DAFNE

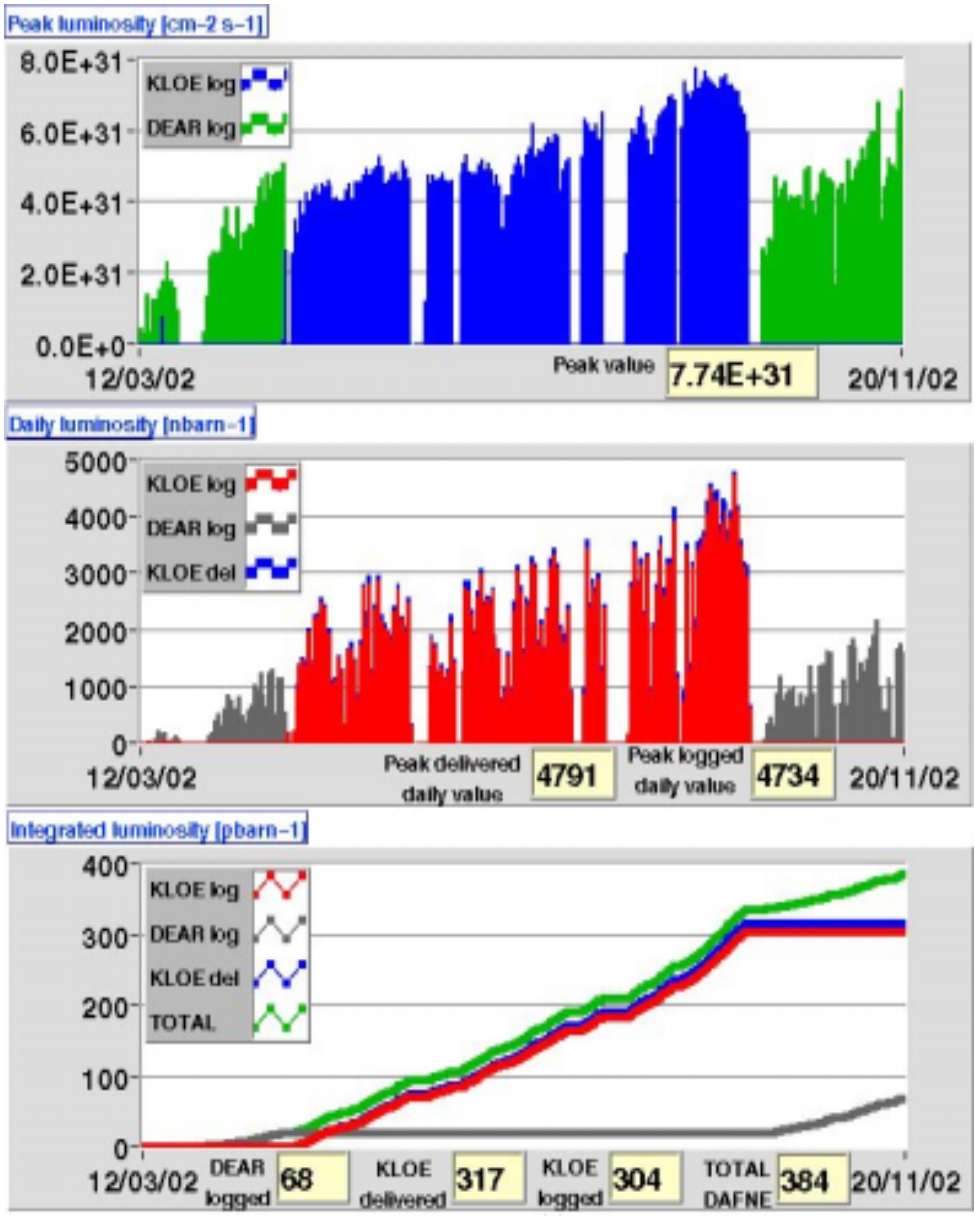
S. Guiducci

Workshop on e^+e^- in the 1-2 GeV Range:
Physics and Accelerator Prospects

Alghero 10/9/03

DAFNE operations summary and plans

- **2002** **Kloe run results**
  Dear run results
- **2003**
  - **New Interaction Regions installation**
  - **Hardware modifications and upgrades**
  - **Optics studies**
  - **Performances expectations**



2002 DEAR and KLOE luminosity

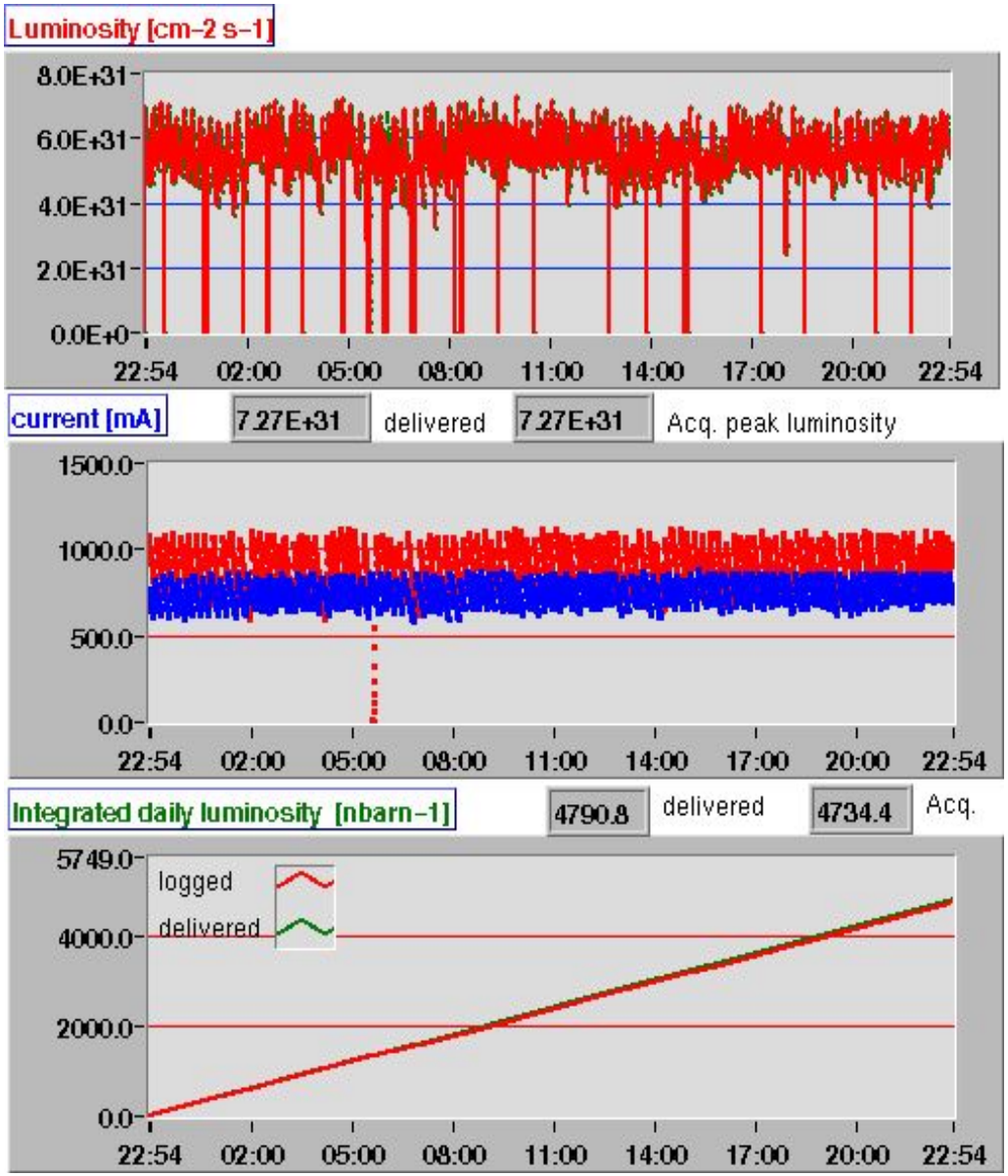
OBTAINED PERFORMANCE WITH KLOE

• Number of bunches per beam	49 + 49
• Total current per beam e-/e+(A)	≈ 0.8/1.1
• Peak luminosity ($cm^{-2}s^{-1}$)	0.75 $x10^{32}$
• Beam-beam tune shift ξ	~ .02
• Average luminosity ($cm^{-2}s^{-1}$)	≈ 0.5 $x10^{32}$
• Delivered luminosity per day (pb^{-1})	4.2 (4.8 best)
• Luminosity lifetime (h)	≈ 0.6
• Number of fillings per hour	≈ 3
• Injection frequency e-/e+ (Hz)	2/1
• Data acquisition during injection	on

Kloe Run Results

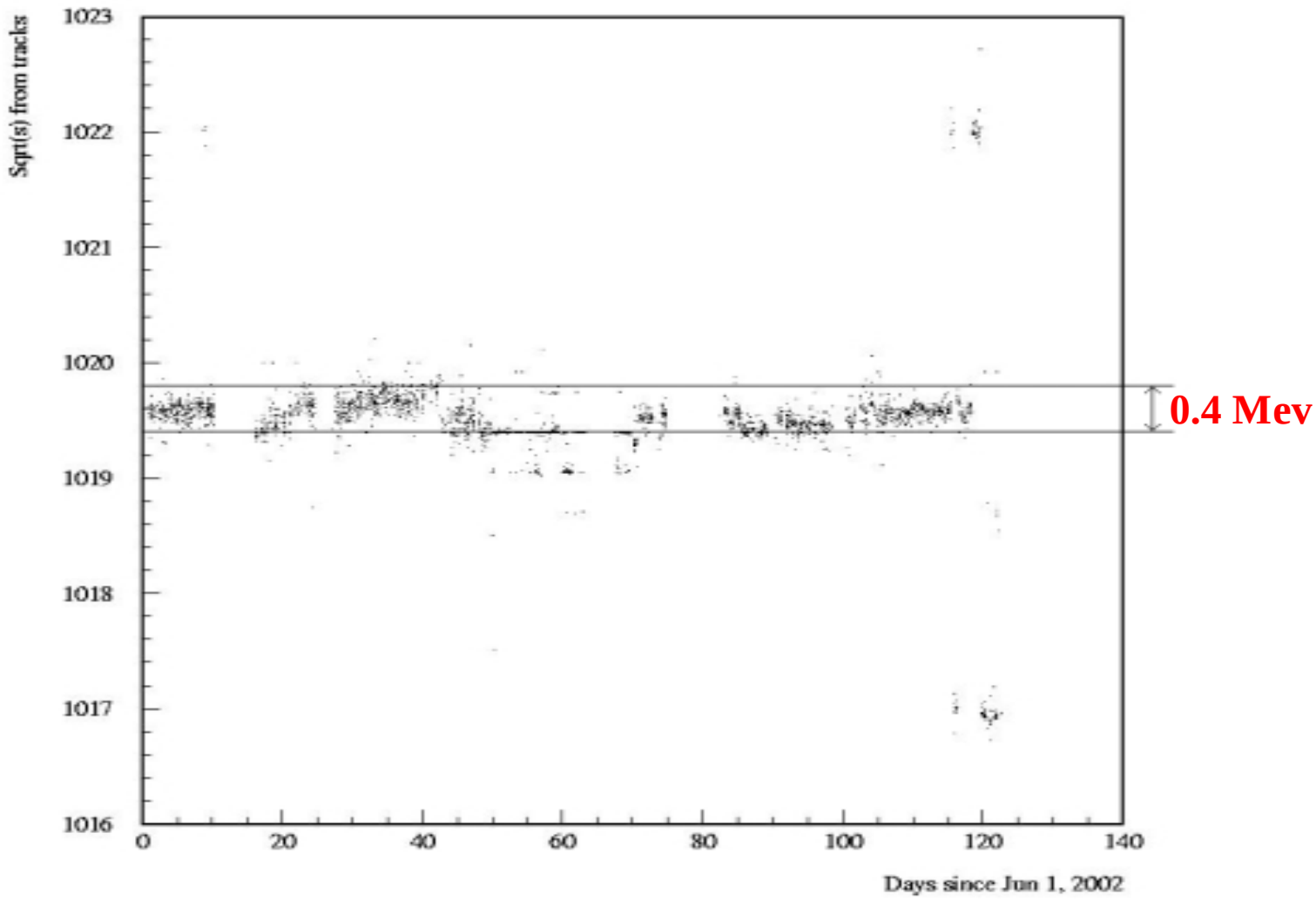
- **Background and Lifetime Optimization**
- **Lowered β_x at IP(from 5.6m to 2.7m)**
- **Orbit Optimization**
- **Old and New Scrapers Optimization**
- **Sextupoles and Octupoles Optimization**
- **Improved linear and non-linear knowledge of the machine**
- **Increased Dynamic aperture with better βs on Sexts and Wigglers**

- **Luminosity Optimization**
- **Adiabatic Tuning**
- **Different Working Point for e- 0.11/0.15 (Q_x/Q_y)**
- **Lowered β_y at IP(from 3.0cm to 2.6cm)**
- **Lowered β_x at IP(from 5.6m to 2.7m)**
- **Decreased horizontal emittance (0.96mm ↓ 0.76mm)**

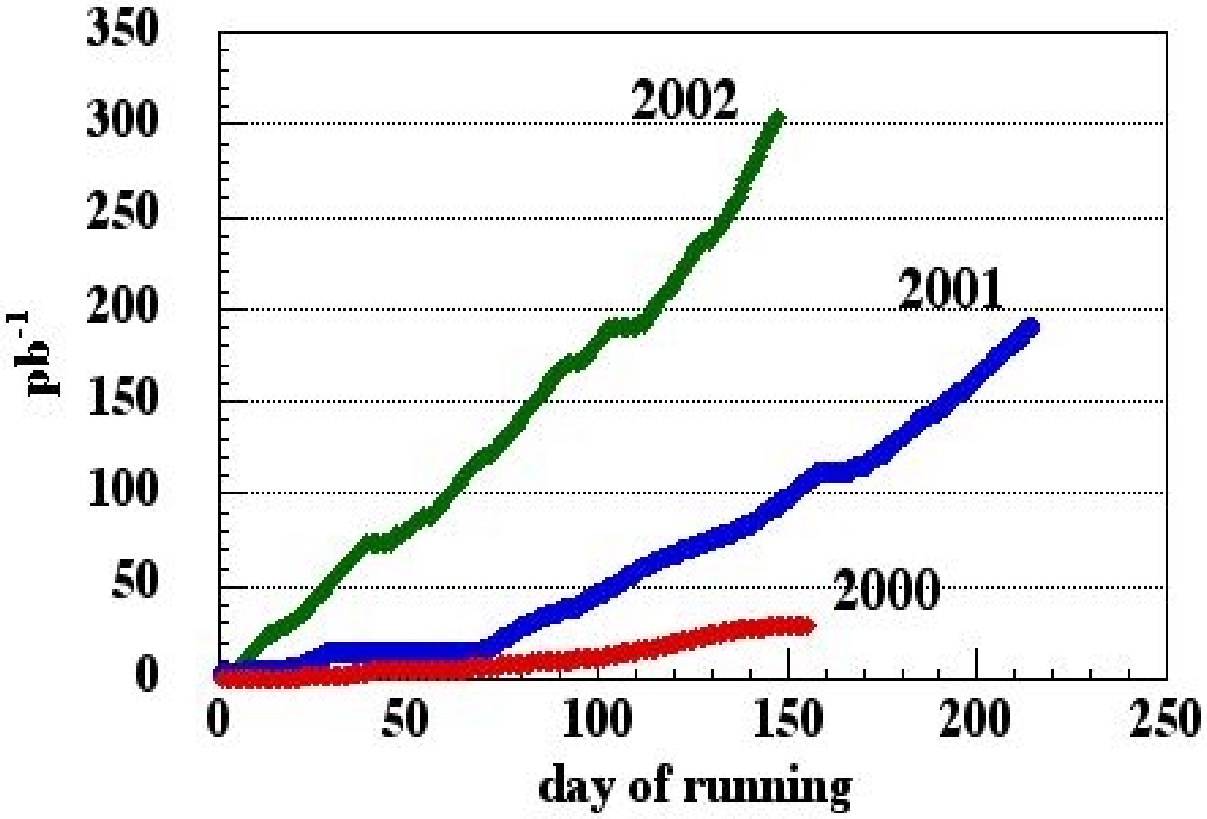


Best 2002 KLOE day
25/09/2002

Energy stability



Kloe Integrated luminosity in the last 3 years



95 Bunches Dear Run

- **Optics modifications**
- **Transverse and longitudinal Feedback very accurate setup**

Allowed to collide 95/120 bunches filling all the buckets at 368 MHz (20% ion clearing gap).

Bunch distance 0.8 m

Luminosity increase same Background level

- **~ 1.5 in peak luminosity**
- **a factor 2 in integrated**

  (1.2pb^{-1}/day => 2.2pb^{-1}/day)

95 Bunches Dear Run

IR Optics

FDF Triplet => DF Doublet

lower β_x at IP and larger crossing angle => reduce parassitic crossings

β_x*= 1.7m

$\theta = \pm 14.5$ mrad

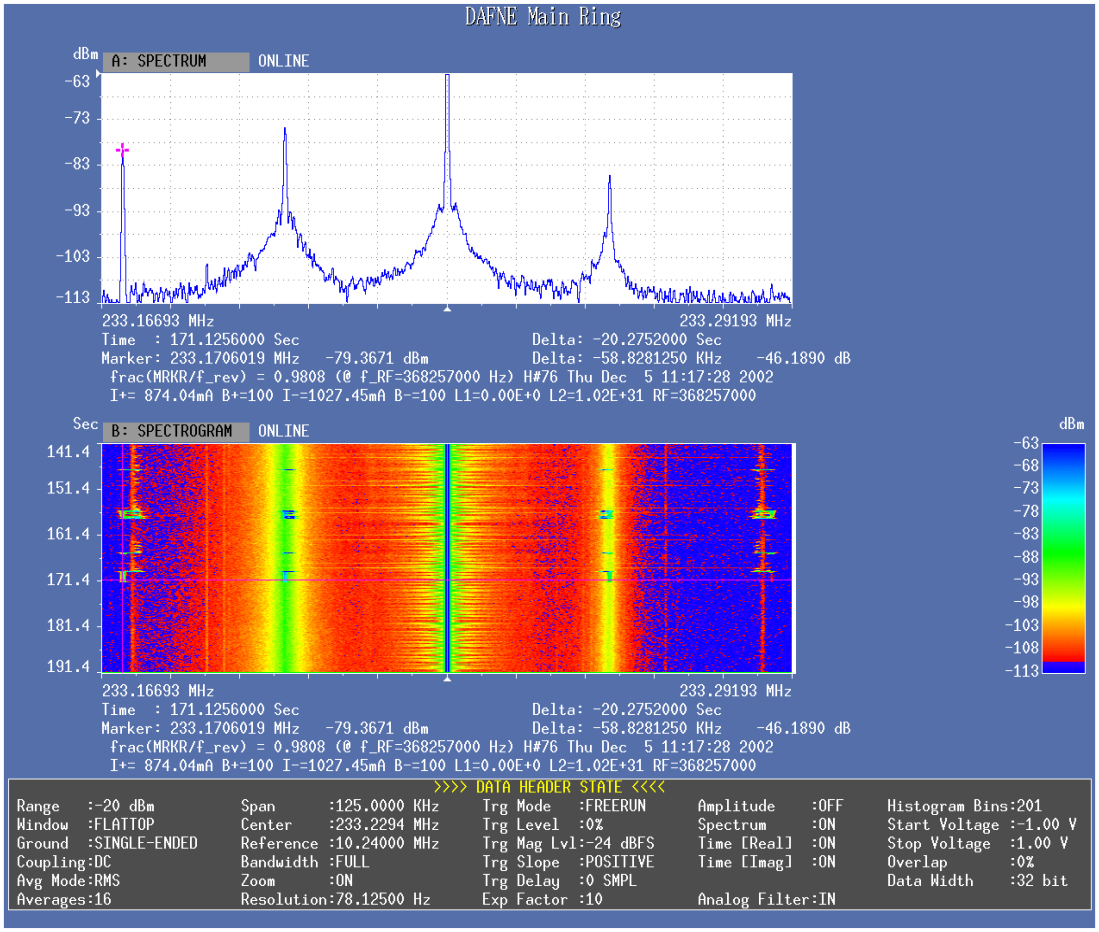
Distance between beam centers

d = 11 σ_x @ .4m from IP

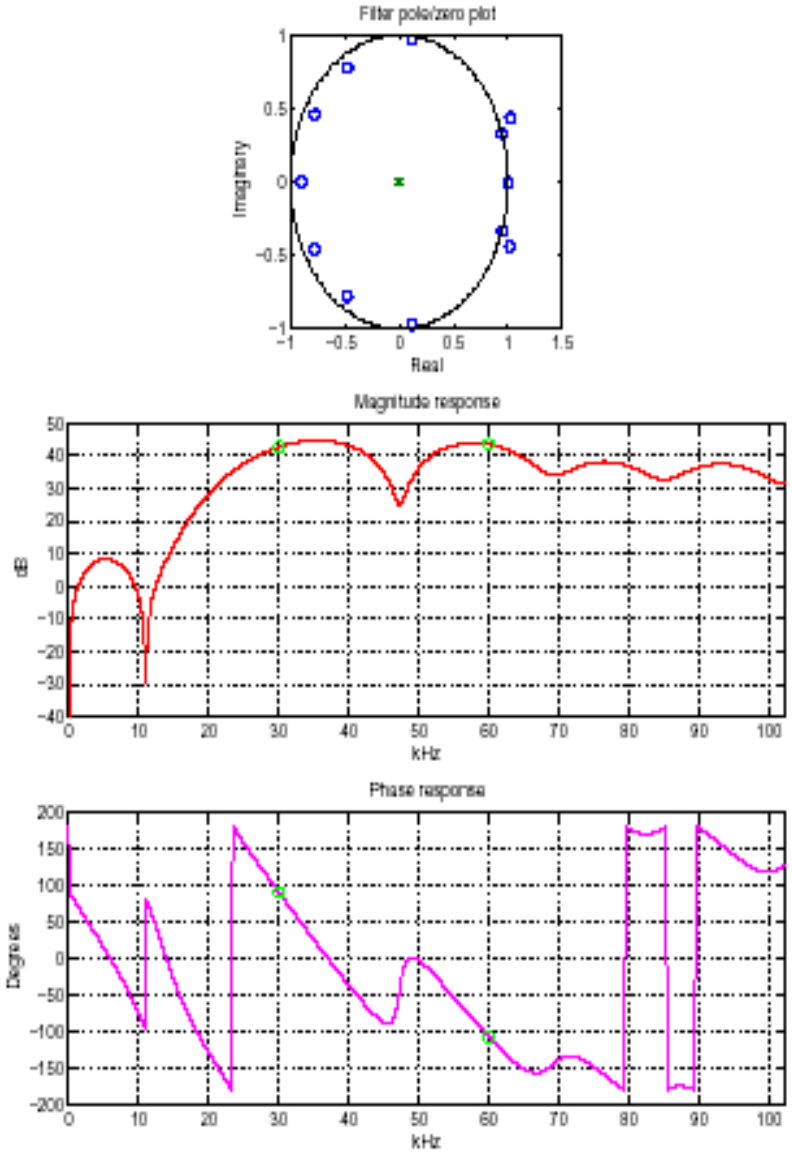
First parassitic crossing

Piwinski's angle $\theta = \sigma_z \theta / \sigma_x = .28$

Longitudinal Quadrupole Instability



- During 2002 deeper knowledge of the phenomenon
- It appears in <u>both</u> rings, at high currents but with different single bunch thresholds: lower for e-, ~20% higher for e+
- In this picture e+ beam power spectrum with 100 bunches, 900mA, during collision
- Longitudinal feedback is able to control the instability

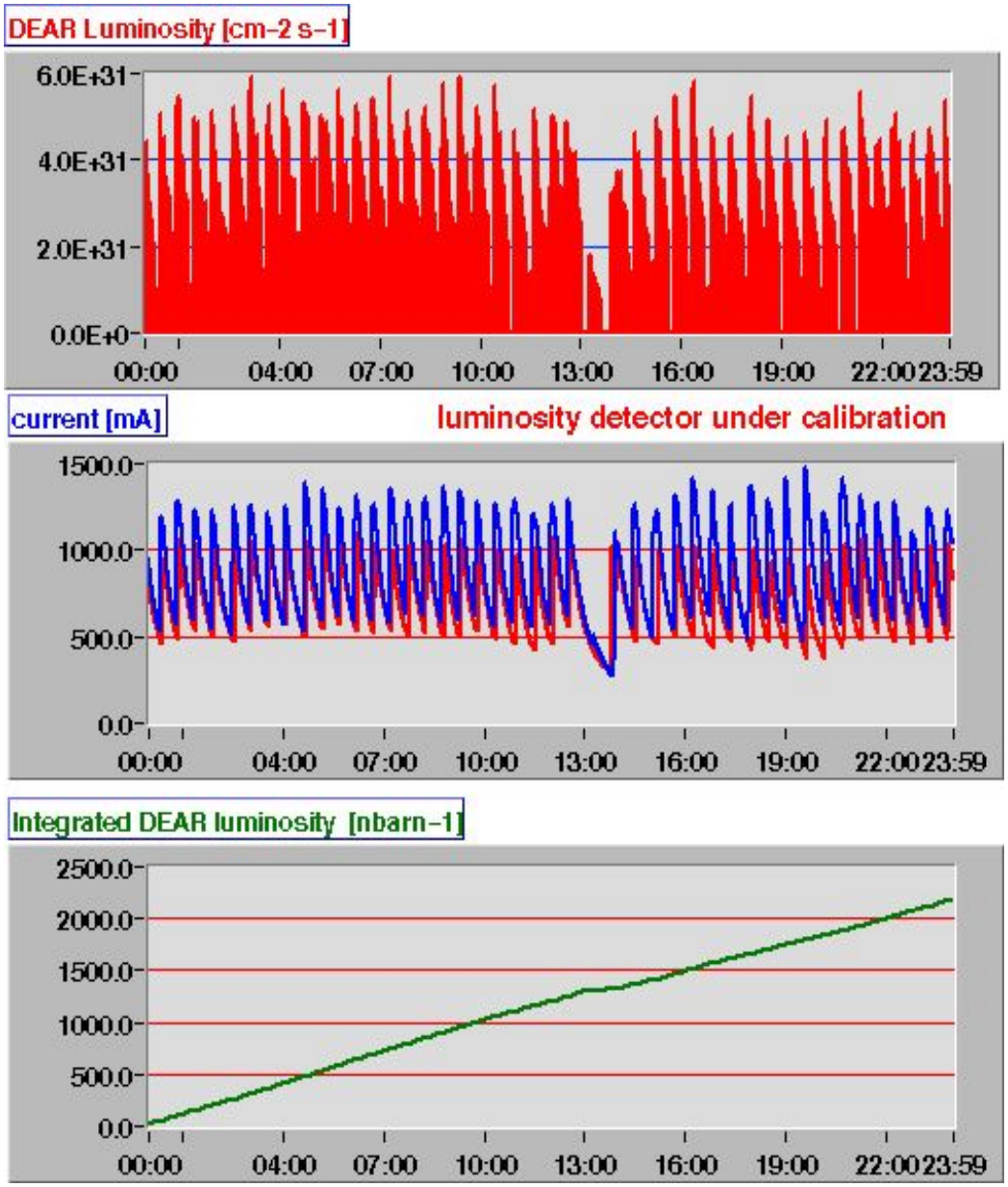


Multi-mode filter response to simultaneously optimize the longitudinal feedback performances at the zero,dipole and quadrupole modes.

=> stable beams at higher currents with 100 bunches

DEAR PERFORMANCES OBTAINED IN AUTUMN

• Number of bunches per beam	95 + 95
• Total current per beam e-/e+ (A)	≈ 1.3/1
• Peak luminosity ($cm^{-2}s^{-1}$)	.7 $x10^{32}$
• Beam-beam tune shift ξ	~ .016
• Average luminosity ($cm^{-2}s^{-1}$)	≈ 2 $x10^{31}$
• Integrated luminosity per day (pb^{-1})	2.2 (best)
• Luminosity lifetime (h)	≈ 0.6
• Number of fillings per hour	≈ 1.7
• Injection frequency e-/e+ (Hz)	2/1
• Data acquisition during injection	off



Best 2002 DEAR day

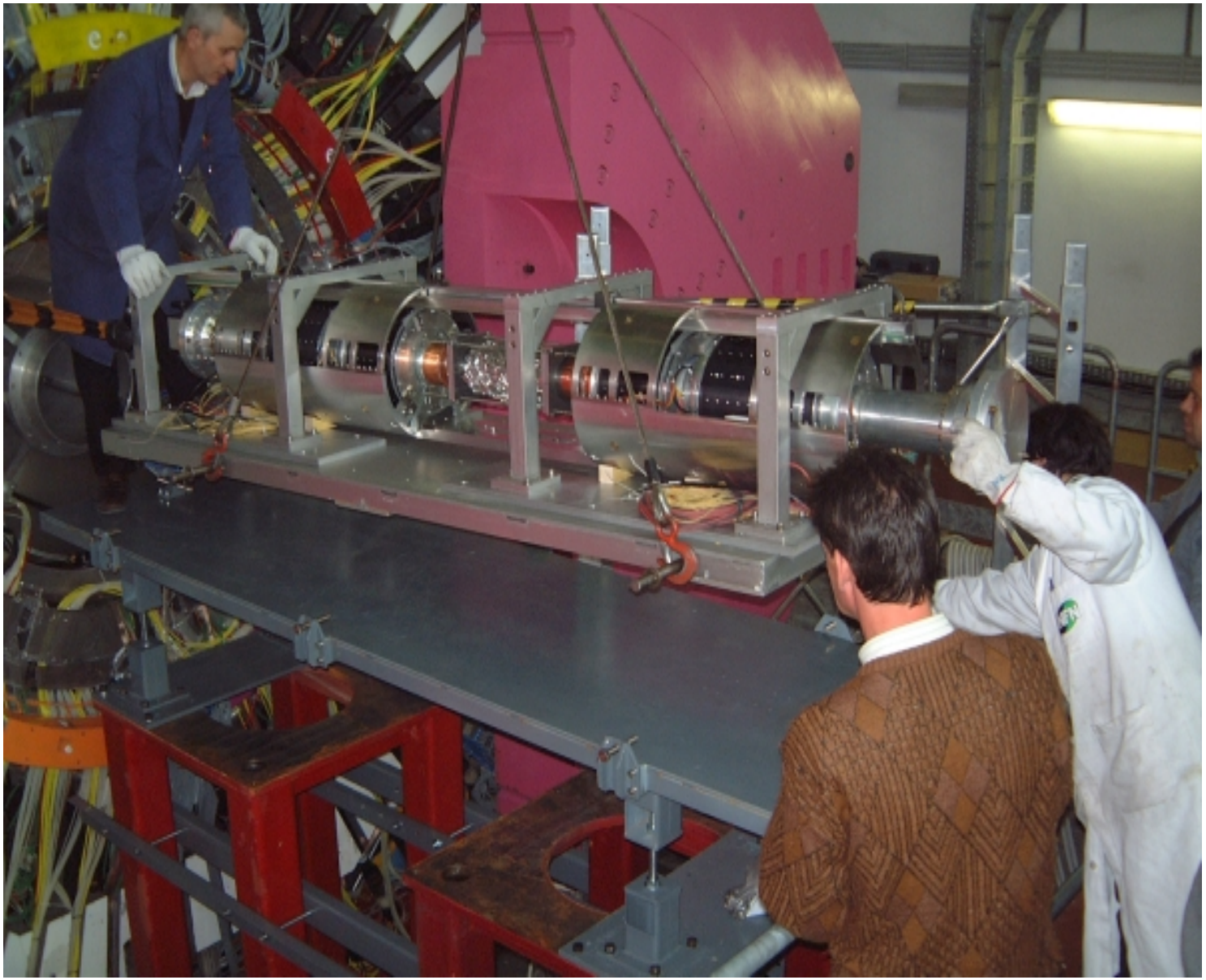
2003 MAIN HARDWARE ACTIVITIES

- **Finuda Installation**
- **Kloe new I.R. installation**
- **Straight long sections and kickers mods**
- **Scrapers mods**
- **Bellows mods**
- **Ion clearing electrodes mods**
- **Wigglers mods**
- **3rd RF harmonic cavity installation**

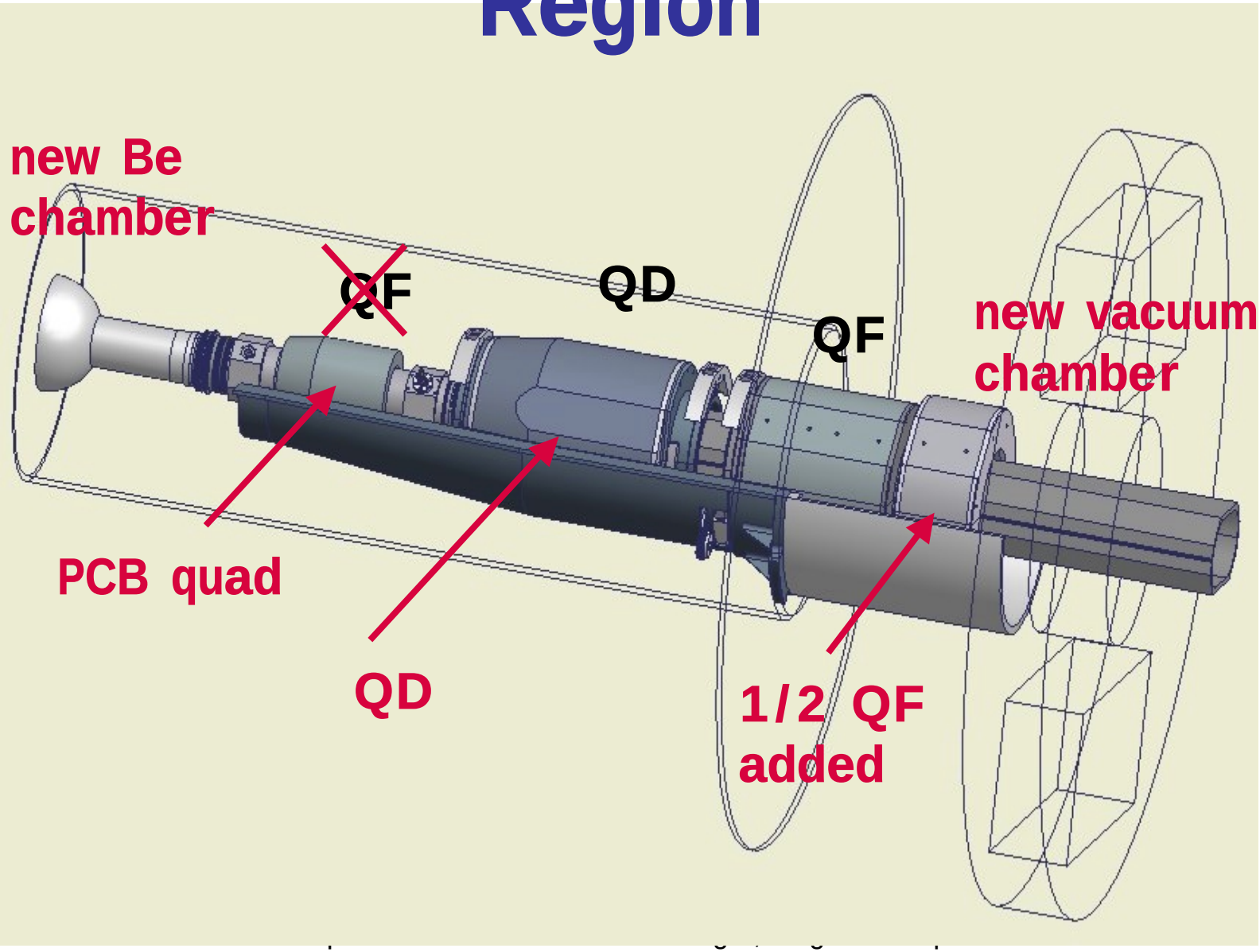
New Interaction Regions

- **Modified optic in order to decrease the IP beta-functions and lattice chromaticity**
- **Masks to optimise background rejection.**
- **Modified supports to provide variable quadrupole rotation to operate at different magnetic fields (from 0 to maximum) in the solenoids.**
- **100 bunches operation should be possible in both IR because, as demonstrated in last DEAR shifts, with a lower β_x at the IP, the parasitic crossing are not critical**

Finuda I.R. installation



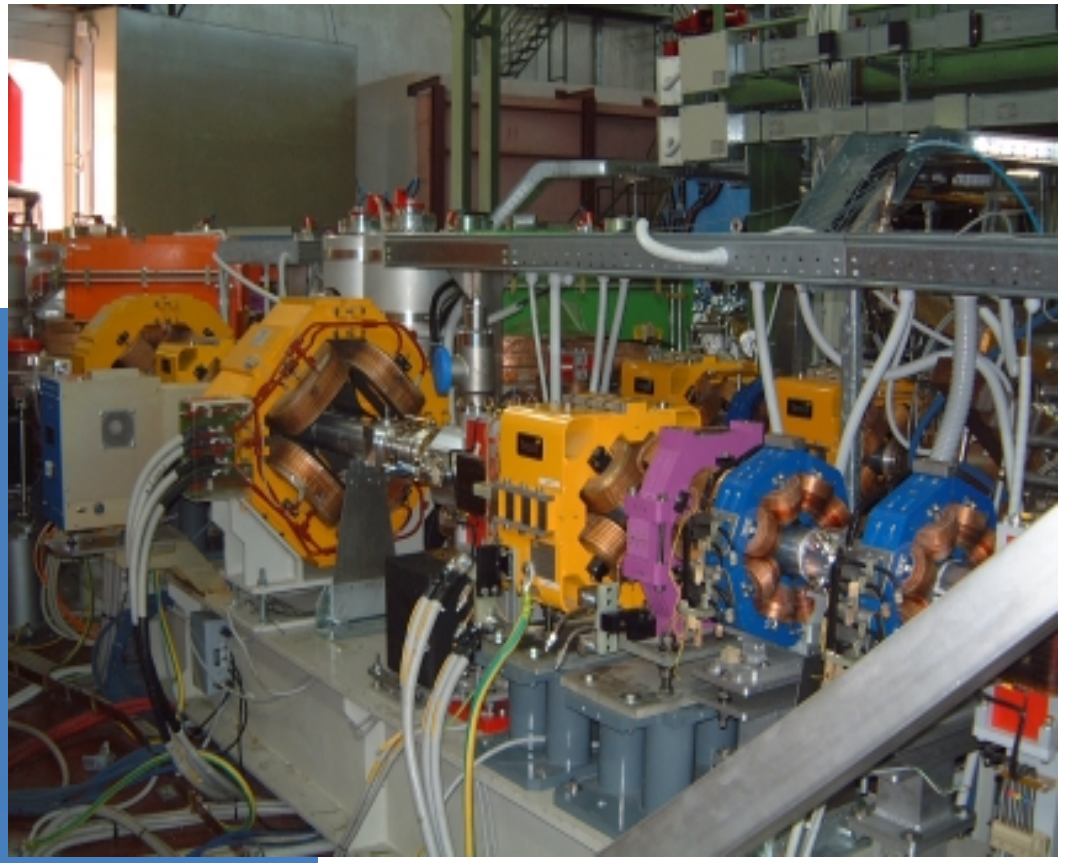
KLOE New Interaction Region

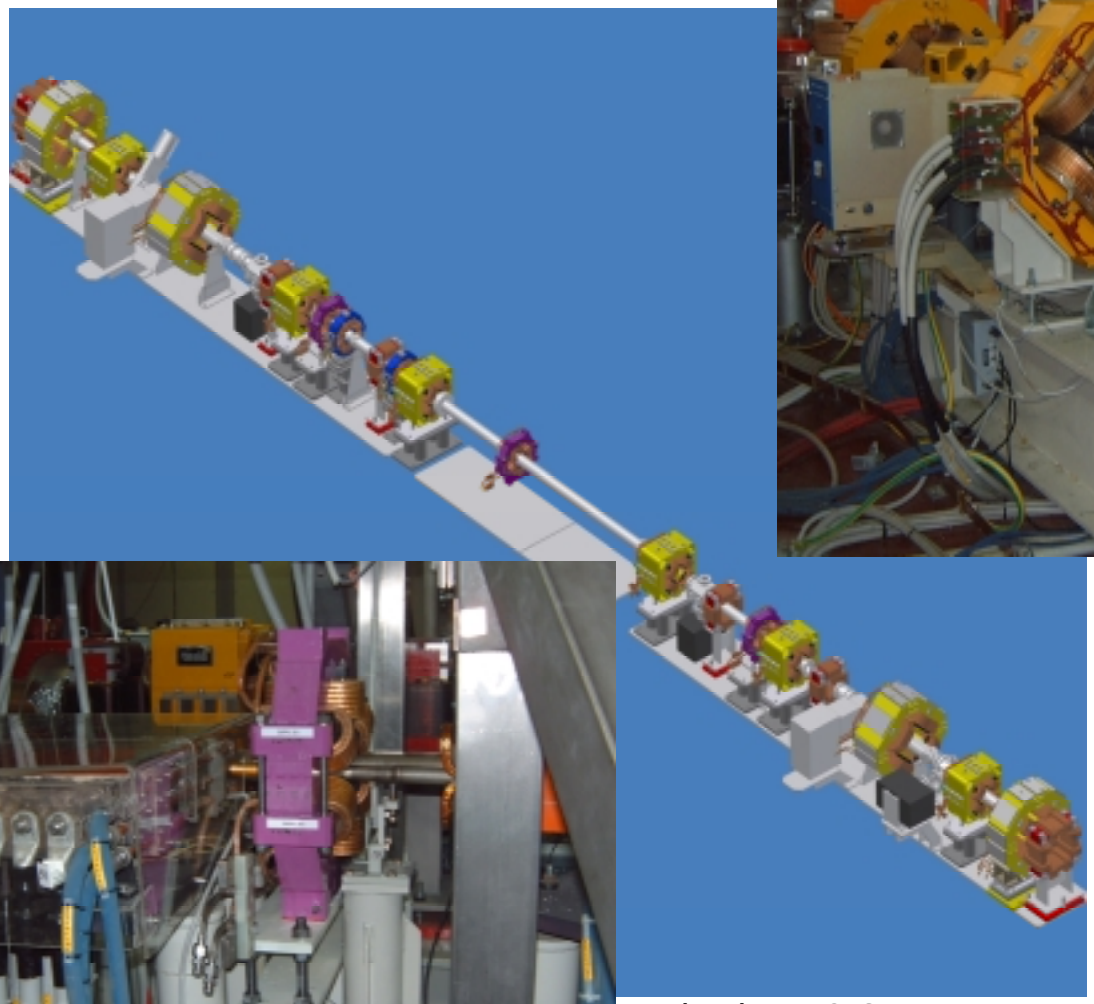


Kloe old I.R. removal

Kloe new I.R (under final assembly)

Straight Sections Mods

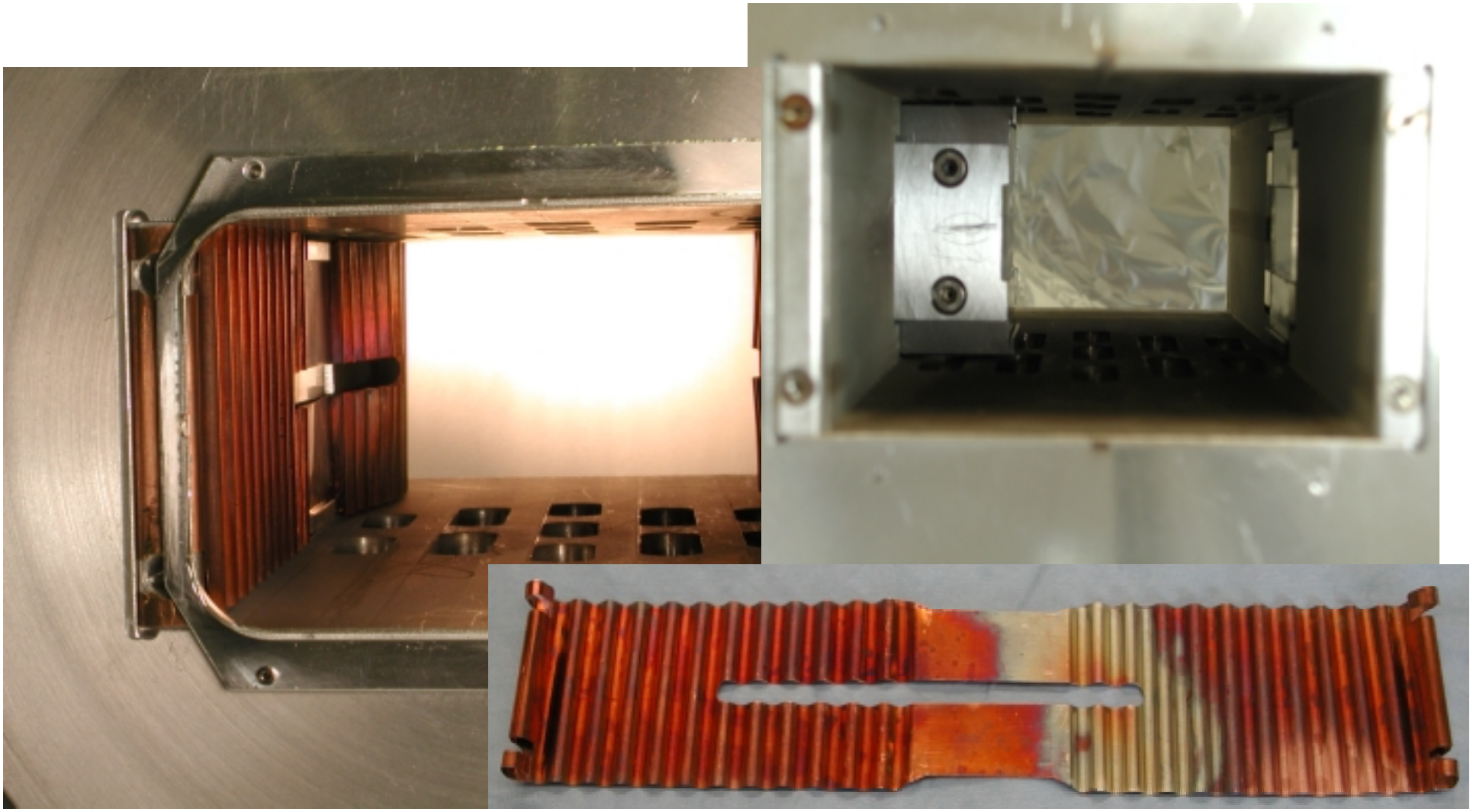




Straight Sections have been rearranged to improve injection efficiency and dynamic aperture

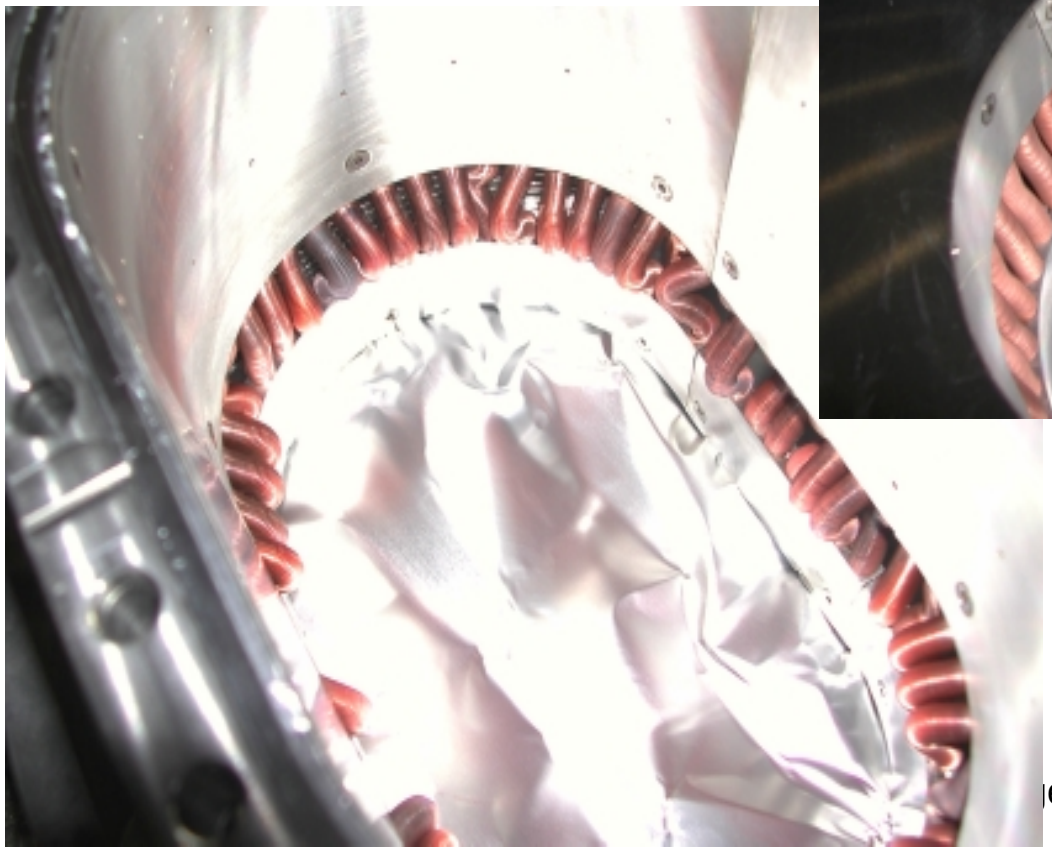
Scrapers modifications

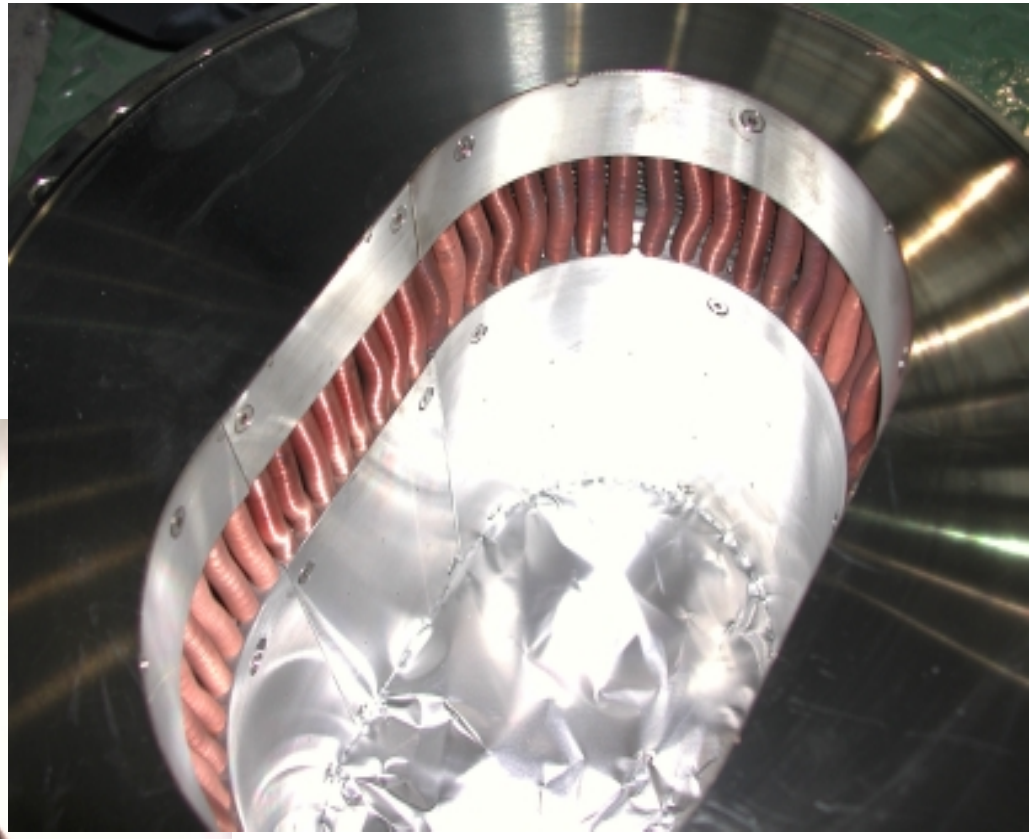
- Overall scrapers efficiency satisfactory
- Some had problems with the tapers
- Tapers removed in the horizontal ones, less critical to the ring impedance, and modified in the vertical ones



Bellows Modifications

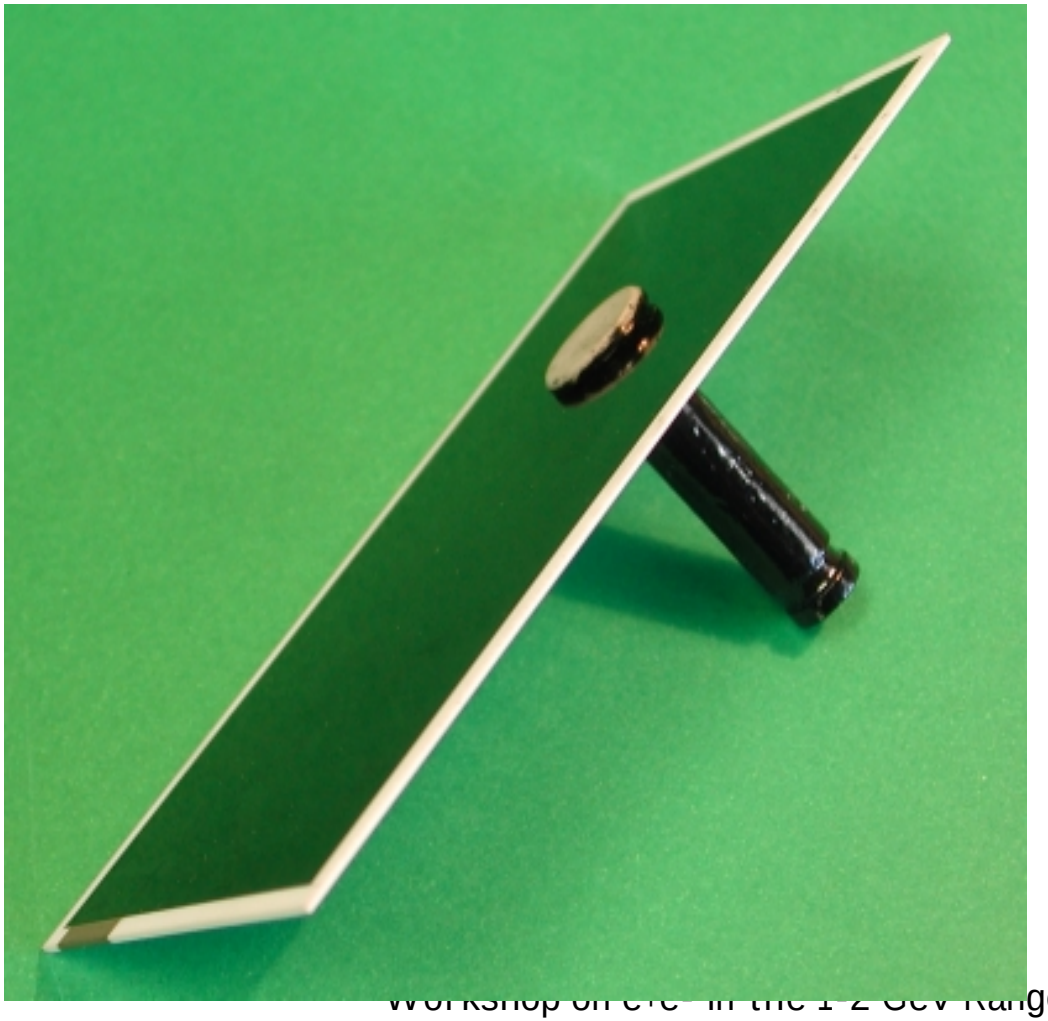
As found





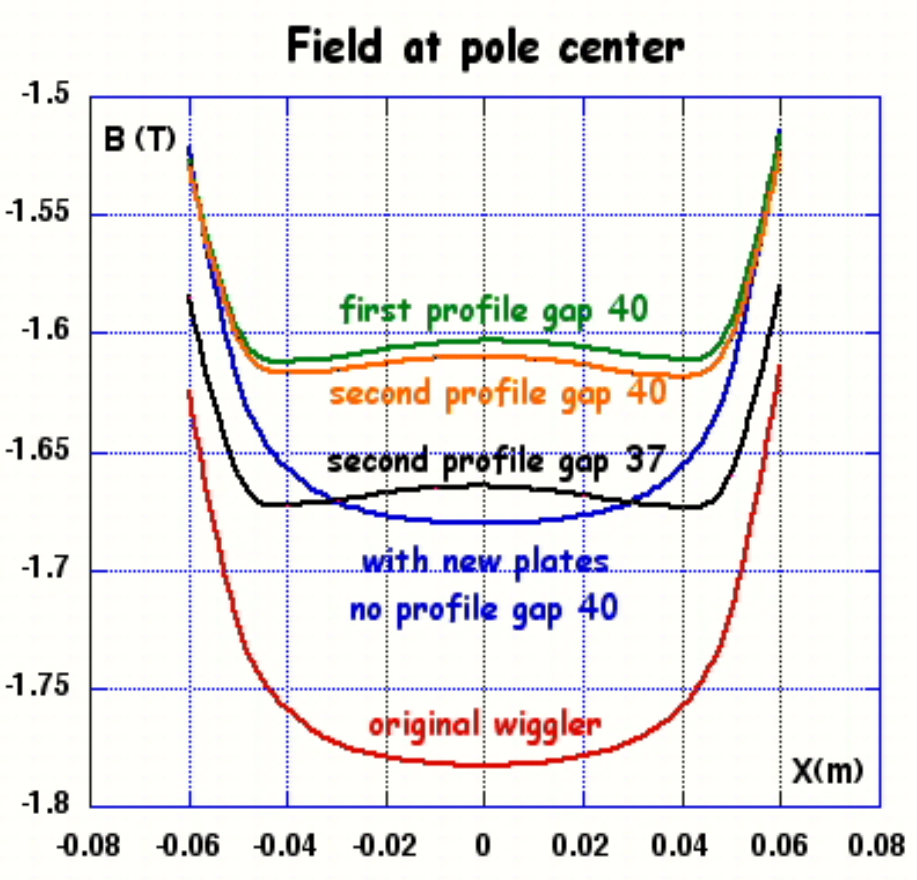
After insertions of pins to straighten the copper bellows

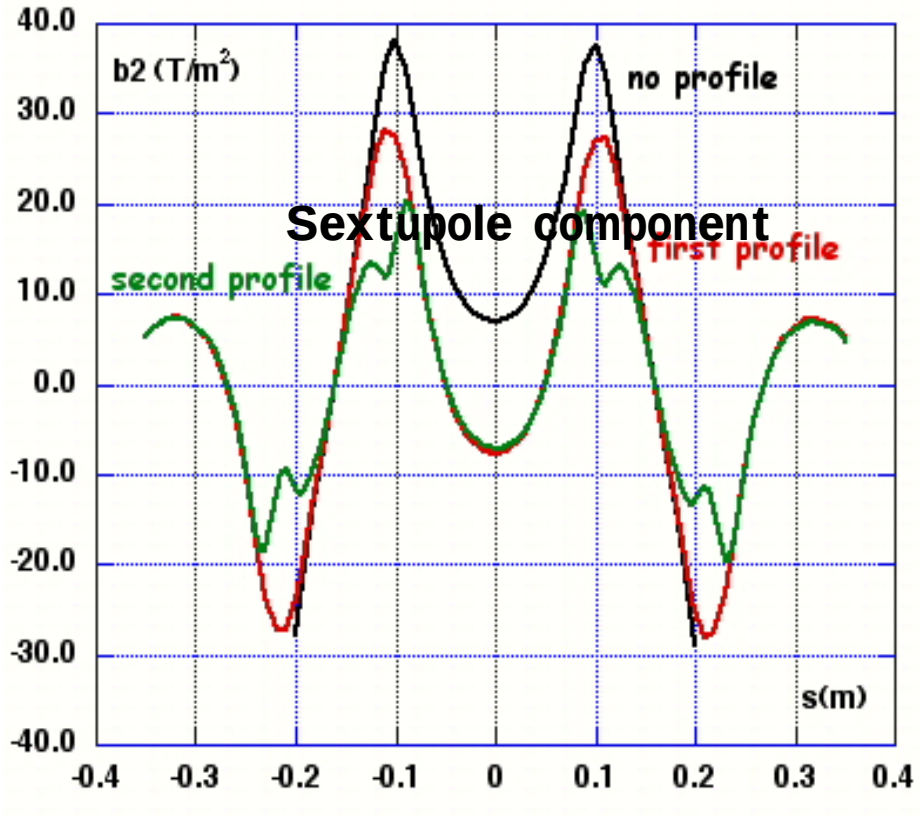
New Ion Clearing Electrodes



About 50% of ICE broken due to faulty welding. Most of the ICE replaced with welding-free electrodes

Wiggler field modifications

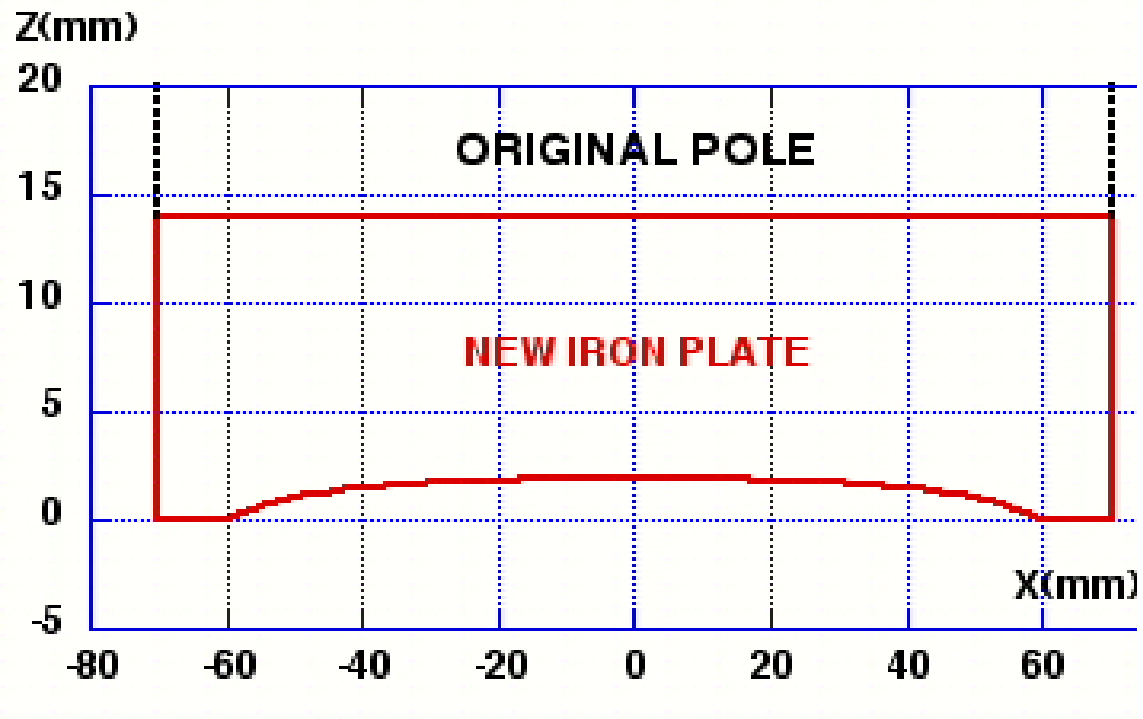




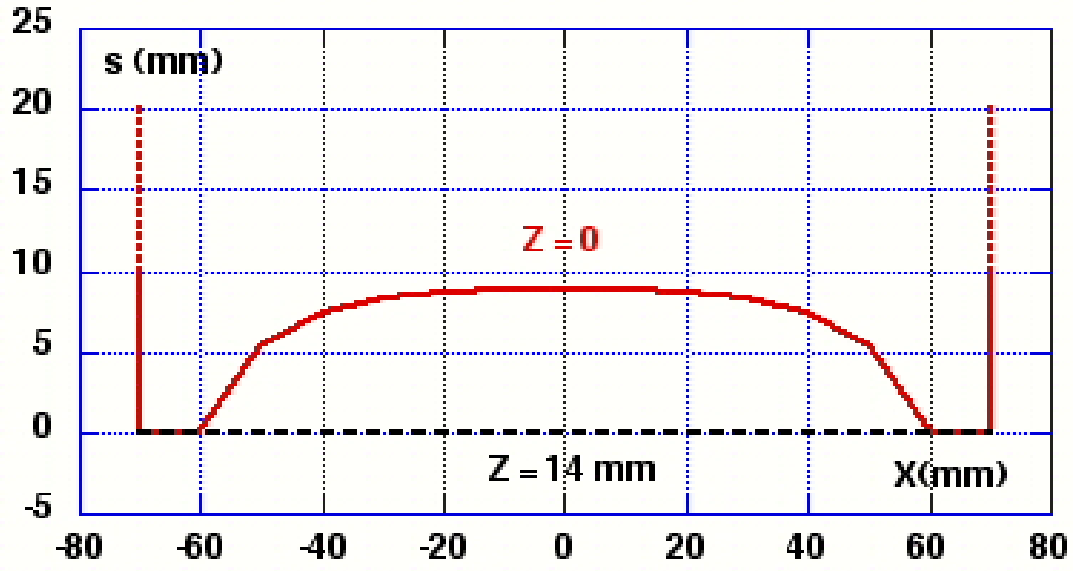
Reduction of the dynamic aperture due to:

- **Strong sextupole components (~x^2 like)**
- **Field roll off at large offsets (~x^6 like)**

Wigglers poles modifications

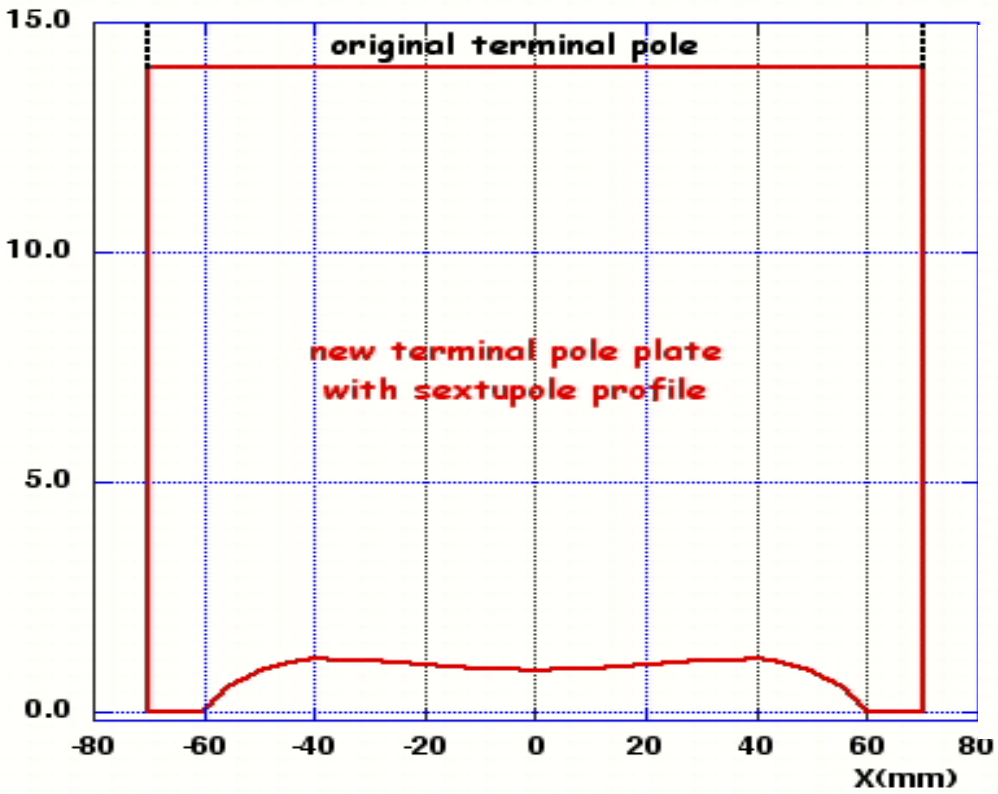


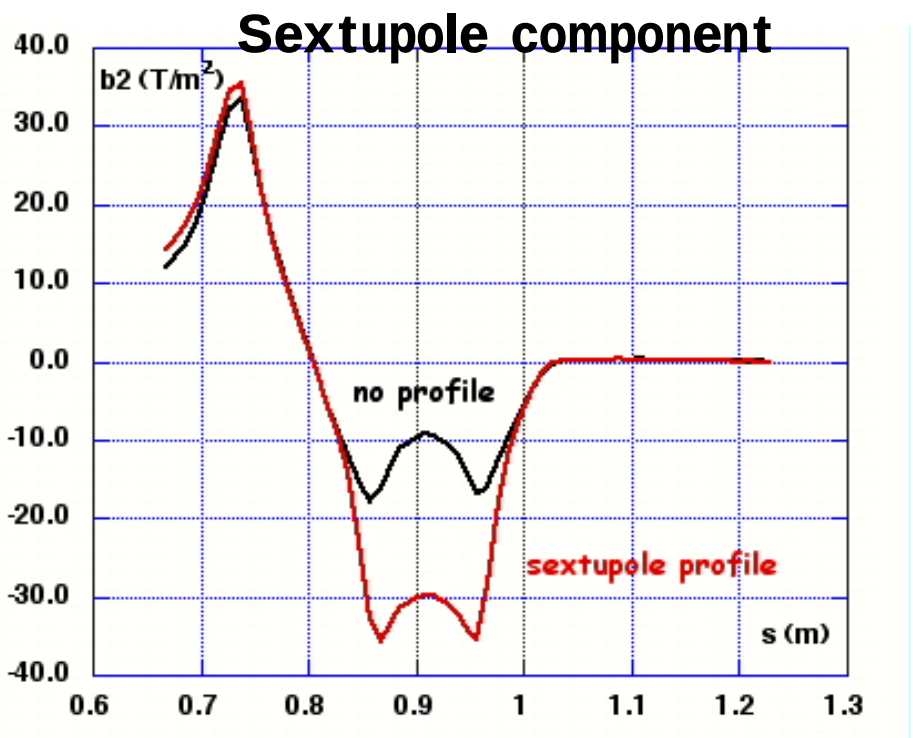
Longitudinal poles modifications



Vertical poles modifications

Terminal Pole Modifications

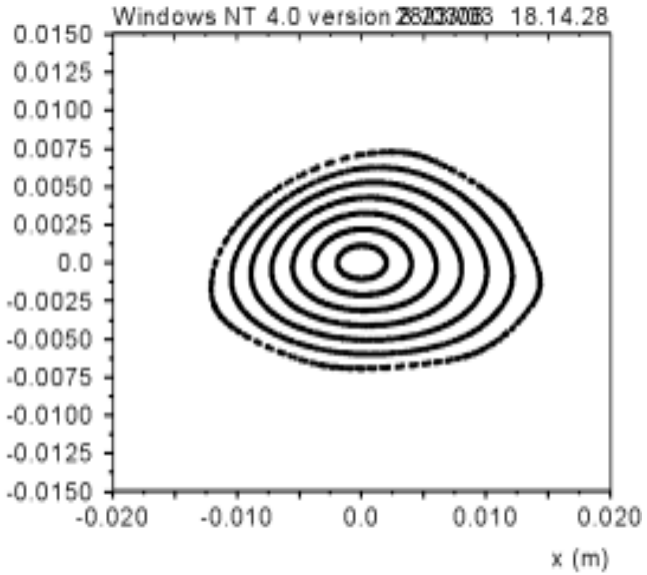




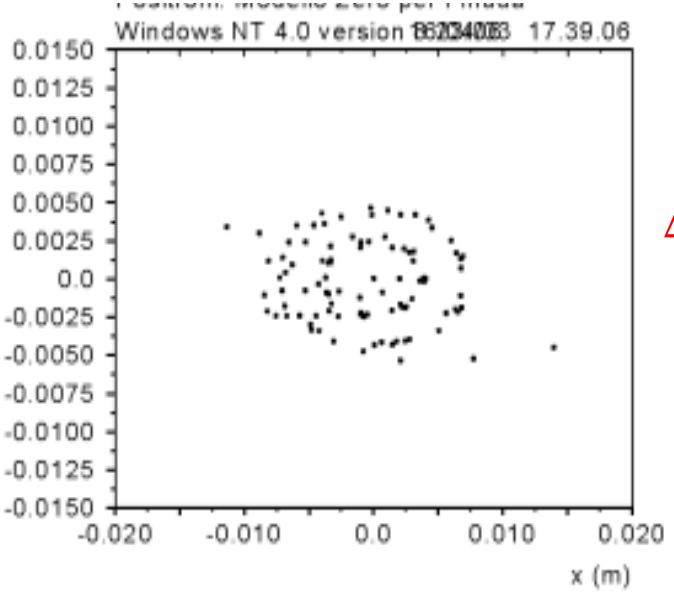
One of the two terminal pole has been modified in order to INCREASE its sextupole component. This operation is beneficial to the dynamic aperture, at least as the reduction of the main poles non-linearities

Horizontal dynamic aperture

Original wigglers

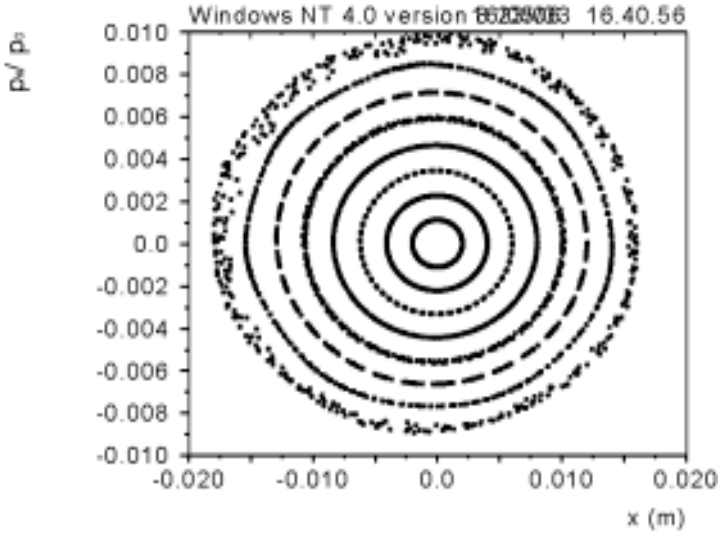


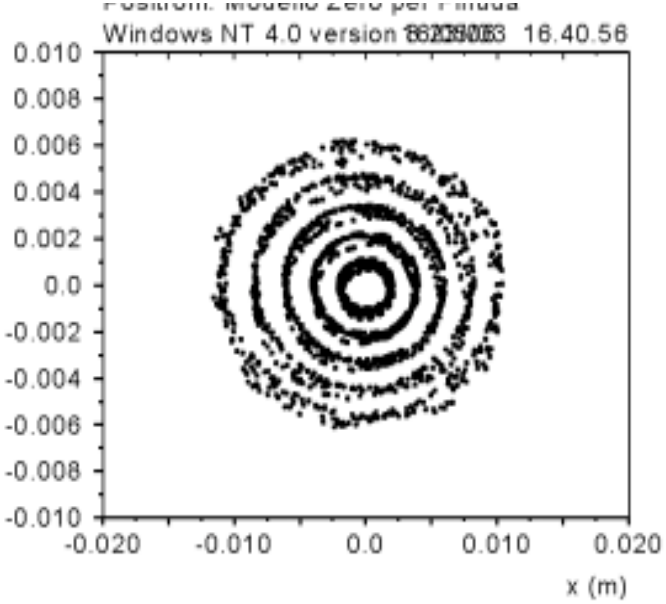
On energy



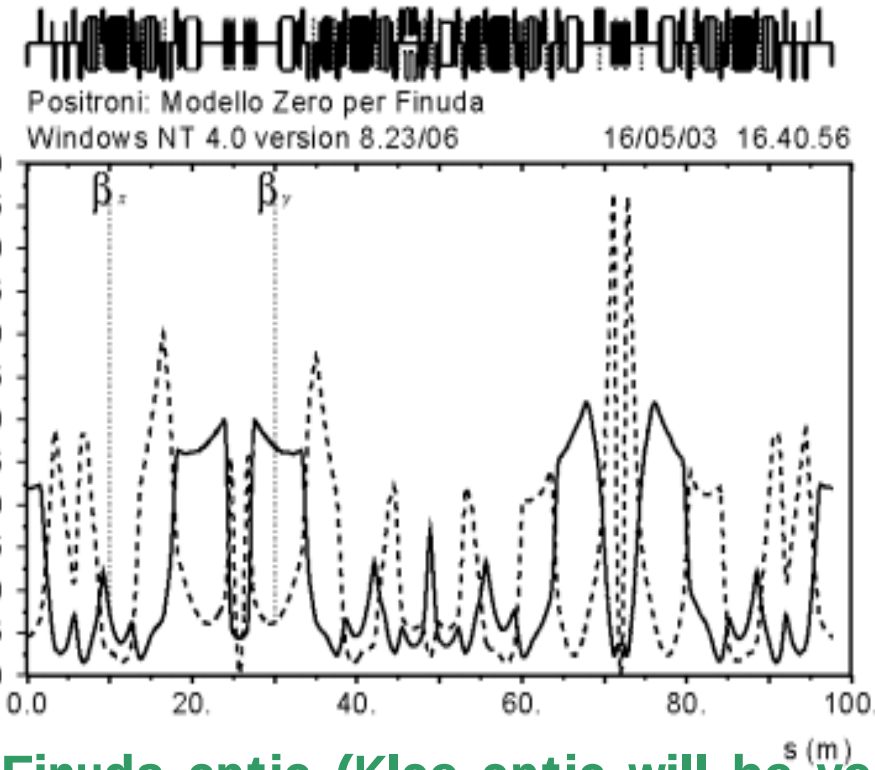
$\Delta p/p=.8\%$

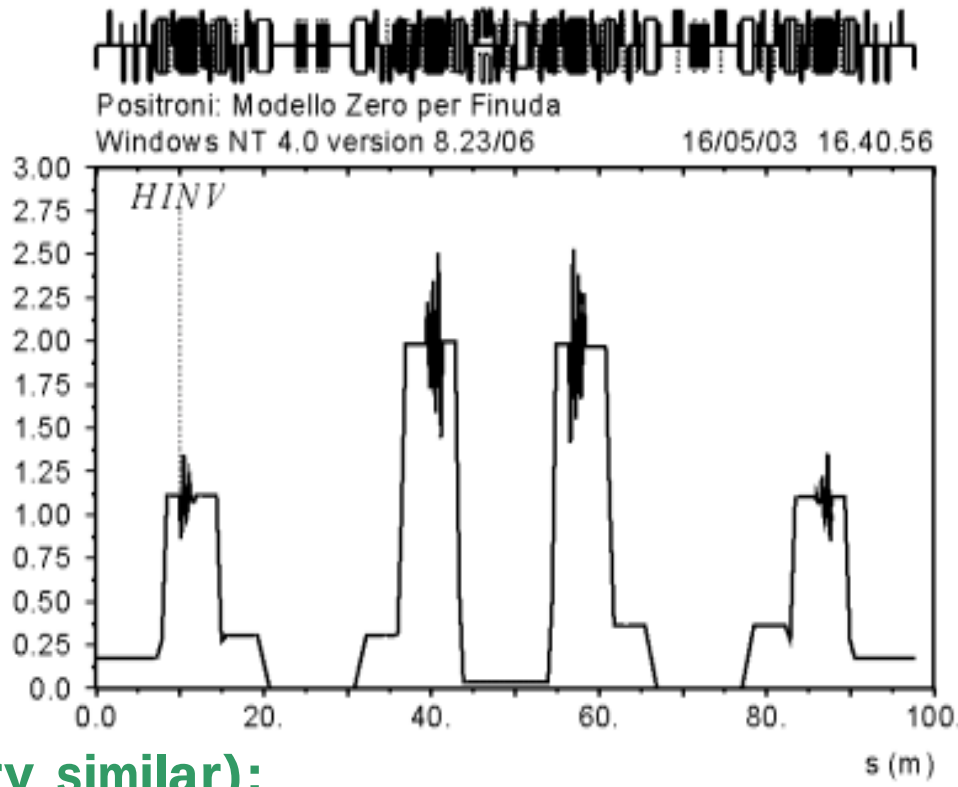
Modified wigglers





e 1-2 GeV Range , Algł





Finuda optic (Kloe optic will be very similar):

Lower emittance: 0.42μm

Lower betas in the wigglers to minimize non-linearities

IP β_x=1.7m to allow 100 bunches ops

IP β_y=27mm, just about equal to the bunch length

Additional sextupoles in the wigglers and at the septum

Phase advance between the sextupoles optimized

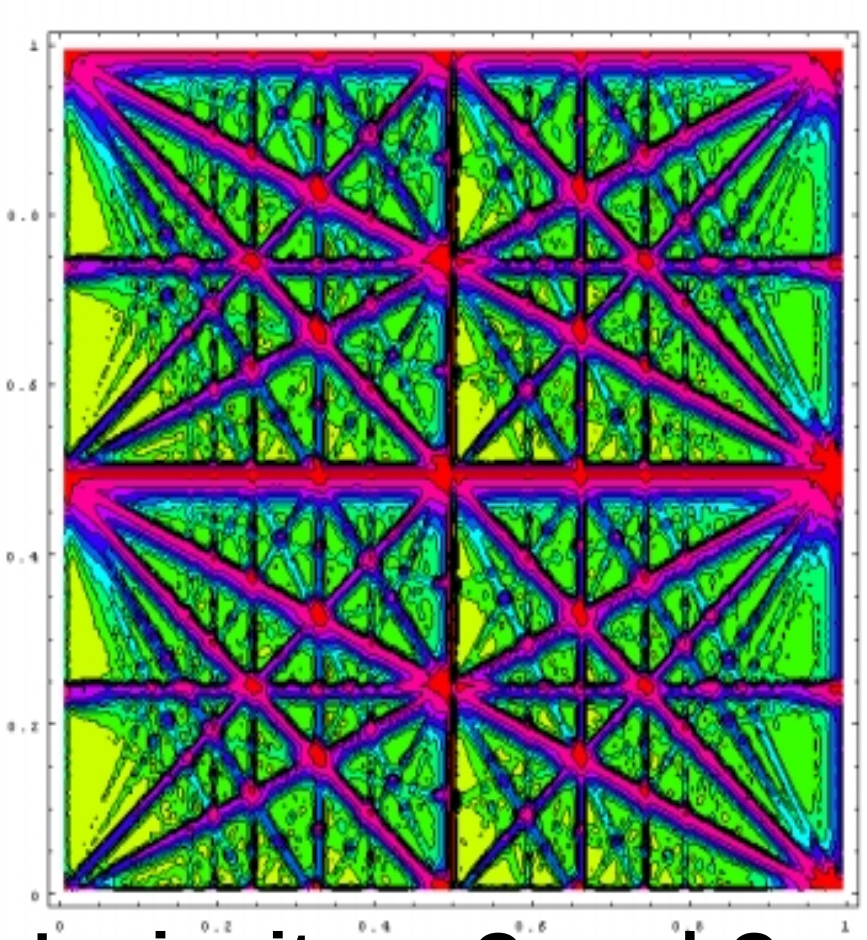
Low invariants to minimize background

Straight sections optimized for injection efficiency and dynamic aperture

Performances goals for Kloe and Finuda (what we feel we can achieve)

- 100-110 bunches collisions operations (done with DEAR)
- 2 Amps/beam (asymptotically in 2 year)
- 2e30 single bunch luminosity (at 20 mAmps)
- >1hr lifetimes (at 2 Amps and 2e32) (Improved dynamic aperture)
- $10pb^{-1}$/day, 200pb-1/month, $1.0fb^{-1}$/0.5years delivered
- Goals based on extrapolations of 2002 results and the new low betas I.R.s.

Going beyond, what we would like to play with (but don't count on it)



Luminosity vs Qx and Qy

- try to minimize the beam-beam blow-up exploring different working points much closer to the integer or half-integer (as in other factories).
- reduce the bunch length, and consequently the vertical beta function, by changing sign to the machine momentum compaction (from 25mm down to 15mm) (Zobov et al.)

Present Status

- **Hardware installation completed mid July**
- **All machine subsystems checked**
- **Commissioning of the rings with the new FINUDA optics just started (5-6 mA e+, ~1mA e- stored).**