 


# *SuperB a Super-Flavour-Factory*

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*on behalf of the SuperB Accelerator Team*

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# SuperB Accelerator

- SuperB is a 2 rings, asymmetric energies ($e^-$ @ 4.18, $e^+$ @ 6.7 GeV) collider with:
  - large Piwinski angle and "crab waist" (LPA & CW) collision scheme
  - ultra low emittance lattices
  - longitudinally polarized electron beam
  - target luminosity of $10^{36}$ $cm^{-2}$ $s^{-1}$ at the $\Upsilon$(4S)
  - possibility to run at $\tau$/charm threshold with L = $10^{35}$ $cm^{-2}$ $s^{-1}$
- Criterias used for the design:
  - Minimize building costs
  - Minimize running costs
  - Minimize wall-plug power and water consumption
  - Reuse of some PEP-II B-Factory hardware (magnets, RF)
- SuperB can be also a good "light source": there will be some Sinchrotron Radiation beamlines (collaboration with Italian Institute of Technology) → work in progress

# SuperB design

- The design requires state-of-the-art technology for emittance and coupling minimization, vibrations and misalignment control, $e^-$ cloud suppression, etc...

- SuperB has many similarities with the Damping Rings of ILC and CLIC, and with latest generation SL sources, and can profit from the collaboration among these communities

- For details see the new Conceptual Design Report (Dec. 2010) on:

  http://arxiv.org/abs/1009.6178

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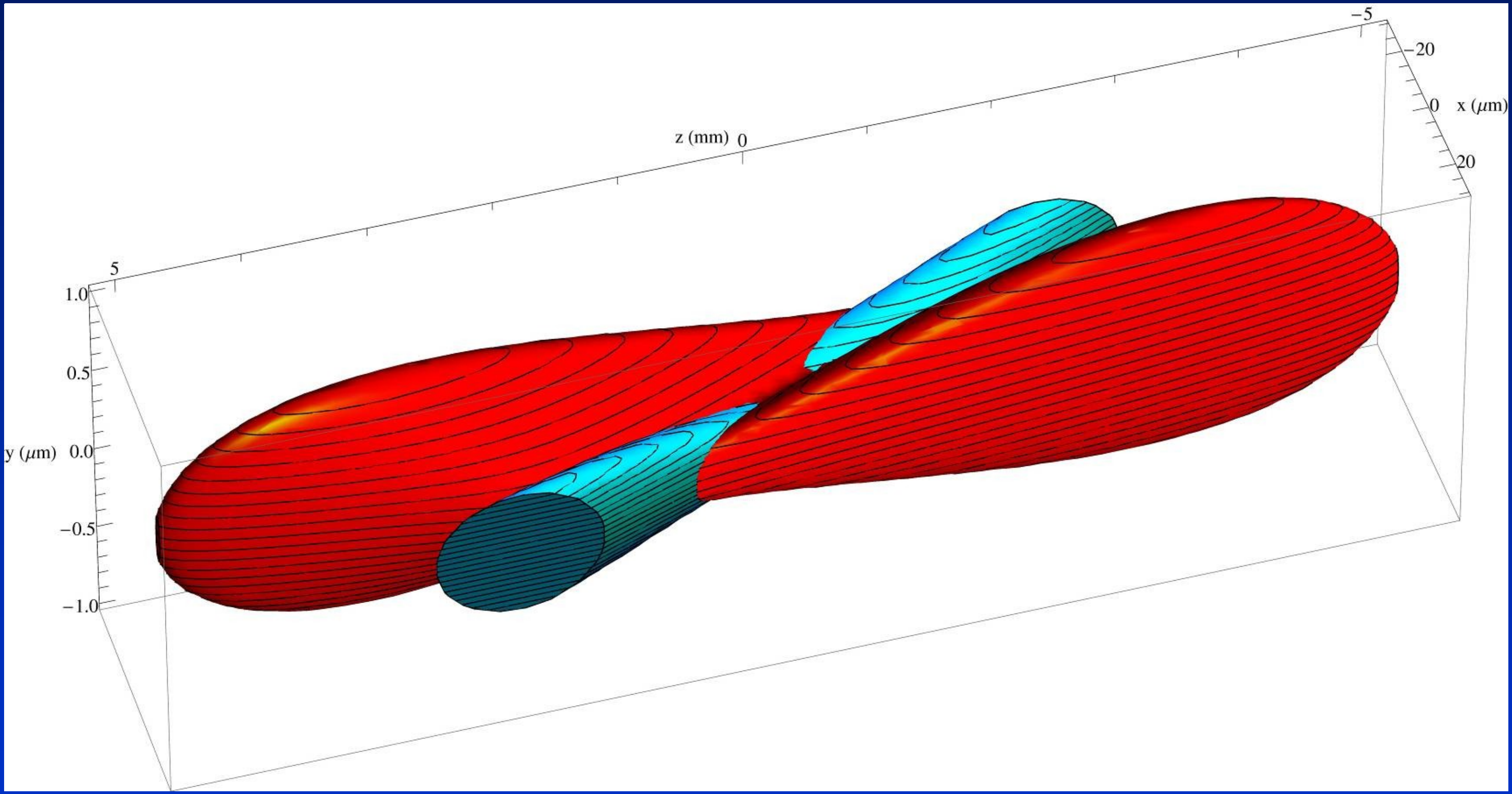
# *Crab-waist scheme*

**Raimondi, Shatilov, Zobov**
**http://arxiv.org/abs/physics/0702033**

**Crab sextupoles OFF: Waist line is orthogonal to the axis of other beam**




**Crab sextupoles ON: Waist aligned with path of other beam**

- **particles at higher ß do not see full field of other beam**
- **no excessive beam-beam parameter due to hourglass effect**

# SuperB Parameters

- IP and ring parameters have been optimized based on several constraints. The most significant are:
  - Maintain wall plug power, beam currents, bunch lengths, and RF requirements comparable to past B-Factories;
  - Plan for the reuse as much as possible of the PEP-II hardware;
  - Require ring parameters as close as possible to those already achieved in the BFactories, or under study for the ILC Damping Ring or achieved at the ATF ILC-DR test facility;
  - Simplify IR design as much as possible. In particular, reduce the synchrotron radiation in the IR, reduce the HOM power and increase the beam stay-clear;
  - Eliminate the effects of the parasitic beam crossing;
  - Relax as much as possible the requirements on the beam demagnification at the IP;
  - Design the Final Focus system to follow as closely as possible already tested systems, and integrating the system as much as possible into the ring design

# SuperB Parameters (cont.)

- Column 1 of Table shows the baseline parameters set that closely matches these criteria.

- The machine is also designed to have flexibility for the parameters choice with respect to the baseline. In particular:
  - horizontal emittance can be decreased by about a factor 2 in both rings by changing the partition number (by changing the RF frequency [LEP] or the orbit in the ARCS) and the natural ARC emittance by readjusting the lattice functions;
  - Final Focus system as a built-in capability of about a factor 2 in decreasing the IP beta functions;
  - RF system will be able to support higher beam currents (up to a factor 1.6) than the baseline ones, when all the available PEP RF units are installed

# Parameter Table

| Parameter | Units | Base Line HER (e+) | Base Line LER (e-) | Low Emittance HER (e+) | Low Emittance LER (e-) | High Current HER (e+) | High Current LER (e-) | Tau/Charm (prelim.) HER (e+) | Tau/Charm (prelim.) LER (e-) |
|---|---|---|---|---|---|---|---|---|---|
| LUMINOSITY | $cm^{-2} s^{-1}$ | 1.00E+36 | | 1.00E+36 | | 1.00E+36 | | 1.00E+35 | |
| Energy | GeV | 6.7 | 4.18 | 6.7 | 4.18 | 6.7 | 4.18 | 2.58 | 1.61 |
| Circumference | m | 1258.4 | | 1258.4 | | 1258.4 | | 1258.4 | |
| X-Angle (full) | mrad | 66 | | 66 | | 66 | | 66 | |
| Piwinski angle | rad | 22.88 | 18.60 | 32.36 | 26.30 | 14.43 | 11.74 | 8.80 | 7.15 |
| $\beta_x$ @ IP | cm | 2.6 | 3.2 | 2.6 | 3.2 | 5.06 | 6.22 | 6.76 | 8.32 |
| $\beta_y$ @ IP | cm | 0.0253 | 0.0205 | 0.0179 | 0.0145 | 0.0292 | 0.0237 | 0.0658 | 0.0533 |
| Coupling (full current) | % | 0.25 | 0.25 | 0.25 | 0.25 | 0.5 | 0.5 | 0.25 | 0.25 |
| $\varepsilon_x$ (without IBS) | nm | 1.97 | 1.82 | 1.00 | 0.91 | 1.97 | 1.82 | 1.97 | 1.82 |
| $\varepsilon_x$ (with IBS) | nm | 2.00 | 2.46 | 1.00 | 1.23 | 2.00 | 2.46 | 5.20 | 6.4 |
| $\varepsilon_y$ | pm | 5 | 6.15 | 2.5 | 3.075 | 10 | 12.3 | 13 | 16 |
| $\sigma_x$ @ IP | μm | 7.211 | 8.872 | 5.099 | 6.274 | 10.060 | 12.370 | 18.749 | 23.076 |
| $\sigma_y$ @ IP | μm | 0.036 | 0.036 | 0.021 | 0.021 | 0.054 | 0.054 | 0.092 | 0.092 |
| $\Sigma_x$ | μm | 11.433 | | 8.085 | | 15.944 | | 29.732 | |
| $\Sigma_y$ | μm | 0.050 | | 0.030 | | 0.076 | | 0.131 | |
| $\sigma_L$ (0 current) | mm | 4.69 | 4.29 | 4.73 | 4.34 | 4.03 | 3.65 | 4.75 | 4.36 |
| $\sigma_L$ (full current) | mm | 5 | 5 | 5 | 5 | 4.4 | 4.4 | 5 | 5 |
| Beam current | mA | 1892 | 2447 | 1460 | 1888 | 3094 | 4000 | 1365 | 1766 |
| Buckets distance | # | 2 | | 2 | | 1 | | 1 | |
| Ion gap | % | 2 | | 2 | | 2 | | 2 | |
| RF frequency | Hz | 4.76E+08 | | 4.76E+08 | | 4.76E+08 | | 4.76E+08 | |
| Harmonic number | | 1998 | | 1998 | | 1998 | | 1998 | |
| Number of bunches | | 978 | | 978 | | 1956 | | 1956 | |
| N. Particle/bunch | | 5.08E+10 | 6.56E+10 | 3.92E+10 | 5.06E+10 | 4.15E+10 | 5.36E+10 | 1.83E+10 | 2.37E+10 |
| Tune shift x | | 0.0021 | 0.0033 | 0.0017 | 0.0025 | 0.0044 | 0.0067 | 0.0052 | 0.0080 |
| Tune shift y | | 0.0970 | 0.0971 | 0.0891 | 0.0892 | 0.0684 | 0.0687 | 0.0909 | 0.0910 |
| Long. damping time | msec | 13.4 | 20.3 | 13.4 | 20.3 | 13.4 | 20.3 | 26.8 | 40.6 |
| Energy Loss/turn | MeV | 2.11 | 0.865 | 2.11 | 0.865 | 2.11 | 0.865 | 0.4 | 0.166 |
| $\sigma_E$ (full current) | dE/E | 6.43E-04 | 7.34E-04 | 6.43E-04 | 7.34E-04 | 6.43E-04 | 7.34E-04 | 6.94E-04 | 7.34E-04 |
| CM $\sigma_E$ | dE/E | 5.00E-04 | | 5.00E-04 | | 5.00E-04 | | 5.26E-04 | |
| Total lifetime | min | 4.23 | 4.48 | 3.05 | 3.00 | 7.08 | 7.73 | 11.41 | 6.79 |
| Total RF Power | MW | 17.08 | | 12.72 | | 30.48 | | 3.11 | |

**Tau/charm threshold running at $10^{35}$**

**Baseline + other 2 options:**
- **Lower y-emittance**
- **Higher currents (twice bunches)**

**Baseline:**
- **Higher emittance due to IBS**
- **Asymmetric beam currents**

**RF power includes SR and HOM**

# SuperB Parameters (cont.)

- Columns 2 and 3 in Table show different parameters options:

  1. Low Emittance case relaxes the RF requirements and all the problems related to high current operations (including wall-plug power) but put more strain on the Optic and the Tuning Capabilities
  2. High Current case has the opposite characteristics. The requirements on vertical emittance and IP $\beta$-functions are relaxed but the high currents issues are enhanced (instabilities, HOM and synchrotron radiation, wall-plug power etc…)

- Overall the collider should be flexible enough to reach the target specifications, superseding the encountered limitations by pushing more the less critical parameters
- The cases shown have several parameters kept has much constant as possible (bunch length, IP stay clear etc…), in order to reduce their impact on other unwanted effects (Detector backgroung, HOM heating etc…)

# SuperB at τ/charm threshold

- SuperB can operate at a lower cm energy with a somewhat reduced luminosity (last Column in Table). In order to operate at τ/charm threshold energies (in the vicinity of 3.8 GeV) with minimal modifications to the machine, beam energies will be scaled, maintaining the nominal energy asymmetry ratio used for operation at the cm energy of the Υ(4S). All magnet currents will be rescaled accordingly
- In order to provide the necessary damping at low current wigglers can be installed in the straight sections (dispersion free) and in the ARCs, in a relative number matched to achieve the desired beam parameters (emittance etc…). The permanent magnets in the IR will be replaced with weaker versions
- Luminosity should scale linearly with energy, but damping time and collective effects will result in a further decrease the luminosity. However, given all factors, we expect that operations at lower energy will require a decrease of the beam current and an increase of the beam emittance
- It is thus reasonable to expect a luminosity about 10 times lower than that at 10.58 GeV

# *The crab waist @ DAΦNE*

- In 2007-2008 DAΦNE was upgraded to include a crab-waist IR for testing the principle
- There were some additional (conventional) improvements as well
  - Improved injection
  - Improved impedence reduction
  - Improved feedback systems
- The predicted luminosity increase was about a factor of 3 (from $1.6x10^{32}$ to $4.5x10^{32}$)

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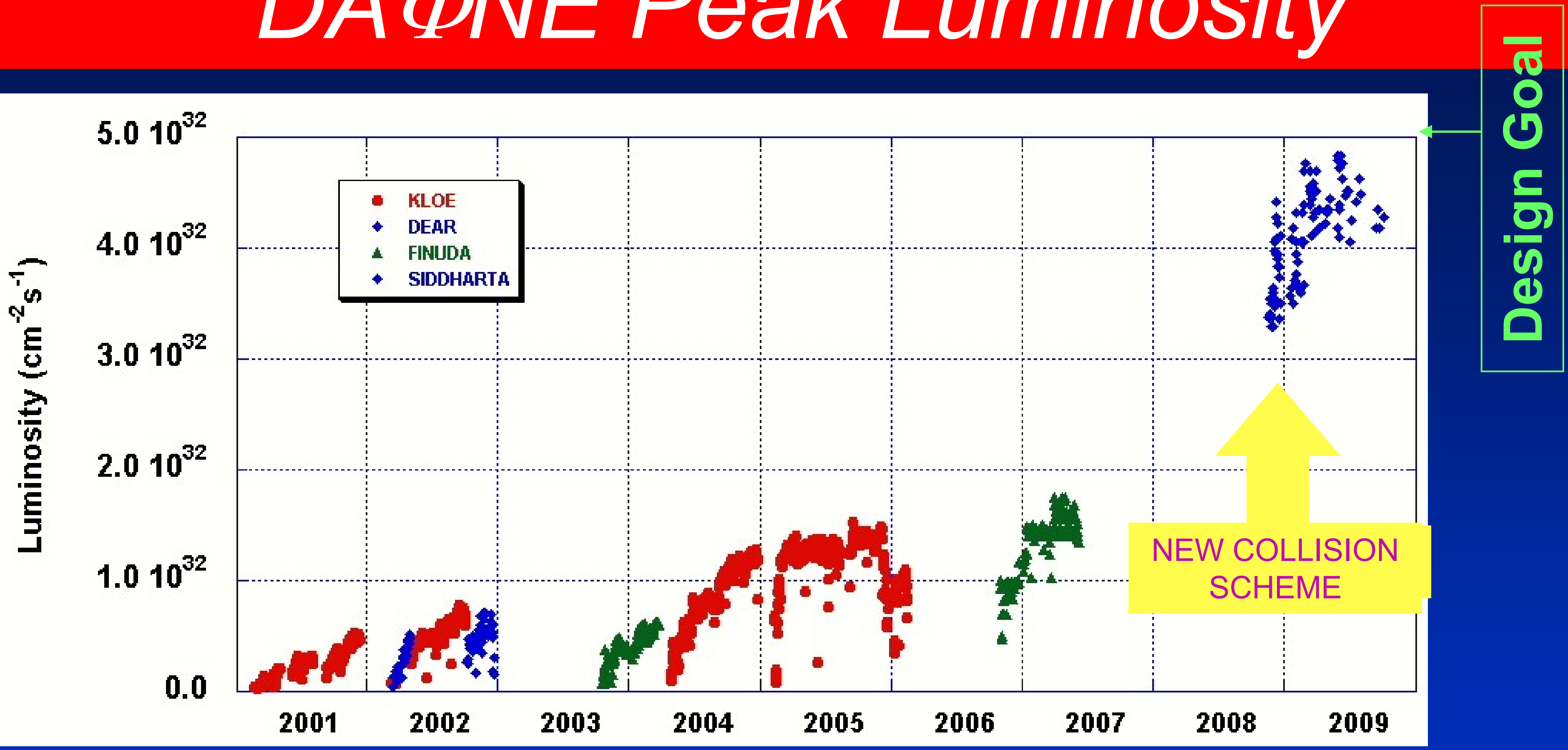
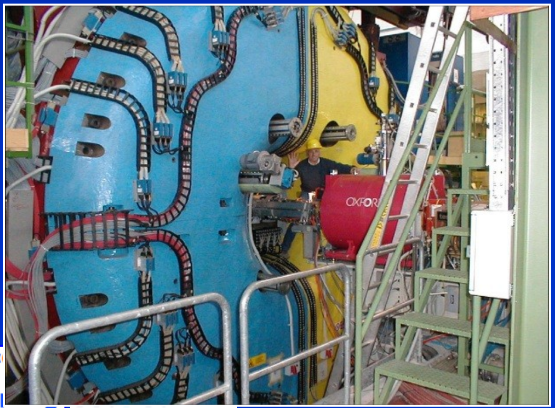
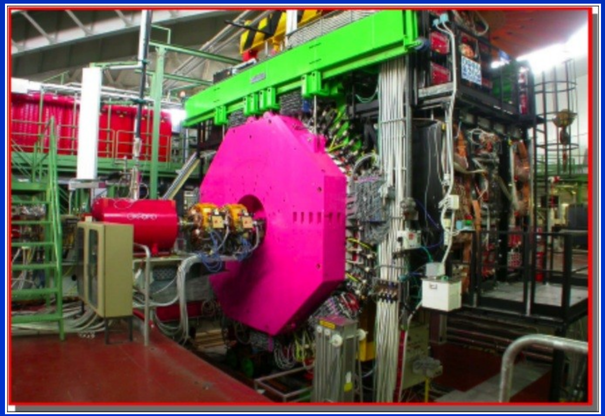
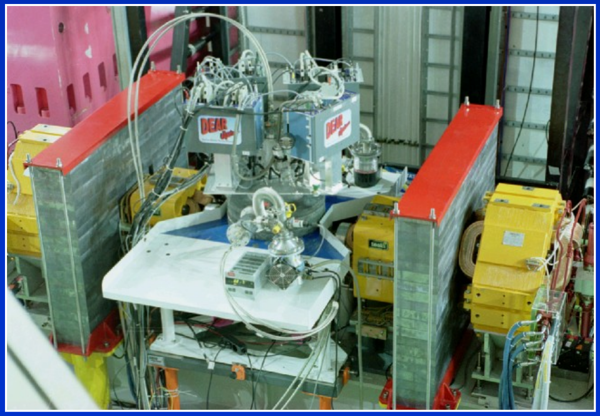
# DAΦNE Peak Luminosity







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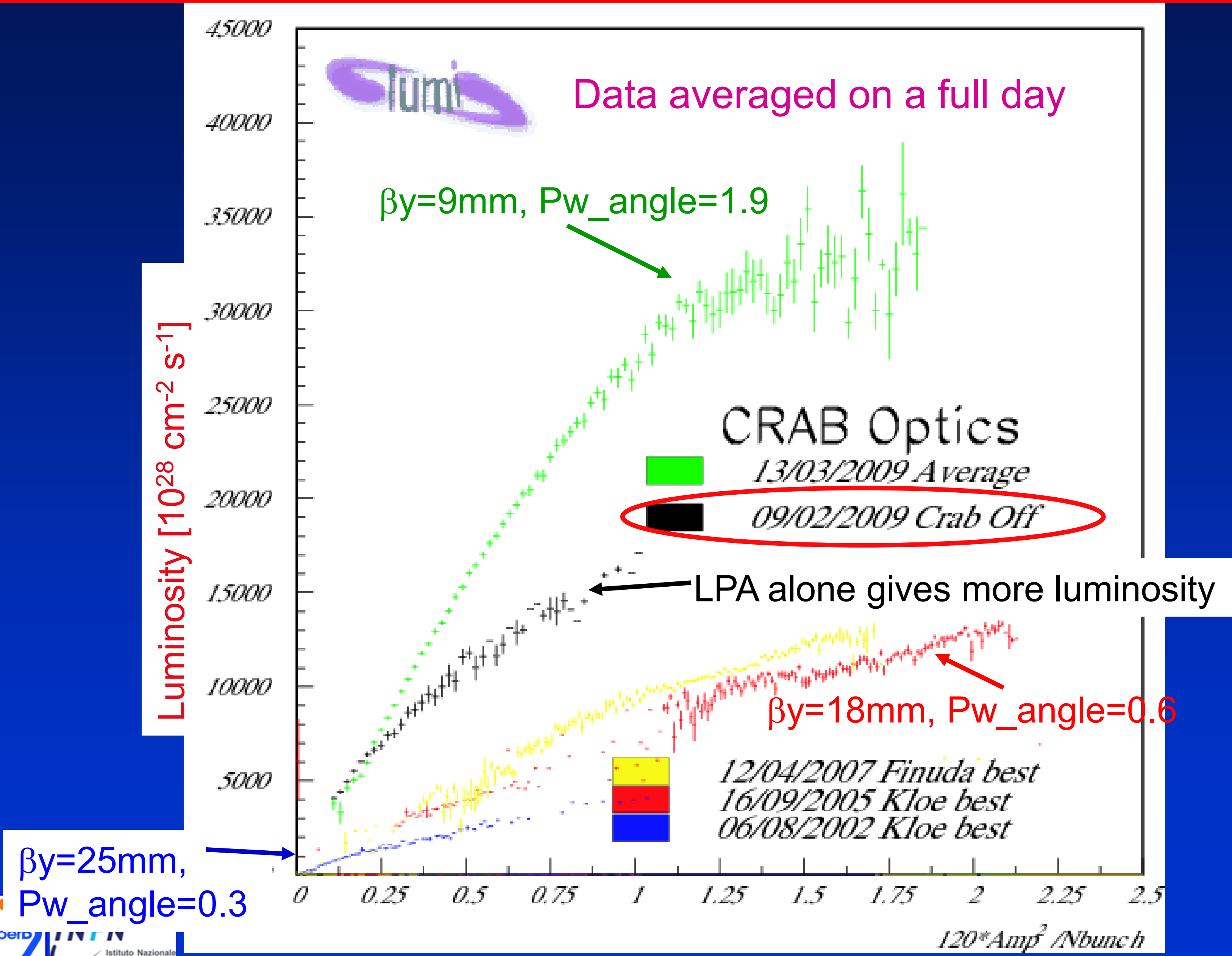
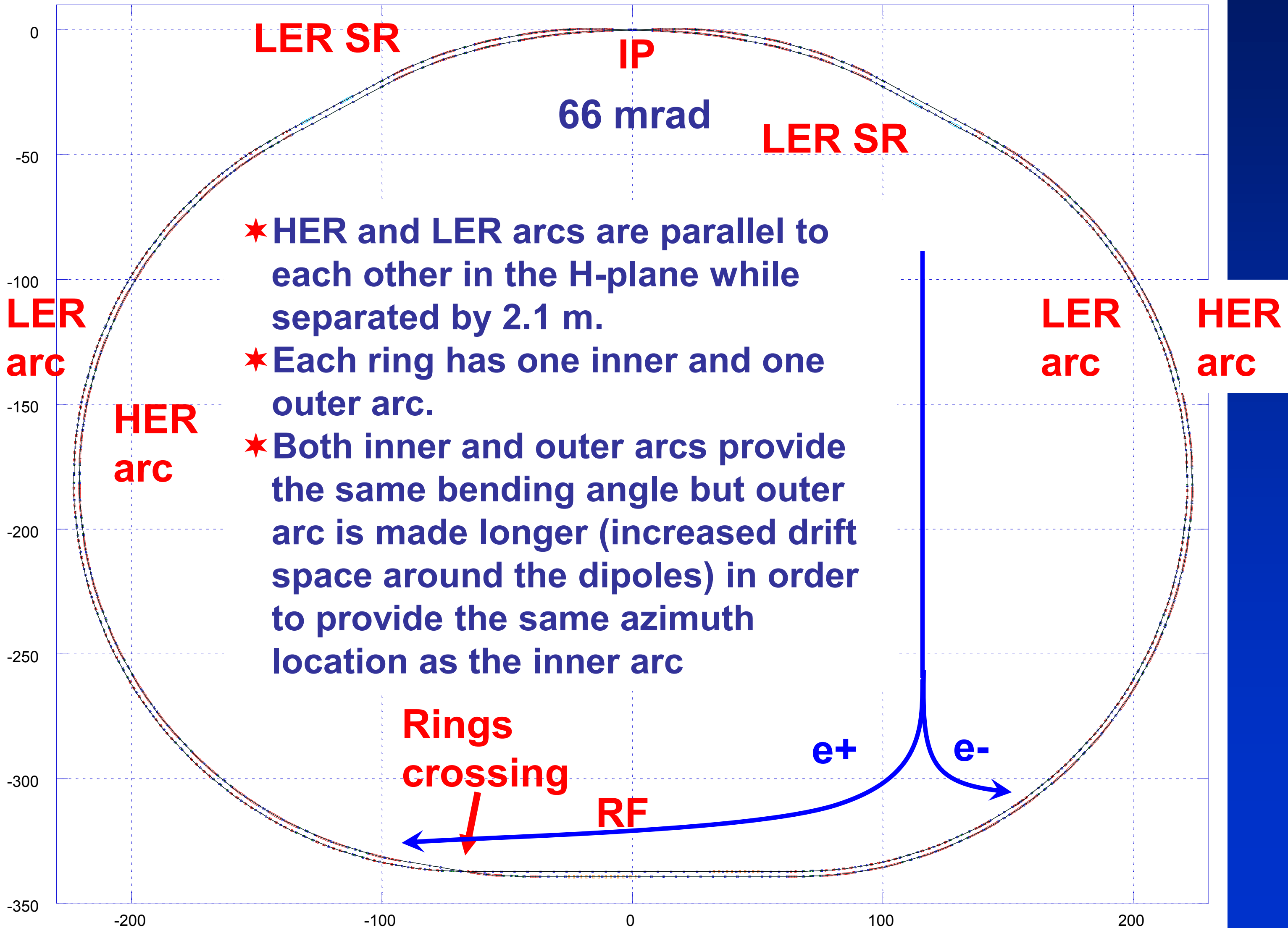
# Peak luminosity vs currents



# Layout 2 rings, 1 tunnel




- HER and LER arcs are parallel to each other in the H-plane while separated by 2.1 m.
- Each ring has one inner and one outer arc.
- Both inner and outer arcs provide the same bending angle but outer arc is made longer (increased drift space around the dipoles) in order to provide the same azimuth location as the inner arc

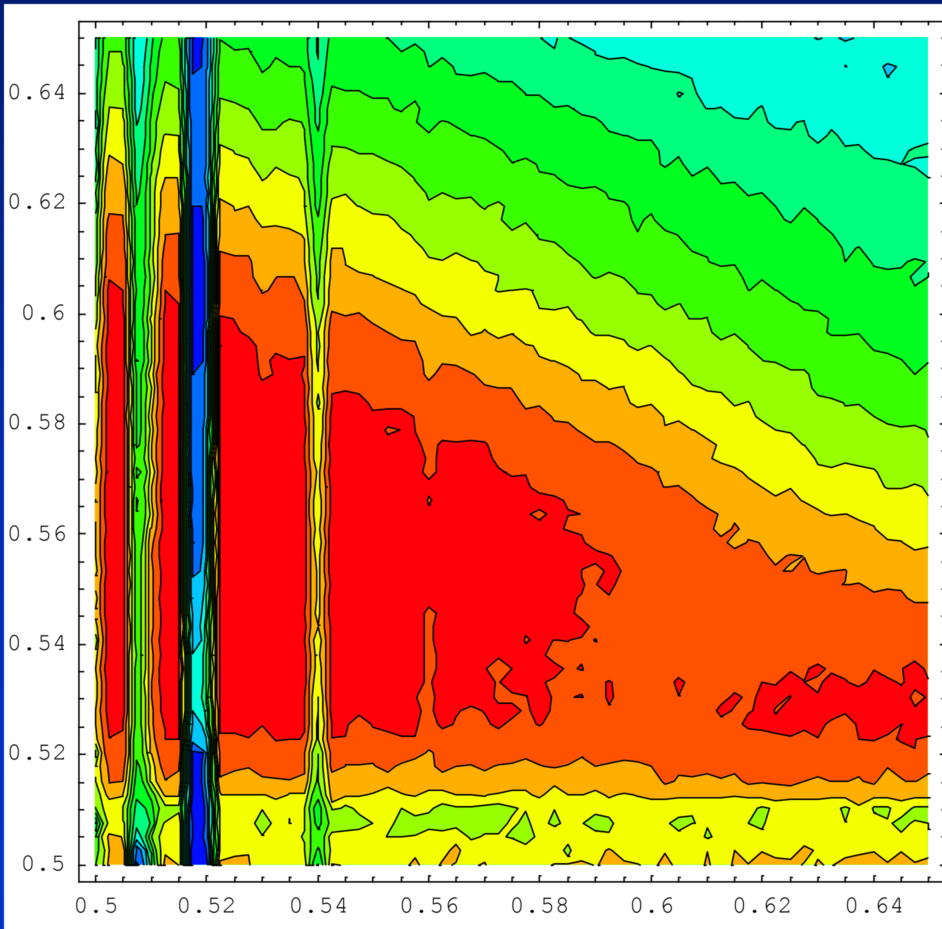
# *Beam-beam in LPA and CW regime*

- Beam-beam tune scan performed with latest beam parameters and latest beam-beam code, improved to take into account crabbed beams (D.Shatilov, BINP)
- Comparison with previous parameters: lower bb tune shift increases tune operation area and achievable luminosity (10^36 in the large red area)
- Needs to be run including lattice nonlinearities for beam beam tails and lifetime, as soon as the lattice is “reasonably” stable

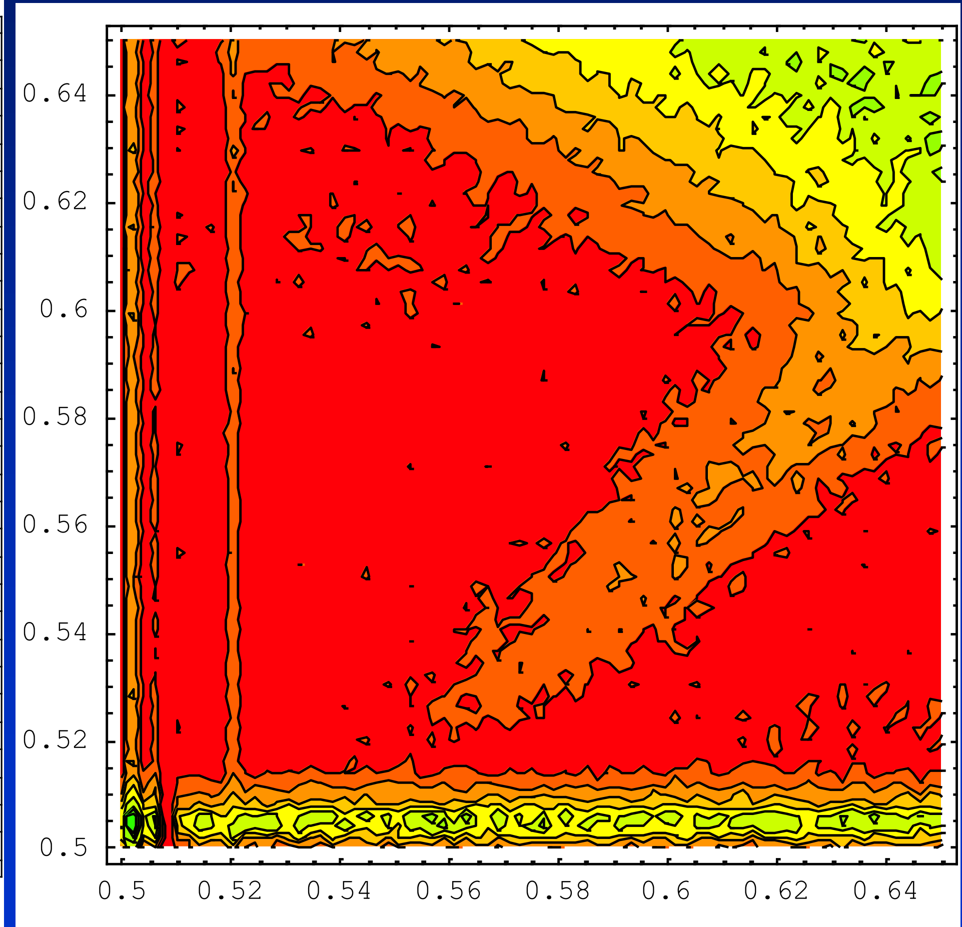
# *Beam-beam tune scan*

D.Shatilov

CDR, $\xi_y = 0.17$




CDR2, $\xi_y = 0.097$

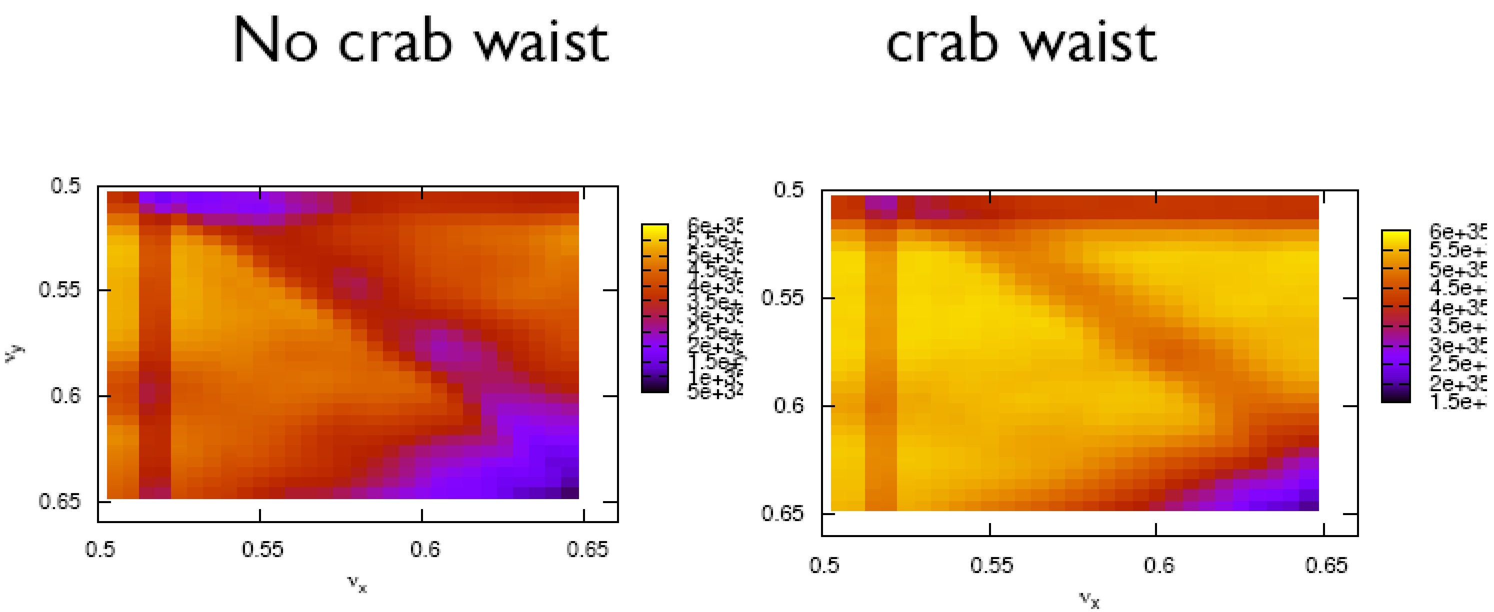



**L (red) = 1. $\cdot 10^{36}$**

# Strong-strong bb

K.Ohmi

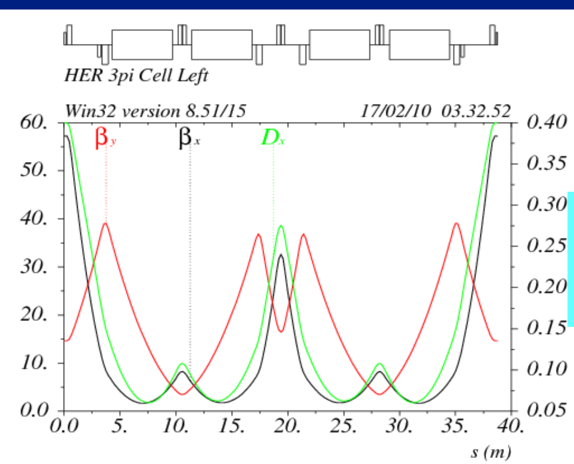
## Tune scan with/without crab waist



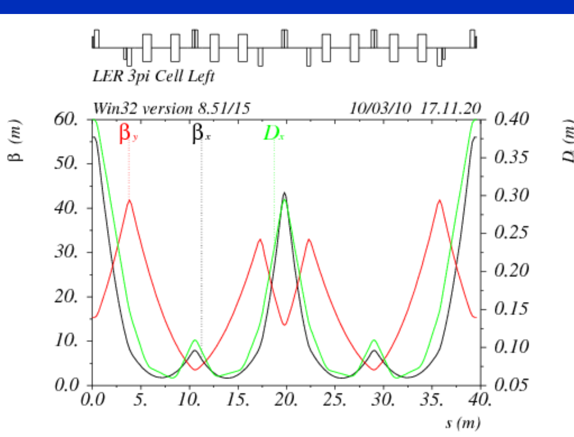

- Crab waist gives better performance.
- Synchro-beta resonance is seen in both cases.

# SuperB Arcs

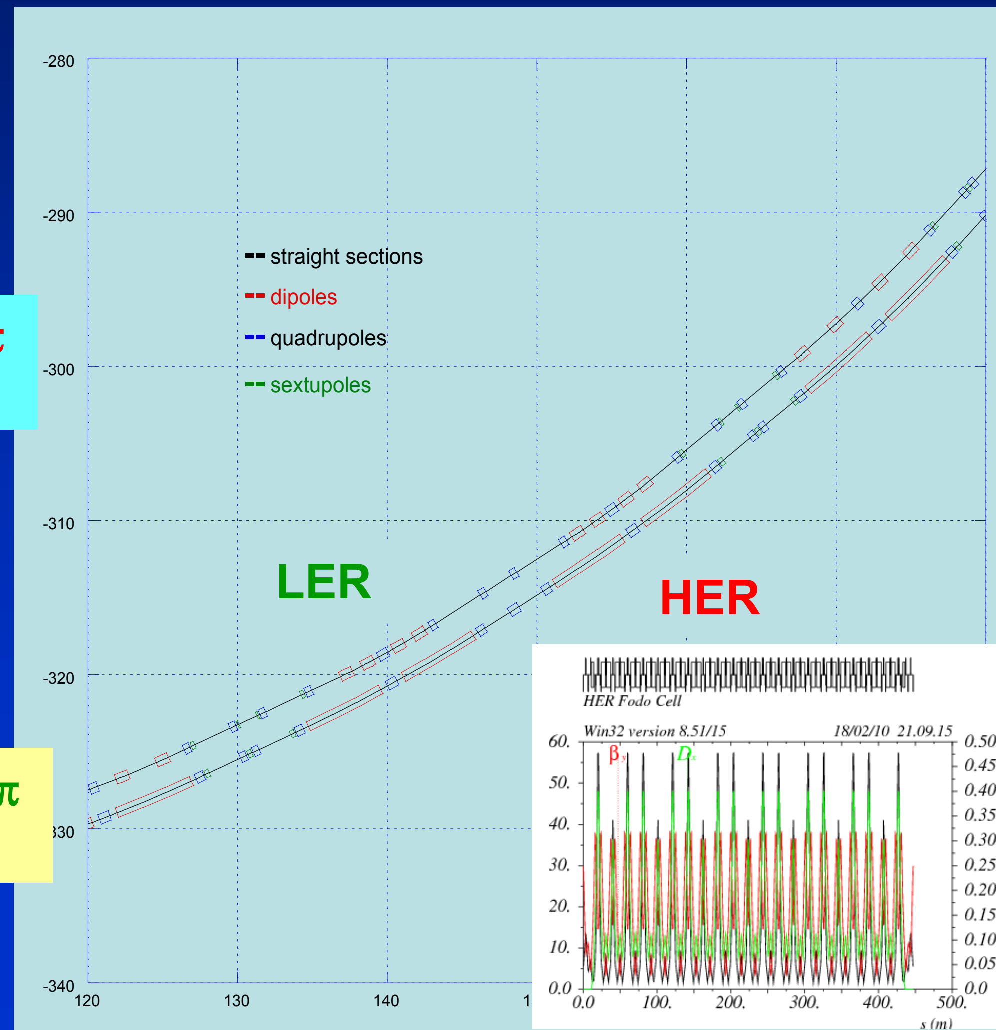
- HER and LER arcs have conceptually the same lattice. LER arc dipoles are shorter (bend radius about 3 times smaller) than in the HER in order to match the ring emittances at the asymmetric beam energies




$\mu_x = 3\pi$, $\mu_y = \pi$
**Cell in HER**

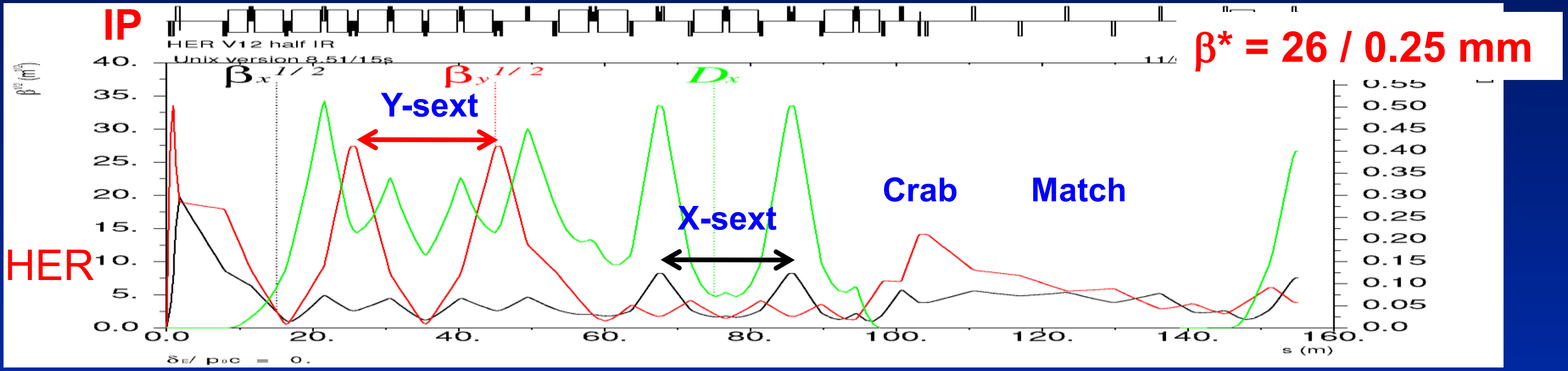



$\mu_x = 3\pi$, $\mu_y = \pi$
**Cell in LER**

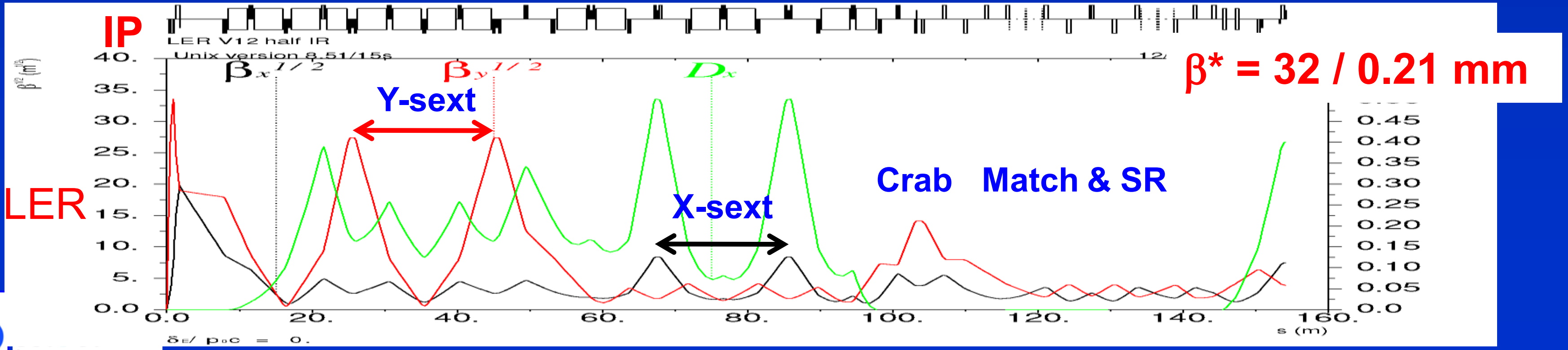


# FF optics

- "Spin rotator" optics is replaced with a simpler matching section



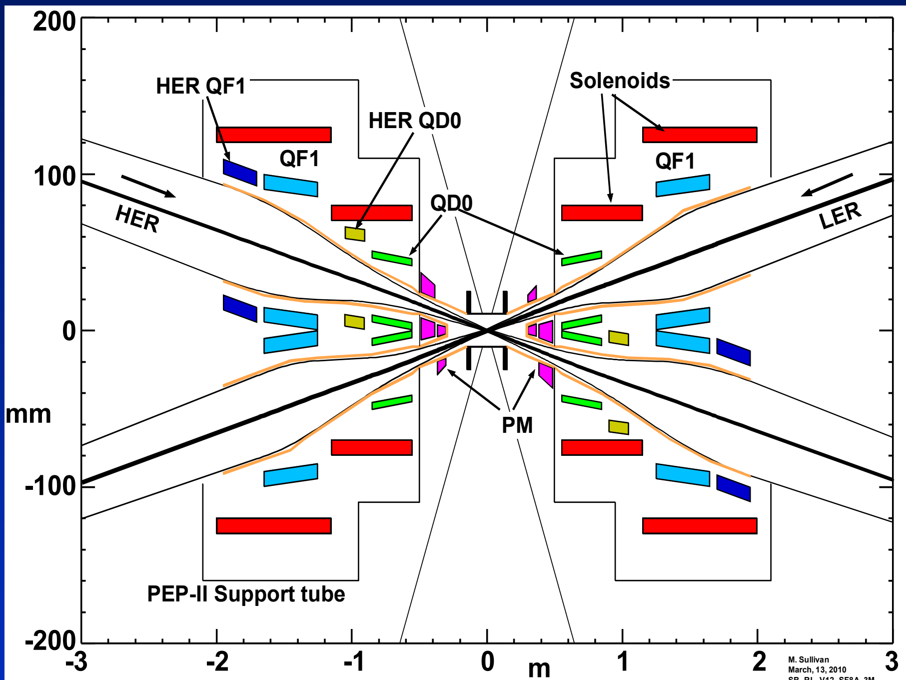

- Matching section is shorter than HER to provide space for spin rotator optics.
- ±33 mrad bending asymmetry with respect to IP causes a slight spin mismatch between SR and IP resulting in ~5% polarization reduction.



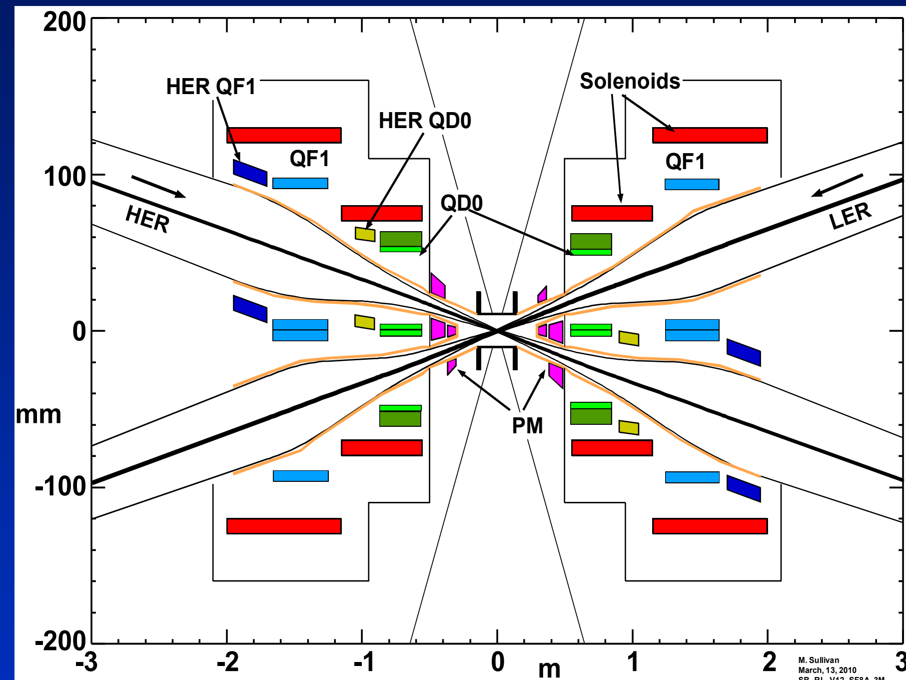
# IR design

- We have two designs that are flexible and have good:
  - SR backgrounds
  - Lattice functions
  - Beam apertures
- The two designs are:
  - Vanadium Permendur for QD0 and QF1
  - Parallel air-core dual quads for QD0 and QF1 (prototype in progress)
    - Both designs include additional vanadium permendur Panofsky quads on the HER
- These IR design demonstrates initial robustness
  - Two separate QD0 designs work
  - The direction of the beams can be either way with a weak preference for the incoming beams to be from the outside rings due to the location of the SR power on the cryostat beam pipe

# QD0 Design: 2 possible choices




*Vanadium Permendur “Russian” Design*




*Air core “Italian” QD0, QF1 Design*

# QD0 DESIGN OPTIONS

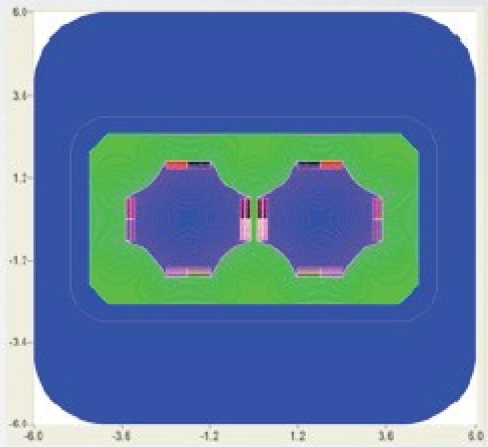
## "Italian" Design

## "Russian" Design

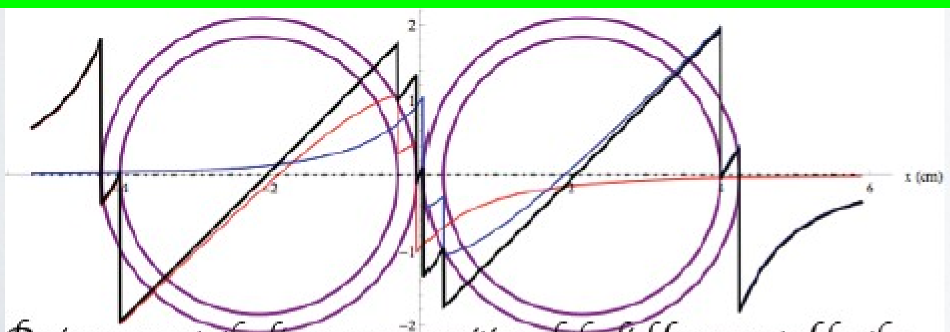
I. Okunev, V. Syrovatin, A. Bragin, P. Vobly

E. Paoloni,
P. Fabbricatore,
R. Musenich,
S. Farinon,
S. Bettoni

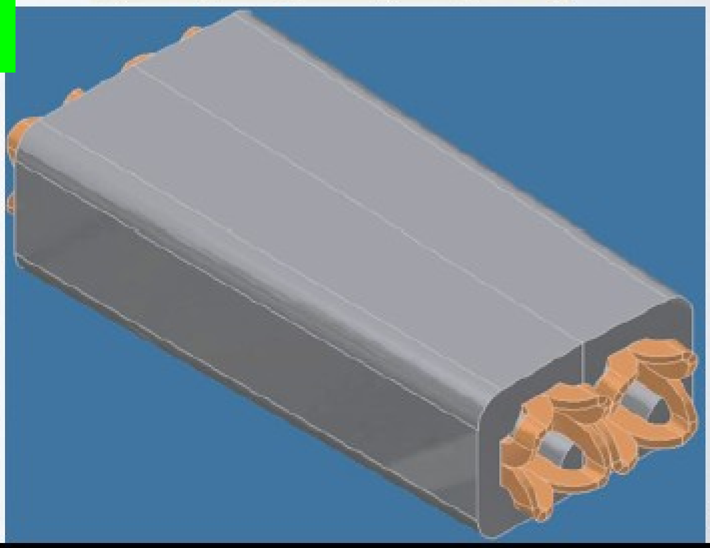
Conceptual sketch



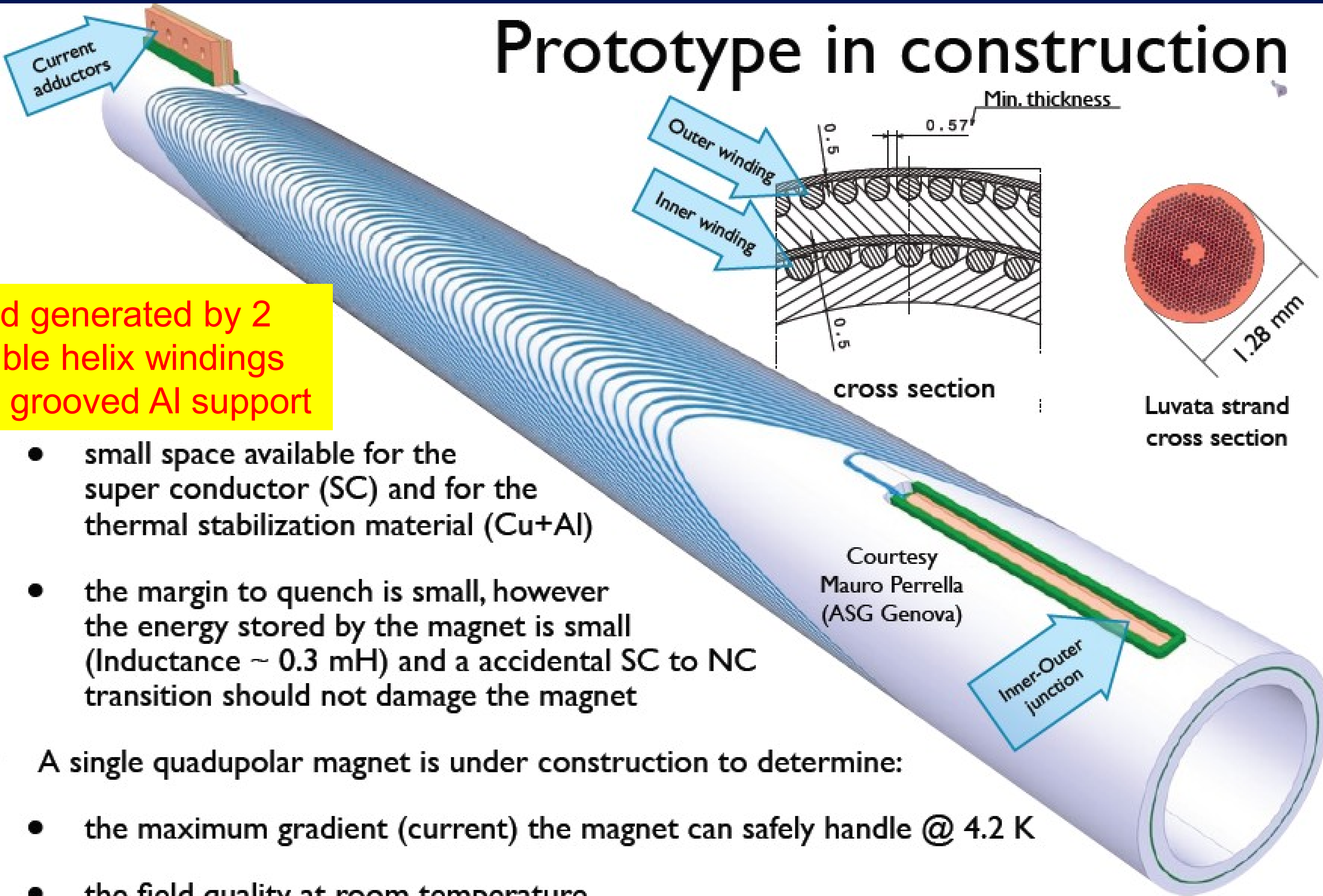
Air-core QD0 is a SC iron free septum double quad




Design concept: the linear superposition of the fields generated by the left coil (in red) and by the right one (in blue) produces the needed quadrupolar field (in black).



# Prototype in construction



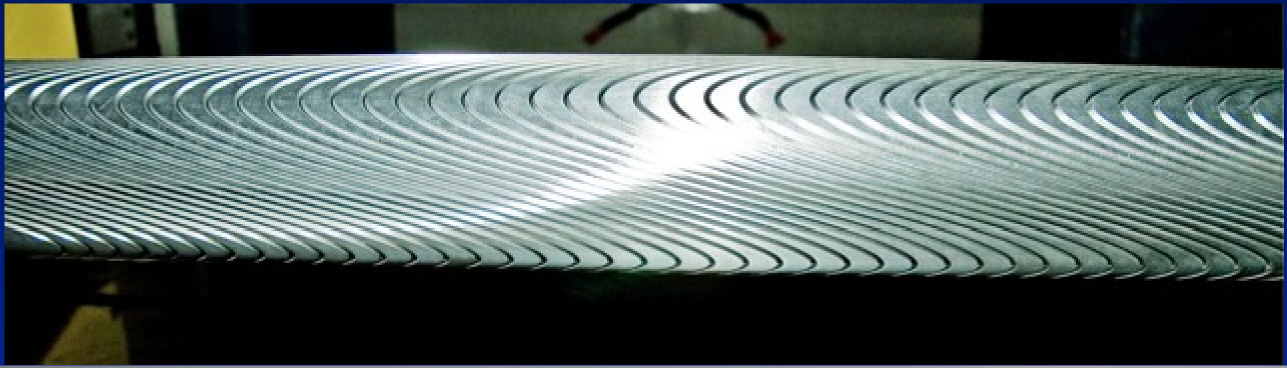

Field generated by 2 double helix windings in a grooved Al support

- small space available for the super conductor (SC) and for the thermal stabilization material (Cu+Al)
- the margin to quench is small, however the energy stored by the magnet is small (Inductance ~ 0.3 mH) and a accidental SC to NC transition should not damage the magnet

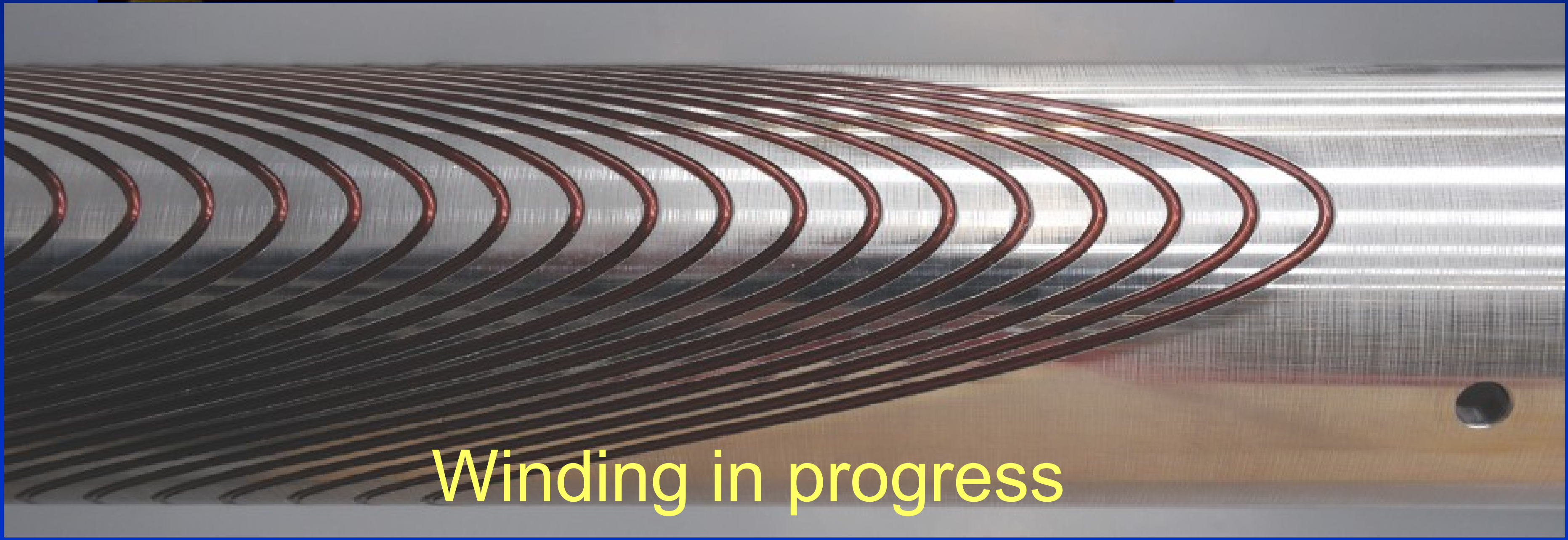
- A single quadupolar magnet is under construction to determine:
  - the maximum gradient (current) the magnet can safely handle @ 4.2 K
  - the field quality at room temperature
- 200 m of SC wire kindly gifted by Luvata: Φ=1.28 mm, Cu/NbTi = 1.0, Ic 2450 A @ 4T, 4.2K

Fabbricatore, Farinon, Musenich (Genova) Paoloni (Pisa)

# The actual QD0

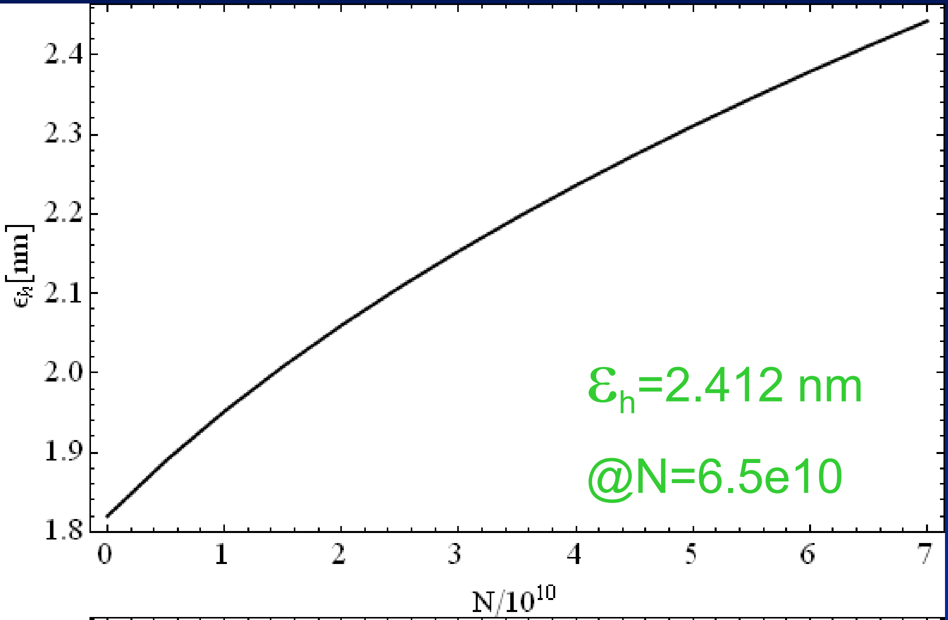


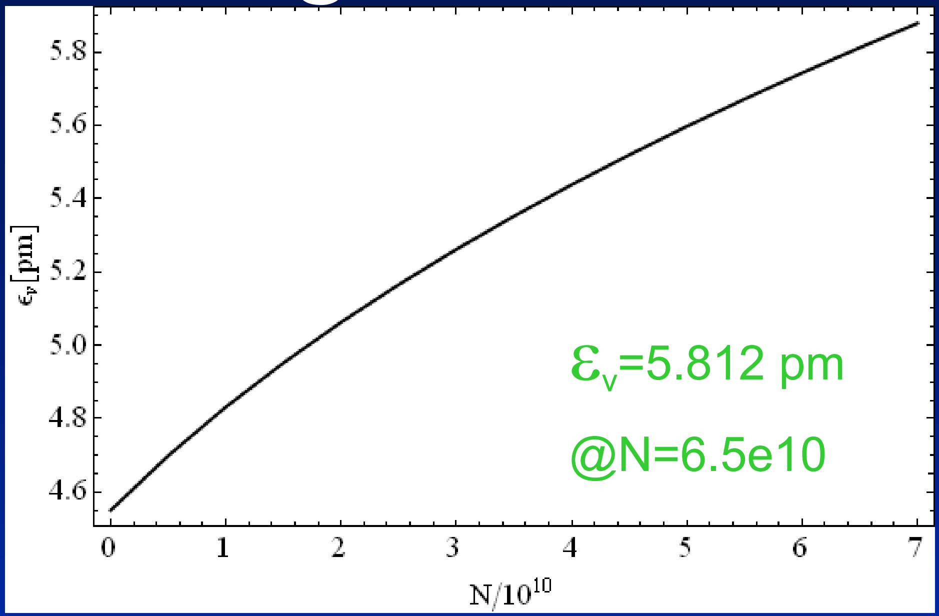
Grooved Al support

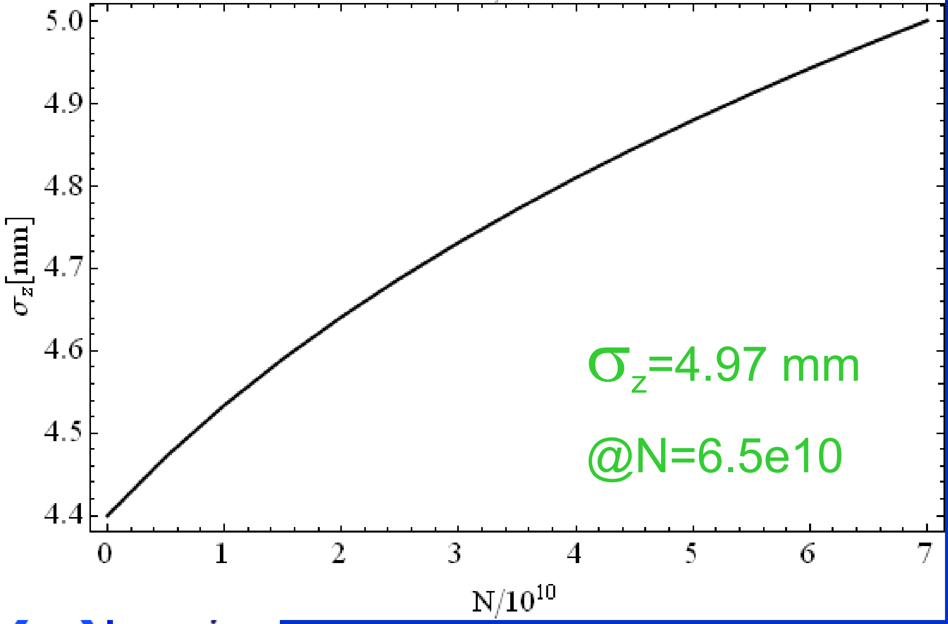



Ready this Summer for tests and field measurements @ CERN

# *Intra Beam Scattering in LER*




The effect of IBS on the transverse emittances is about 30% in the LER and less then 5% in HER.

Interesting aspects of the IBS such as its impact on damping process and on generation of non Gaussian tails are being investigated with a multiparticle algorithm →6D MC

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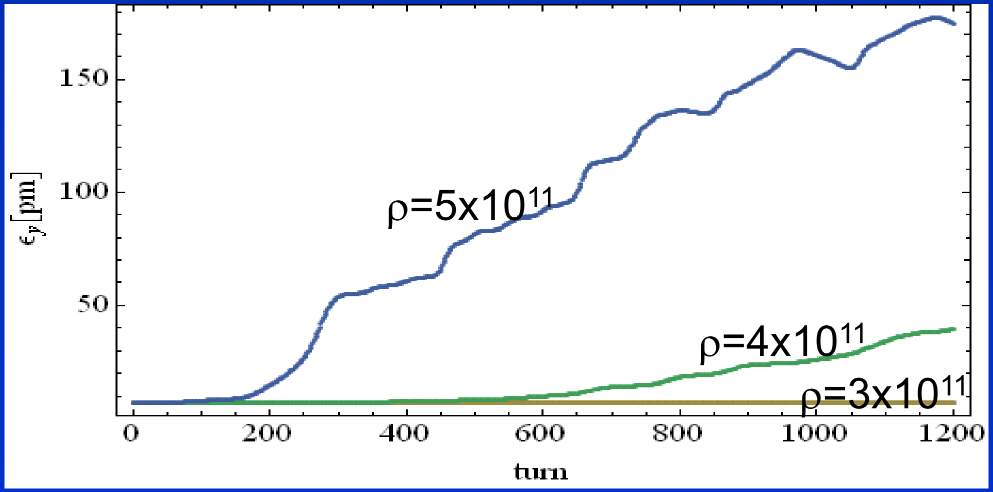
# e-cloud instability

- Single bunch instability simulations for SuperB HER taking into account the effect of solenoids have been performed using CMAD (Pivi, SLAC). They indicate a threshold density of ~$10^{12}$ e-/$m^3$ (roughly 2 times previous estimates)
- The obtained thresholds have to be compared with build-up simulations using updated parameters to determine safe regions of the parameter space (SEY, PEY)
- Work is in progress to:
  - Estimate the effect of radiation damping on long term emittance growth
  - Estimate the fraction of synchrotron radiation absorbed by antechambers

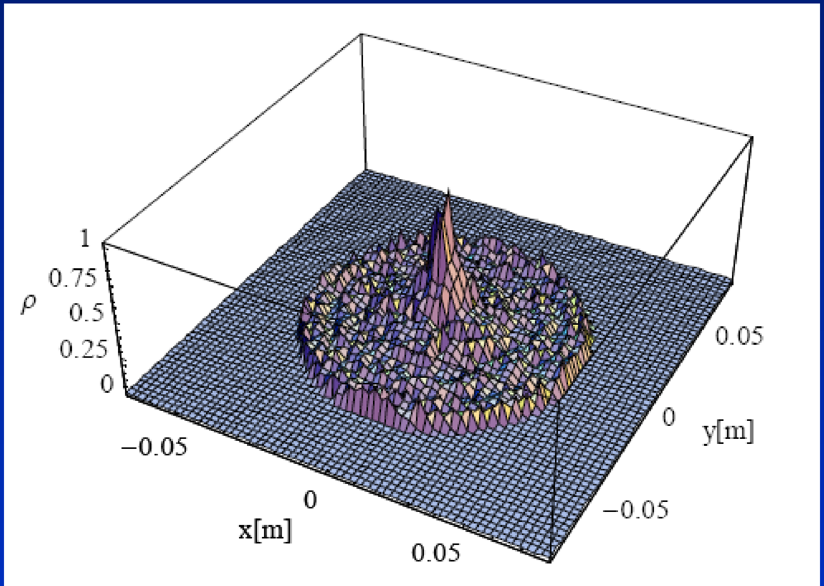



Vertical emittance growth

induced by e-cloud

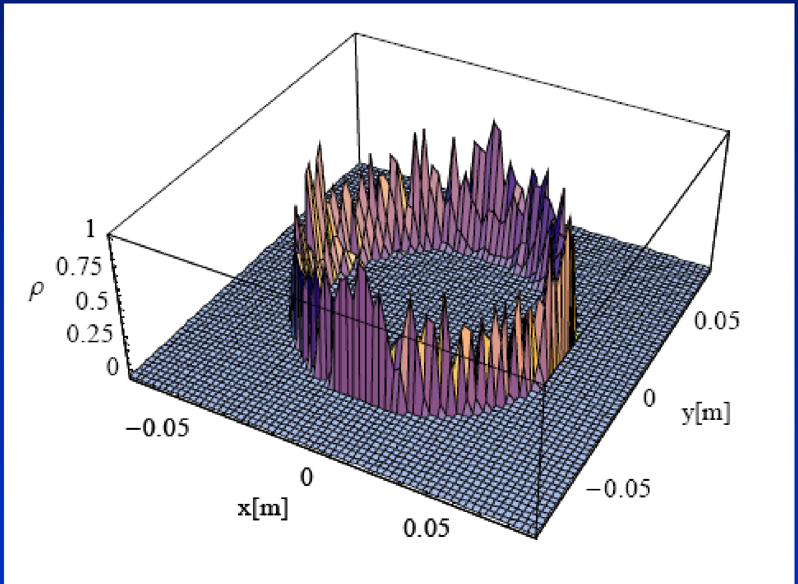
# Build-up in Free Field Regions

Snapshot of the electron (x,y) distribution




Density at center of the beam pipe is larger then the average value.

Snapshot of the electron (x,y) distribution
50G solenoids on




Solenoids reduce to 0 the e-cloud density at center of beam pipe

# Low Emittance Tuning

Steering:
Orbit and Dispersion Free Steering +
Coupling and Beta-Beating Free Steering

Response matrices **(RM)** for the following quantities are used for the correction.
R is the vector of BPM readings.

$$\vec{R} = RM \; \vec{K}$$

Dispersion measured by :

$$\vec{\eta} = \frac{\vec{R}_{+\frac{\Delta E}{E}} - \vec{R}_{-\frac{\Delta E}{E}}}{2\frac{\Delta E}{E}}$$

DE/E=0.0025

Coupling measured by :

$$\vec{C} = \begin{pmatrix} \frac{\vec{x}_{+\Delta V} - \vec{x}_{-\Delta V}}{2\Delta V} \\ \frac{\vec{y}_{+\Delta H} - \vec{y}_{-\Delta H}}{2\Delta H} \end{pmatrix}$$

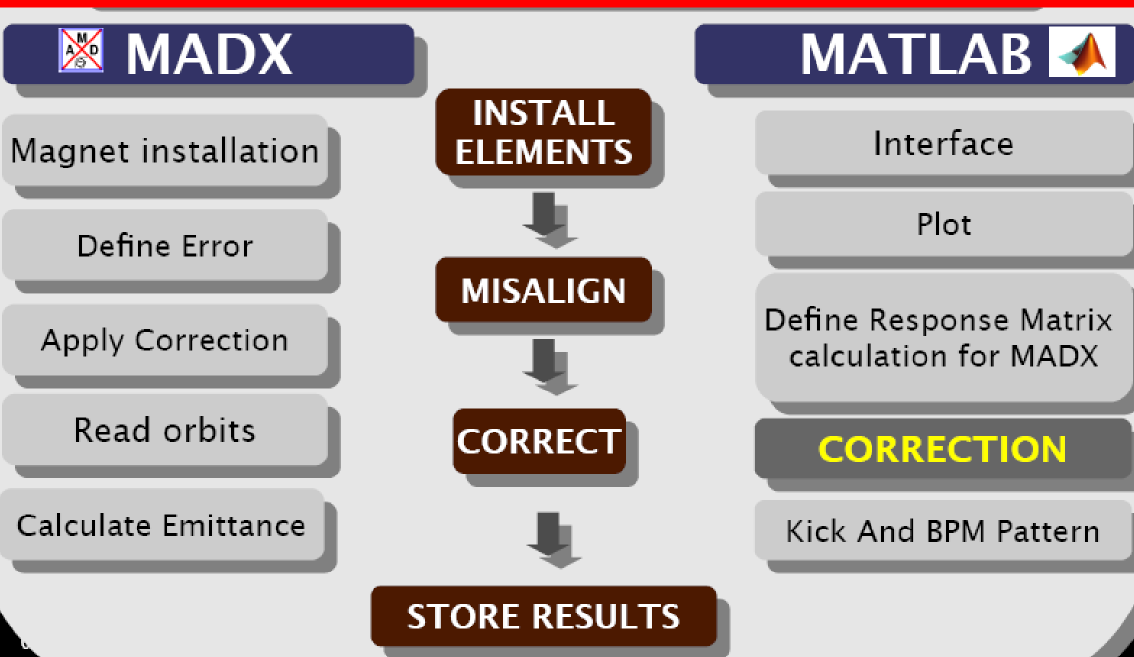
RM V Correctors

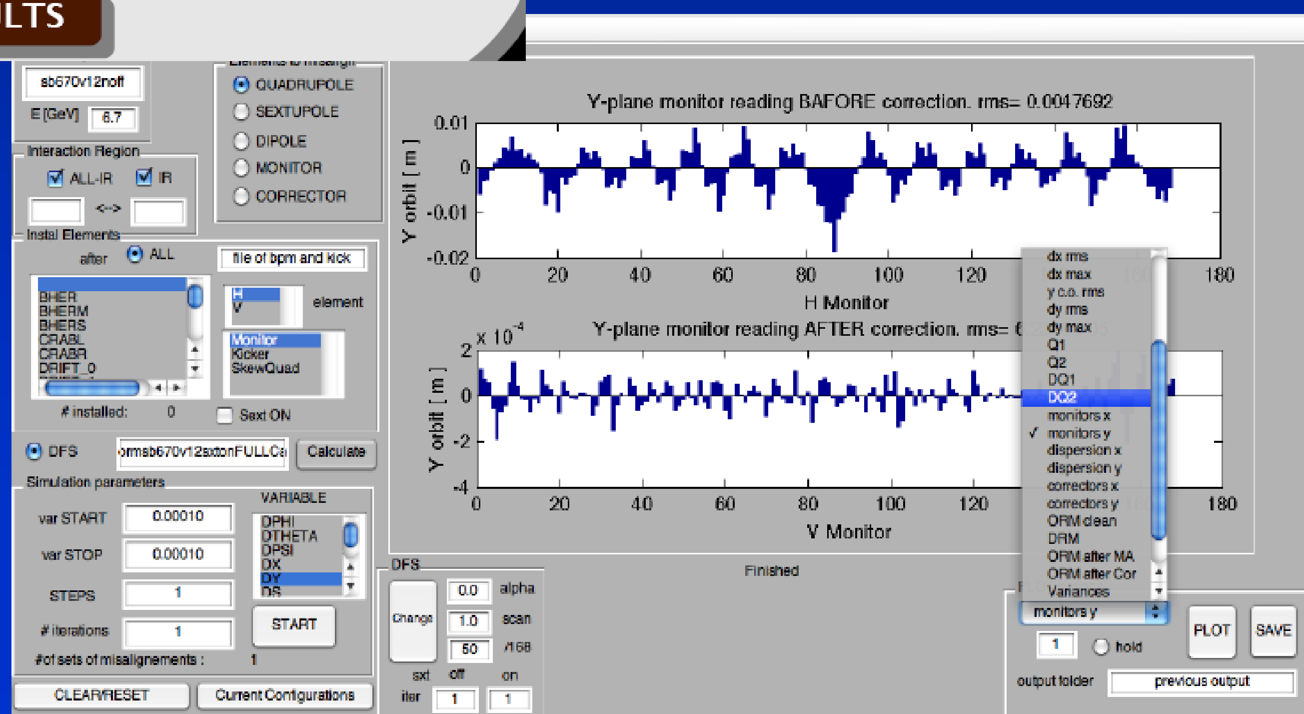
Beta beating measured by :

$$\vec{\beta} = \begin{pmatrix} \frac{\vec{x}_{+\Delta H} - \vec{x}_{-\Delta H}}{2\Delta H} \\ \frac{\vec{y}_{+\Delta V} - \vec{y}_{-\Delta V}}{2\Delta V} \end{pmatrix}$$

RM H Correctors

# LET Tool


MADX
MATLAB
INSTALL ELEMENTS
MISALIGN
CORRECT
STORE RESULTS
Magnet installation
Define Error
Apply Correction
Read orbits
Calculate Emittance
Interface
Plot
Define Response Matrix calculation for MADX
CORRECTION
Kick And BPM Pattern


sb670v12noff
E [GeV]
6.7
QUADRUPOLE
SEXTUPOLE
DIPOLE
MONITOR
CORRECTOR
Interaction Region
ALL-IR
IR
Instal Elements
after
ALL
file of bpm and kick
element
BHER
BHERM
BHERS
CRABL
CRABR
DRIFT_0
Monitor
Kicker
SkewQuad
# installed:
0
Sext ON
DFS
Calculate
Simulation parameters
VARIABLE
var START
0.00010
var STOP
0.00010
STEPS
1
# iterations
1
DPHI
DTHETA
DPSI
DX
DY
START
#of sets of misalignements :
1
CLEAR/RESET
Current Configurations
Y-plane monitor reading BAFORE correction. rms= 0.0047692
Y orbit [ m ]
H Monitor
Y-plane monitor reading AFTER correction. rms=
V Monitor
Finished
dx rms
dx max
y c.o. rms
dy rms
dy max
Q1
Q2
DQ1
DQ2
monitors x
monitors y
dispersion x
dispersion y
correctors x
correctors y
ORM clean
DRM
ORM after MA
ORM after Cor
Variances
PLOT
SAVE
hold
output folder
previous output
Change
alpha
scan
sxt
off
on
iter

# Low Emittance Tuning: HER tolerances

Steering:
Orbit & Dispersion Free steering +
Coupling & Beta-beating Free steering
Using only correctors
Or
Correctors and skew quads

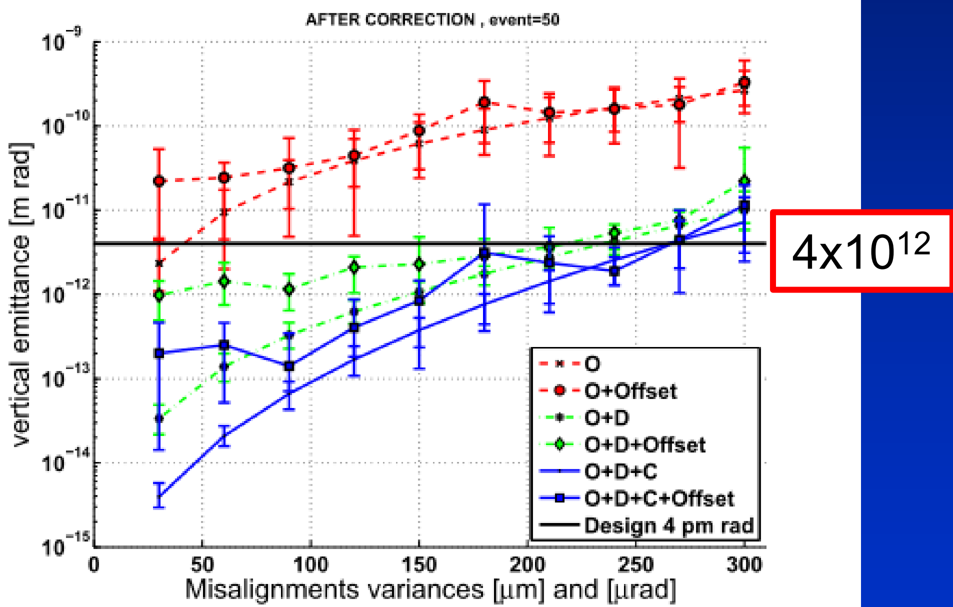



Figure 2: Vertical emittance (m) for machine misalignment from 30 to 300$\mu$m H and V for Sext and Quad and qudrupole Tilts of 30-300 $\mu rad$. Orbit (O), Dispersion (D) and Coupling and Beta-beating (C) Free Steering are compared

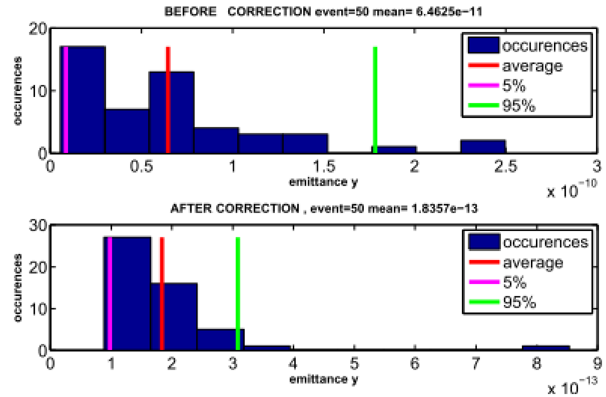



Figure 4: Vertical emittance for 50 simulation with misalignment and tilts from Table 1.

Table 1: Tolerances; values of the combined tolerated displacements, tilts and monitor offsets.

| error | tolerance |
|---|---|
| quadrupole Y | 300 $\mu m$ |
| quadrupole X | 300 $\mu m$ |
| quadrupole tilt | 300 $\mu rad$ |
| sextupole Y | 150 $\mu m$ |
| sextupole X | 150 $\mu m$ |
| BPM OFFSET | 400 $\mu m$ |
| vertical emittance | $< 1$ pmrad |

# Low Emittance Tuning: LER tolerances

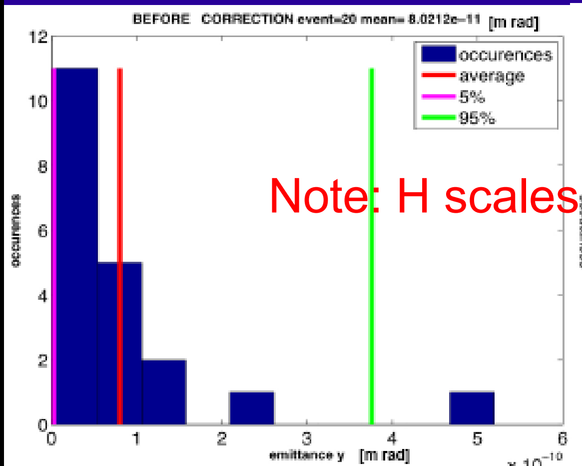
## LER

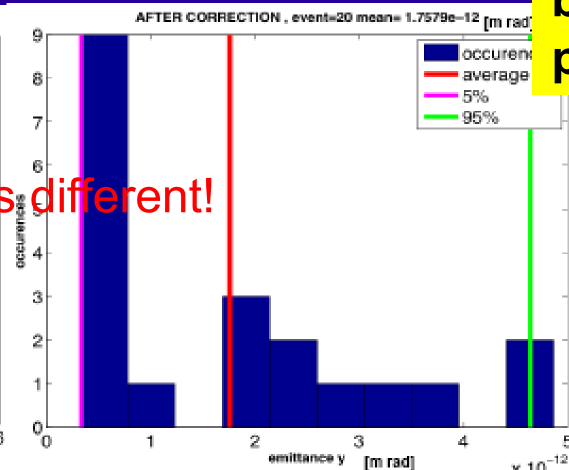
**Elements From QF1R to QF1L are considered as a single element.**

**109-ARCS+60-FF**

| Misalignment | Tolerated value | |
|---|---|---|
| | ARC | FF |
| Quadrupole H and V | **50 μm** | **20 μm** |
| Quadrupole Tilt | **50 μrad** | **20 μrad** |
| Sextupole H and V | **50 μm** | **20 μm** |
| BPM resolution | **1 μm** | **1 μm** |
| BPM Offset | **50 μm** | **20 μm** |

**LER ARC's tolerances evaluated using a Response Matrix technique that optimizes orbit, in order to recover the design values for Dispersion, Coupling and Beta-beating, and obtain the lowest possible vertical emittance**

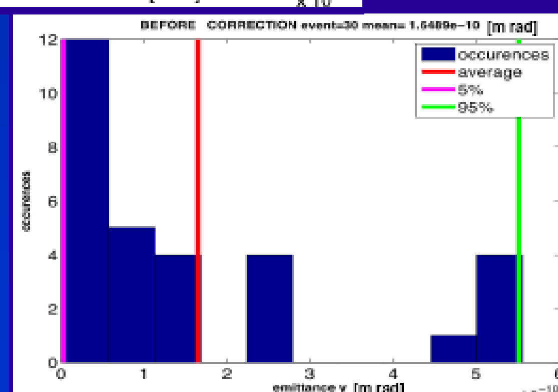


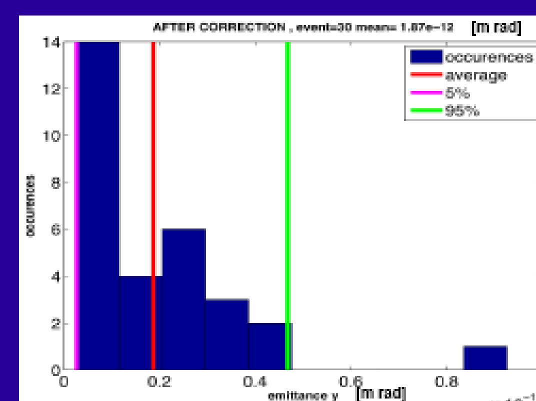




Note: H scales different!

| Misalignment | Value | |
|---|---|---|
| | ARC | FF |
| Quadrupole H and V | **50 μm** | **00 μm** |
| Quadrupole Tilt | **50 μrad** | **00 μrad** |
| Sextupole H and V | **50 μm** | **00 μm** |
| BPM resolution | **1 μm** | **0 μm** |
| BPM Offset | **50 μm** | **00 μm** |

**Final Focus introduces stringent restrictions on alignment of both FF and ARCS (even for no errors in FF)**




The introduction of the Final Focus In the lattice defines more stringent tolerances also in the arcs

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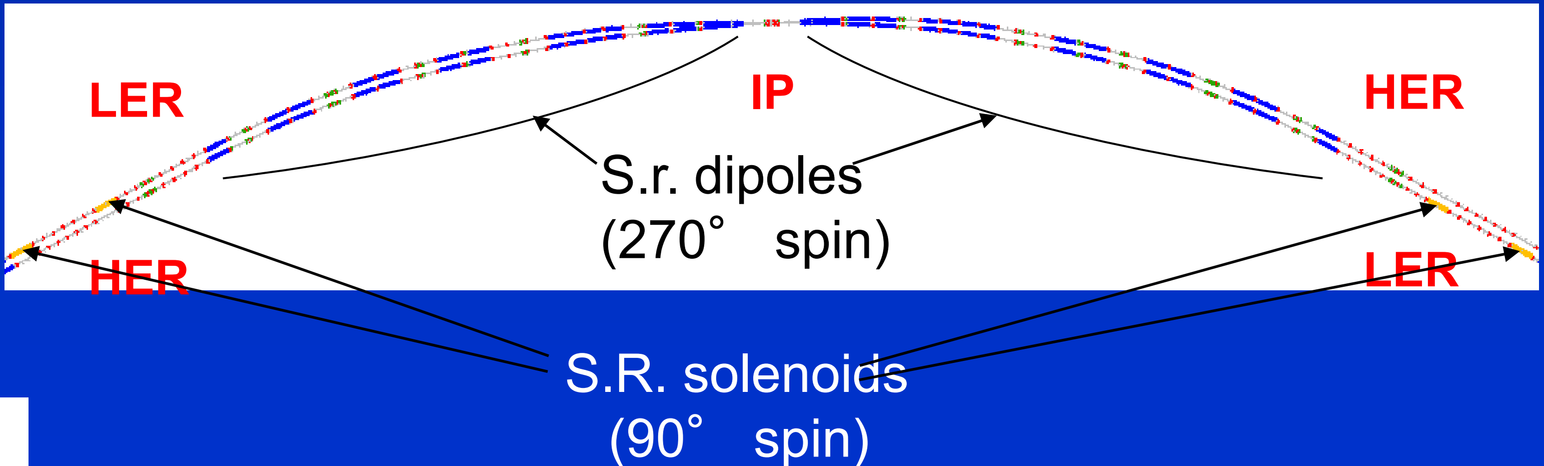
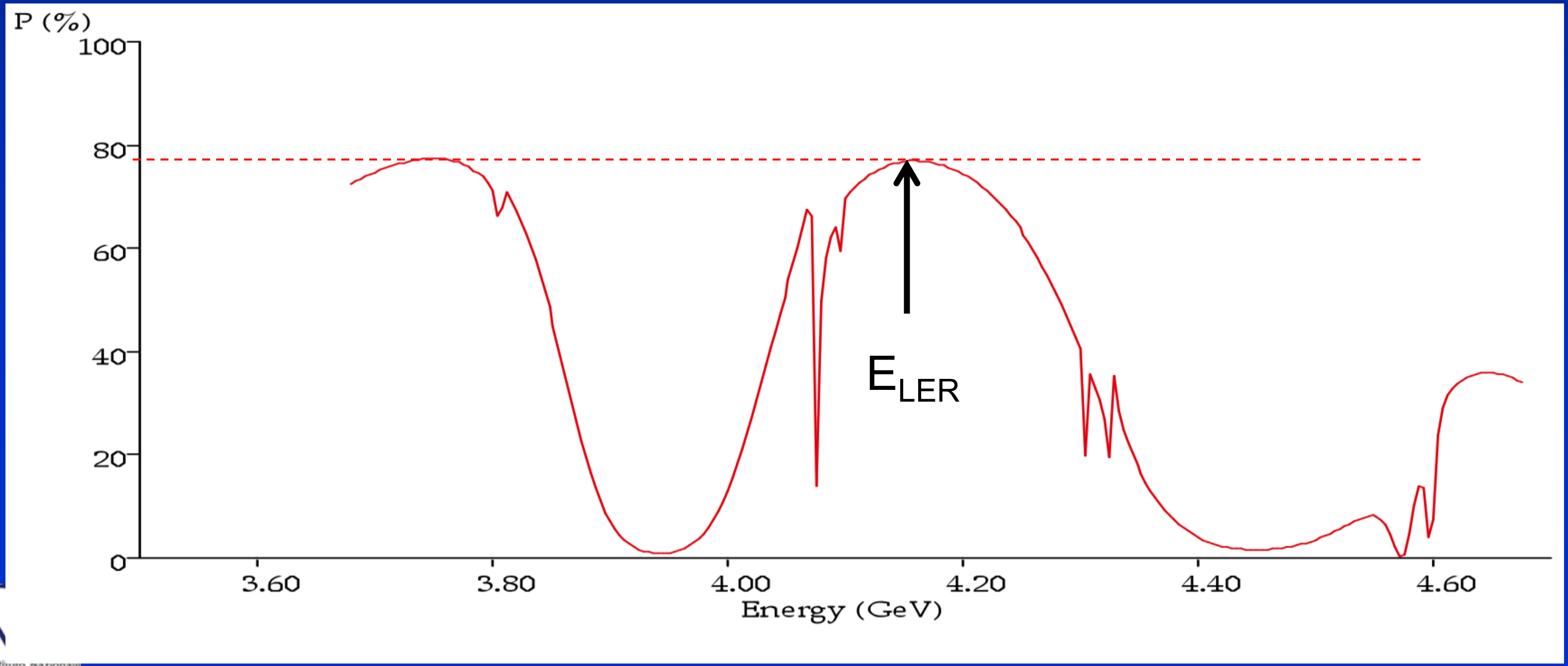
# *Polarization in SuperB*

- 90° spin rotation about *x* axis
  - 90° about *z* followed by 90° about *y*
- "flat" geometry → no vertical emittance growth
- Solenoid scales with energy → LER more economical
- Solenoids are split & decoupling optics added
- The SR optics design has been matched to the Arcs and a similar (void) insertion added to HER
- This design poses severe constraints on the FF bending angles of LER and HER in order to achieve the "right" spin dynamics
- A polarimeter has been designed to measure polarization



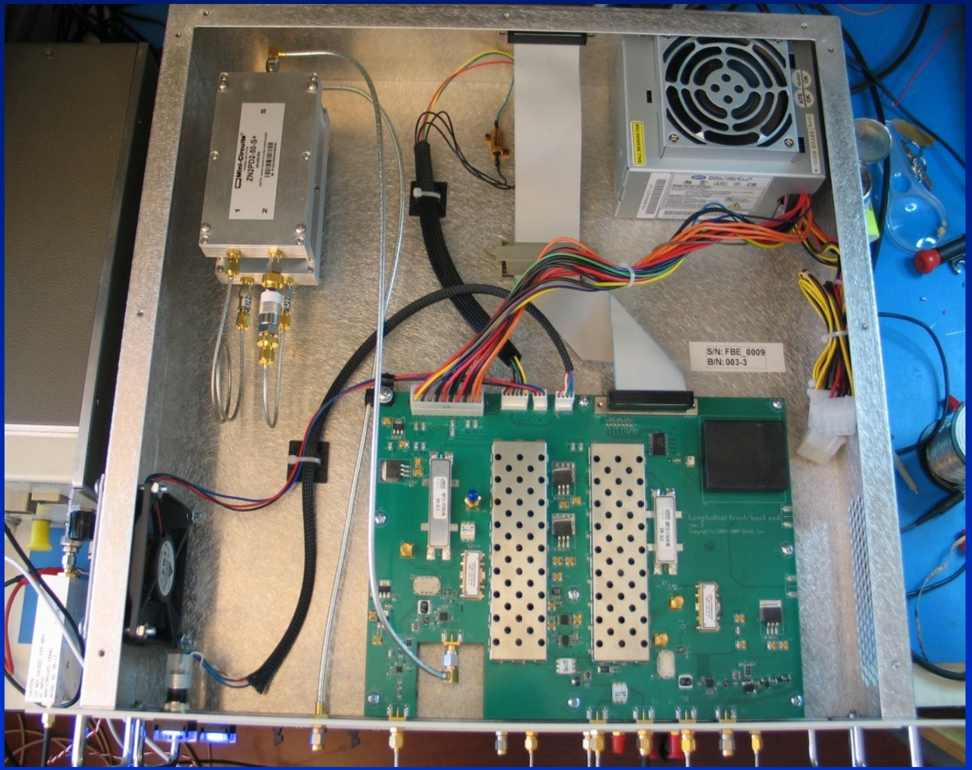
# Polarization resonances

- Beam polarization resonances do constraint the beam Energy choice
- Plot shows the resonances in the energy range of LER
- Beam polarization computed assuming
  - 90% beam polarization at injection
  - 3.5 minutes of beam lifetime (bb limited)
- From this plot is clear that the best energy for LER should be 4.18 GeV → HER must be 6.7 GeV



# *Bunch-by-bunch feedback*

- All 6 DAΦNE feedbacks have been upgraded with a new 12bit system
- VFB – new 12 bit iGp systems with larger dynamic range and software compatibility with the previous version
- LFB - completely new systems in place of the old systems designed in 1992-1996 in collaboration with SLAC/LBNL: fe/be analog unit connected to iGp-8 as processing unit
- HFB: upgrade hw/sw of the iGp-8bit system already used
- This will be the baseline design for SuperB H-V-L feedbacks




- New front-end/back-end analog unit used in the longitudinal feedback

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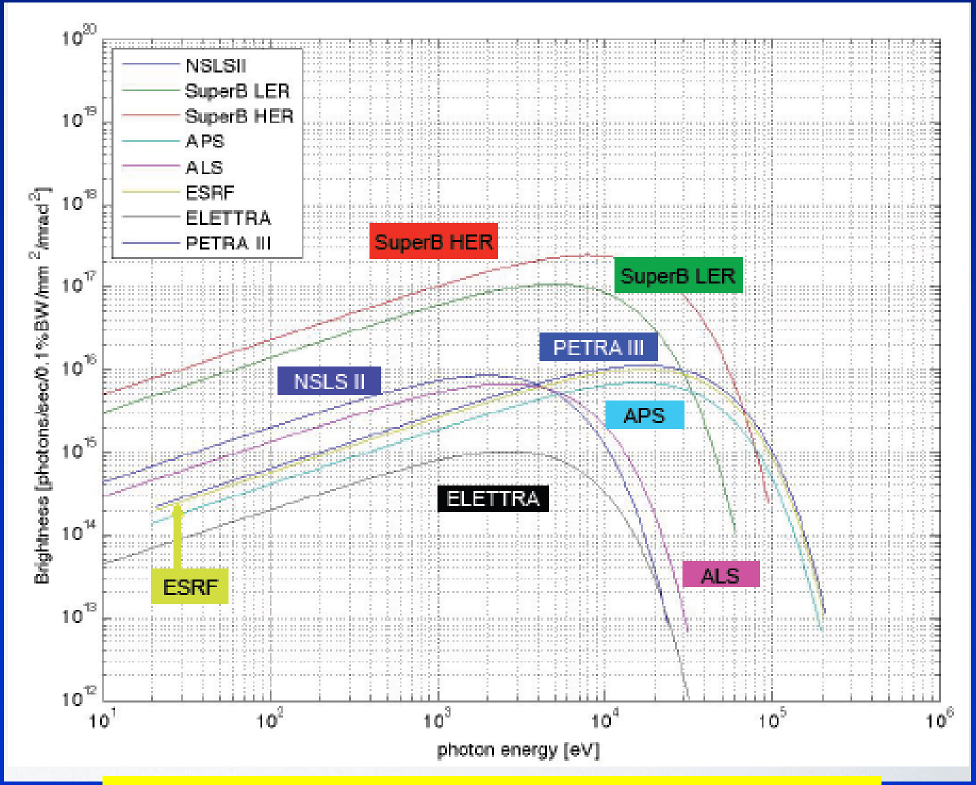
# Synchrotron light options @ SuperB

- Comparison of brightness and flux from bending magnets and undulators for different energies dedicated SL sources & SuperB HER and LER
- Synchrotron light properties from dipoles are competitive
- Assumed undulators characteristics as NSLS-II
- Light properties from undulators still better than most LS, slightly worst than PEP-X (last generation project)

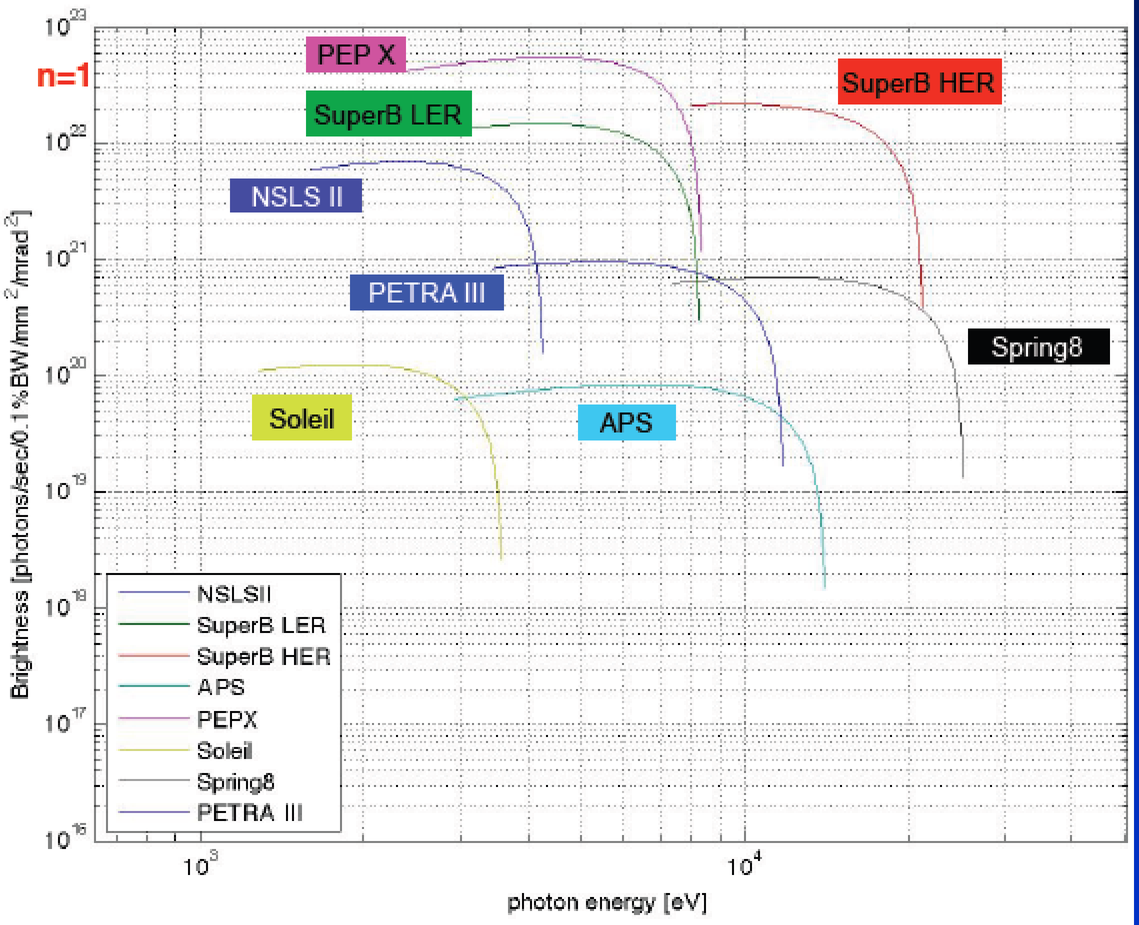
| Parameters * | SuperB HER | SuperB LER | NSLS II |
|---|---|---|---|
| E [GeV] | 6.7 | 4.18 | 3 |
| I [mA] | 1892 | 2447 | 500 |
| ρ [m] | 69.64 | 26.8 | 24.975 |
| εx [m rad] | 2.0 E-9 | 2.46 E-9 | 0.55 E-9 |
| εy [m rad] | 5.0 E-12 | 6.15 E-12 | 8.0 E-12 |
| γy [m^-1] | 0.334 | 0.537 | 0.05 |
| σx [mm] | 82.1 E-3 | 92.1 E-3 | 125.0 E-3 |
| σy [mm] | 8.66 E-3 | 9.11 E-3 | 13.4 E-3 |



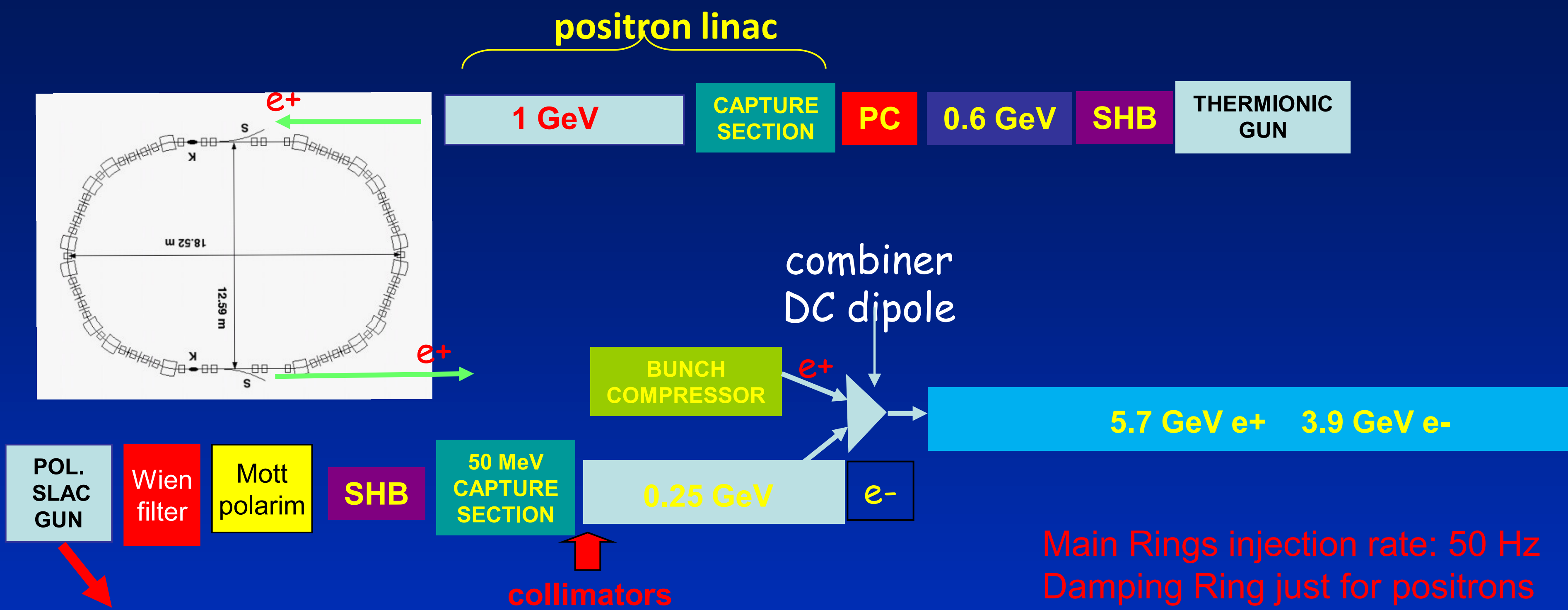

Brightness from bending magnets

# Brightness from undulators

| Parameters * | SuperB HER | SuperB LER | NSLS II |
|---|---|---|---|
| | IVU20 | IVU20 | IVU20 |
| E [GeV] | 6.7 | 4.18 | 3 |
| I [mA] | 1892 | 2447 | 500 |
| σx [mm] | 60.0 E-3 | 66.5 E-3 | 33.3 E-3 |
| σy [mm] | 2.4 E-3 | 2.6 E-3 | 2.9 E-3 |
| σx' [mrad] | 33.3 E-3 | 37.0 E-3 | 16.5 E-3 |
| σy' [mrad] | 2.1 E-3 | 2.7 E-3 | 2.7 E-3 |
| N [1] | 148 | 148 | 148 |
| λu [mm] | 20 | 20 | 20 |
| Kmax [1] | 1.83 | 1.83 | 1.83 |
| Kmin [1] | 0.1 | 0.1 | 0.1 |



# Injection System




Main Rings injection rate: 50 Hz
Damping Ring just for positrons

| Parameter | Units | SLC |
|---|---|---|
| Electron charge per bunch | nC | 16 |
| Bunches per pulse | | 2 |
| Pulse rep rate | Hz | 120 |
| Cathode area | $cm^2$ | 3 |
| Cathode bias | kV | -120 |
| Bunch length | ns | 2 |
| Gun to SHB1 drift | cm | 150 |
| $e_{n,rms,gun}$ (fm EGUN) | $10^{-6}$ m | 15 |

from A. Brachmann - SuperB Workshop
SLAC, October 2009

Round beam
Emittance @ 4.16 GeV = 1.8 nm
Required bunch charge for e- ≈ 0.3 nC
… scrapers .. collimators needed

# Layout, Site

- The rings footprint is at the moment the same as the baseline (2 rings in same tunnel, about 1250 m long)
- The insertion of synchrotron beamlines, with their impact on the layout and lattice is being studied
- We are looking for a green field site in order to exploit at best the facility (SuperB and SL)
- Several sites seems available, first pick at the moment is in Tor Vergata University campus and we are studying its compatibility with the requirements
- Preliminary ground measurements have been performed at Tor Vergata in mid-April, waiting for their elaboration
- The layout will be adjusted as soon as the site is chosen to further optimize the system performances

SuperB
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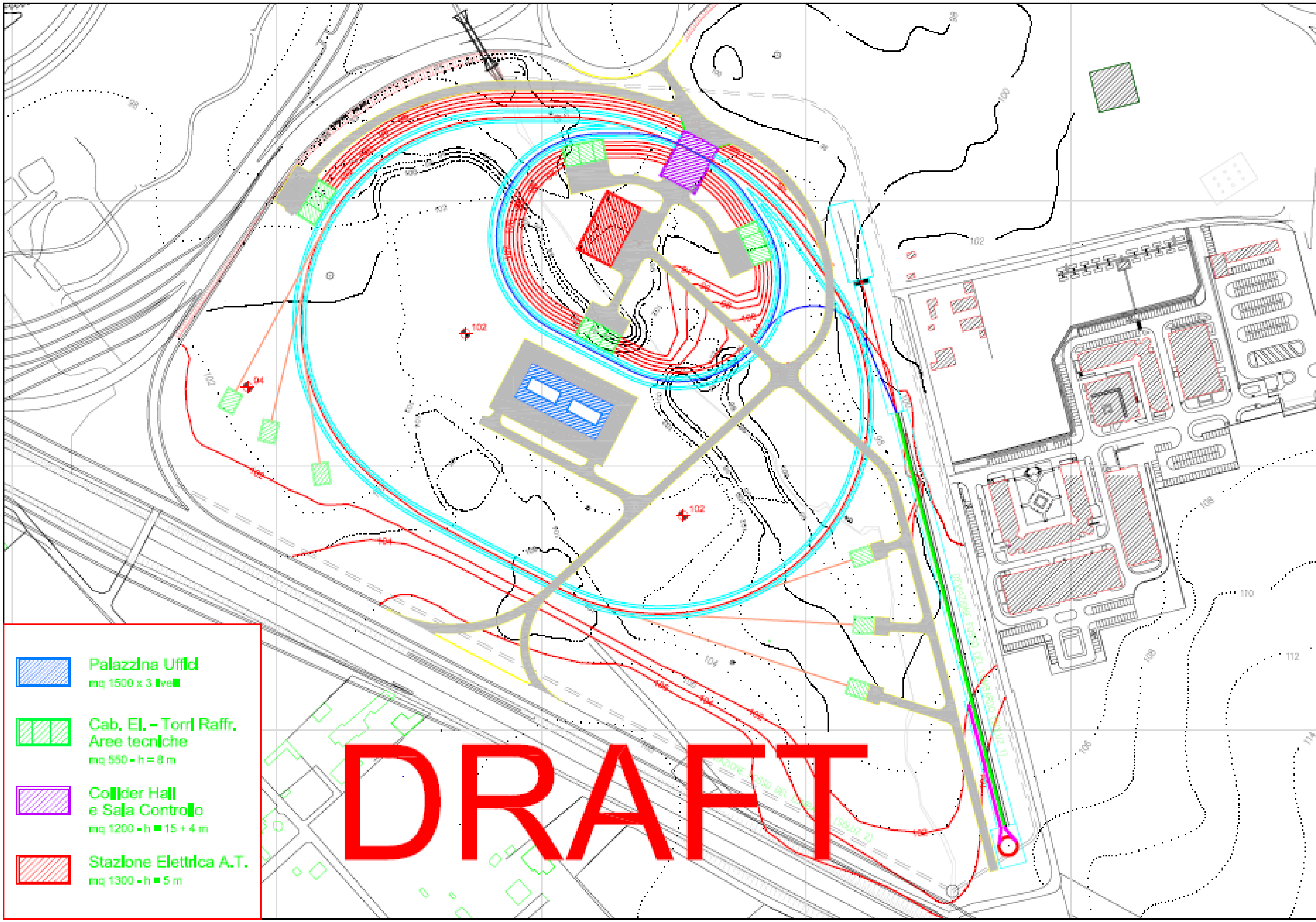
# Recent developments

- SL users need a lower emittance lattice, dedicated ID cells, long beamlines: difficult to achieve with 2 rings at different energies in the same tunnel
- HER can be some 100 m shorter (no need of matching sections to match LER spin rotators)
- A shorter (about ½ HER) LER ring can be better optimized:
  - Same SR power (present LER arcs have many unused drifts just to match HER geometry)
  - Polarization is about 5% larger since spin rotators geometry can be optimized (no matching to HER)
  - With $\varepsilon_x \approx$ ½ → Luminosity ≈ x2 ($L \propto 1/\varepsilon_x$)
  - Collective effects in a shorter ring are less severe
  - Final Focus also simpler (left=right)
  - The boost $\beta$ can be increased for $\tau$/charm running (good for physics)

# *Possible layout (1 & 2 tunnels)*

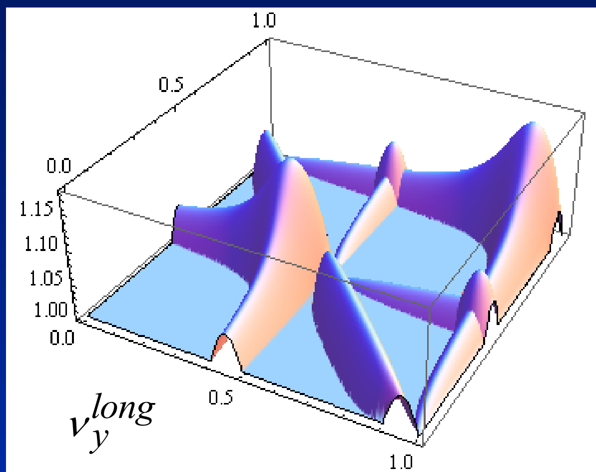


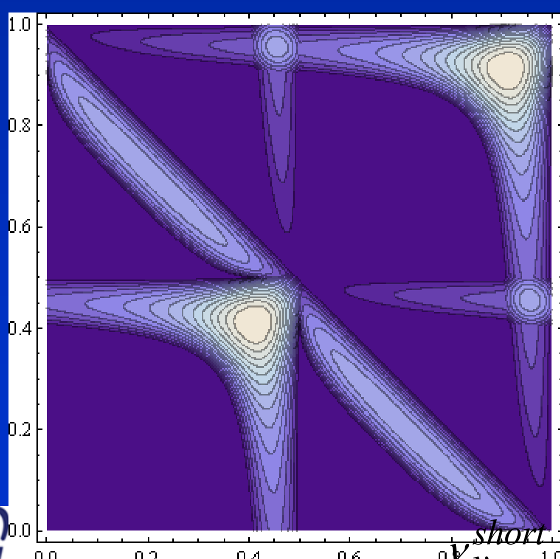
# Beam-beam resonances for asymmetric rings

- The «short» against «long» rings collision has been theoretically studied in the early ‘90 by Hirata, Keil, Chao…
- They pointed out the rising of strong low order coherent resonances for asymmetric colliding rings
- Some analytical estimation have been done for the simple example of DAΦNE by M. Zobov (LNF)
- Strong-strong bb simulations are needed, work in progress by Y. Zhang (BEPCII) on the same example
- For the moment results are that a suitable choice of the tunes (close to half-integer for «short» ring and to integer for «long» ring) can avoid the resonances and provide enough space for operation even with a high vertical tune shift

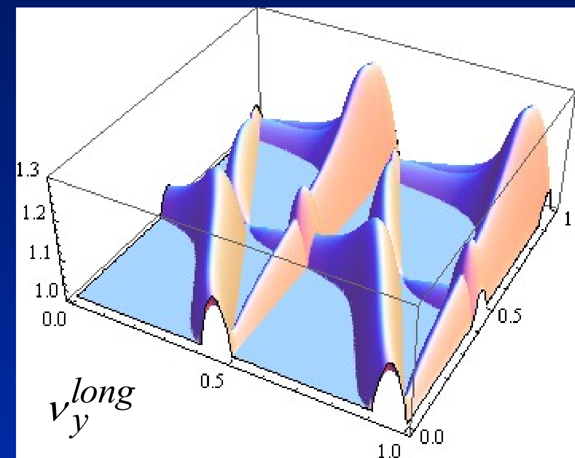
# *Tune space with coherent bb resonances*

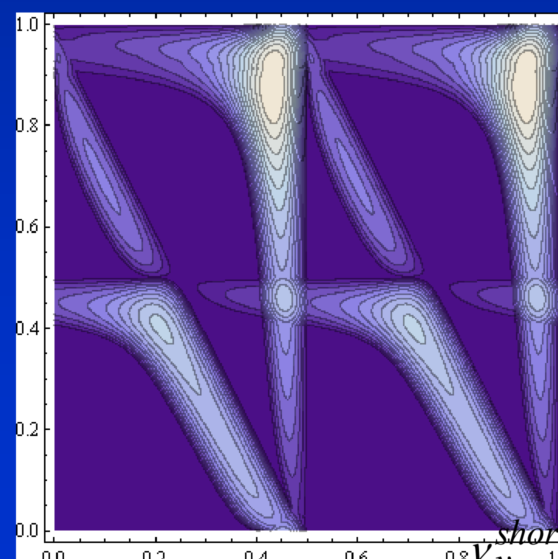
## Symmetric Rings



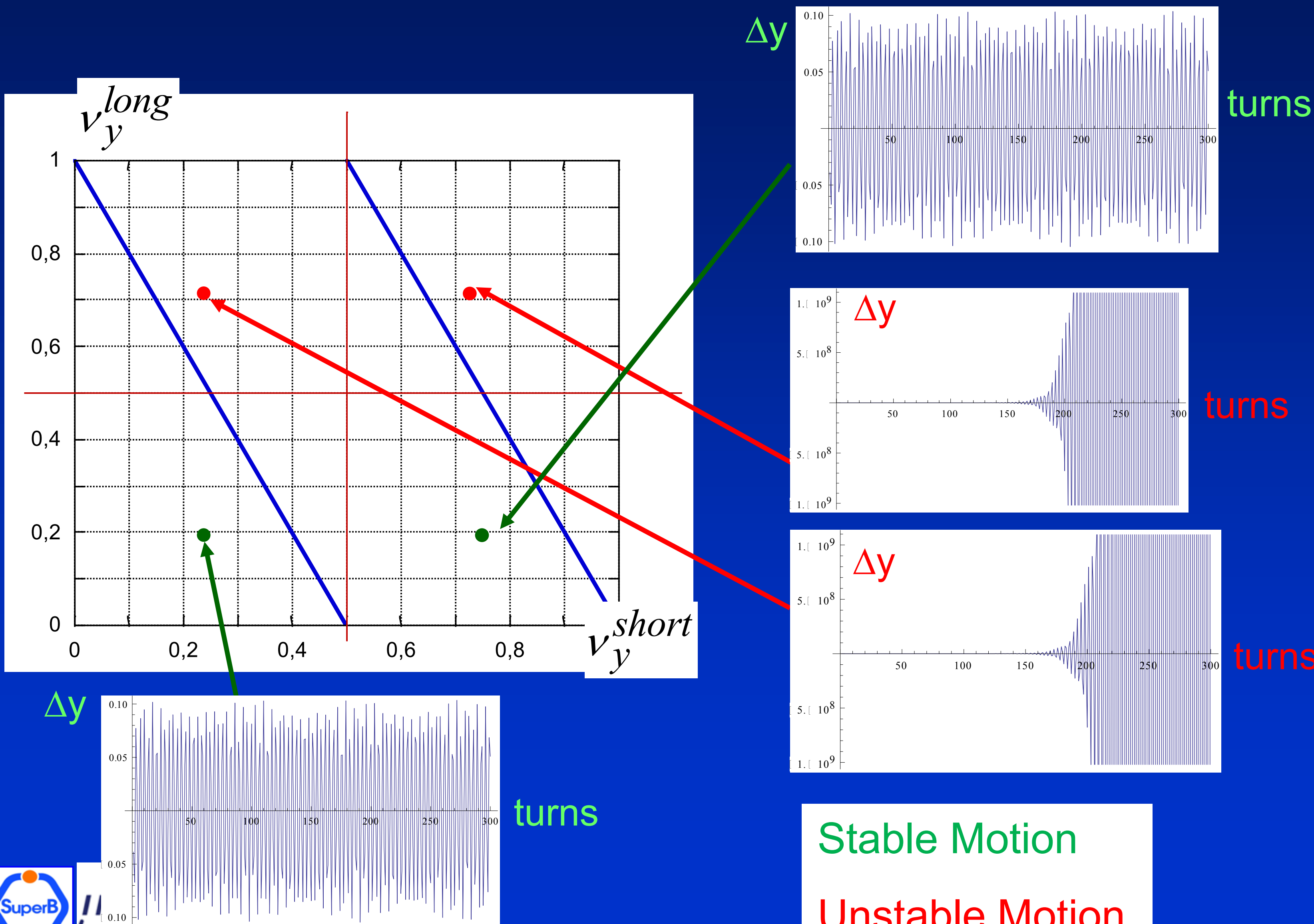

## Asymmetric Rings (2:1)




M. Zobov

# Working Point Choice to Avoid Coherent Beam-Beam Resonances



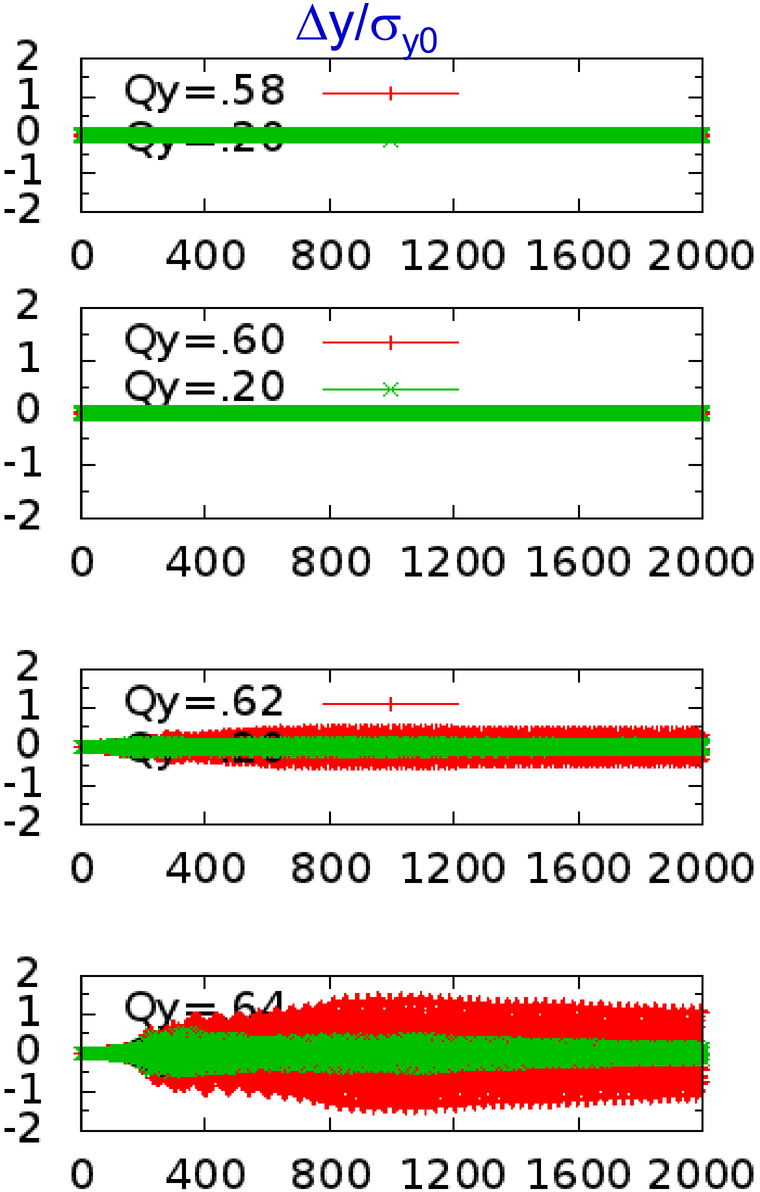

Stable Motion

Unstable Motion

M. Zobov

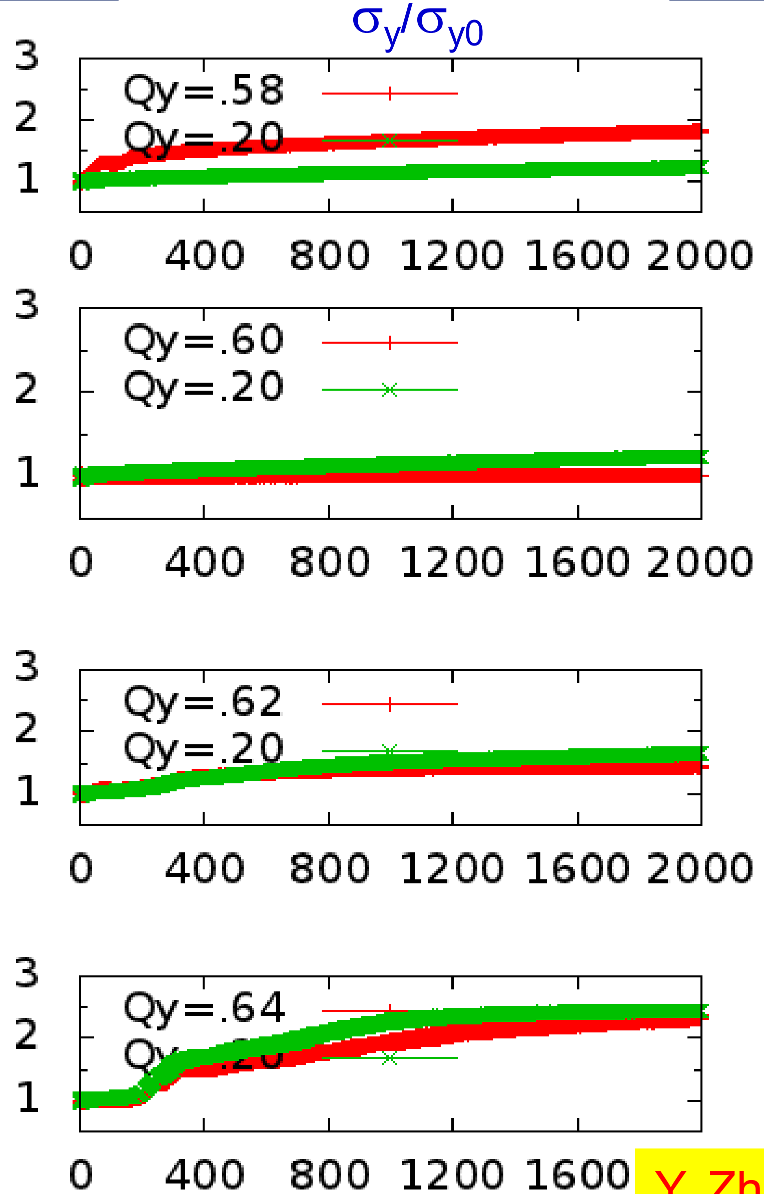
# Preliminary strong-strong bb simulations for different tune WPs

## Vertical beam baricenter movement




DIFFERENT WORKING POINTS

## Vertical beam blow-up




Y. Zhang

# *Synergies with state-of-the art international efforts*

- SuperB design has many characteristics in common with state-of-the-art colliders (LC, CLIC) and SL sources, to cite just a few:
  - Alignment of magnets, and orbit and coupling correction with the precision needed to produce vertical emittances of just a few pico-meters on a routine basis
  - Optimization of lattice design and tuning to ensure sufficient dynamic aperture for good injection efficiency (for both) and lifetime (particularly for SuperB LER), as well as control of emittances
  - Feedbacks (IP and rings)
  - Control of beam instabilities, including electron cloud, ion effects and CSR
  - Reduction of magnet vibration to a minimum, to ensure beam orbit stability at the level of a few microns
- All these issues are presently active areas of research and development, the similarity of the proposed operating regimes presents an opportunity for a well-coordinated program of activities that could yield much greater benefits than would be achieved by separate, independent R&D programs

# Conclusions

- Accelerator design is converging
- Lattice and parameters optimization is continuing, for better performances and more flexibility
- Synchrotron Light beamlines are being considered
- A possible new layout is being studied, with special IDs insertions
- Work is in progress on more subtle beam dynamics issues (IBS, FII, CSR, e-cloud, beam-beam, feedbacks,…)
- Components and lattice tolerances with corrections are being studied
- Polarization is progressing: beam-beam depolarization studies, trying to simplify the polarized gun, spin tracking, spin measurements set-up
- We are collaborating with other Labs (SLAC, LAL, BINP, CERN, PSI, DIAMOND, IHEP, Cornell,…) to solve common issues