DAFNE STATUS and PLANS

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for the DAFNE team

Scientific Committee, May-2003

2003 Dafne operations summary and plans

- New Interaction Regions installation
- Hardware modifications and upgrades
- Optics studies
- Performances expectations
- Mid and long term plans

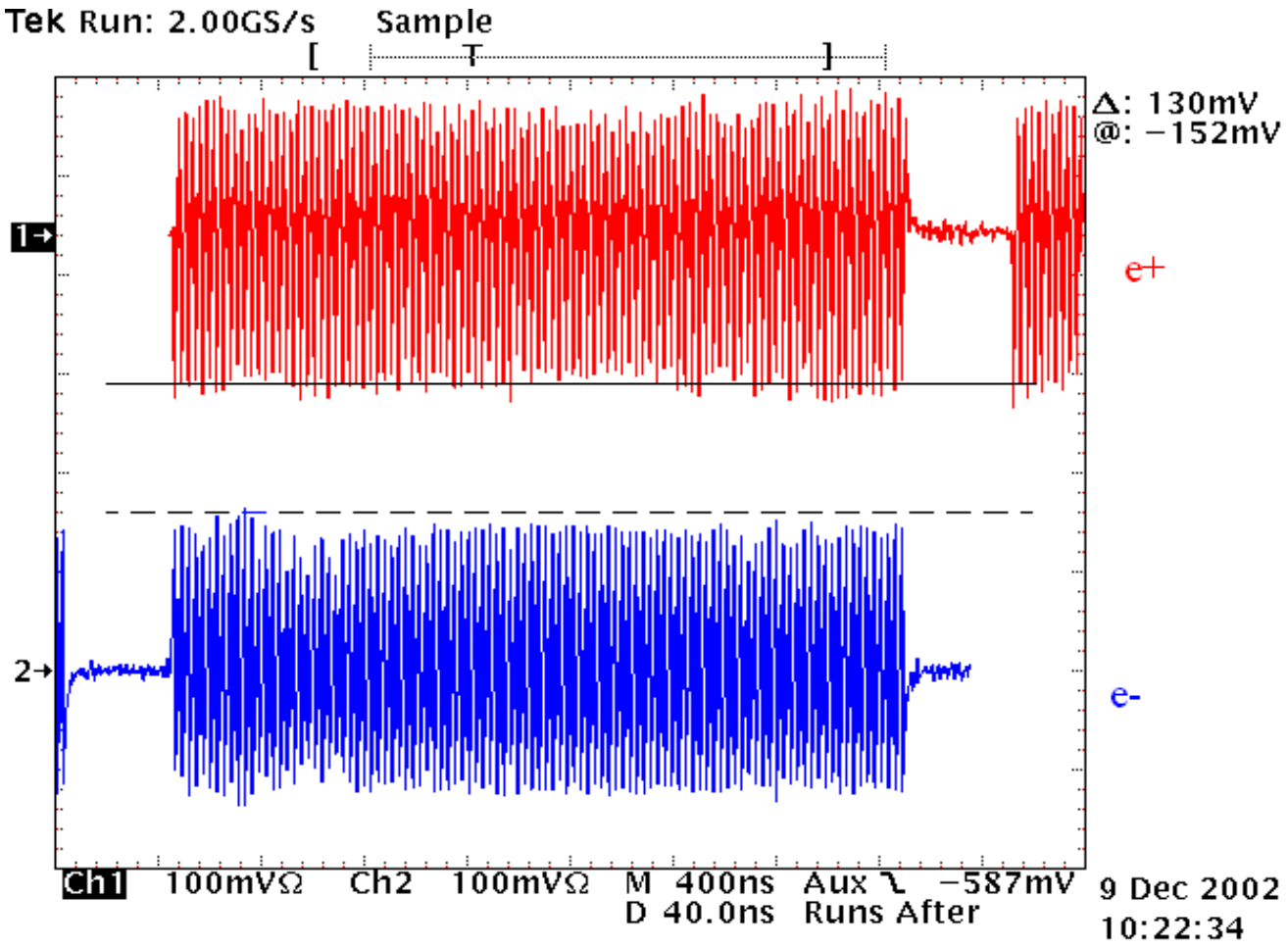
MAIN HARDWARE ACTIVITIES

- 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

- The new interaction regions for KLOE and FINUDA, have modified optic (doublet configuration) and supports in order to decrease the IP beta-functions and lattice chromaticity, optimise background rejection and 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 beta at the IP, the parasitic crossing are not critical

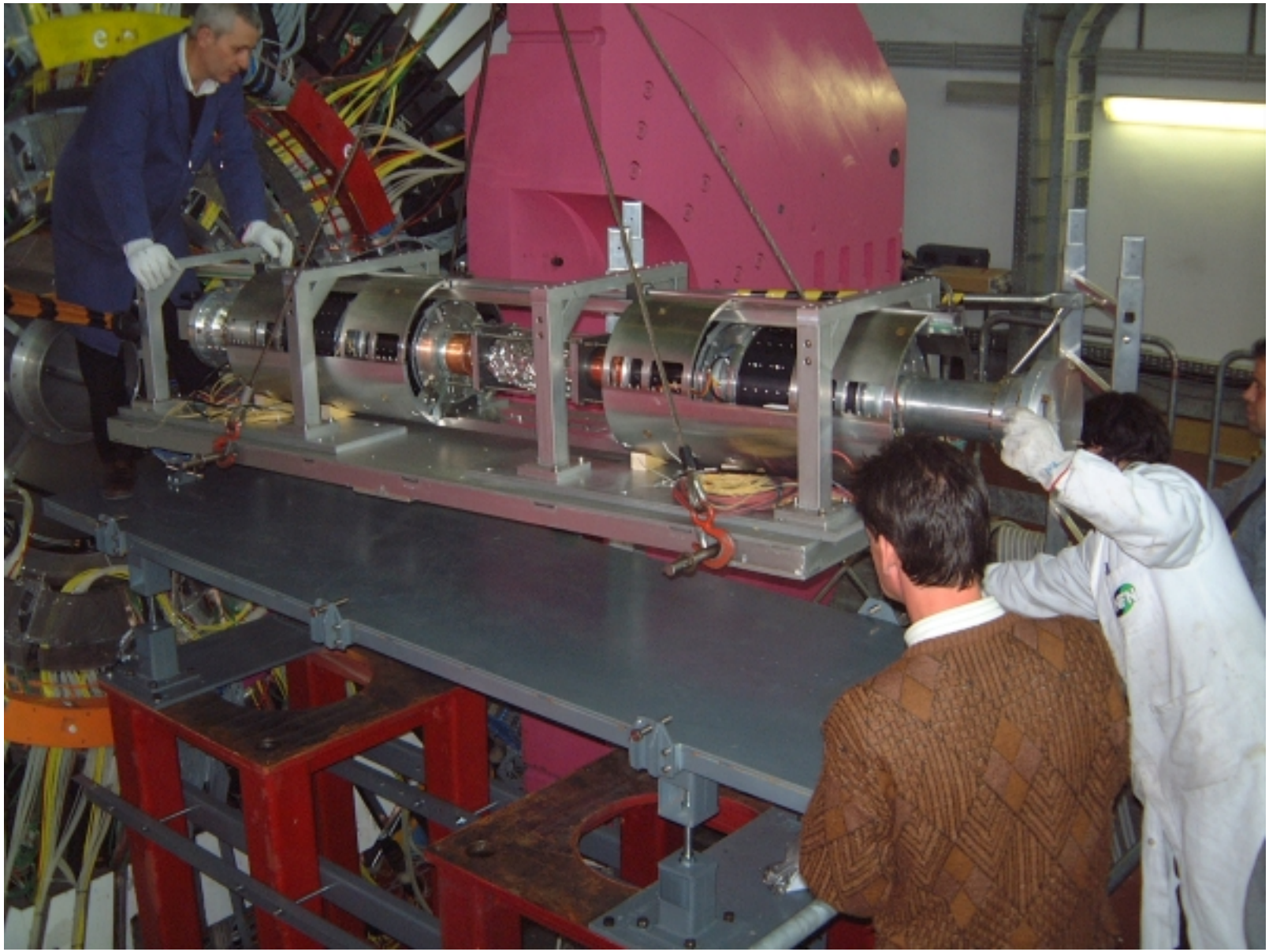
100 bunches have been successfully used for colliding in last two months shifts of 2002



e+ bunch train

e- bunch train

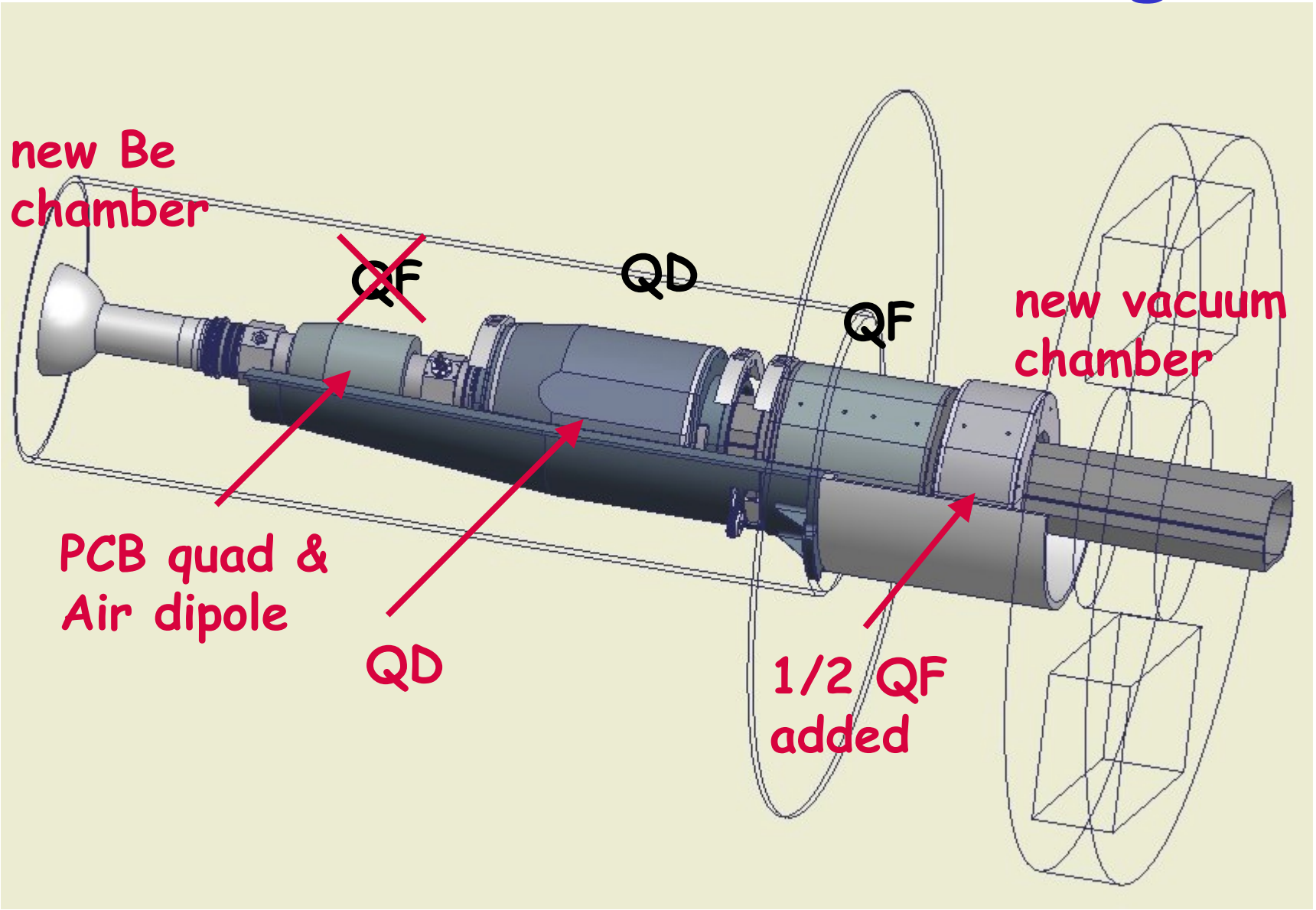
Finuda I.R. installation



Kloe old I.R. removal

Kloe I.R. installation hardware

KLOE New Interaction Region



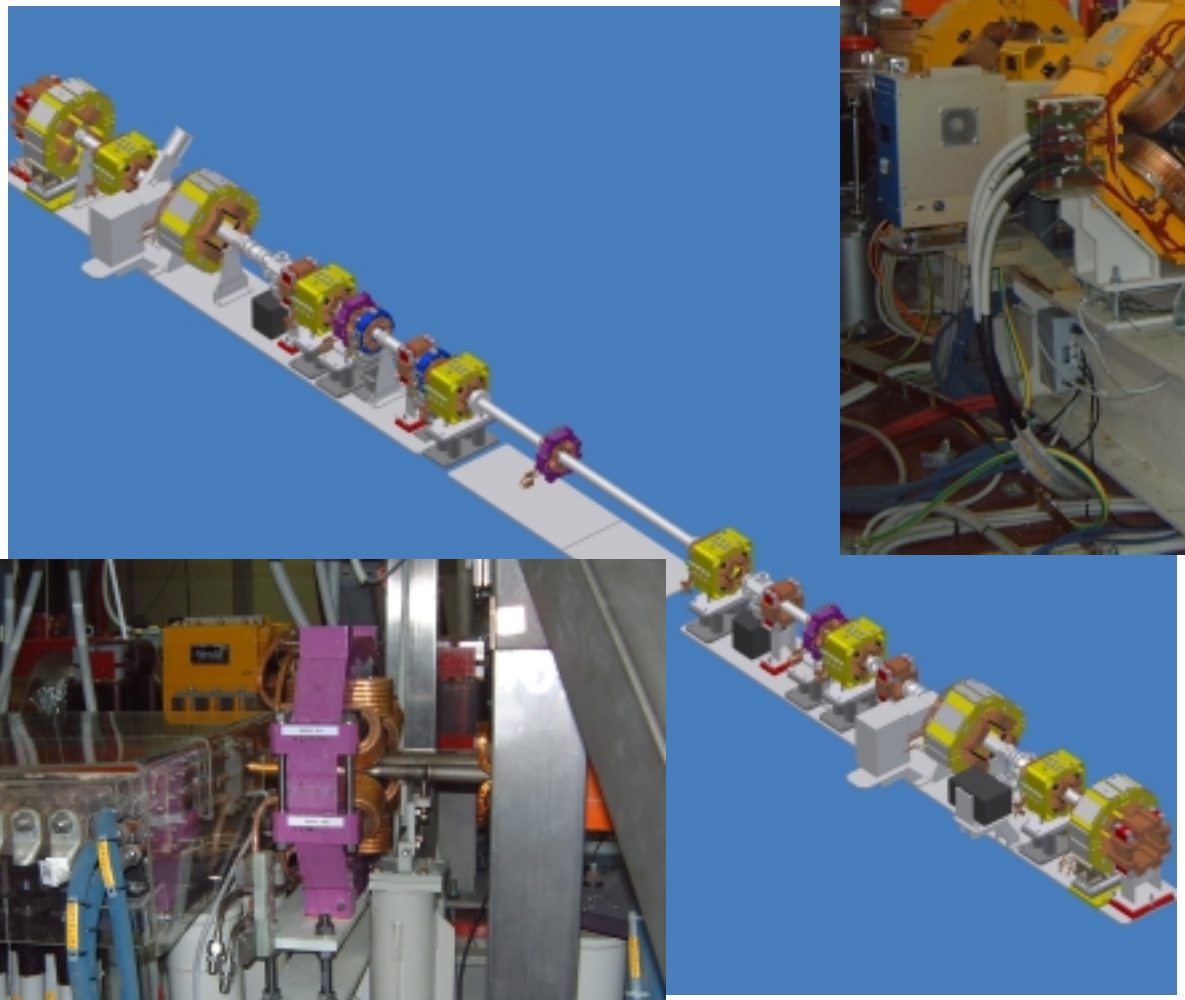
Kloe new I.R (under final assembly)

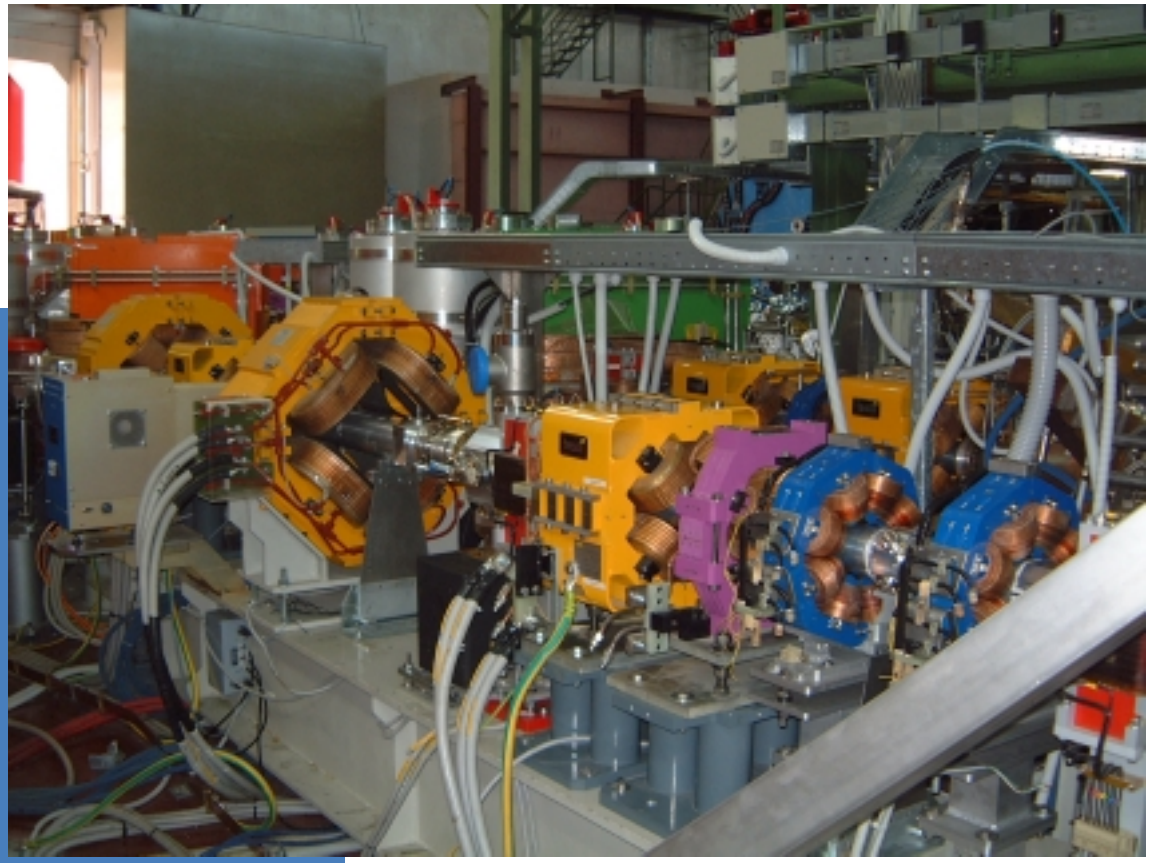
Straight Sections Modifications

The straight sections, where the beams are injected, have been modified in order to:

- Improve injection efficiency
- Decrease injection sensitivity of the stored beam (kick angle and kick duration both reduced by 50%)
- Reduce dispersion at the septum
- Optimize optic functions and phase advance in the section with respect to dynamic aperture

Straight Sections Mods





Straight Sections have been completely dismantled and rearranged

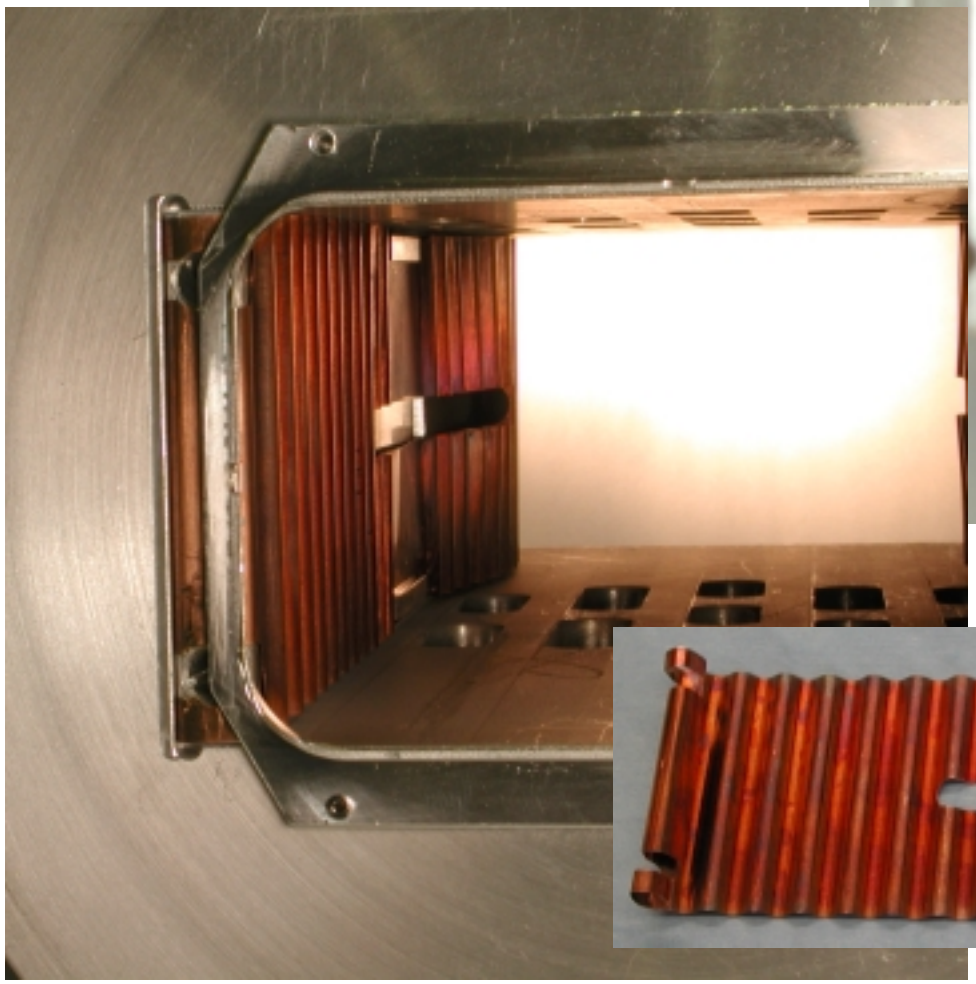
Scrapers modifications

- Overall scrapers efficiency satisfactory, but few jaws were not working properly.
- Decided to inspect them in the shutdown
- Found problems with the tapers, and decided to remove the horizontal ones, that are the least critical to the ring impedance (Spataro,Zobov), and to modify the vertical ones, that were intercepting the beam instead of the jaws

Horizontal Scrapers modifications

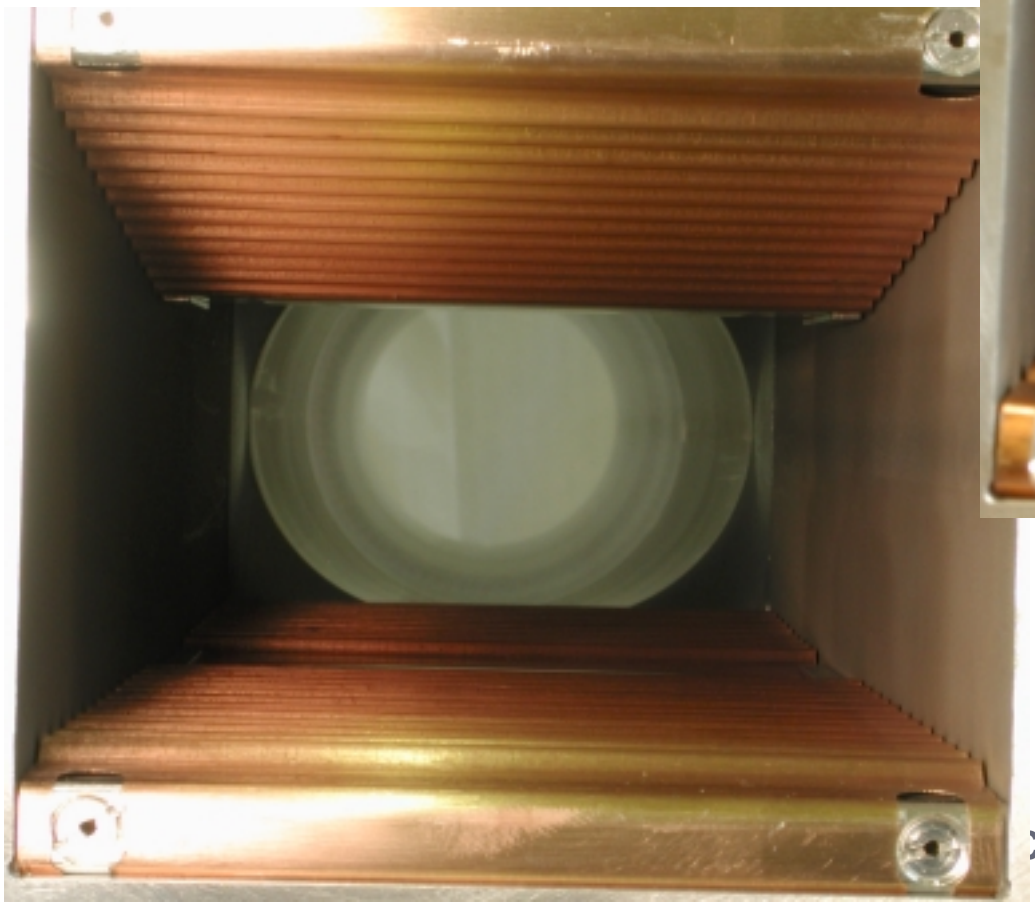
After tapering sheet removal

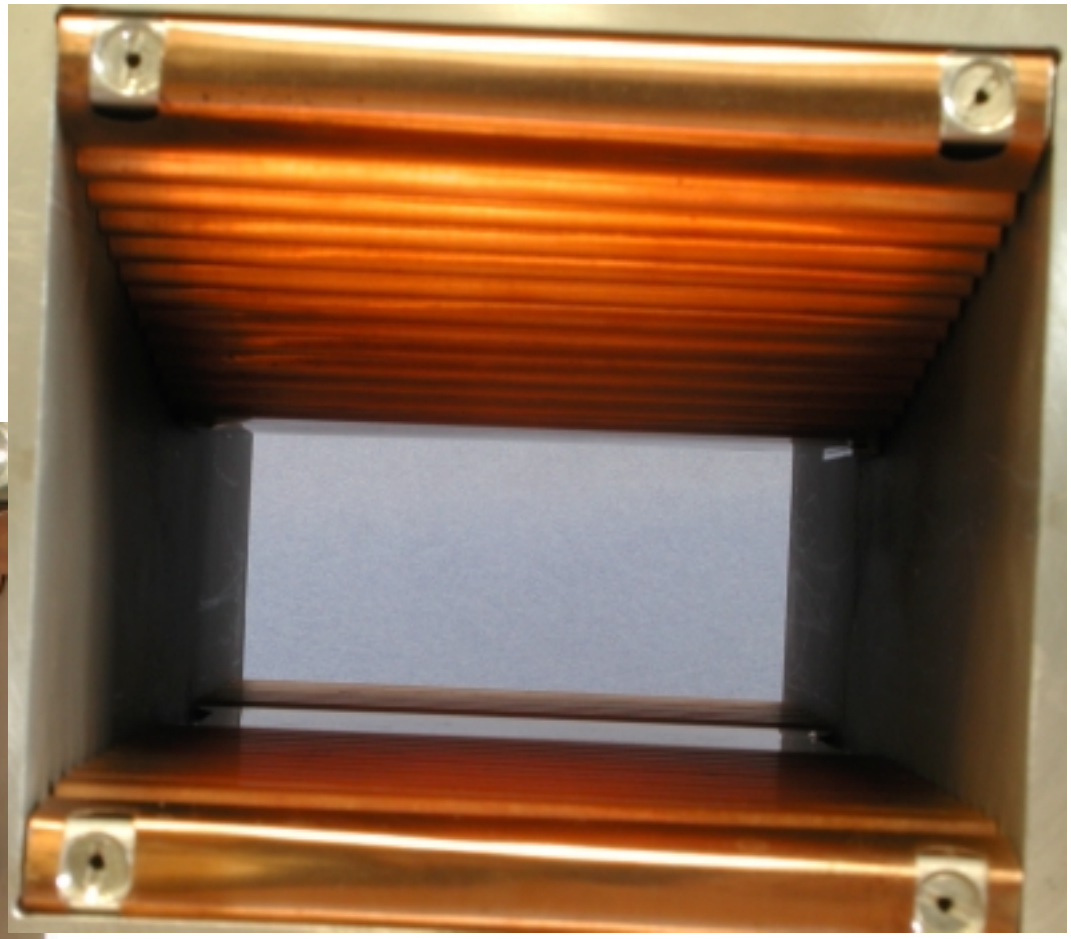
As found



Vertical scrapers modifications

As found

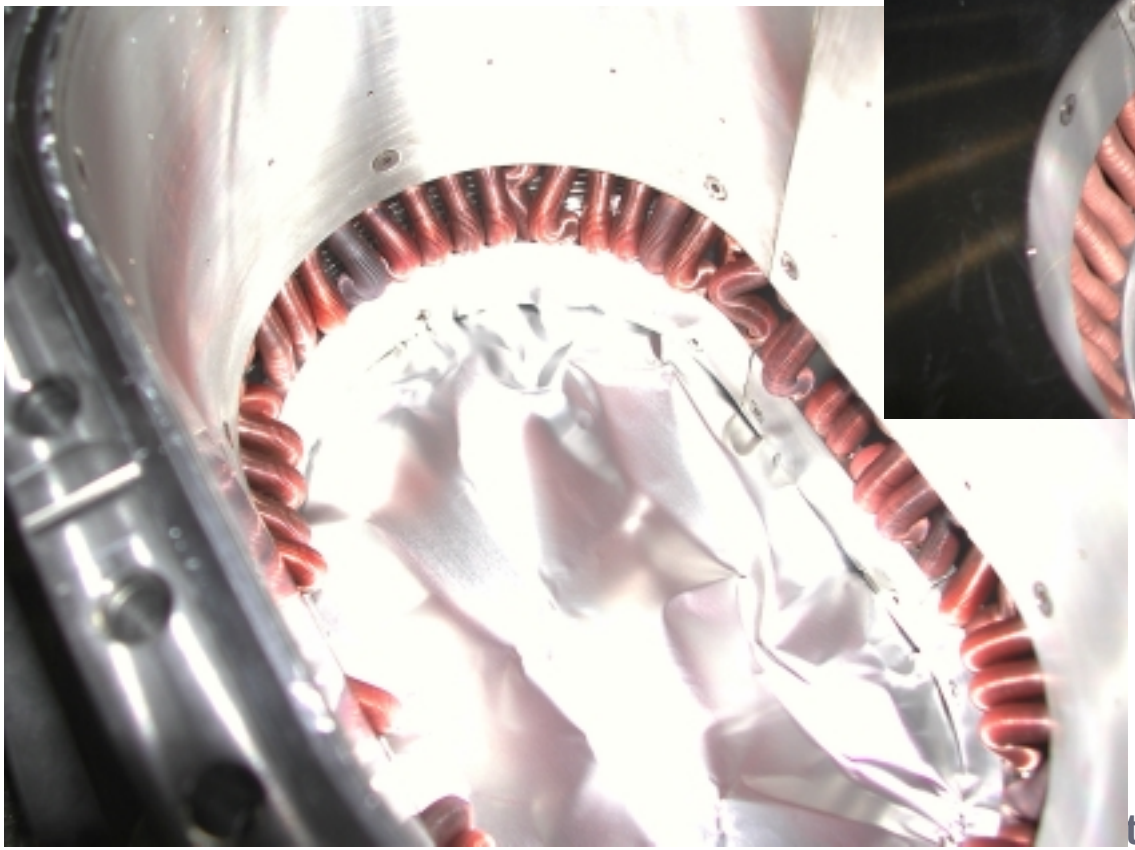


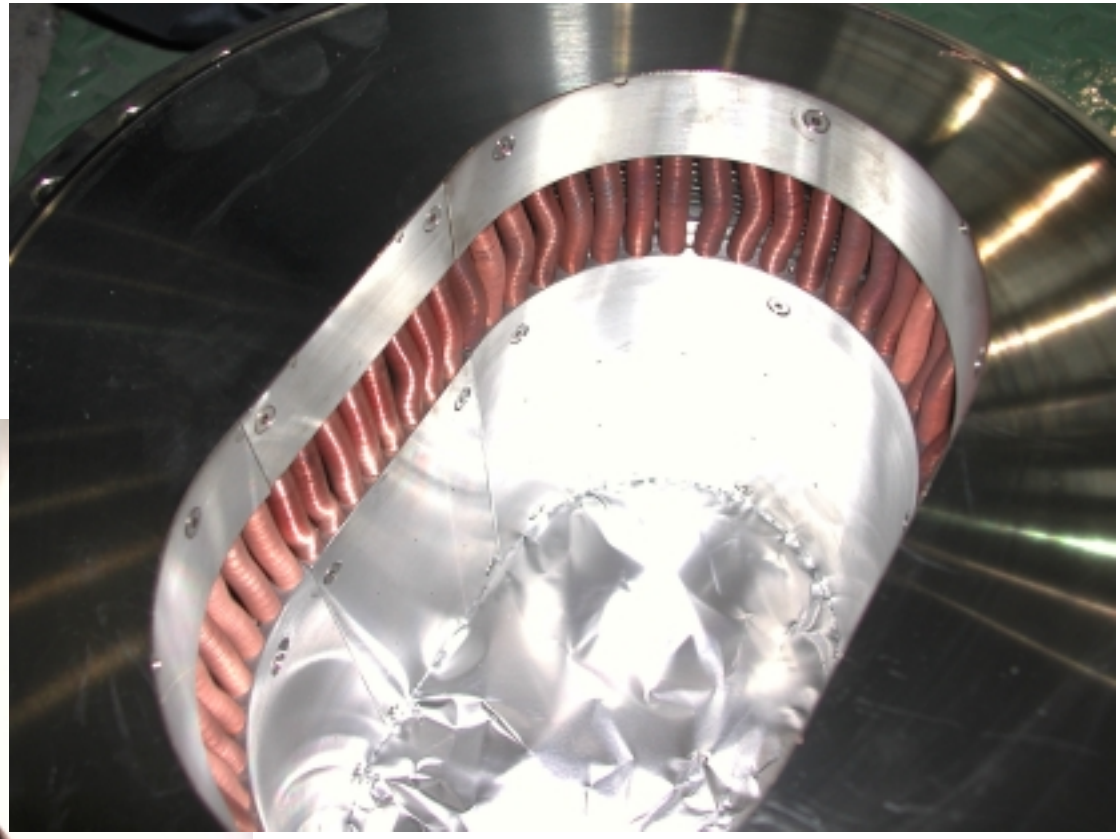


After tapering sheets modifications

Bellows Modifications

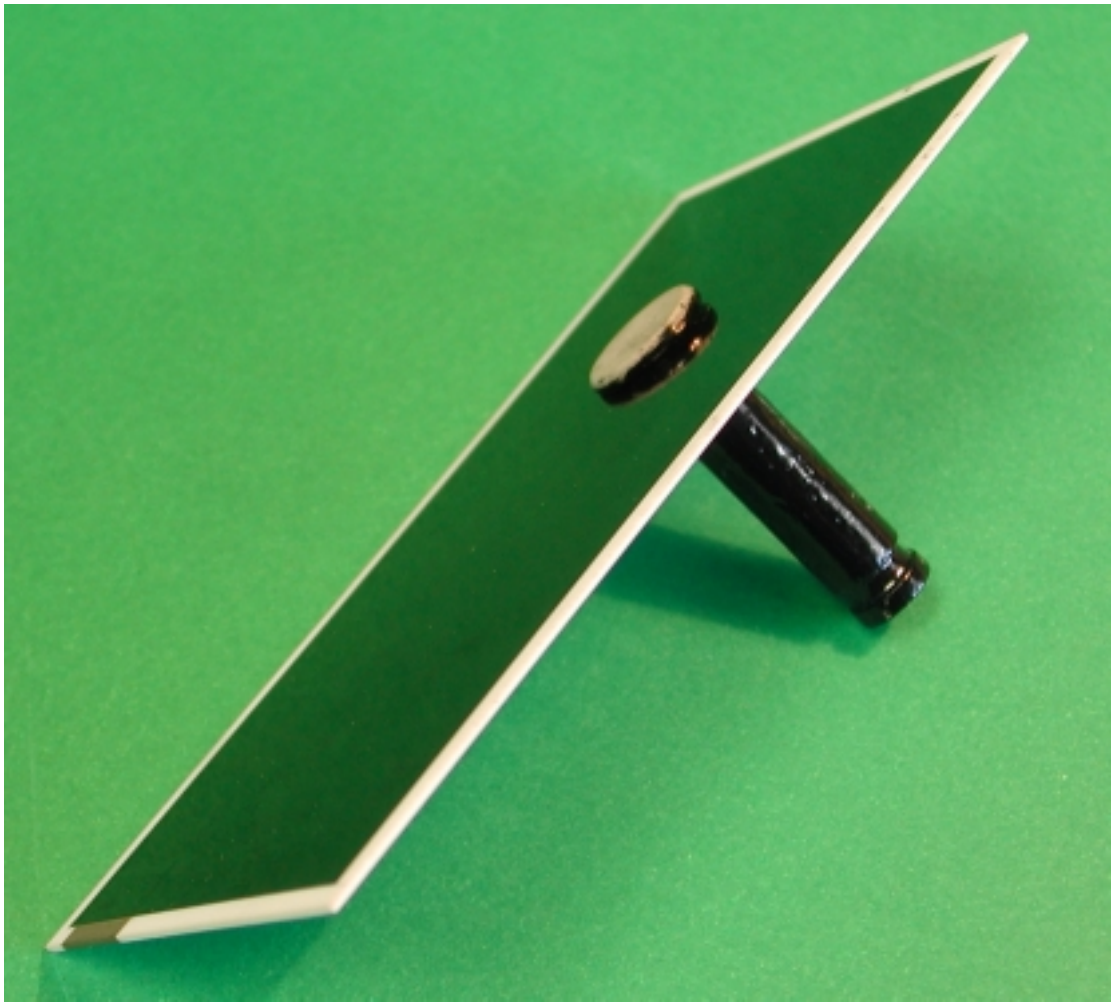
As found





After insertions of pins to straighten the copper bellows

New Ion Clearing Electrodes

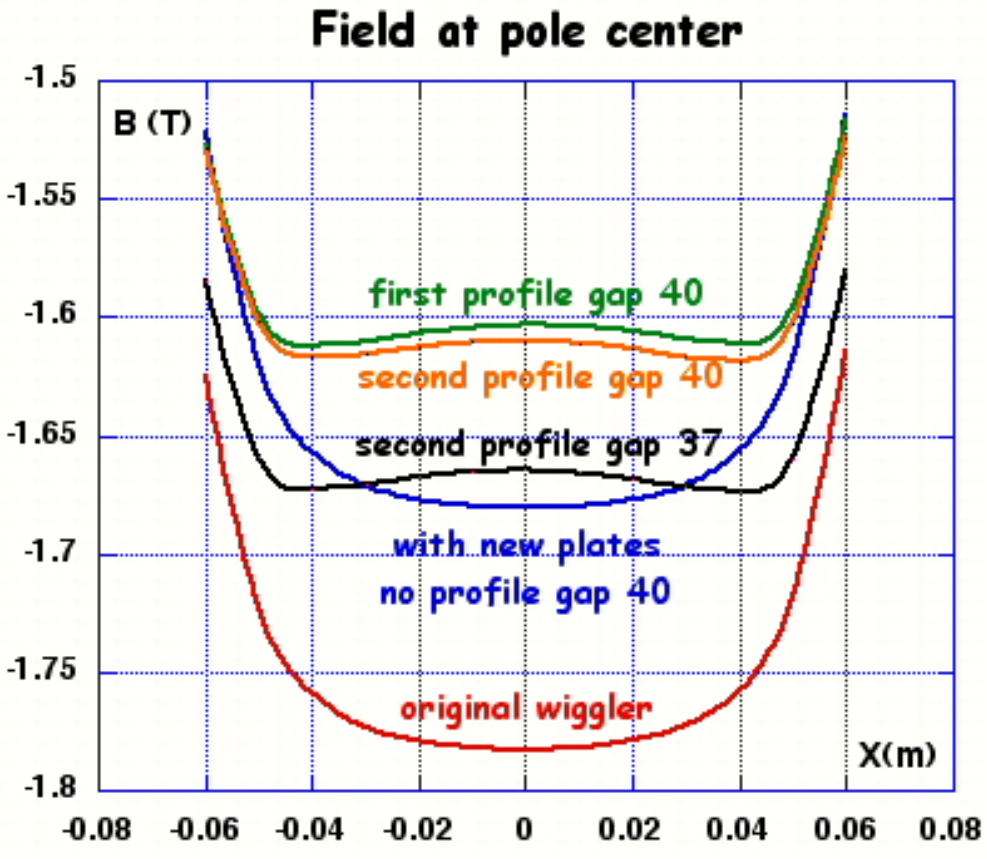


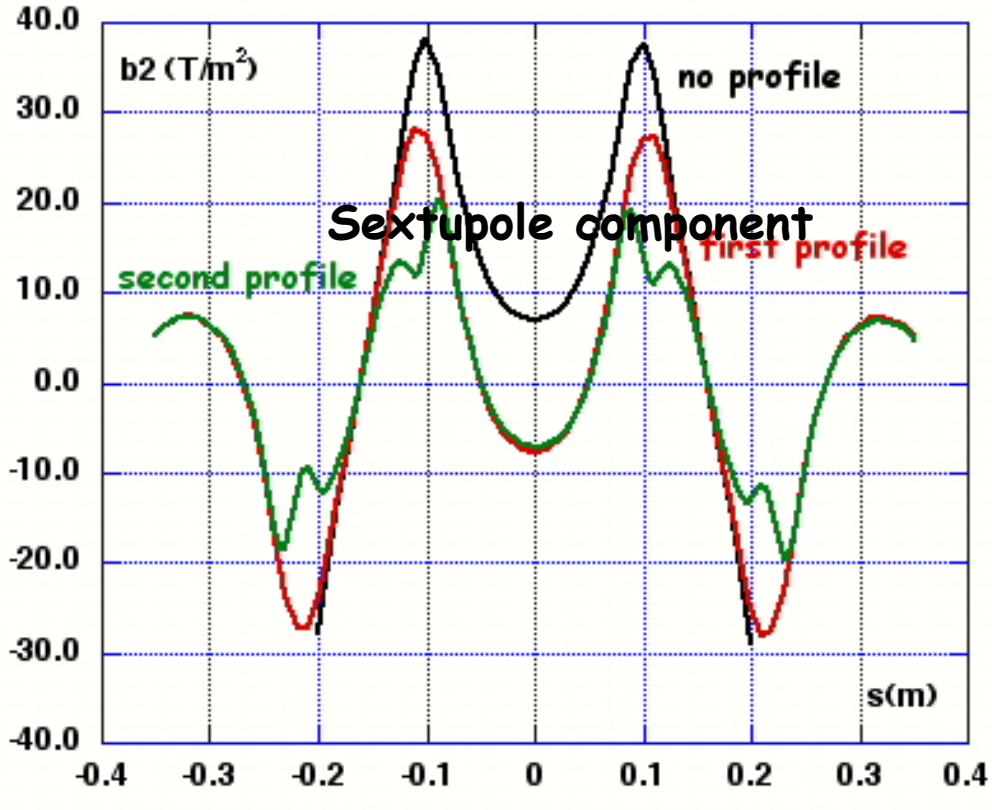
About 50% of ICE broken due to faulty welding.
Most of the ICE replaced with welding-free electrodes

Wigglers modifications

- A new wiggler (arrived at the lab. beginning 2003) has been used to map the magnetic field and to study the pole modifications in order to improve the field quality.
- Final profile defined, Dafne wigglers will be modified accordingly, from June-1 to June-20.
- According to tracking, the dynamic aperture and lifetimes should more than double.

Wiggler field modifications

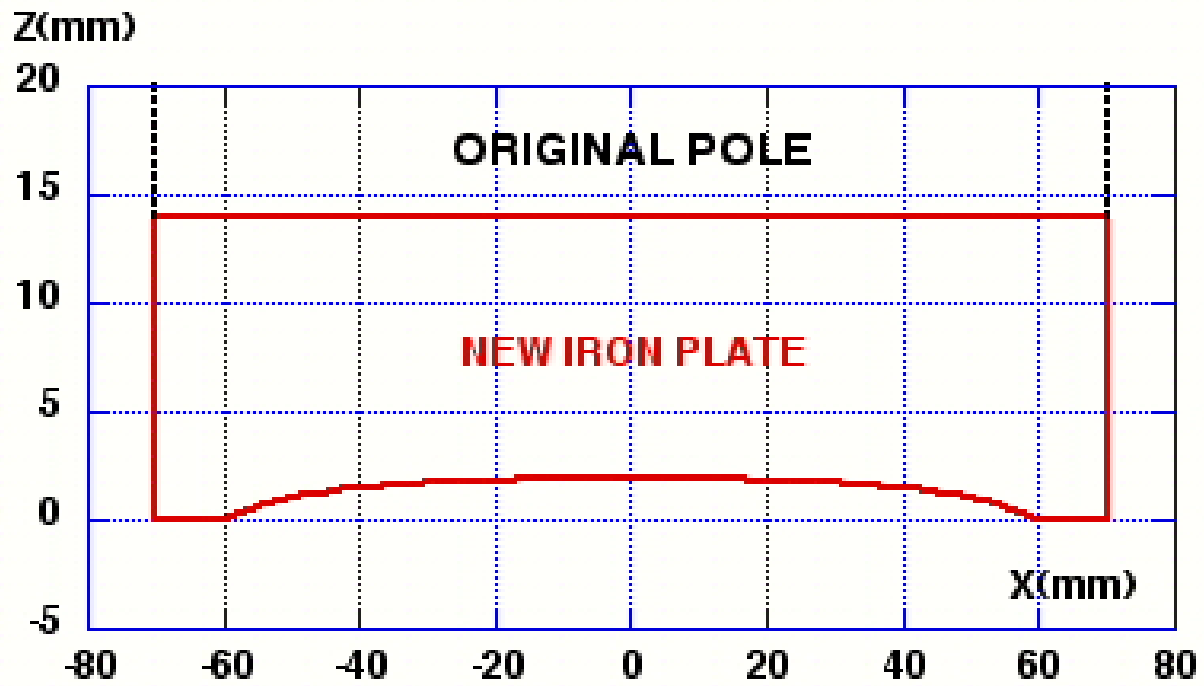




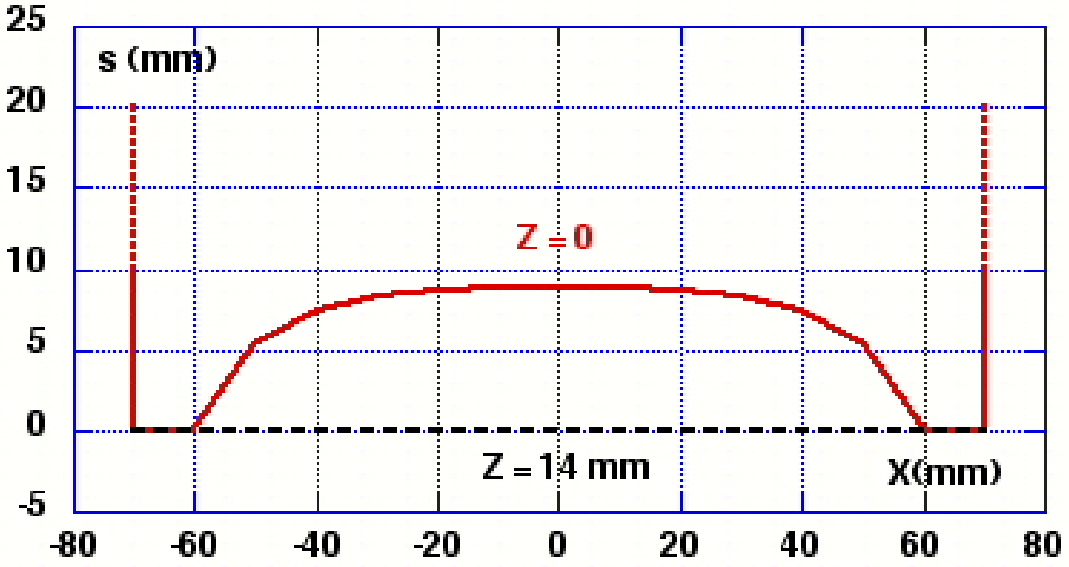
Reduction of the dynamic aperture due to:

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

Wigglers poles modifications

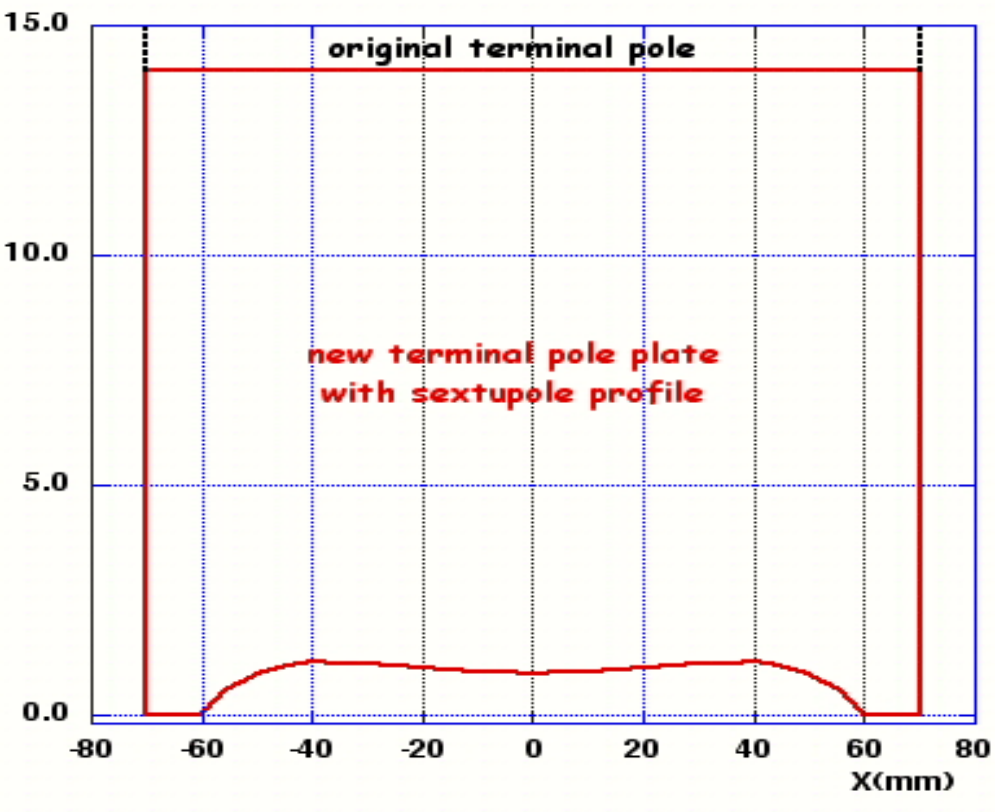


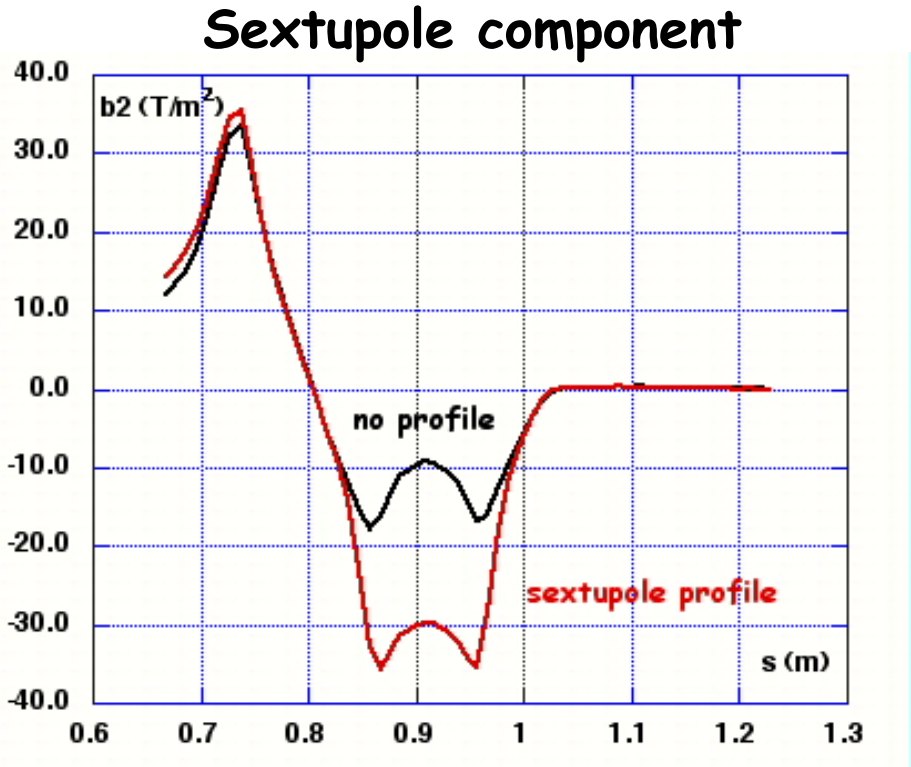
Longitudinal poles modifications



Vertical poles modifications

Terminal Pole Modifications

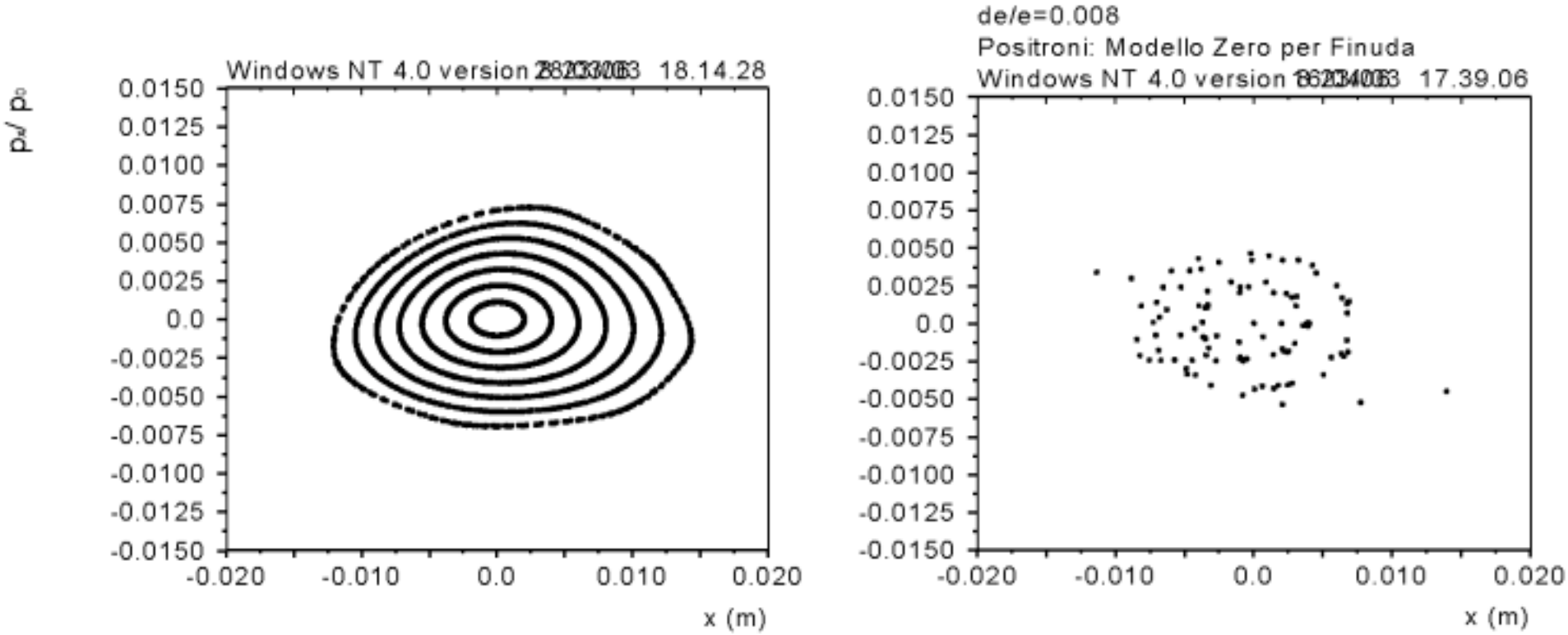




One of the two terminal pole has been modified in order to INCREASE its sextupole component. This operation is beneficial to the dynamic aperture, at least as the reduction of the main poles non-linearities

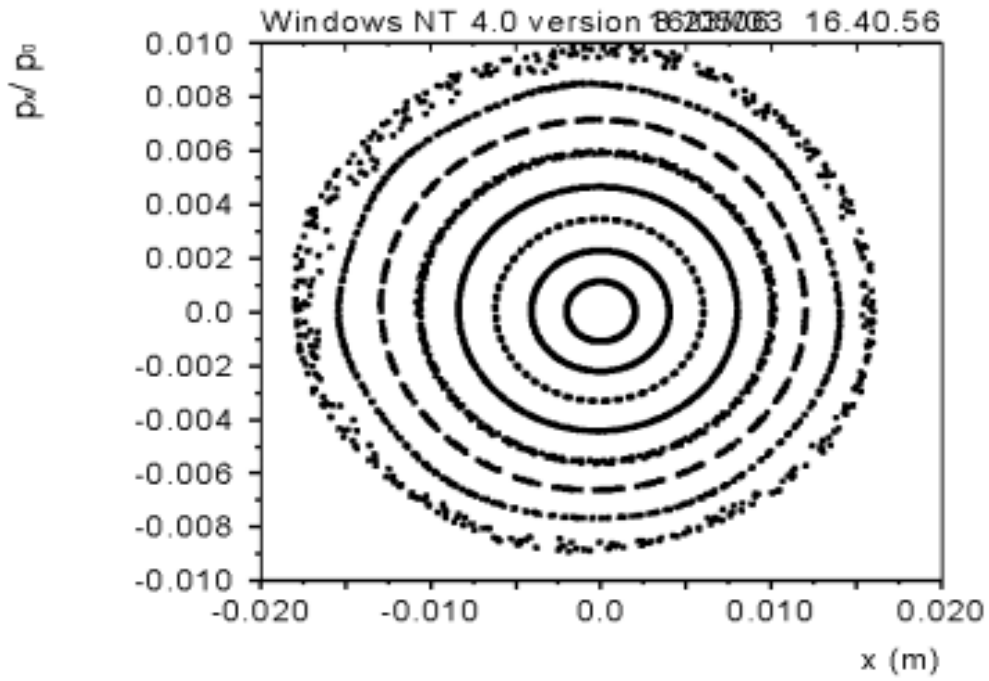
Scientific Committee, May-2003

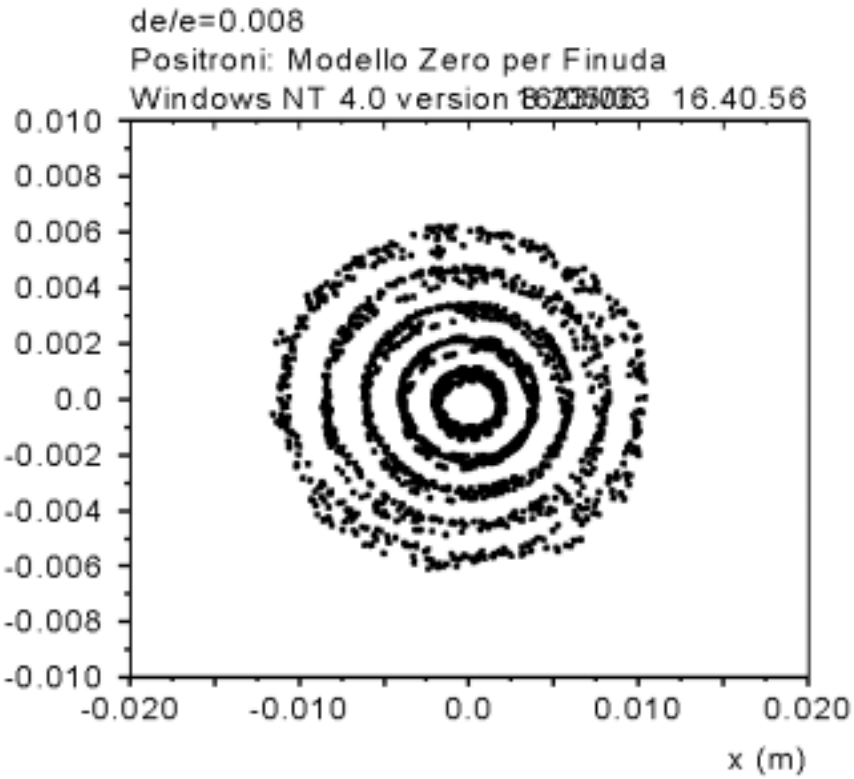
Horizontal dynamic aperture with original wigglers



Each ring is a 2-sigma contour in the horizontal phase space for on energy and off energy (0.8%) beam

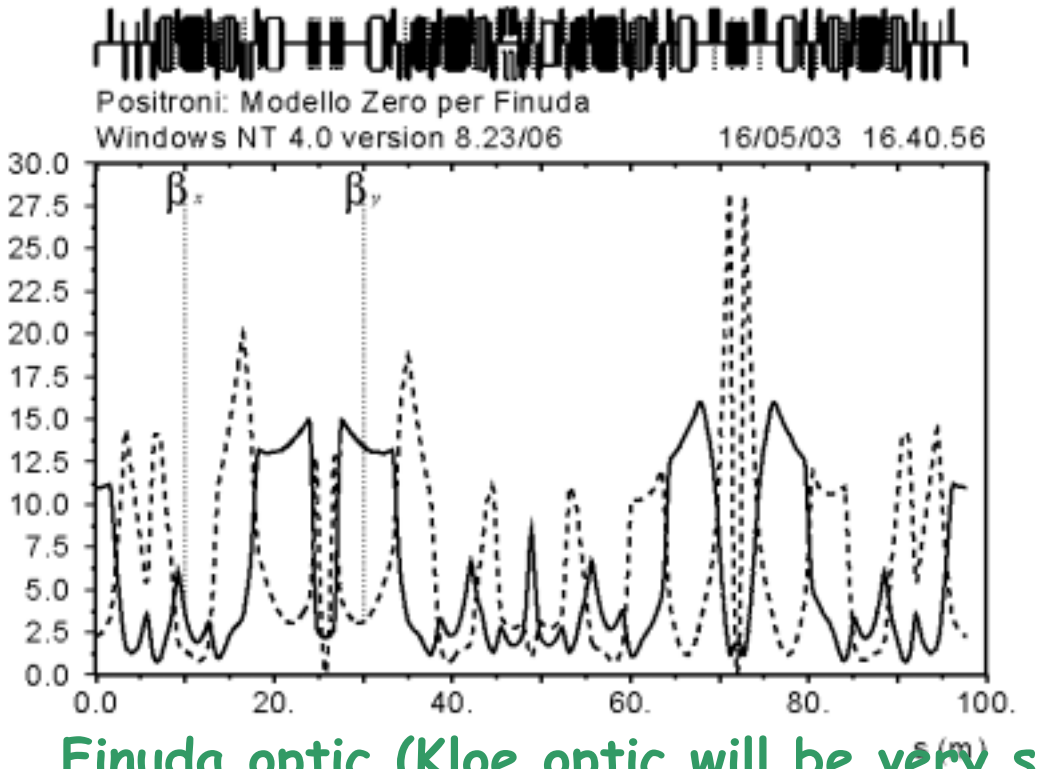
Horizontal dynamic aperture with modified wigglers

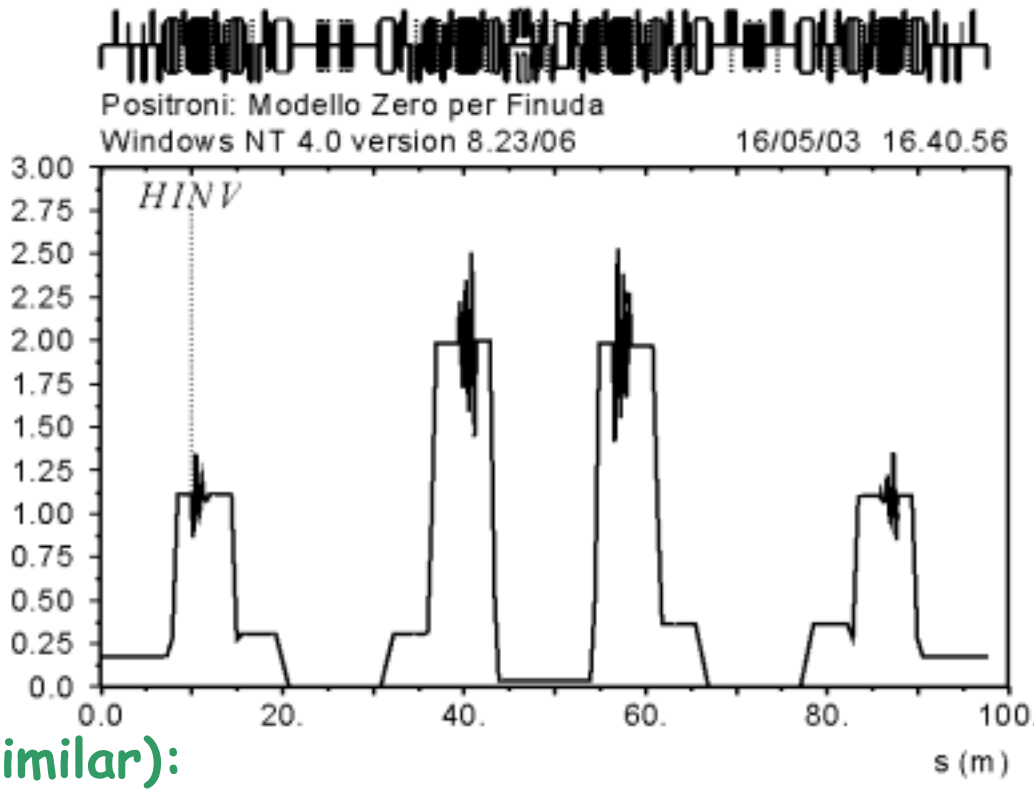




On Energy improvement mainly due to sextupole added on the end-pole.

Off energy benefits from better central poles and end-pole sextupole (Reduction of the aperture is only due to the residual wiggler non-linearities)





Finuda optic (Kloe optic will be very similar):

Lower emittance: 0.42um

Lower betas in the wigglers to minimize non-linearities

IP betax=1.7m (or less if necessary) to allow 100 bunches ops

IP betay=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

Predicted Lifetimes>3hrs at 2e30 single bunch luminosity (20mAmps)

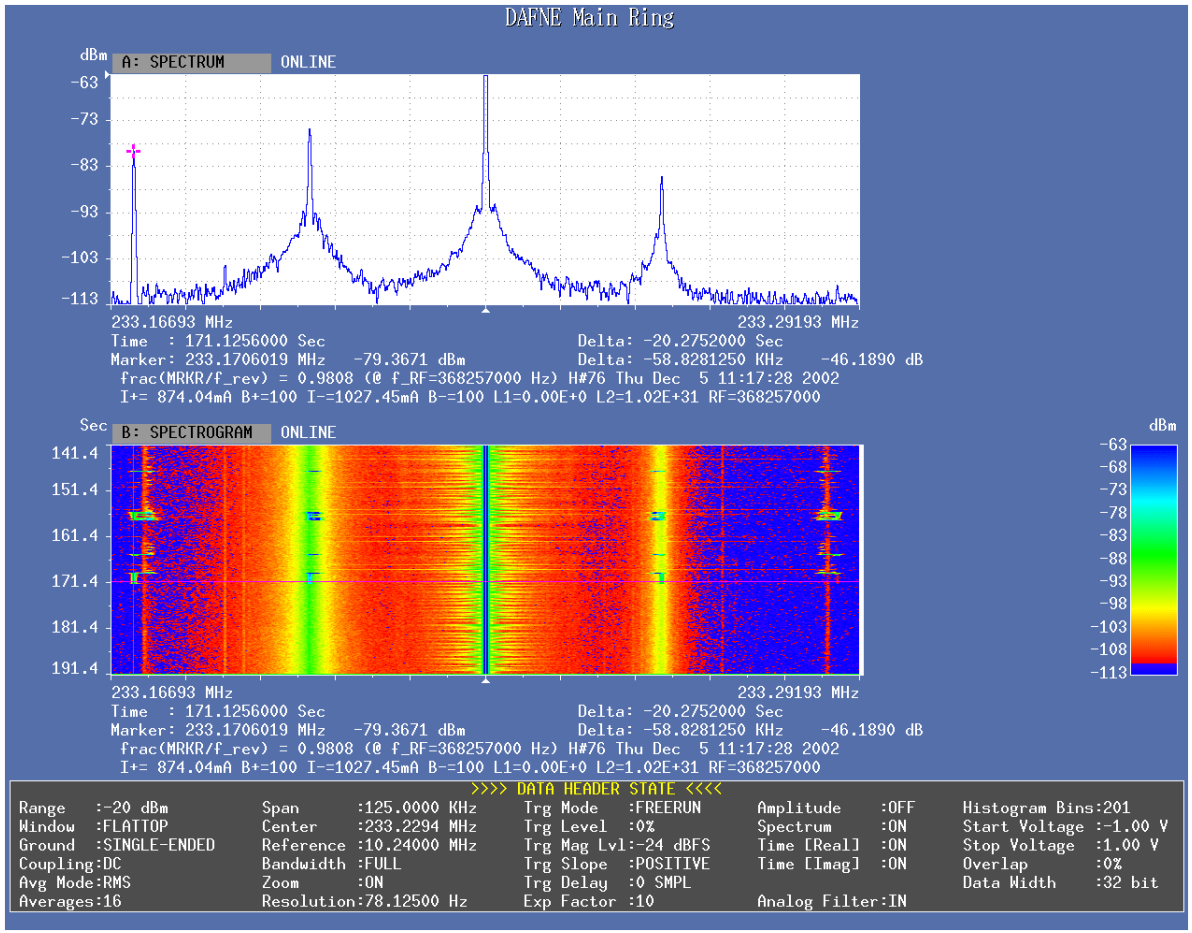
Additional upgrades and modifications

- 3rd harmonic RF cavity added to add bunch-length tunability and RF energy acceptance.
- Increased horizontal feedback power (will become like the vertical one).
- Removed one kicker per ring (2 kickers/ring remain), removed two valves and two bellows in each I.R. to further reduce ring impedance.
- Found (in the last days of the DEAR run) the cause of the e- current limit, due to a faulty kicker.
- Found a faulty Power Supply and Bend coil, responsible of the positron horizontal instability

Upgrades and modifications (cont)

- New cameras for the Synchrotron Light Monitor for better emittance diagnostic
- New electronics for the transfer line Beam Position Monitors to read and optimize the transmission in non-invasive mode
- 50 Hz linac operation in order to inject positrons at 2 Hz (electron injection at 2Hz since last July)
- New (custom) helium transfer lines to cool the solenoidal compensators with the existing crio-plant

Longitudinal Quadrupole Instability



- During 2002 deeper knowledge of the phenomenon
- It appears in both 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

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, with present working point, with a linear extrapolation of the obtained results)
- >1hr lifetimes (at 2 Amps and 2e32) (MAD tracking code predicts >3hrs)
- 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. All other upgrades are meant just as safety margins.

OBTAINED PERFORMANCES WITH KLOE

• Number of bunches per beam	49 + 49
• Total current per beam e-/e+(A)	≈ 0.8/1.1
• Peak luminosity ($cm^{-2}s^{-1}$)	0.8×10^{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

GOAL PERFORMANCES WITH KLOE & FINUDA

• Number of bunches per beam	110 + 110
• Total current per beam e-/e+(A)	≈ 2.0/2.0
• Peak luminosity ($cm^{-2}s^{-1}$)	2.0×10^{32}
• Delivered luminosity per day (pb^{-1})	10
• Luminosity lifetime (h)	≈ 1.2
• Number of fillings per hour	≈ 1.5
• Injection frequency e-/e+ (Hz)	2/2
• Data acquisition during injection	on

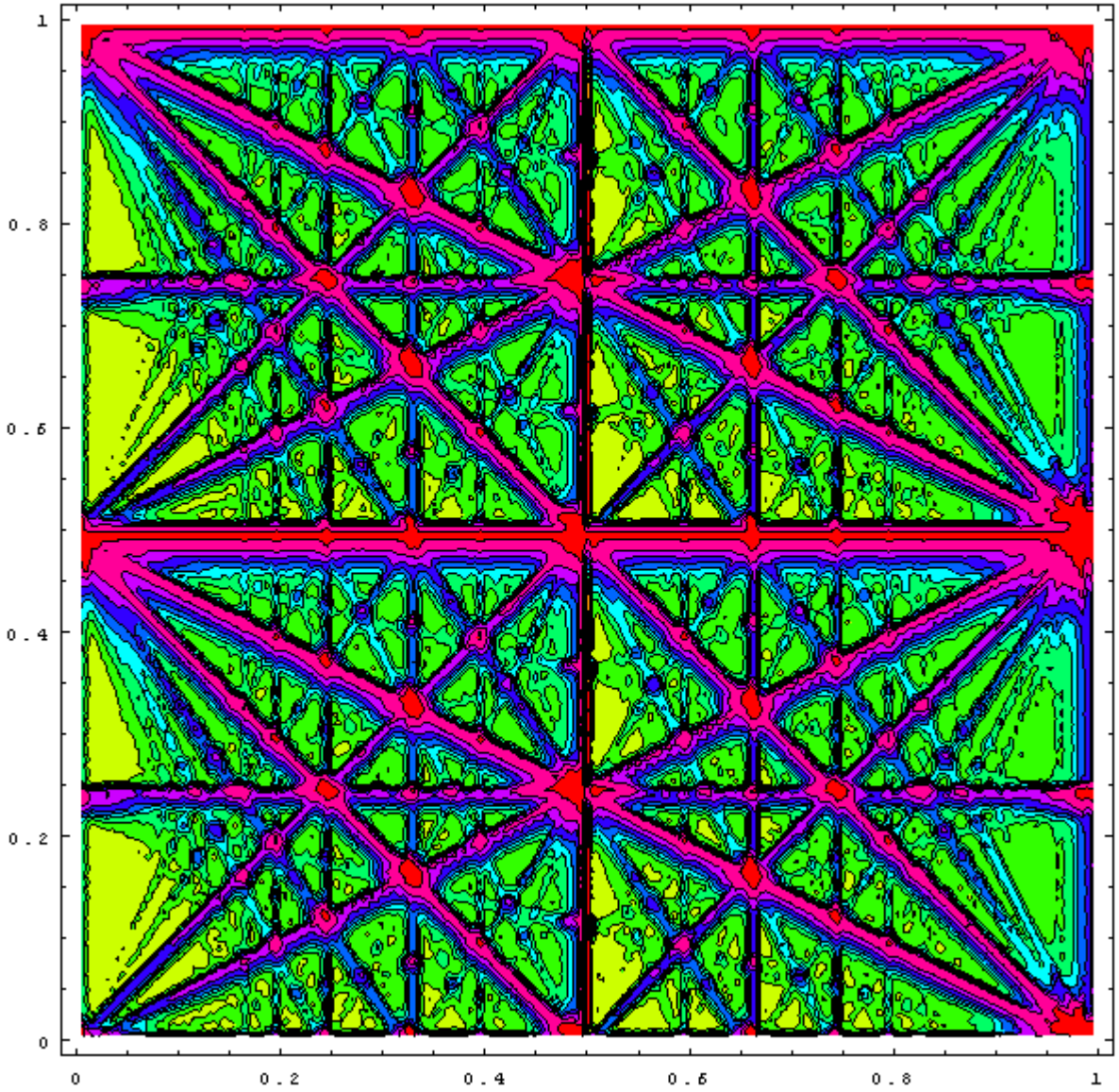
Going beyond, what we would like to play with (but don't count on it)

- In order to try to further improve the specific luminosity, a possibility is to try to minimize the beam blow-up due to beam-beam effects.
- The first possibility is to explore different working points much closer to the integer or half-integer, were the predictions show almost no-blow-up. Such working points have been adopted by all the other factories.
- Second possibility is to 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.)

Going beyond (cont)

- For all these points it is essential to reach the predicted dynamic aperture, that is strongly affected by the non-linearities in the near-integer tune space.
- Moreover in a non blow-up regime, the lifetimes are consequently smaller
- If the machine can operate in such areas, a further factor two is predicted by tracking codes, and an additional factor two if the bunch can be shortened
- We do not expect such order of magnitude of improvements, but we do have clear theoretical and experimental (from kek/pep) indications that this could be a very promising approach to higher luminosities

Luminosity vs Qx and Qy



Dafne working points:
e- 0.11/0.15 (Qx/Qy)
e+ 0.15/0.21 =>
L~2e30 (achieved and predicted)

Kek working points:
e- 0.52/0.56
e+ 0.52/0.59

Possible new Dafne working points around 0.06/0.14 =>
L>4e30
and if sigma_z<15mm with alfac<0 =>
L>6e30

2003-Spring 2005 PLAN (DRAFT)

- Complete the hardware installation by June-30
- Fix the new hardware failures, commission the new rings FINUDA optics and simultaneously do vacuum conditioning in the first three weeks.
- Use preliminary low-luminosity collisions to test the FINUDA detector during the same period.
- FINUDA data taking for next two weeks, until August shutdown (1-2 weeks). Goal: Deliver ~20 pb^{-1} for preliminary FINUDA analysis
- Switch to KLOE run (for at least 2 months), if FINUDA needs time to digest DATA and DETECTOR
- FINUDA data taking for 2 months (or more if luminosity is low).
  Goal: Deliver > 250 pb^{-1}
- IF the FINUDA phase-1 program is completed, the detector could be rolled out in about one week, to easy the installation of the new targets into the detector and allow the single-low-beta optics for the rings, much more suitable for best KLOE performances
- KLOE data taking for the following 12 (-2) months. Goal: Deliver > 2 fb^{-1}
- Roll-in Finuda for the phase-2, run for 3 months
- Roll-out Finuda and install DEAR-2 (~3 months running)

Many many thanks to all the Accelerator Division and in particular to the engineers and the technicians for the great work performed during the shutdown