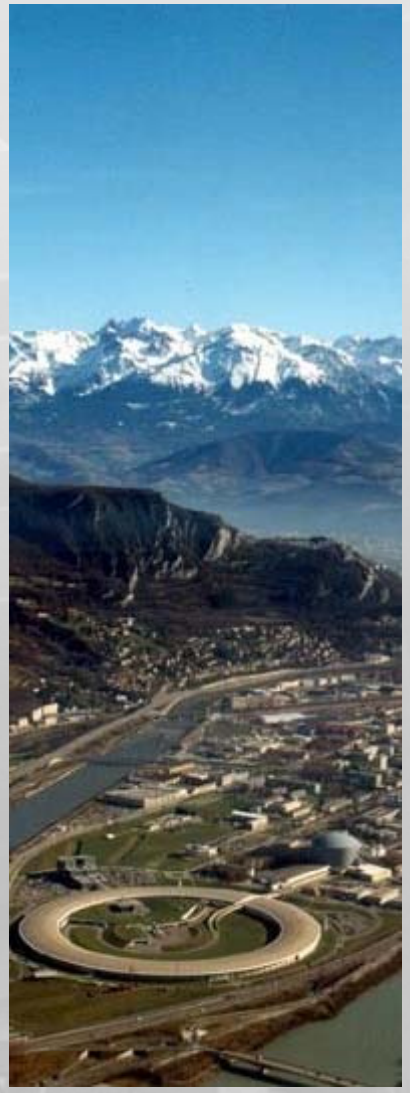


ESRF
Status and Upgrade

P. Elleaume

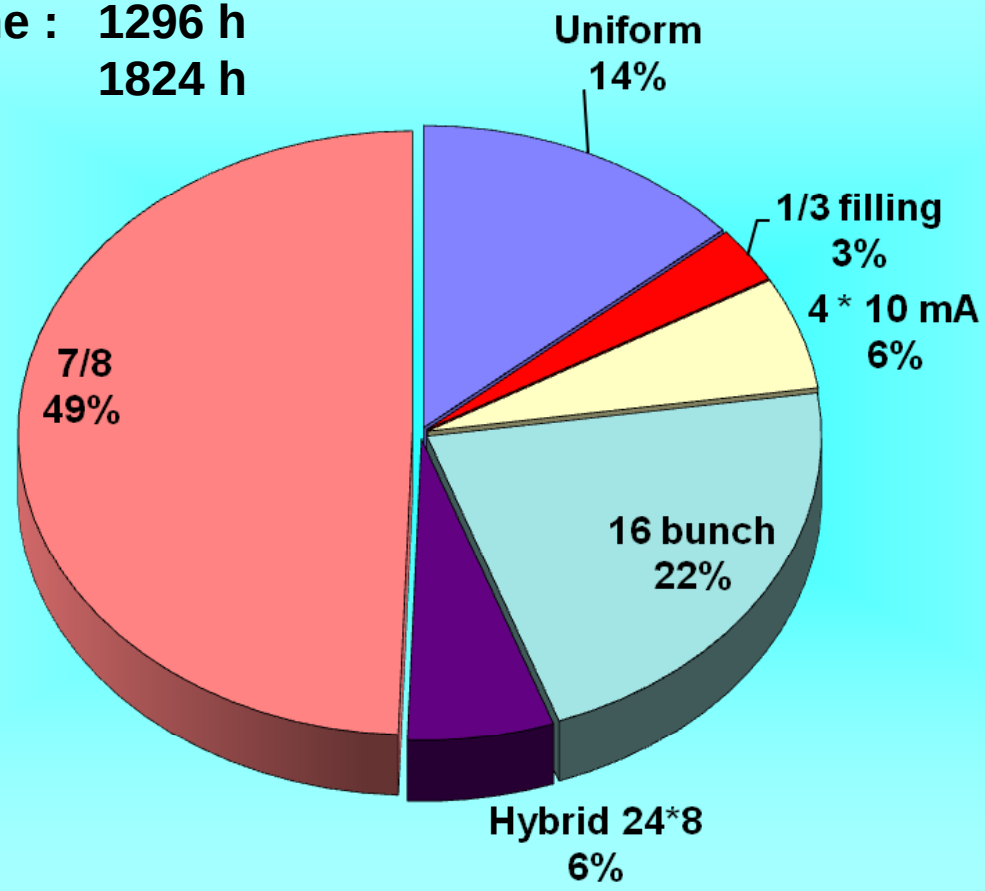
Statistics 2008-2010

	2008	2009	2010*
Availability (%)	98.30	99.04	98.83
Mean time between failures (hrs)	64.50	75.80	70.80
Mean duration of a failure (hrs)	1.10	0.73	0.83

*updated on 18 October 2010

Longitudinal Filling Pattern 2010

User Time : **5640 h**
Machine Time : **1296 h**
Shutdown : **1824 h**



ESRF Publications 2005-2009

In 2009

- 1791 Referred Publications

- 200 high-impact publications

Cell, Nature, Nature cell biology, Nature materials, Science, PRL, PNAS, Angewante Chemie, Nano letters, EMBO J., APL, Advanced materials, JACS

Reduced Vertical Emittance

- Improved resolution of the closed orbit measurement (Libera bpm electronics)
- Improved algorithm to correct magnets alignment errors

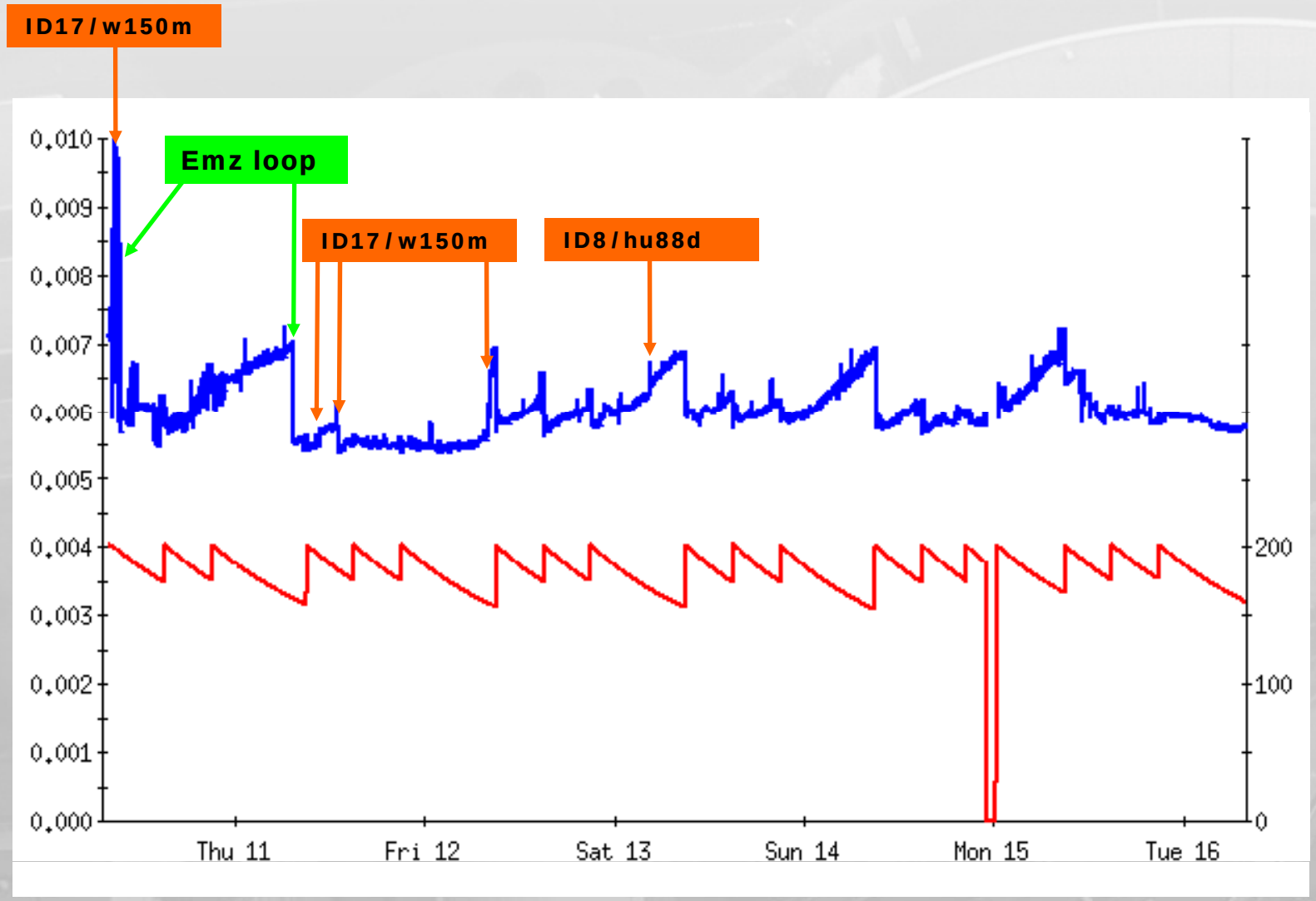
$\Rightarrow$ Vertical Emittance reduced and stabilised around 5pm (10 pm) in 7/8 and 2 x 1/3 (Uniform) filling modes

- More Skew correctors => < 2 pm in 2011

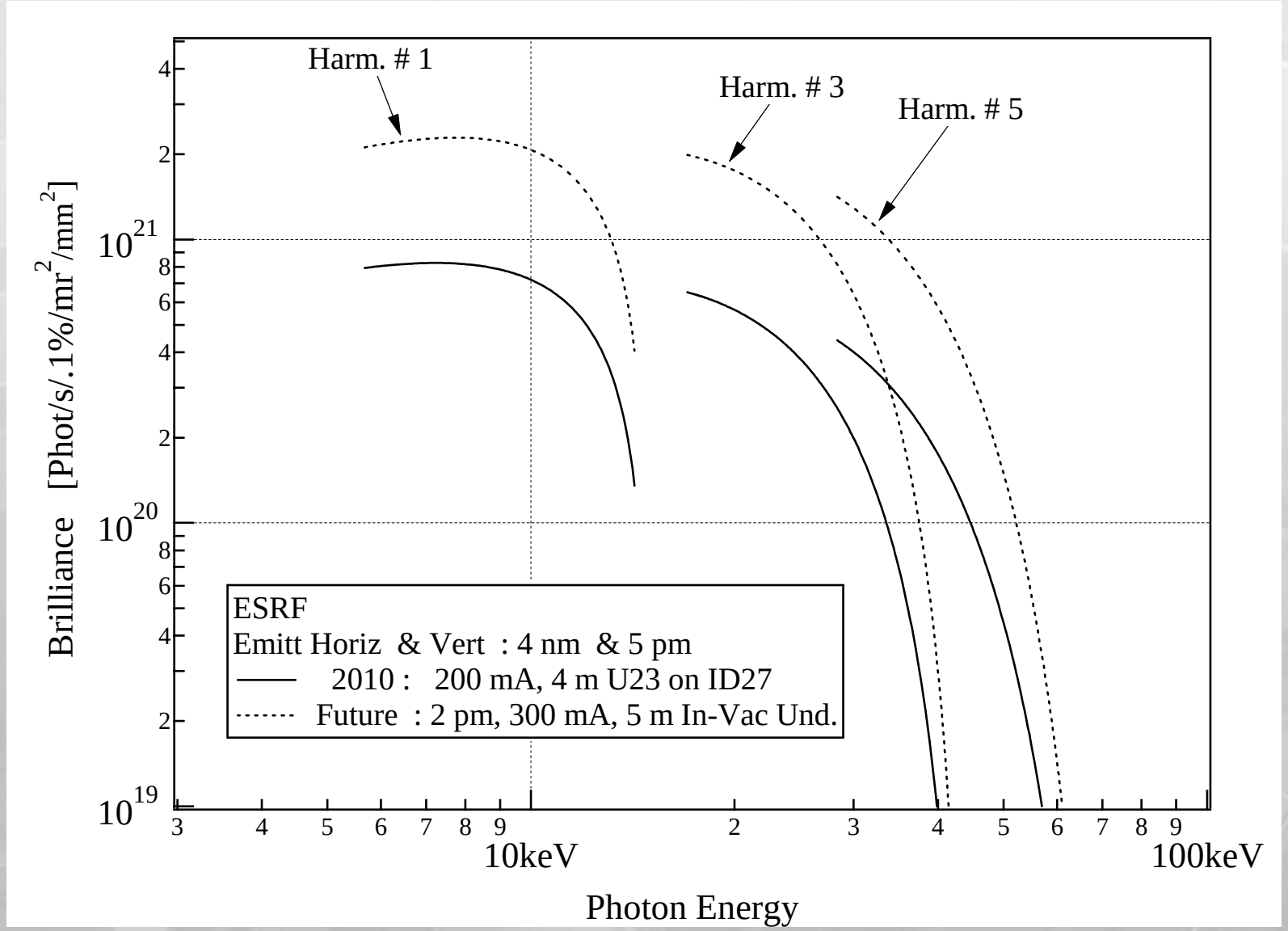
- See **Presentation by A. Franchi**

- New Orbit correction with 96 H &V correctors and 224 BPM operating from 0-1kHz under development, See **Presentation by K. Scheidt**

Efforts to Stabilize the Vertical Emittance



Record Brilliance in ID27



Upgrade Program 2009-2015

-Rebuild 10 beamlines

-Extend the Experimental Hall

-Renovation of Accelerator Systems

Experimental Hall Extension (EX2)

2010 - 2012

- APS validated May 2010
- APD validated 10 November 2010
- Works will start in September 2011
- 1st long shutdown: 12-2011 to 03-2012
- 2nd shutdown: 08-2012

April 2013:

- Commissioning of buildings
- Long beamlines construction starts

UP: Status of the EX2 project

Reduction of the Programme to accommodate budget cuts

ASD Technical Developments

•Renovation of Orbit monitoring
- 224 Libera in operation (2009)
- New Orbit stabilization system (2011)

Reduce the vertical emittance
- Add 32 skew quadrupole correctors (2011)

•Upgrade to 6m and 7 m ID Straights:
- ID30 and ID18 completed
- ID24 and ID20 scheduled for December 2010 and July 2011
- Production of High Gradient quadrupoles

• Insertion Devices:
- 11 ID magnetic assemblies delivered
- 4 revolver under manufacture
- New cryogenic in-vacuum undulator under test, installation spring 2011
- New 2.5 m long in-vacuum undulator under manufacture

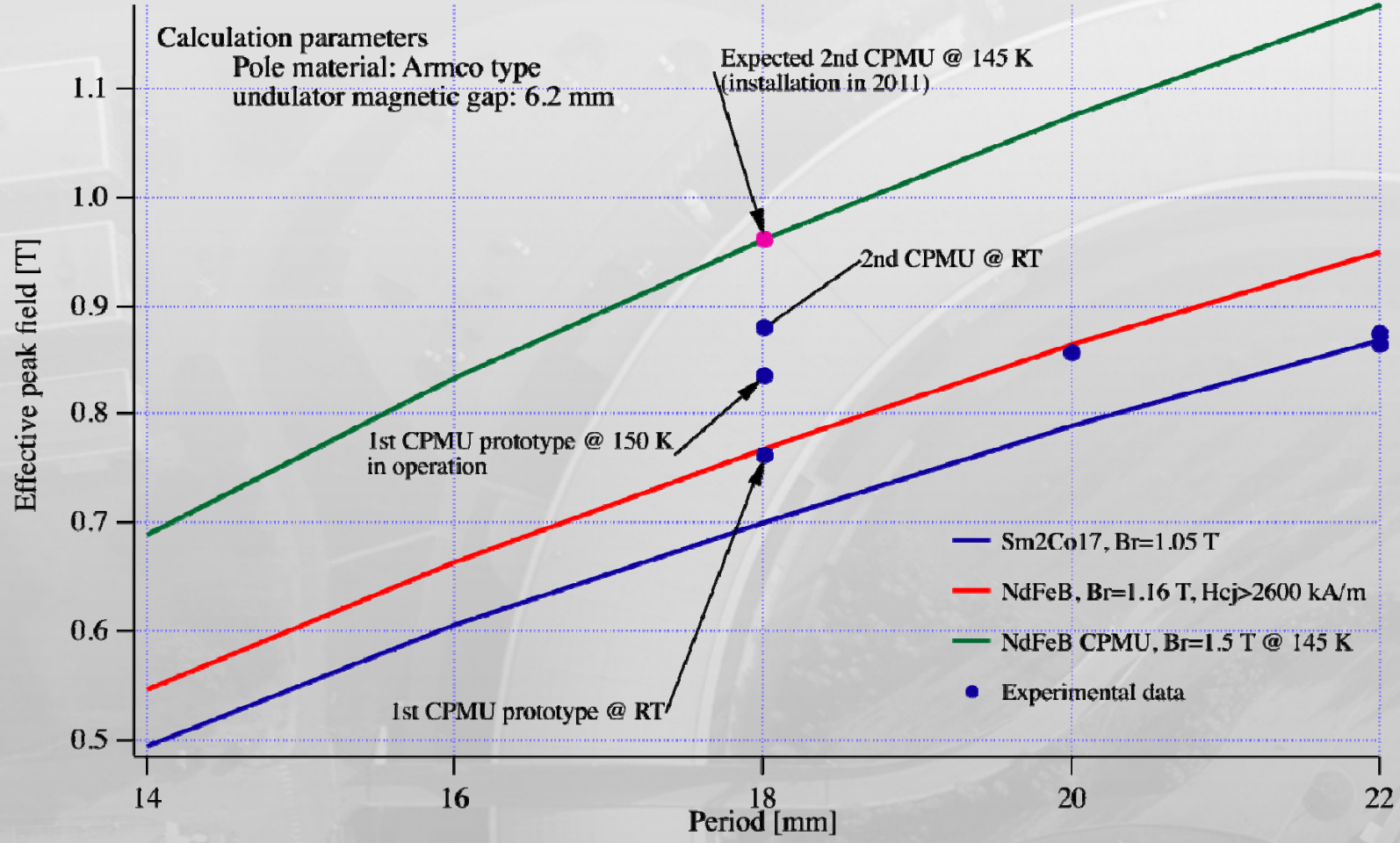
• Beamlines Canting (x 4):
- Permanent Magnet steerers delivered and shimmed
- New sextupoles Ordered

• Solid State Power Amplifiers:
- 1 MW of SSA Ordered in 2009
- First 75 kW tower to be delivered January 2011

• HOM damped Copper RF cavities:
- Two prototypes by end of 2010, the third one in spring 2011

• 300mA Operation:
- Fully tested in Accelerator dedicated time
- Few USM shifts scheduled in 2010

2nd Cryogenic Perm. Und.



CPMU Technology transferred to DANFYSIK

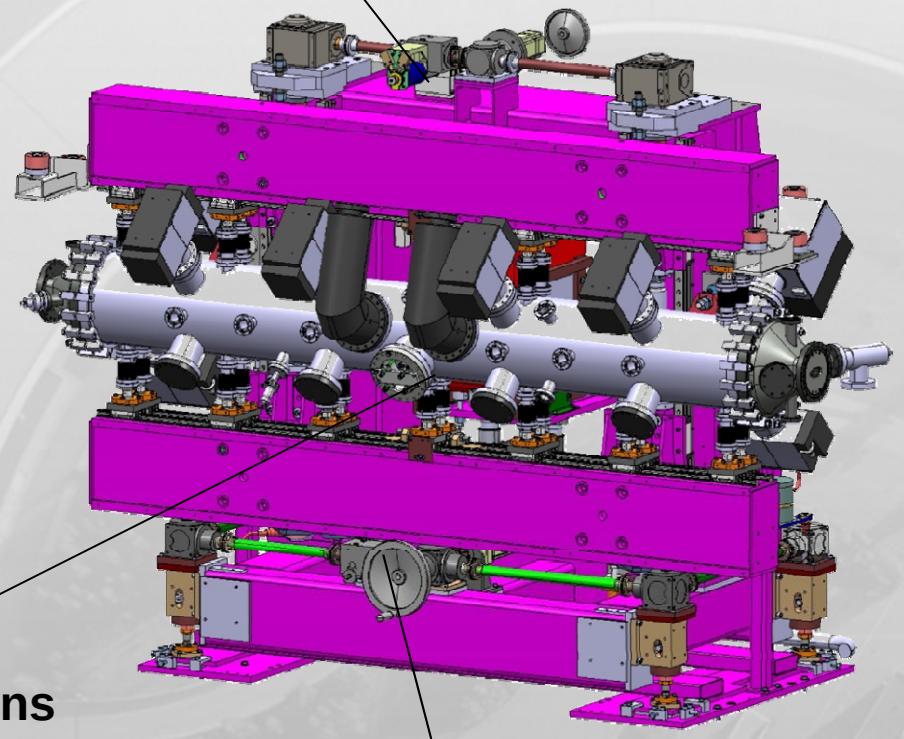
2.5 m IVUs

Longer device

- **previous design with 2 m magnetic length**
- **new version with 2.5 m magnetic length**

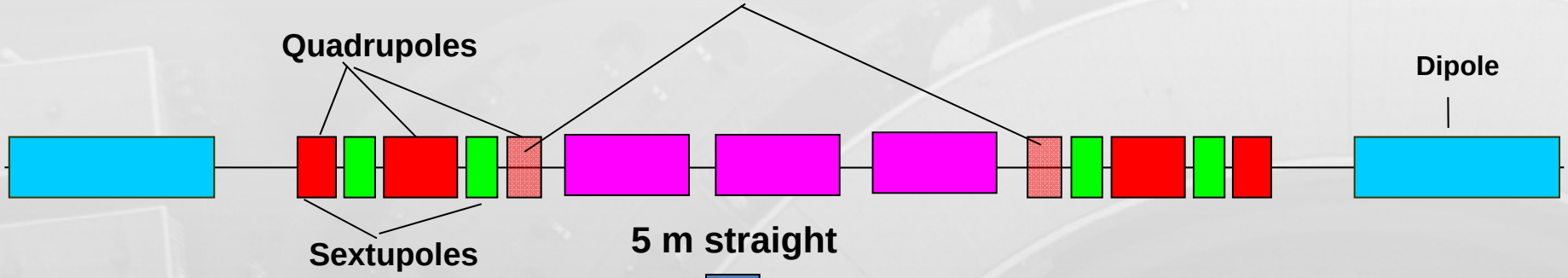
Complete structure revisited

- **Higher stiffness**
  - **Frame,**
  - **main girders**
  - **linear guides**

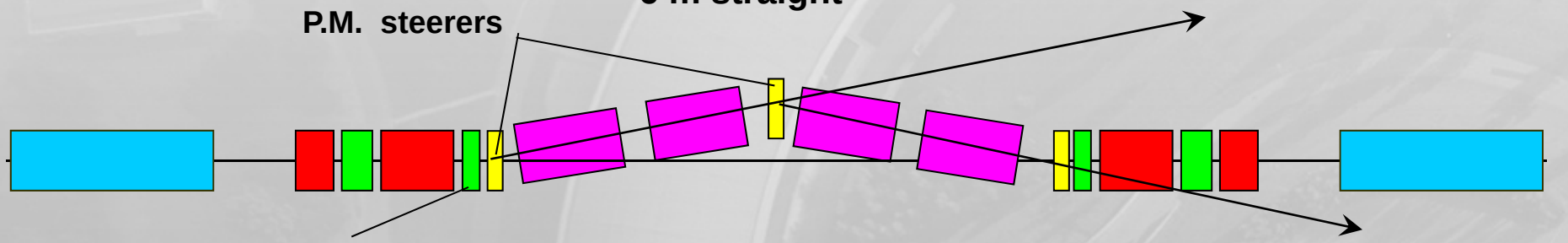


6 m ID Straight sections

Present lattice with I=0 A in quadrupoles next to ID straight



6 m straight



Shorter sextupole
0.4 m -> 0.2 m

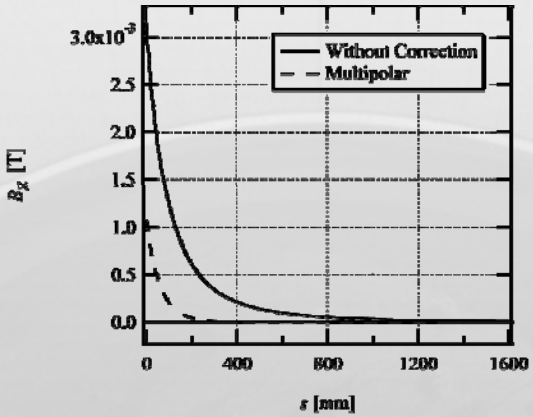
Canted section as an option: (maximum separation angle 5.4 mrad)

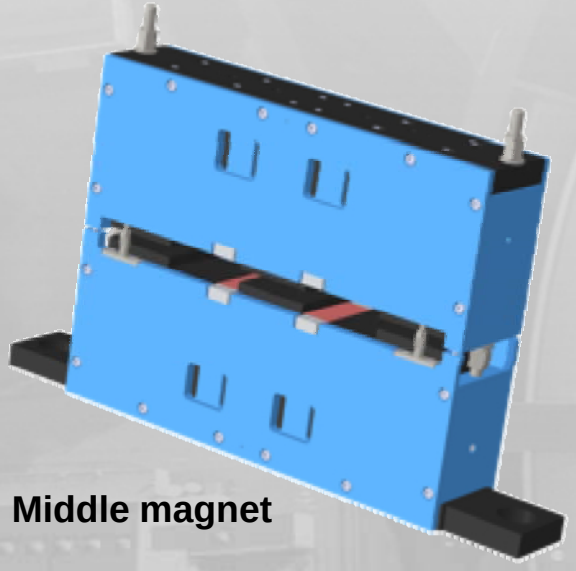
6 upgraded beamlines in first phase, 3 with canting

Canted undulators

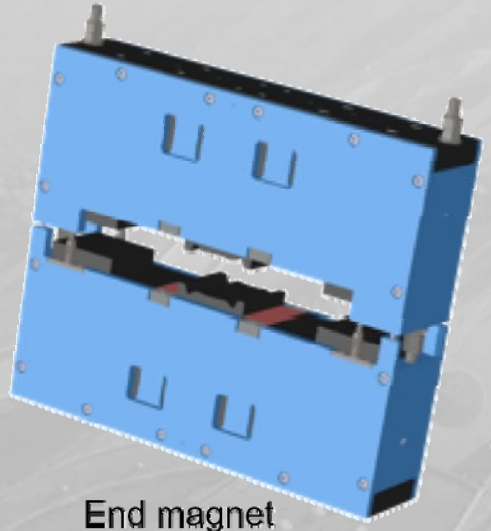
Canting based on permanent magnet dipoles: Sm2Co17 material

- minimum space occupancy along beam
  - short field decay along beam axis
  - compact design (thickness <100 mm)
- optimized transverse flat field profile



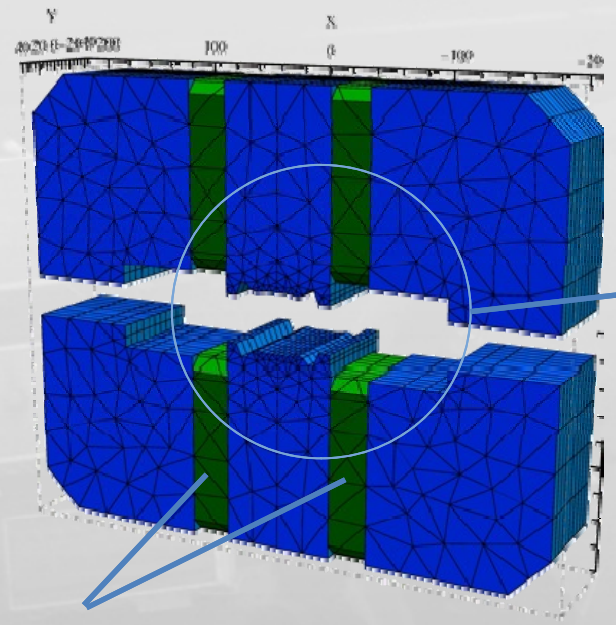


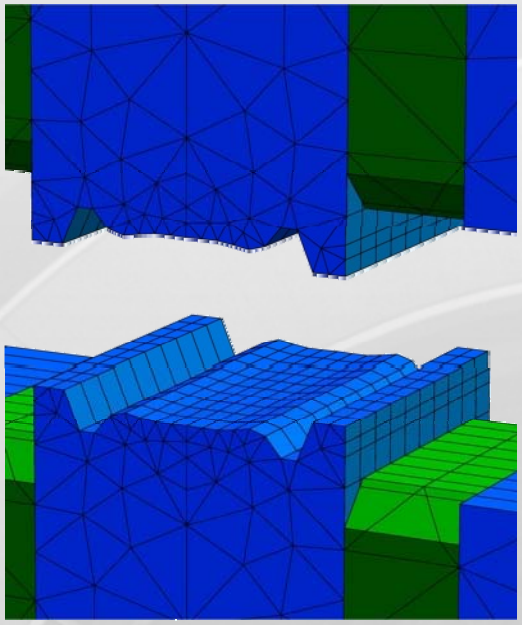
Middle magnet

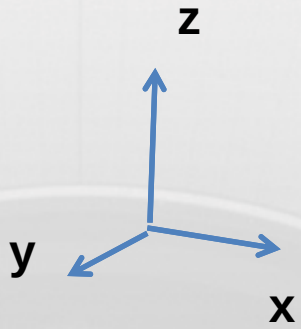


End magnet

Permanent magnet dipole





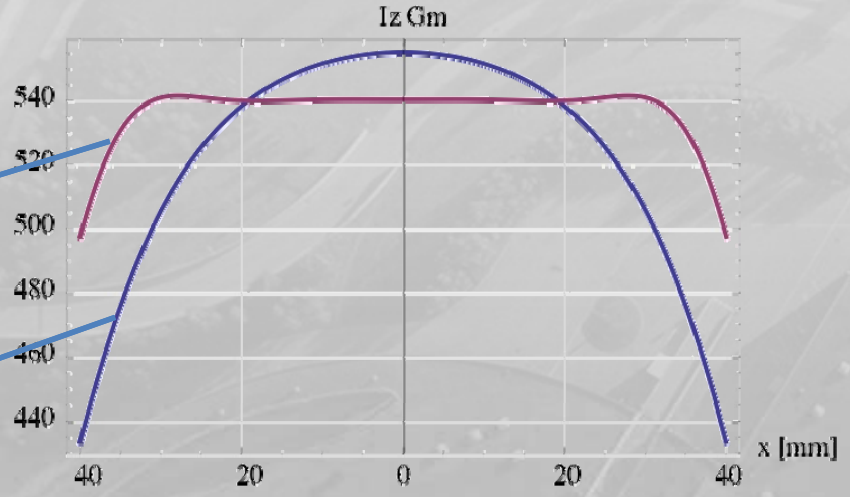


Magnet blocks

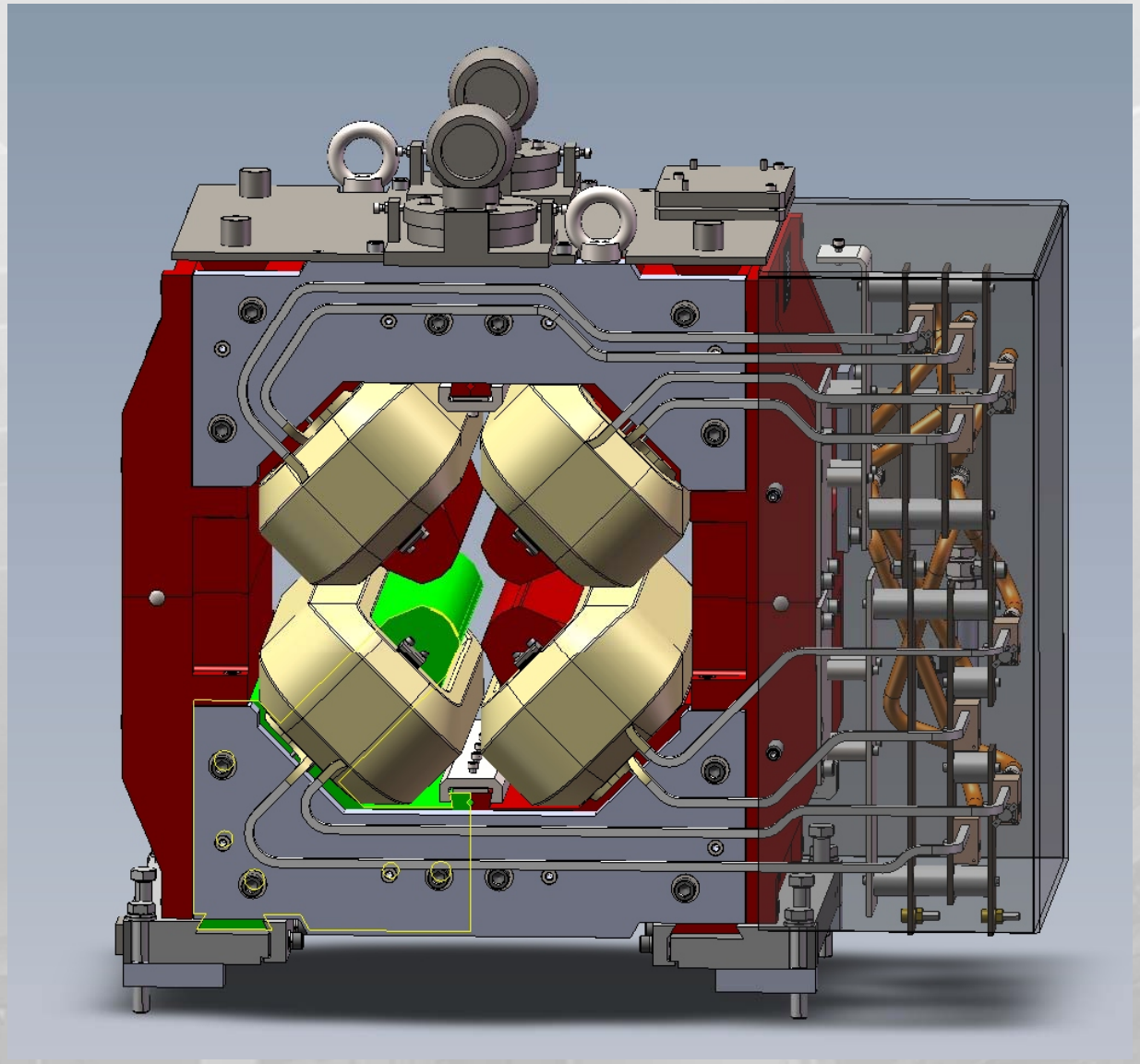
Optimize field “flatness” vs x
Link pole profile to local field in Radia
- Iteratively solved

Optimized profile

Flat pole



High Gradient Quadrupoles



- 12 units manufactured by Antec
- Needed for 7 m straights
- Gradient 26 T/m
- Diameter 66 mm

- Prototype Delivered
- Magnetic Field Measurement of prototype at ALBA/ ESRF

Magnetic Measurement Bench

Stretched Wire

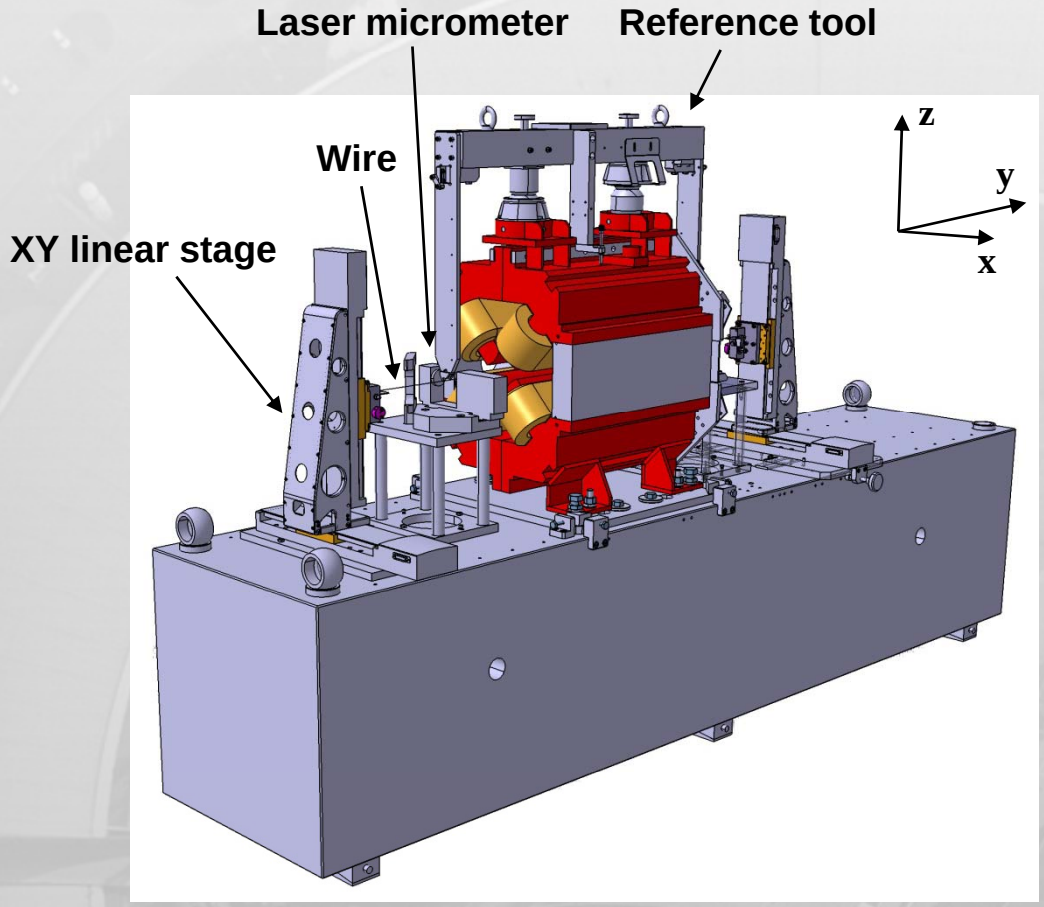
- Magnetic center
- Harmonic analysis

Transfer to survey monument

- Reference tool
- Laser micrometer

Applications

- Quadrupoles
- Sextupoles
- Undulators
- Steerers
- …



Quadrupole measurement bench

Magnetic Bench Performances

New quadrupole measurement bench

- Noise level similar to that of solid rotating coils
- Highly flexible and can be customized for high precision measurement of any type of magnet

Main results for Quadrupole measurement

Magnetic center measurement

- Repeatability < 1 µm for position measurements
- Repeatability < 10 µm for transfer to survey monuments

Double field integral measurement

- Standard deviation < 70 µrad on quadrupole direction

Harmonic measurements

- Normalized standard deviation $< 50\ 10^{-6}$ on field integral (with respect to quadrupole field) on 30 mm radius
- Repeatability < 10 µrad on tilt measurements

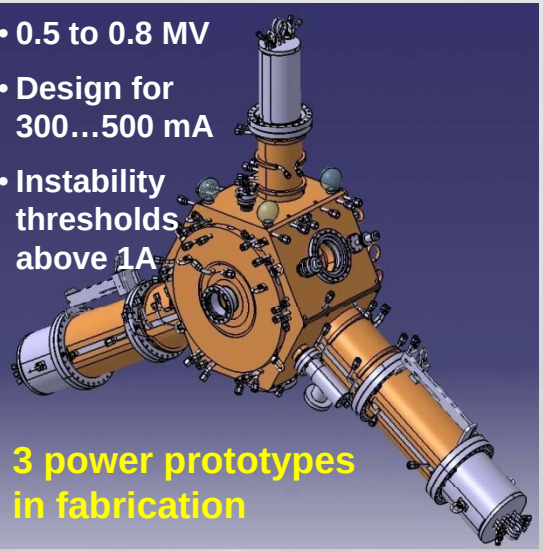
Probably a revolution in Magnetic field measurement intrumentation for accelerator magnets

- Makes bucking coils obsolete (move wire along the primary field lines)
- Build Field Model in arbitrary profile (not limited to circle)
- Obtain Gradient of qaudrupole or sextupole vs hor. Posiiton with a much higher precision than rotating coils.
- The principle is to move the wire on a close path very close to the surface of yoke or magnet and reconstruct the surface current over that path
- Improve the interpretation of field errors in term of geometrical errors

J. Chavanne, G LeBec, to be published

Single cell NC HOM damped cavity prototypes

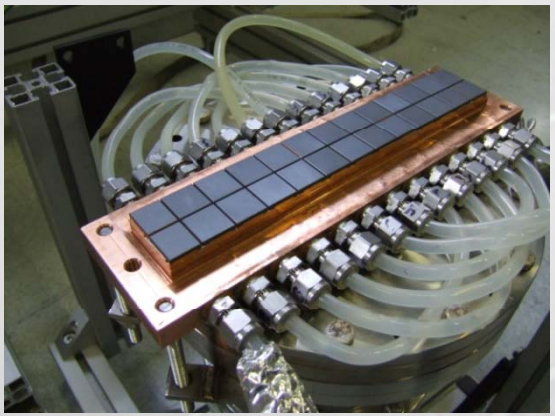
- 0.5 to 0.8 MV
- Design for 300…500 mA
- Instability thresholds above 1A



3 power prototypes in fabrication

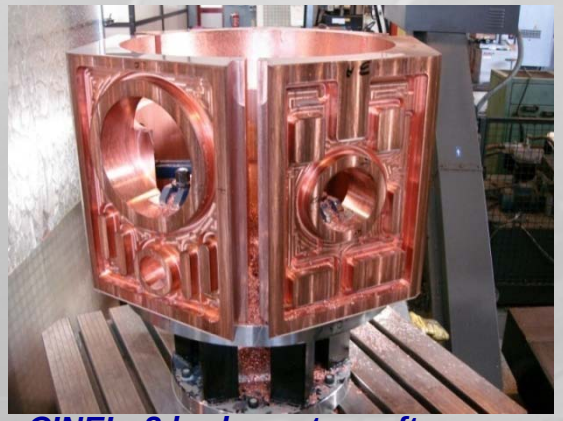
RI, SDMS, Cinel

☞ **Tests with beam on Storage Ring: cavity by cavity in cell 25, after removal of SR cavity 5, from mid 2011**



RI: Ferrite HOM absorber for IR thermal test at ESRF, April 2010

RI: Body after e-beam welding of the HOM coupling sections, April 2010

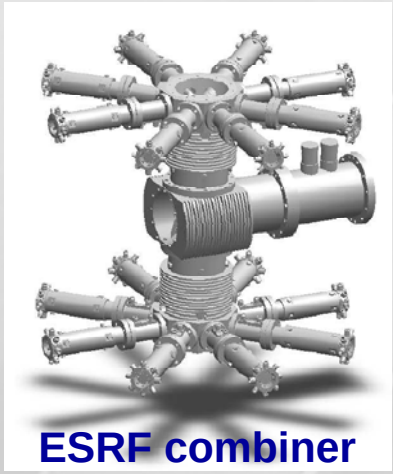


CINEL: 3 body sectors after machining of the water cooling channels, September 2010

SDMS: Body after e-beam assembly of the 3 sectors, November 2010

This work, carried out within the framework of the ESRFUP project, has received research funding from the EU Seventh Framework Programme, FP7.

2. Contract for 7 SSA of phase 1 with ELTA



SOLEIL 315 W module

SOLEIL 300 V / 30 V dc-dc converter

- Offer essentially along the initial SOLEIL design
- New 6th generation LDMOS-FET transistors allow for a more compact design with only **2 towers** to obtain **150 kW**:

  315 W → 650 W per module

  Coaxial combiners: 650 kW x 8 x 8 x 2 – losses = 75 kW / tower
- November 2009, contract with ELTA for:
  - 4 x 150 kW SSA for the booster (10 Hz pulsed operation)
  - 3 x 150 kW SSA for the SR (CW operation)
- First 75 kW tower built in close collaboration between SOLEIL and ELTA (transfer of technology)

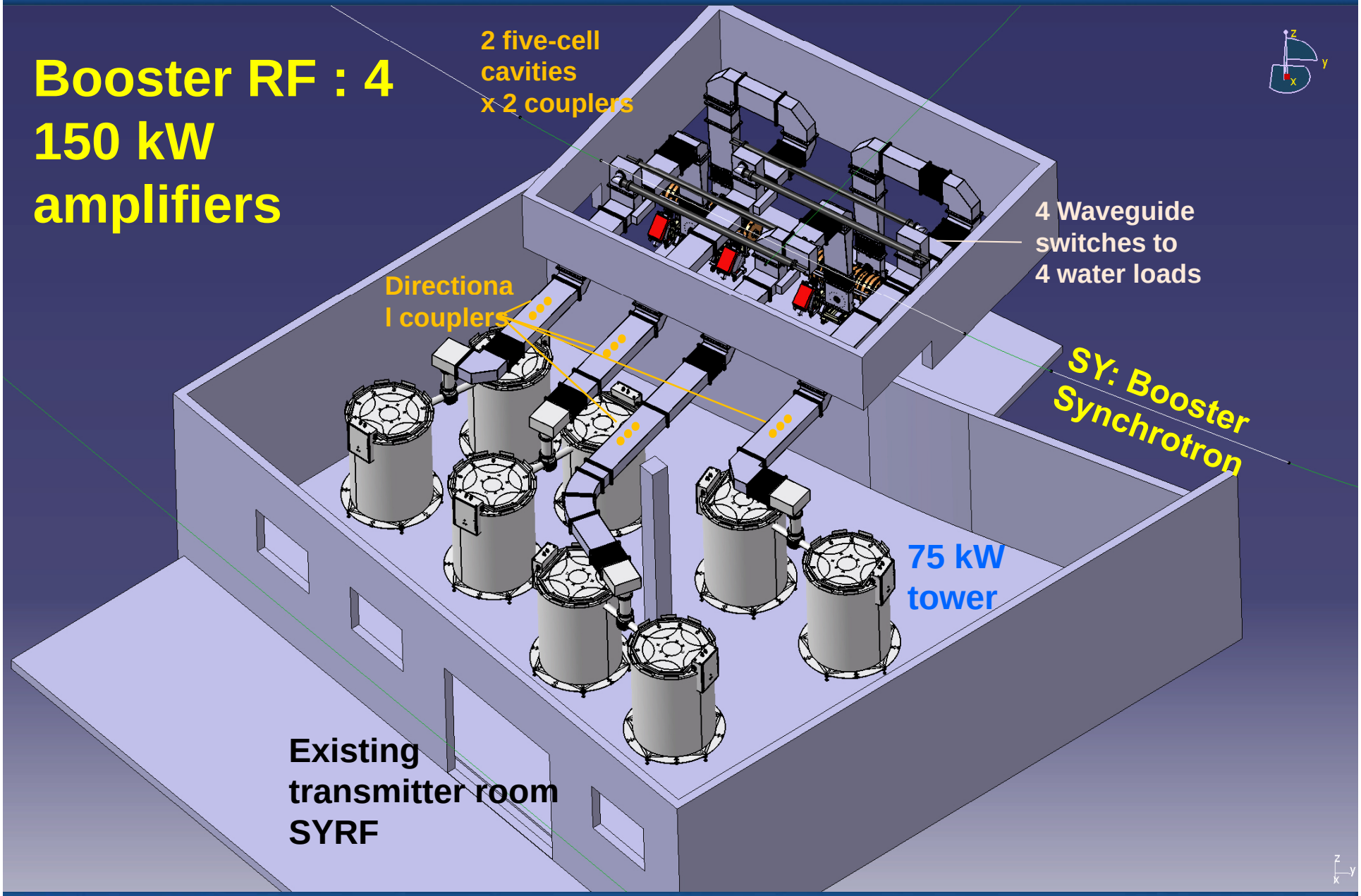
Schedule:

- February 2010: Successful test of the first RF module, validation of the design:

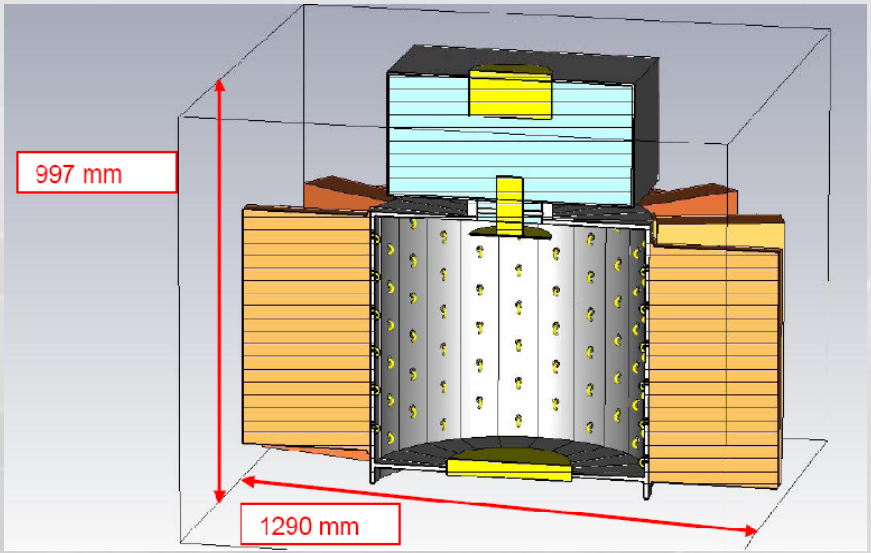
  η_{module} > 72 % (measured)

  ⇒ expected total η_{SSA} > 55 % (> spec)
- July 2010: Successful test of the first combination of 16 RF modules, including 500 hours ON/OFF fatigue test (7500 x 4 min on/off cycles)
- January 2011: Acceptance test of the first 75 kW tower at ESRF
- January 2012: commissioning of the 4 x 150 kW SSA connected to the ESRF booster cavities

Booster RF : 4 150 kW amplifiers



3. R&D – SSA using a Cavity Combiner



For ESRF application:

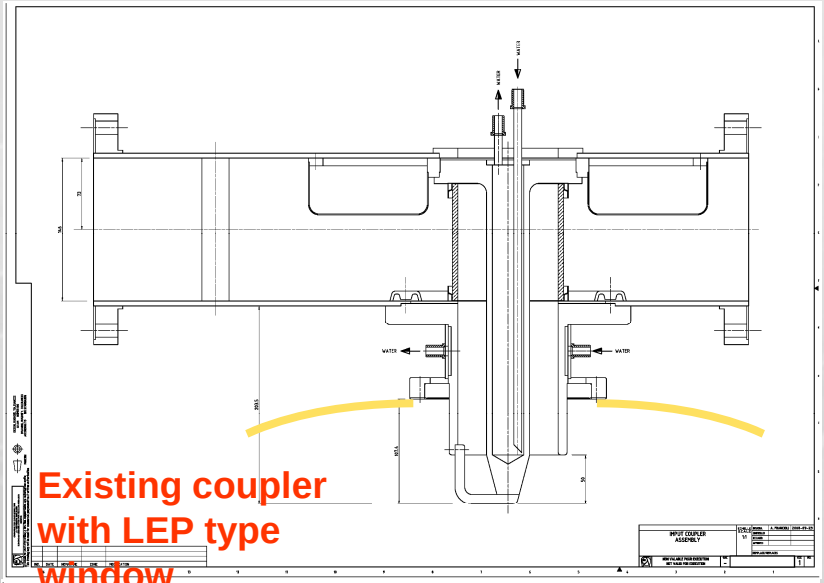
- **6 raws x 22 Columns x [600 …800 W per transistor module]**

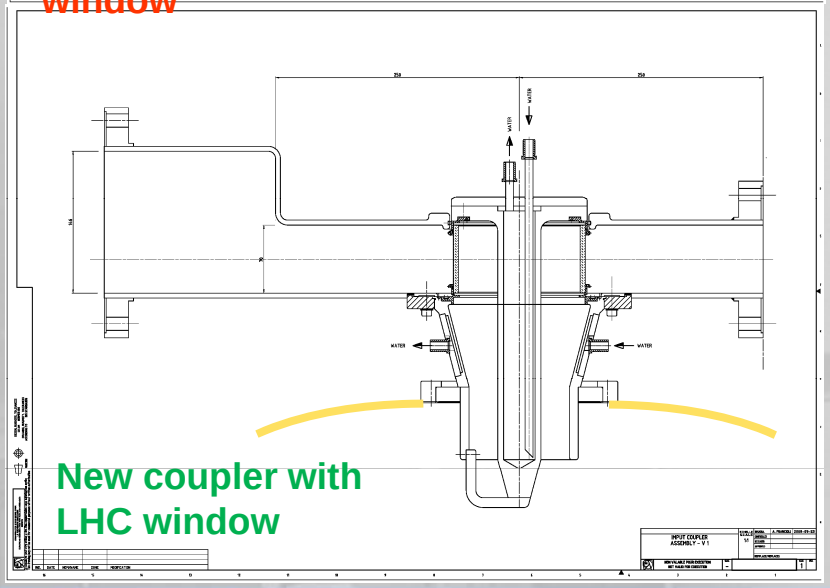
  ⇒ 75 … 100 kW
- **More compact than SOLEIL type coaxial combiners**

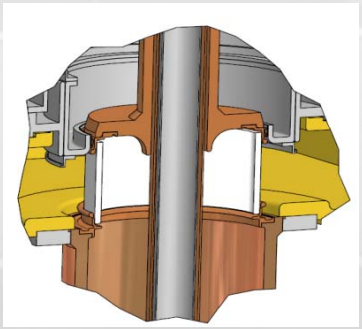
  Coupling: $ß_{waveguide} \approx n_{module} \times ß_{module} >> 1$
- **Easy to tune if n_{module} is varied**
- **Reduction of losses ⇒ higher η**

- **SSA with Cavity Combiner**
  - Mechanical design ready to build a 10 kW prototype (18 modules)
  - Main goal: develop an adequate electrical & mechanical interface between RF modules & cavity, for easy plug in
- In parallel:
  - In house development of amplifier modules,
  - Using latest LDMOS-FETs
  - Goal:
    - Acquire expertise in SSA design,
    - Implement the design improvements
    - Prepare the future operation follow up
    - Set reference for coming procurements
- **Prepare next step:**
  - **Full scale prototype at 75…100 kW**

4. New coupler using LHC window - CERN-ESRF-SOLEIL collaboration







LHC window directly brazed into copper collars:
- ◊ **No sharp edges**
- ◊ **Well defined current paths**
- ☞ **Sustains very high power: tested at 575 kW full reflection without damage**

1. Develop couplers for ESRF and SOLEIL using LHC window to
- ◊ Increase the power capability and improve the reliability
- ◊ Obtain a new standard and high performance plattform for high power couplers
- ◊ **Electrical & mechanical compatibility with existing LEP coupler for both NC and SC applications**
- ◊ ESRF: 1 prototype for high power tests + 2 production prototypes
- ◊ **SOLEIL: 2 production prototypes**
- ◊ Including waveguide transformers

2. CERN's interest
- ◊ Re-develop the brazing and subsequent electron beam welding in the CERN workshops
- ◊ **Safeguard specialized know-how and guarantee durability of this strategic component**

3. Status
- ◊ **Successful ceramic / copper brazing at CERN (inspection of a cut sample)**
- ◊ Prototype foreseen in December 2010
- ◊ **Production prototypes for ESRF and SOLEIL in June 2011**

Budget cut ahead !

Following financial difficulties of some ESRF partners a 6% Reduction of 2011 budget will be discussed at the next Council meeting (29th–30th November 2010) !

- Reduction of Investment as well as Personal costs
- Scale Down the Building Program
- Close some beamlines
- Concerning Accelerator Division
  - Stop investment for 300 mA operation
  - Reduce the RF program (Cavity)
  - Delay the 7 m beamlines upgrade