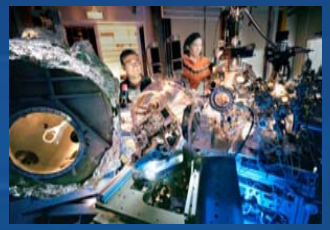


THE ESRF UPGRADE :

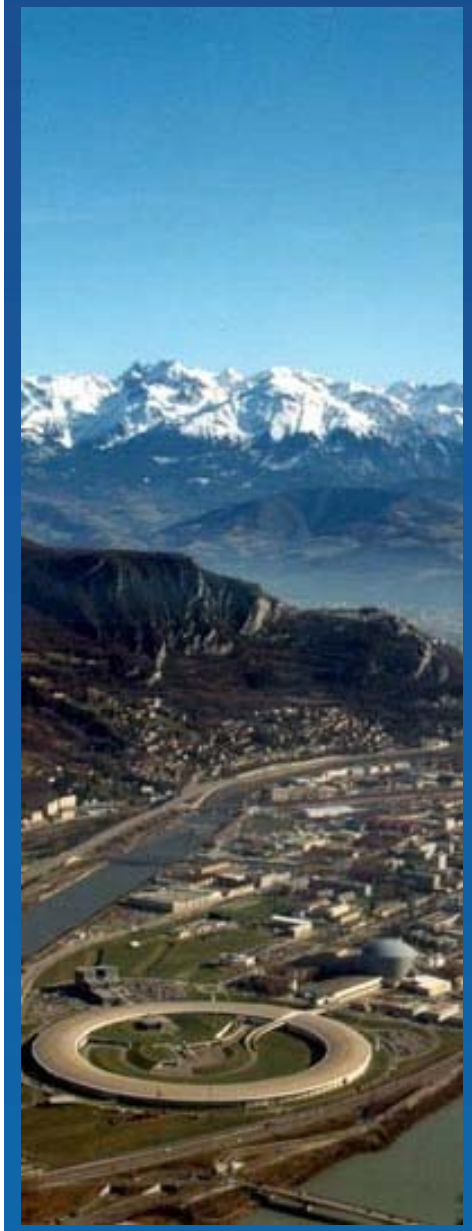
CHALLENGES FOR THE EUROPEAN SCIENTIFIC COMMUNITY

Yves Dabin

European Synchrotron Radiation Facility

Grenoble - France

On behalf of all my ESRF colleagues



Outline:

- **The upgrade concept around the drivers**

The upgrade phasing:

- **Phase 1**
- **Phase 2**

Main Features of the ESRF Upgrade Programme

- **Upgrade of the Accelerator Complex:**
  Increased brightness, stability

- **New, refurbished and Upgraded Beamlines:**
  Improved performance and routine nano-focus beams

- **Extension of about 1/3 of the Experimental Hall:**
  *long beamlines (> 100m) enabling **nanometre** and **nano**radian focused beams.*

- **Development of new SR Instrumentation:**
  Underpin science from beamlines and source improvements

- **New Infrastructure Enabling Science-driven Partnerships:**
  New science and applications with increased participation of academia, industry, laboratories …. .

Science drivers of the Upgrade Programme

http://www.esrf.eu/AboutUs/Upgrade

Upgrade Programme Deliverables

Renew Beamline Portfolio
(11 new beamlines + 2 moving beamlines)

Accelerator Upgrade

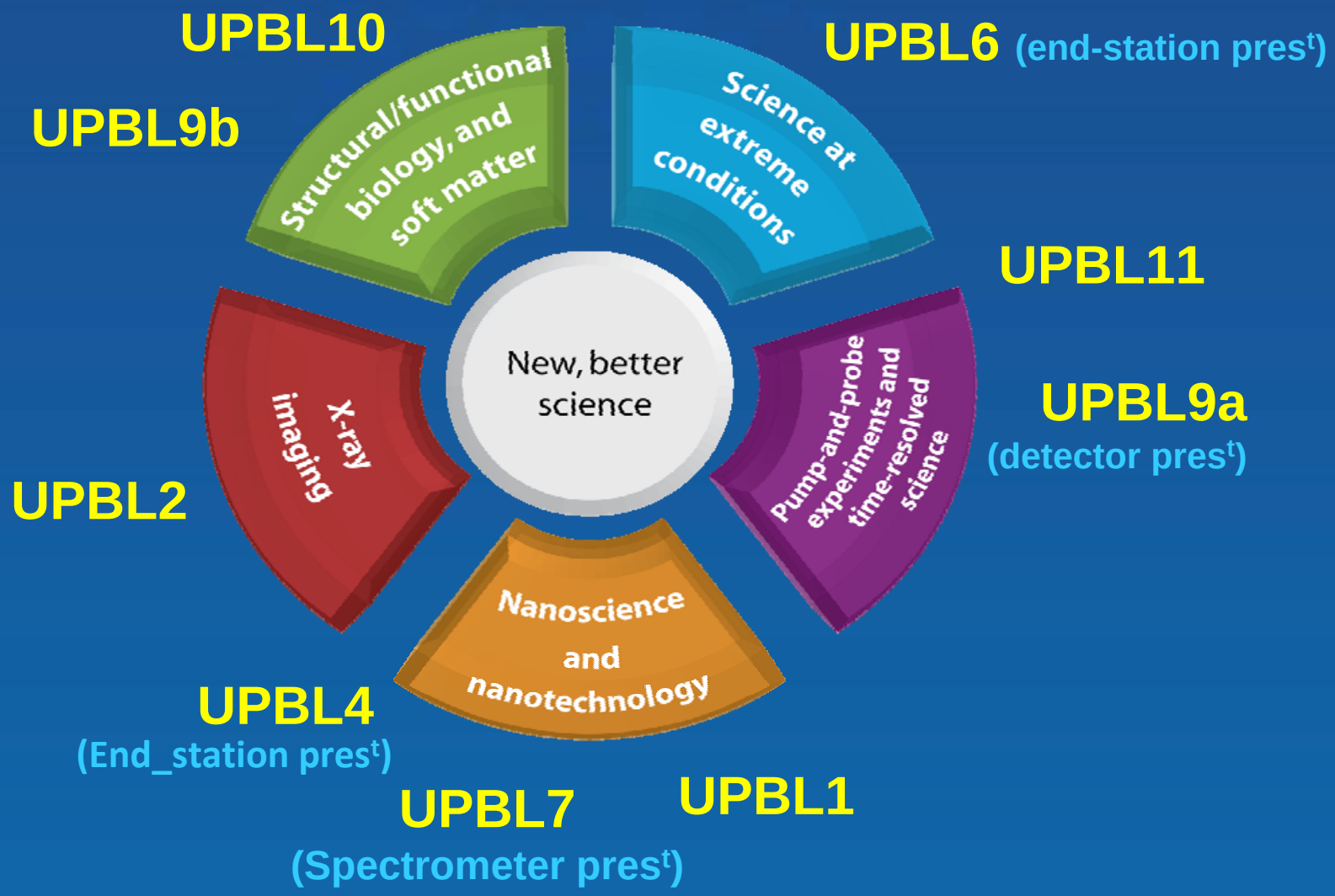
- ***IDs,***
- ***straight sections,***
- ***orbit correction system,***
- ***RF***
- ***New emittance, source size***

New Building Infrastructure
New Data Center

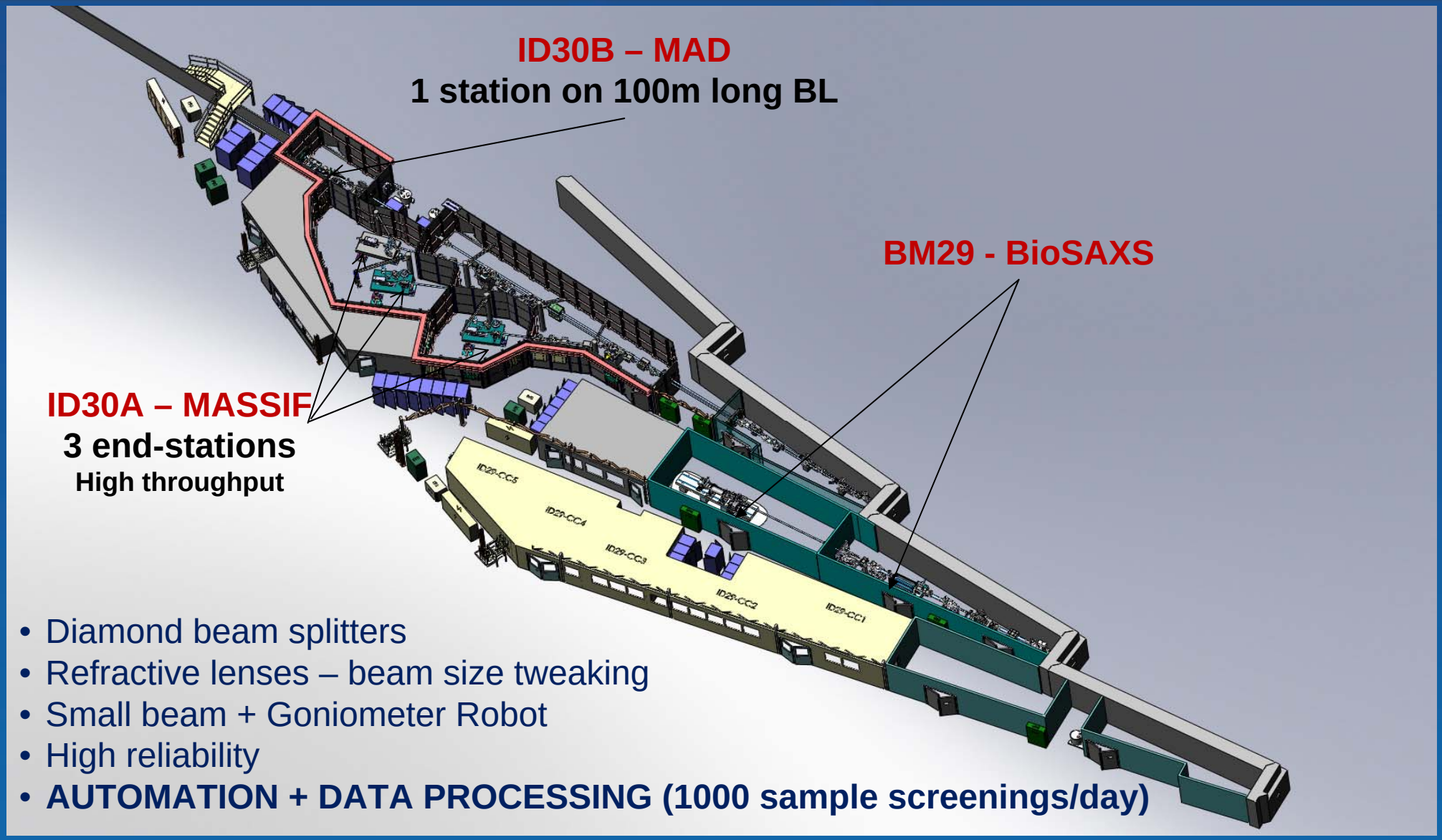
Upgrade Programme BeamLine projects for Phase I

- **UPBL1:** Local probe coherent diffraction imaging
- **UPBL2:** High energy beamline
- **UPBL3:** Nuclear resonance beamline
- (refurbishment ID18)
- **UPBL4:** Beamline for imaging, fluorescence and spectroscopy at the nanoscale
- **UPBL5:** Beamline for parallel and coherent beam imaging (refurbishing ID19)
- **UPBL6:** High energy resolution inelastic scattering
- **UPBL7**: Soft X-rays for nano-magnetic and electronic spectroscopies
- **UPBL8**: Nano- and micro-beam crystallography (phase2?)
- **UPBL9(a):** Sub-micro-radian angular resolution small-angle scattering
- **UPBL9(b):** Structural dynamics of molecular assemblies
- **UPBL10**: Large-scale automated screening, crystallography
- **UPBL11**: Pushing the limits of energy dispersive X-ray absorption spectroscopy

Five Science Highlight Areas – 8 approved UPBLs



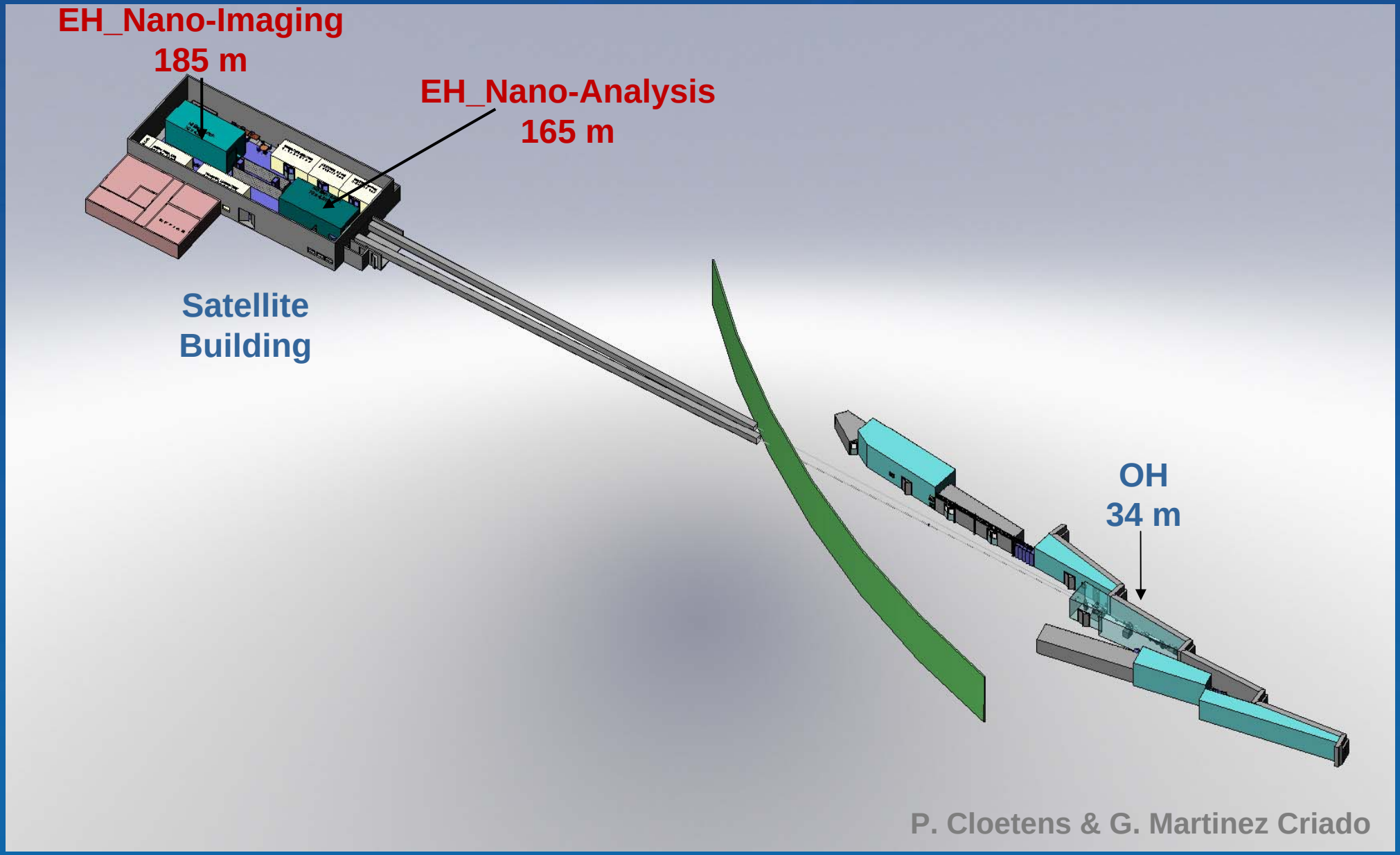
UPBL10 Project – MASSIF : MX Village



- Diamond beam splitters
- Refractive lenses – beam size tweaking
- Small beam + Goniometer Robot
- High reliability
- **AUTOMATION + DATA PROCESSING (1000 sample screenings/day)**

T. Mueller-Dieckmann, M. Bowler, P. Pernot

UPBL4 – NINA – ID16



The ESRF upgrade phasing

(medsi units)

2010 2012 2014 2016 2018 2020

Probably 3 next medsi to talk about the upgrade !!!!

Phase 1

Long geometry
Focus
Stability
Buildings
7 m straight section
transmitters
End-stations
Detectors
175M€

Phase 2

Source size
Emittance
Critical Instruments (optics)
Detectors
150M€

Let's go to phase 1

(medsi units)

2010 2012 2014 2016 2018 2020

Phase 1

Long geometry
Focus
Stability
Buildings
7 m straight section
transmitters
End-stations
Detectors

Implementation of UPBLs

TDR	Construction	Completed

TDR: Technical Design report

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
UPBL7	ID08	ID32	Soft X-rays/nano-magnetic & electronic spectroscopy
UPBL9a	ID02	ID02	Time-resolved ultra small angle scattering
UPBL9b	ID09TR	ID09	Pump-probe and time-resolved experiments
UPBL10	ID14	ID30	Massively Automated Sample Se egrated Facility
UPBL11	ID24/BM29	ID24/BM23	Time-resolved and Extreme conditions

Close To completion

Close To completion

completed

Floorplan defines 3 classes of beamlines

1. **UPBL beamlines: 8 UPBL projects, 11 beamlines = 15 end-stations**
2. **Moving beamlines: 2 moving beamlines**
3. **Non-moving beamlines: 19 beamlines**

1/3rd of ESRF

A real challenge

To renew beamline portfolio of the ESRF

with minimum downtime in the facility operation during the upgrade

---

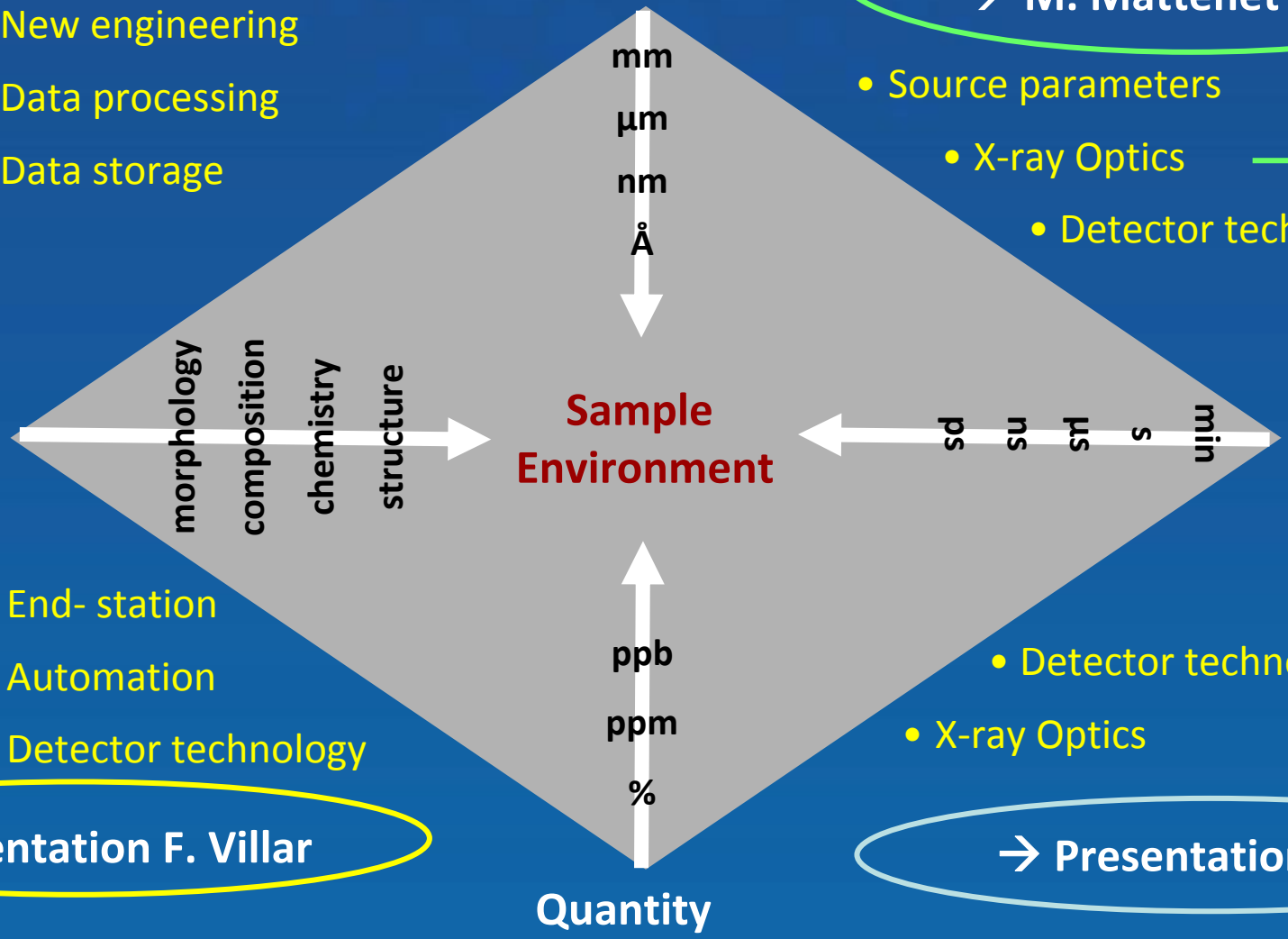
Beamline requirements and major technological issues

→ Presentation Ph. Marion

- New engineering
- Data processing
- Data storage

→ Presentation B. Baker
→ M. Mattenet L. Zhang

- Source parameters
- X-ray Optics
- Detector technology



- End- station
- Automation
- Detector technology

→ Presentation F. Villar

- Detector technology
- X-ray Optics

→ Presentation H. Hignette

A Mandatory Evolution for the ESRF

✓ In-house culture tailored by 20 years of user operation

✓ De-centralisation of resources over a large number of instruments

- Need for a fully integrated multi-disciplinary approach
- Need for transverse project structure
- Complement and maximise potential of existing instrumentation groups

➢ Adaptation of the internal organisation

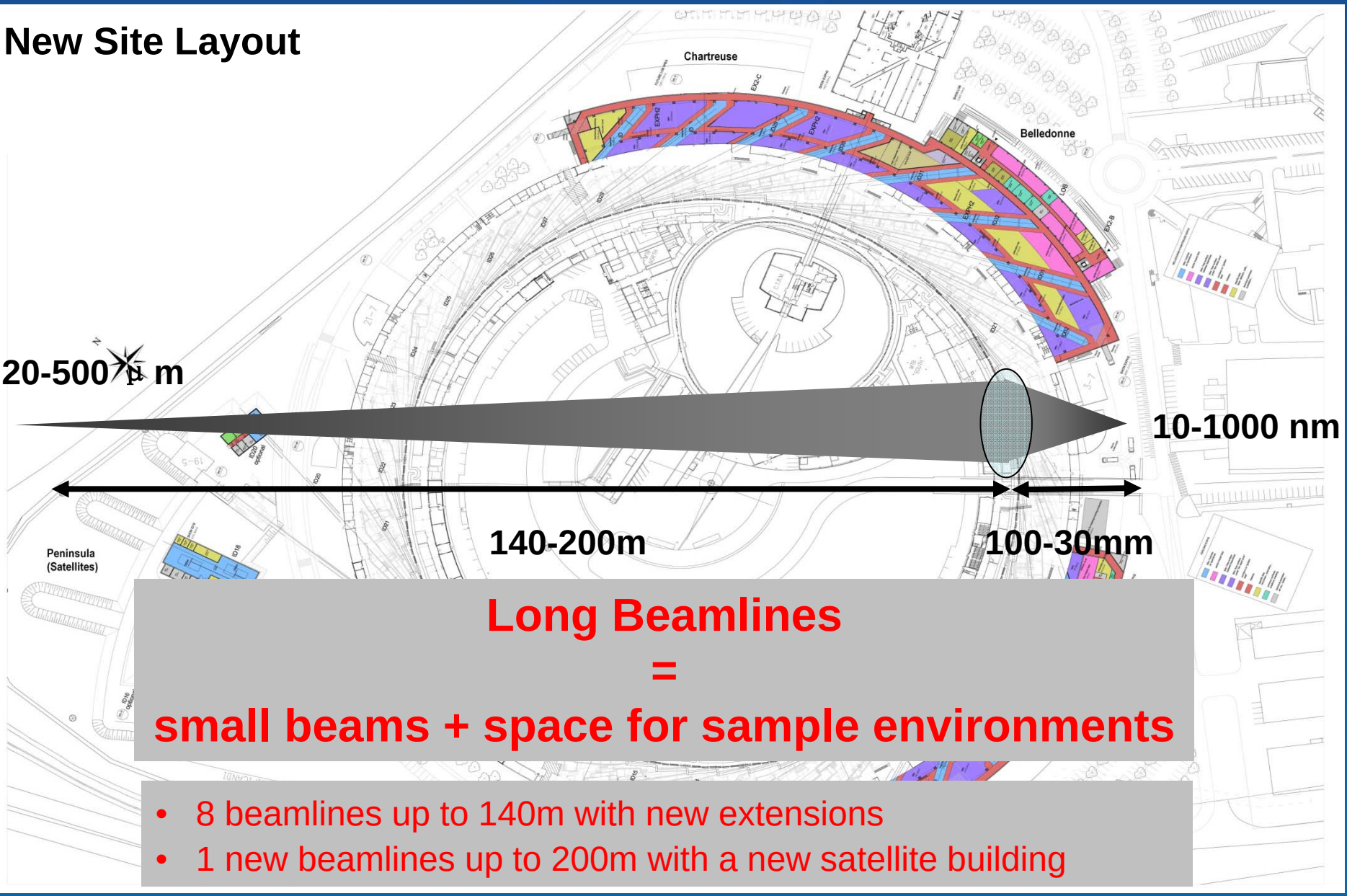
➢ Implementation of new practices

Engineering methodology

Creation of new entity:
Instrument
Support
Development
Division

Enabling long beamlines

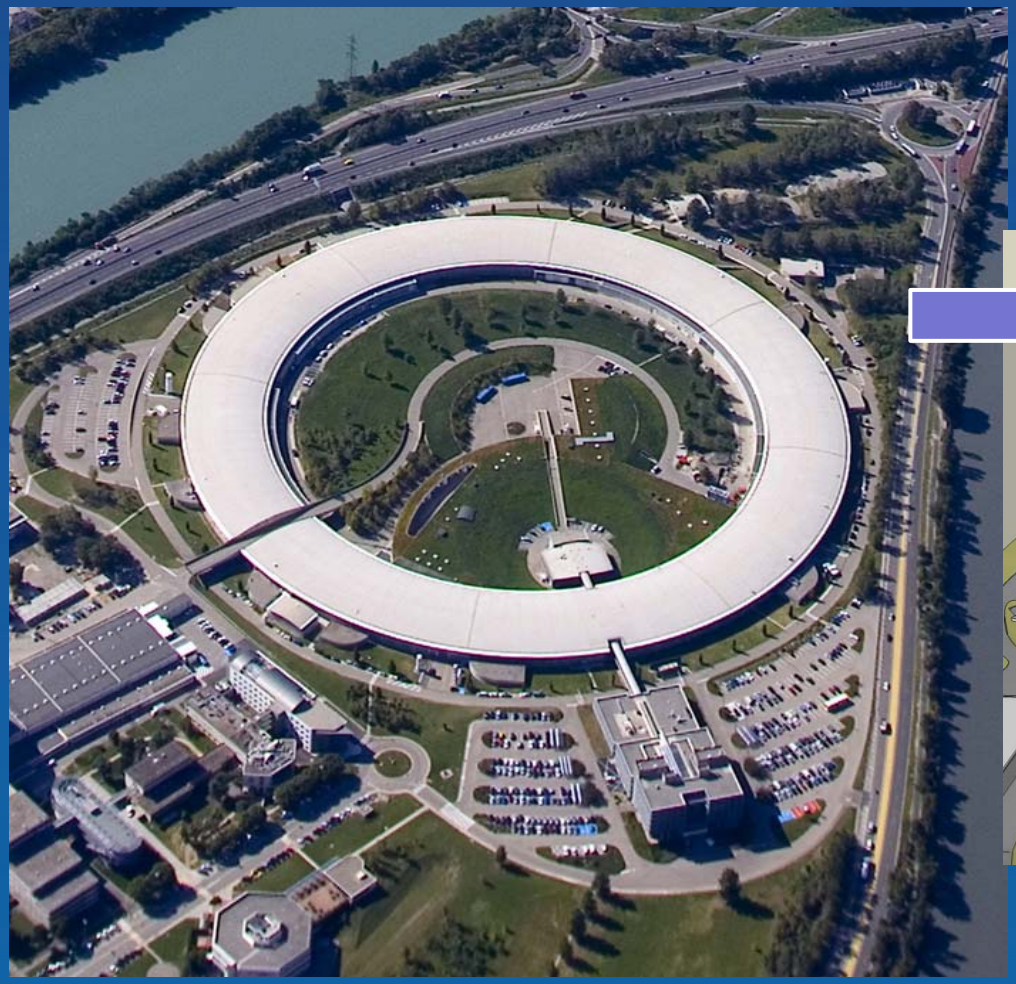
New Site Layout



Long Beamlines
=
small beams + space for sample environments

- 8 beamlines up to 140m with new extensions
- 1 new beamlines up to 200m with a new satellite building

Experimental Hall Extension (EX2)



2010 Budget Cut (-6%)
Reconfiguration of the upgrade

Postponed to phase 2

Site civil works: A high source of disturbs for continuous operation

We built abysses and mountains

Finally new exp. hall

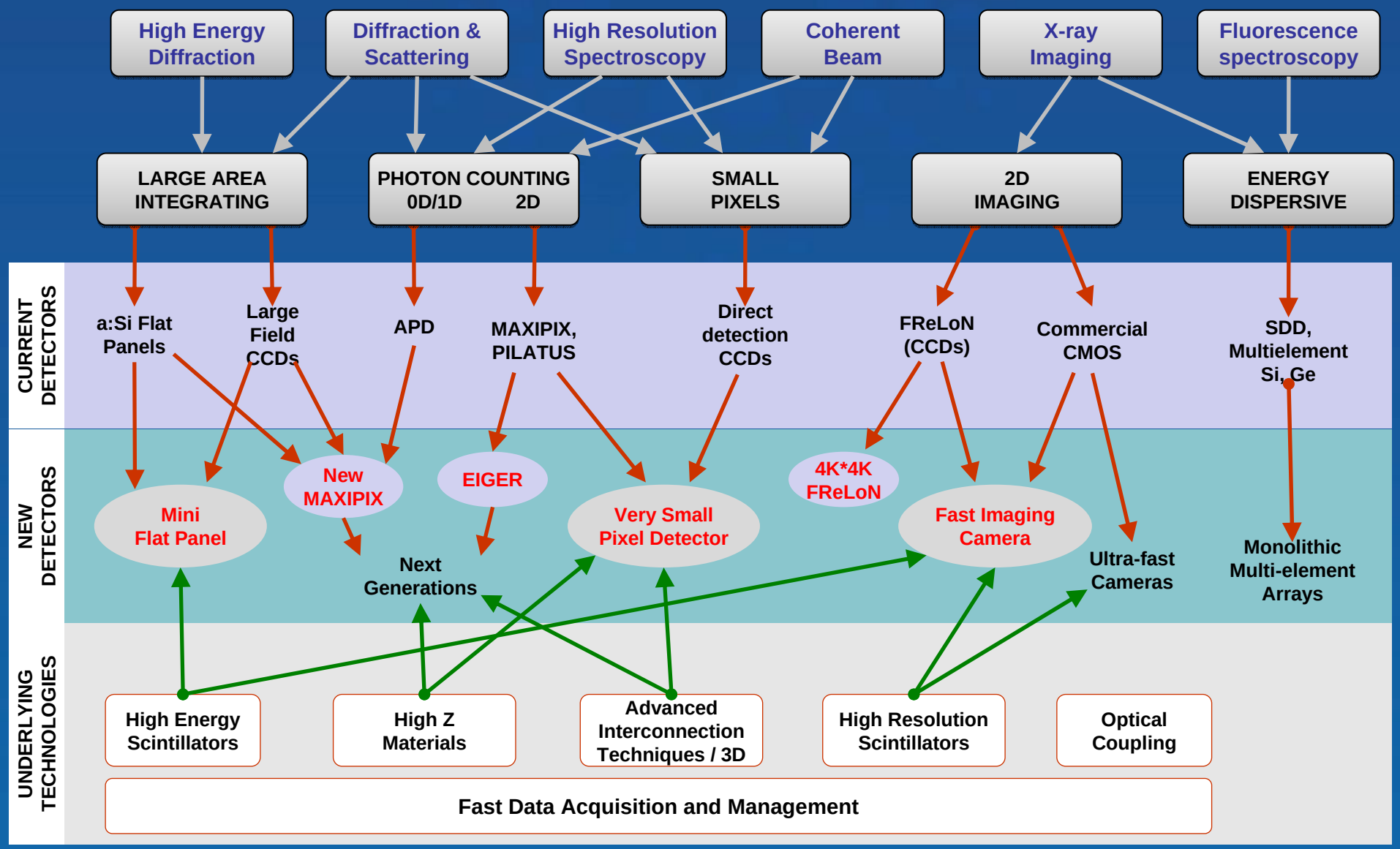
And new lab. and offices bldgs

Better slab: working with industry to make them understanding our pb's

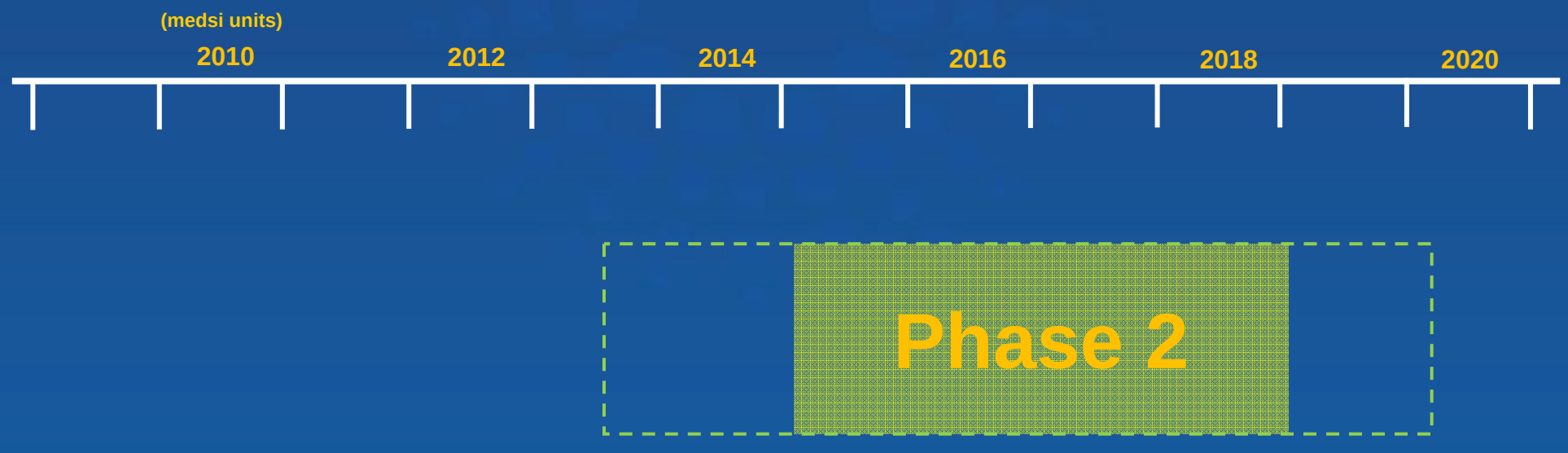
Meticulous concrete studies (cement formulae)

Recently a first sat. bldg. is achieved (ID16-NINA)

X-Ray Detectors at the ESRF: a global picture



And soon…



Buildings
Source size
Emittance
Critical Instruments (optics)
Detectors

Conceptual studies for new source size and divergence

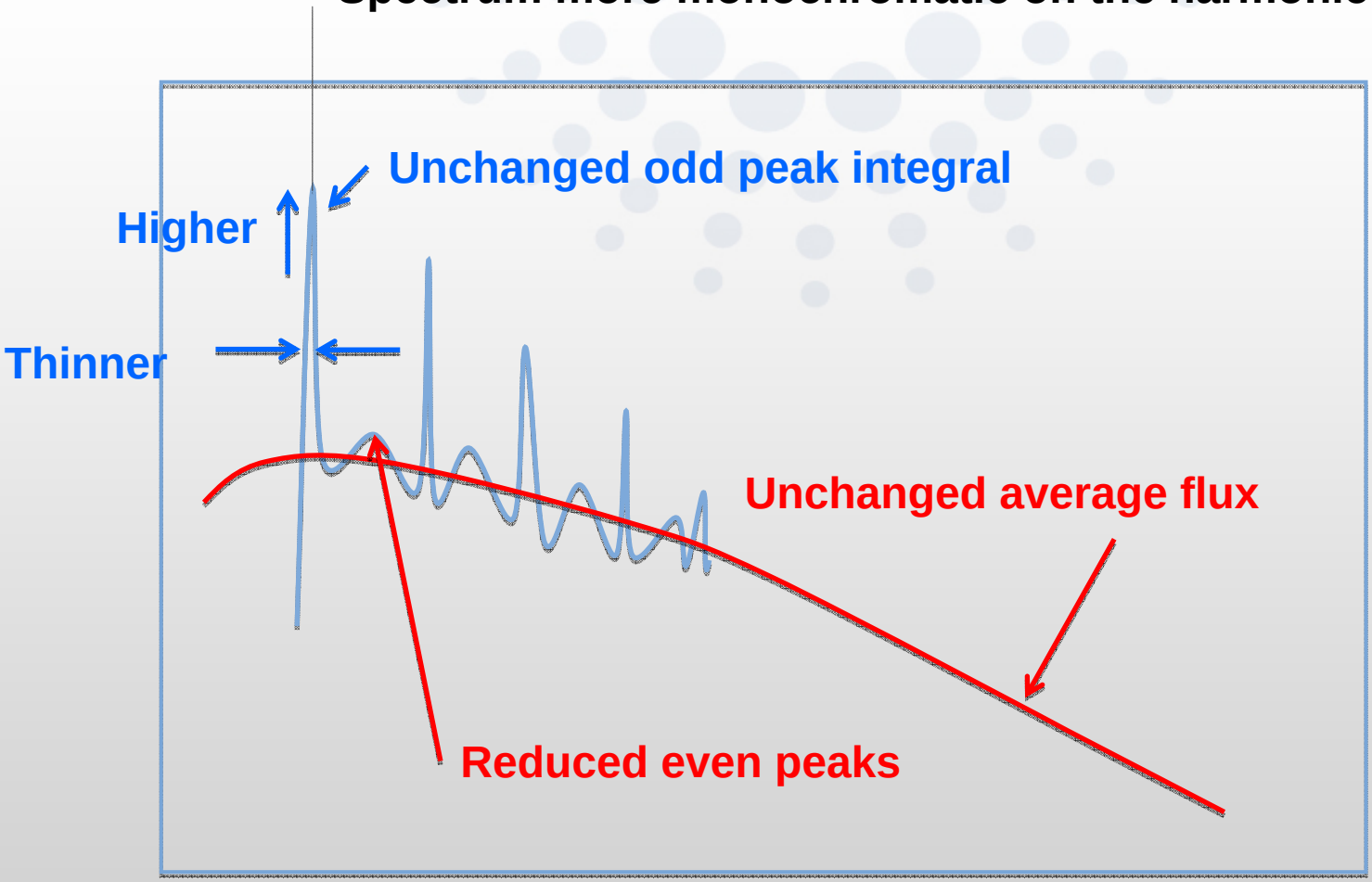
Rms size and divergence

	Emittance		Beta [m]		λ [Å]	Size [µm]		Divergence [µrad]	
	H [nm]	V [pm]	H	V		H	V	H	V
High beta	4	5	37.2	3	6.2	409	10.8	14.5	10.3
					1	409	5.6	11.9	6.1
					0.2	409	4.7	11.3	4.7
Low beta	4	5	0.37	3	6.2	50	10.8	104	10.3
					1	49	5.6	104	6.1
					0.2	49	4.7	104	4.7
New lattice	0.13	2	4.7	2.7	6.2 (2 KeV)	26.7	10.3	11.4	10.2
					1 (12.4 KeV)	25	4.7	7.4	5.3
					0.2 (62 KeV)	25	3.5	6.8	4.4

Now

Photon beam parameters: new undulator harmonics

Spectrum more monochromatic on the harmonic



Gain at the Mono level

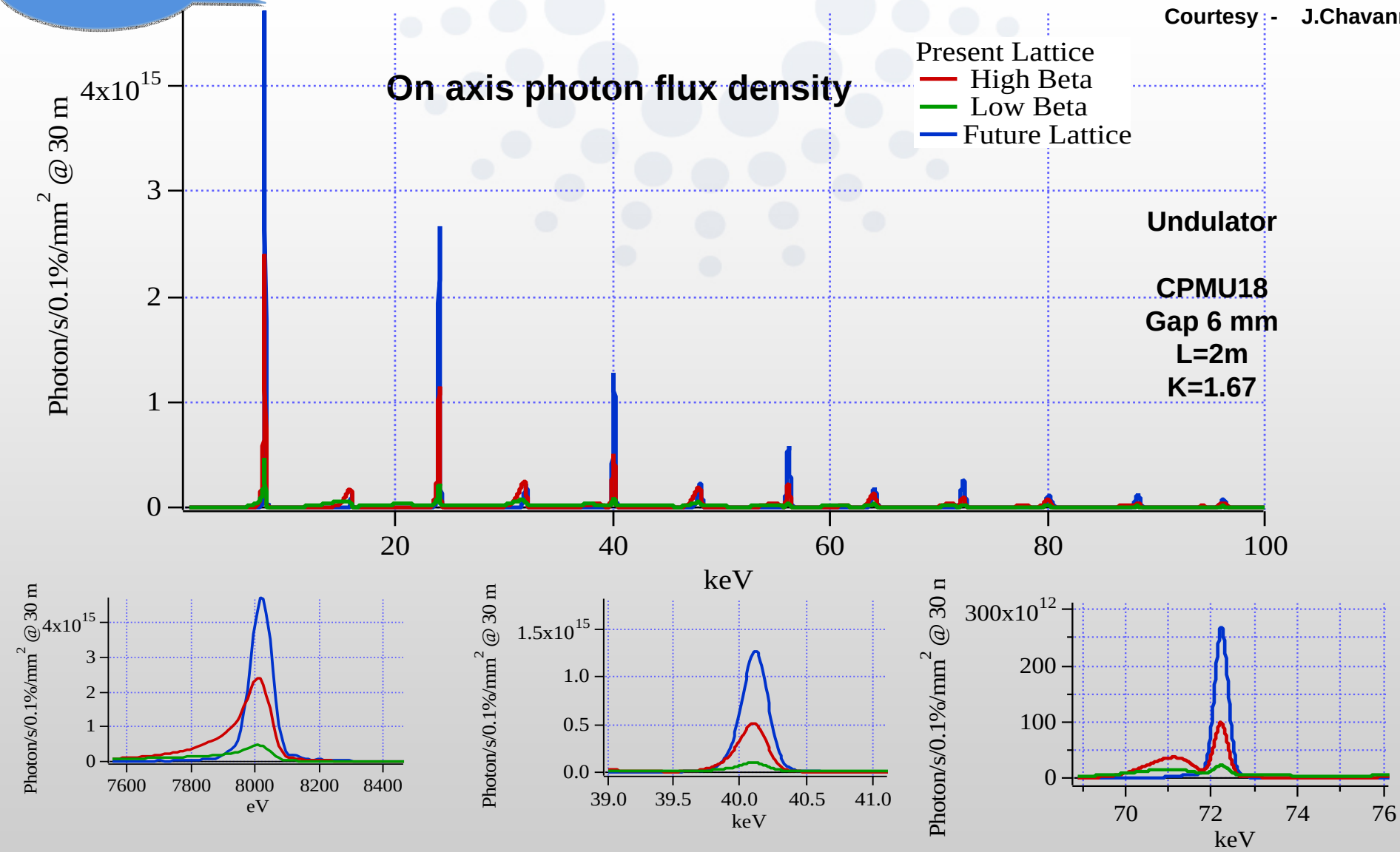
At the sample too

InVac.Us & CryoPermMag.Us

A Light for Science

New Harm.

Courtesy - J.Chavanne



Relative bandwidth (FWHM) at undulator harmonics will reduce by a factor of 1.5 maximum

Thus making new emittance means:

Nevertheless challenging issues:

- ✓ Explore and find a new storage ring lattice (orbit imposed)
- ✓ Get support from the community of users
- ✓ Implement intricate chain of components (8 dipoles /period)
- ✓ Adapt the low beta to high beta optics
- ✓ Solve complex equation:
  remove and replace the ring in the minimum downtime
  … typically ≤ one year

Concluding remarks:

- The upgrade is a chance of keeping high science level at the ESRF

- Keeping attractiveness of a high level storage ring facility

- For staff, applying recent ideas from highly trained and expert people

Thank you for your attention
Xeixei