ESRF | The European Synchrotron

ESRF Accelerator Operation and Upgrade Status Report

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On behalf of the Accelerator & Source Division

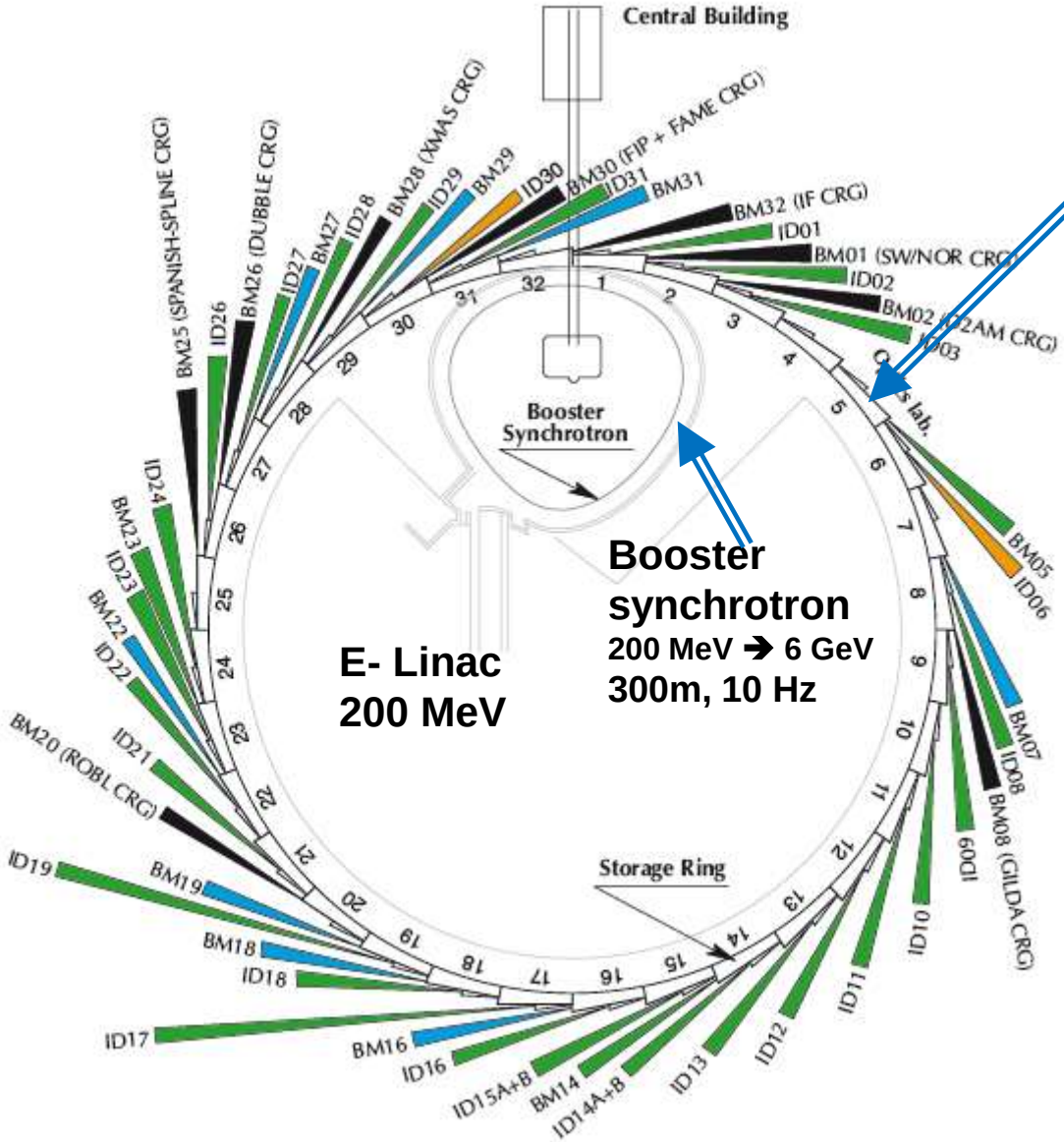
Frascati, July 24 - 2014

ACCELERATOR AND SOURCE DIVISION (ASD) PROGRAMME

- **Deliver the X-ray Beam to the USERs > 5000 hours/year**
- **Deliver the Accelerator Phase I Upgrade Programme**
- **Implement the proposed Accelerator Phase II Upgrade Project**

The ASD has the additional duty of constantly improving the performances and reliability of the Source independently from the Upgrade Programmes.

The ESRF today



Storage ring
6GeV, 844 m

Energy	GeV	6.04
Multibunch Current	mA	200
Horizontal emittance	nm	4
Vertical emittance	pm	3.5

32 straight sections

DBA lattice

42 Beamlines

12 on dipoles

30 on insertion devices

72 insertion devices:
55 in-air undulators, 6 wigglers,
11 in-vacuum undulators, including
2 cryogenic

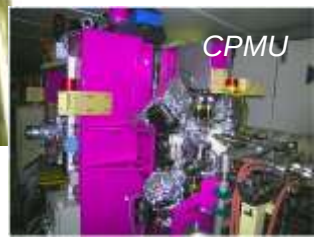
ACCELERATOR UPGRADE PHASE I 2009-2015 MAIN PROJECTS

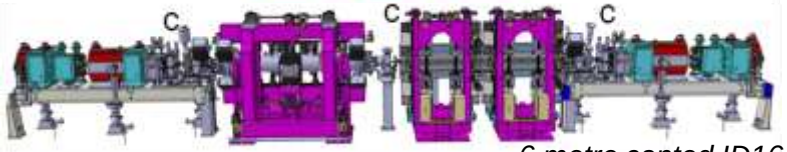
- **Upgrade of BPM electronics** ✓Done

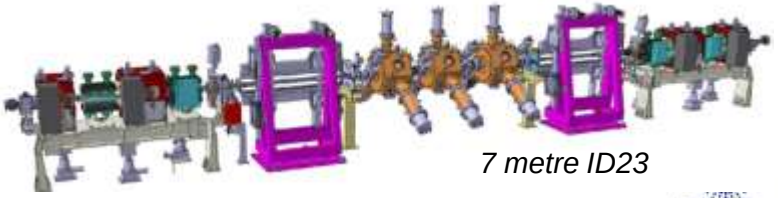
Improvement of the beam position stability ✓Done

Coupling reduction ✓Done *(4pm)*

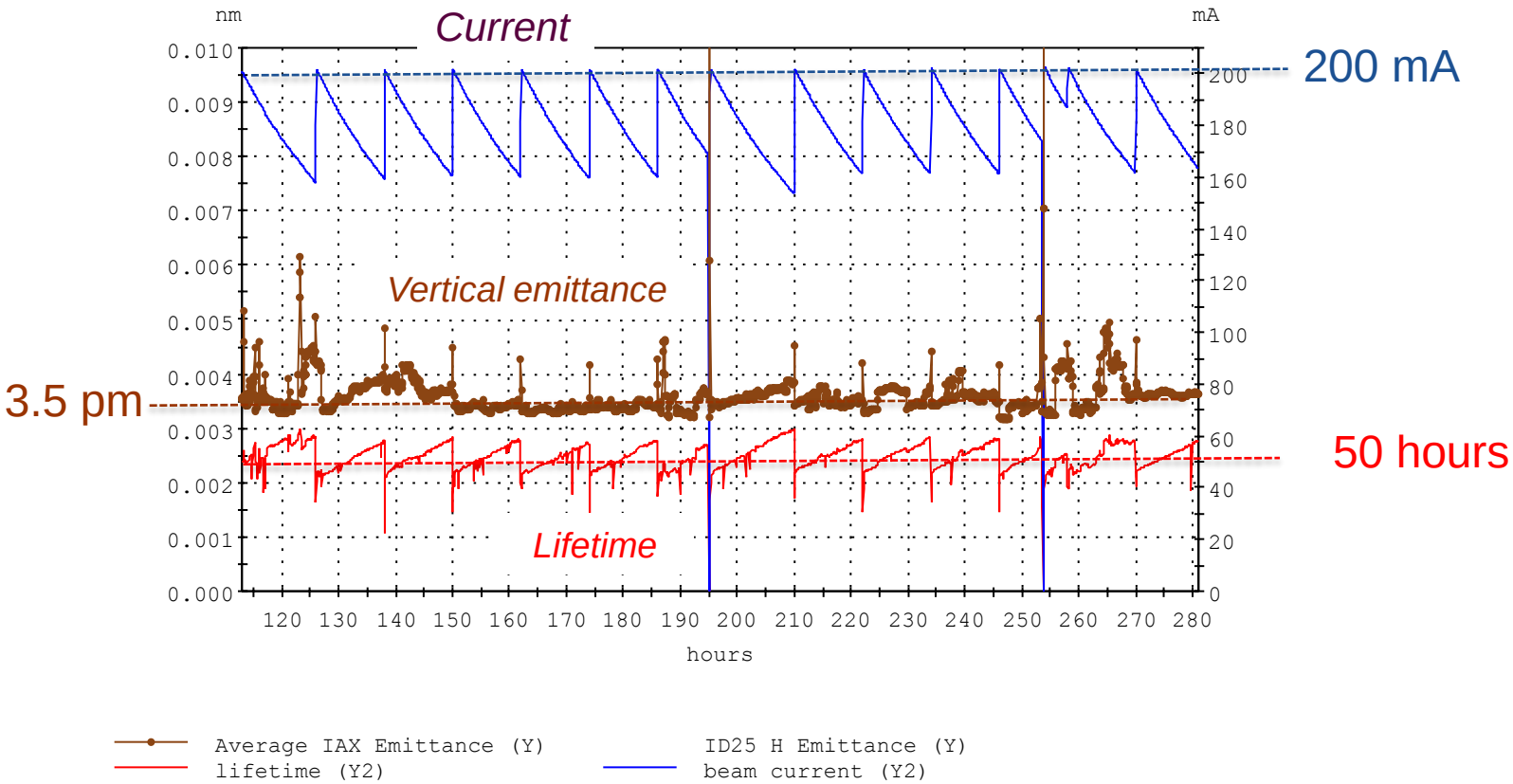
- **6 m long straight sections** ✓Done
- **Cryogenic in-vacuum undulators** ✓Done
- **7 m straight sections** ✓Done
- **New RF SSA Transmitters** ✓Done
- **New RF Cavities** ✓Done
- **Top-up operation** ✓Project ongoing
- **Studies for the reduction of the horizontal emittance** ✓TDS completed







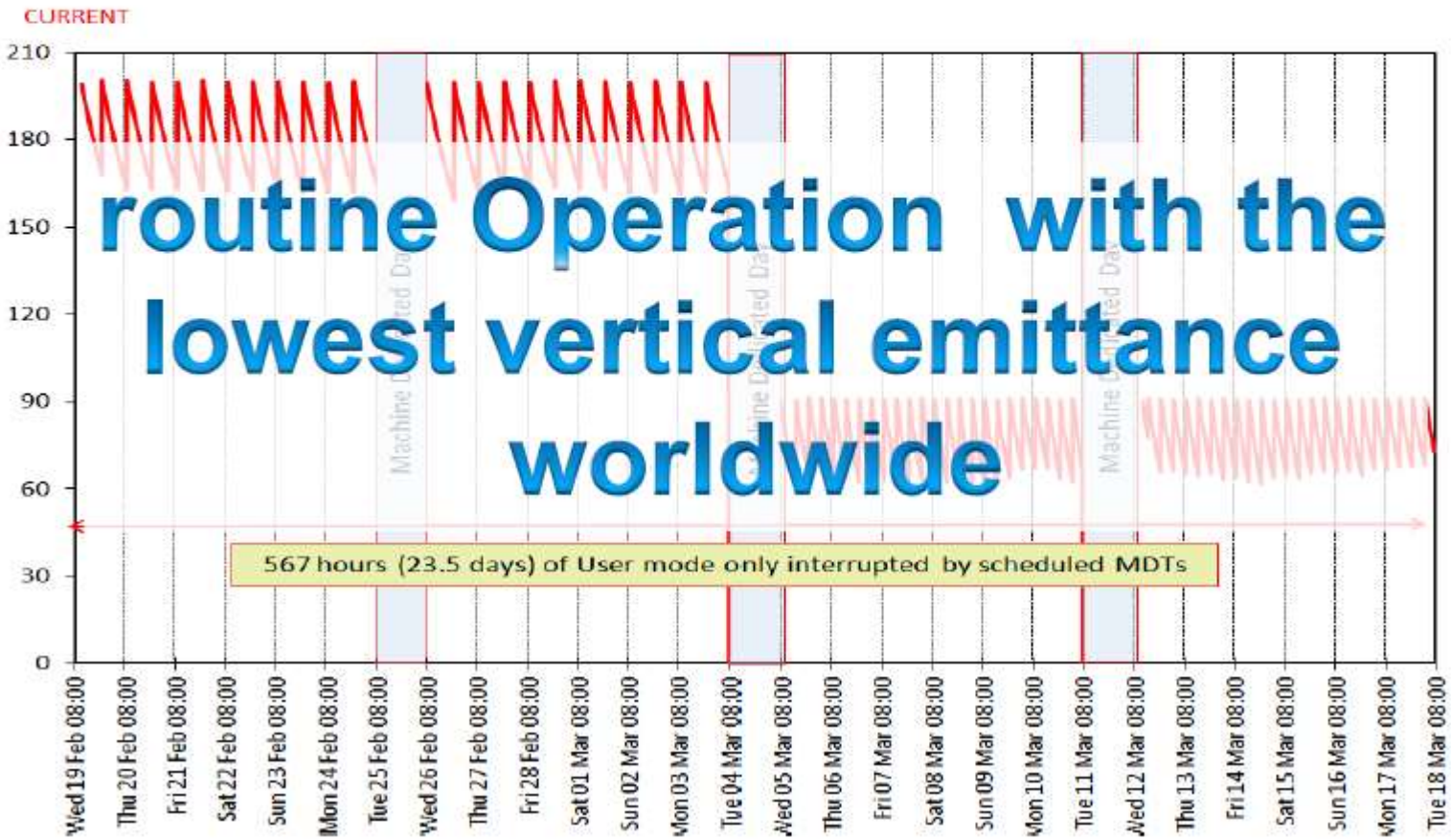
Maintaining low emittance during USM: 1 week delivery



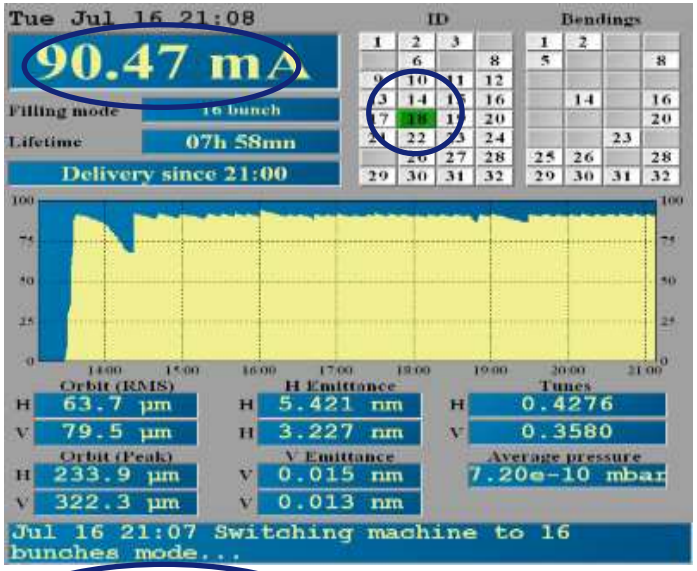
@ Vertical Diffraction Limit reached routinely

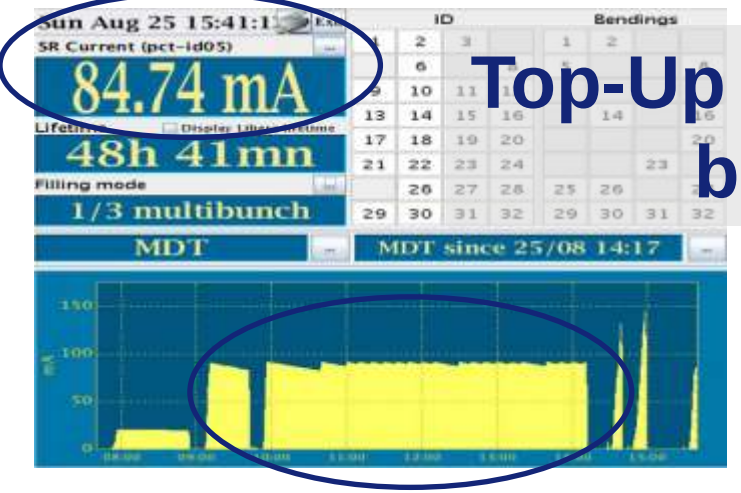
OPERATION STATISTICS

Run 2014-01: 567 hours of USM interrupted only with scheduled Machine Dedicated Time

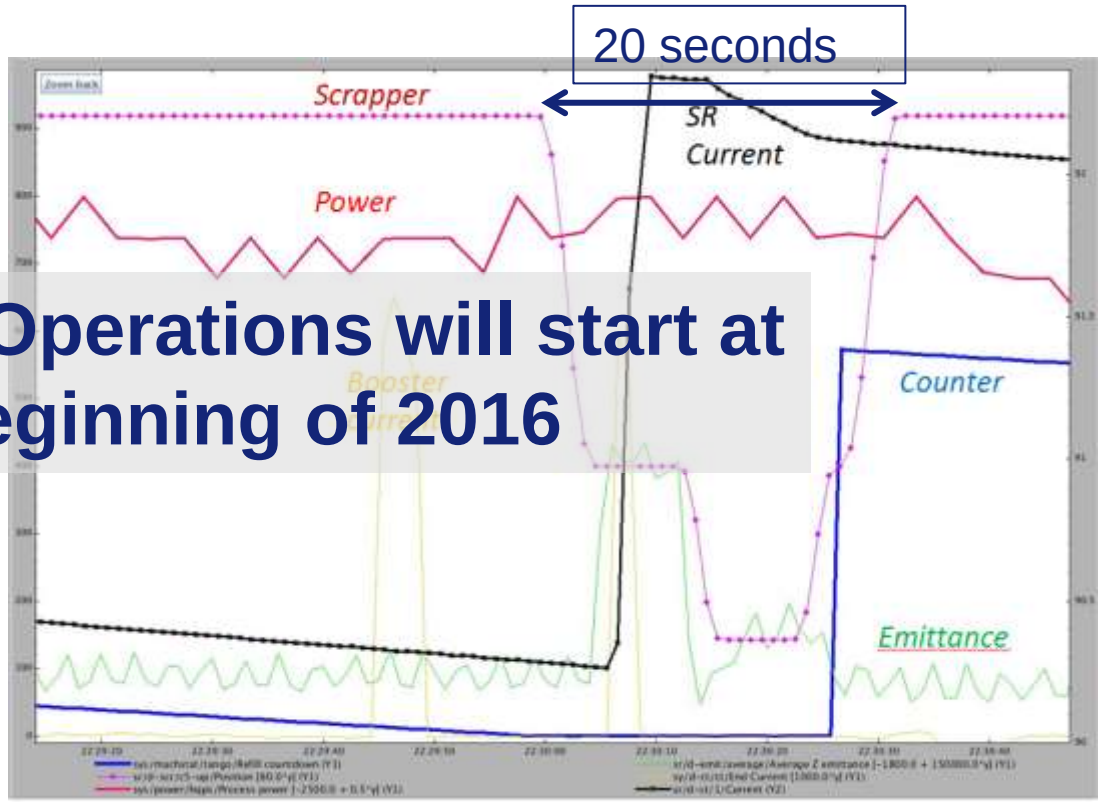


PHASE I: TOP-UP FEASIBILITY



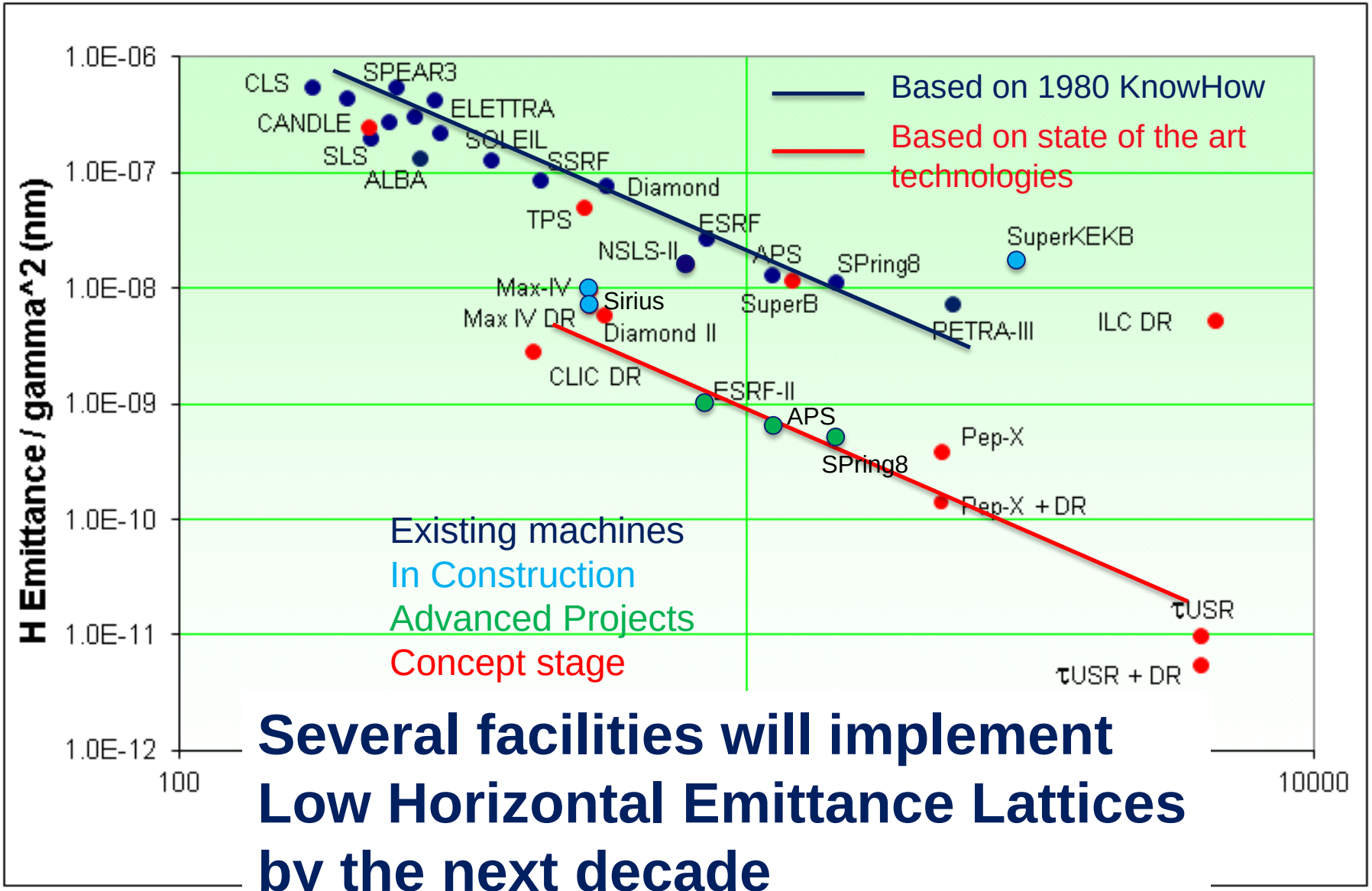


- ✓Optimise the topping sequence
- ✓Check the injector reliability
- ✓Reduce the injection time



Top-Up Operations will start at beginning of 2016

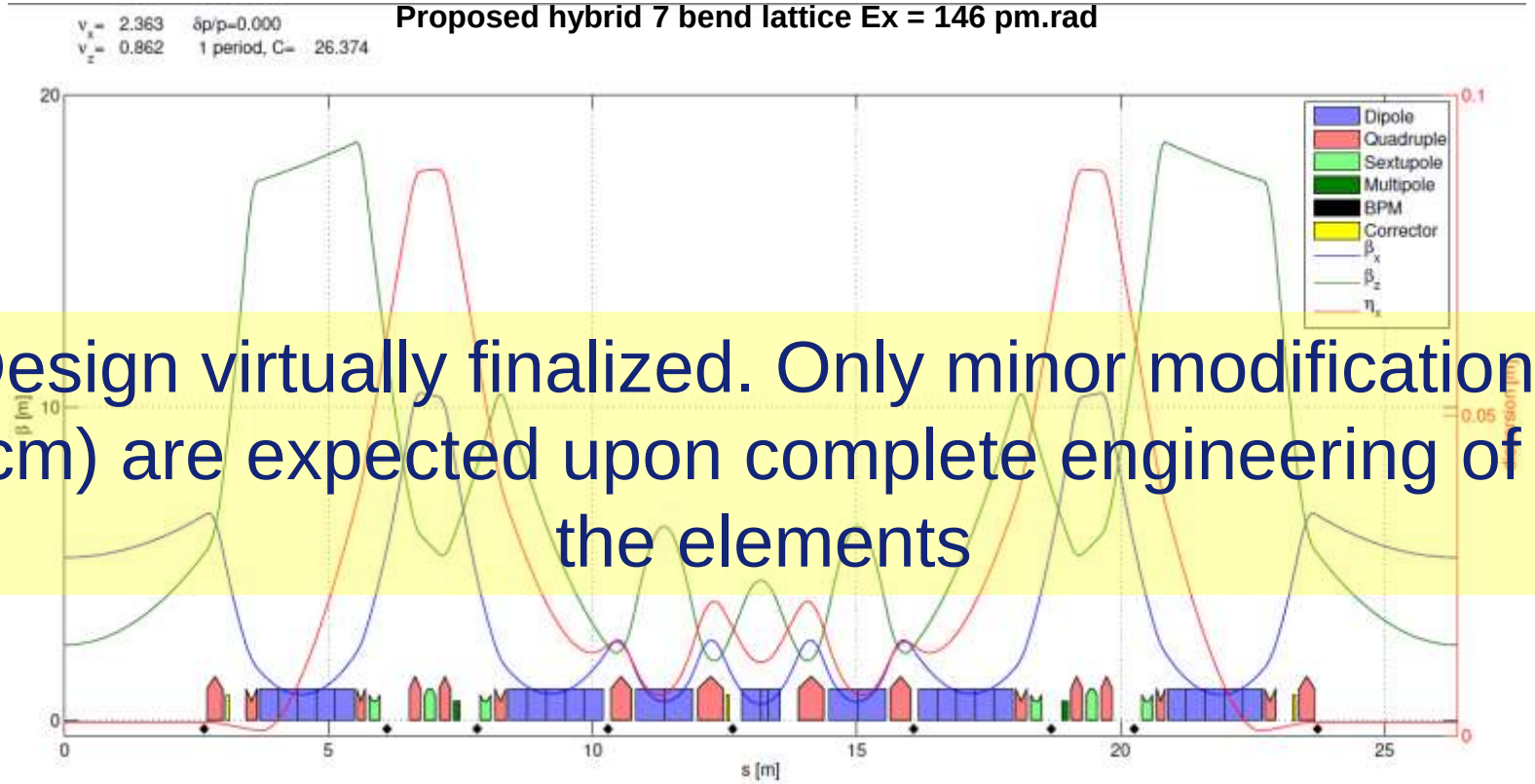
LOW EMITTANCE RINGS TREND



Several facilities will implement Low Horizontal Emittance Lattices by the next decade

The ESRF Low Emittance Lattice

Proposed hybrid 7 bend lattice Ex = 146 pm.rad

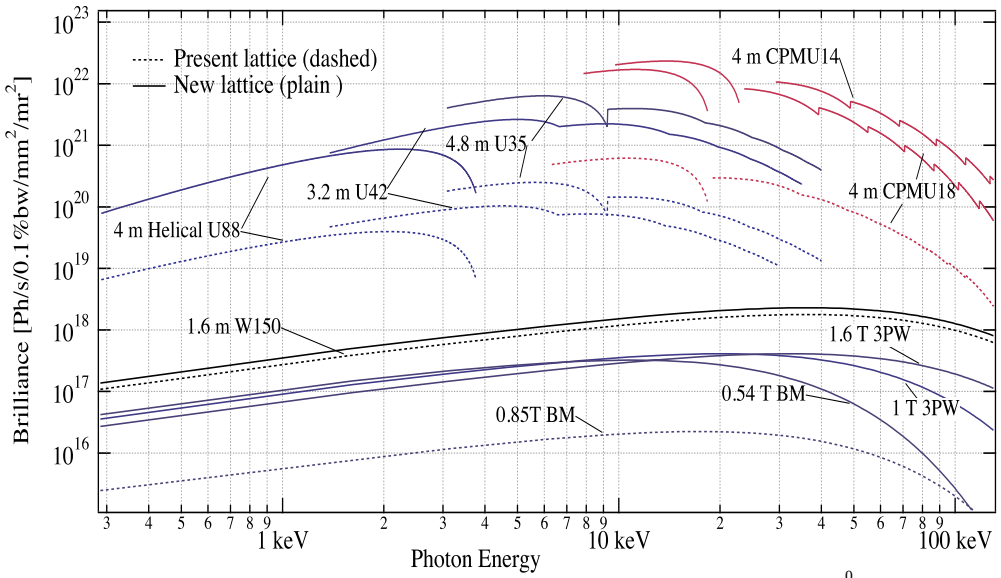


Design virtually finalized. Only minor modifications (~cm) are expected upon complete engineering of all the elements

Several iterations made between:

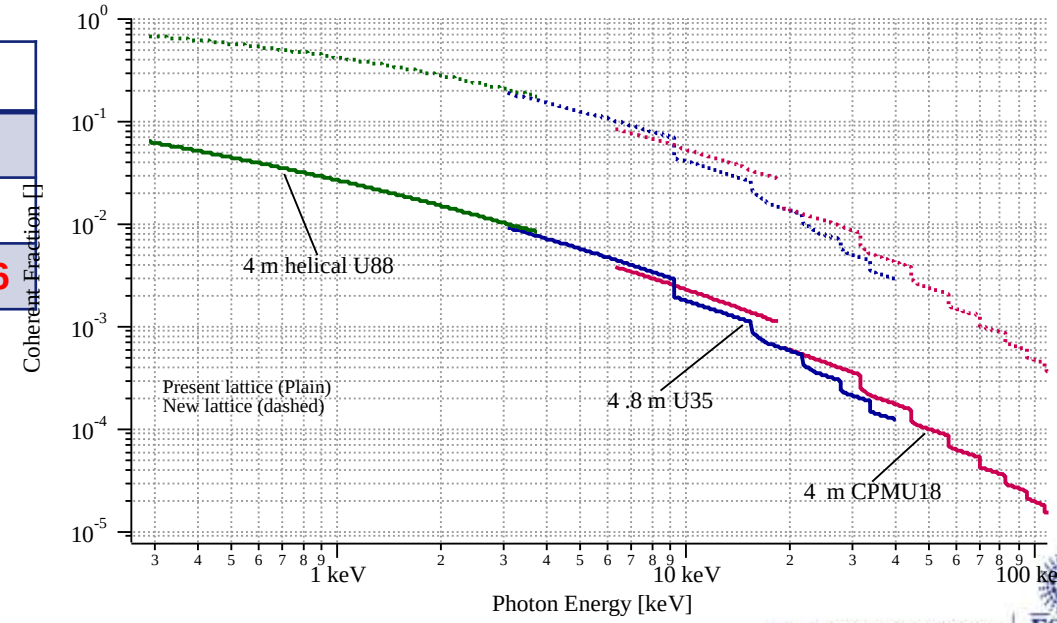
- Optics optimization: general performances in terms of emittance, dynamic aperture, energy spread etc…
- Magnets requirements: felds, gradients…
- Vacuum system requirements: chambers, absorbers, pumping etc
- Diagnostic requirements
- Bending beam lines source

BRILLIANCE AND COHERENCE INCREASE



Brilliance

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



Coherence

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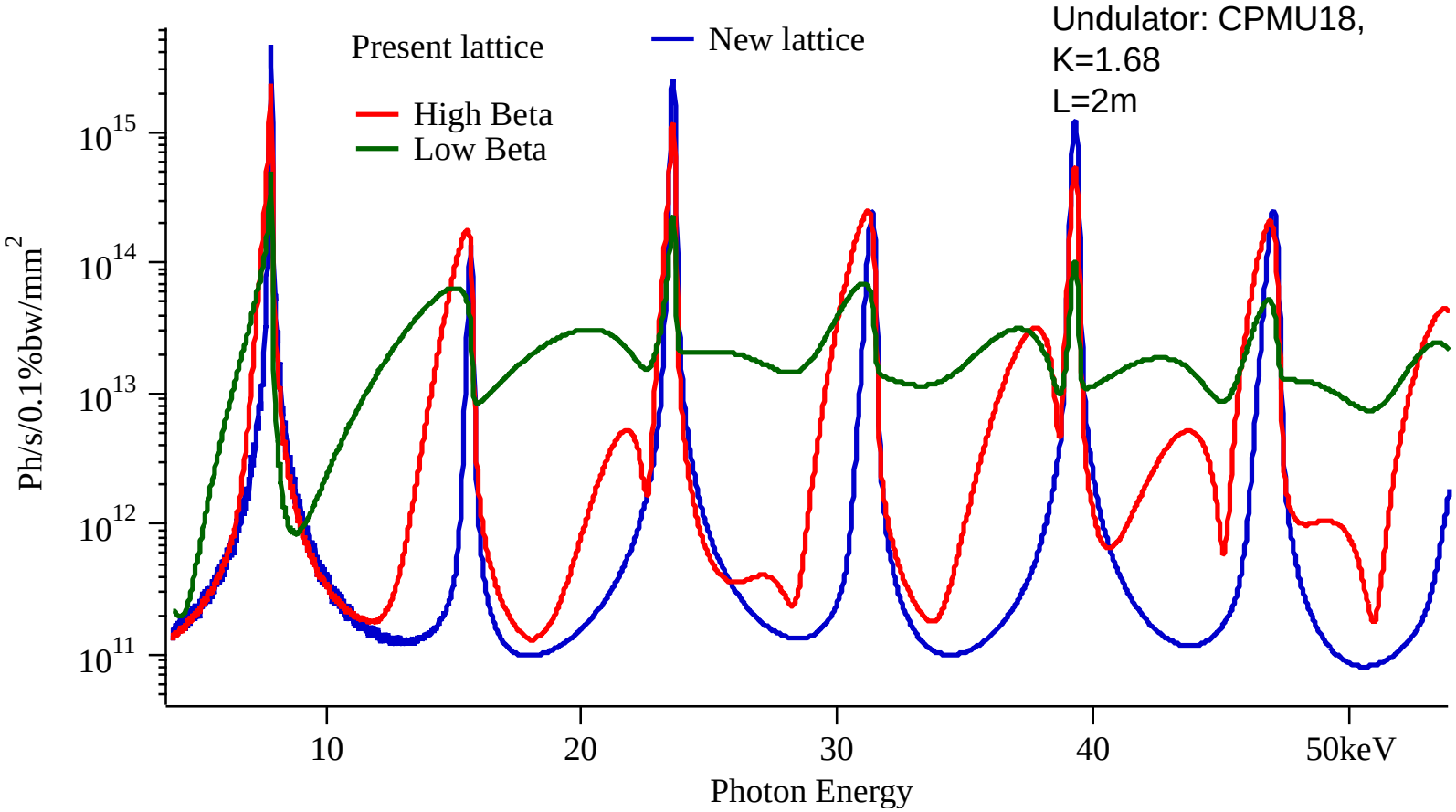
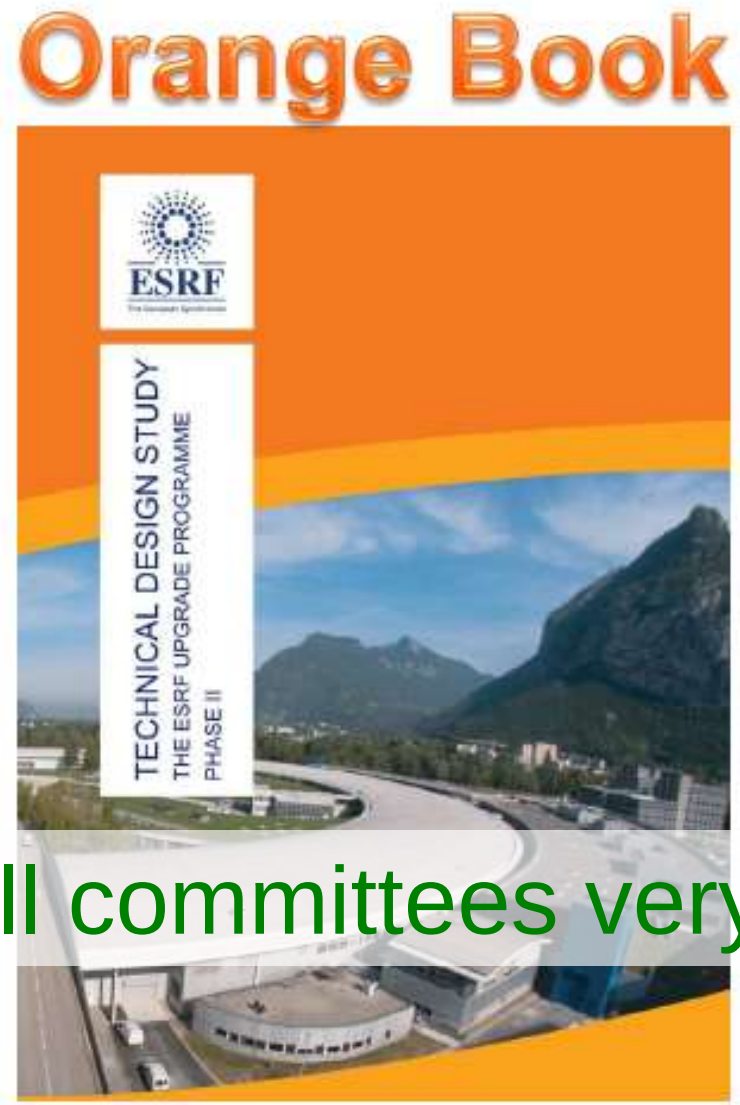
IMPROVEMENT OF UNDULATOR X-RAY BEAM



Hor. Emittance [nm]	**4**	**0.15**
Vert. Emittance [pm]	**3**	**2**
Energy spread [%]	**0.1**	**0.09**
β_x[m] High/Low	**37/0.3**	**5.2**
β_z [m]	**3.1**	**2.6**

PREPARING THE UPGRADE PHASE II



Technical Design Study (TDS)
Completed and submitted to:

Science Advisory Committee (SAC)

Accelerator Project Committee (APAC)

Cost Review Panel (CRP)

ESRF Council

All committees very positive to go ahead

ACCELERATOR PROJECT ROADMAP

Project Schedule:

◊ *Nov 2012*	White paper	✓Done
Nov 2012- Nov 2014	Technical Design Study	✓TDS submitted for review
◊ *June 2014*	Project approved by Council	
Jan 2015 – Oct 2018	Design finalized, Prototypes, Procurement, Pre-Assembly	✓Design very advanced ✓Prototyping in progress
Oct 2018 – Sep 2019	Installation	
Sep 2019 – Jun 2020	Commissioning	
◊ *Jun 2020*	User Mode Operation	

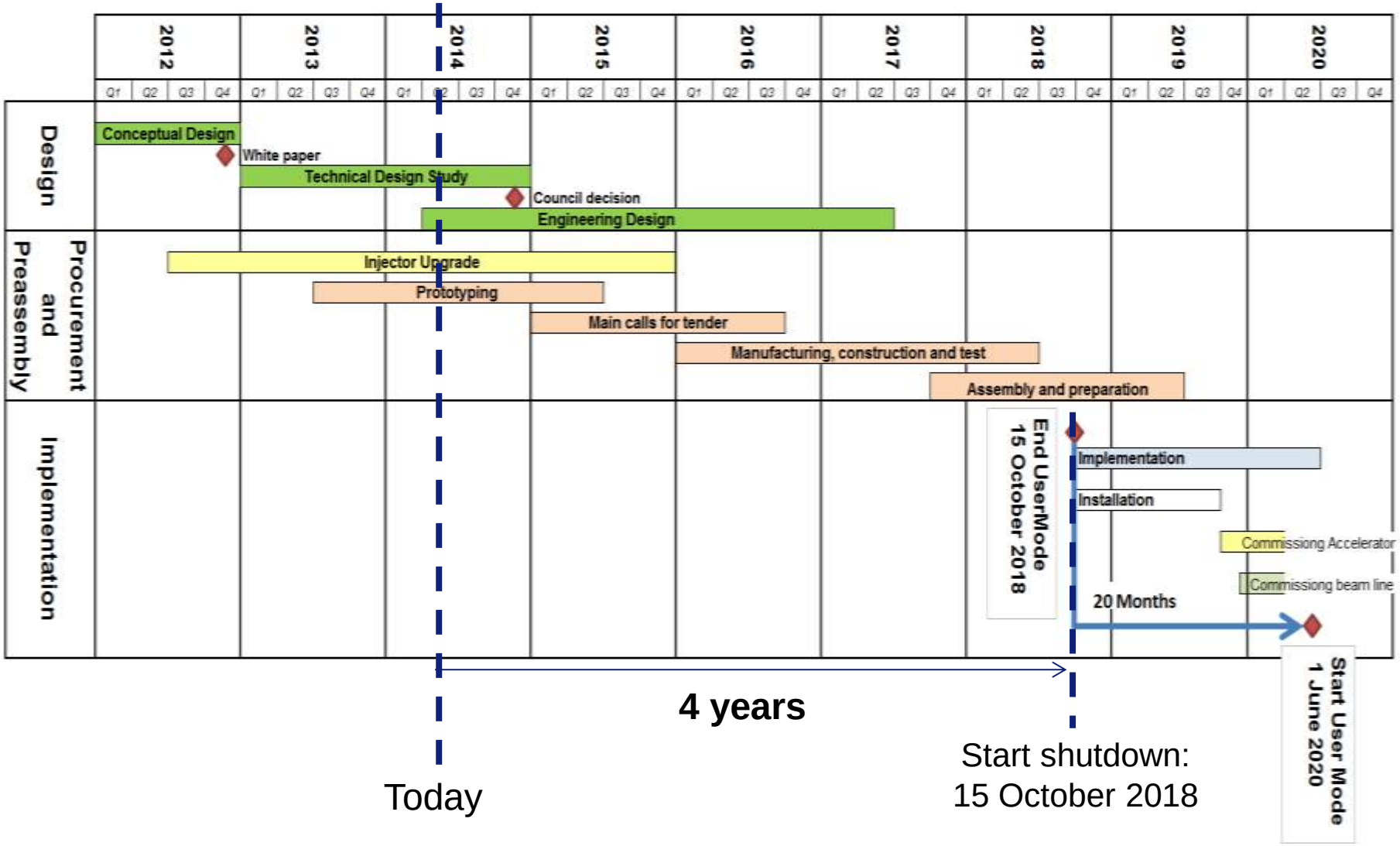
10 Work Packages defined in the TDS:

- *WP0: Installation*
- *WP1: Beam dynamics*
- *WP2: Magnets*
- *WP3: Mechanical and Vacuum Engineering*
- *WP4: Power supplies*
- *WP5: Radiofrequency*
- *WP6: Control System*
- *WP7: Diagnostics and feedbacks*
- *WP8: Photon source*
- *WP9: Injector upgrade*

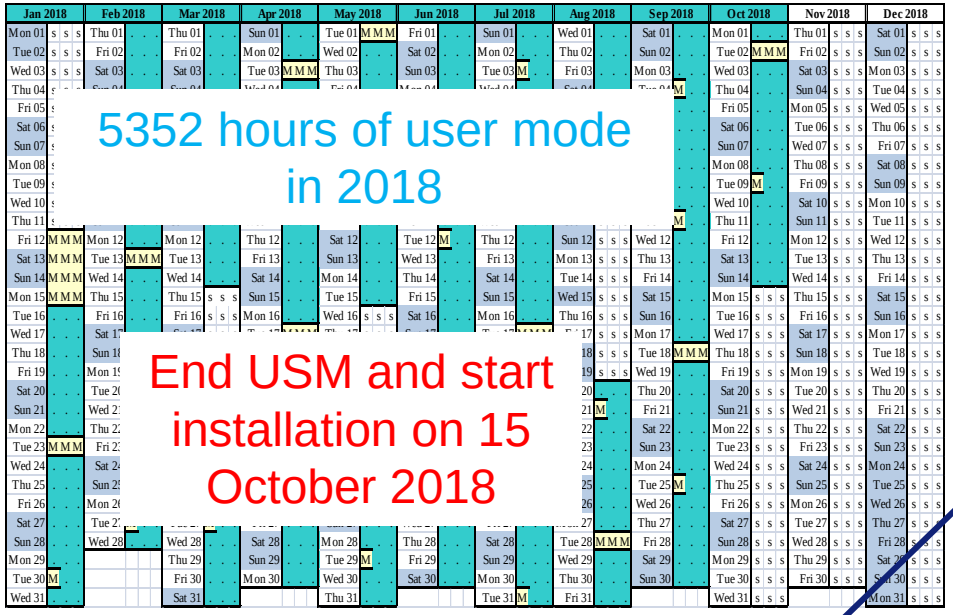
Accelerator Project Budget:

103.5 M€ Construction and commissioning of the new storage ring

TIME SCALE

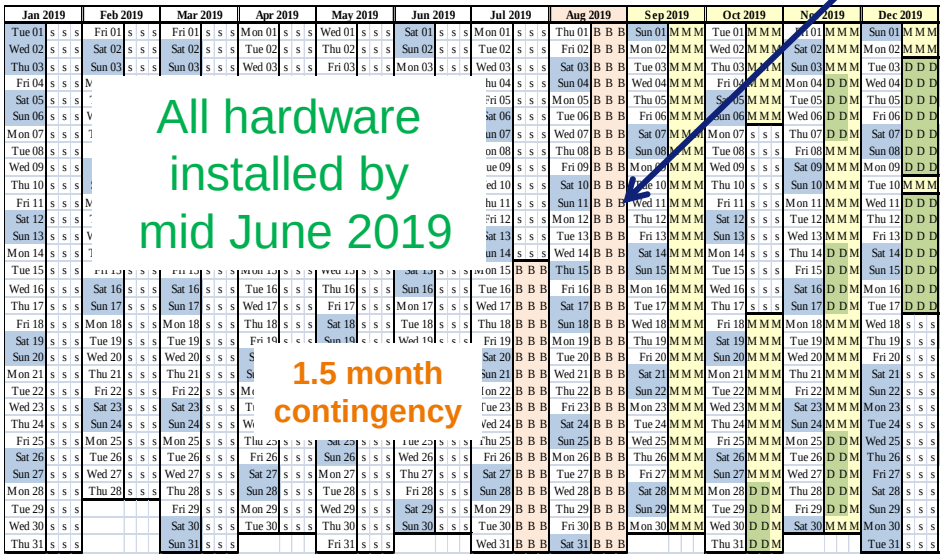

2012
2013
2014
2015
2016
2017
2018
2019
2020
Q1 Q2 Q3 Q4
Design
Conceptual Design
White paper
Technical Design Study
Council decision
Engineering Design
Procurement and Preassembly
Injector Upgrade
Prototyping
Main calls for tender
Manufacturing, construction and test
Assembly and preparation
Implementation
Implementation
Installation
Commissiong Accelerator
Commissiong beam line
End UserMode 15 October 2018
20 Months
Start User Mode 1 June 2020
4 years
Today
Start shutdown: 15 October 2018

INSTALLATION: 15 OCTOBER 2018 – 01 JUNE 2020



5352 hours of user mode in 2018

End USM and start installation on 15 October 2018



All hardware installed by mid June 2019

1.5 month contingency

Commissioning start beginning September 2019

Yellow =machine

Green = beamlines

Start User mode beginning June 2020

3 months contingency

Upgrade Foreward

In the June 2014 ESRF Council Meeting:

- The Phase II Upgrade Programme was approved and launched

- The Accession of Russian to the ESRF was approved as well. This greatly help to secure the financial aspect of the Upgrade

ESRF is building collaborations with many labs:

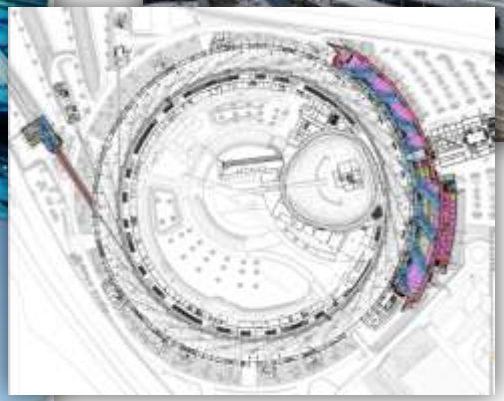
- **Established an MOU with INFN, to be followed by collaboration contracts for designing and building critical components**

- **Under finalization an MOU with Advanced Photon Source (APS), in order to share expertise and know (APS has decided to cut-and-paste the ESRF upgrade scheme)**

- **Collaboration with Diamond on many topics of common interest…**

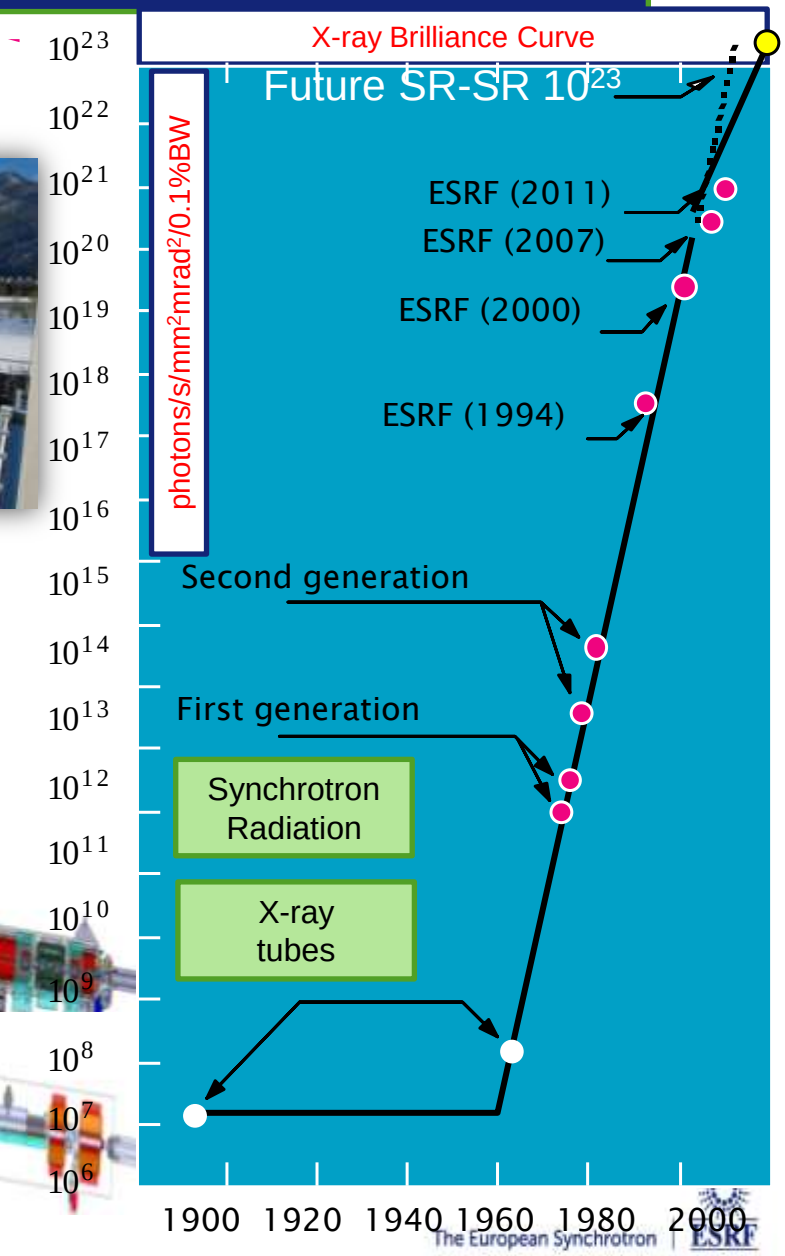
- **Possible involvement of BINP on design and fabrication phases.**

ESRF push toward higher performances



Present ESRF Lattice: Ex=4nm

Low Emittance Lattice: Ex=0.15nm



MANY THANKS FOR YOUR ATTENTION