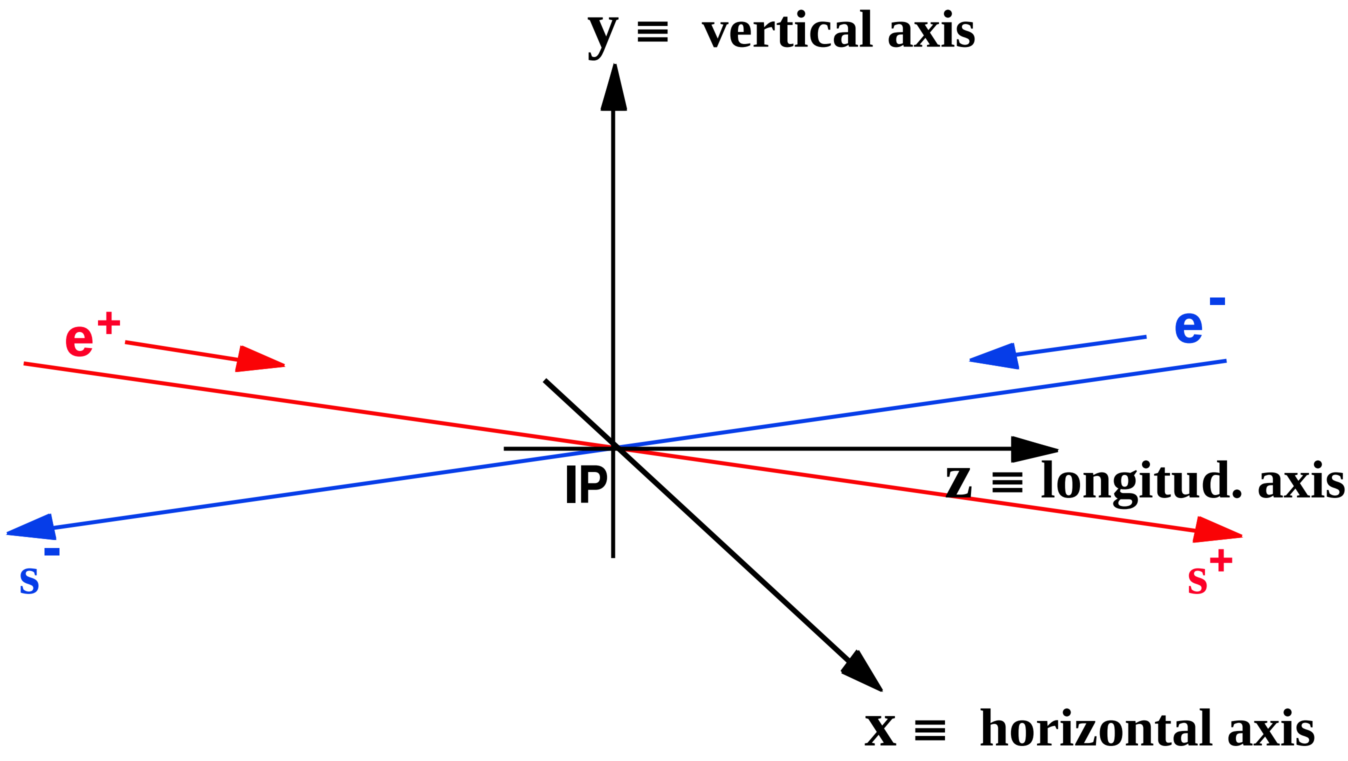
Outline

- Basic Definitions
- Geometrical Luminosity
- Beam-beam Effects
- Luminosity as a Function of the Collider Parameters
- Single Bunch Luminosity (DAΦNE Case)
- Multi Bunch Luminosity (DAΦNE Case)
- KLOE Detector Implications
- Luminosity Optimization Process in DAΦNE
- The DAΦNE Luminosity Monitor
- Integrated Luminosity Optimization
- Main References

IR Reference Frame



{ x, y, z } ≡ Lab. Reference Frame

Basic Definitions

Cross Section:

Event Rate
per Unit Incident Flux
per Target Particle

Luminosity:

Counting Rate
for a
Unit Cross Section Event

Counter Rotating Beams Luminosity

$$n_{\pm}(x,y,z,t)$$

$$\iiint dx dy\, dz\; n_{\pm}(x,y,z,t) = N_{\pm}$$

- Single Bunch
- Head-on Collision
- Counter-rotating Beams with Longitudinal Speed v
- Revolution Frequency f_R

$$L = 2 v f_R \iiiint dx\, dy\, dz\, dt\; n_{+}(x,y,z,t)\, n_{-}(x,y,z,t)$$

Gaussian Beam Single Bunch Luminosity

$$n_-(x,y,z,t) = N_- \frac{e^{-\frac{x^2}{2\sigma_{x-}^2}-\frac{y^2}{2\sigma_{y-}^2}-\frac{(z-vt)^2}{2\sigma_{z-}^2}}}{(2\pi)^{3/2}\sigma_{x-}\sigma_{y-}\sigma_{z-}}$$

$$n_+(x,y,z,t) = N_+ \frac{e^{-\frac{x^2}{2\sigma_{x+}^2}-\frac{y^2}{2\sigma_{y+}^2}-\frac{(z+vt)^2}{2\sigma_{z+}^2}}}{(2\pi)^{3/2}\sigma_{x+}\sigma_{y+}\sigma_{z+}}$$

$\sigma_{x\pm}, \sigma_{y\pm}$ ≡ **constants**

$$L = f_R \frac{N_+ N_-}{2\pi\sqrt{(\sigma_{x+}^2 + \sigma_{x-}^2)(\sigma_{y+}^2 + \sigma_{y-}^2)}}$$

$\sigma_{x+} = \sigma_{x-}$ $\sigma_{y+} = \sigma_{y-}$

$$L = f_R \frac{N_+ N_-}{4\pi\, \sigma_x \sigma_y}$$

Geometrical Luminosity

Very Low Currents → **Negligible Beam-Beam Effects**

$$L = 2 f_R \frac{v}{c} \cos\alpha \sqrt{c^2 - v^2 \sin^2\alpha} \iiiint dxdydzdt \;\; f_+ f_-$$

$$f_+ = \frac{N_+ e^{-\frac{(x\cos\alpha - z\sin\alpha)^2}{2\sigma_{x+}^2(x,z)} - \frac{y^2}{2\sigma_{y+}^2(x,z)} - \frac{(x\sin\alpha + z\cos\alpha - vt)^2}{2\sigma_{z+}^2}}}{(2\pi)^{3/2}\; \sigma_{x+}(x,z)\; \sigma_{y+}(x,z)\; \sigma_{z+}}$$

$$\sigma_{k+}^2 = \sigma_{k+}^{2}\left[1 + \frac{(x\sin\alpha + z\cos\alpha - \Delta w_+)}{\beta_{k+}^2}\right] \qquad k = x, y$$

$$f_- = \frac{N_- e^{-\frac{[(x-\Delta x)\cos\alpha + z\sin\alpha]^2}{2\sigma_{x-}^2(x,z)} - \frac{(y-\Delta y)^2}{2\sigma_{y-}^2(x,z)} - \frac{[-(x-\Delta x)\sin\alpha + z\cos\alpha + v(t-\Delta t)]^2}{2\sigma_{z-}^2}}}{(2\pi)^{3/2}\; \sigma_{x-}(x,z)\; \sigma_{y-}(x,z)\; \sigma_{z-}}$$

$$\sigma_{k-}^2 = \sigma_{k-}^{2}\left[1 + \frac{(-x\sin\alpha + z\cos\alpha - \Delta w_-)}{\beta_{k-}^2}\right] \qquad k = x, y$$

GEOLUM Fortran Code

Luminosity as a Function of the Collider Parameters

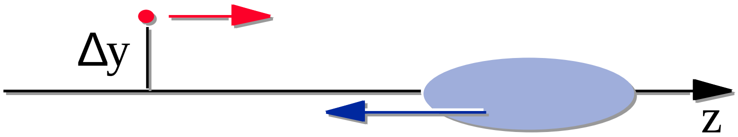
$$L = f_R \frac{N_+ N_-}{4\pi\ \sigma_x^* \sigma_y^*}$$

$$\eta_x = \eta_y = 0$$

$$\sigma_y^* = \sqrt{\frac{\kappa}{1+\kappa}\varepsilon\,\beta_y^*} \qquad \sigma_x^* = \sqrt{\frac{1}{1+\kappa}\varepsilon\,\beta_x^*}$$

$$L = f_R \frac{N_+ N_- (1+\kappa)}{4\pi\ \varepsilon \sqrt{\kappa\,\beta_x^* \beta_y^*}} \cong f_R \frac{N_+ N_-}{4\pi\ \varepsilon \sqrt{\kappa\,\beta_x^* \beta_y^*}}$$

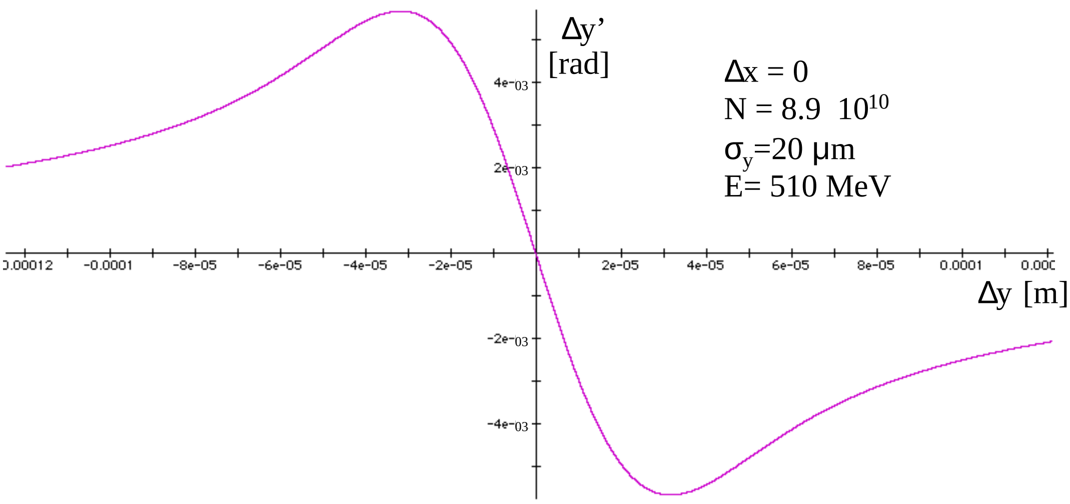
Beam-Beam Effects



For a gaussian charge distribution:

$$\Delta y' = -\frac{2 N r_e \Delta y}{\gamma} \int_0^{\infty} \frac{\exp\left(-\frac{\Delta x^2}{2\sigma_x^2 + w} - \frac{\Delta y^2}{2\sigma_y^2 + w}\right)}{\left(2\sigma_y^2 + w\right)^{\frac{3}{2}} \left(2\sigma_x^2 + w\right)^{\frac{1}{2}}} dw$$

$$\Delta x' = -\frac{2 N r_e \Delta x}{\gamma} \int_0^{\infty} \frac{\exp\left(-\frac{\Delta x^2}{2\sigma_x^2 + w} - \frac{\Delta y^2}{2\sigma_y^2 + w}\right)}{\left(2\sigma_y^2 + w\right)^{\frac{1}{2}} \left(2\sigma_x^2 + w\right)^{\frac{3}{2}}} dw$$



Beam-Beam Linear Approach

$$\Delta y \ll \sigma_y^* \qquad \Delta x \ll \sigma_x^*$$

$$\Delta y' \quad -\frac{1}{f_y}\Delta y \qquad f_y^{-1} = \frac{2Nr_e}{\gamma\sigma_y^*\left(\sigma_x^* + \sigma_y^*\right)}$$

$$\Delta x' \quad -\frac{1}{f_x}\Delta x \qquad f_x^{-1} = \frac{2Nr_e}{\gamma\sigma_x^*\left(\sigma_x^* + \sigma_y^*\right)}$$

Focussing Quadrupole (thin lens):

$$\mathbf{Q}_F^k \equiv \begin{pmatrix} 1 & 0 \\ -1/f_k & 1 \end{pmatrix} \qquad k = x, y$$

Beam-Beam Deflection

Linear Beam-Beam Tune Shift

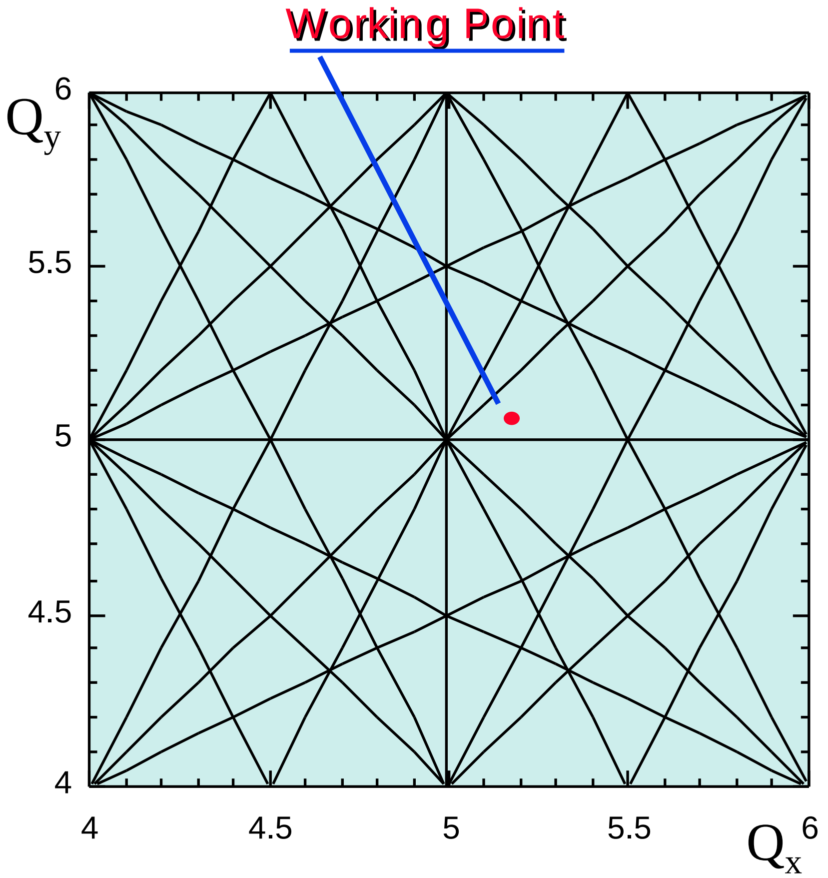
$$\xi_y^+ = \frac{N_- r_e \beta_y^+}{2\pi\gamma\,\sigma_y^-\left(\sigma_y^- + \sigma_x^-\right)} = \Delta Q_y \qquad \xi_x^+ = \frac{N_- r_e \beta_x^+}{2\pi\gamma\,\sigma_x^-\left(\sigma_y^- + \sigma_x^-\right)} = \Delta Q_x$$

Choice of the Working Point

Tune Resonances

$$mQ_x + nQ_y = p \qquad m,n,p \quad \mathbf{N}$$

$$|m| + |n| = resonance\ order$$

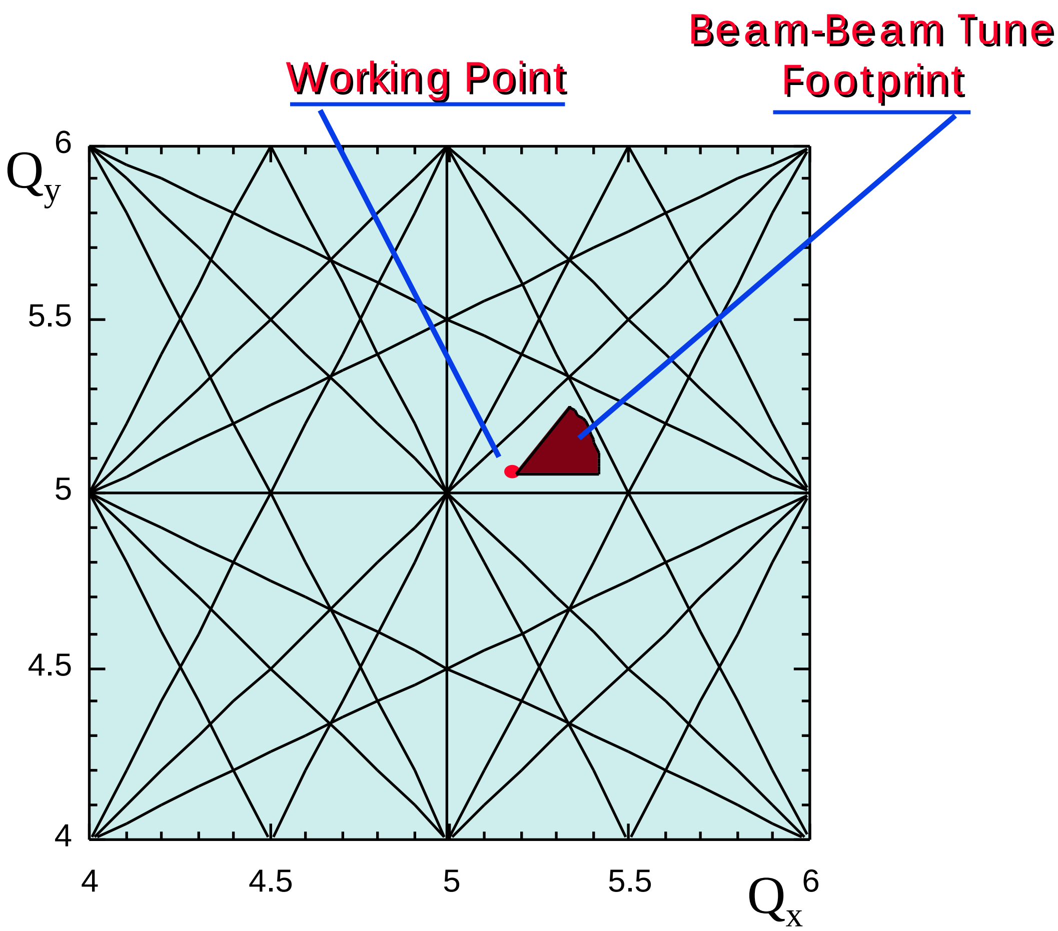


Choice of the Working Point

Tune Resonances

$$mQ_x + nQ_y = p \qquad m, n, p \quad \mathbf{N}$$

$$|m| + |n| = resonance\ order$$



Beam-Beam Nonlinear Effects

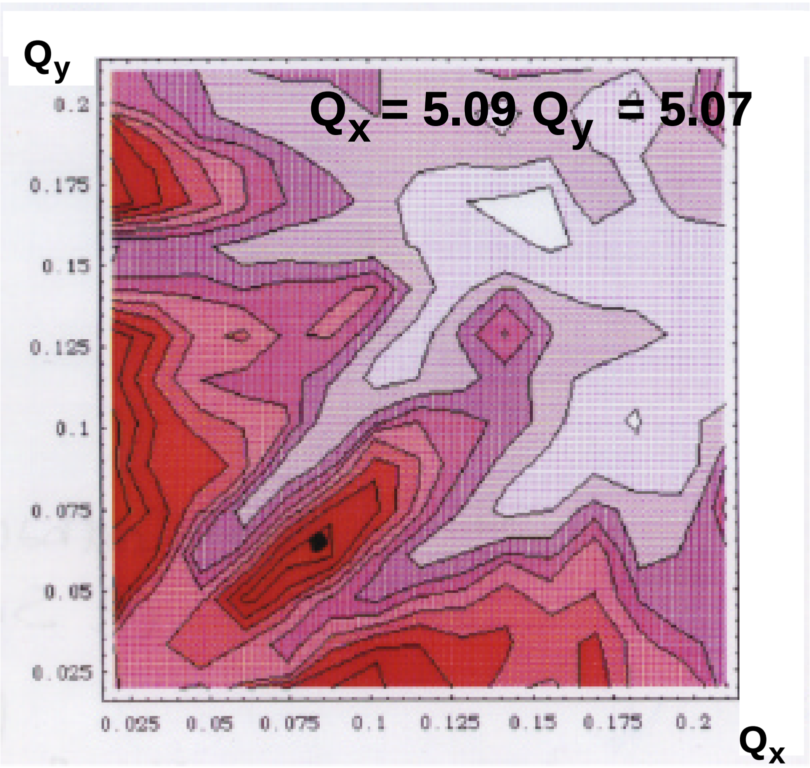
- Nonlinear Beam-beam Kick
- Synchro-betatron Effects
- Radiation Damping
- Quantum Fluctuations in Synchrotron Radiation Emission
- Lattice Nonlinearities (sextupoles, higher order multipoles)
- RF Nonlinearities

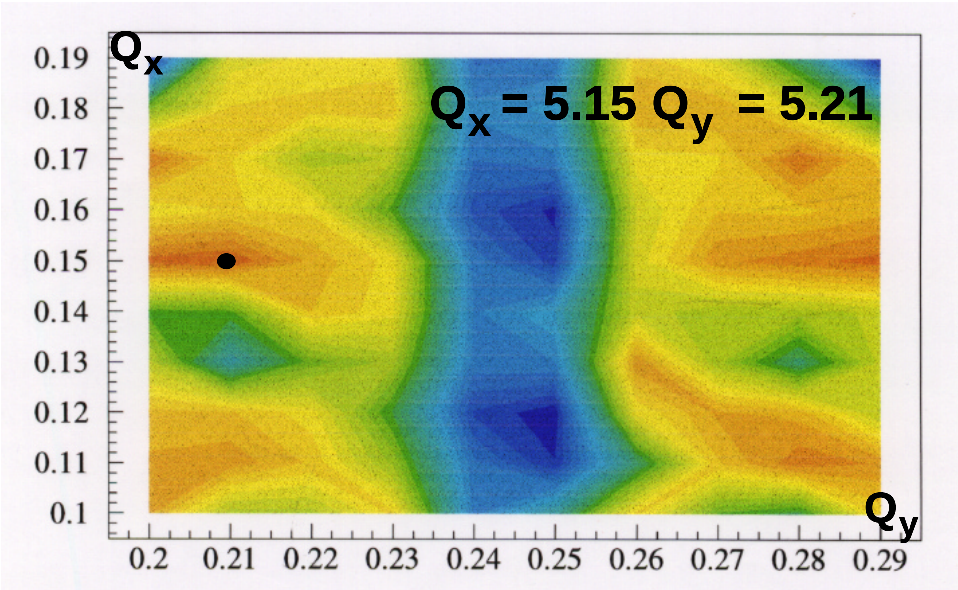
Simulation Codes
(used for DAΦNE)

LIFETRACK by Shatilov

BBC by Hirata

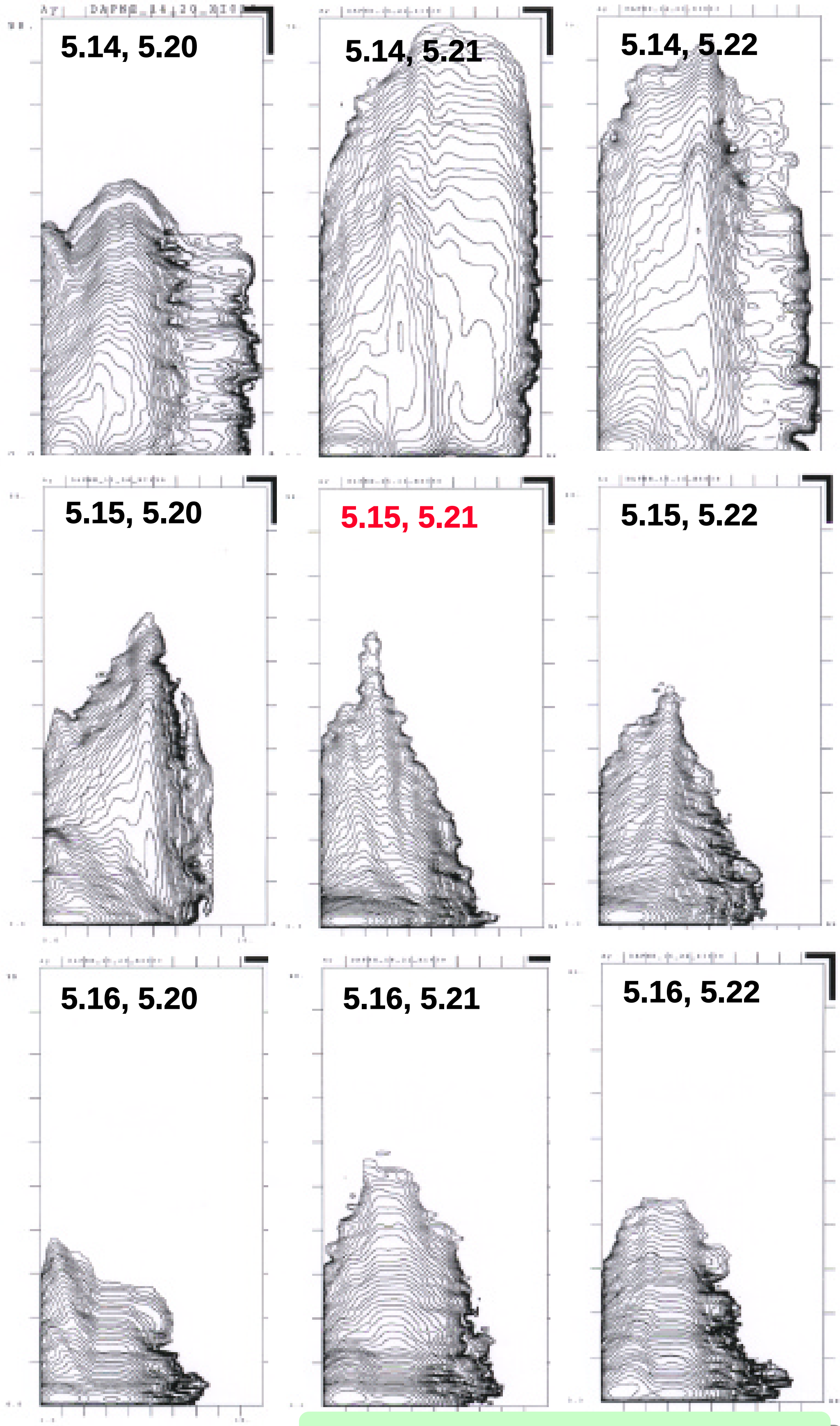
Working Point Simulations





Beam-beam Simulation Information

- Beam Blowup: Vertical and Horizontal
- Distribution Tails
- Beam Lifetime in Collision
- Beam-beam effects in Presence of Coupling (Transverse Tilt and Emittance Ratio)
- Beam-beam effects vs IR Parameters (vertical angle, vertical displacement,...)
- Luminosity Degradation



‘LifeTrack’ Code (D.Shatilov)

Maximum Linear Beam-beam Tune Shift

The Linear Beam-beam Tune Shift Actually Sets the Maximum Achievable Luminosity in Practically all the Existing Colliders

No Consistent and Exhaustive Theory Exists

Estimate of the Max Linear Tune Shift:

Phenomenological models:
J. Seeman Crtiterion
M.Bassetti Criterion

Statistical Elaboration of the Maximum Linear Tune Shifts Achieved in the Existing Colliders

Single Bunch luminosity vs Collider Parameters

$$L = f_R \frac{N_+ N_-}{4\pi \, \sigma_x^* \sigma_y^*}$$

$$\xi_w = \frac{N \, r_e \beta_w}{2\pi\gamma \, \sigma_w^* \left(\sigma_y^* + \sigma_x^*\right)} \qquad w = x, y$$

$$N_+ = N_- = N$$

$$\sigma_x = \sqrt{\frac{1}{1+\kappa} \varepsilon \beta_x} \qquad \sigma_y = \sqrt{\frac{\kappa}{1+\kappa} \varepsilon \beta_y}$$

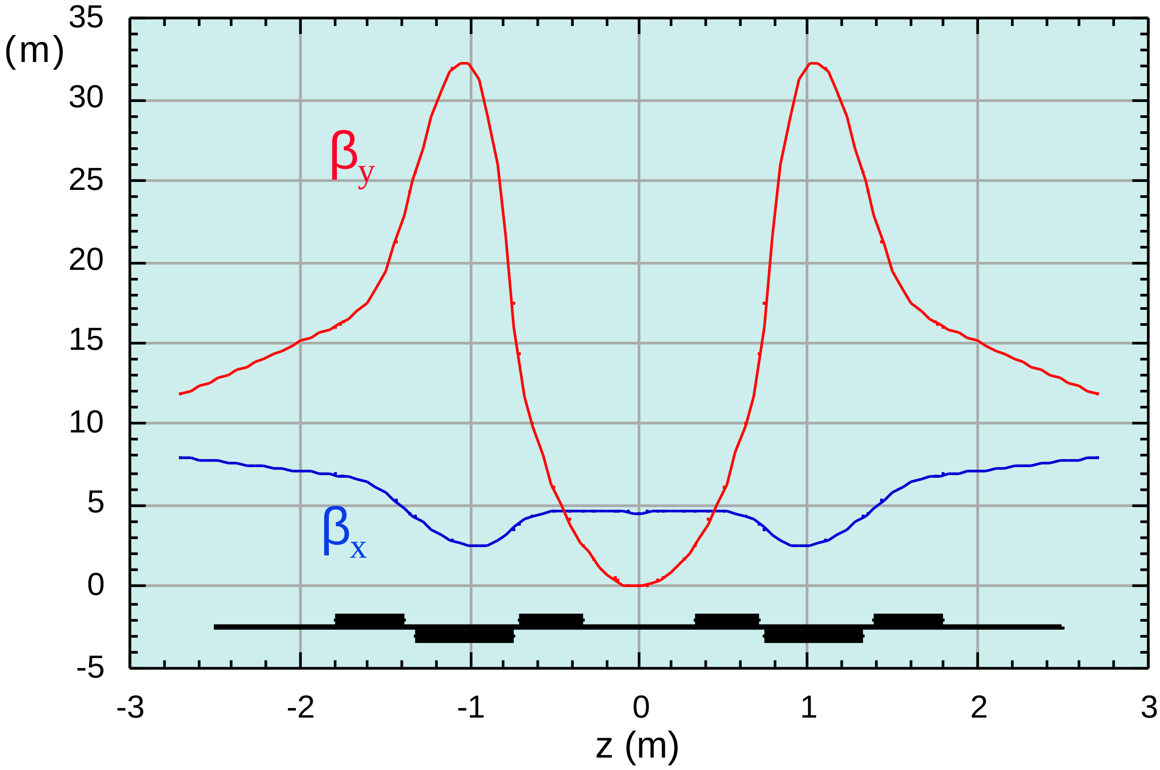
$$L = \pi \left(\frac{\gamma}{r_e}\right)^2 f_R \frac{\varepsilon}{1+\kappa} \left(\frac{1}{\sqrt{\beta_y^*}} + \sqrt{\frac{\kappa}{\beta_x^*}}\right)^2 \xi_x \xi_y$$

$$\frac{\beta_y}{\beta_x} = \kappa \quad \Leftrightarrow \quad \xi_x = \xi_y = \xi$$

Equal Tune Shift Design

$$L = \pi \left(\frac{\gamma}{r_e}\right)^2 f_R \, \varepsilon \, (1+\kappa) \, \frac{\xi^2}{\beta_y}$$

Low Beta Scheme



Few Centimeters Vertical Beta @ IP Obtainable:

Between the IP and the First Quadrupole:

$$\beta_w(z)=\beta_w\left[1+\left(\frac{z}{\beta_w}\right)^2\right] \qquad w=x,y$$

Low Beta Scheme Implications

Large Vertical Beta Functions in D Quads @ IR

Larger Negative Values of Vertical Chromaticities

Stronger Correcting Sextupoles

Smaller Dynamic Aperture

Decrease of Beam Lifetime

Short Bunches for Minimizing the Hourglass Effect

Increase of Toushek Effect

Decrease of Beam Lifetime

Higher Frequency Components in the Beam Spectrum

Possible Coupling with High Frequency Vacuum Chamber Modes: Instabilities

Higher Peak RF Voltages: Larger Number of Cavities

RF Nonlinearities, Stronger High Order Modes

Coherent Synchrotron Radiation with High Current per Bunch

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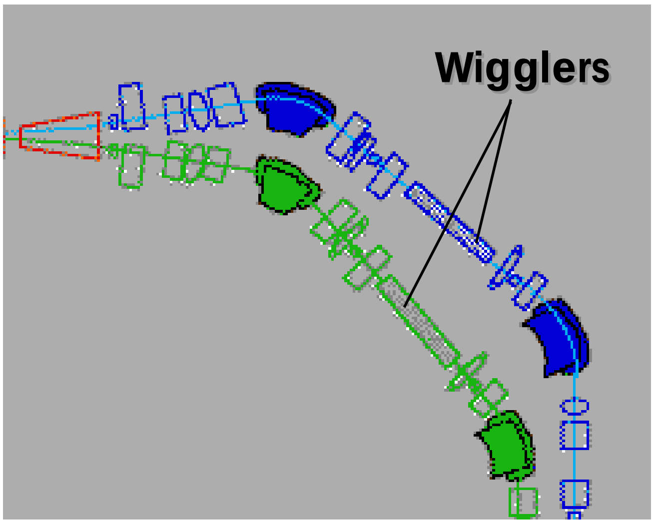
Large Emittance Lattice



DAΦNE BWB Arc:

**The Wiggler in the Arc
Increases the Radiation Damping
and Allows To Modify the Emittance
Value without Changing the
Damping Times**

Large Emittance Implies:

**Large Beam Dimensions
Large Physical Aperture
Large Dynamic Aperture
to Preserve Beam Lifetime**

Round Beam vs Flat Beam

Round Beam (k~1):

A Factor 2 of Luminosity Gain
Both the Beta Functions @ IP Must Be Small:
Technically Difficult to Obtain
Large Negative Chromaticities in Both Planes
Strong Sextupole Correction
Small Dynamic Aperture
Strong Beam-beam Effects
Increased Toushek Effect
Poor Beam Lifetime

Flat Beam (k<<1):

A Factor 2 of Luminosity Loss
Chromaticity Handling not Critical:
It is Possible to Arrange the
Collider Parameters in Order to
Obtain Better Luminosity Performances

Multibunch Luminosity

$$L = N_B L_{SB}$$

Large Number of Bunches:

- Separate Rings
- Small Distance Between 2 adiacent bunches
- Multibunch Instabilities
- Low Impedance Vacuum Chamber
- HOM 'Free' Ring Components
- Longitudinal Feedback System
- Horizontal Crossing Angle @ IP Required in Order to Avoid Parasitic Crossing
- Synchro-betatron Resonances

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- Large Stored Current
- Vacuum System Limitations
- Large Rf Power
- Vacuum Chamber Large Heating Load

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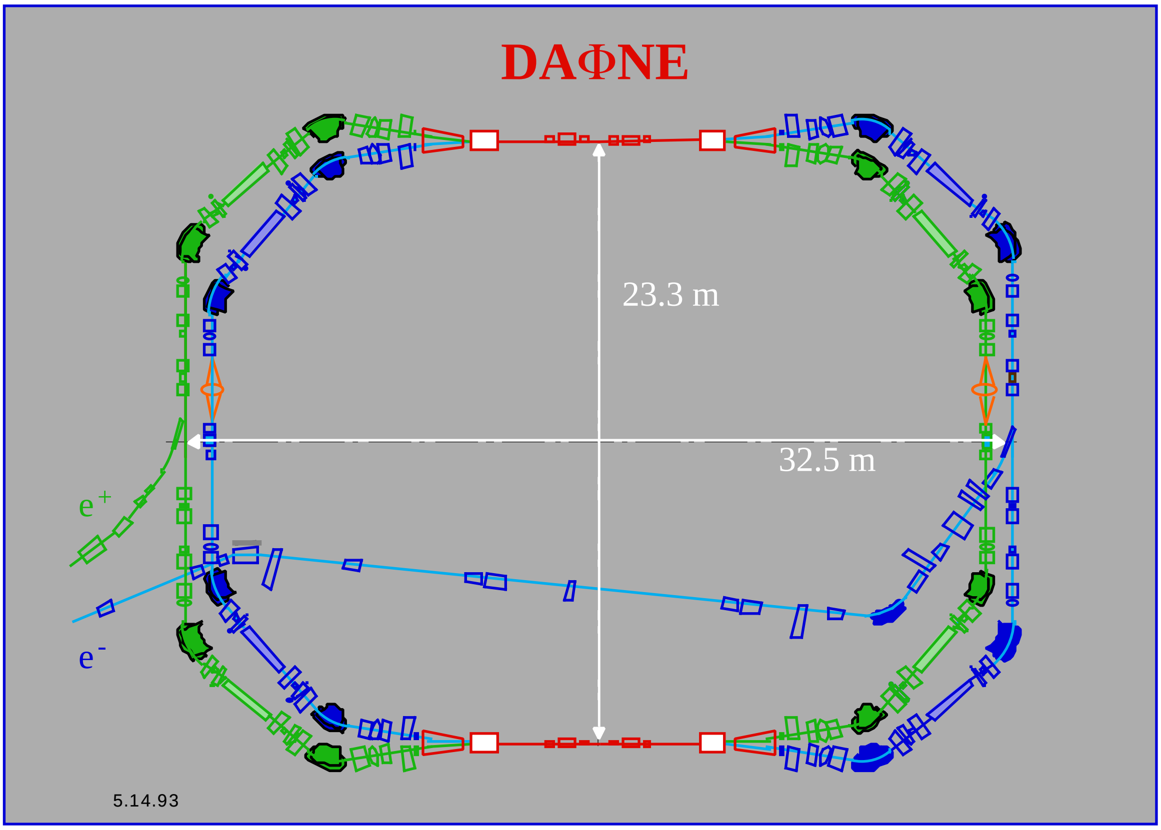


DAΦNE Design Parameters

Energy	510 MeV/beam
Single Bunch Luminosity	$4.4\ 10^{30}\ cm^{-2}\ s^{-1}$
Multibunch Luminosity	$5.3\ 10^{32}\ cm^{-2}\ s^{-1}$
Beam-beam Tune Shift (V/H)	0.04/0.04
Ring Length	97.69 m
Dipole Bending Radius	1.4 m
Natural Emittance	10^{-6} m rad
Coupling	0.01
Natural Relative Energy Spread	$4\ 10^{-4}$
r.m.s. Bunch Length	$3.0\ 10^{-2}$ m
Damping Times (L/T)	17.8/36.0 ms
Beta Functions @ IP (V/H)	4.5/450 cm
Horizontal Crossing Angle	12.5 mrad
Particles/Bunch	$8.9\ 10^{10}$
Max Number of Bunches	120
RF Frequency	368.26 MHz

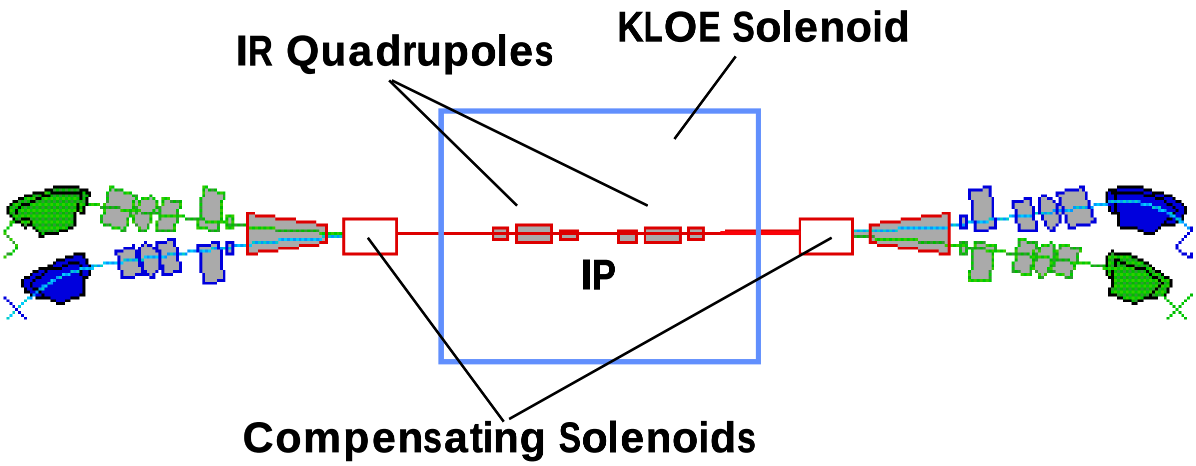
KLOE Detector Implications

Because of the DAΦNE Low Energy The Detector Solenoid Effects Cannot Be Treated as a Lattice Perturbation.

The Solenoidal Field Introduces Coupling between the Vertical and Horizontal Planes that Must Be Carefully Corrected.

Experimental Requirements Concerning Solid Angle Stay Clear Forced to Have Permanent IR Quadrupoles and a Very Reduced Configuration of Beam Dignostics

KLOE Effects Compensation



Solenoid Frame Rotation Angle:

$$\theta_S = \frac{1}{2(B\rho)} \int_{z_1}^{z_2} B_z(s)\,ds$$

Field Integral Compensation:

$$\int_{Comp.1} B_z(s)\,ds + \int_{KLOE} B_z(s)\,ds + \int_{Comp.2} B_z(s)\,ds = 0$$

Rotated IR Quadrupoles to correct Coupling:

$$\theta_n^Q = \frac{1}{2(B\rho)} \int_{IP}^{C_n} B_z(s)\,ds \quad n = 1,2,3 \qquad C_n \equiv \text{n}-\text{th quad center position}$$

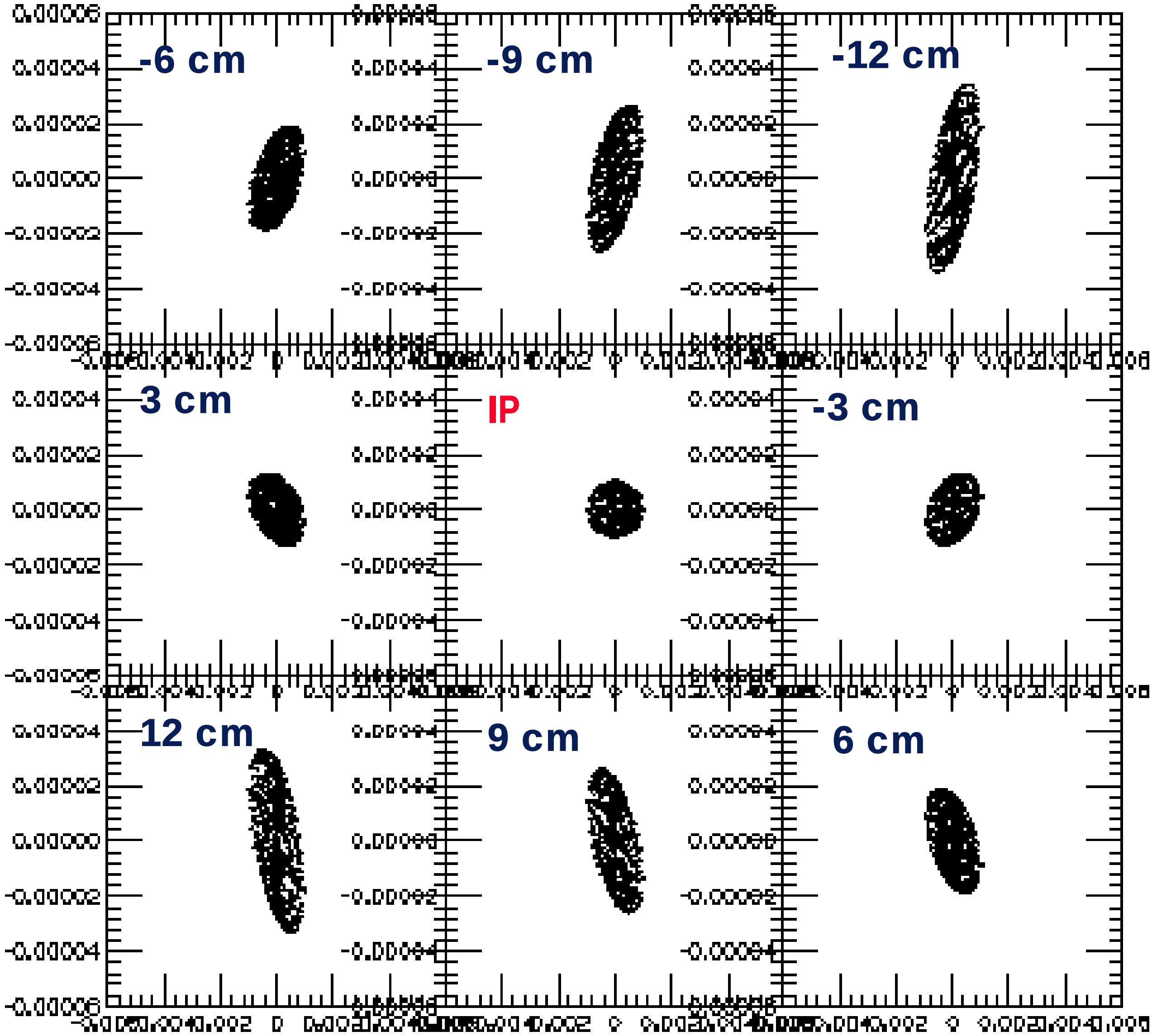
$$B_z = 0.6\ T \qquad (B\rho) = 1.70\ T\ m$$

$$C_1 = 0.53\ m \qquad C_2 = 1.04\ m \qquad C_3 = 1.59\ m$$

$$\theta_1^Q = 5.35\ \text{deg} \quad \theta_2^Q = 10.5\ \text{deg} \quad \theta_3^Q = 16.1\ \text{deg}$$

Solenoid Field Effects @ IR

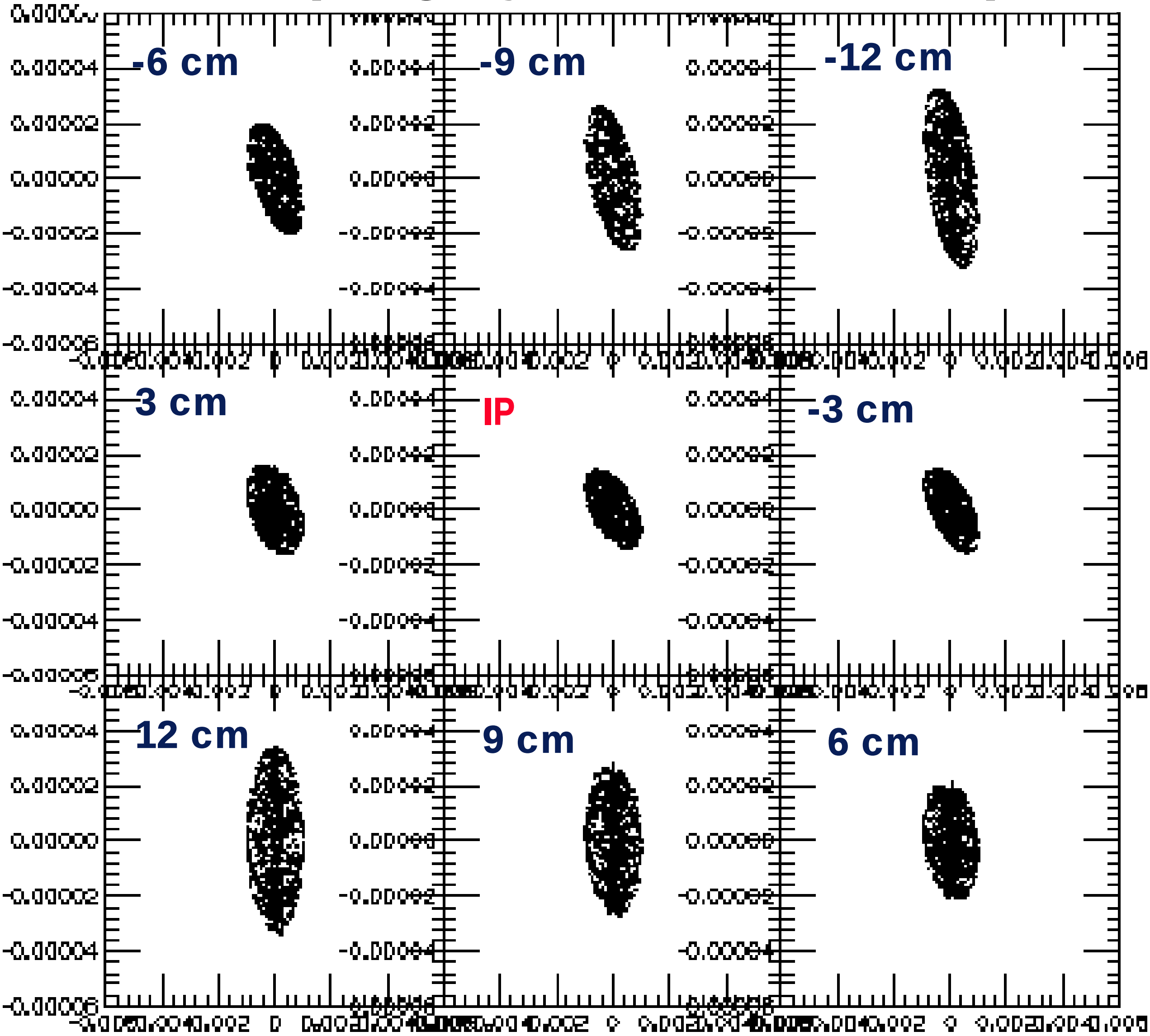
Solenoid Field Effect - No AdditionalCoupling



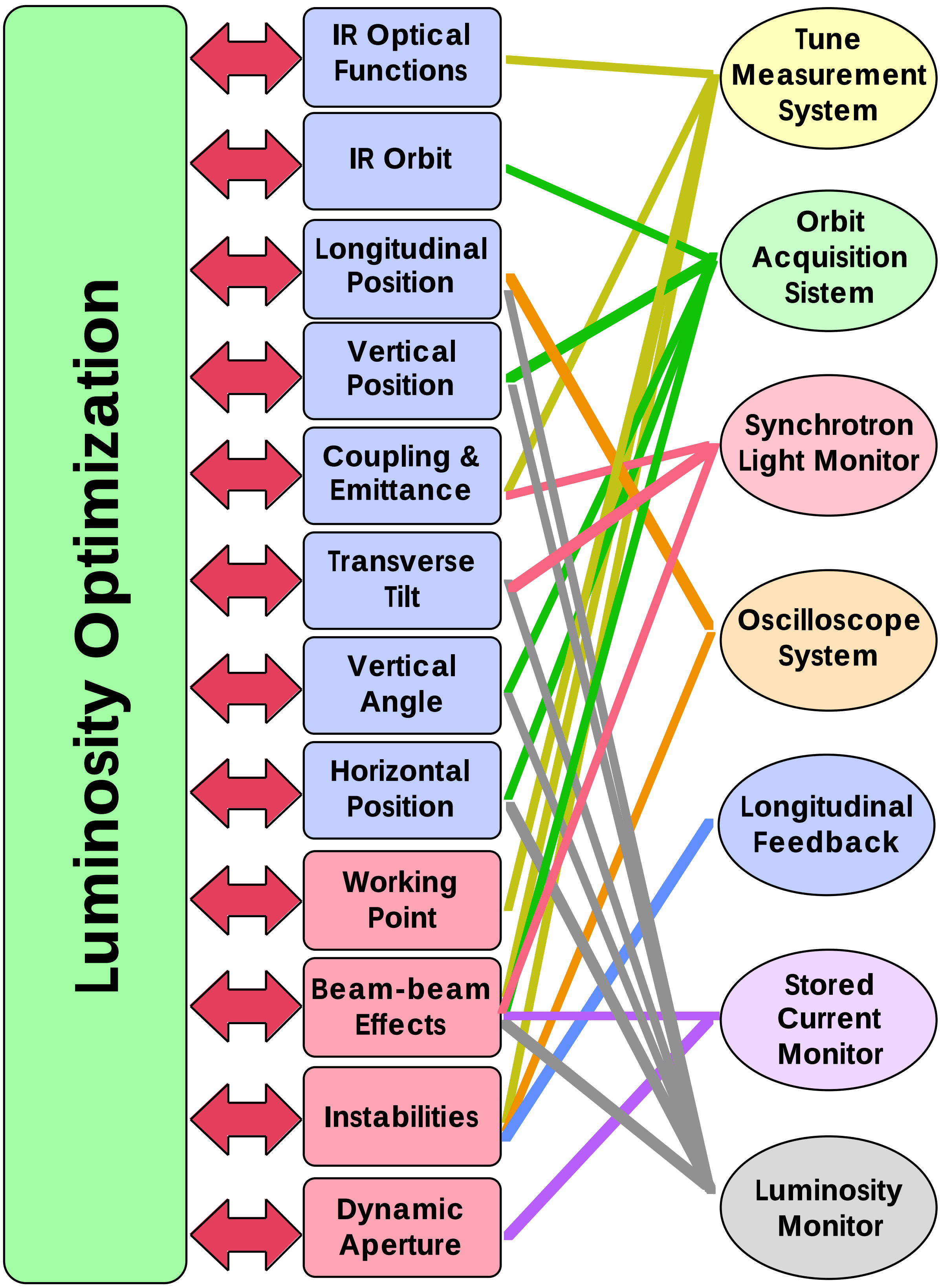
Vertical scale 100 times the Horizontal one

Coupling Effects @ IR

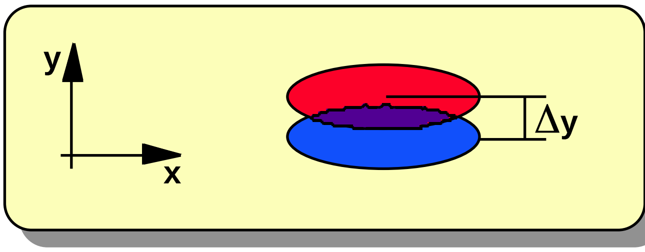
1% Coupling by a Skew Quadrupole



Vertical scale 100 times the Horizontal one


Luminosity Optimization
IR Optical Functions
IR Orbit
Longitudinal Position
Vertical Position
Coupling & Emittance
Transverse Tilt
Vertical Angle
Horizontal Position
Working Point
Beam-beam Effects
Instabilities
Dynamic Aperture
Tune Measurement System
Orbit Acquisition Sistem
Synchrotron Light Monitor
Oscilloscope System
Longitudinal Feedback
Stored Current Monitor
Luminosity Monitor

Vertical Position @ IP

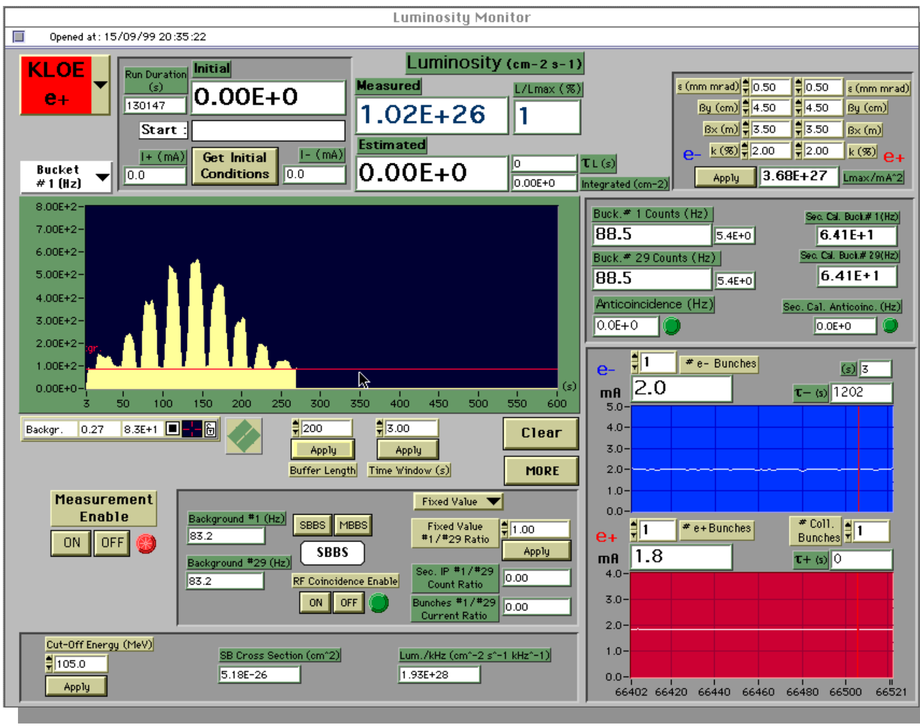


σ_y = 20 μm
with κ = 1%
β_y = 4.5 cm
ε = 10^{-6} m

IR Orbit Correction
± 10 μm

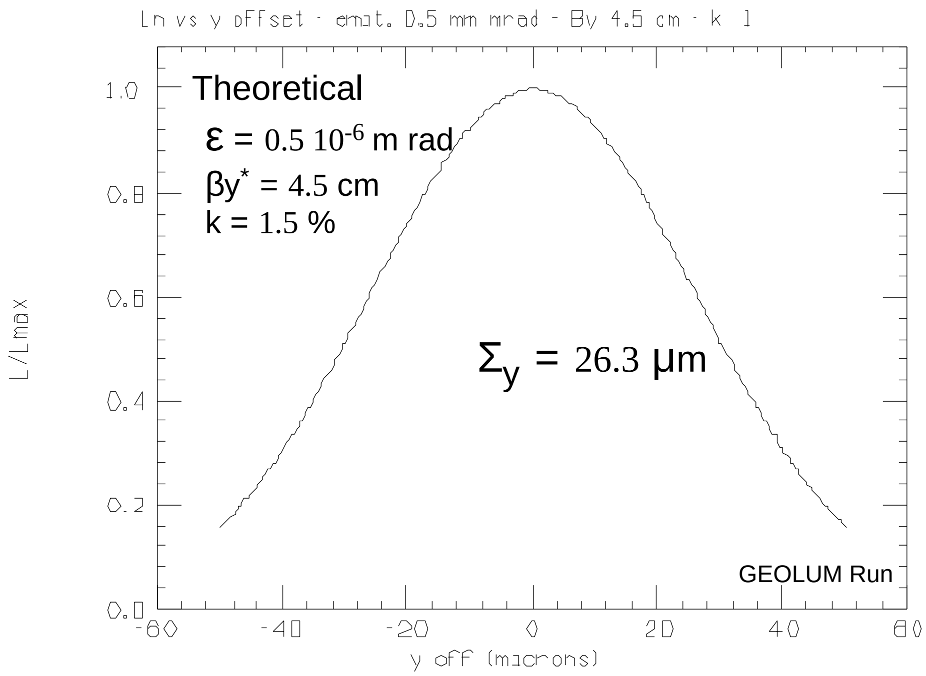
Fine Tuning by Luminosity Scans:
Luminosity vs Vertical Mutual Position
(Single Beam Vertical Bump - 5 μm Step)

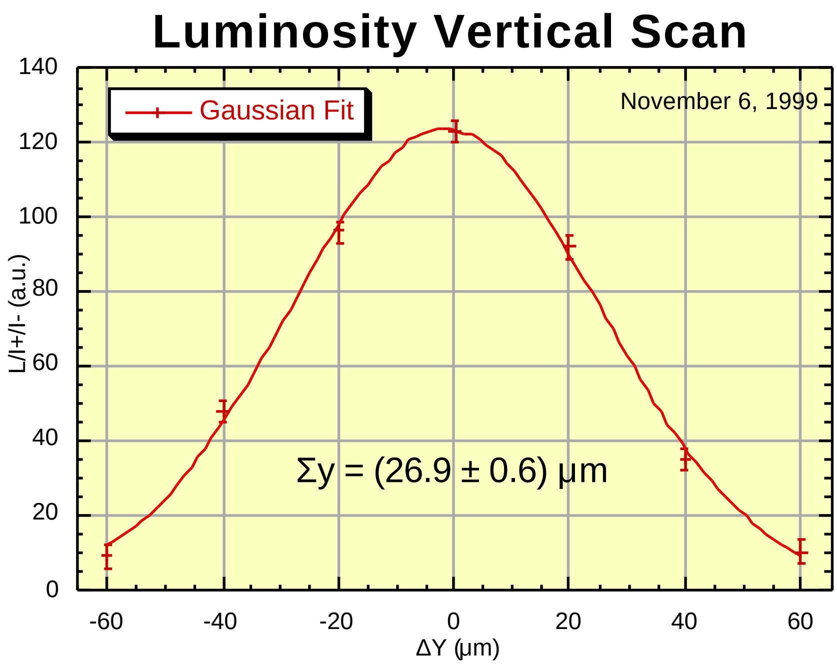
VERTICAL OVERLAP



Luminosity Vertical Scan

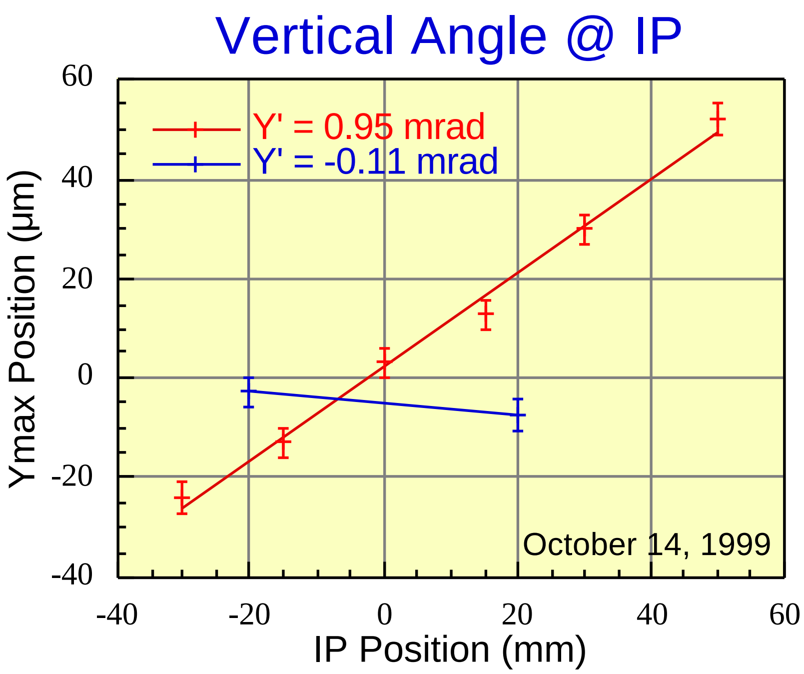
$$\Sigma_y = \sqrt{\sigma_{y+}^2 + \sigma_{y-}^2} \qquad \Sigma_y = \sqrt{2}\ \sigma_y \qquad if: \sigma_{y+} = \sigma_{y-}$$

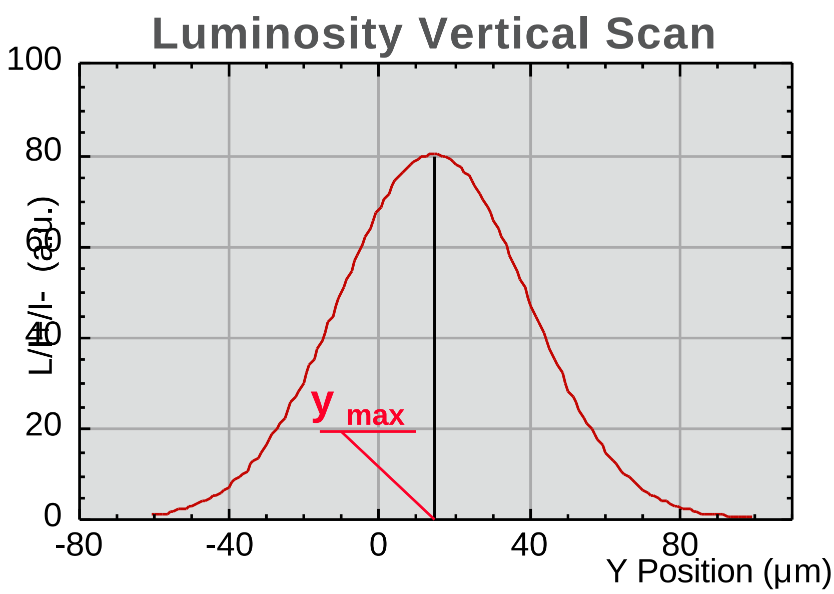




$$\Sigma_y = \sqrt{2}\ \sigma_y \longrightarrow \sigma_y = (19.0 \pm 0.4)\ \mu m$$

IP Vertical Angle Measurement





In the Solenoid Rotating Frame:

$$y_{\max}(z_{IP}) = \left(y'^{+}_{IP} - y'^{-}_{IP}\right)\ z_{IP}$$

IP Optics Measurement

Very Low Currents

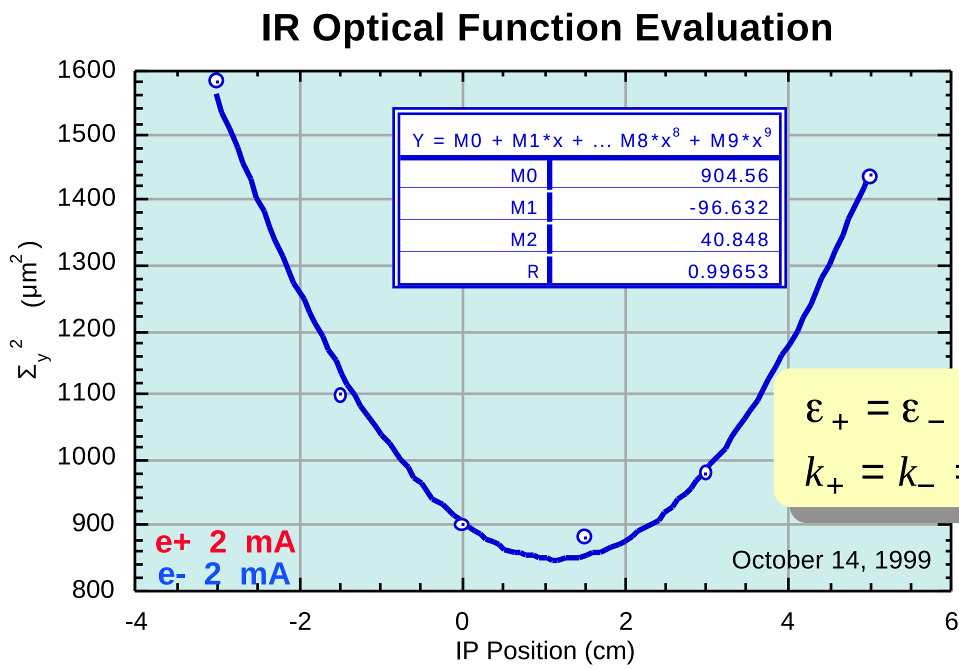
Negligible Beam-Beam Effects

$$if: \quad \eta_y^+ = \eta_y^- = 0 \qquad \varepsilon_+ = \varepsilon_- = \varepsilon \qquad k_+ = k_- = k$$

Fit Function:

$$\Sigma_y^2 = \frac{\varepsilon k}{1+k}\left[\left(\frac{1}{\beta_{y+}} + \frac{1}{\beta_{y-}}\right) z_{IP}^2 - \frac{2w}{\beta_{y-}} z_{IP} + \beta_{y+} + \beta_{y-} + \frac{w^2}{\beta_{y-}}\right]$$

$\Sigma_y = \sqrt{\sigma_{y+}^2 + \sigma_{y-}^2}$ by Luminosity Scans or Beam − Beam Deflection

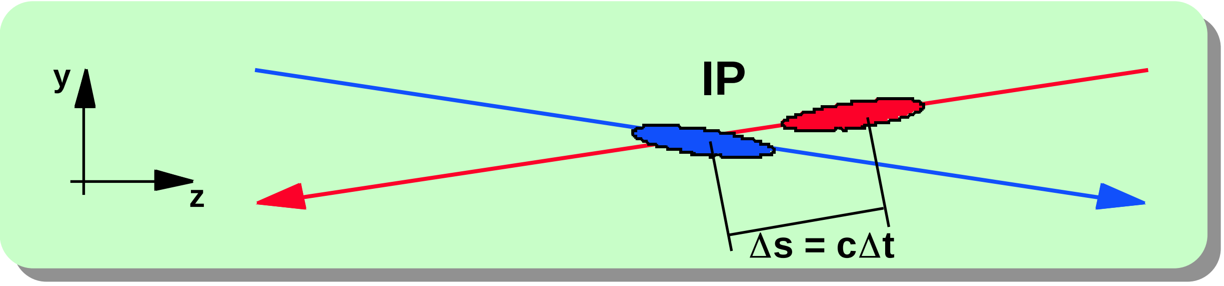


$$\varepsilon_+ = \varepsilon_- = 5\ 10^{-7}\ m\ rad$$
$$k_+ = k_- = 1.5\ \%$$

$$\beta_{y+} = 2.5\ cm \qquad \beta_{y-} = 6.9\ cm$$

w = waists reciprocal distance = 4.5 cm

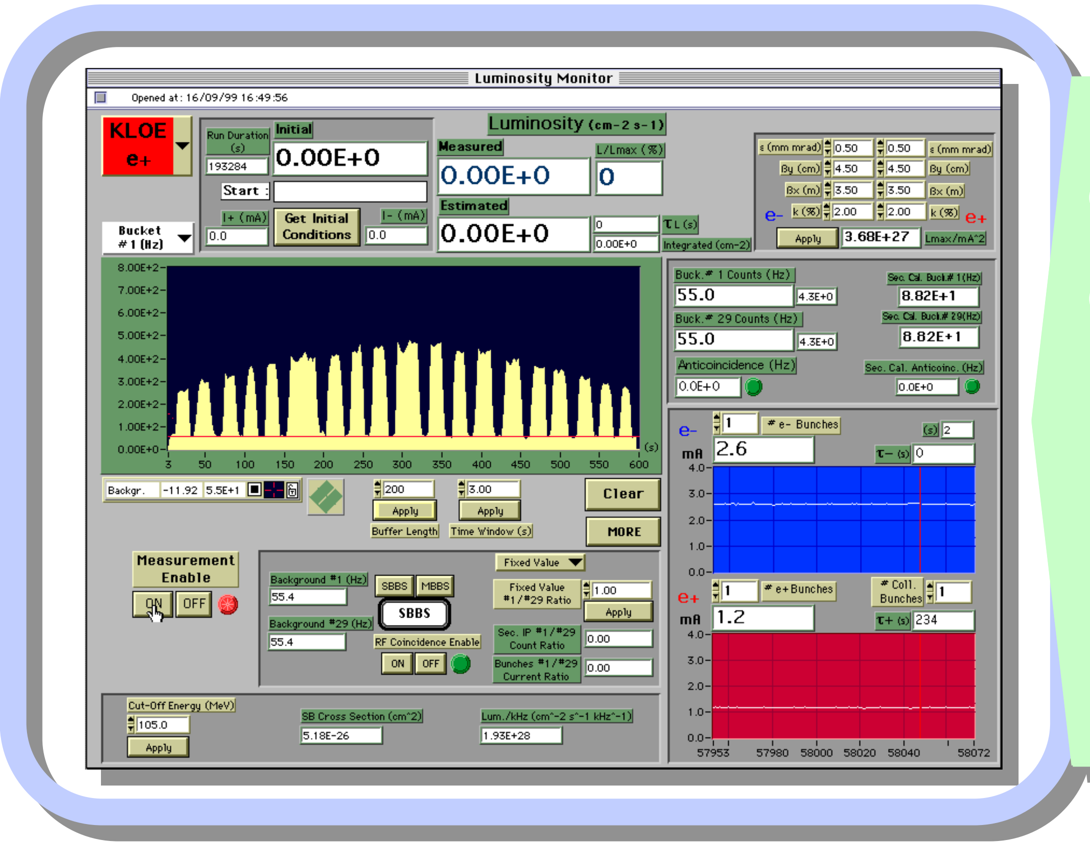
Longitudinal Position @ IP



Positioning by IR BPM's
± 20 ps

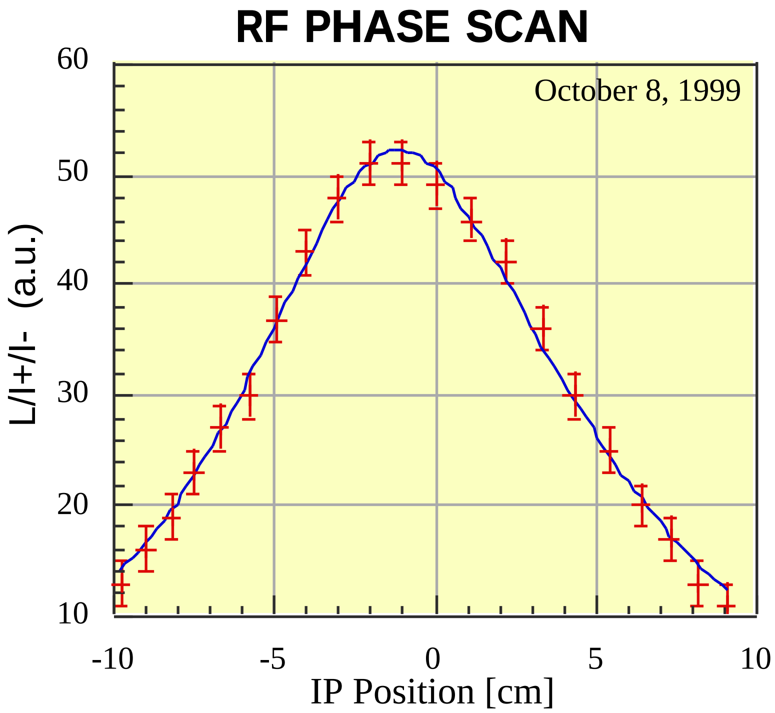
σ_t = 33 ÷ 100 ps
⇔
σ_s = 1÷ 3 cm

Fine Tuning by Luminosity Scans:
Luminosity vs RF Cavity Phase
(5 ps Step)



L O N G I T U D I N A L

Luminosity Longitudinal Scan



Measured Quantities:

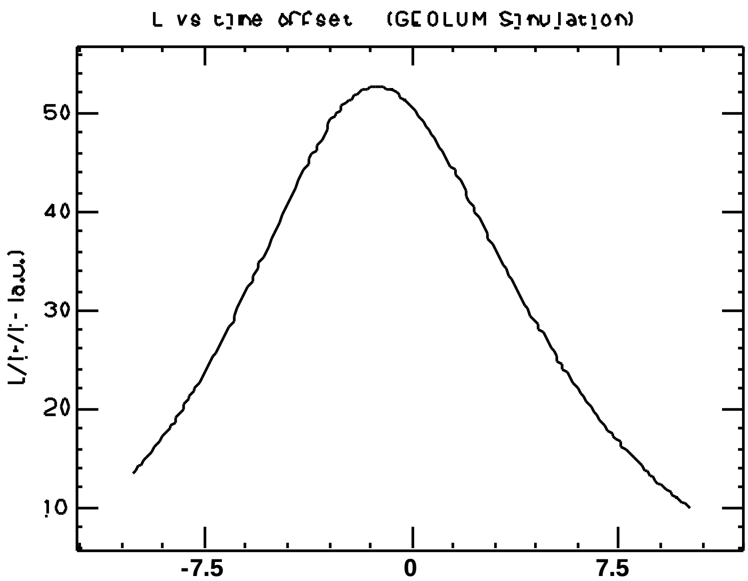
α = 12.5 *mrad*

$\varepsilon^+ = \varepsilon^- = 0.5 \; 10^{-6}$ *m rad*

$\beta^*_x = \beta^*_y$ = 4.5 *m*

k^+ = 2.7 %

k^- = 4.0 %



Fit Results:

$\beta_+ = 4.02 \; cm$

$\beta_- = 5.25 \; cm$

$w_- = -2.72 \; cm$

$w_+ = -0.39 \; cm$

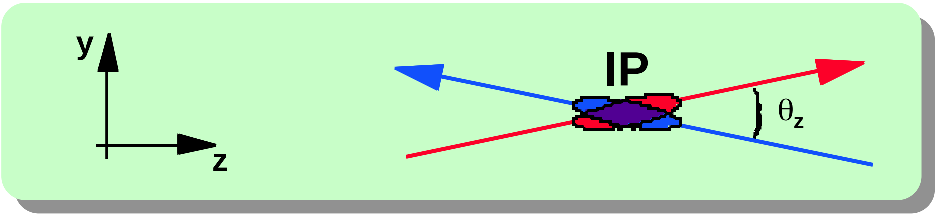
$\Delta x = -36.1 \; \mu m$

$A = 28.72$

Fit Function:

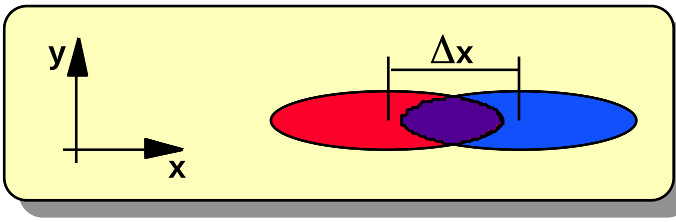
$$L(z_{IP}) = \frac{A e^{-\frac{(\Delta x + 2\alpha z_{IP})^2}{4\sigma_x^2}}}{\sqrt{k_+(1+k_-)\beta_{y+}\left[1+\left(\frac{z_{IP}-w_+}{\beta_{y+}}\right)^2\right] + k_-(1+k_+)\beta_{y-}\left[1+\left(\frac{z_{IP}-w_-}{\beta_{y-}}\right)^2\right]}}$$

Vertical Angle



IR Orbit Correction → Fine Tuning by Luminosity Scans:
Luminosity vs Mutual Vertical Angle
Single BeamBump with 50 μrad Step

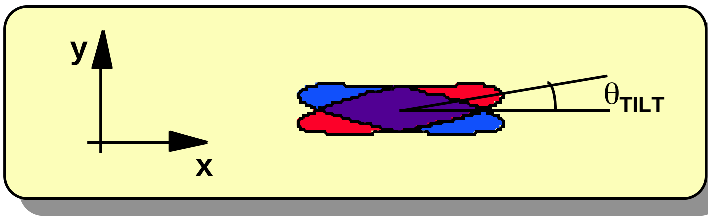
Horizontal Position



σ_x = 2.1 mm
with κ = 1%
$\varepsilon = 10^{-6}$ m
β_x = 4.5 m

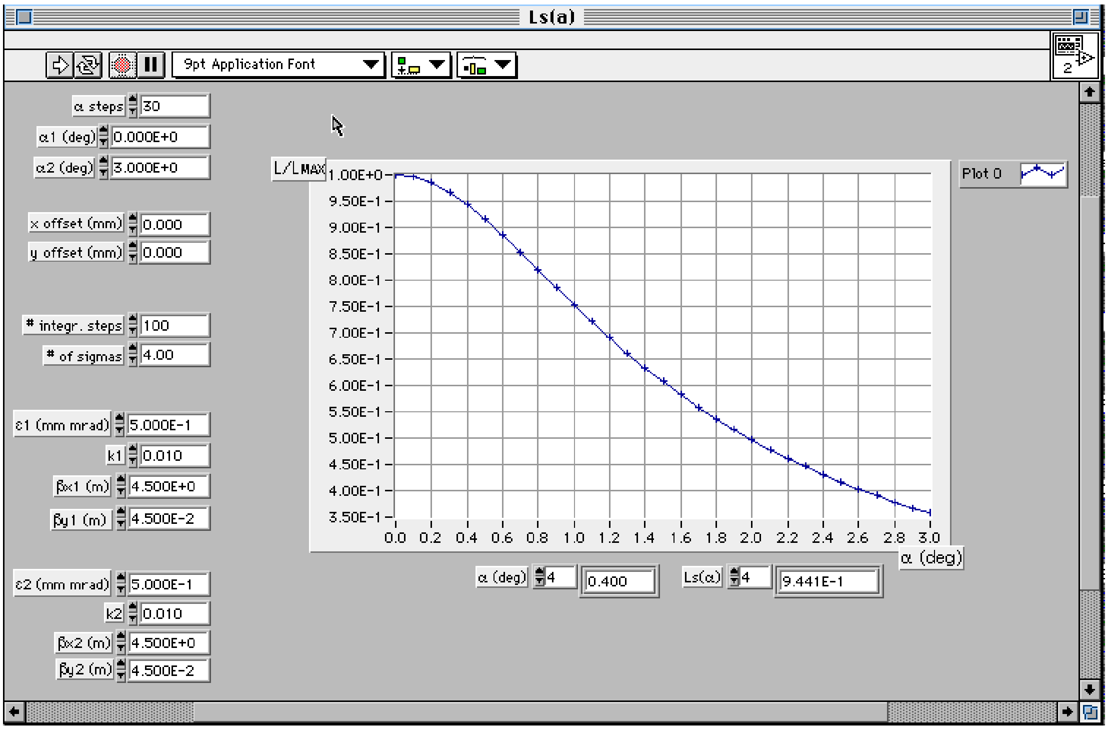
Fine Tuning by Luminosity Scans:
Luminosity vs Horzontal Mutual Position
Single BeamBump with 100 μm Step

Transverse Tilt

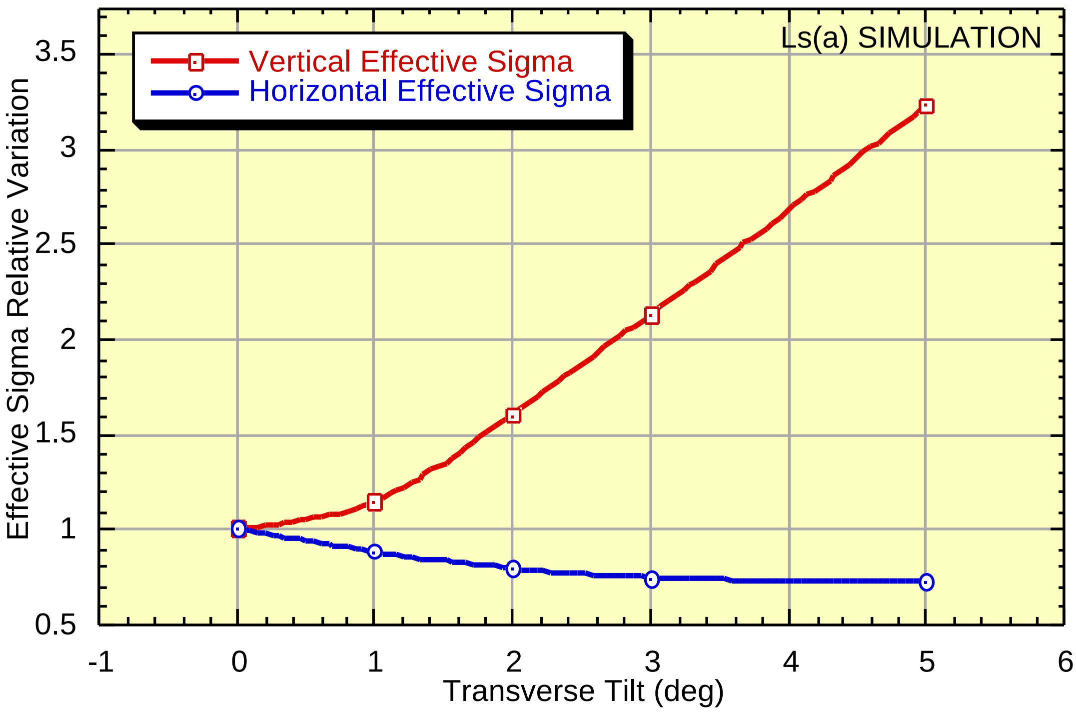


$\theta_{TILT} = 0$ → Luminosity Maximum → Luminosity Scans:
Luminosity vs Skew
Quad Adjustment

Transverse Tilt Geometrical Effect

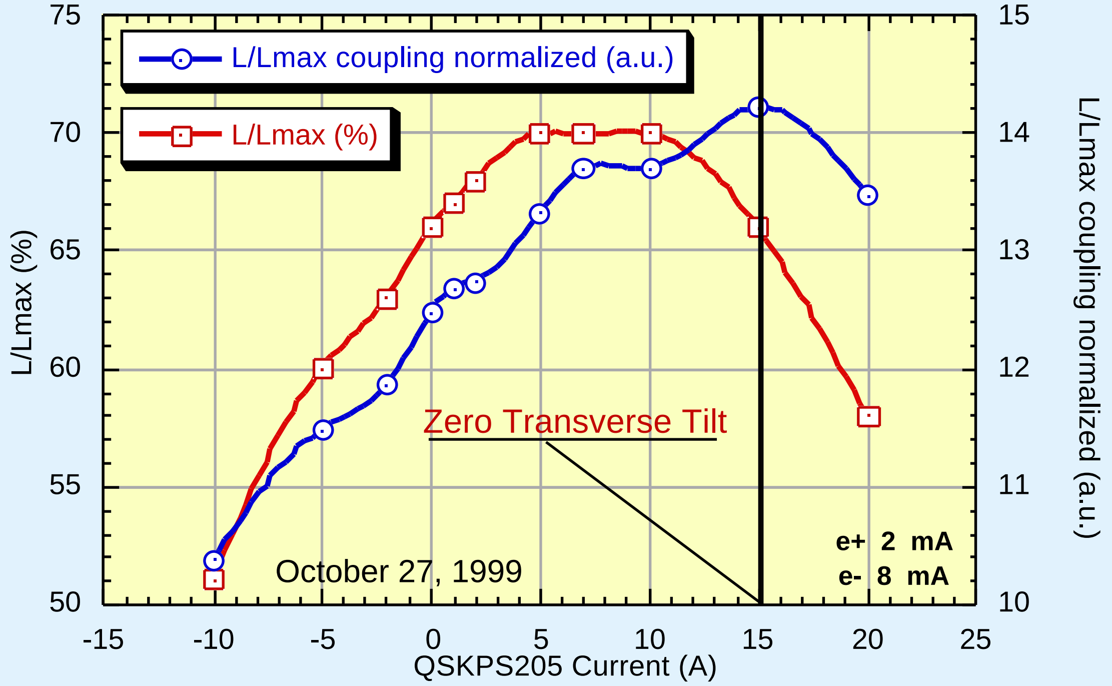


Effective Sigmas vs Transverse Tilt



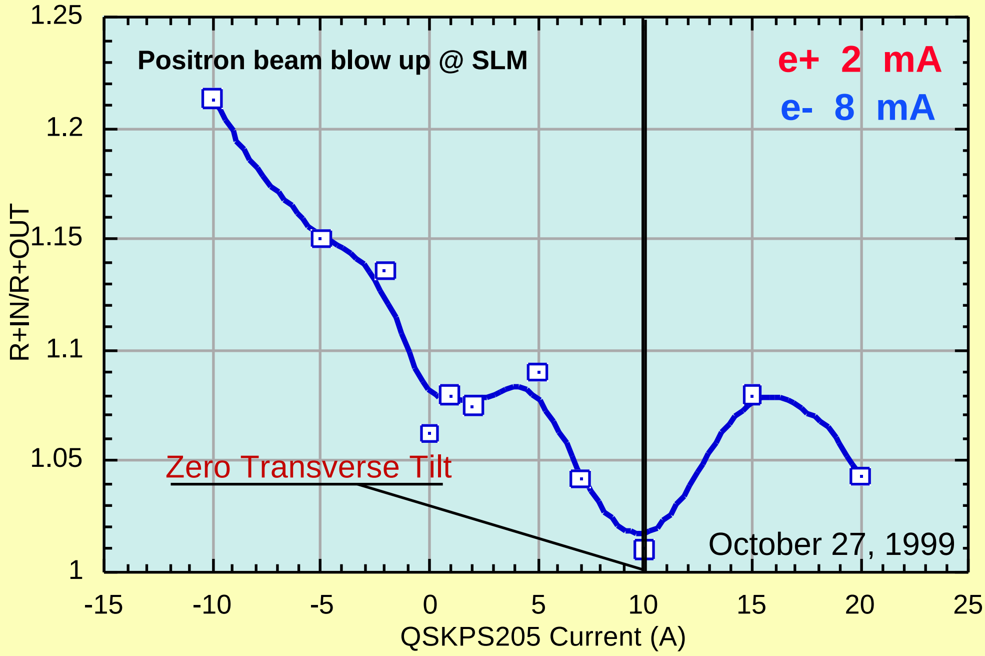
Transverse Tilt Estimate

Luminosity vs Skew Quad Current

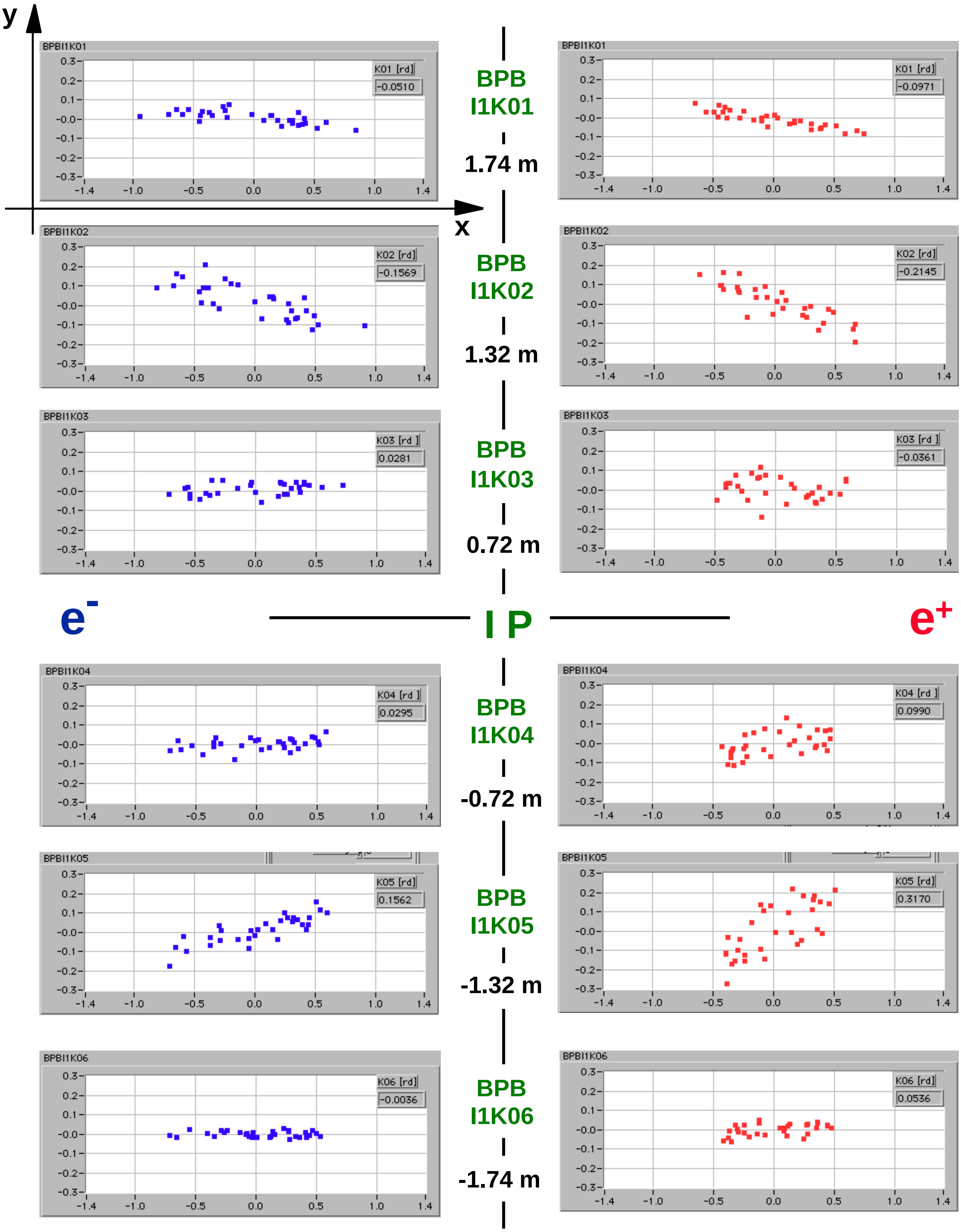


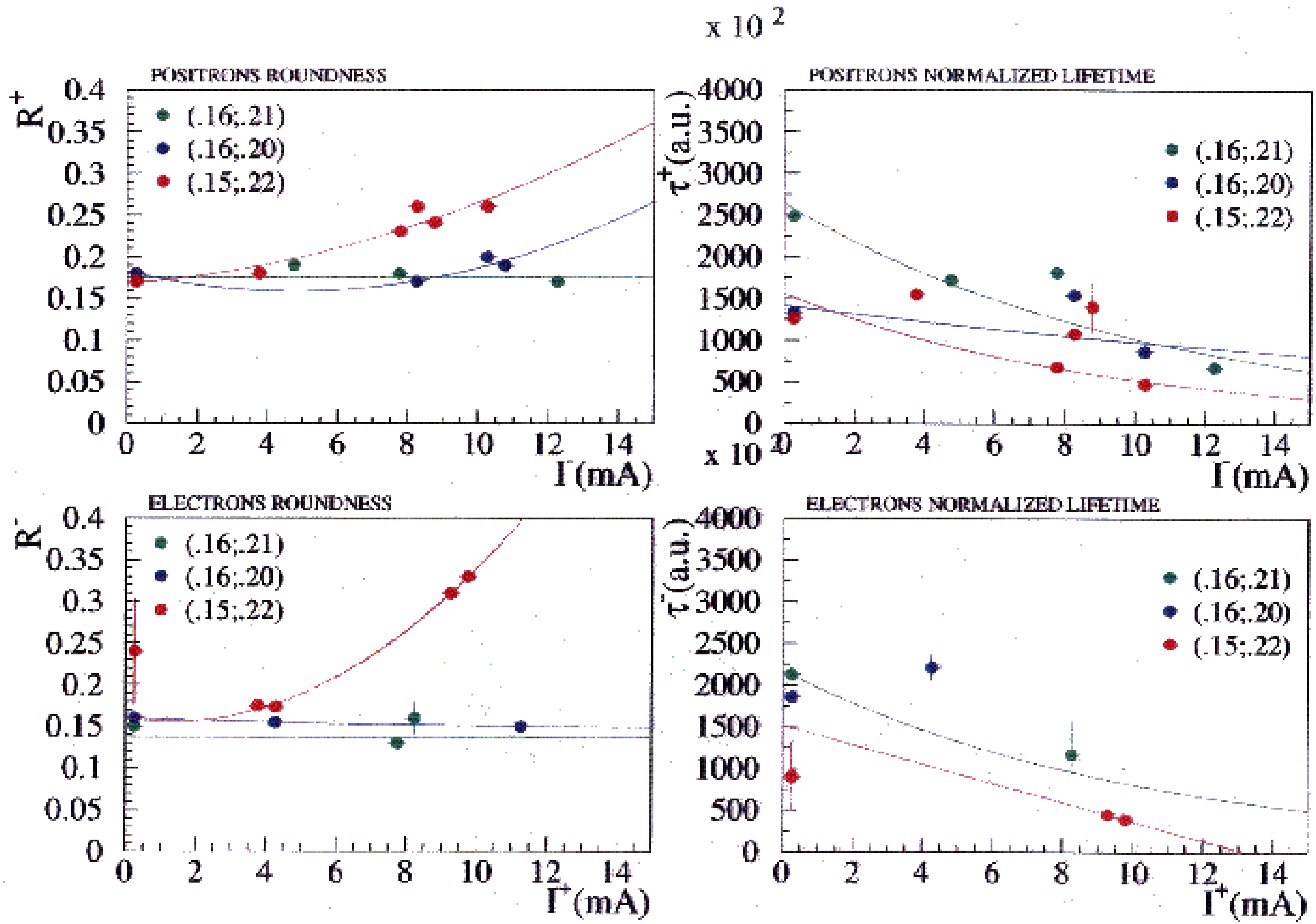
$$L \quad \frac{1}{\sqrt{\frac{k_+}{1+k_+}+\frac{k_-}{1+k_-}}} \qquad \mathit{if} \qquad \beta_x^{\;+}=\beta_x^{\;-},\;\; \beta_y^{\;+}=\beta_y^{\;-},\;\; \varepsilon_+=\varepsilon_- \;\; \mathit{and} \;\; k_\pm <<1$$

Blow up vs Skew Quad Current



Response Matrix
IP Coupling Analysis

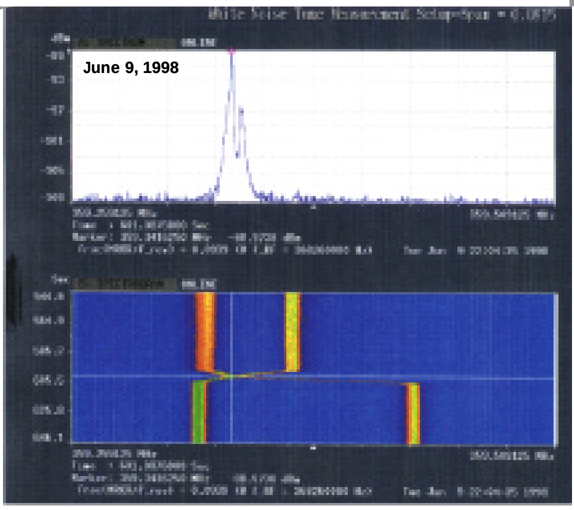




POSITRONS ROUNDNESS
POSITRONS NORMALIZED LIFETIME
ELECTRONS ROUNDNESS
ELECTRONS NORMALIZED LIFETIME
(.16;.21)
(.16;.20)
(.15;.22)
x 10 2
R+
R-
τ+(a.u.)
τ-(a.u.)
I-(mA)
I+(mA)

Tune Monitor Measurements

Coupling Measurement

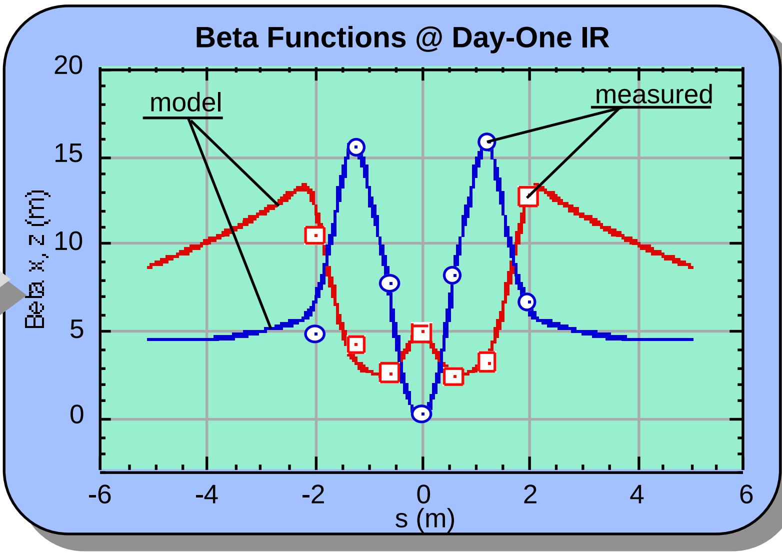


Closest Tune Approach

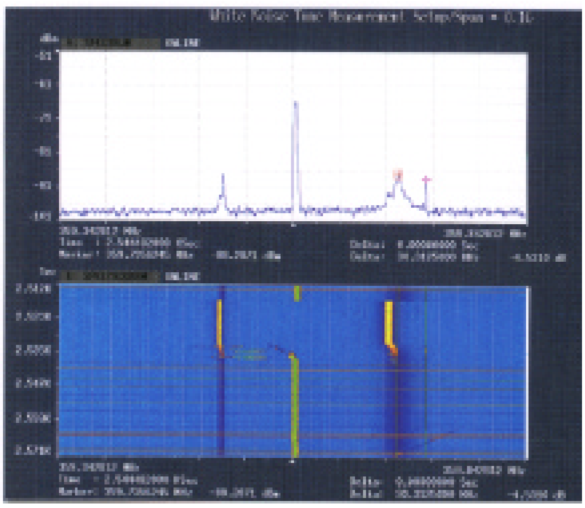
$$k = 1 - \frac{2r^2 + 1}{4r^2 + 1}$$

$$r = \frac{\Delta q}{2|q_H - q_V|}$$

$$\Delta q = -\frac{1}{4\pi} L\beta\Delta k^2$$



Coherent Beam-Beam



Tune Shift

and:

Ion Trapping,
Chromaticity,
Instabilities,
. . .

Beam-Beam Tune Shift Measurement

Incoherent B-B Tune Shift

$$\xi^{\pm}_{x,y} = \frac{r_e \beta^{\pm}_{x,y} N^{\mp}}{2\pi\gamma\,\sigma^{\mp}_{x,y}\left(\sigma_x^{\mp} + \sigma_y^{\mp}\right)}$$

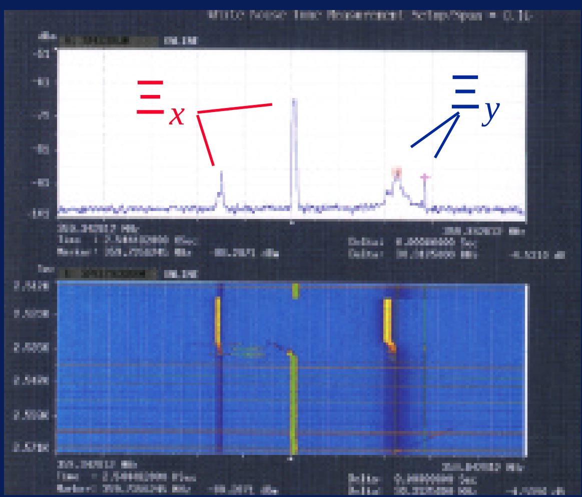
Flat Beam Coherent B-B Tune Shift

$$\Xi_x \quad 1.33\,\xi_x \qquad\qquad \Xi_y \quad 1.24\,\xi_y$$

K.Yokoya, H.Koiso

Example: (7 + 7) mA

(September 30, 1999)



$$\varepsilon = 5\ 10^{-7}\quad m\ rad$$

$$k = 0.029$$

$$E = 510\ \ MeV$$

$$N = 1.42\ \ 10^{10}$$

$$\beta_x = 4.5\ \ m$$

$$\beta_y = 4.5\ \ cm$$

$$\xi_x^{Theor.} = 0.0129$$

$$\xi_y^{Theor.} = 0.0073$$

$$\Xi_x = 0.0169$$

$$\Xi_y = 0.009$$

$$\xi_x^{Meas.} = 0.0127$$

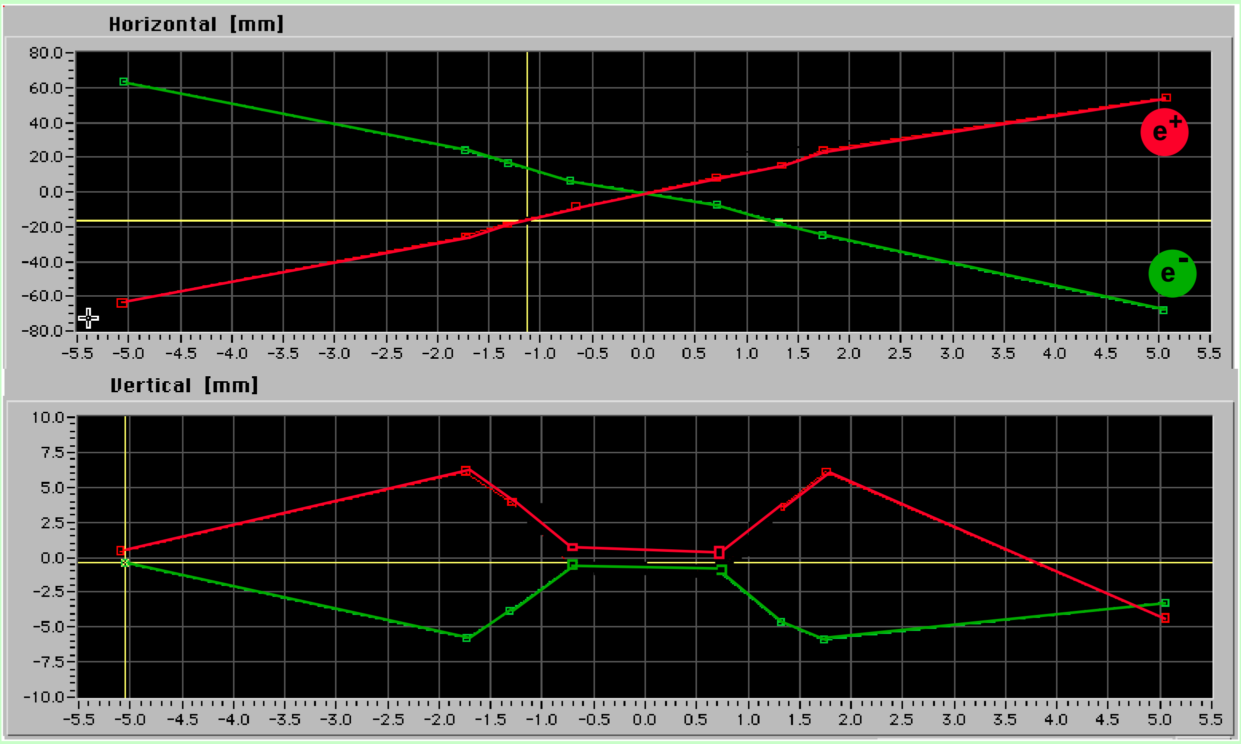
$$\xi_y^{Meas.} = 0.0074$$

WARNING: Perturbative Measurement !

Orbit Aquisition System Measurements

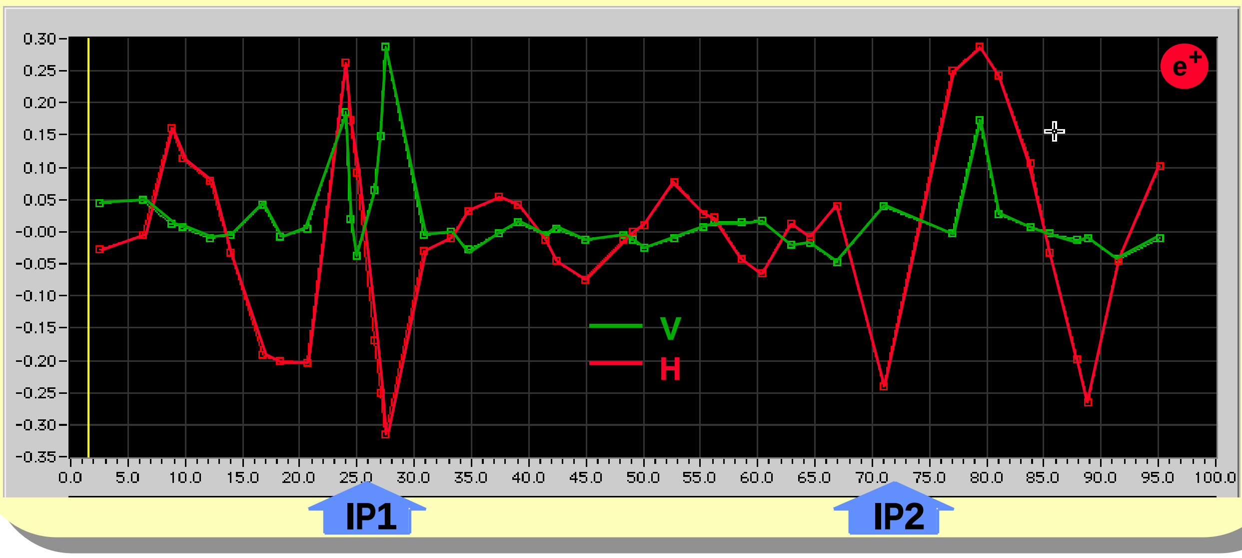
Orbit measurement at IR

(IR1)



Beam-Beam Deflection Orbit

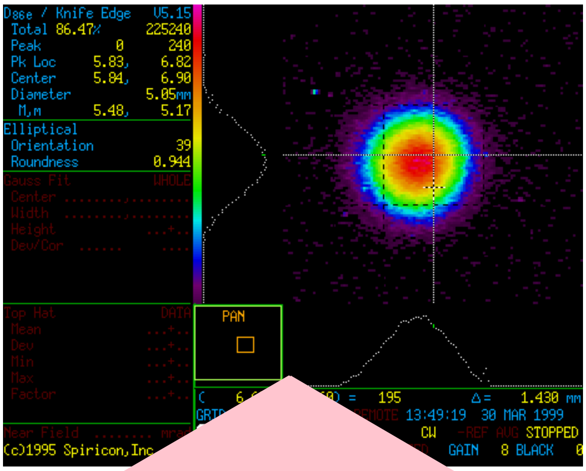
IP1 Colliding Beams
IP2 Separated Beams

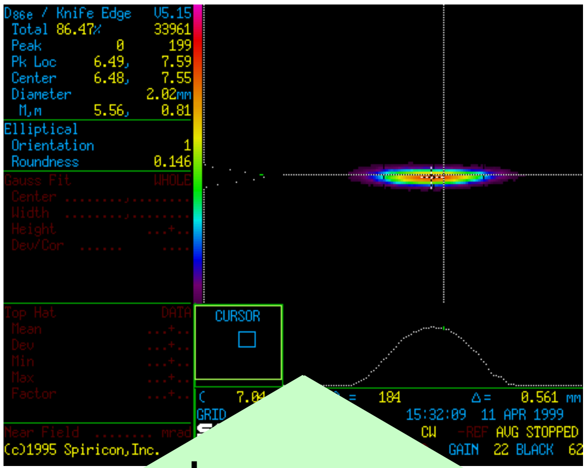


+ Global Orbit, Global and IR Dispersion, ...

SLM Measurements

Coupling Measurement





First Stored e$^+$ with KLOE Magnet ON:
45% Coupling!
(March 30, 1999)

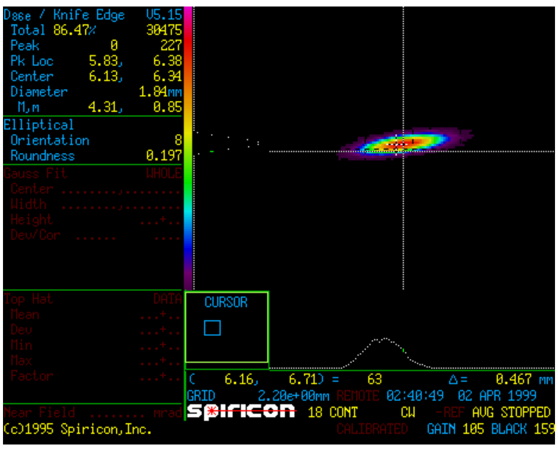
e$^+$ beam after compensating the KLOE Magnet Field:
1.1% Coupling!
(April 11, 1999)

Emittance

$$\varepsilon = (1+\kappa)\frac{\sigma_x^2}{\beta_x} \quad \text{if } \eta_x = 0$$

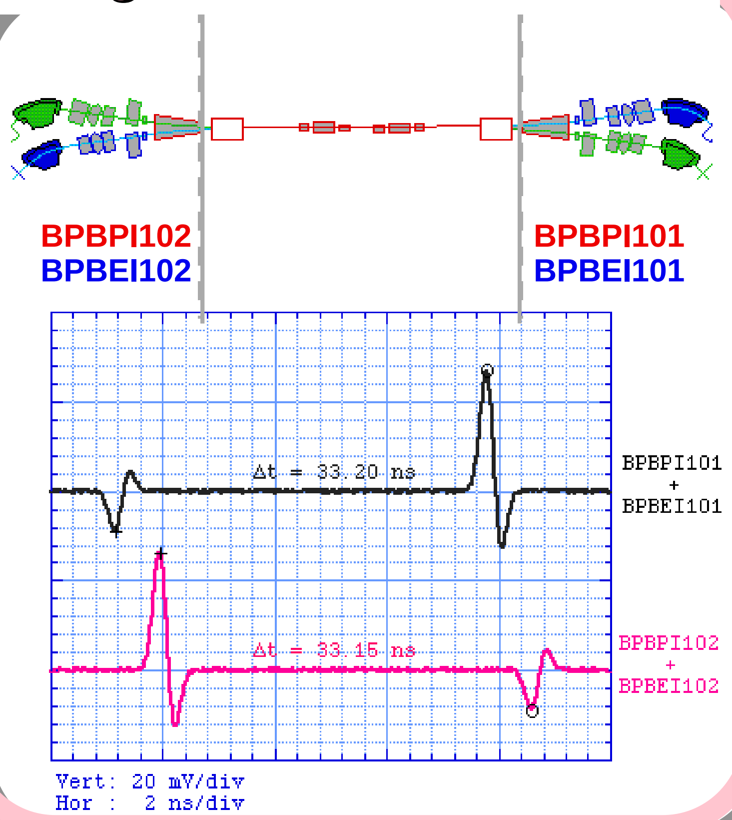
ε^+= (0.5 ± 0.1) 10^{-6} m rad
ε^-= (0.5 ± 0.1) 10^{-6} m rad
April 25, 1999

Tilt Measurement



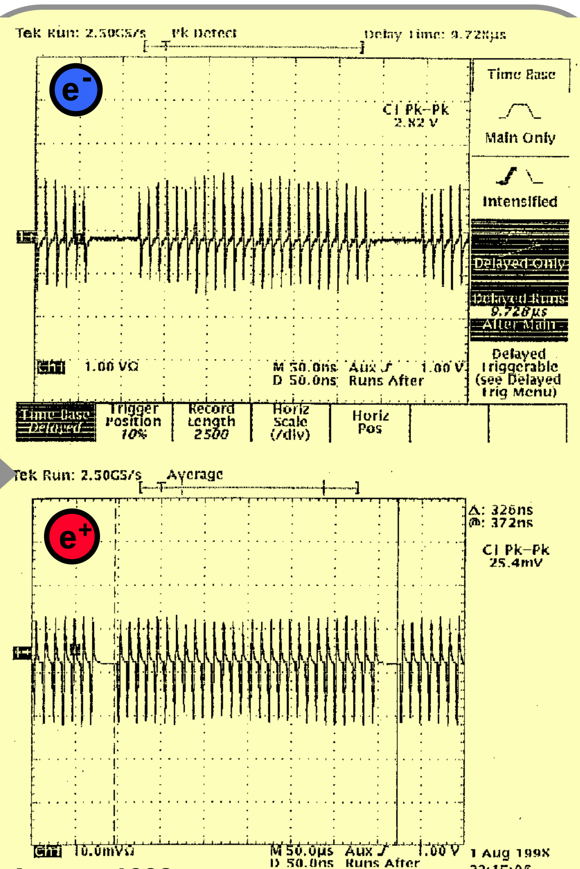
Oscilloscope System

Longitudinal Position @ IP



500 MHz 1.5 GS/s Digital Scope + RF MUX

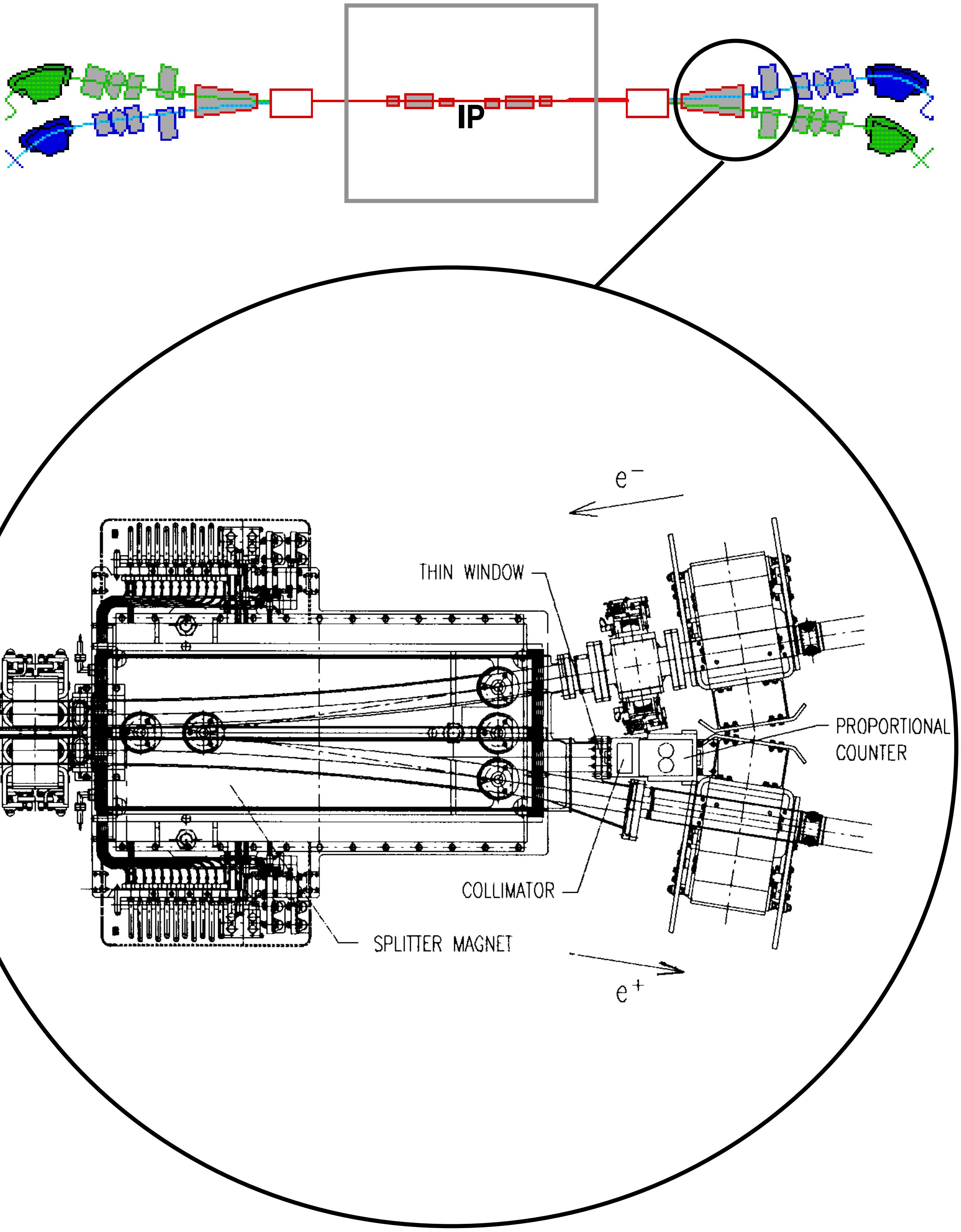
Multibunch filling pattern



August, 1998

Luminosity Monitor
Proportional Counter Position

KLOE Interaction Region

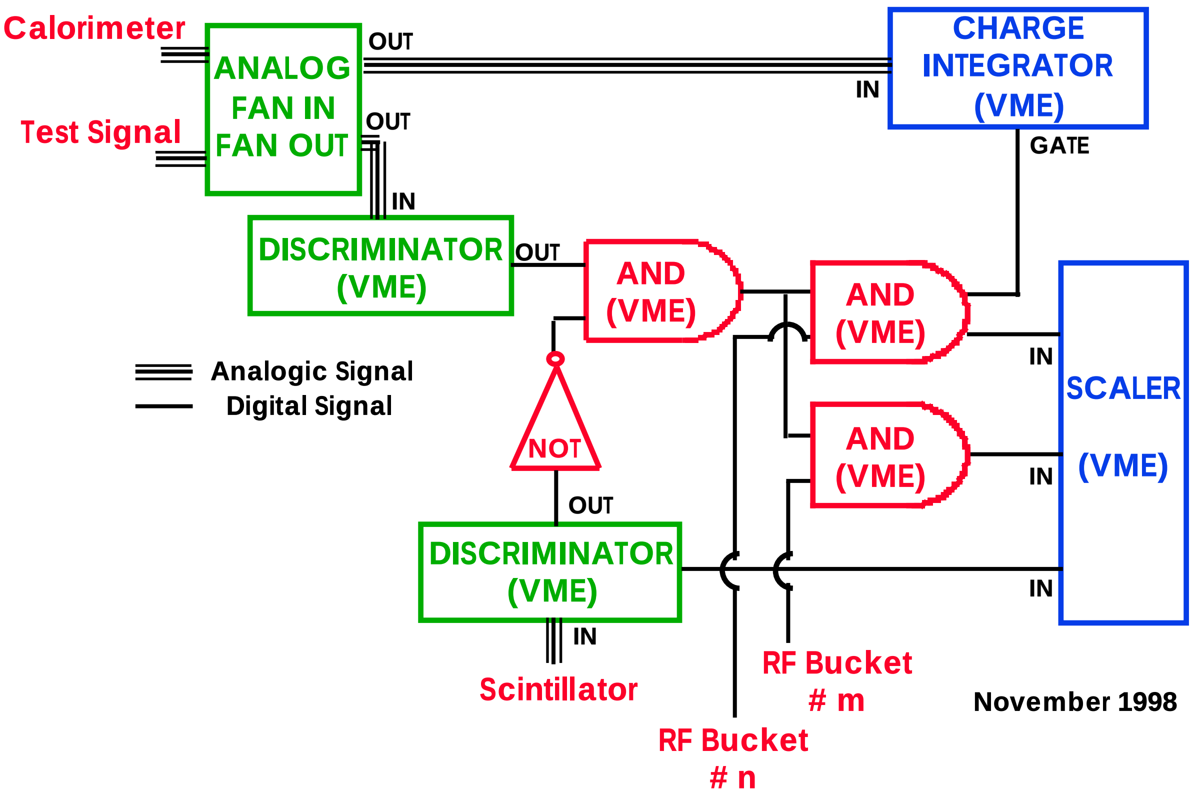


Luminosity Monitor

Single Bremsstrahlung:

$$e^+ + e^- \rightarrow e^+ + e^- + \gamma$$

$$L = \dot{N}_{SB} \Big/ \int_{E_T}^{E_{MAX}} dE \int_{\Omega_D} d\Omega \frac{\partial^2 \sigma_{SB}}{\partial E \partial \Omega}$$

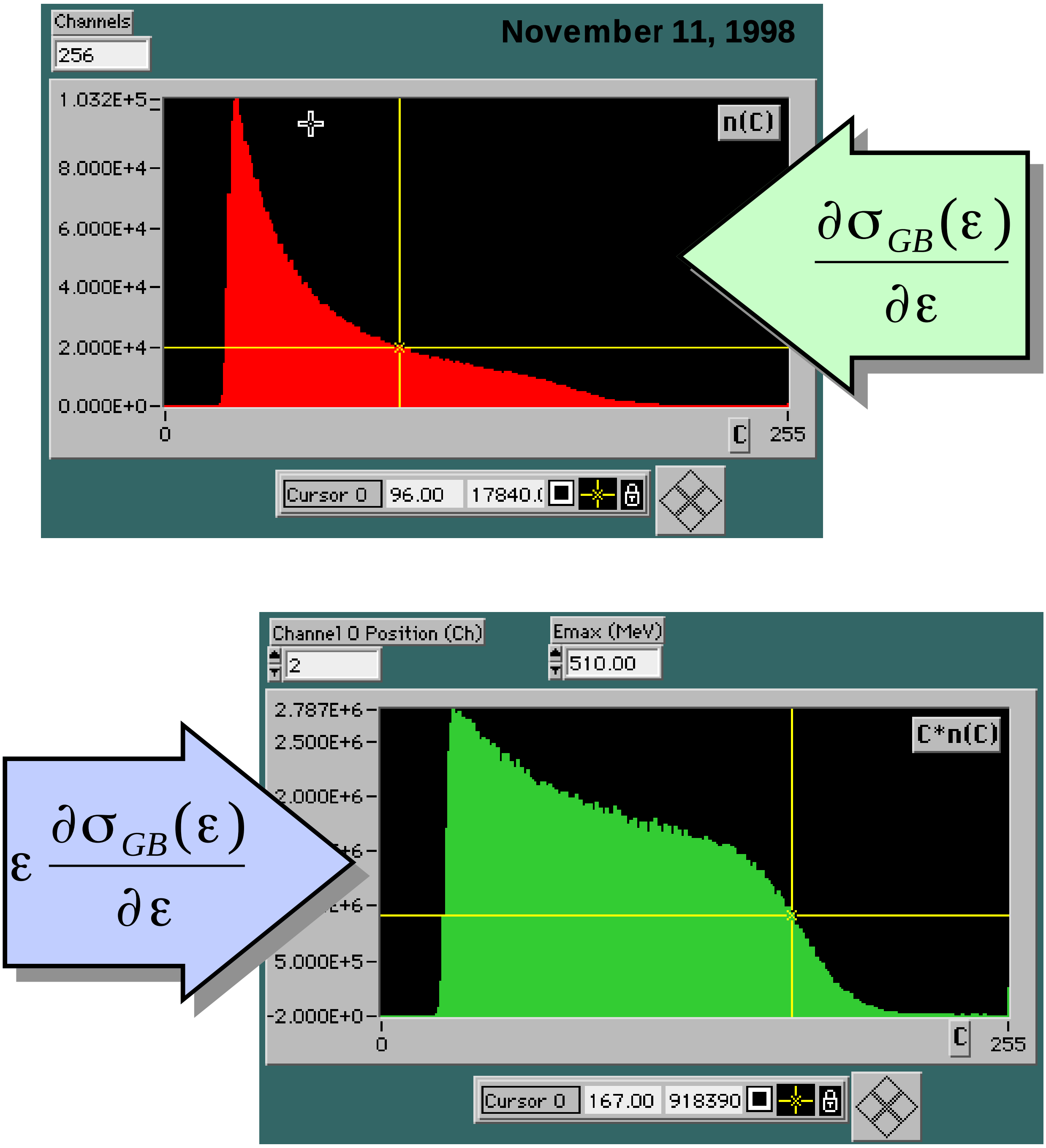


November 1998

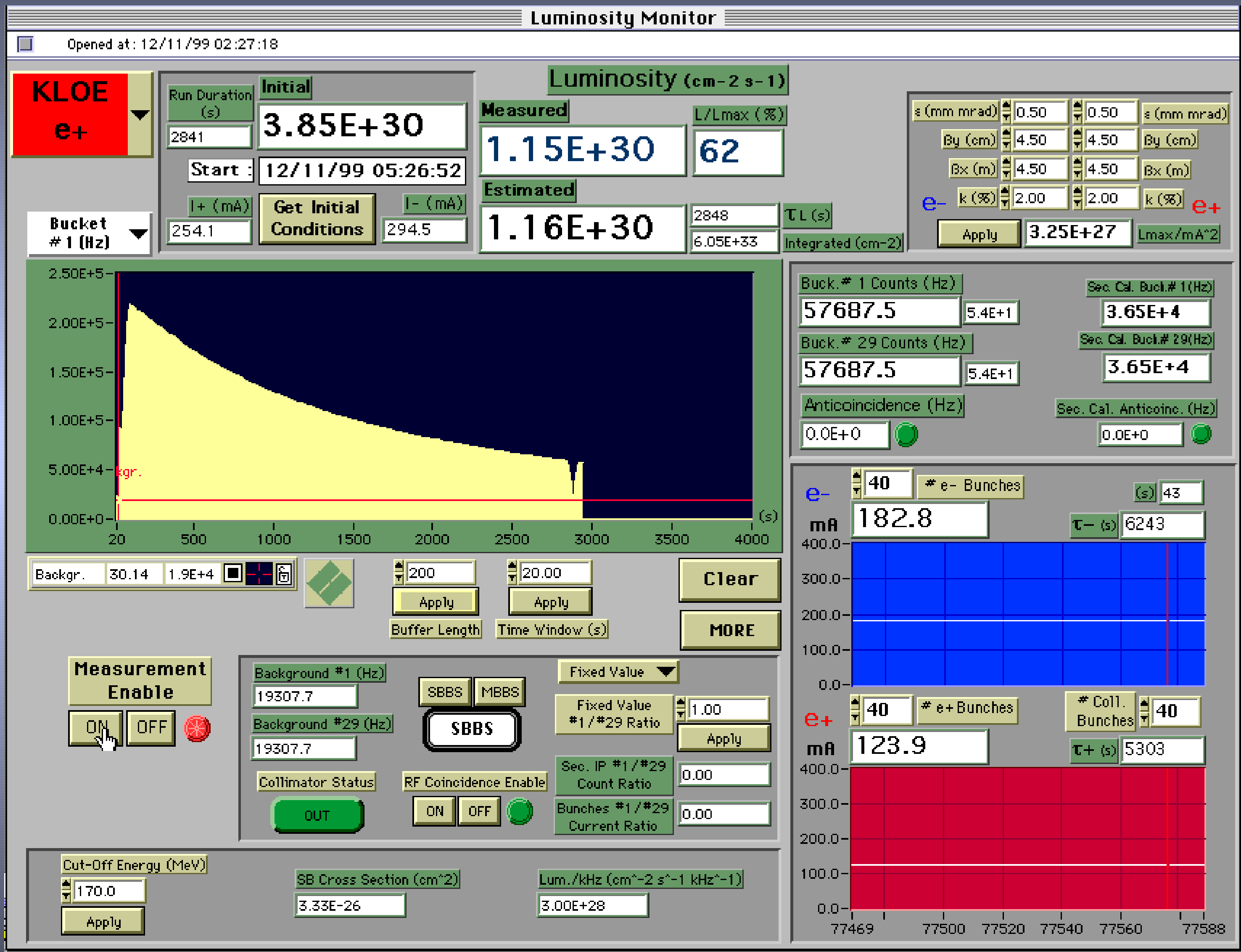
CALORIMETER:

KLOE-like Proportional Counter
Alternated Layers of Lead (0.5 mm) and Scintillating Fibers (1 mm diameter)
(by F.Cervelli INFN PISA)

Energy Threshold Calibration by Gas Bremsstrahlung



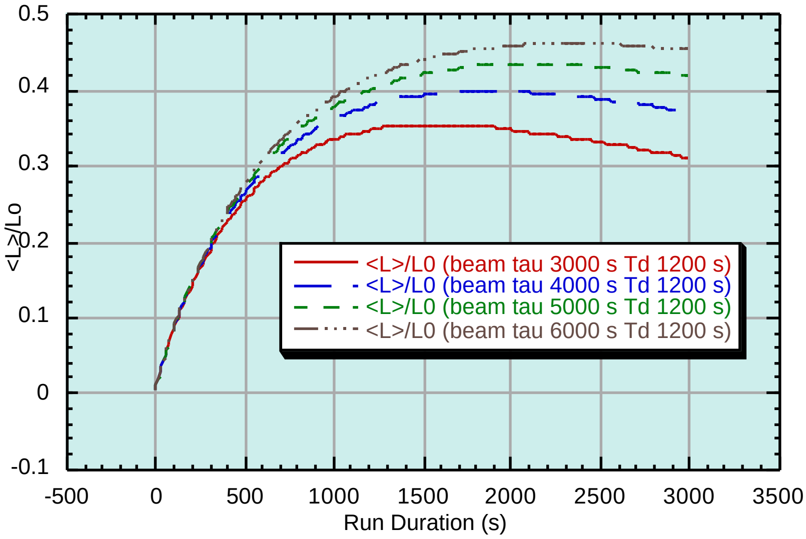
Luminosity Measurement
Total Error < ± 15 %

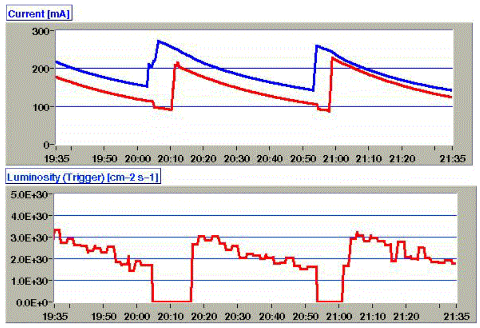


Luminosity Monitor
Opened at : 12/11/99 02:27:18
KLOE
e+
Run Duration (s)
2841
Initial
3.85E+30
Start : 12/11/99 05:26:52
I+ (mA)
254.1
Get Initial Conditions
I- (mA)
294.5
Bucket #1 (Hz)
Luminosity (cm-2 s-1)
Measured
1.15E+30
L/Lmax (%)
62
Estimated
1.16E+30
2848
τL (s)
6.05E+33
Integrated (cm-2)
ε (mm mrad) 0.50 0.50 ε (mm mrad)
βy (cm) 4.50 4.50 βy (cm)
βx (m) 4.50 4.50 βx (m)
e- k (%) 2.00 2.00 k (%) e+
Apply
3.25E+27
Lmax/mA^2
Buck.# 1 Counts (Hz)
57687.5
5.4E+1
Sec. Cal. Buck.# 1(Hz)
3.65E+4
Buck.# 29 Counts (Hz)
57687.5
5.4E+1
Sec. Cal. Buck.# 29(Hz)
3.65E+4
Anticoincidence (Hz)
0.0E+0
Sec. Cal. Anticoinc. (Hz)
0.0E+0
2.50E+5
2.00E+5
1.50E+5
1.00E+5
5.00E+4
0.00E+0
kgr.
20 500 1000 1500 2000 2500 3000 3500 4000
(s)
Backgr. 30.14 1.9E+4
200
Apply
Buffer Length
20.00
Apply
Time Window (s)
Clear
MORE
Measurement Enable
ON OFF
Background #1 (Hz)
19307.7
Background #29 (Hz)
19307.7
SBBS MBBS
SBBS
Fixed Value
Fixed Value #1/#29 Ratio
1.00
Apply
Sec. IP #1/#29 Count Ratio
0.00
Bunches #1/#29 Current Ratio
0.00
Collimator Status
OUT
RF Coincidence Enable
ON OFF
Cut-Off Energy (MeV)
170.0
Apply
SB Cross Section (cm^2)
3.33E-26
Lum./kHz (cm^-2 s^-1 kHz^-1)
3.00E+28
e-
40
e- Bunches
(s) 43
mA
182.8
τ- (s) 6243
400.0 300.0 200.0 100.0 0.0
e+
40
e+ Bunches
Coll. Bunches
40
mA
123.9
τ+ (s) 5303
400.0 300.0 200.0 100.0 0.0
77469 77500 77520 77540 77560 77588

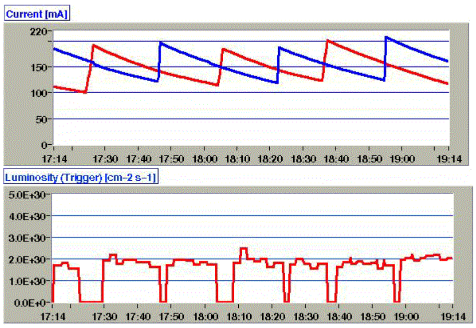
Integrated Luminosity Optimization

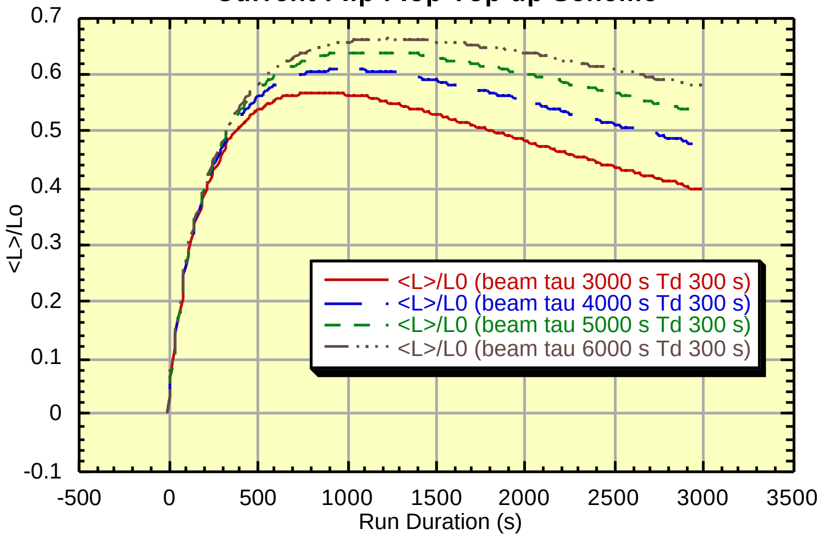
Average Luminosity vs Run Duration
Complete Injection Scheme



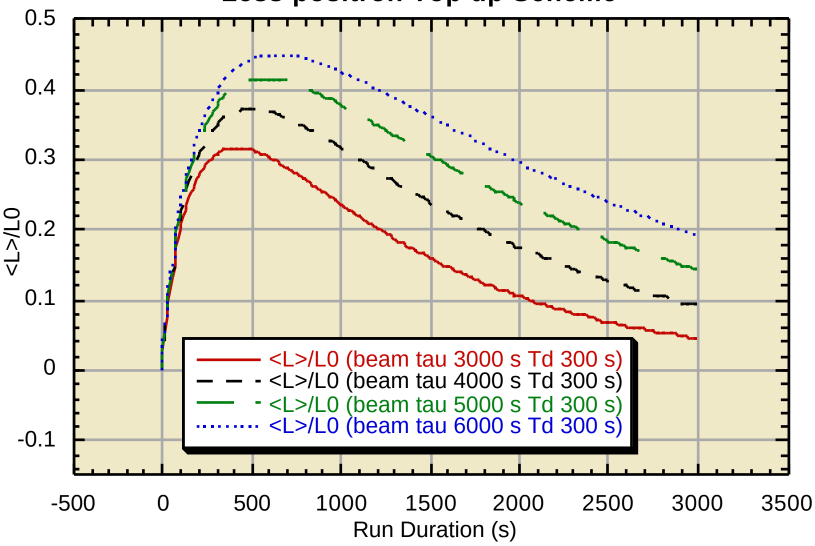


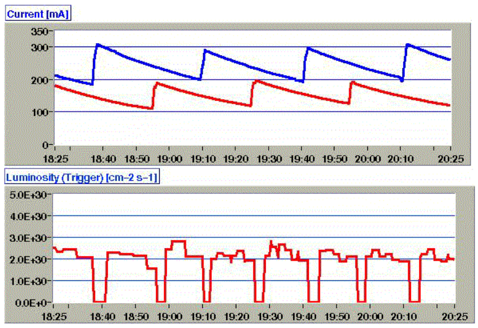
Average Luminosity vs Run Duration
Current Flip Flop Top up Scheme





Average Luminosity vs Run Duration
Less positron Top up Scheme





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