DAΦNE Operation with the FINUDA experiment

Catia Milardi

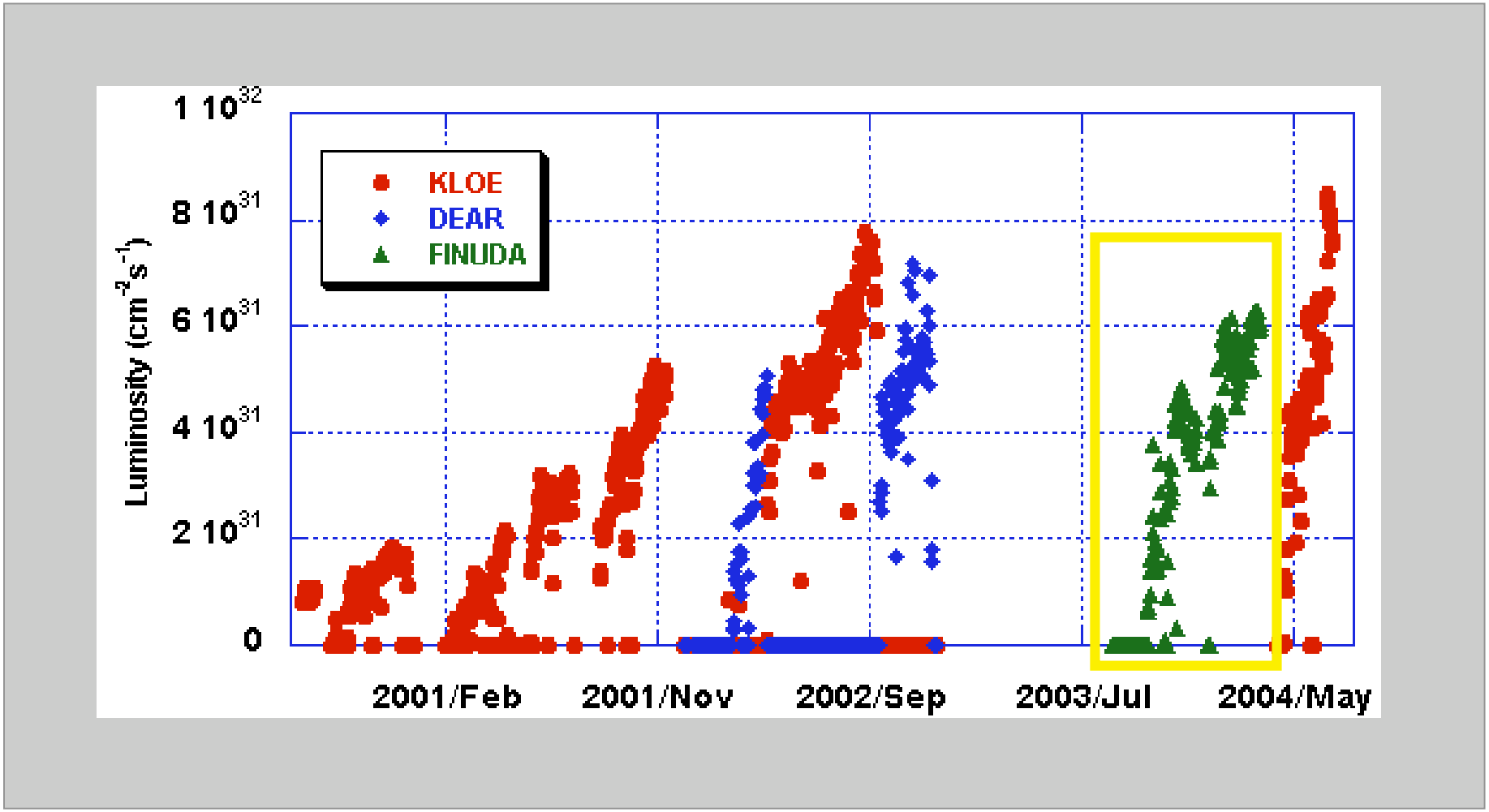
on behalf of the DAΦNE Team

9th European Particle Accelerator Conference, July 5 - 9, 2004 Lucerne

DAΦNE Team

D. Alesini, G. Benedetti, M.E. Biagini, C. Biscari,
R. Boni, M. Boscolo, A. Clozza, G. Delle Monache,
G. Di Pirro, A. Drago, A. Gallo, A. Ghigo, S. Guiducci,
M. Incurvati, C. Ligi, F. Marcellini, G. Mazzitelli,
C. Milardi, L. Pellegrino, M.A. Preger, P. Raimondi,
R. Ricci, U. Rotundo, C. Sanelli, M. Serio, F. Sgamma,
B. Spataro, A. Stecchi, A. Stella, C. Vaccarezza,
M. Vescovi, M. Zobov.

$\mathcal{L}$ FINUDA runs Oct 14th 2003 ÷ March 25th 2004



Outline

- DAΦNE & FINUDA
- 2003 shutdown
- 2003 ÷ 2004 FINUDA run results
- Present activity & achievements

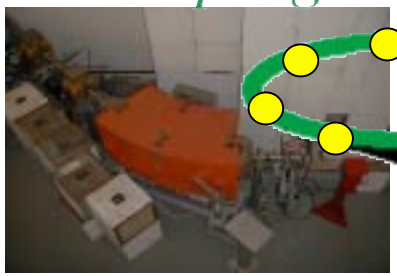
DAΦNE

e^+e^-

$C = 97$ m

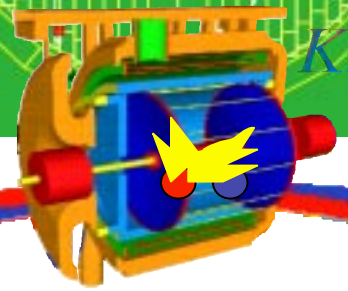
$E = 0.51$ GeV (Φ)

Damping ring



Test beam

Main rings



DAFNE-Light

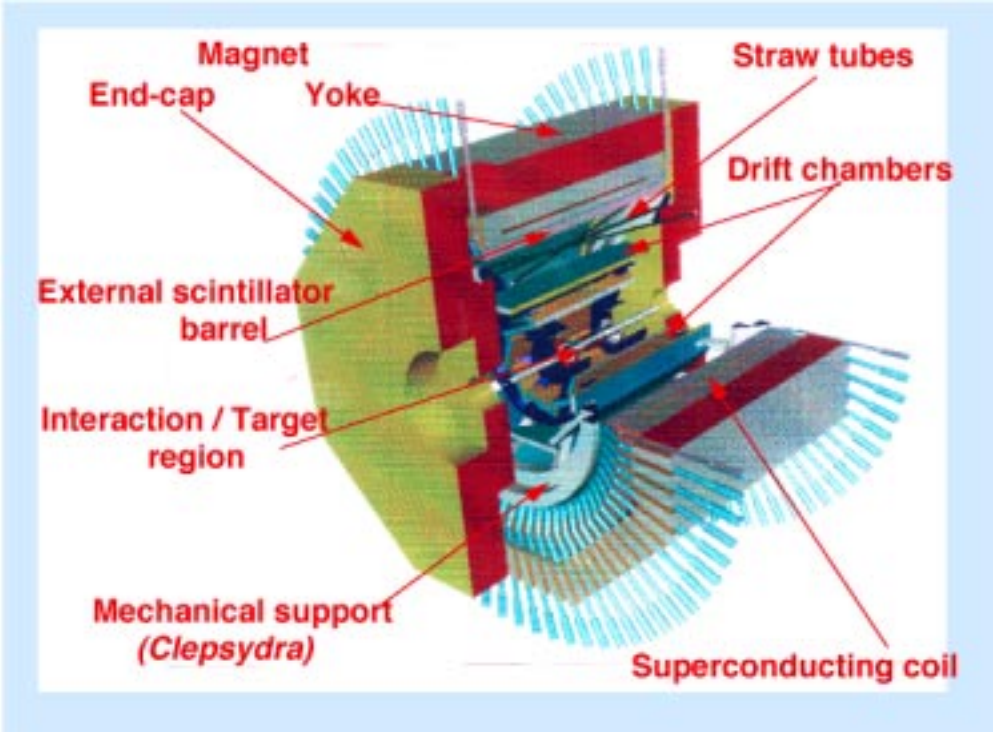
Linac

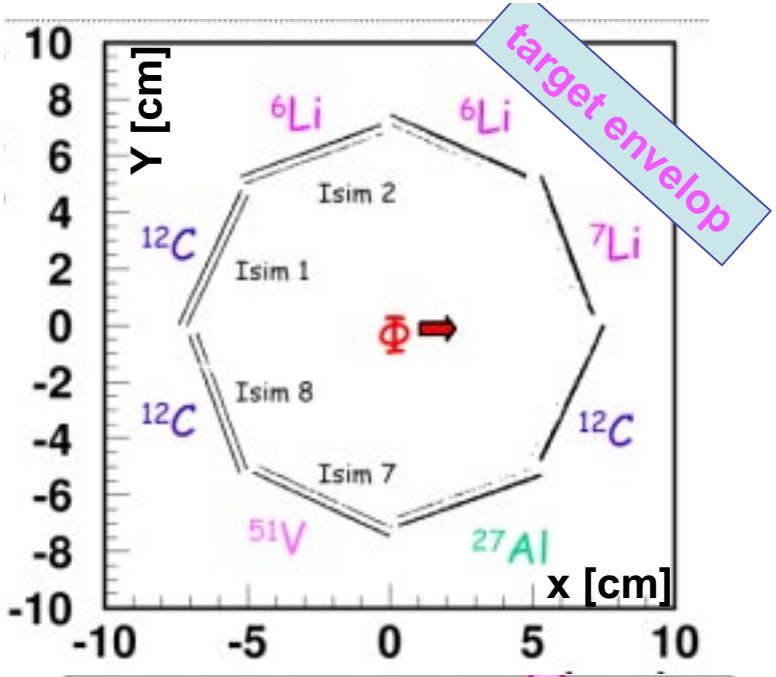
DEAR

&

FINUDA

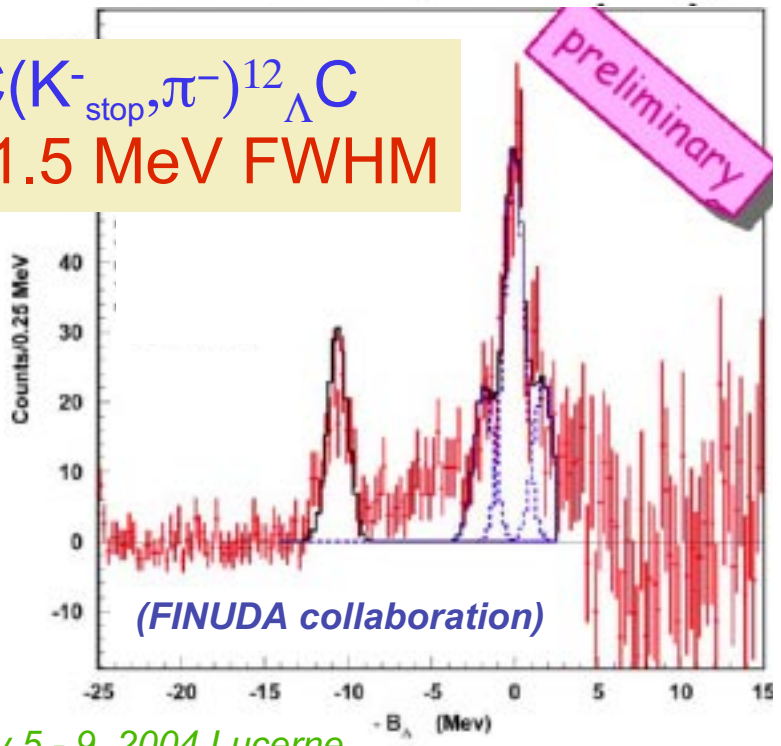
FINUDA detector





$^{12}C(K^-_{stop},\pi^-)^{12}_{\Lambda}C$

$\Delta E \sim 1.5$ MeV FWHM



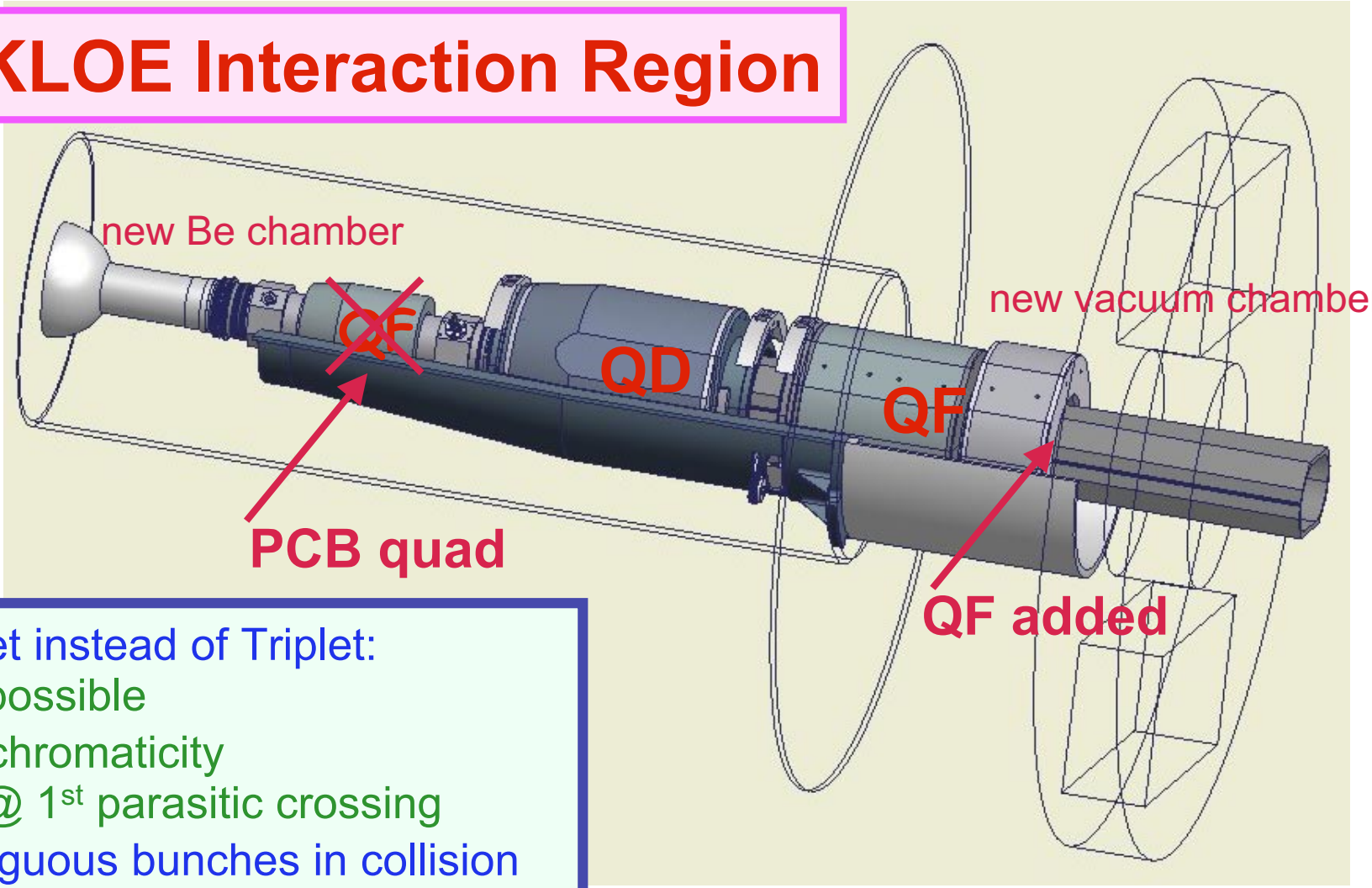
- 2π high resolution detector for:
  - hypernuclei search
  - hypernuclear spectroscopy
  - hypernuclear rare decay

Shut-down Jan. 1st ÷ Jun. 30th

Layout evolution:

- new KLOE I.R. (from DEAR experience 2002 runs)
- new FINUDA I.R.
- FINUDA detector
- wiggler upgrade
- long straight sections rearrangement

New KLOE Interaction Region



QUADs Doublet instead of Triplet:

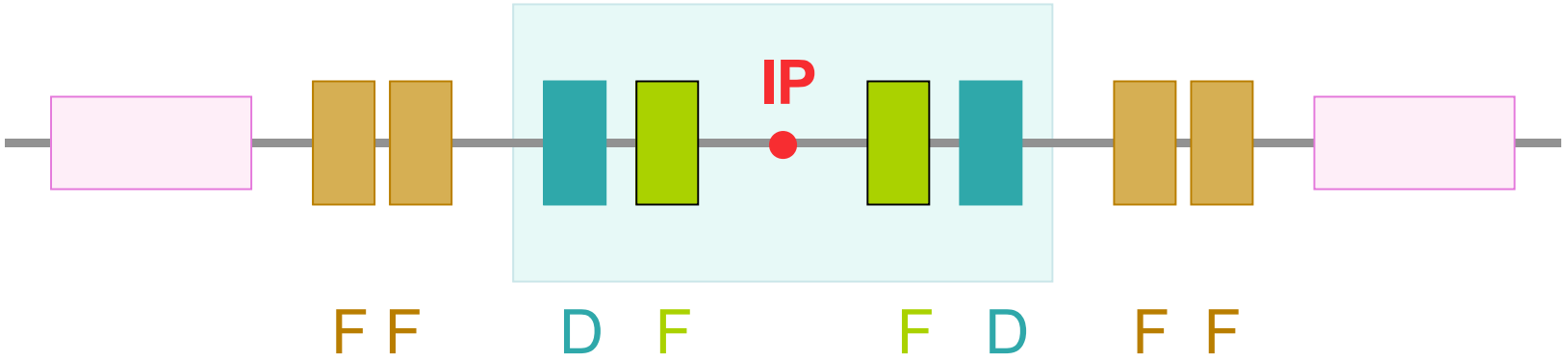
- lower β_y possible
- reduced chromaticity
- lower β_x @ 1st parasitic crossing

up to 120 contiguous bunches in collision

Independently rotating QUADs:

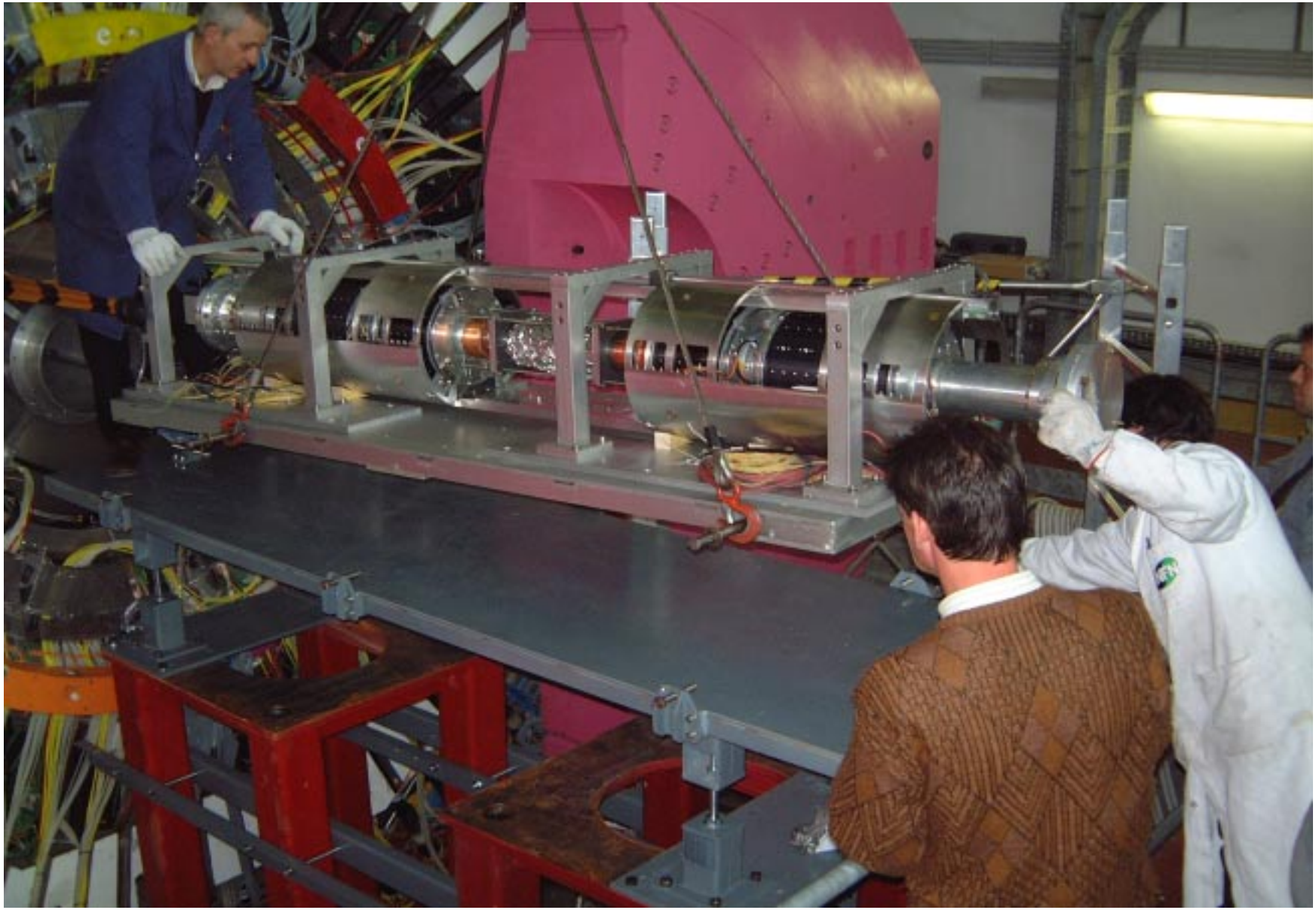
- different solenoid current allowed
- better coupling correction

FINUDA IR

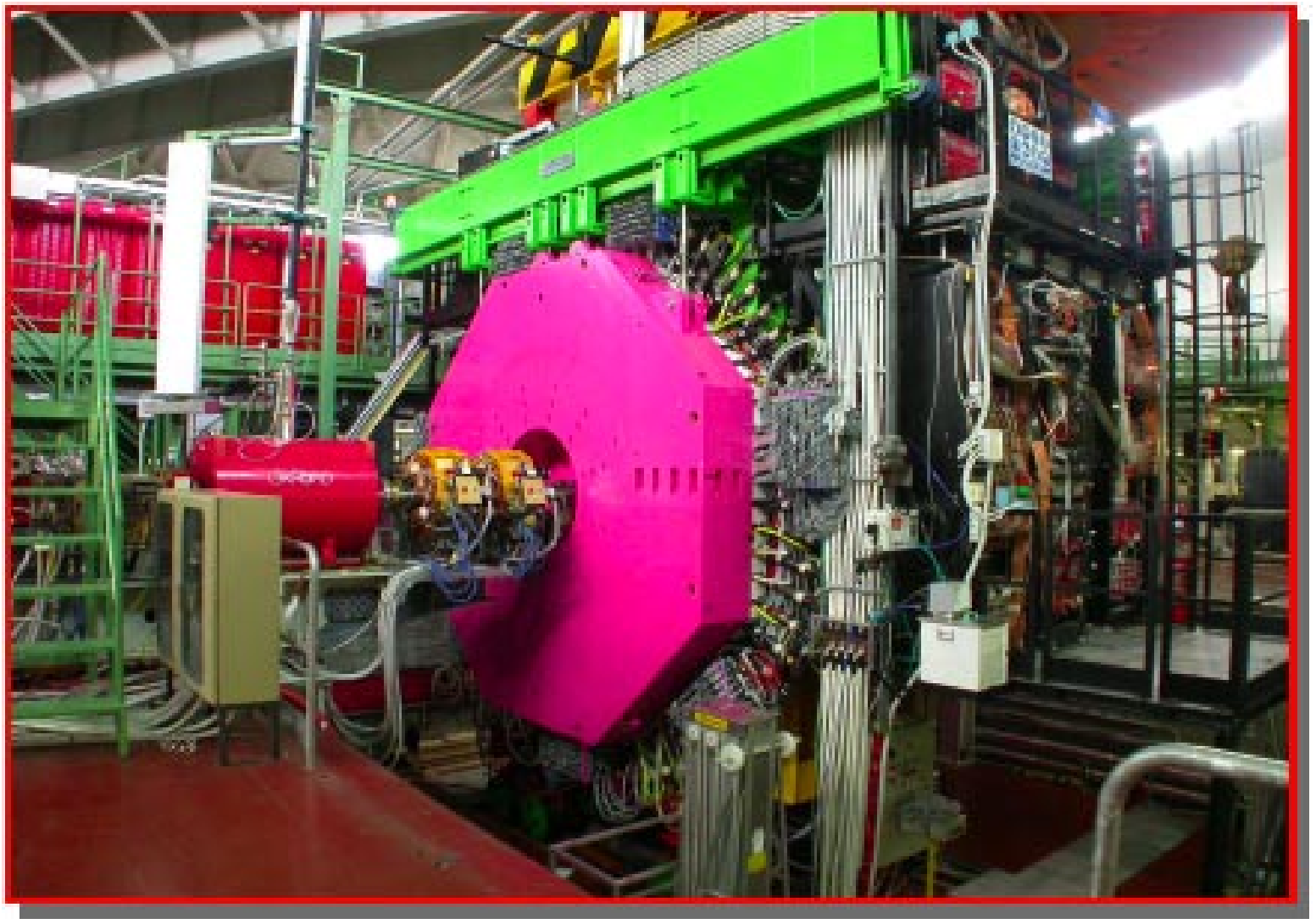


- $\int B\,\delta l = 2.4$ Tm
- 2 superconductive compensator solenoids
- 4 permanent magnet QUADs
- 4 electromagnetic QUADs
- Independent QUADs rotation

Installing the FINUDA IR



FINUDA @ DAΦNE



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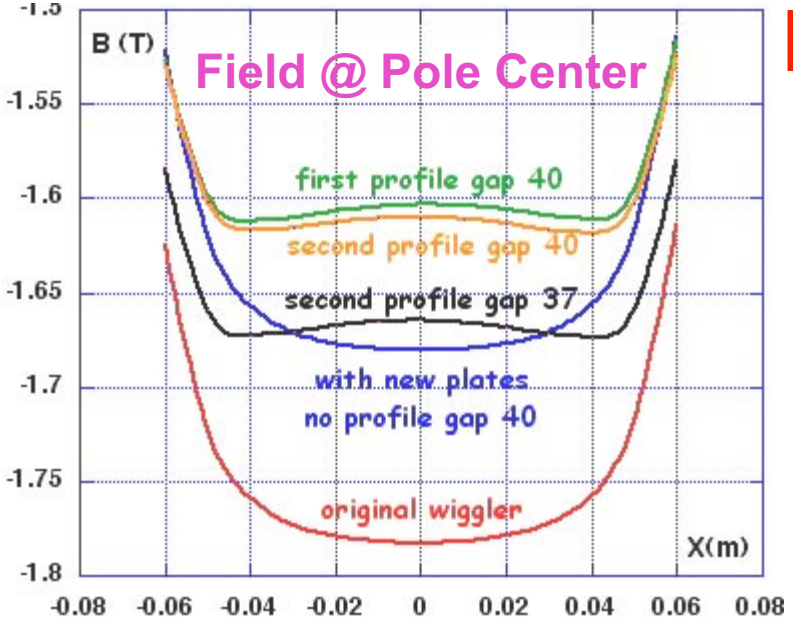
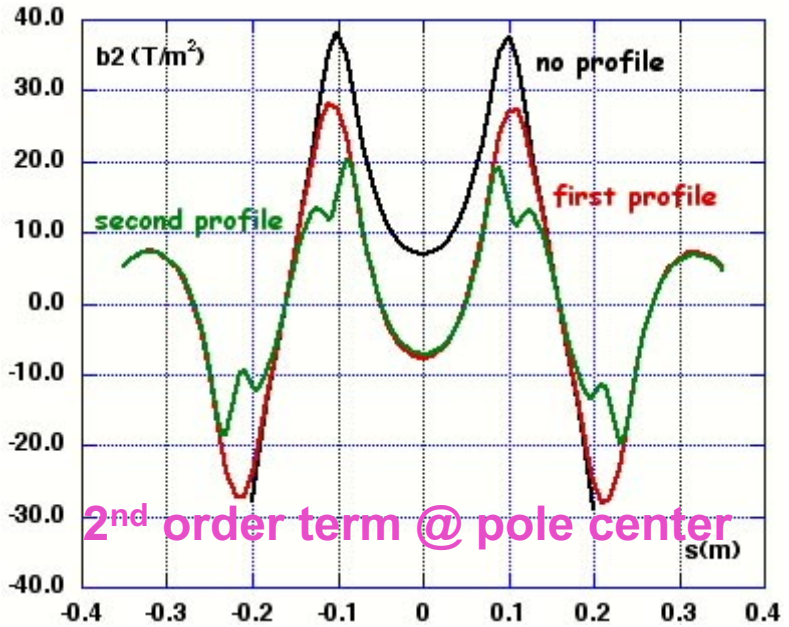
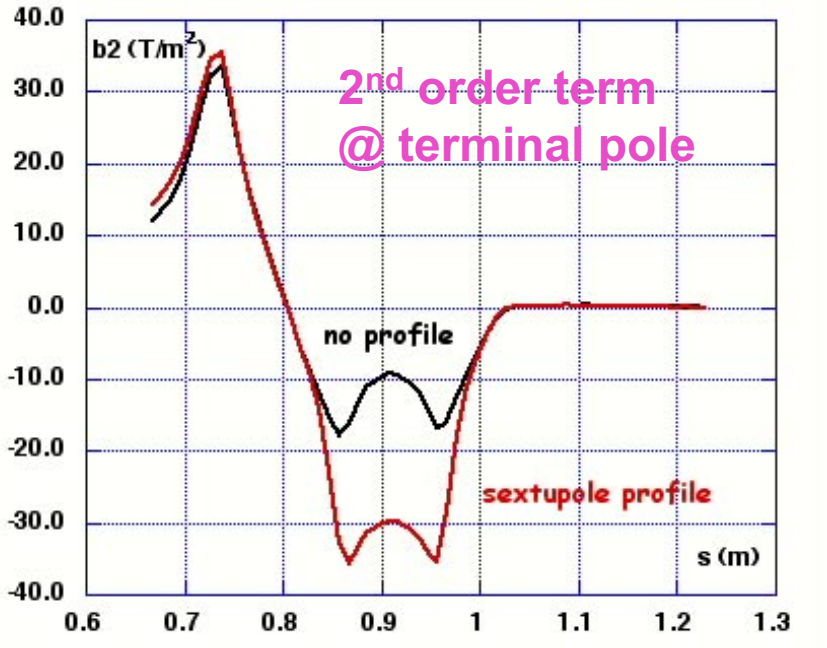
Upgrading the WIGGLER field quality by pole shimming





- Improves Dynamic Aperture & τ_{beam} by reducing: non linear terms
  2nd order chromaticity



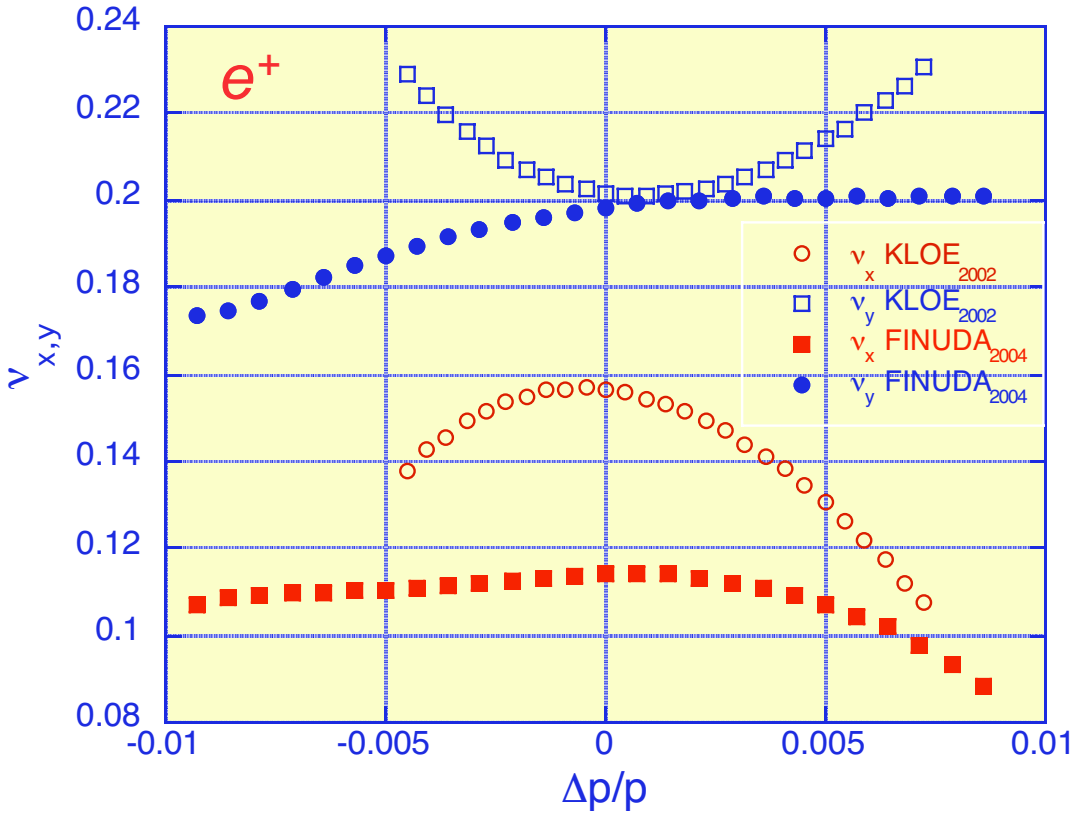
(S. Guiducci WEPKF034)

- Magnetic Measurements show:
  - 3rd order term reduced by 2.5
- Tests using the beam
  - confirm magnetic measurements
  - show a factor 2 in the energy acceptance

$$\nu_x = \nu_{x0} + m_{1x}\frac{\Delta p}{p} + m_{2x}\left(\frac{\Delta p}{p}\right)^2$$

$$\nu_y = \nu_{y0} + m_{1y}\frac{\Delta p}{p} + m_{2y}\left(\frac{\Delta p}{p}\right)^2$$

	m_{2x}	m_{2y}
KLOE 2002	-882	823
FINUDA 2004	-194	-144



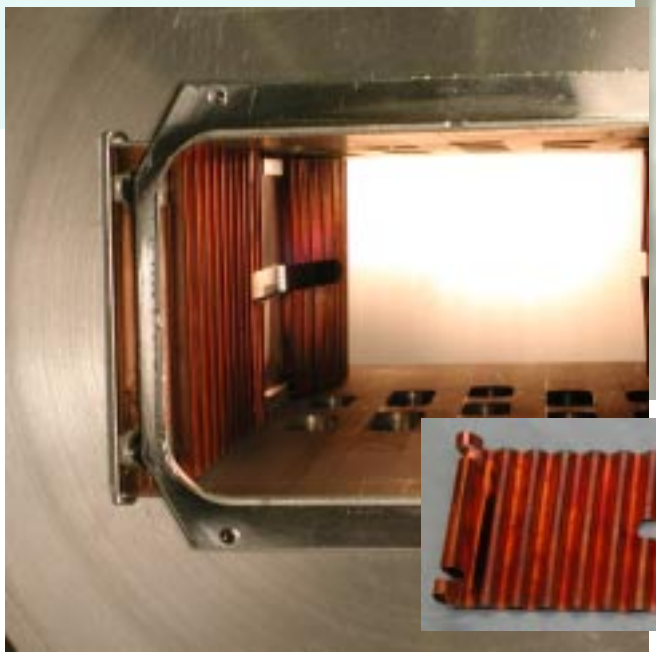
Straight section upgrade

- added:
  - 1 sextupole
  - 2 quadrupoles
- removed 1 injection kicker
- all the elements rearranged

Shut-down Jan. 1st ÷ Jun. 30th

Element maintenance & upgrade:

- Strip-lines (TL) acquisition electronics
- LINAC 50 Hz operation mode
- Ion clearing electrodes
- Cryo plant upgrade
- Scrapers
- Bellows



Tuning the new DAΦNE configuration

Ring Model:

- layout update
- new wiggler model
- new FINUDA IR model
- comparison with beam measurements

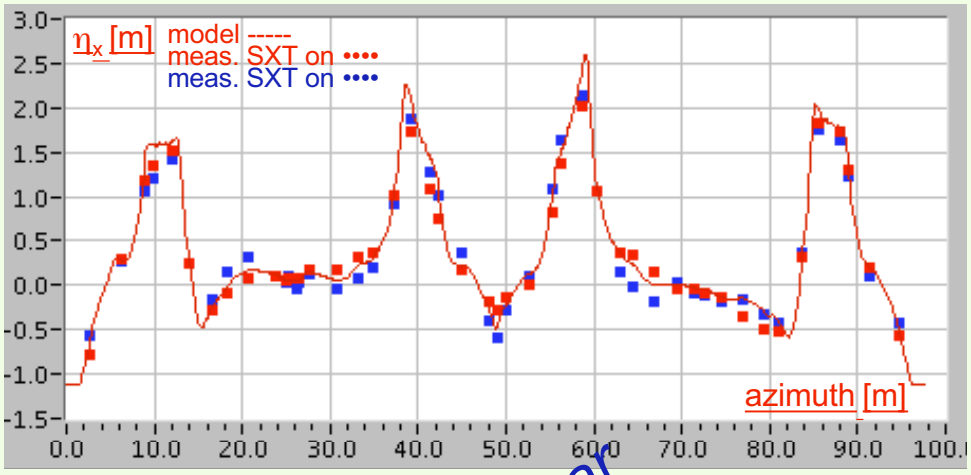
Betatron Coupling correction:

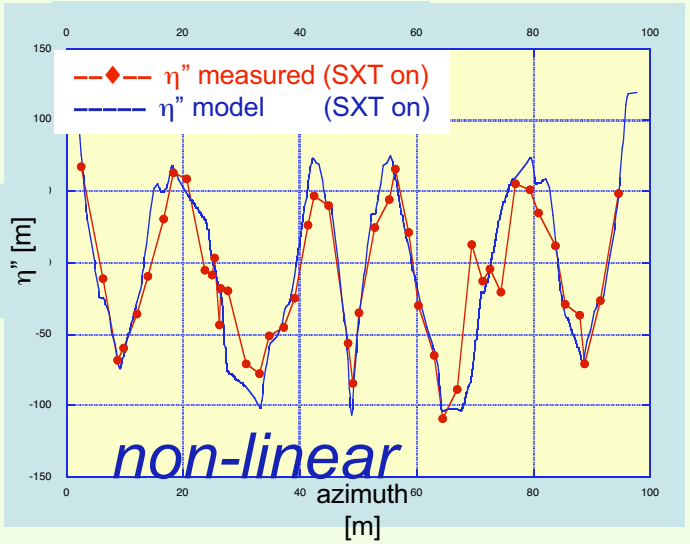
- local correction by rotating QUADs in the IRs

Optics for collision

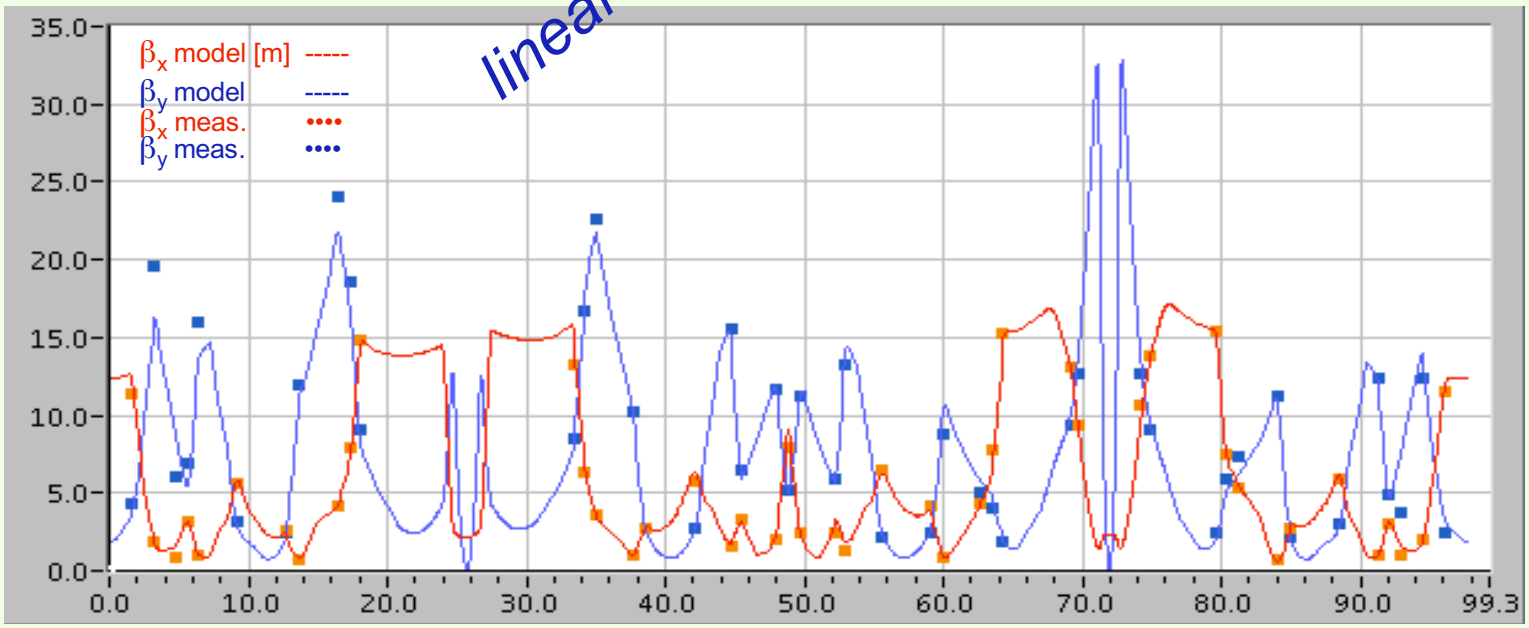
Model & Measurements

(e^+ ring Nov 25th 2003)





linear



DAΦNE optics

- KLOE solenoids off (IP_1)
- ε_x = .34 μ

  $\Delta x \sim 13\ \sigma_x$ @ 1st par. cros.

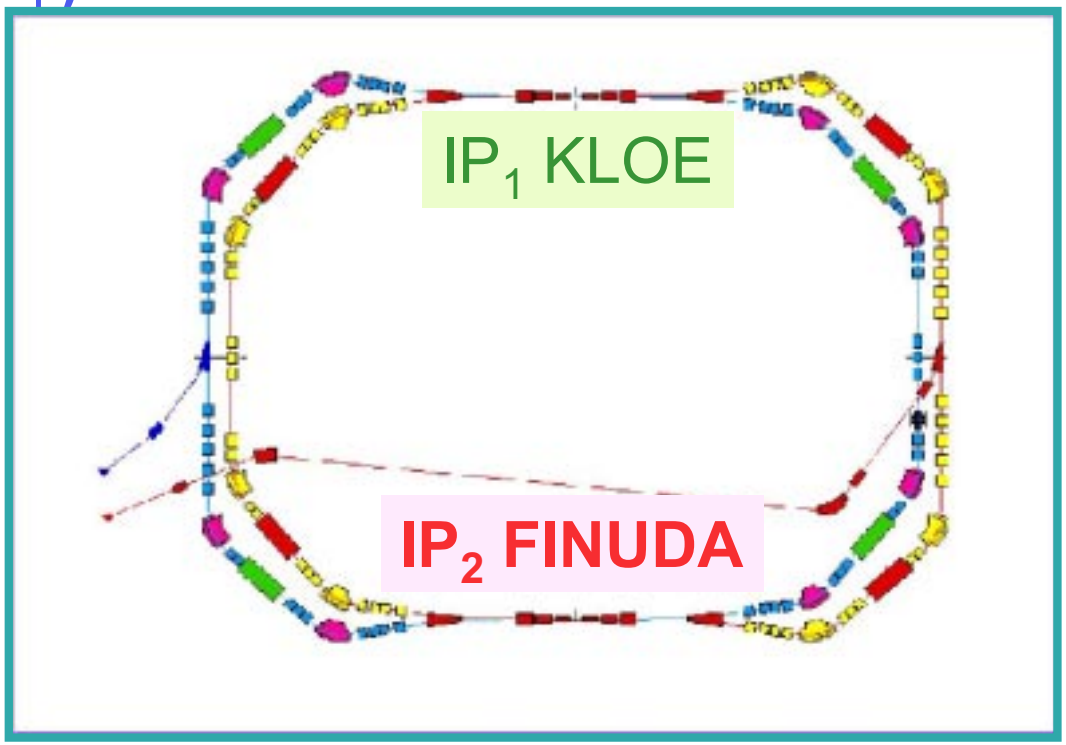
  100 consecutive bunches

  (1 bucket 2.7 ns)
- low-β @ FINUDA IP_2

  β^*_x = 2.33 m

  β^*_y = .024 m

  θ_x = .021 rad



Betatron coupling correction

- local correction
  - by minimizing the coupling term of the measured Response Matrix by the IRs QUAD rotations $\Delta\phi_j$ j=1..8

$$M\Delta\phi = C^{meas}$$

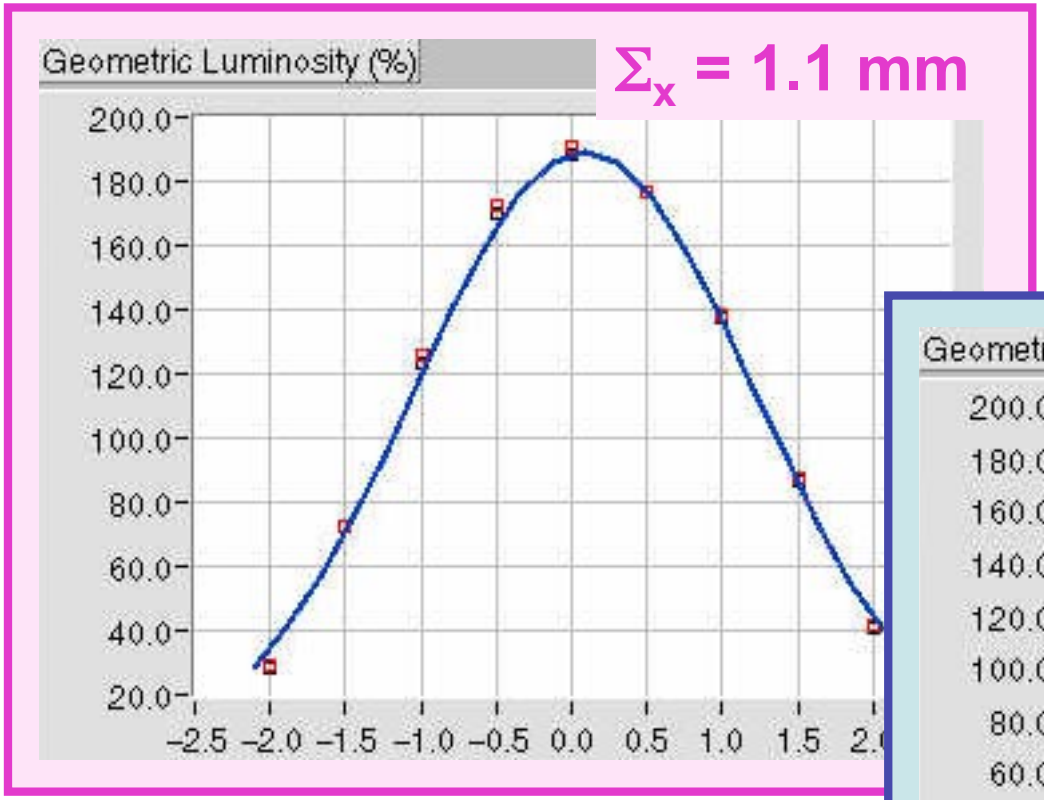
$$M^{\mathrm{mod}} = \begin{bmatrix} \frac{\partial y_{m_1}}{\partial k_{h1}\partial \phi_1} & \cdots & \frac{\partial y_{m_1}}{\partial k_{h1}\partial \phi_8} \\ \vdots & & \vdots \\ \frac{\partial y_{m_{nBPM}}}{\partial k_{h\,n\,kick}\partial \phi_1} & & \frac{\partial y_{m_{nBPM}}}{\partial k_{h\,n\,kick}\partial \phi_8} \\ \frac{\partial x_{m_1}}{\partial k_{v1}\partial \phi_1} & & \frac{\partial x_{m_1}}{\partial k_{v1}\partial \phi_8} \\ \vdots & & \vdots \\ \frac{\partial x_{m_{nBPM}}}{\partial k_{v\,n\,kick}\partial \phi_1} & & \frac{\partial x_{m_{nBPM}}}{\partial k_{v\,n\,kick}\partial \phi_1} \end{bmatrix}$$

$$C^{meas} = \begin{bmatrix} \frac{\partial y_{m_1}}{\partial k_{h_1}} \\ \vdots \\ \frac{\partial y_{m_{nBPM}}}{\partial k_{h\,n_{nkick}}} \\ \frac{\partial x_{m_1}}{\partial k_{v_1}} \\ \vdots \\ \frac{\partial x_{m_{nmon}}}{\partial k_{vn_{kick}}} \end{bmatrix}$$

- linear system solved by SVD
- after few iteration 40% reduction in rms (C^{meas})

- global correction by SKEW QUADs

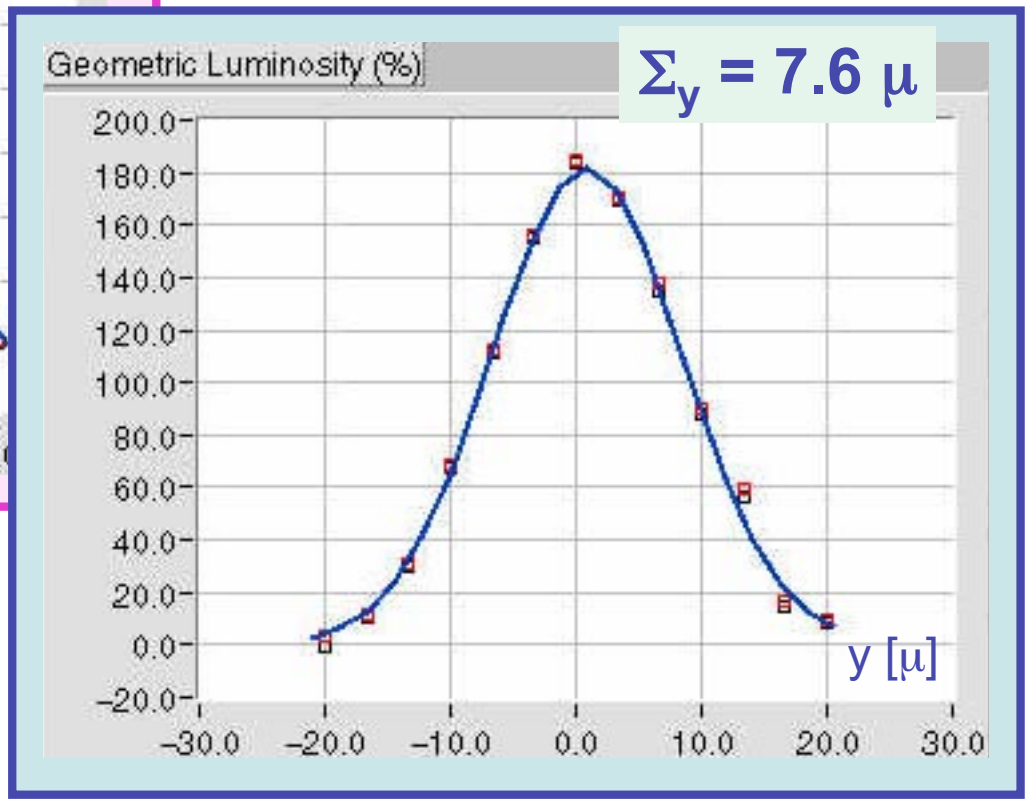
$\kappa = .3\%$



$\Sigma_x = 1.1$ mm

measured by

- beam - beam scan
- beam aspect ratio @ SLM



$\Sigma_y = 7.6\ \mu$

$$\Sigma_{x,y} = \sqrt{(\sigma^{+^2}_{x,y} + \sigma^{-^2}_{x,y})}$$

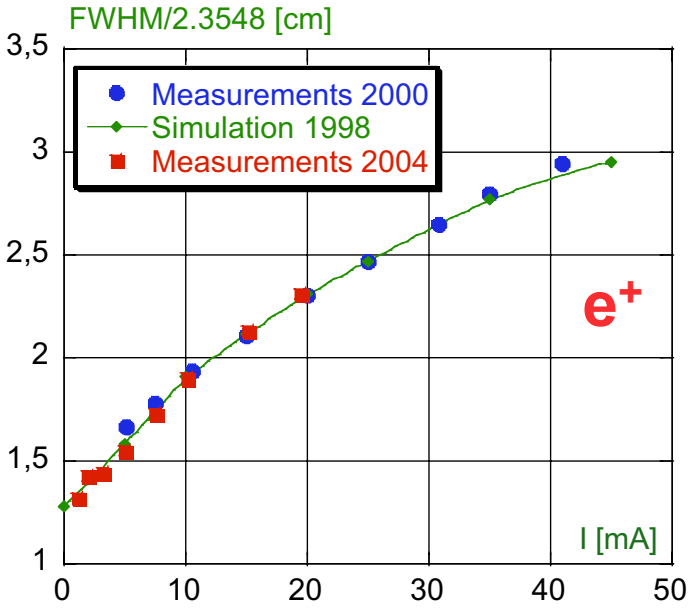
High Current Issues

- Despite many modifications the rings have the same Z

$$\left(\frac{\sigma_z}{R}\right) \approx \left(\frac{2}{\pi}\right)^{1/6} \xi^{1/3} \left(\frac{Z}{n}\right)_o^{1/3} \qquad \xi = \frac{\alpha_c I}{\nu_s^2 (E/e)} = \frac{2\pi I}{h V_{RF} \cos\phi_c}$$

$$\left(\frac{Z}{n}\right)_0 \approx 0.6\,\Omega$$

e+



- Horizontal Transverse FBK installed

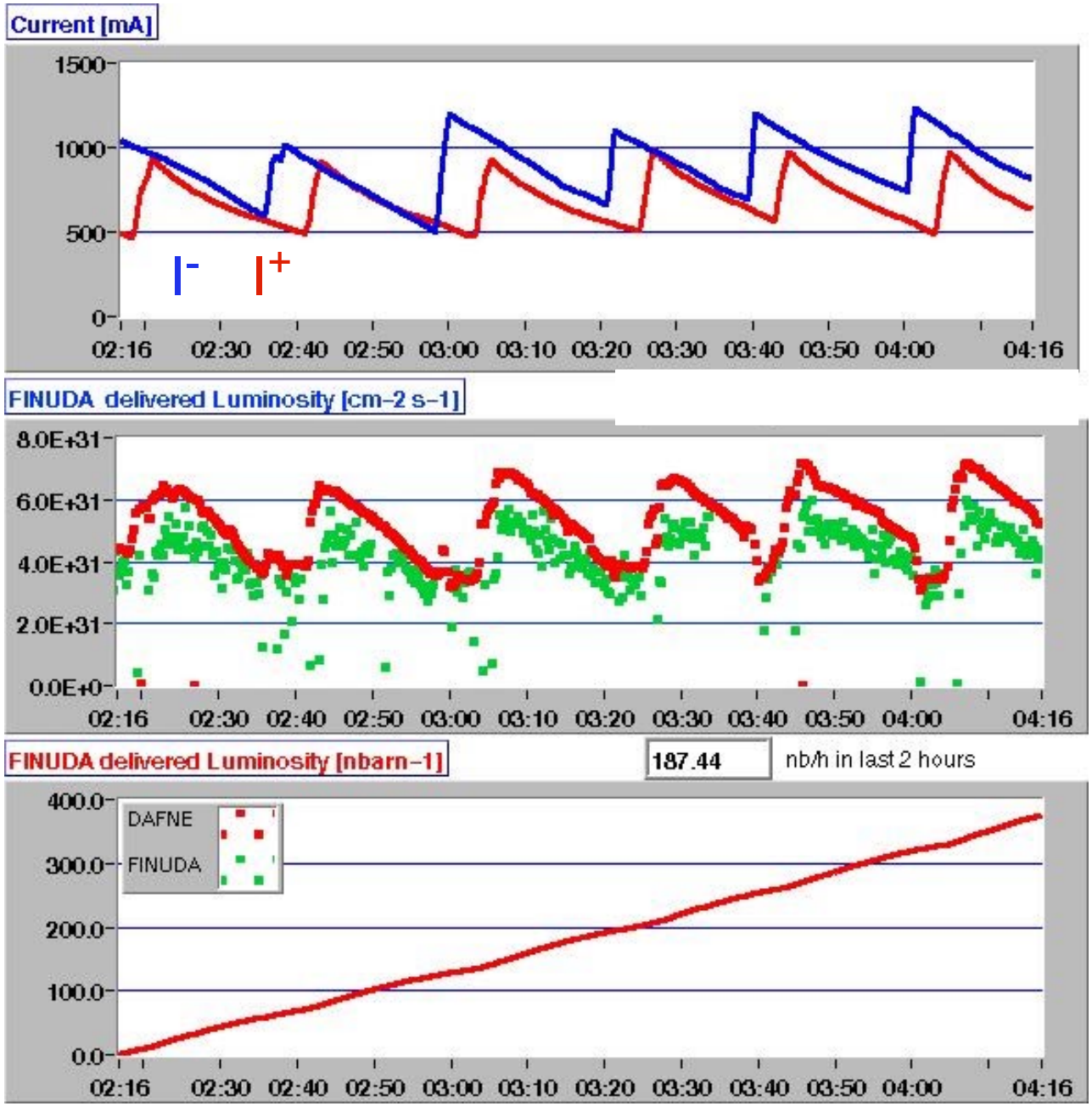
(A. Drago THPLT056)

- Maximum current in collision:

  I^- ~ 1.2 A & I^+ ~ 1 A

- Maximum single beam current:

  I^- ~ 2.4 A & I^+ ~ 1.2 A

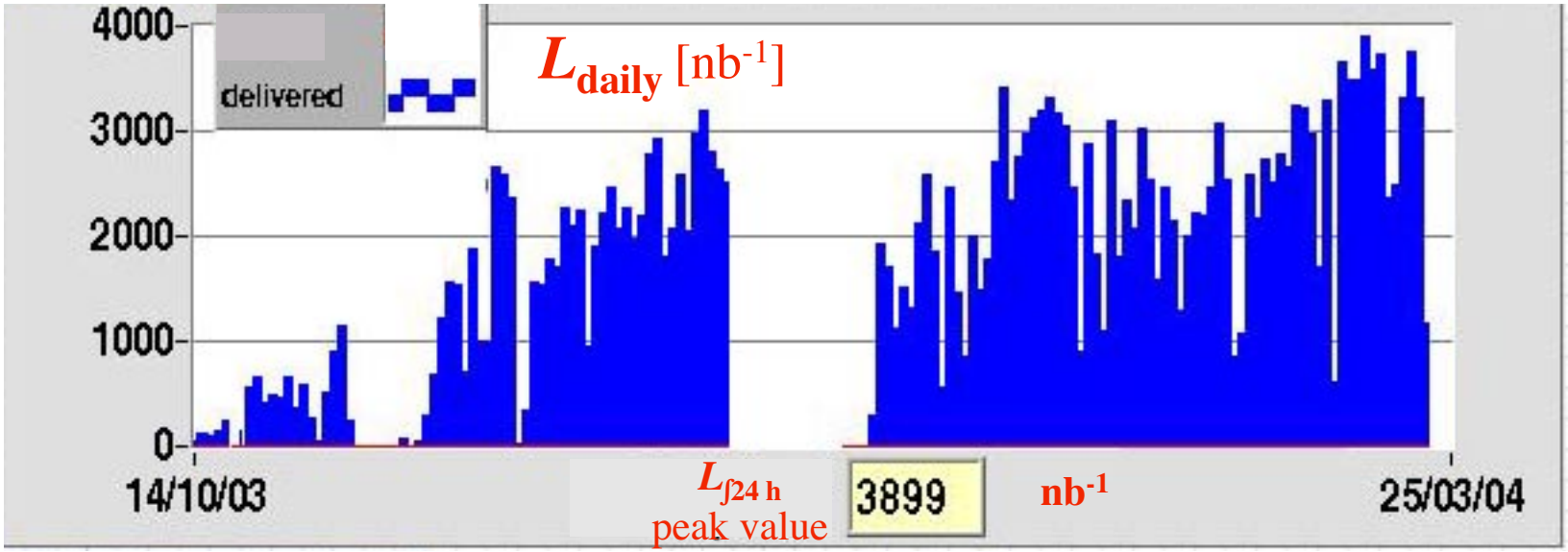


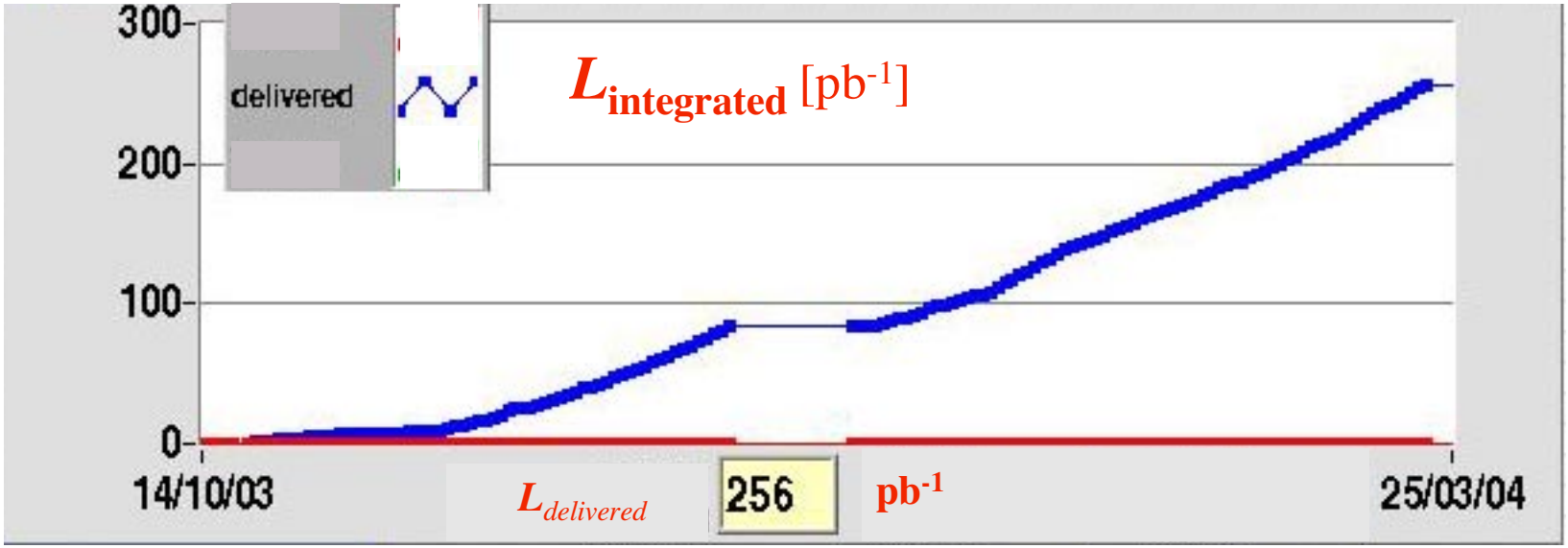
Best FINUDA run

100 colliding bunches

$\mathcal{L}\int_{1hr} \geq 187\ nb^{-1}$

Daily & total integrated LUMINOSITY





Conclusions

- FINUDA has completed the first phase of its scientific program
- Nonlinear terms in the WGL field have been reduced & energy acceptance has been doubled
- The betatron coupling can be corrected by rotating the permanent magnet quadrupoles, final value .3%
- Consecutive bunches collide without major problems (100 b)

FINUDA Luminosity results

- $\mathcal{L}_{peak}$ ~ .6 •10^{32} cm^{-2} s^{-1}
- $\mathcal{L}_{\int day}$ ~ 4 pb^{-1}/day
- $\mathcal{L}_{\int 2003 \div 2004}$ ~ 256 pb^{-1}

  ($\mathcal{L}_{required}$ ~ 250 pb^{-1})

- very low background rate

- FINUDA IR removed
- KLOE runs
- 100 consecutive bunches
- $\mathcal{I}$ > 1.1 A in collision for both beams
- half background than in the 2002 KLOE run
- $\mathcal{L}_{peak}$ ~ .85 •10^{32} cm^{-2} s^{-1}

…. what is going on ?!

toward $\mathcal{L}_{peak}$ > 10^{32} and DAFNE II

(C. Biscari MOPLT056)
(A. Gallo MOPLT057)