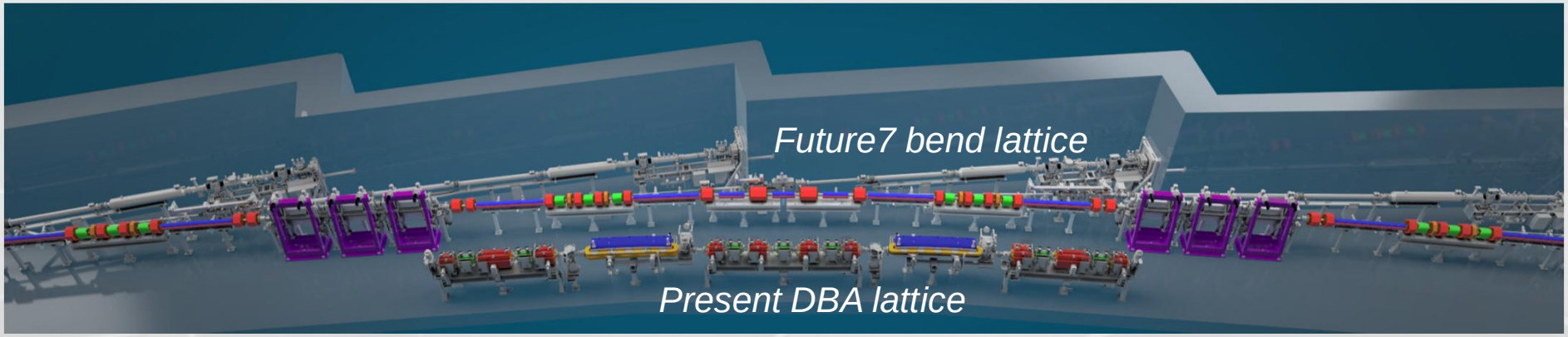


ESRF Upgrade Phase II

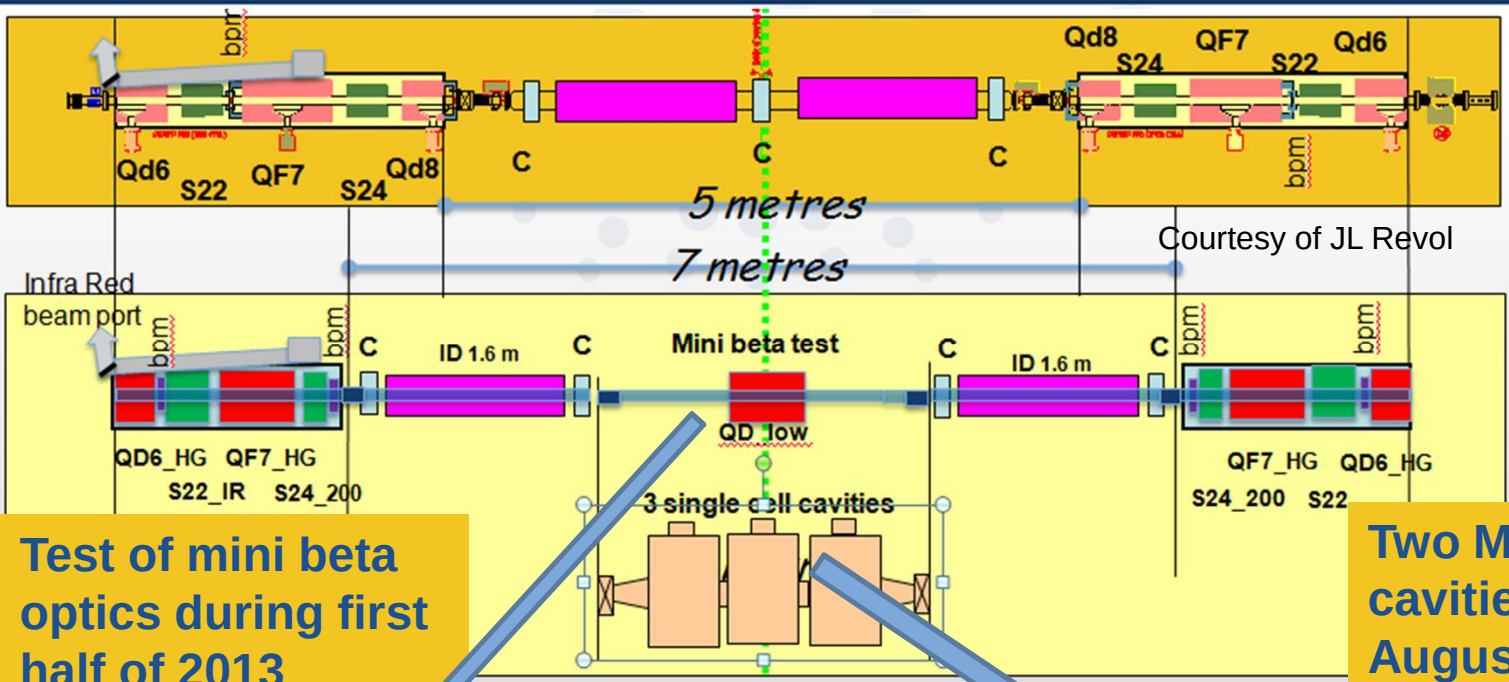
P. Raimondi
On behalf of the
Accelerator & Source Division

SLAC December 9-11, 2013

Phase I activities, mandatory for Phse II:

- 2 RF Cavities and SSA transmitters installed in the 7m section in the summer shutdown
- Cavities powered and in Active Mode in USM
- 12 Cavities Procurement under progress
- Top-up operation tests and components procurement under progress

PHASE 1: 7 meters long straight section



Test of mini beta optics during first half of 2013

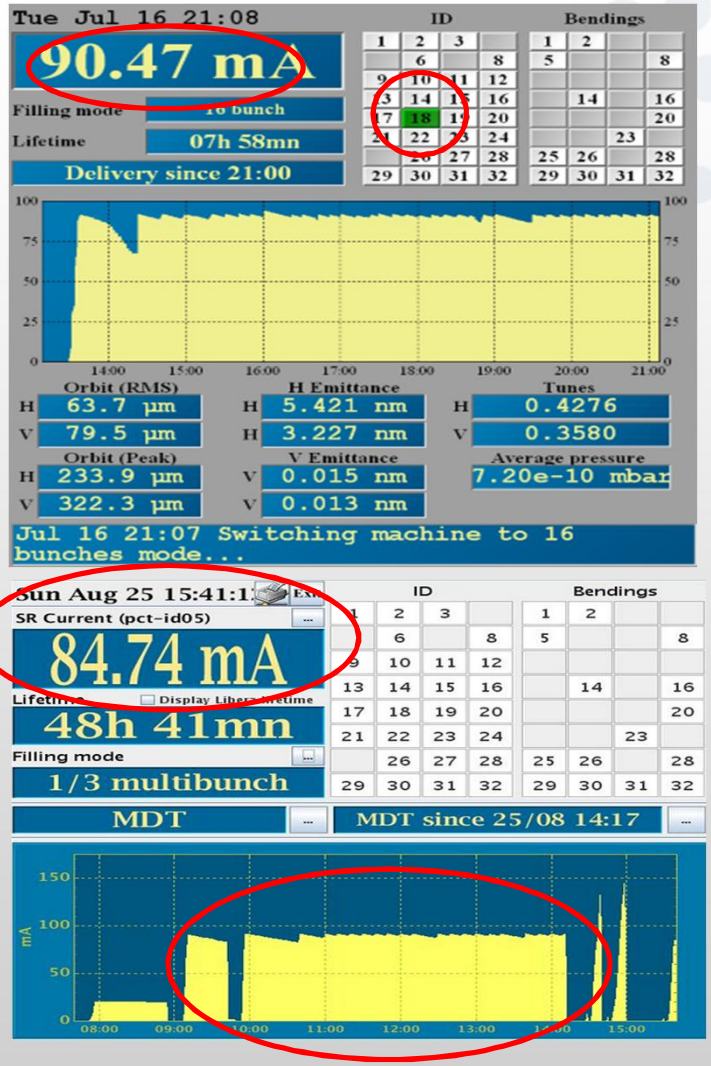
Create 2 lower vertical beta points to reduce the in-vacuum undulator gap from 6 to 4 mm

First 7 m straight section operational in January 2013

Two Mono-cell cavities installed in August 2013

Redistribute RF cavities to install undulators in the present dedicated RFstraight sections

PHASE 1: **Top-Up feasibility**

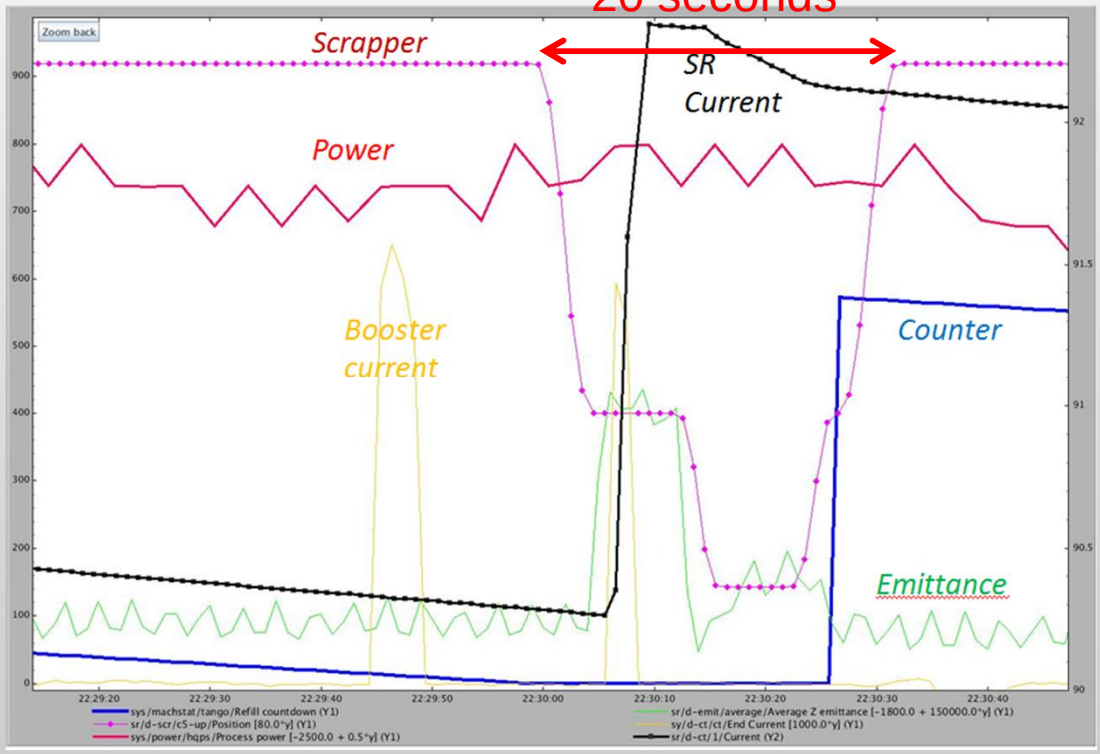


✓Optimise the topping sequence

✓Check the injector reliability

✓Reduce the injection time

20 seconds



Courtesy of JL Revol

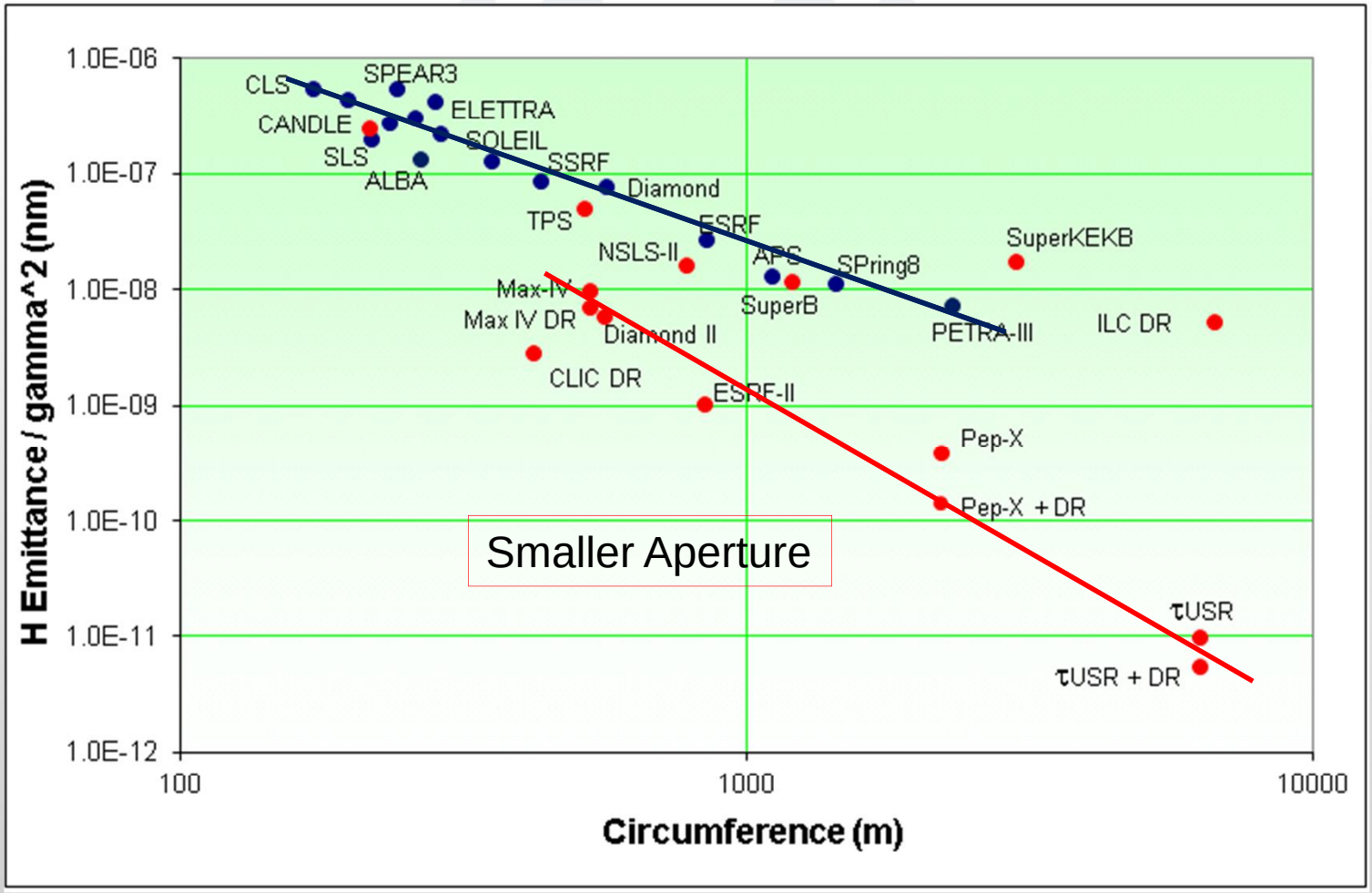
Storage ring performance (current and future sources)

horizontal emittance

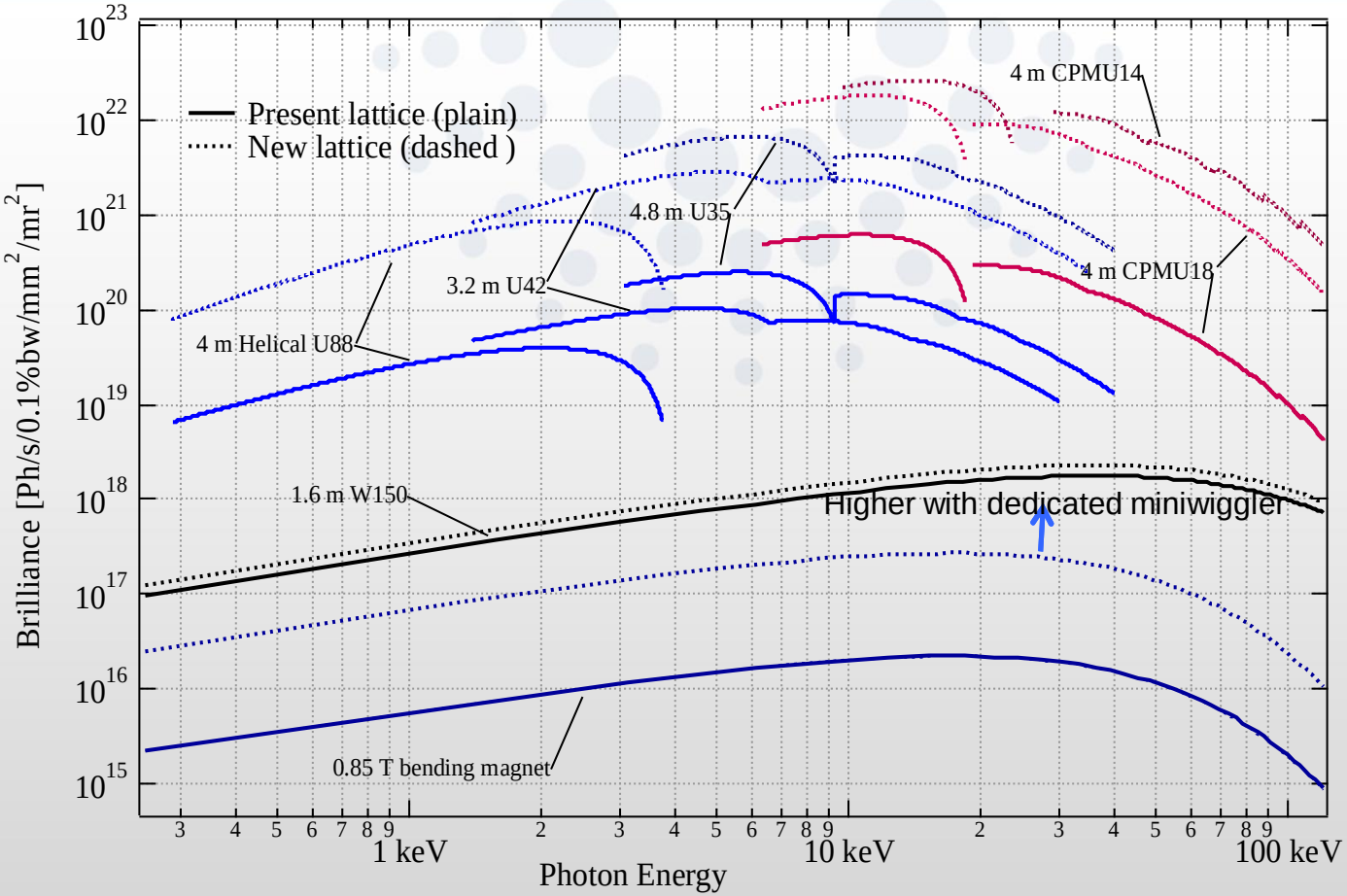
- ESRF 2BA **4000** pm – 6 GeV, operational
- PETRA III 2BA **1000** pm – 6 GeV, operational
- NSLS II 2BA **~350** pm – 3 GeV, construction
- MAX IV 7BA **~300** pm – 3 GeV, construction
- Sirius 5BA **~250** pm – 3 GeV, construction
- Spring-8 6BA **~70** pm – 6 GeV, in planning
- ESRF 7HBA **~150** pm – 6 GeV, in planning
- APS 7HBA **~60** pm – 6 GeV, in planning

Almost linear increase of brightness and coherence fraction down to 50-100pm
For lower emittance the gain becomes less than linear due to:
- the diffraction limit
- mismatch of the electron beam with the X-ray beam

Low Emittance Rings Trend



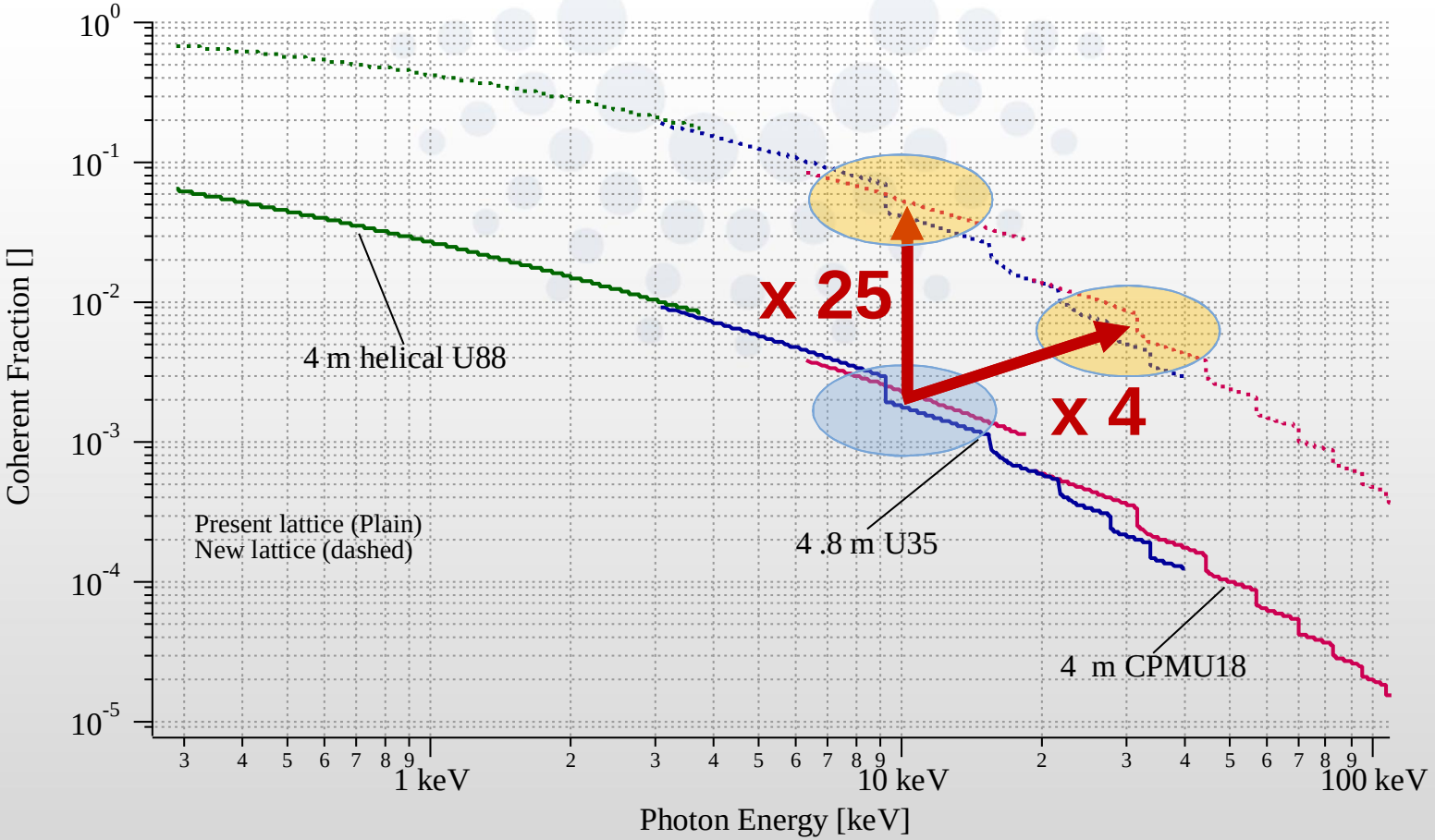
Brilliance at lower horizontal emittance



Hor. Emittance [nm]	**4**	**0.15**
Vert. Emittance [pm]	**3**	**2**
Energy spread [%]	**0.1**	**0.09**
β_x[m]/β_z [m]	**37/3**	**4.3/2.6**

E = 6.04 GeV
I = 200 mA

Coherence at lower horizontal emittance



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E = 6.04 GeV
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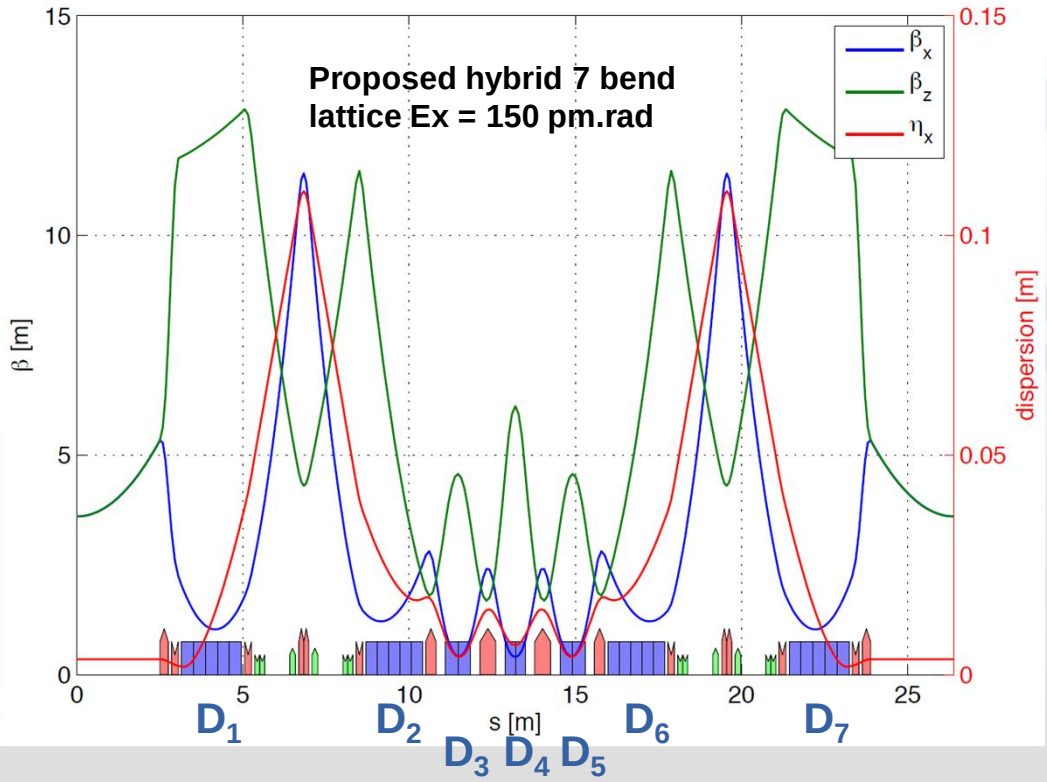
The ESRF low emittance lattice



Bleu: Dipoles Red: Quadrupoles Green: sextupoles

Design still evolving, iterating between:

Optics optimization: general performances in terms of emittance, dynamic aperture, energy spread etc…

Magnets requirements: felds, gradients…

Vacuum system requirements: chambers, absorbers, pumping etc

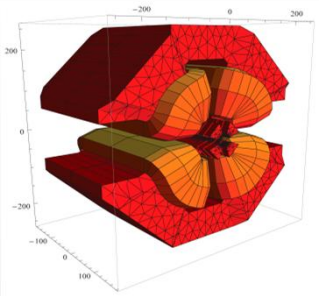
Diagnostic requirements

Bending beam lines source (Joel presentation)

Design should be very close to be frozen by June 2014

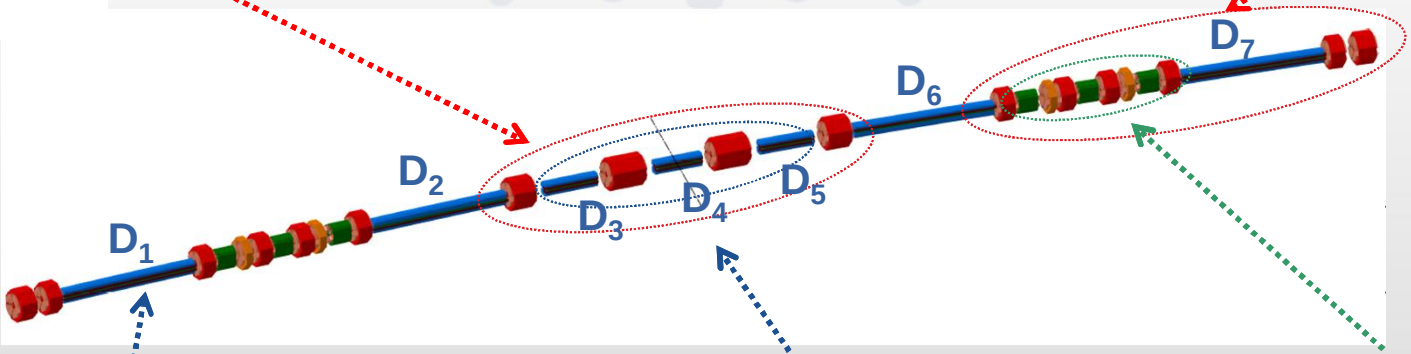
Technical challenge: magnet system

High gradient quadrupoles 100 Tm^{-1}



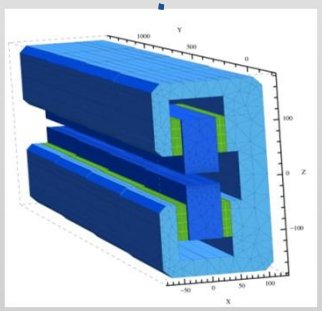
- Spec:100 T/m x 335 mm
- **Bore radius: 11 mm**
- Mechanical length: 360-500 mm
- 1-2 kW

Quadrupole
Around 60Tm^{-1}



Combined dipole quadrupoles
0.85 T / 45 Tm^{-1} & 0.34 T / 50 Tm^{-1}

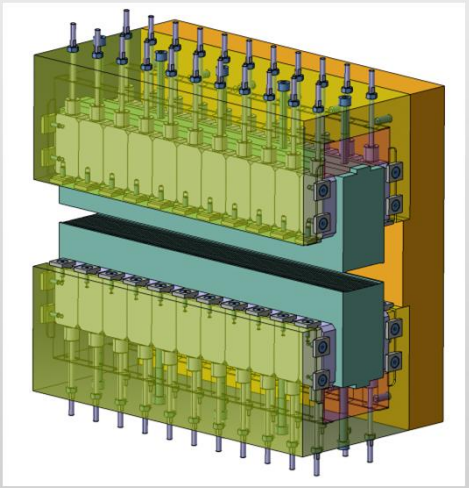
Sextupoles
200mm
1500 Tm^{-2}



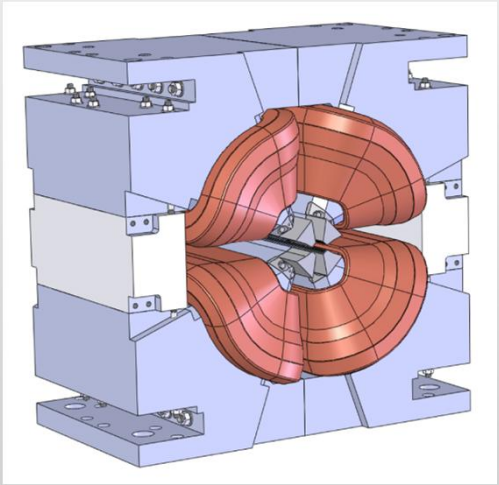
Permanent magnet (Sm_2Co_{17}) dipoles
longitudinal gradient 0.16 – 0.6 T, magnetic gap 22 mm
2 metre long, 5 modules
With a small tuning coil 1%

Magnet Design Status

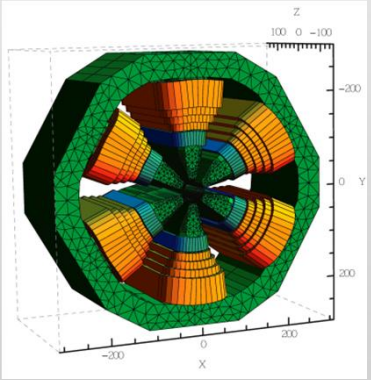
- Dipole, quadrupole, sextupole and octupole are well advanced
- Combined dipole-quadrupole in progress
- Prototyping started



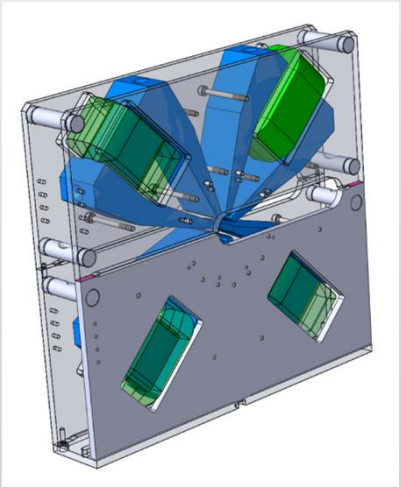
PM dipole module



High gradient quadrupole

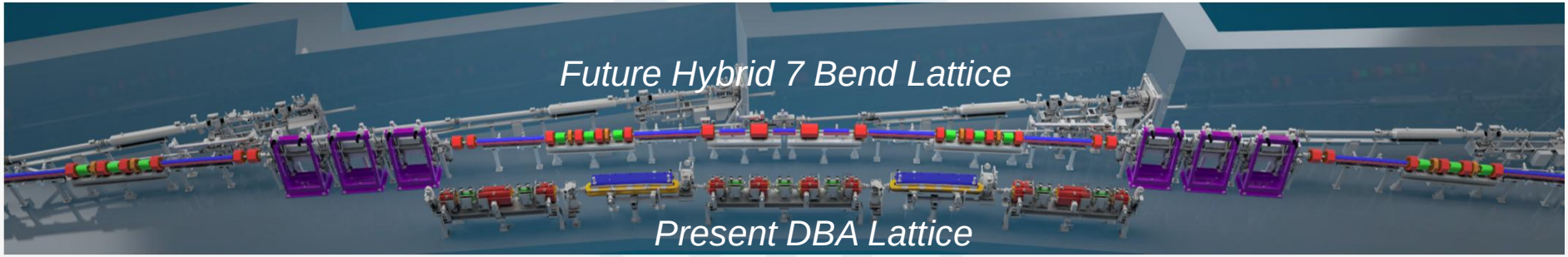


Sextupole



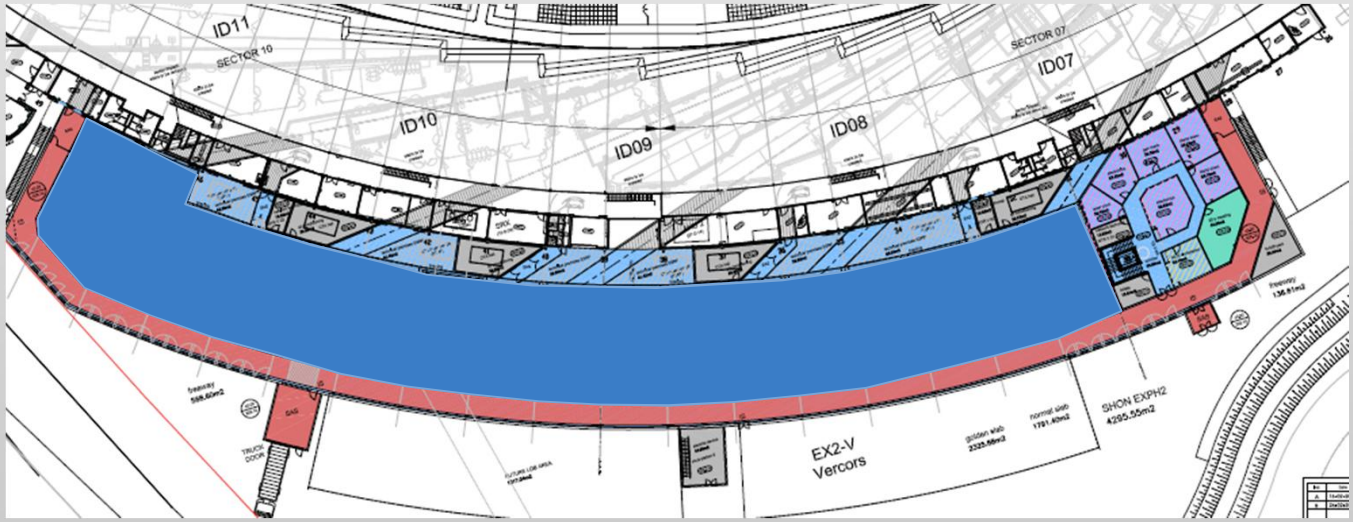
Octupole

Implementation



@ Extension of the experimental hall to provide
2500 m2 of preparation and storage area

@ Dismount and reconstruct the whole storage ring in about
9 months in 3 sliding parallel working areas



Use the hall later for long beamlines and support facilities

Road map

Schedule:

◊ *Nov 2012*	White paper ✓ Done
Nov 2012- Nov 2014	Technical Design Study ✓ TDS in progress
◊ *Nov 2014*	Council decision
Jan 2015 – Aug 2018	TDR and procurement
◊ *End 2016*	Preparation and storage building
Aug 2018– Aug 2019	Shutdown for installation and commissioning
◊ *Autumn 2019*	Back to operation

First APAC Meeting held on 5-6 September
Very positive and constructive event
3 APAC Meetings foreseen in 2014 (first on January 23-25)
Very positive feedback by last SAC and Council meetings (last two months)

Budget:

100 M€	Construction and commissioning of the new storage ring lattice
10 M€	Extension for the experimental hall extension
20 M€	Four state of the art beamlines
20 M€	Instrumentation and support facilities

Conclusions (1)

All the **Phase I** related developements are continuing, but are more and more related/finalized to Phase II.

Phase II TDS progressing.

ESRF personnel resources are being carefully reallocated on Phase II activities.

Extra resources are being procured.

Full benefits are expected for the beginning of the construction Phase (2015)

Conclusions (2)

Thanks to the large expertise gained during **ESRF UP Phase I** and the worldwide efforts to develop an Ultimate Storage Ring **ESRF Upgrade Phase II** will be an excellent opportunity to:

- Drastically increase the brightness of our Light Source to maintain world-wide excellence for the next 1-2 decades
- Improve and expand the science reach of the SR-based light sources
- Enable new technologies
- Provide important know-how to continue the push for higher performances the SR-based Light Sources

At least 2 more facilities (APS and Spring8) are also considering to upgrade their machines with the same strategy

Many thanks for your attention