ESRF ACCELERATOR AND SOURCE UPGRADE

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Summary

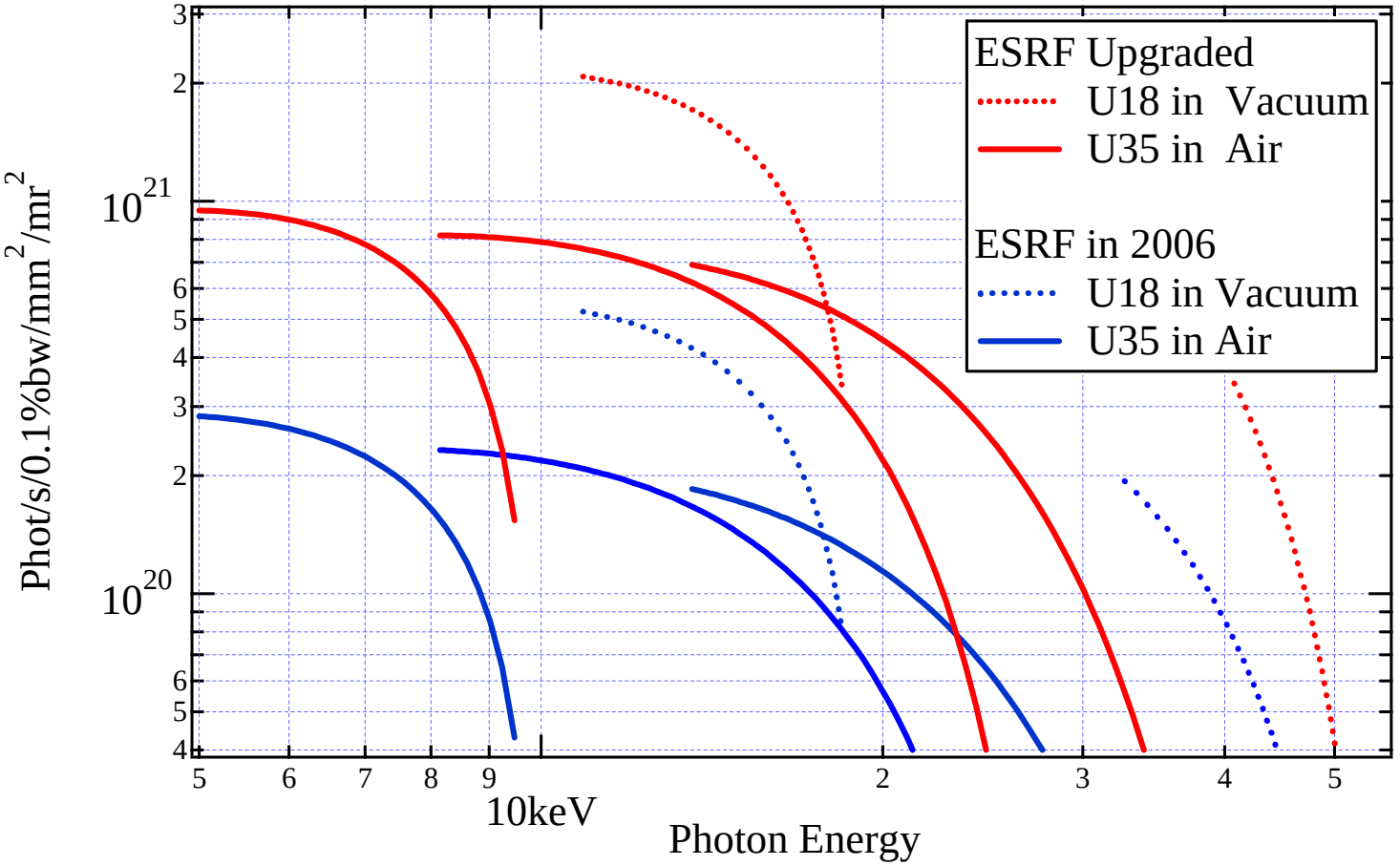
Increase **Flux** ,**Brilliance** and **Capacity** while keeping **reliability**

- Implement 6 and 7 m long ID straight
- Operation at 300 mA
- Reduce Vertical Emittance to 10 pm
- Topping up in time structured mode

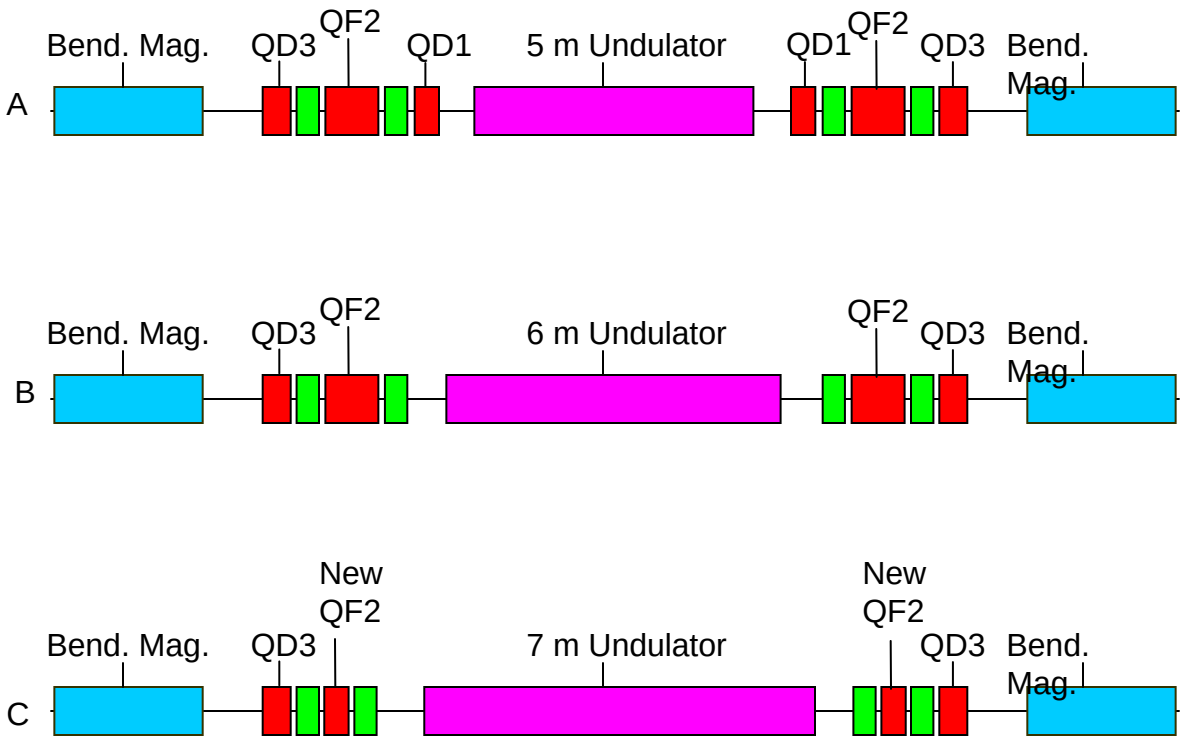
Ensure the **Durability** of the Accelerator Complex

- Digital beam position monitoring
- Upgrade RF power sources
- Upgrade RF cavities

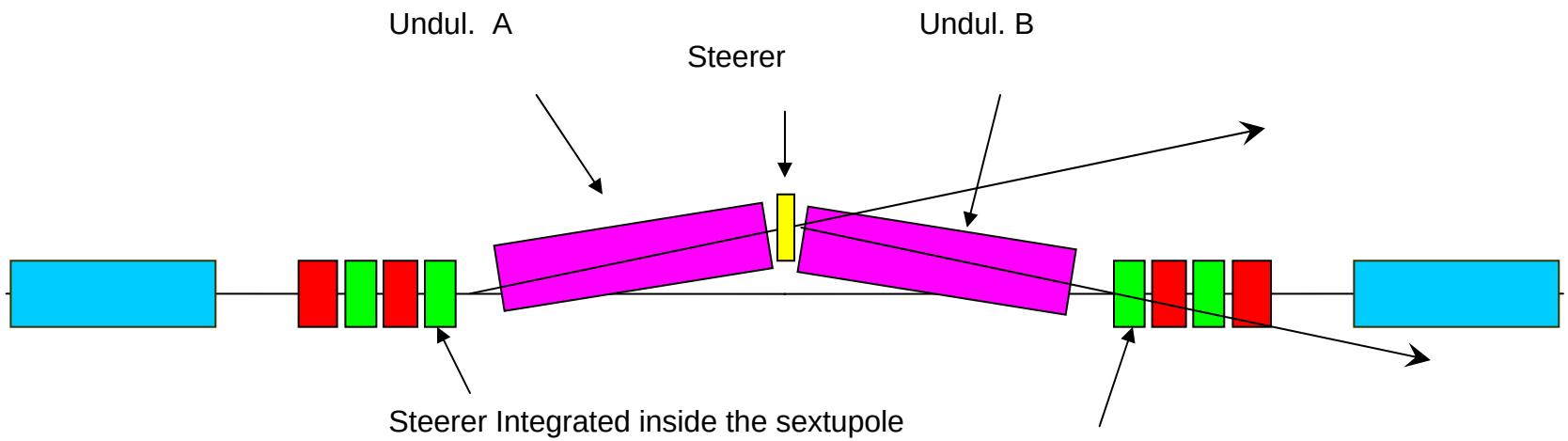
Brilliance


ESRF Upgraded
U18 in Vacuum
U35 in Air
ESRF in 2006
U18 in Vacuum
U35 in Air
Phot/s/0.1%bw/mm^2/mr^2
10^{21}
10^{20}
3
2
6
5
4
3
2
6
5
4
5
6
7
8
9
10keV
2
3
4
5
Photon Energy

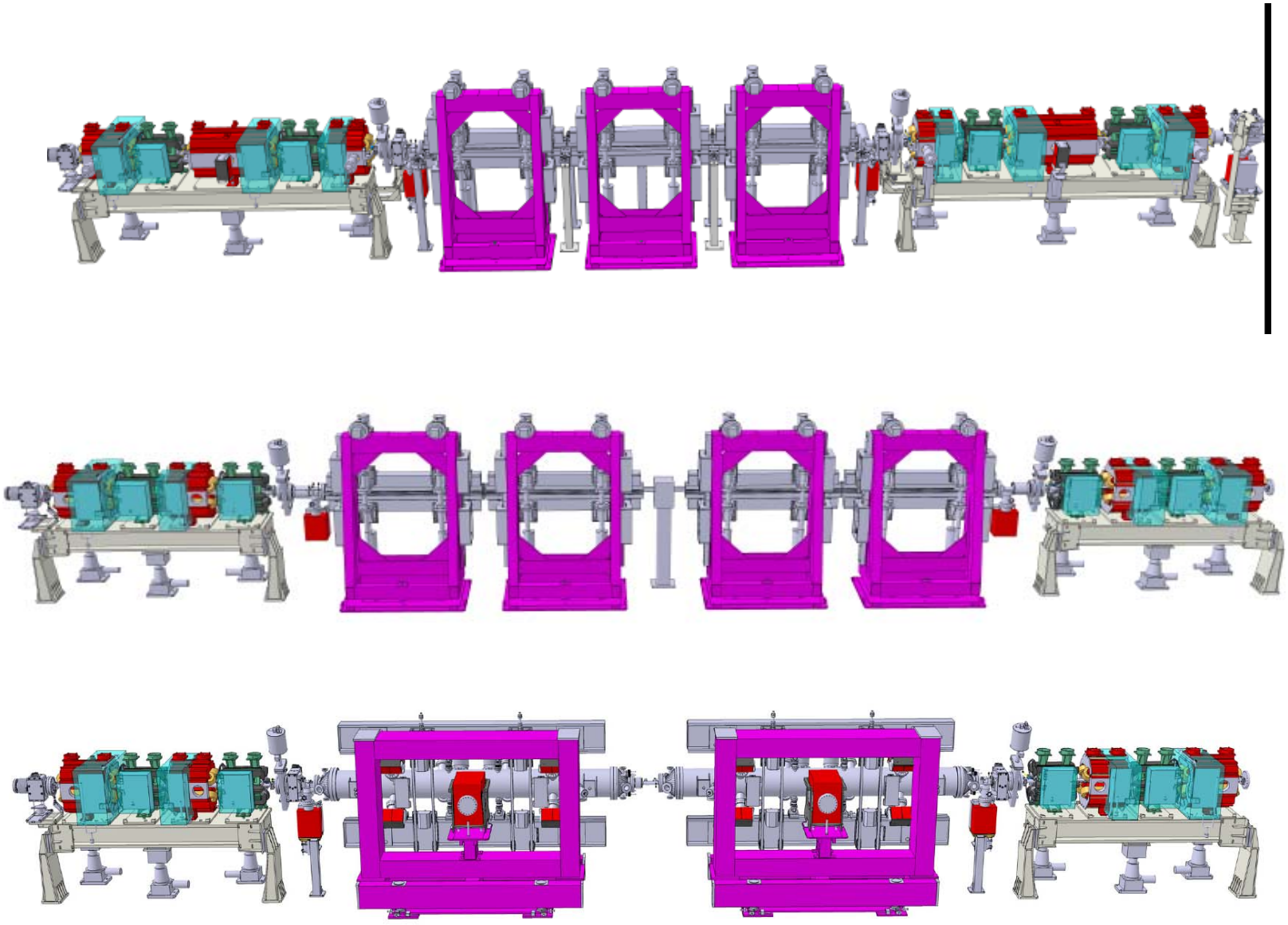
Increasing the ID length



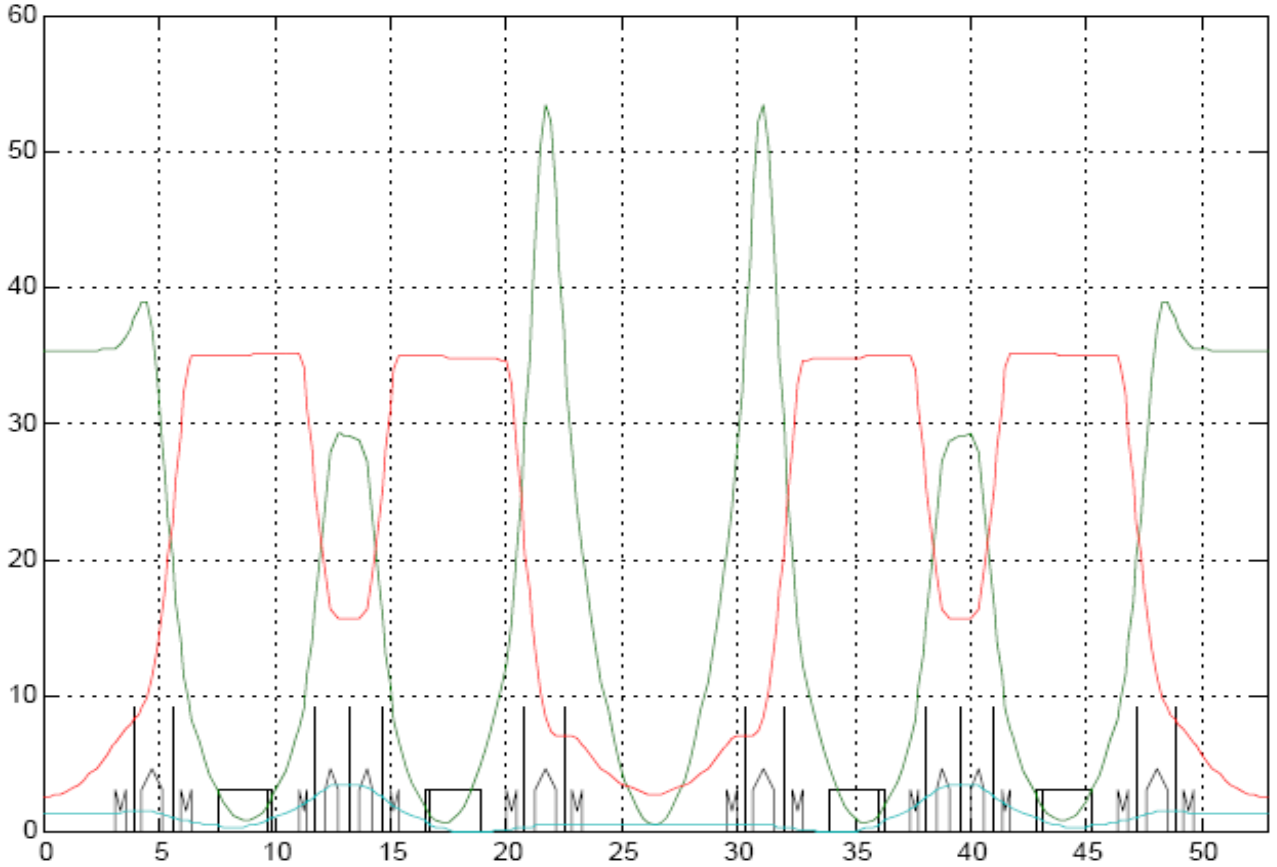
Canting Beamlines



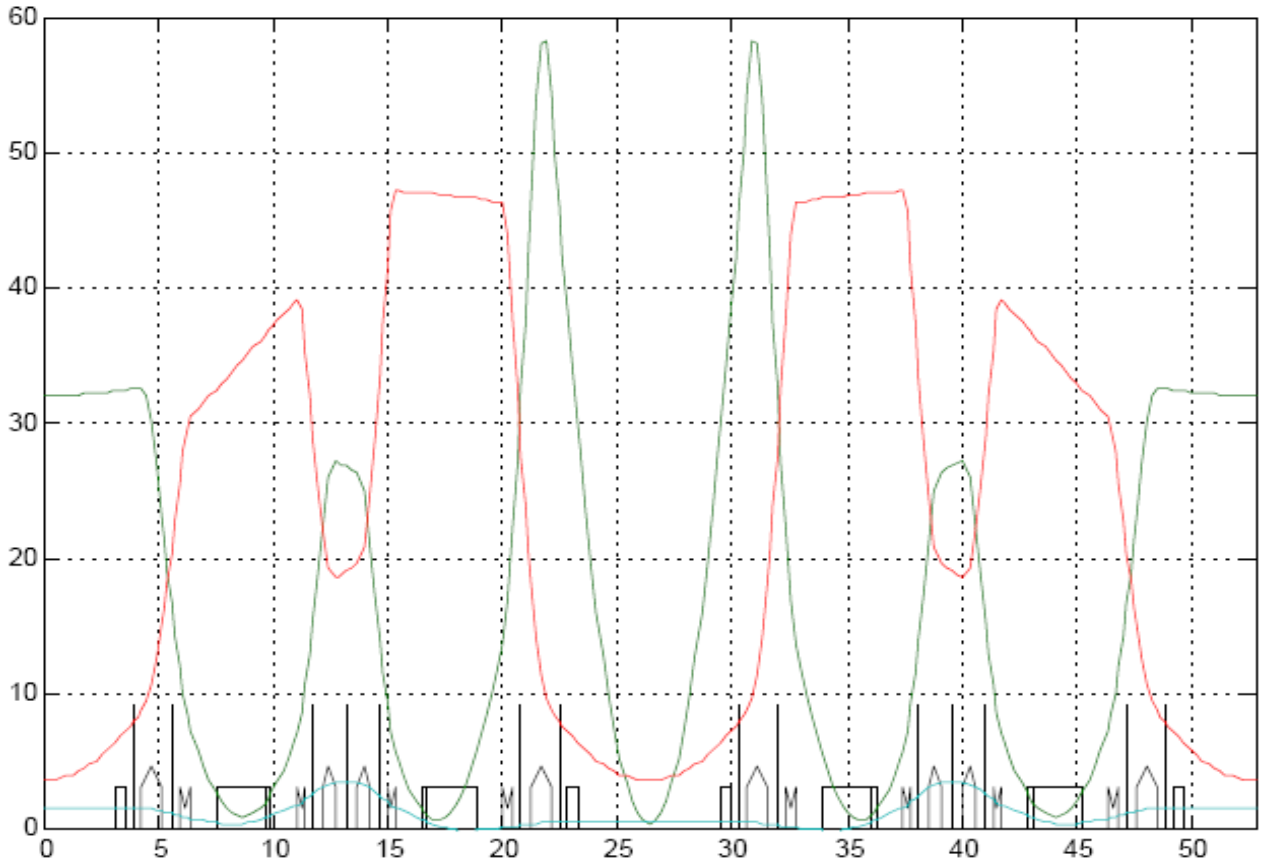
Canting Angle = 2 x 2.7 mrad
ID Length = 2 x 3.35 m



Linear Lattice Before Upgrade



Linear Lattice as of today
(No current in QD1 and QD8)



Lattice Upgrade

- Implement 7 m straight section in all 32 straight ?
  - Ideal for beamline and lattice optimization
  - Need to replace 700 m of vacuum chamber and remove 2/3 of the quadrupole girder
  - Costly and Resource Intensive (~ 1-2 years ?)
- Convert many ID straight to 6 m
  - No consequence on Lattice
  - Can be performed smoothly suring existing shutdowns
- Convert a few ID straight to 7 m
  - Break the lattice symmetry => possible consequence on lifetime and injection efficiency
  - Successful tests of detuning Three straights have been carried-out in 2007.

Ramp Ring Current to 300 mA

- Goal : Operate 300 mA in uniform filling 2x1/3 mode and 7/8+1 modes
- Problem : Longitudinal Coupled Bunch Instability induced by High Order Resonating Modes in the Radio Frequency Cavities
- How to proceed :
  - Precise temperature stabilization of the cavities
  - Bunch by bunch feedback
  - Develop RF Transmitter to restore redundancy
  - Replacement of the existing cavities with HOM free cavities

- Current Status :
  - Stable 300 mA beam in uniform filling mode achieved in December 2006
  - 300 mA to be investigated in 2008 during MDT
  - 300 mA to be delivered in USM in 2009.

Vertical Emittance stabilized below 10 pm

- Interest :
  - For nanofocusing, smaller vertical size of the beam on the sample
- Challenges :
  - Vertical emittance can be corrected but it fluctuates slowly with time due to residual skew quadrupoles in the undulators => Vertical emittance varies with gap change in an unpredictable manner.
- Cure
  - Global correction based on the measured vertical emittance
  - Will need :
    - New vertical emittance diagnostic with low noise and higher measurement rate
    - Optimized algorithm and possibly more correctors

Top-Up

- Benefits
  - Higher Average Current particularly in 16 and 4 bunch mode
  - Stable heatload in the beamlines
  - Lower vertical Emittance
- Challenges
  - The most problematic is to maintain the 10^9 purity between filled and unfilled bucket required by a few beamlines
  - Develop bunch cleaning in the booster.

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Maintain the Durability

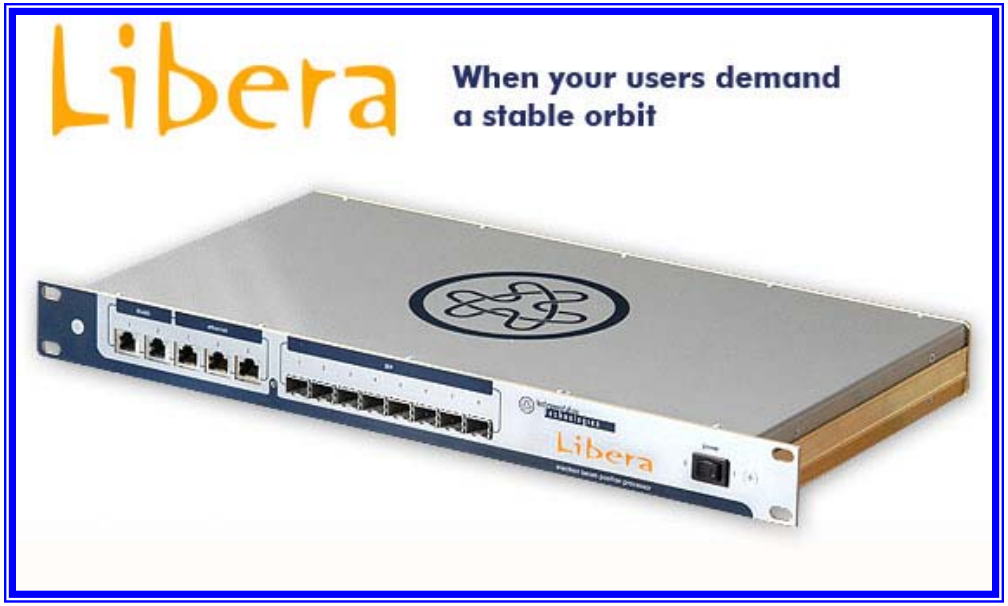
- Some Systems will become difficult to maintain due to the obsolescence and unavailability of spare parts.

- The following equipments have been identified as requiring an upgrade
  - Electronics of beam position monitors
  - RF Transmitters
  - RF cavities
  - …

Upgrade Beam Position Monitoring (BPM) system

ESRF BPM electronics is home made ~19 years old. Suffer from :

- Inefficient in the first turn mode
- Lack turn by turn capabilities
- Only Operate in DC mode



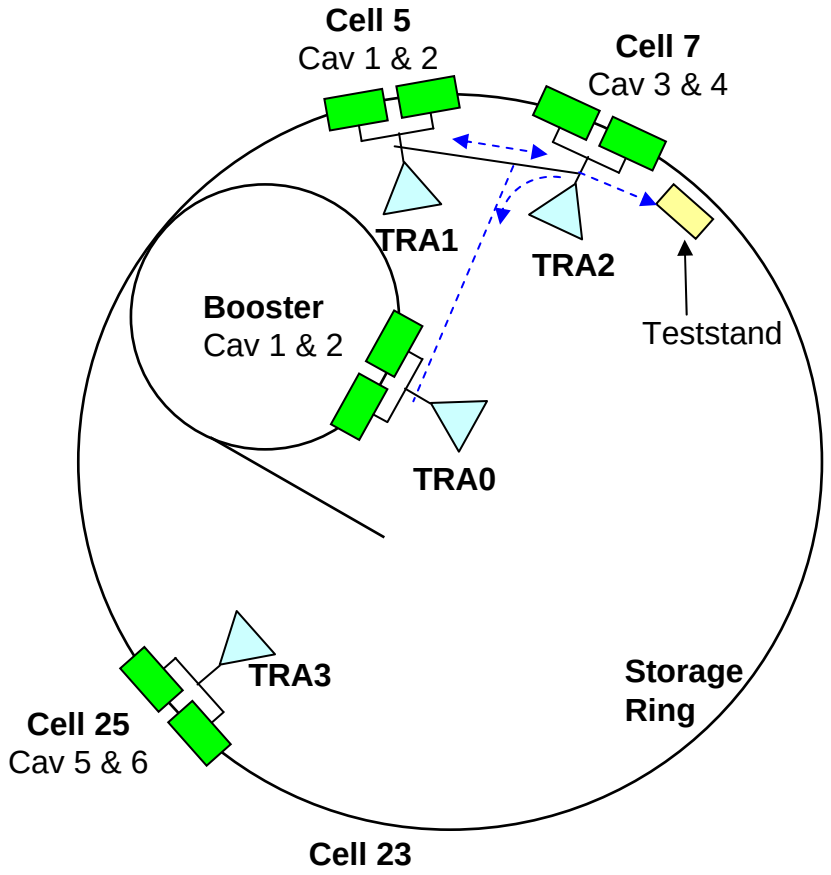
Proposed to upgrade with the "Libera" system from Instrumentation Technologies

- Can be directly integrated into a global DC-AC position feedback to eliminate orbit motion induced by ID gap changes
- Higher sensitivity in First turn mode
- Full turn by turn capability
- Flexible
- Adopted by all new projects (Diamond, Soleil, Elettra, ALBA, Petra III, SRRC,…)

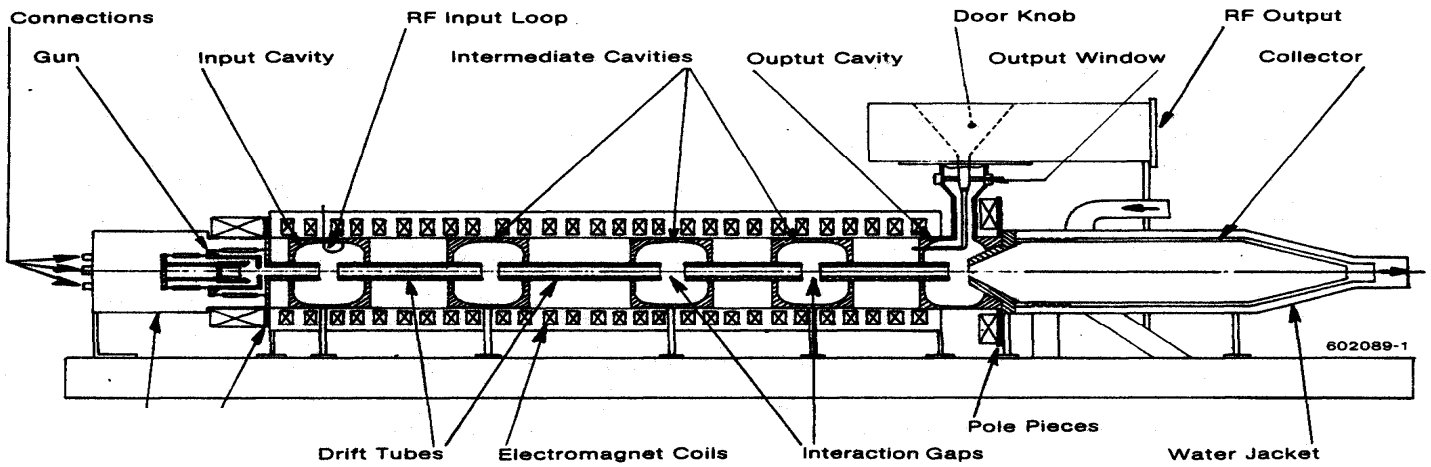
RF System of the ESRF

1.5 MW of RF at 352.2 MHz to Compensate for the energy lost by Synchrotron Radiation

Presently use :
- 4 klystron based Transmitters
- Multi-cell cavities Occupying two Straight Sections



4 Transmitters built with 1.1-1.3 MW CW klystrons



Problems :

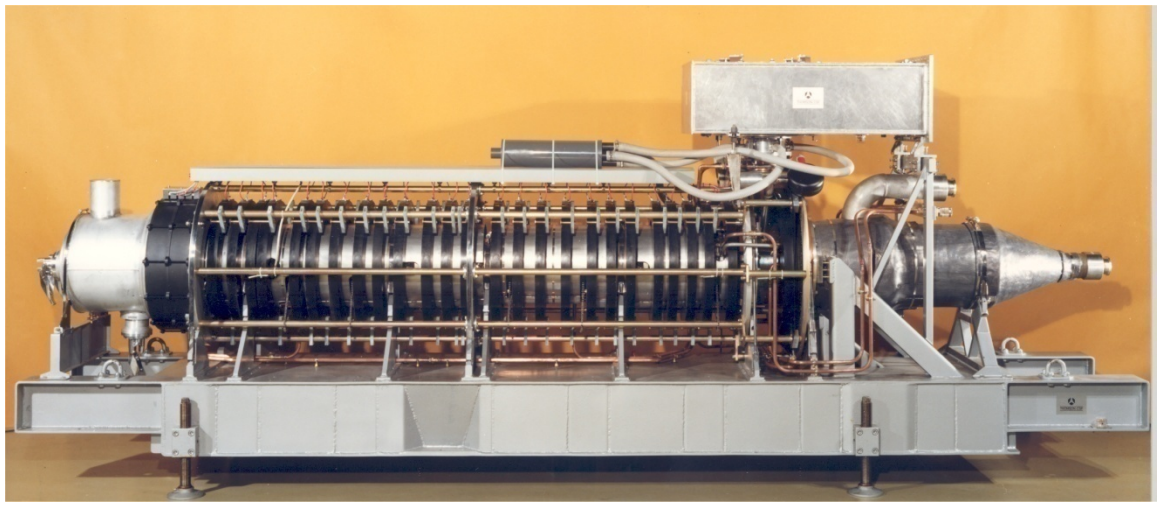
-Source of many beam dump

-Consumable : Need to be replaced every 30-40 000 h

-Single supplier in the world of not so stable klystrons

- Small size world wide market for such klystrons

-Lack redundancy for 300 mA operation



Alternative to klystrons

- Inductive Output Tube (IOT)
  - Moderate Power (< 80 kW) combined in parallel
  - Used for for Analog TV broadcasting
  - Adopted by DIAMOND , ALBA, ELETTRA
  - No market at 352.2 MHz => no hope
- Solid State Amplifiers
  - Parallel operation of a large number of 300 W transistor based amplifiers
  - High Redundancy and Modularity
  - Expect a simpler system with reduced number of beam trip
  - First developed and adopted at SOLEIL

RF Cavity Upgrade

300 mA achieved
with existing cavities &
Bunch by bunch feedback
But more operational reliability
require new cavities

Proposal : Develop new HOM damped cavities. Replace the existing ones. Collaboration initiated with BESSY and ALBA