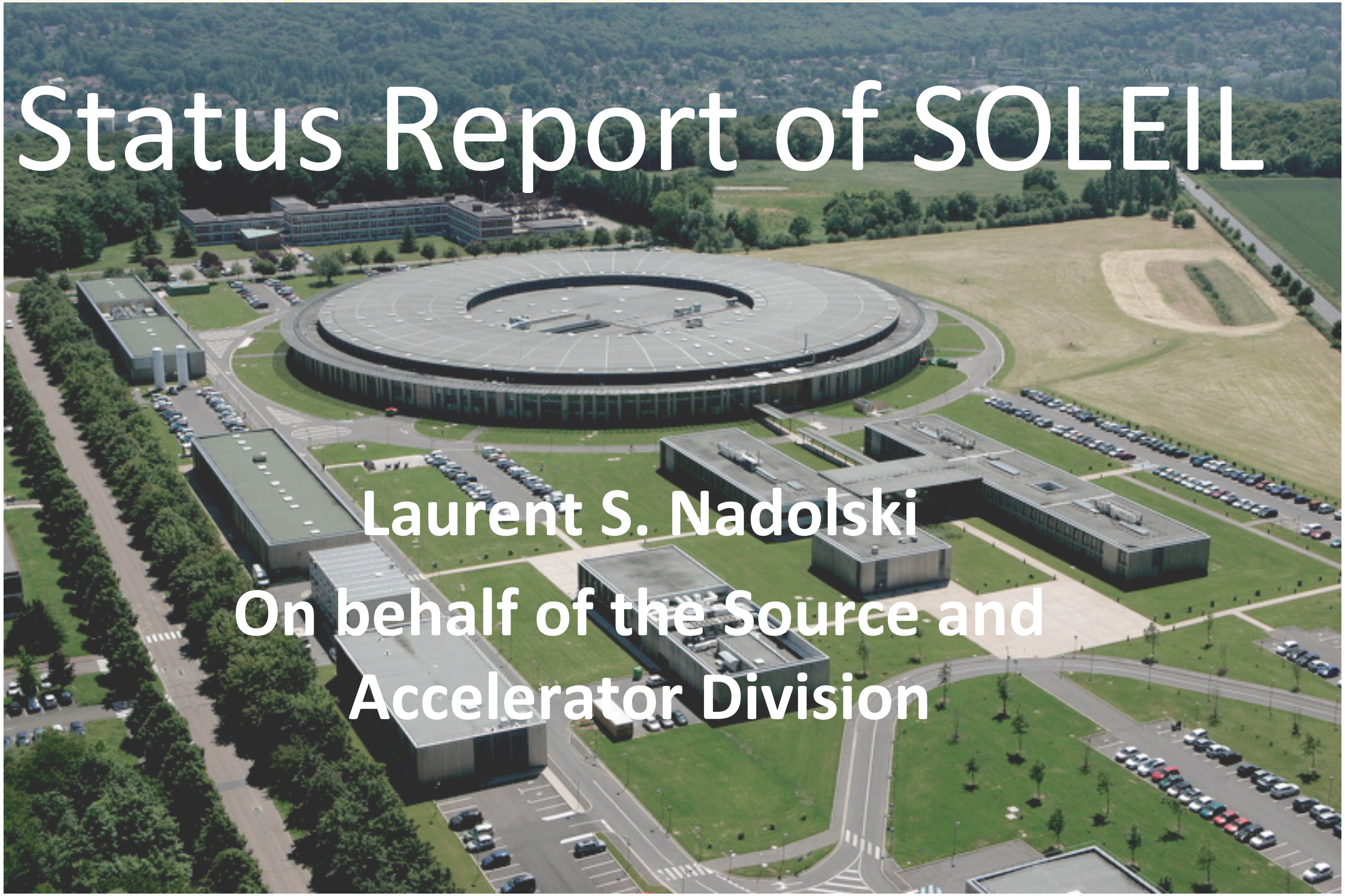


Status Report of SOLEIL

Laurent S. Nadolski
On behalf of the Source and Accelerator Division

Performance

STORAGE RING Parameters

Parameters	Design	Achieved as of Nov2011
Energy (GeV)	2.75	2.74
RF frequency (MHz)	352.202	352.196
Betatron Tunes	18.20 / 10.30	**18.202/10.310**
Natural Chromaticities	-53 / -23	**-51/-21**
Momentum Compaction α_1 / α_2	4.5×10^{-4} / 4.6×10^{-3}	4.5×10^{-4} / 4.6×10^{-3}
Emittance H (nm.rad)	3.73	3.73
Energy spread	1.016×10^{-3}	1.016×10^{-3}
Coupling, $\varepsilon_V/\varepsilon_H$	<1%	0.3% (w/o corr.) 0.9% (w/ corr.)
Current Multibunch mode (mA)	500	500 (400 for Users operation)
Average Pressure (mbar)	1×10^{-9}	1×10^{-9} @ 500 mA
Beam Lifetime (h)	**16 h**	20h @ 400 mA / 14h @ 500 mA
Single bunch current (mA)	12	20 (15 w/ IDs)
Beam position stability, μm (H)	20 (rms)	3 peak to peak
Beam position stability, μm (V)	0.8 (rms)	1 peak to peak

SOLEIL SYNCHROTRON

5 operation modes

① 400 mA 4/4, 1 % coupling, top-up

② 400 mA hybrid ¾ + 5 mA, 1% coupling, top-up

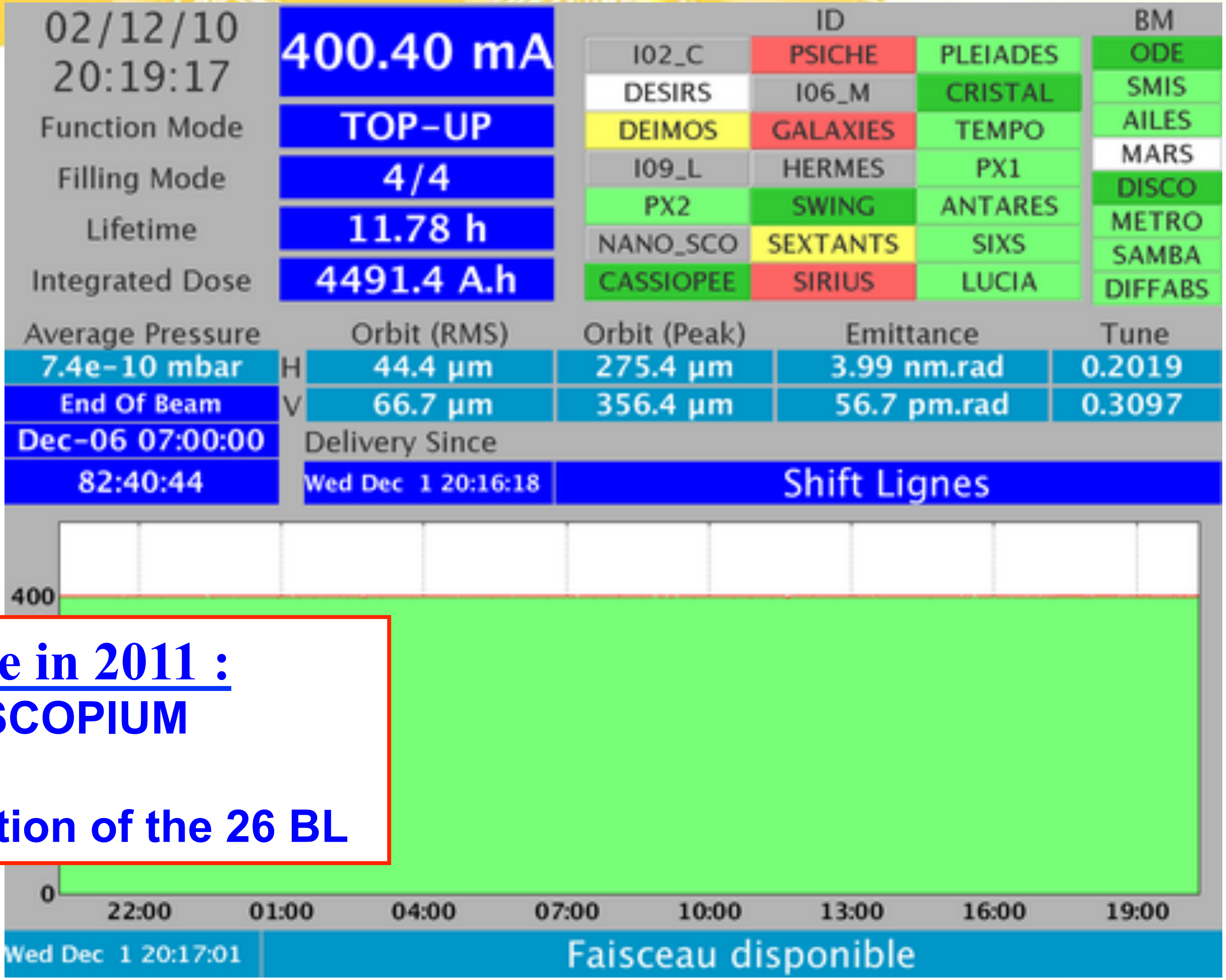
③ Single bunch 11 mA, 1% coupling, top-up

④ 8 bunch 100 mA, 1% coupling, top-up

⑤ Low alpha hybrid 20 mA ¾ + 20 µA, 4% coupling

25 Beamlines are taking beam

17 from IDs, 6 from BM + 2 IR

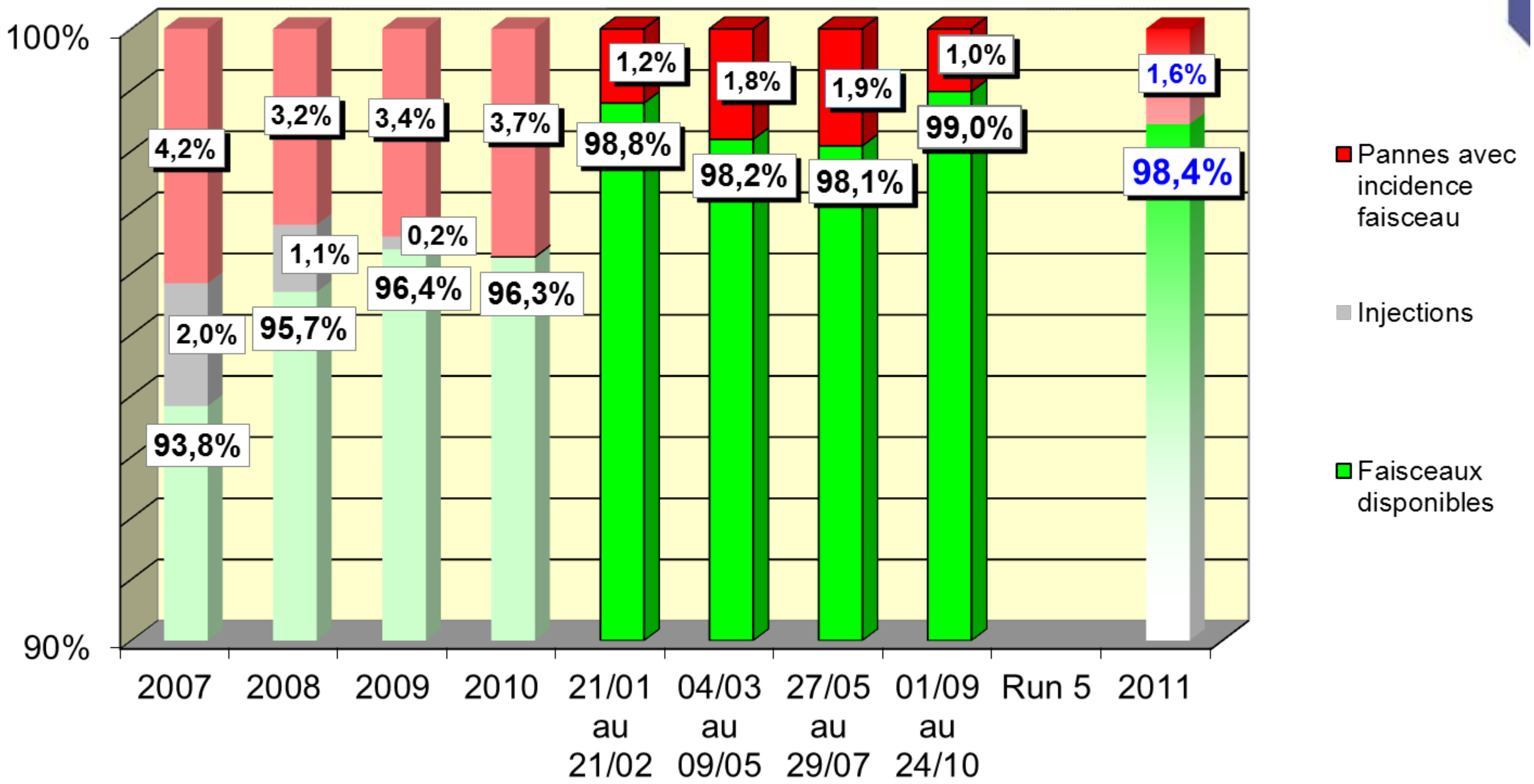


<u>To come in 2011 :</u>
- **NANOSCOPIUM**

Completion of the 26 BL

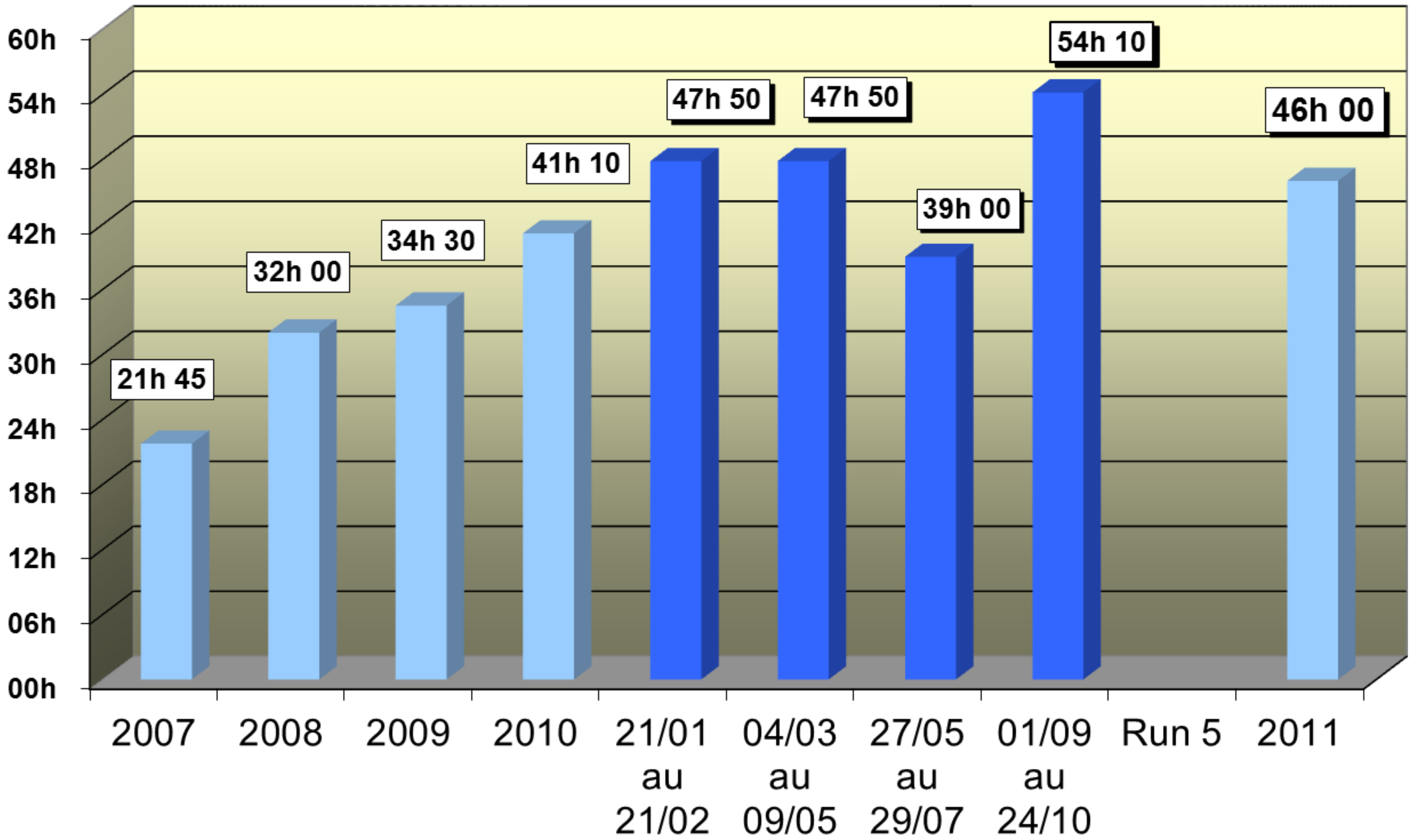
Beam availability in. Jan to Oct. 2011 (users+radiation safety)

4143 hours delivered: 98.4% of scheduled user beam time

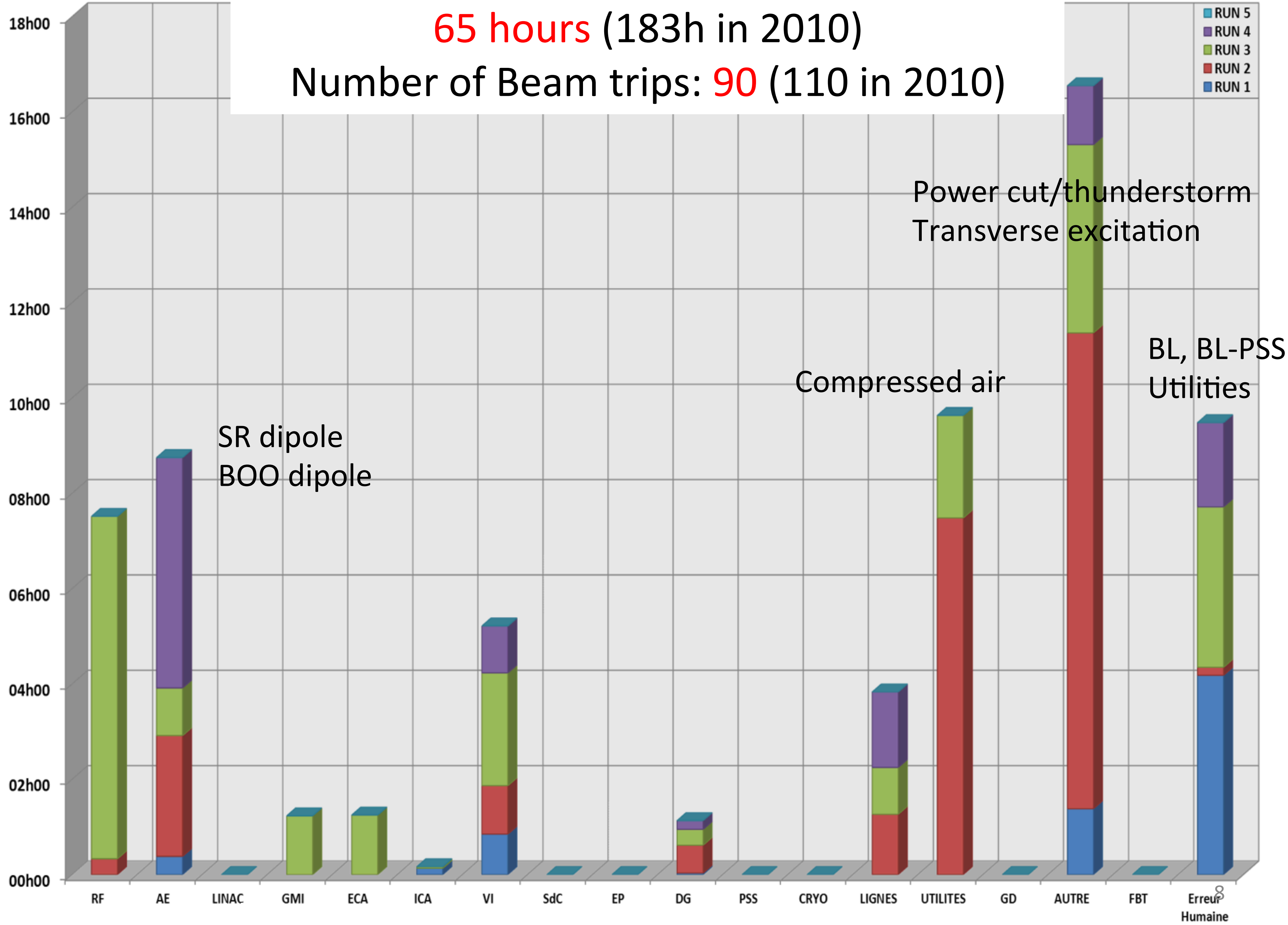


SOLEIL SYNCHROTRON

Averaged Mean Time Between Failure (MTBF) from January to October 2011: 46 hours



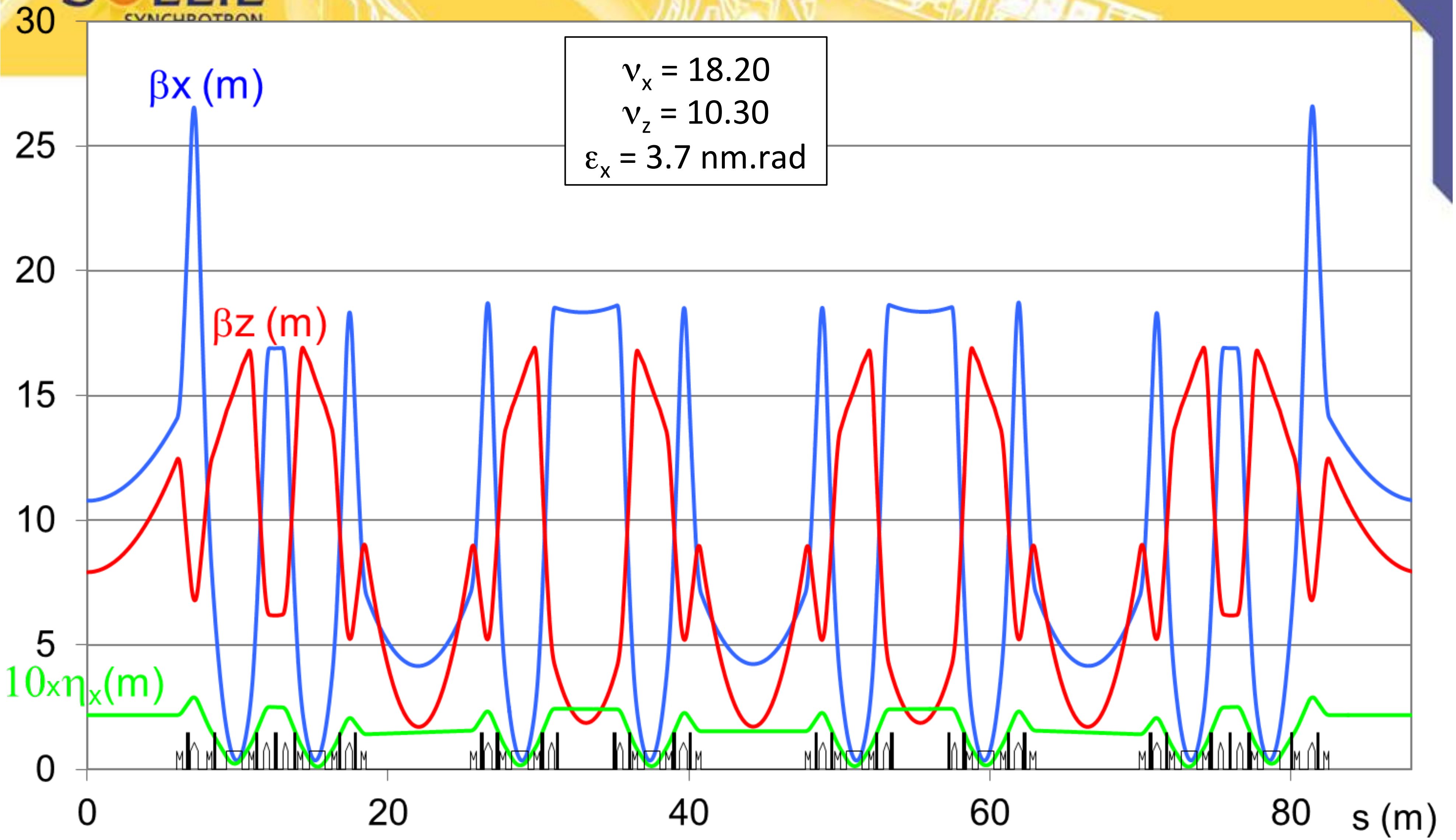
Total beamtime lost from Jan. to Oct. 2011:
65 hours (183h in 2010)
Number of Beam trips: 90 (110 in 2010)



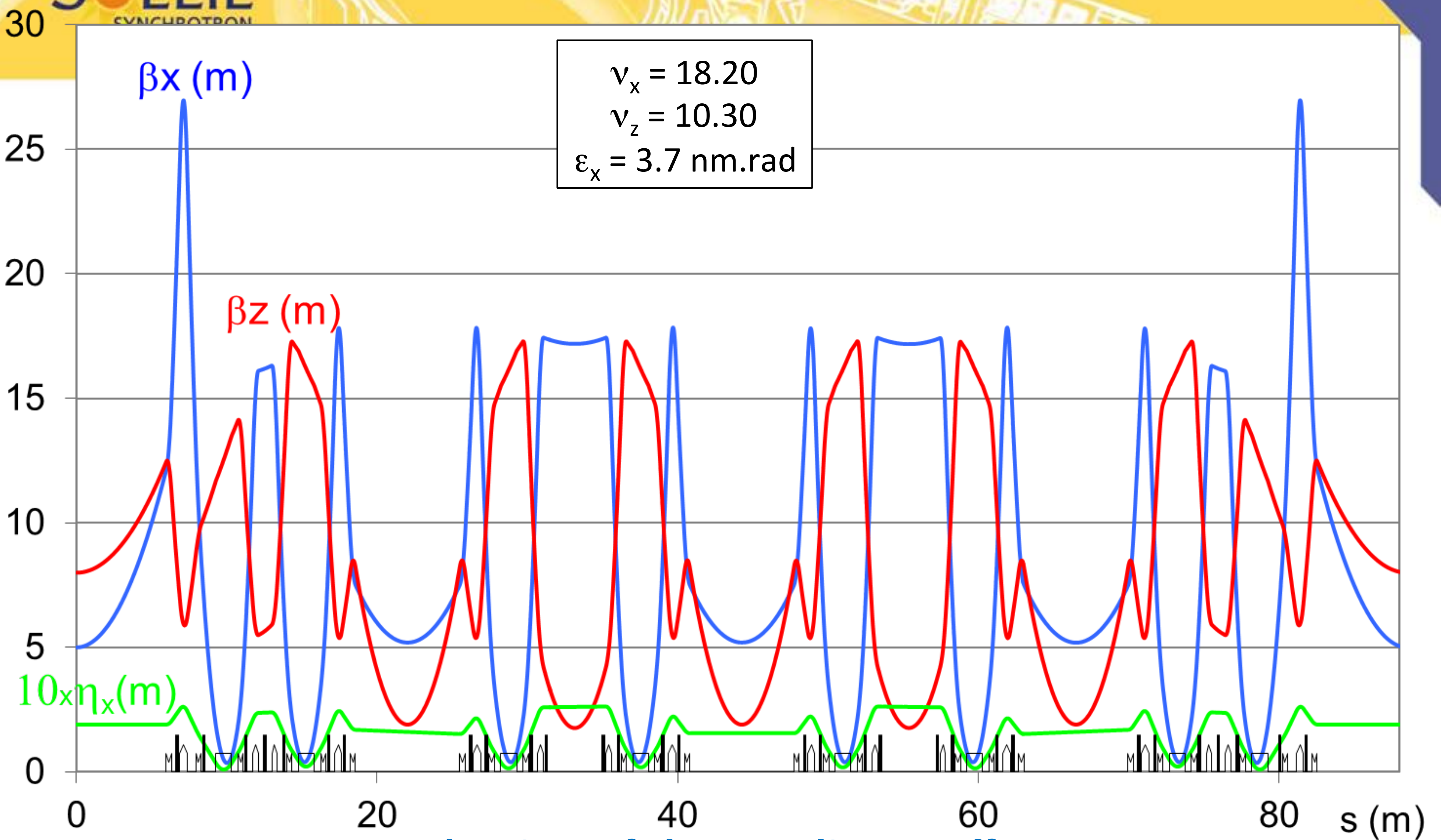
New optics for users

1. Reducing H-beta for IDs
2. Toward Double low beta optics
3. Low alpha/small emittance

NOMINAL Optics
In operation from May 2006 to November 2010

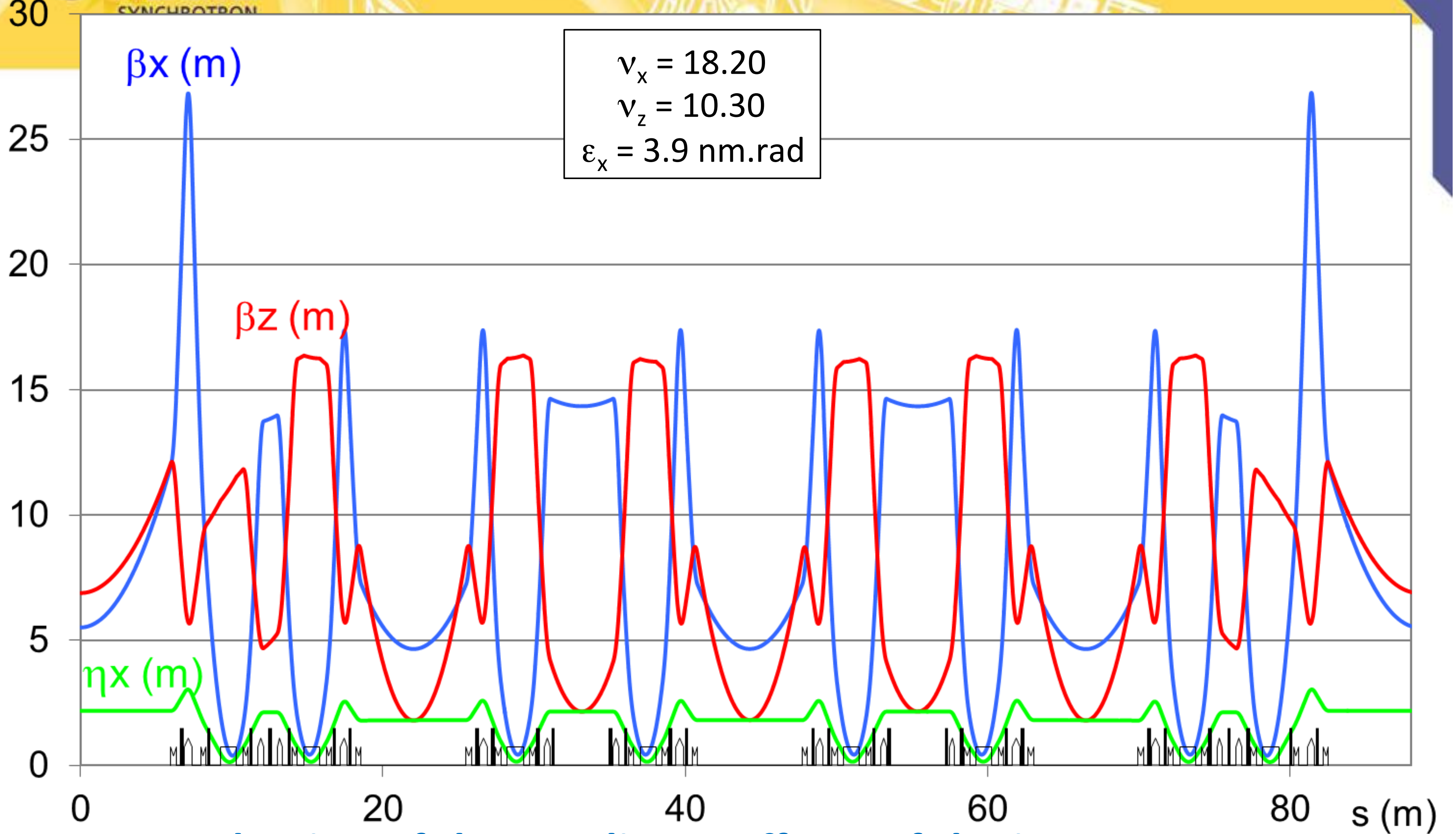


Optics with Low βx in Long straight sections
In operation from November 2010 to July 2011



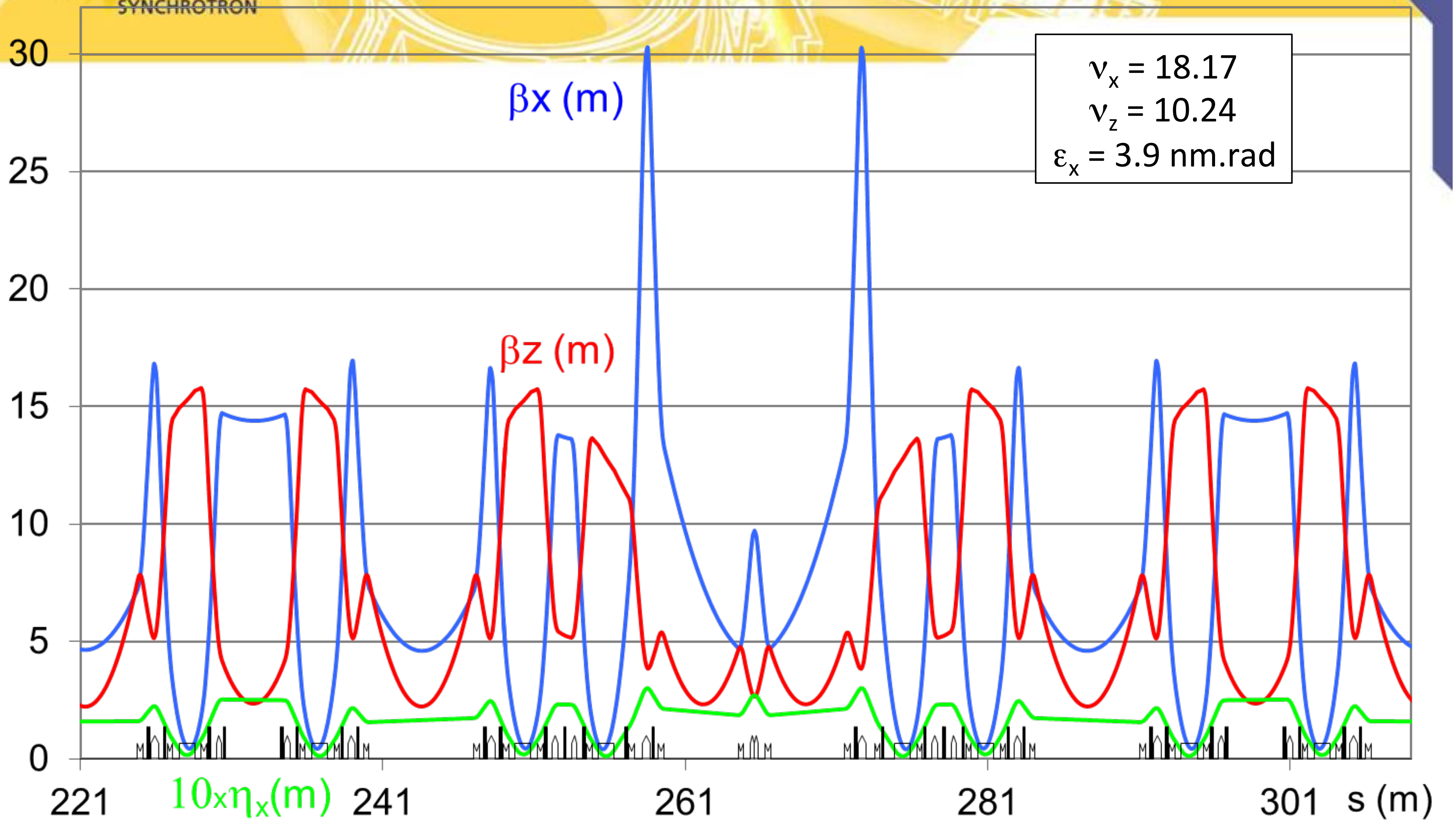
Reduction of the non linear effects of the 10 m long HU640 undulator

PSEUDO-NANOSCOPIUM Optics
In operation from July 2011 to now



Reduction of the non linear effects of the in-vacuum IDs : 5 undulators and 1 wiggler

NANOSCOPIUM/NANO TOMOGRAPHY Optics
To be in operation in 2012

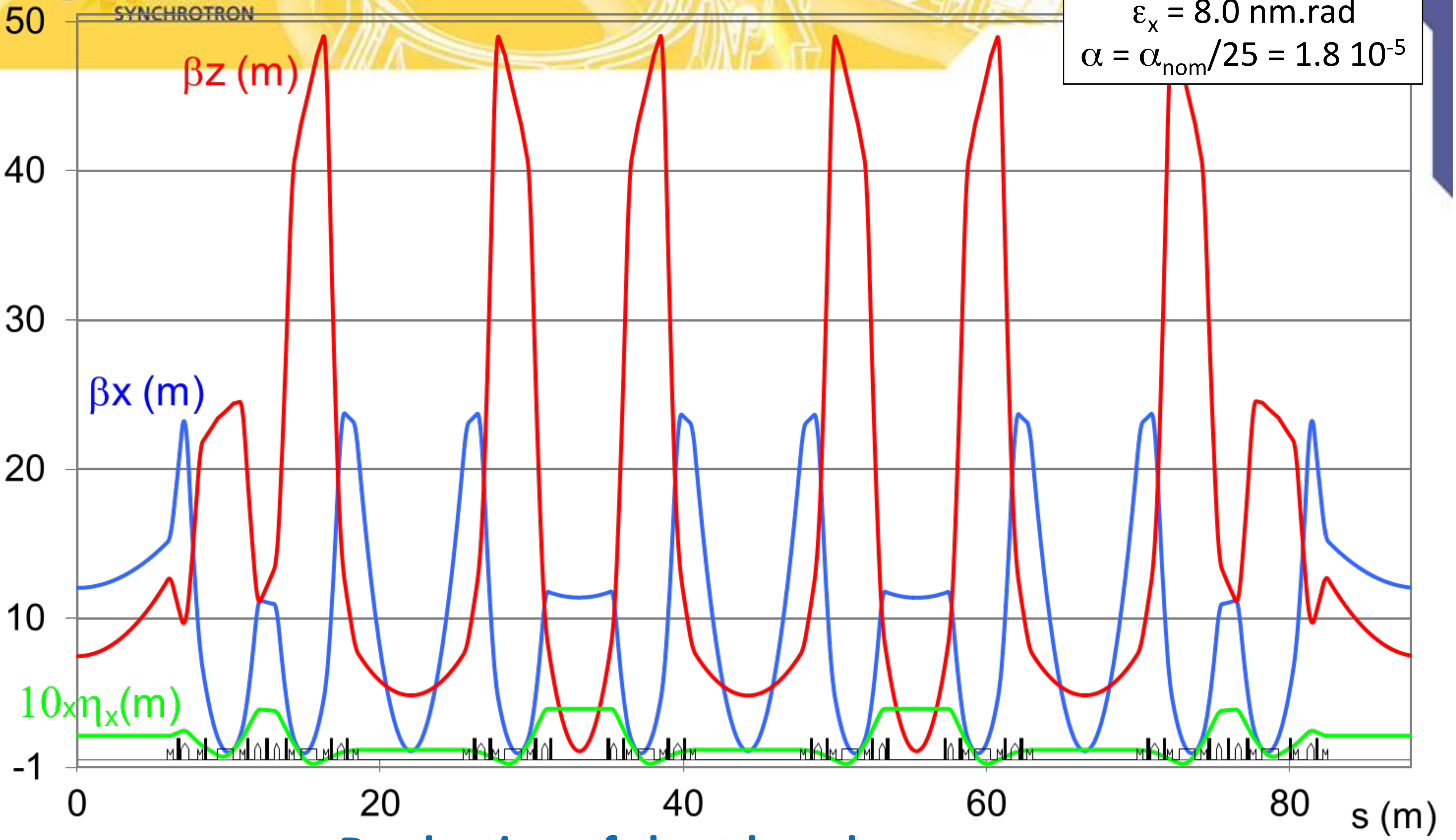


Installation of two canted in-vacuum undulators in a long straight section

LOW-ALPHA Optics

To be in operation on December 10th-11th 2011

$\nu_x = 20.40$
$\nu_z = 10.30$
$\varepsilon_x = 8.0$ nm.rad
$\alpha = \alpha_{nom}/25 = 1.8\ 10^{-5}$



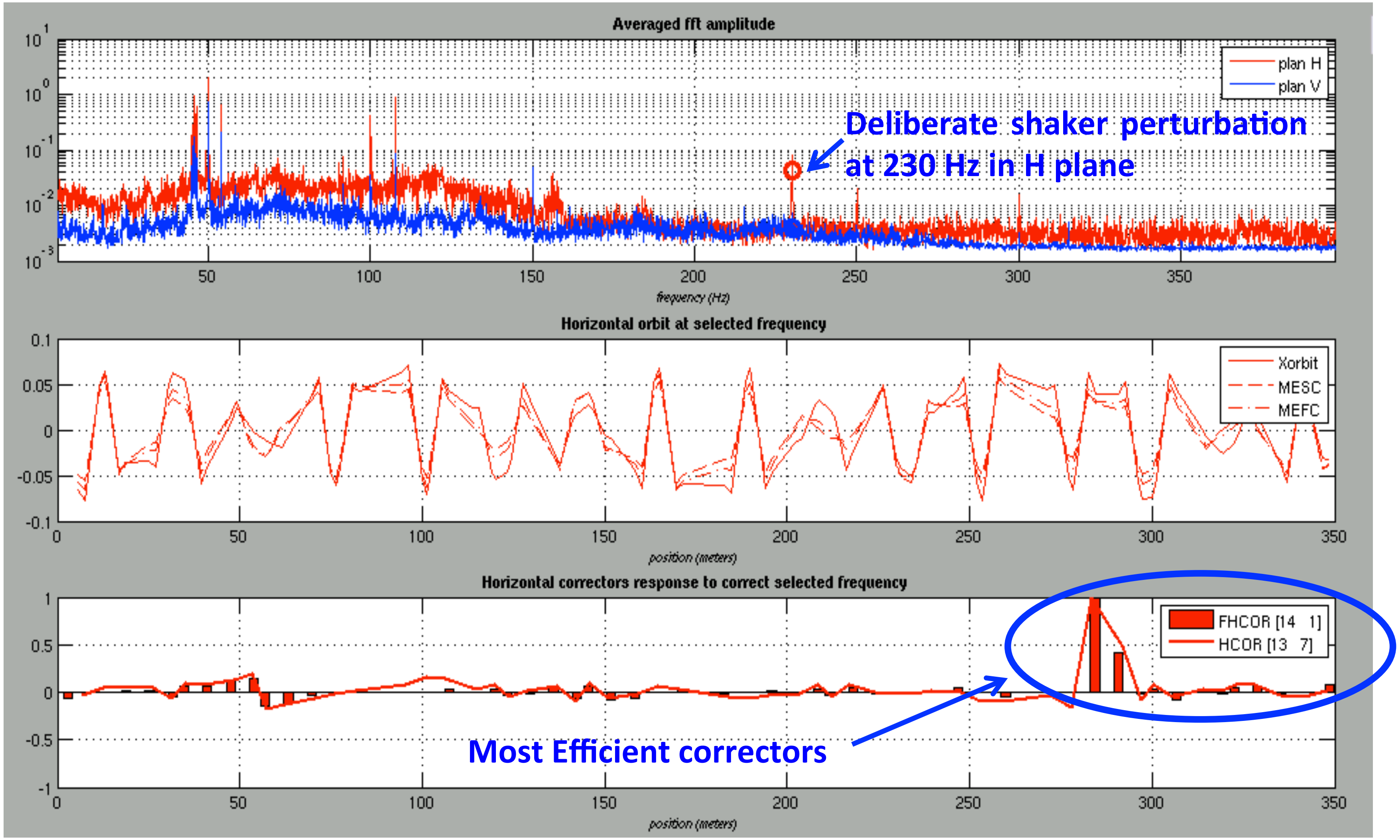
Production of short bunches

Bunch length = 4.8 ps

M. Attal et al., to be published

Stability

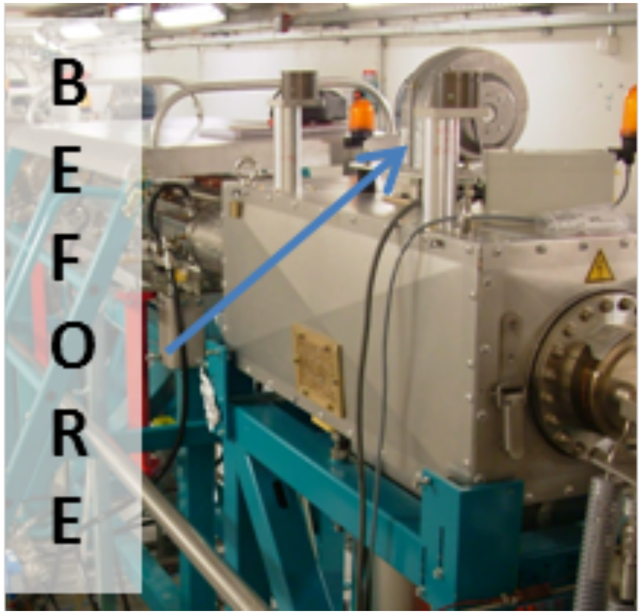
Hunting noise sources



Fans that cool down vacuum chambers have been identified as noise sources for beam orbit stability:

Fan Location	Kickers (injection, machine study H&V)	Shaker	FCT
Horizontal Plane	46Hz, 50 Hz	46Hz	54Hz, 108 Hz
Vertical Plane	46Hz, 50 Hz	46Hz	54Hz

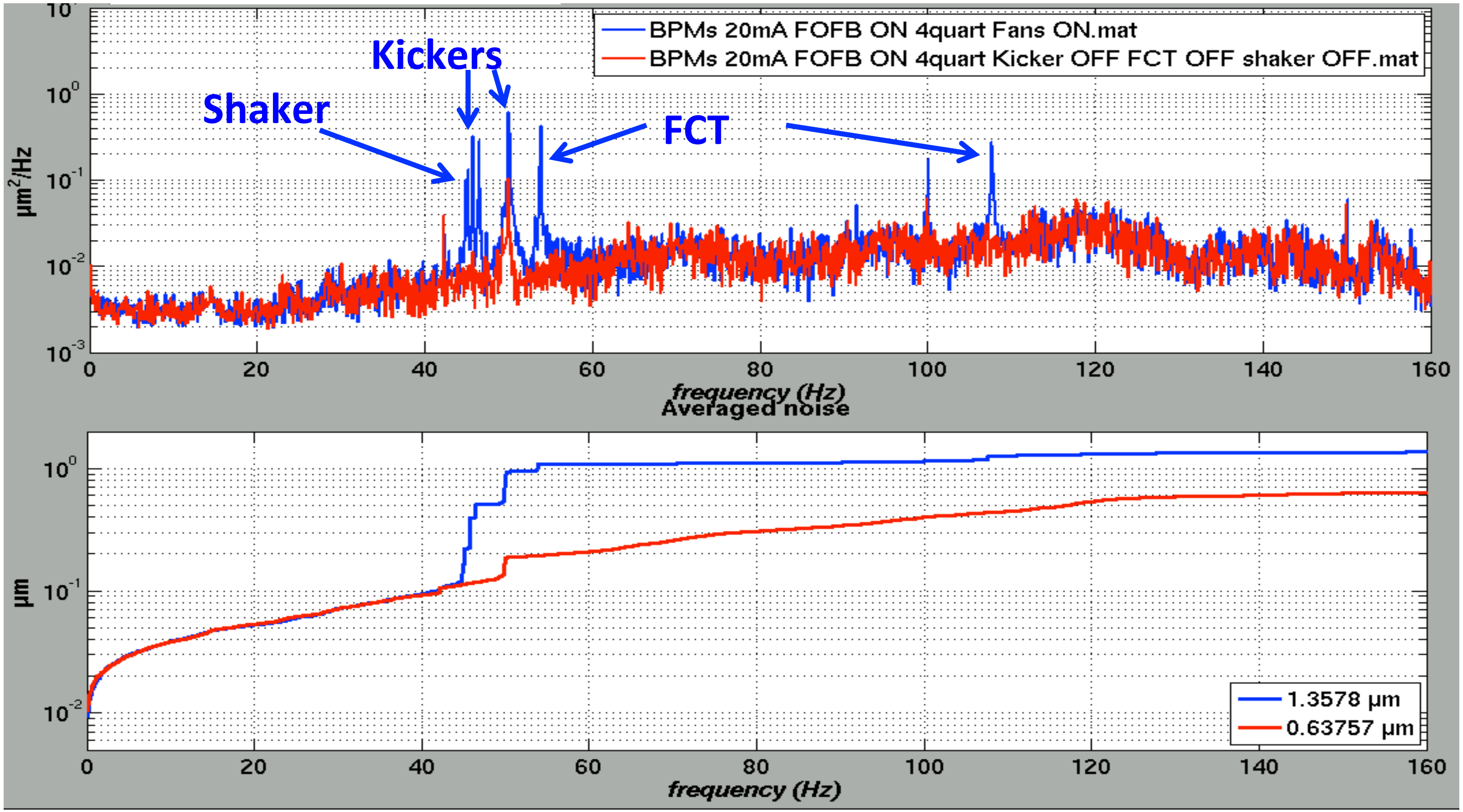
Technical solution: fans are moved away from ceramic vacuum chamber



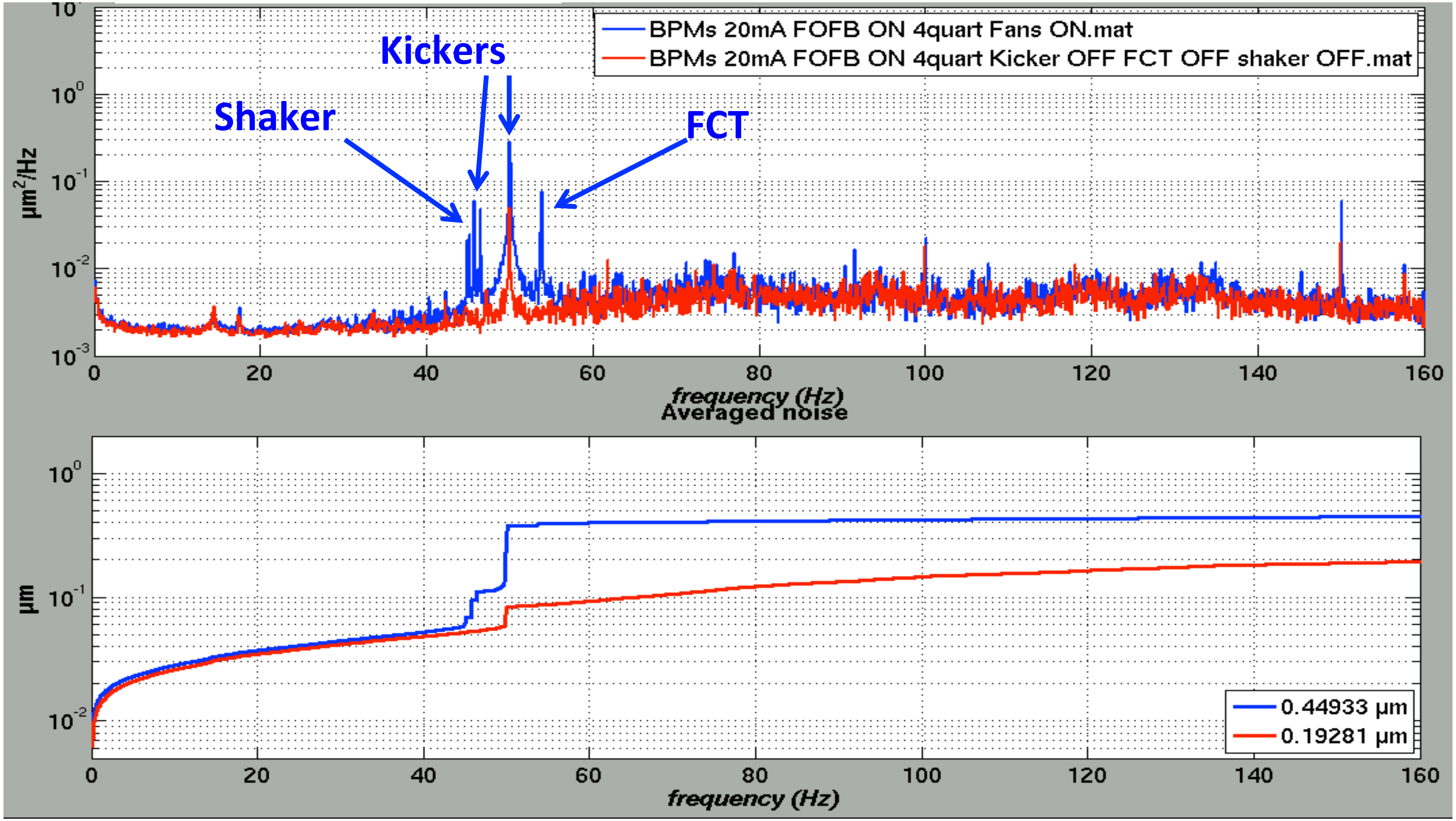
Injection kicker K2 fan at initial position (left) and with adjustable support (right)

Ultimate performance H-plane

HORIZONTAL PLANE



Ultimate performance V-plane

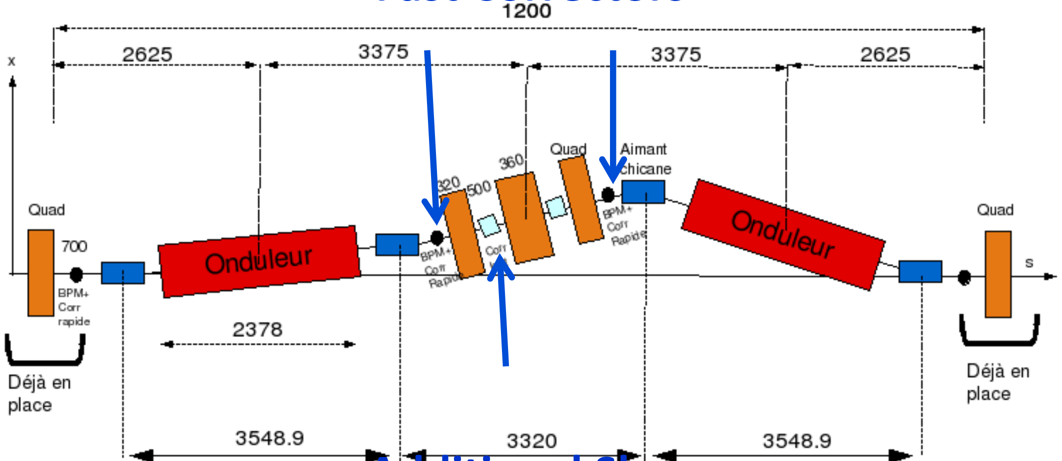


160 m long Nano/tomo BLs

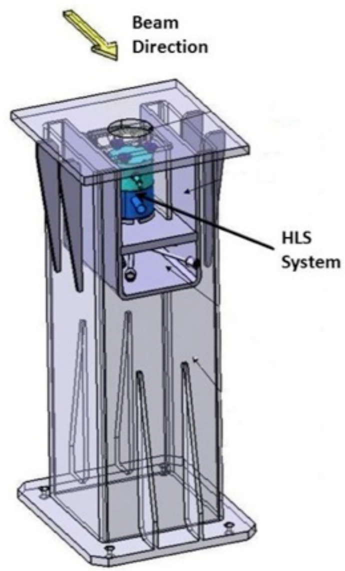
- Canted straight section implied installation of new elements on the machine:
  - 2 Beam Position Monitors
  - 1 Slow Corrector (H&V)
  - 2 Fast Correctors (H&V)
- To be added in orbit feedback loops (slow and fast)

- HLS system:
  - Dedicated network for the beamline
  - HLS sensors integrated in BPM and XBPM stands

Additional BPMs and Fast Correctors



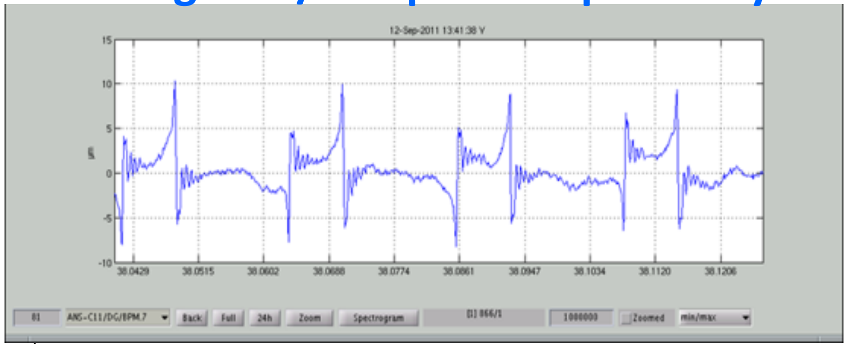
Additional Slow Corrector



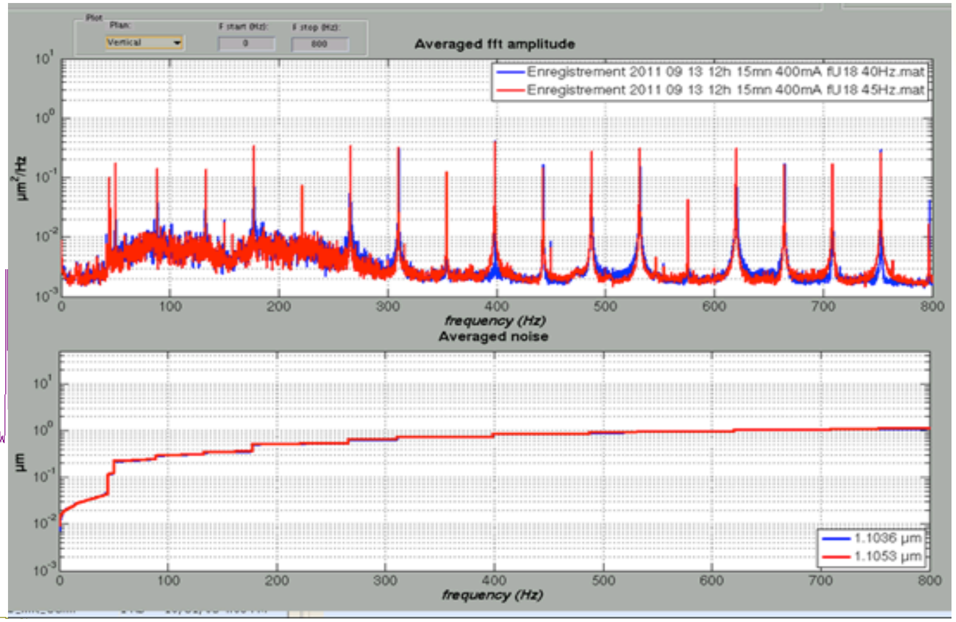
BPM stand in INVAR material

Hunting 45 Hz in Septembre

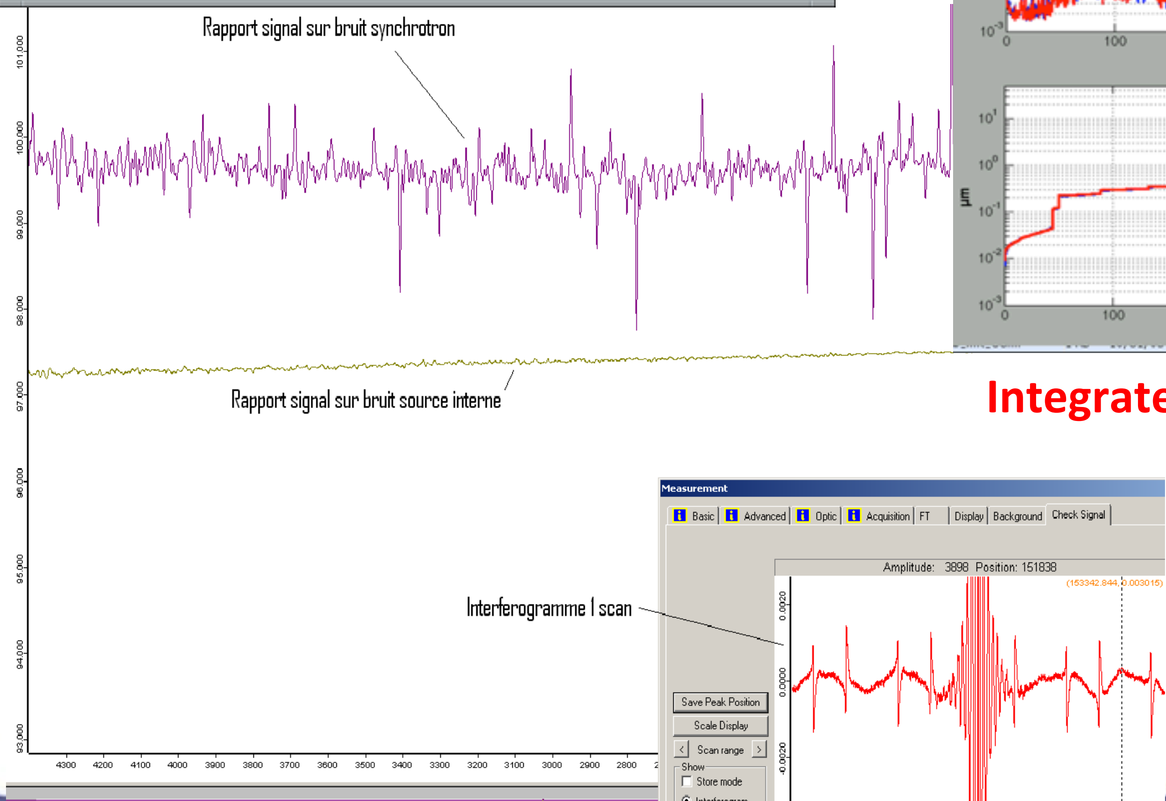
Time signal +/- 10 µm in V-plan only



Frequency spectrum≈ 45 Hz +harmonics

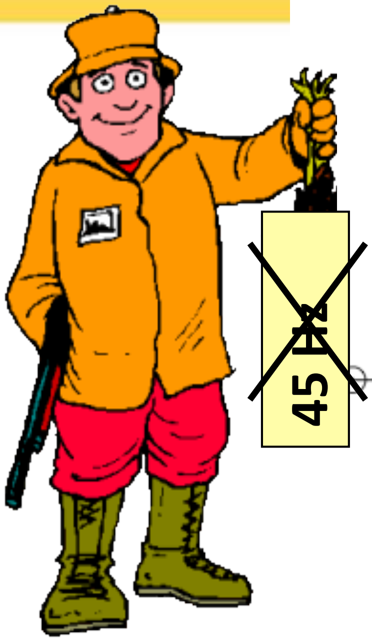


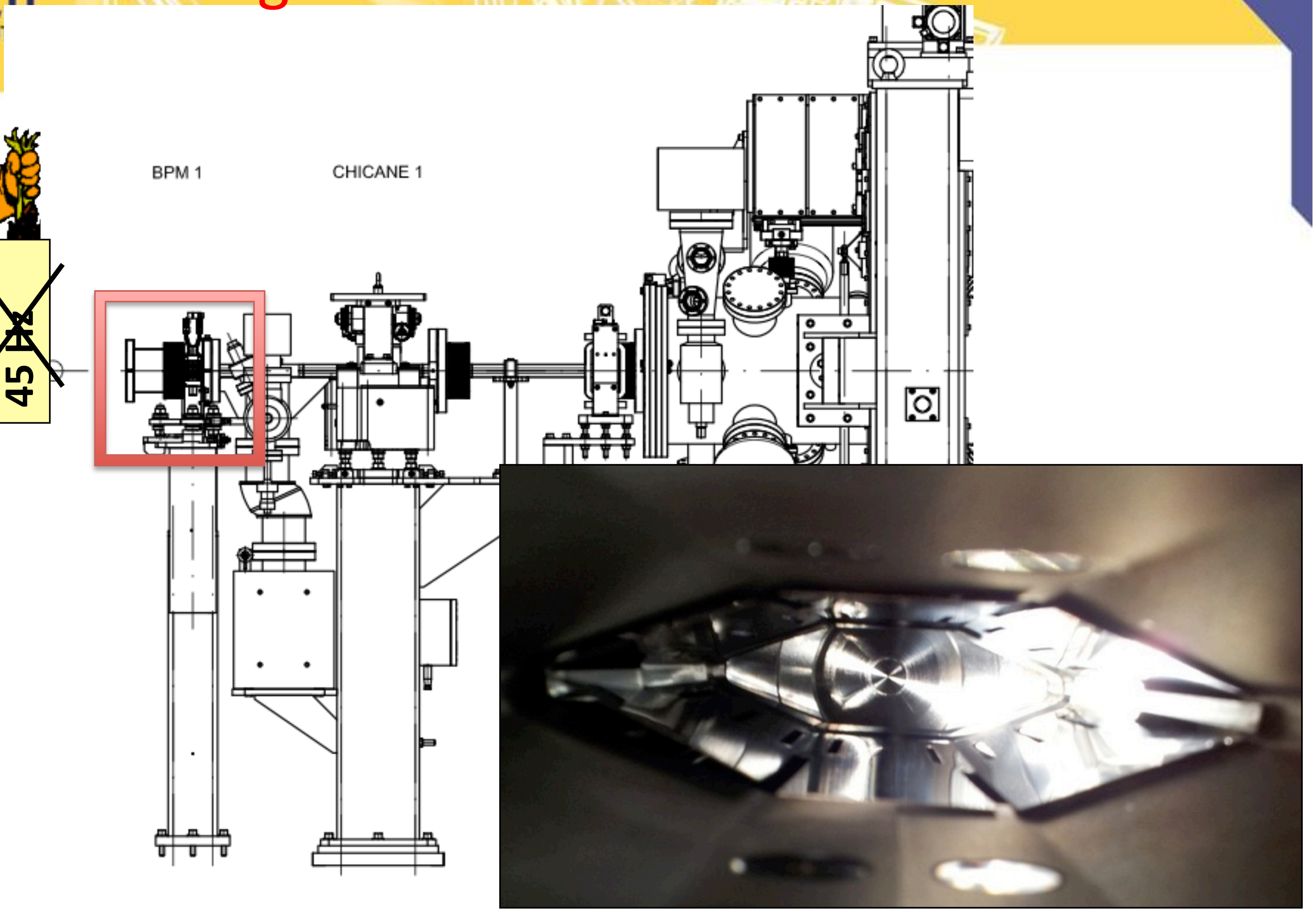
Integrated V-noise: 1.9 µm RMS @ 500 Hz



Interferogram on AILES IR-BL

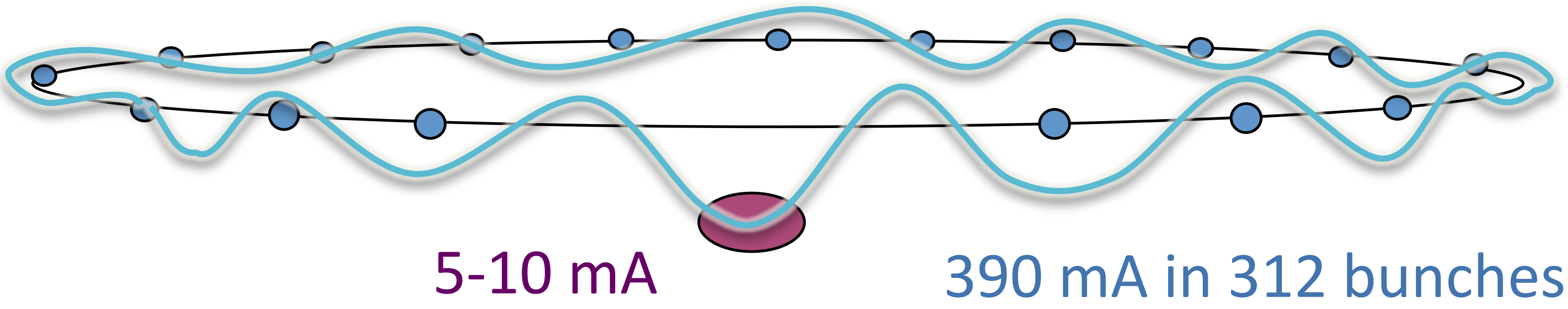
RF fingers mismounted on BPM





Pseudo Single Bunch

Pseudo single bunch (PSB)



The pseudo single bunch principle consists in a **special** hybrid mode in which the isolated bunch is orbiting on a different closed orbit.

The purpose of this mode is to satisfy simultaneously two user communities for:

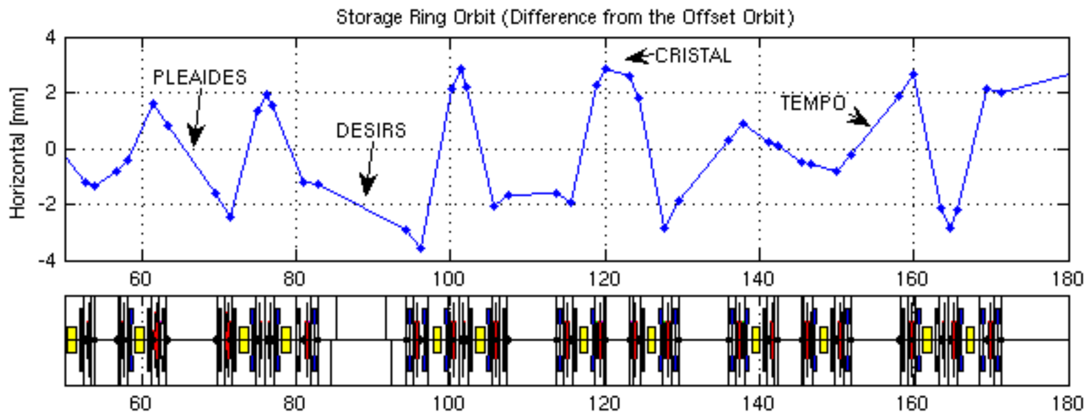
1. **Time resolved experiments** like in single bunch operation
2. **High flux/brilliance experiments** like in multibunch operation

This single bunch is created by one or several **additional pulsed correctors** that are seen only by the isolated bunch. There are then two different closed orbits in the storage ring, one for the multi-bunch electrons and a second for the single bunch

Specifications

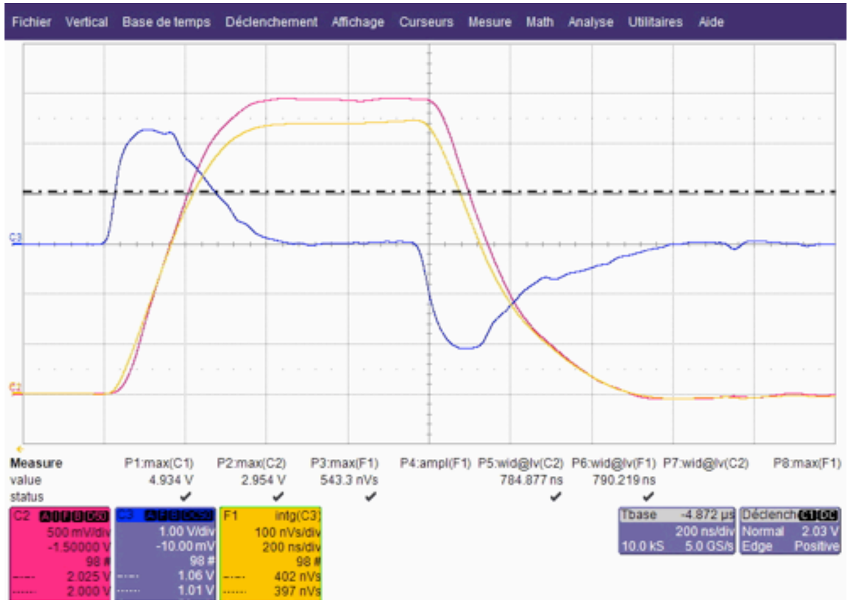
Beamline needs are contradictory for the PSB mode:

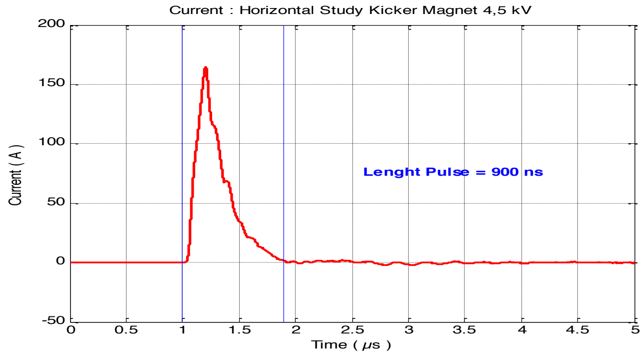
- **Amplitude from a few 100 µm to few mm:**
  - Large amplitude (2.8 mm for CRISTAL) for compatibility with femtosecond slicing operation.

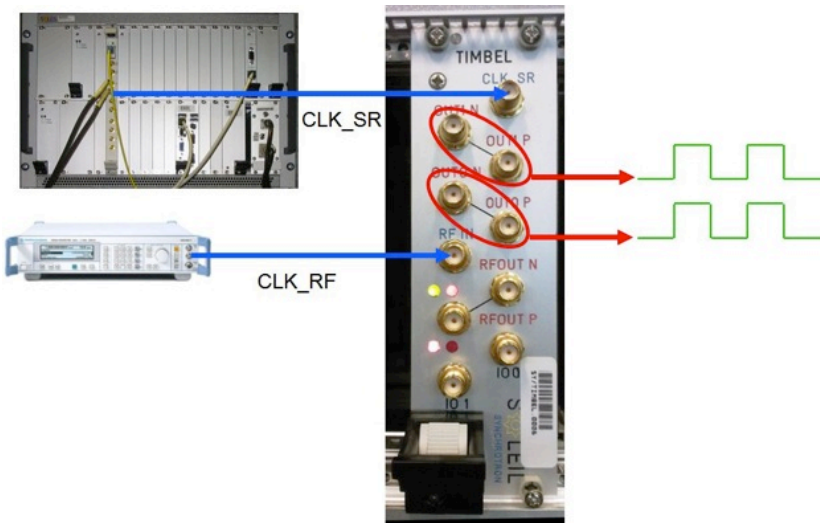


- **Frequency from 0.1 kHz to 847 kHz:**
  - Repetition rate
    - Lower irradiation on sample & match laser rep. rate.
    - Revolution frequency

Equipment upgrade





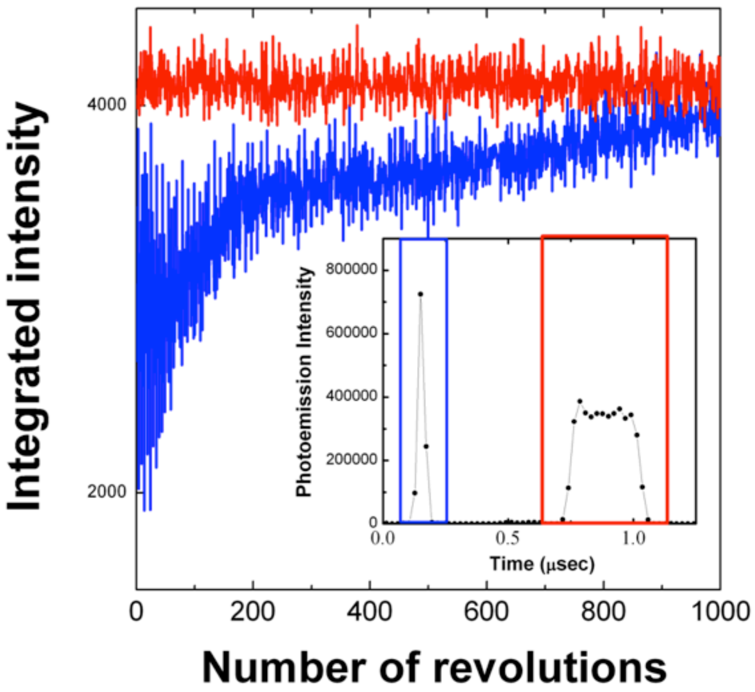


Parameter	Design Value *(H/V)*	Value for PSB experiment (H/V)
Rising time	380/400 ns	280/400 ns
Flat top time	420/480 ns	<40 ns
Falling time	450/380 ns	580/400 ns
Max. frequency	3 Hz	1 kHz
Max. deviation	2.8/1.1 mrad	270/100 μrad

First Experiment

In the inset of figure: time resolved photoemission intensity measured at the TEMPO experimental station on the time interval of the SOLEIL orbit. If the data acquisition is synchronized with the kick excitation frequency, the intensities associated to the ¼ multi-bunch and to the single bunch indicated with the red and blue regions respectively can be used to monitor the kicker operation and the effects on the hybrid intensity for each turn of the electrons in the storage ring.

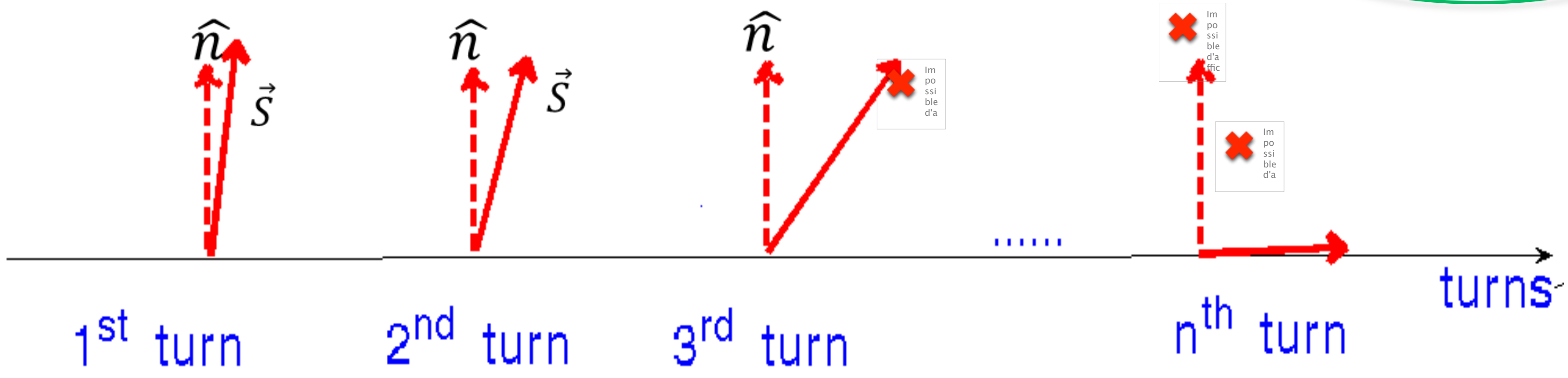
The hybrid photoemission intensity (red curve) is not affected by the kicker operation, while the oscillations of the single bunch are seen at the experimental station as damped periodic oscillations in the photon beam intensity.



Successful Storage Ring Energy Measurement

Experiment principle

Impossible d'afficher l'image. Votre ordinateur manque peut-être de mémoire pour ouvrir l'image ou l'image est endommagée. Redémarrez l'ordinateur, puis ouvrez à nouveau le fichier. Si le x rouge est toujours affiché, vous devrez peut-être supprimer l'image avant de la réinsérer.



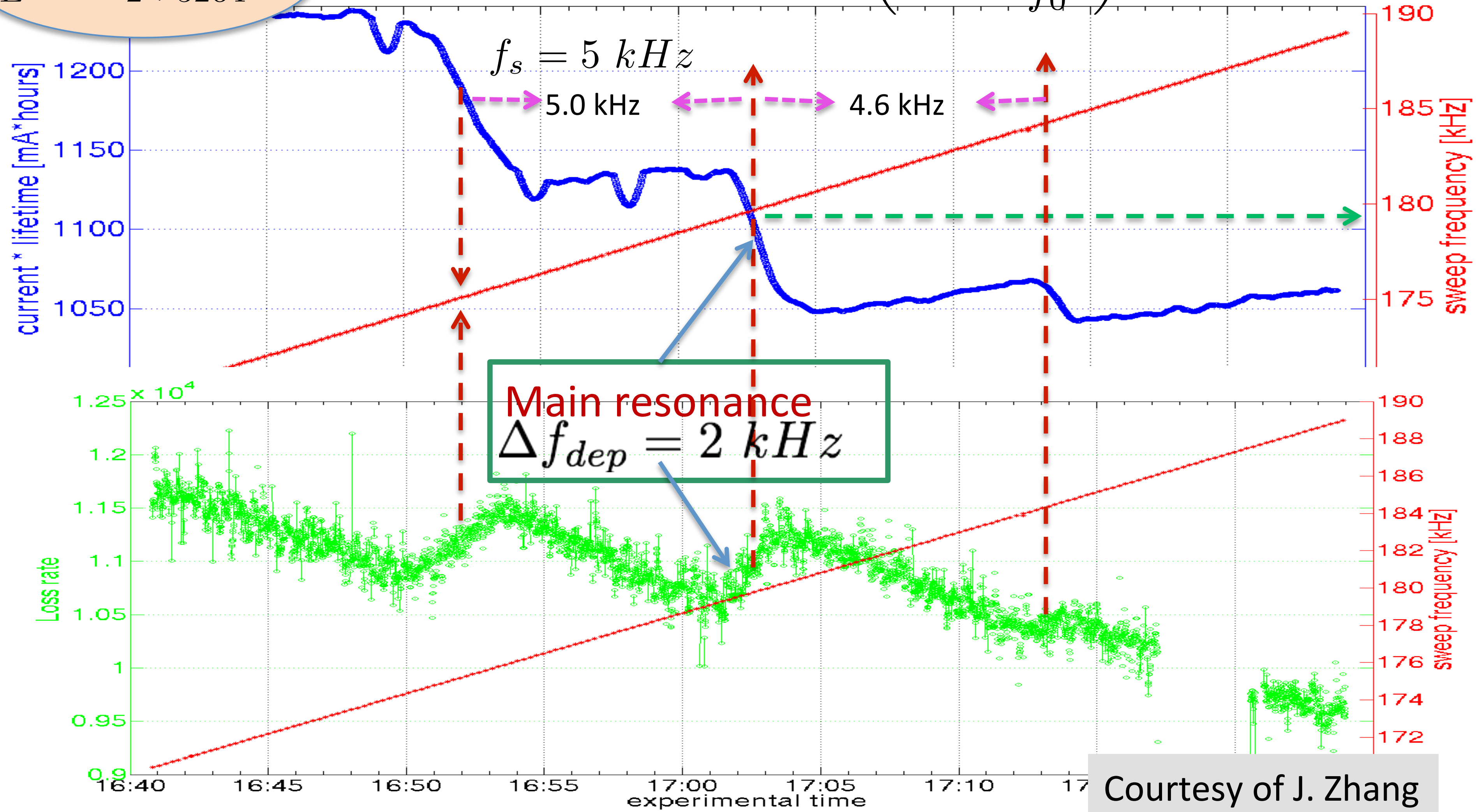
$$\frac{\Delta E}{E} = \frac{\Delta f_{dep}[kHz]}{2*5264}$$

Courtesy of J. Zhang

2^{nd} Experiment results on SOLEIL ring (sweep rate 10 Hz/s)

$$\frac{\Delta E}{E} = \frac{\Delta f_{dep}[kHz]}{2 * 5264}$$

$$E[MeV] = 440.648626 \left([\nu] + \frac{f_{dep}}{f_0} \right)$$

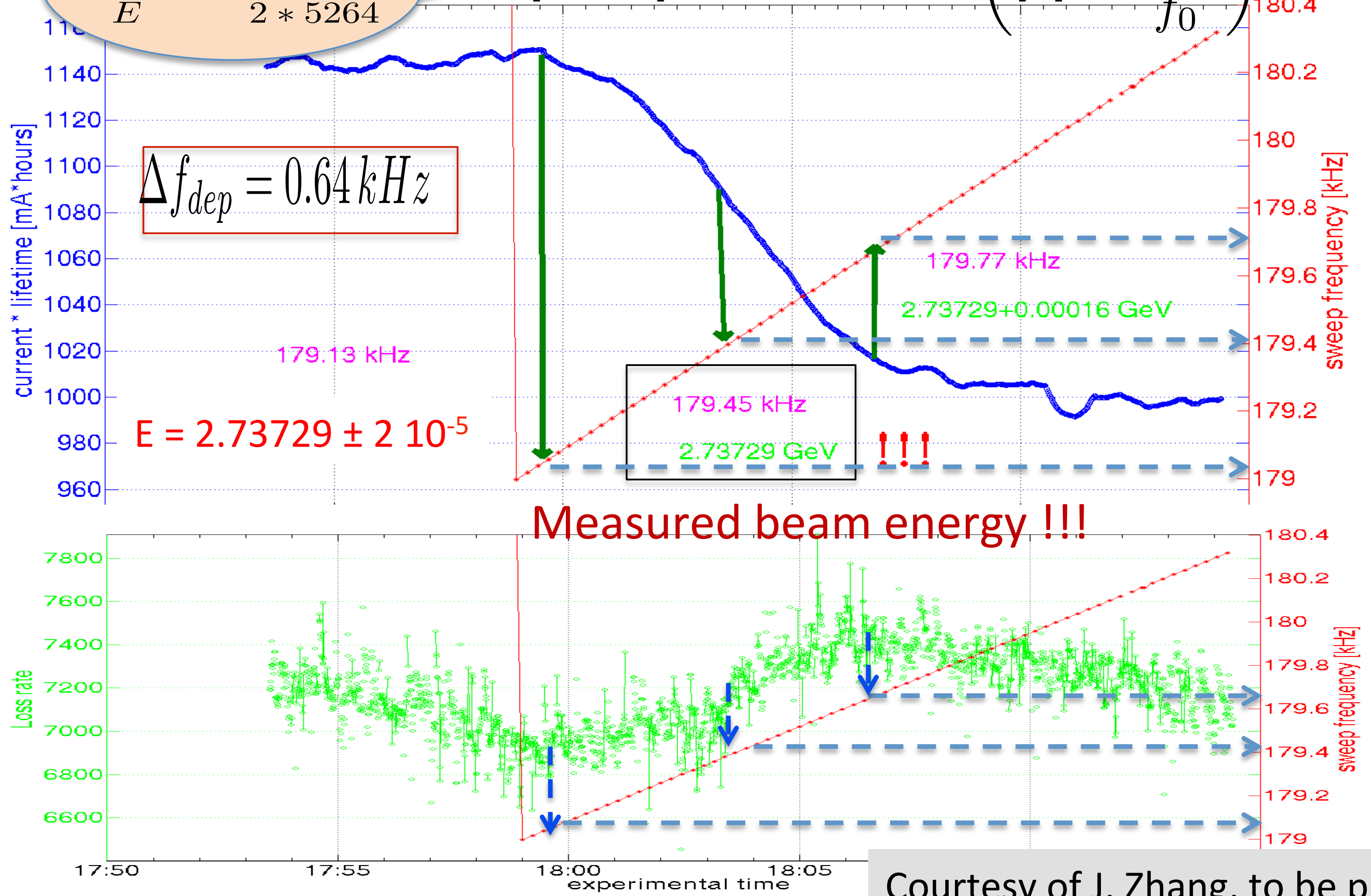


Courtesy of J. Zhang

2^{nd} Experiment results on SOLEIL ring (sweep rate 2 Hz/s)

$$\frac{\Delta E}{E} = \frac{\Delta f_{dep}[kHz]}{2 * 5264}$$

$$E[MeV] = 440.648626 \left([\nu] + \frac{f_{dep}}{f_0} \right)$$

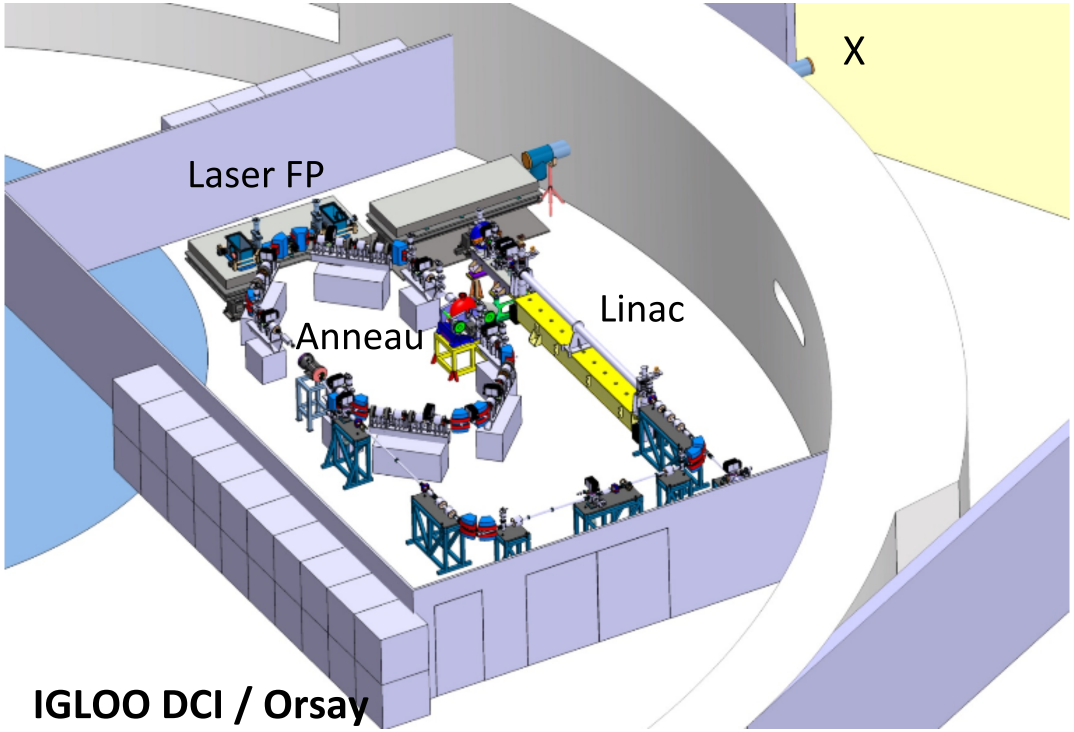


Courtesy of J. Zhang, to be published

ThomX: Compact back scatterring Xray Source

Principle: (10x7 m^2)

Emission X Compton : 10- 80 keV
Low energy ring: 50 MeV, 50 Hz
Fabry-Pérot optical resonator
Average Power > 100 kW



Labs involved:
LAL / SOLEIL / LC2MRF / CELIA / GIN / Neel / ESRF / Thales

Location :
IGLOO DCI (Orsay) for demonstrator

Funded : about 13 M€

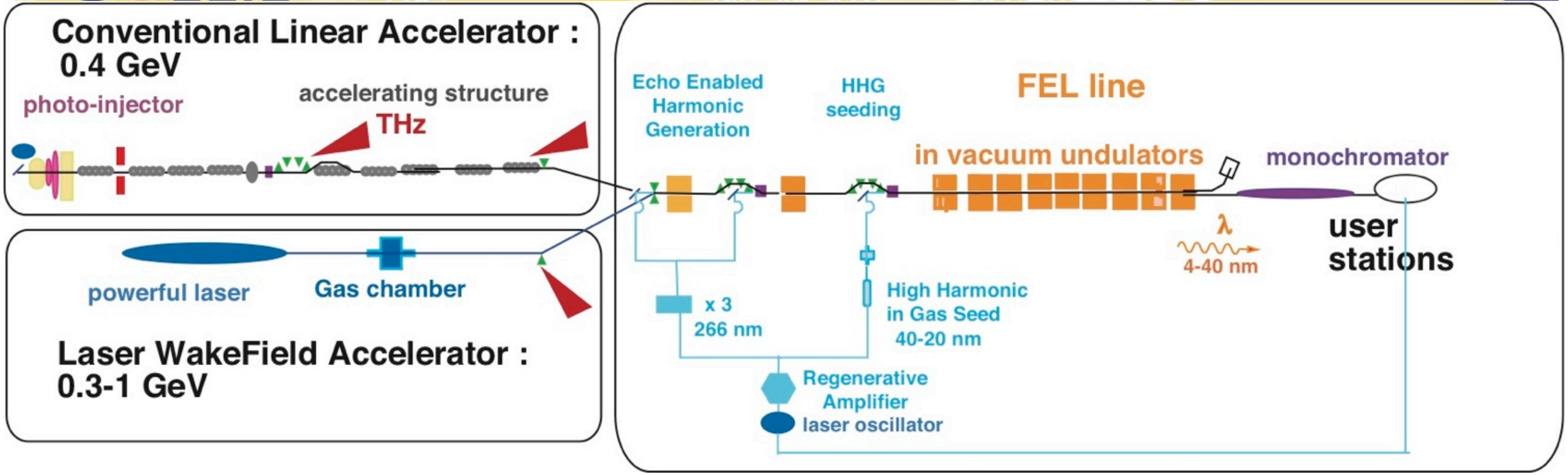
2012-2016

Very ambitious XRay flux: 10^{12}-10^{13} ph/s

Applications:

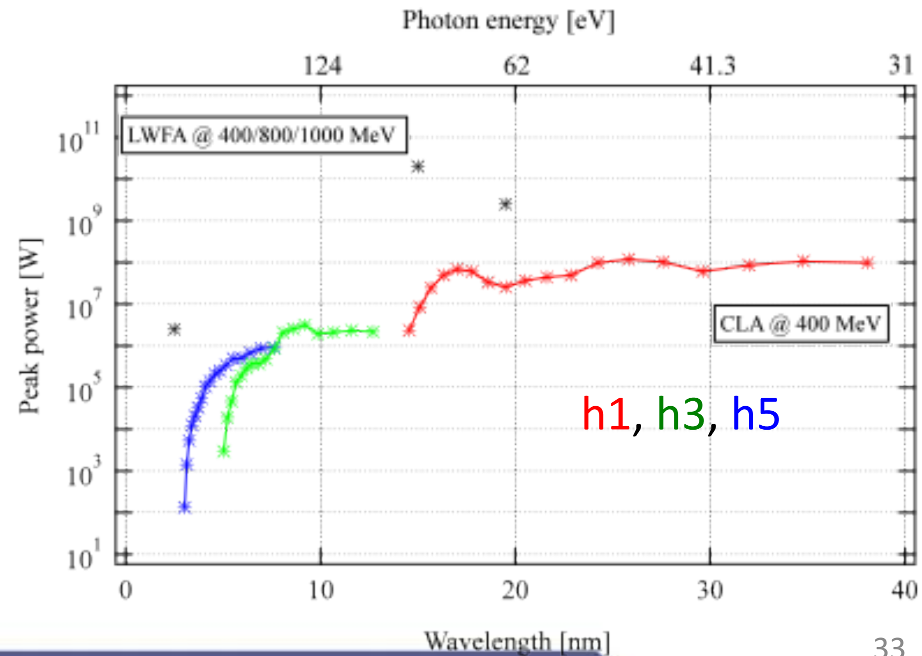
- **Medical**: imagery and therapy
- Metallurgy, lithography, LIGA
- Culturage heritage (museum)

LUNEX5 PROJECT



Motivations of LUNEX5

Beyond third generation light source (undulator spontaneous emission, partial transverse coherence),
progress towards fourth generation light sources (coherent emission, temporal and transverse coherence, femtosecond pulses, high brilliance) via free electron laser process for two pilot user experiments
and towards fifth generation (Conventional Linac replaced by a LWFA)



Perspectives for 2012

- 5328 h of beamtime for users with 5 operation modes
- Increasing stored current from 400 mA to 500mA
- Nano-tomo optics as standard optics (symmetry 1)
- Introducing XBPM in SOFB
- Magnetic correction for non-lin. Effect of insertion devices (HU640, WSV50)
- Construction of WS164 (Modulator for SLICING/PUMA beamline)
- Magnetic design Robinson Wiggler
- Design of the fast kicker for Pseudo-single bunch op.
- Femto-slicing project (Council in December)
- TDR for LUNEX5 project (Council in December)