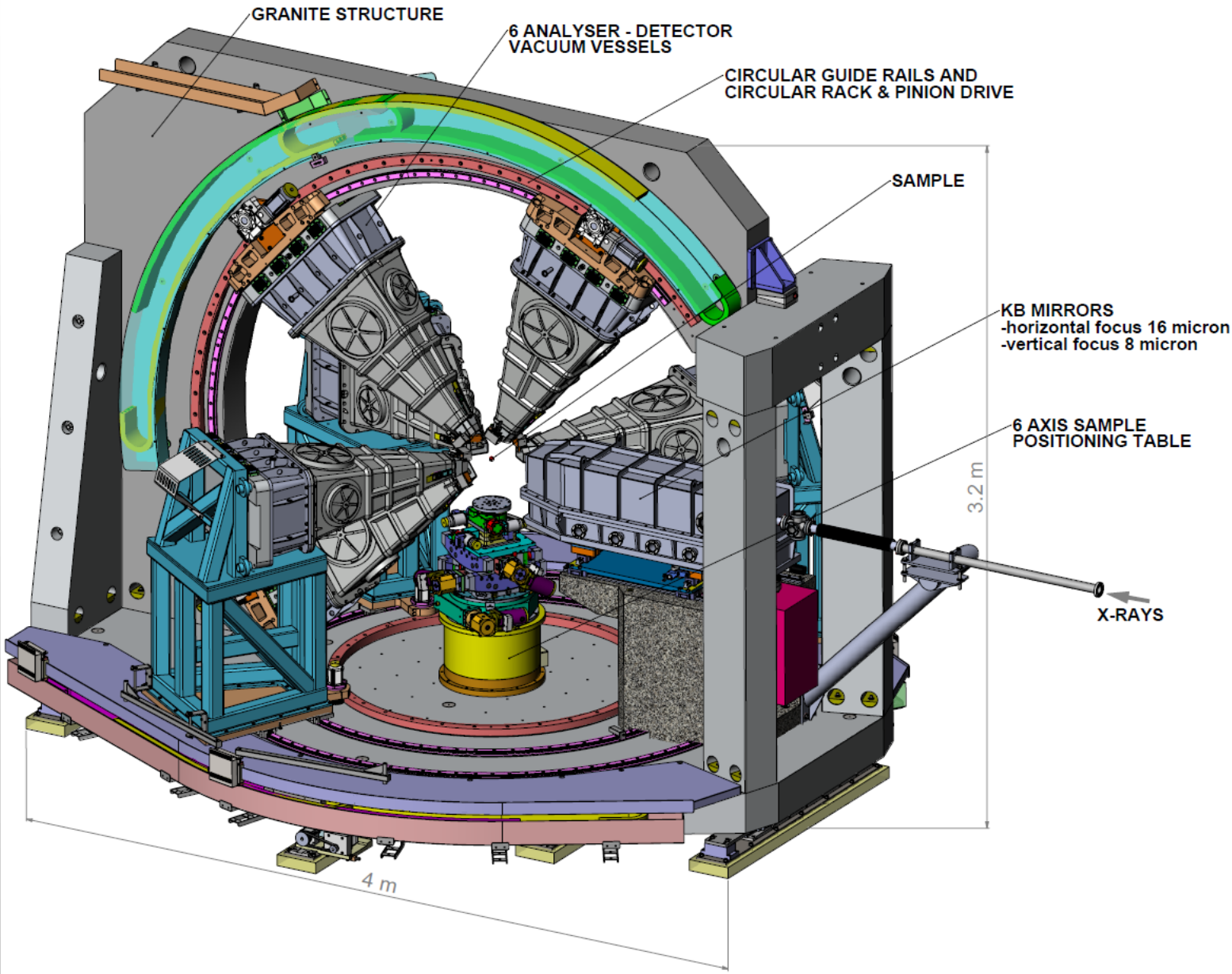
6 units analyser chambers

With

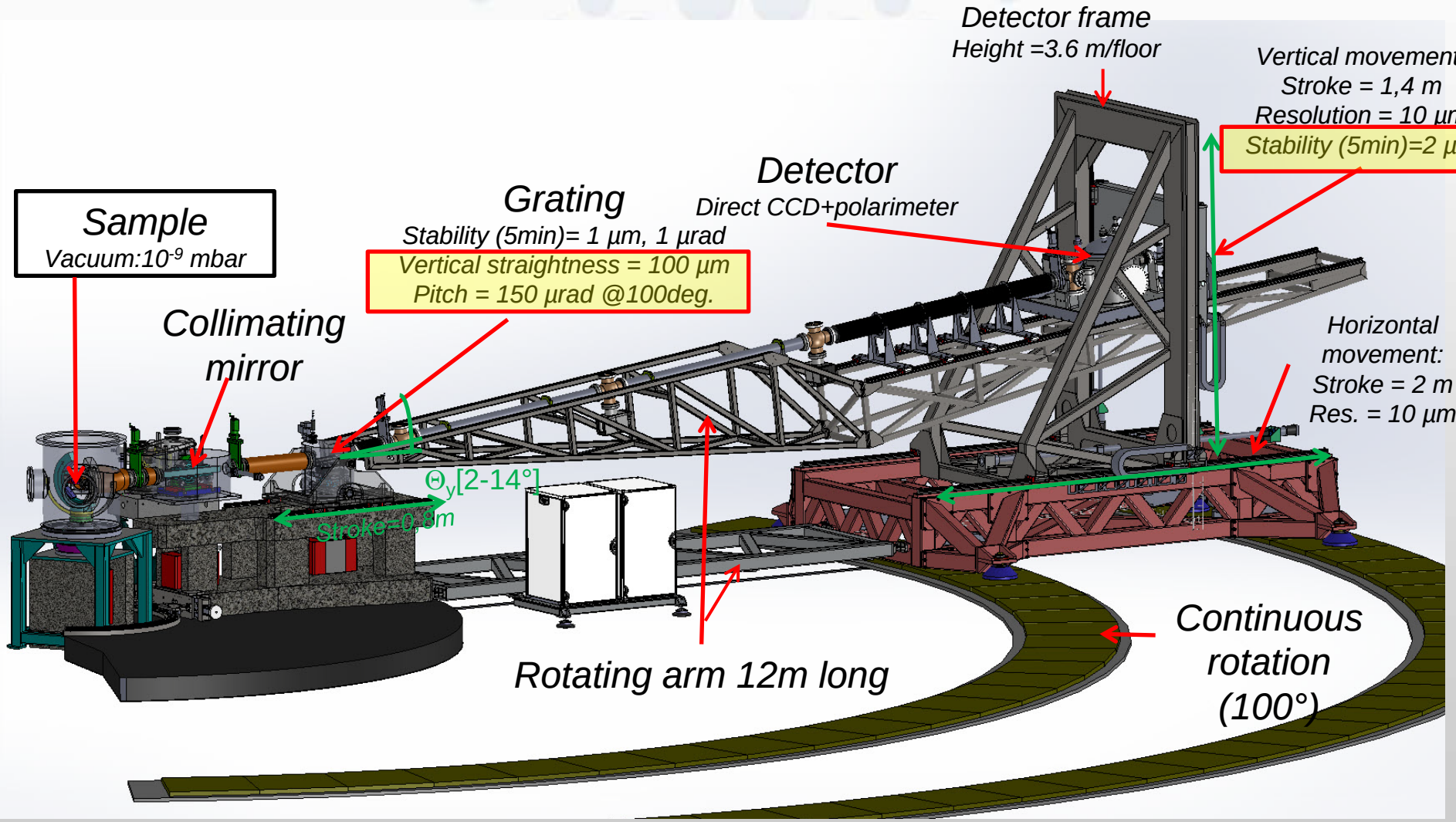
12 analyser crystals and 1 detector.

⇒ 72 analyser crystals

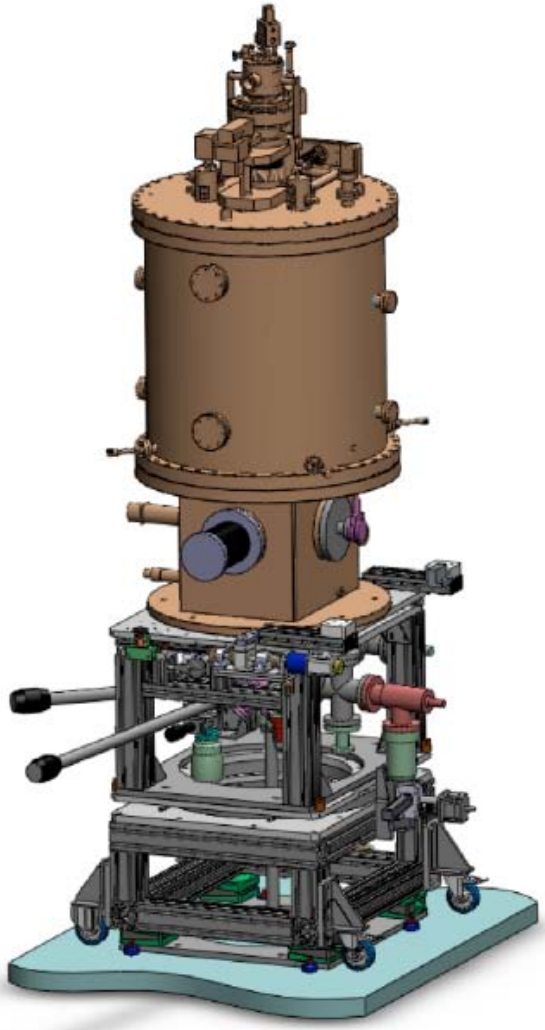
⇒ 6 detectors.

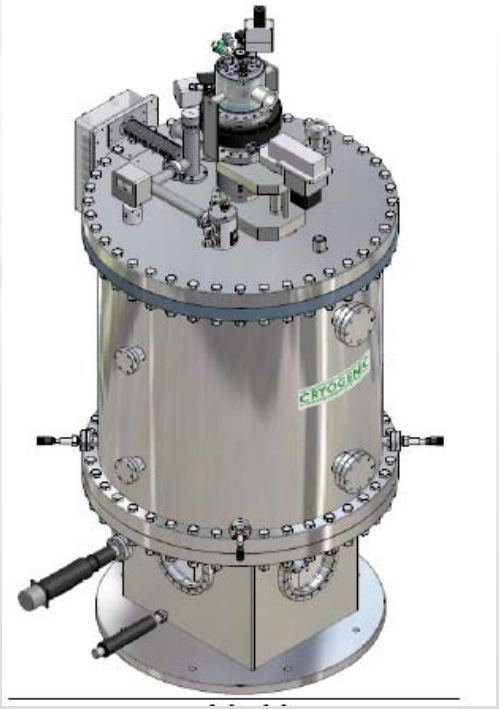


The 12m RIXS spectrometer in EX2



Installation of endstation starting





- Ultra high vacuum (10^{-10}mbar)
- superconducting magnet
- cold bore
- split coil
- 450-3K sample temperature
- 9T along beam (8T/min sweep rate) fast sweeping
- 4T perpendicular to the beam (2T/min sweep rate)

Computing Infrastructure

Extension of the Central Building Data Centre

Creation of a 300 m^2 Data Centre in the **Central Building**

Data Centre in the CB

ESRF Data Centre Upgrad

From **150+75 kW** to

150+350 kW

Commissioning 2011

front

back

Computing Infrastructure

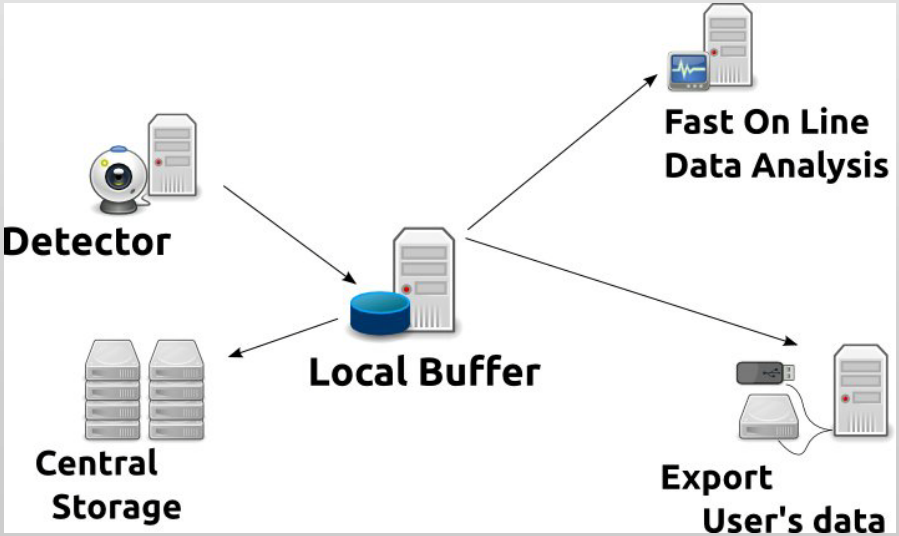
- ESRF computing infrastructure – four pillars:
  - Network
  - Disk base data storage
  - Tape based backup and data archiving
  - Data analysis clusters

- The current infrastructure is well suited for detectors with up to 100 MB/s data output

Computing Infrastructure

- **Beamlines with high-speed detectors will require**
  - **Local buffer storage** for guaranteed bandwidth allowing simultaneous reading while recording data from the detector
  - Access to **massively parallel computing systems** (multi-core systems, GPUs) for on-line and off-line data processing
  - Large **high-performance data storage**

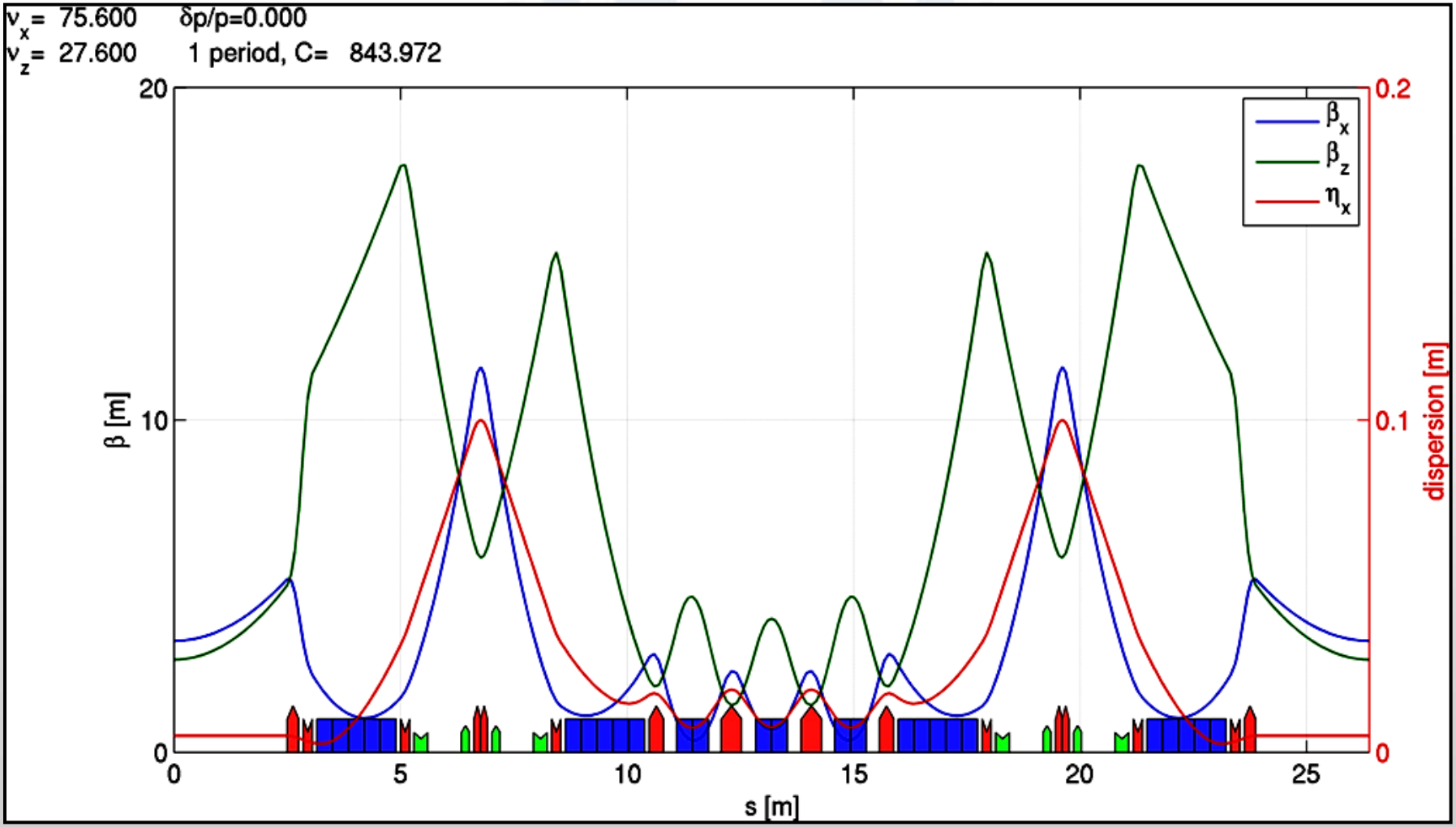
- **Capital investment**
  - significant capital investment is required to implement the proposed strategy



ESRF Upgrade Programme
Preparation of Phase II proposal
2015-2019

- Accelerator and Source
- Beamlines
- Enabling Technologies

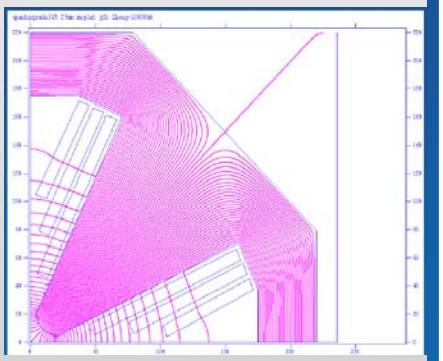
The ESRF Hybrid Multi-Bend (HMB) lattice



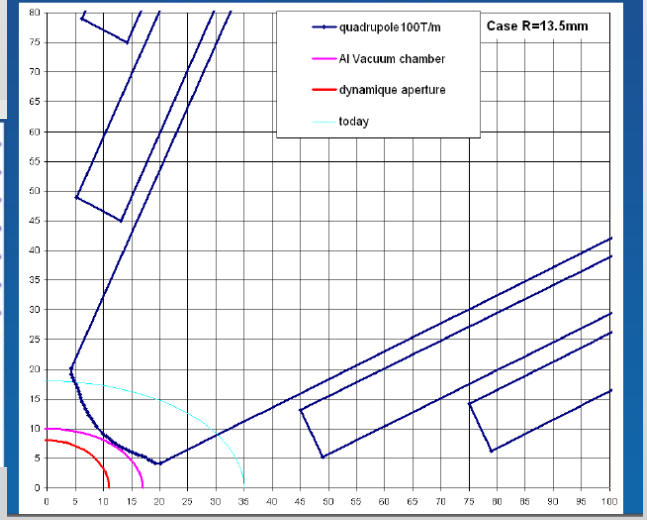
Reuse more than 90% of the existing infrastructure

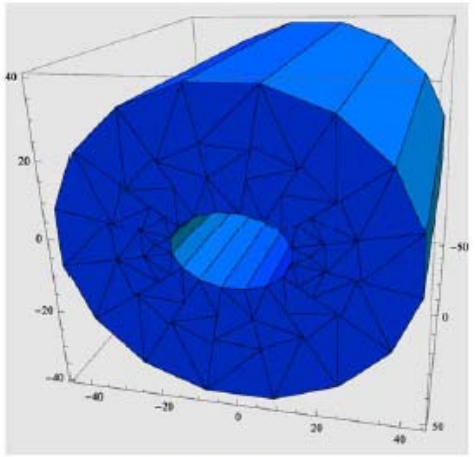
	ESRF	New lattice
Dipole [T]	0.86	0.49
Quadrupole [T/m]	17 (25)	112
Sextupole [T/m2]	460	1650

- Weak bending magnet with strong gradient
  - Equivalent to a quadrupole of 33 T/m offset by 1.5 cm
- Strong quadrupoles
- Very strong sextupoles

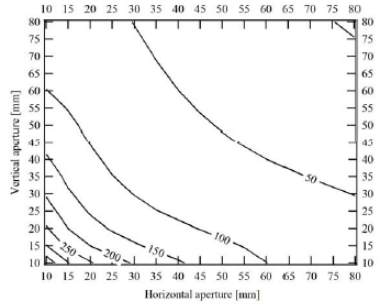


Room for the vacuum chamber





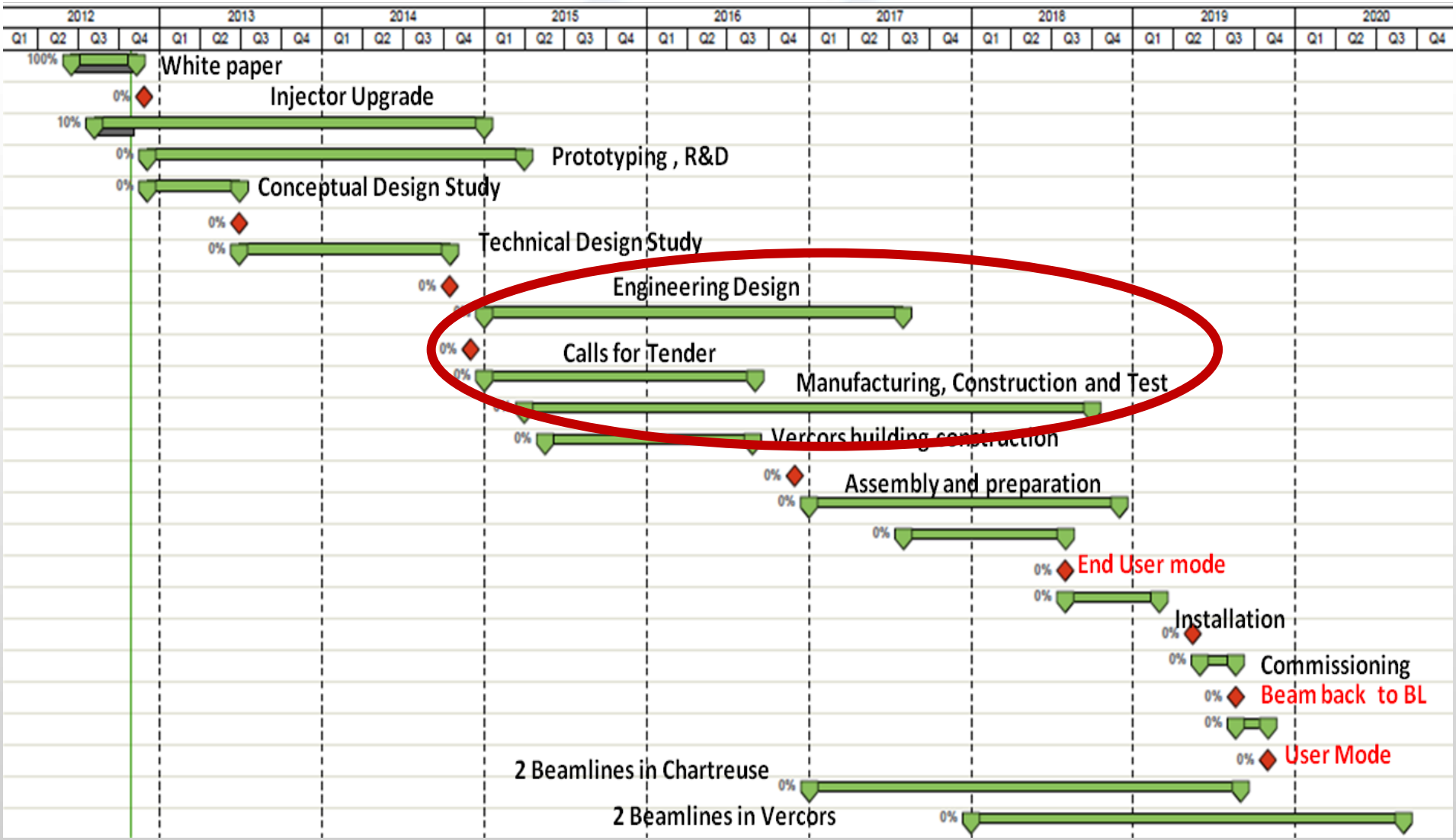
Halbach quadrupole
with 20x30 mm² aperture



Gradient [T/m] vs. aperture

Hardware requirements are very demanding

New lattice project schedule

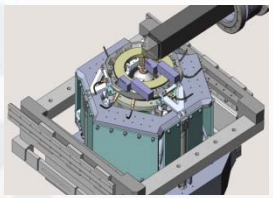


TECHNOLOGY DEVELOPMENT FOR THE BEAMLINES

Beamline Control & Data Analysis

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

High Precision Engineering



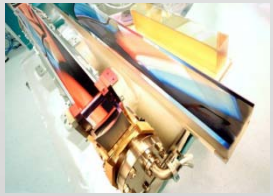
- o *Consolidation and further developments of expertise in Mechatronics*
  - *Advanced modeling tools*
  - *Advanced control methods*
  - *in-situ metrology*

Phase 1

↓

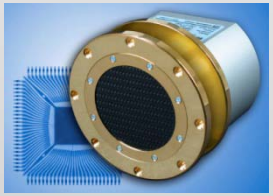
Phase 2

X-Ray Optics



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

X-Ray Detectors



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

More synergies with XFELs

ESRF relations with Industry