Beam Profile Monitor

- Crossing angle, z location, and B field : a preliminary study -

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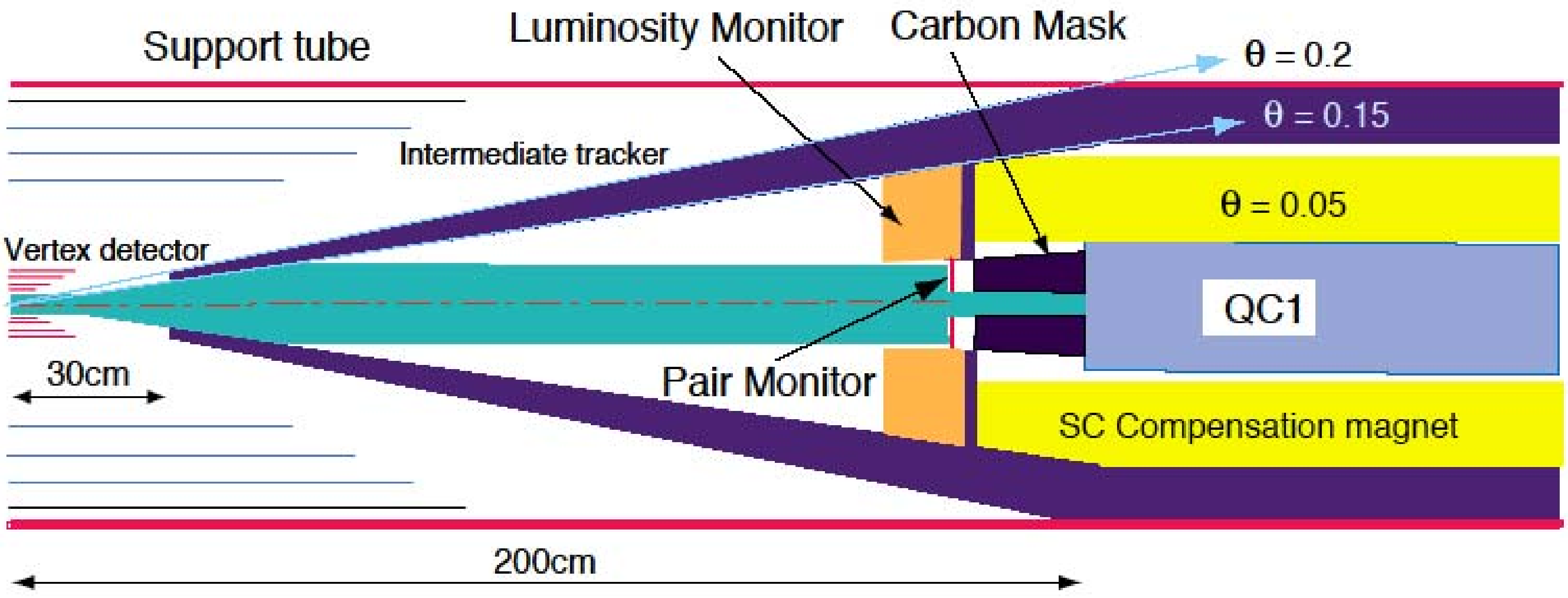
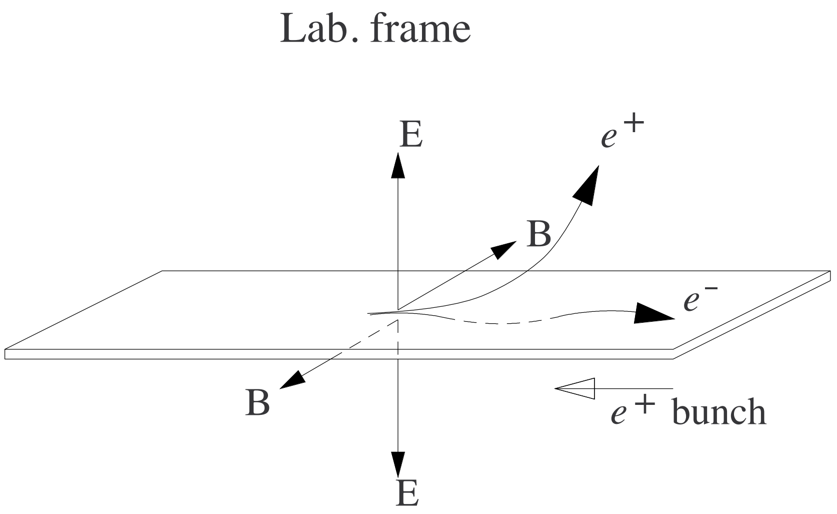
Example of IR configuration

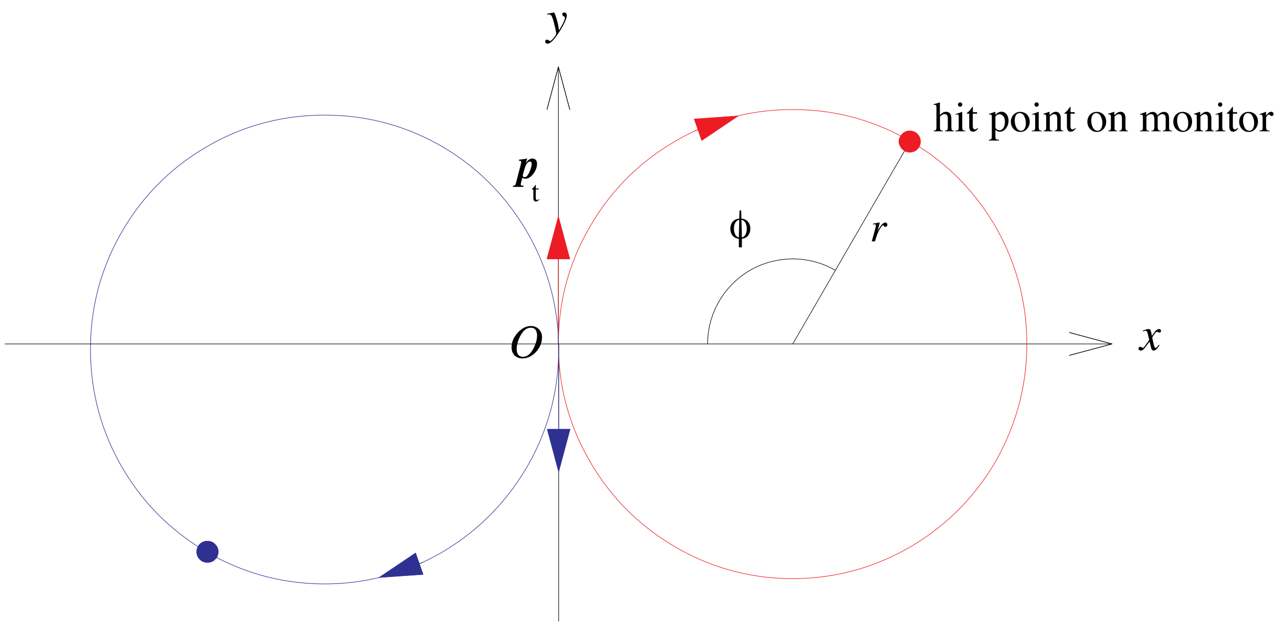


Kinematic Configuration of Pair 'Background'



- $|E| = |B| \rightarrow$ no force from the co-moving bunch.
- $E(dyne/esu) = B(gauss) \sim 4 \times 10^7$
  $\rightarrow r \sim 170\mu$m for $p = 300$ MeV/c ($\sigma_z \sim 300\mu$m)
- For an incoming e^+ bunch,
  e^- oscillates around the beam plane.
  e^+ acquires a large p_t kick (vertical).
- Round beam $\rightarrow$ no ϕ dependence,
  ϕ dependence $\rightarrow \sigma_y/\sigma_x$ ratio.

Hit Location on the Pair Monitor

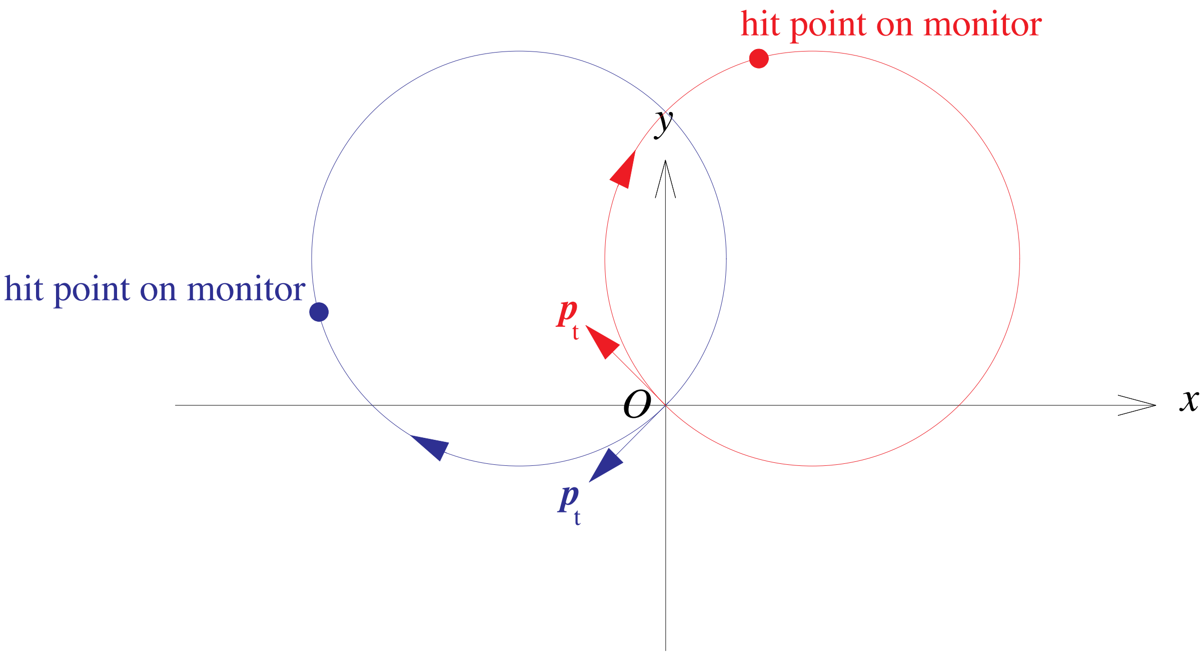


$$\rho(\mathrm{cm}) = \frac{p_t(\mathrm{MeV}/c)}{3B_0(\mathrm{Tesla})}, \quad \phi = \frac{3B_0(\mathrm{Tesla})L(\mathrm{cm})}{p_z(\mathrm{MeV}/c)}$$

L : distance to IP

- ρ measures p_t and ϕ measures p_z.
- For $L = 176$ cm, $p_z \sim 350$ MeV$/c \to \phi \sim \pi$.
- The larger B_0L, the greater the dilution of pattern.

Hit Location on the Pair Monitor (w/ Xing angle)



- Crossing angle θ_X gives horizontal p_t of $\theta_X p_z/2$ (comparable to original p_t if $\theta_X \sim 30$mrad).
- The focused paritcles get horizontal p_t $\longrightarrow$ hit the monitor (more hits on monitor).

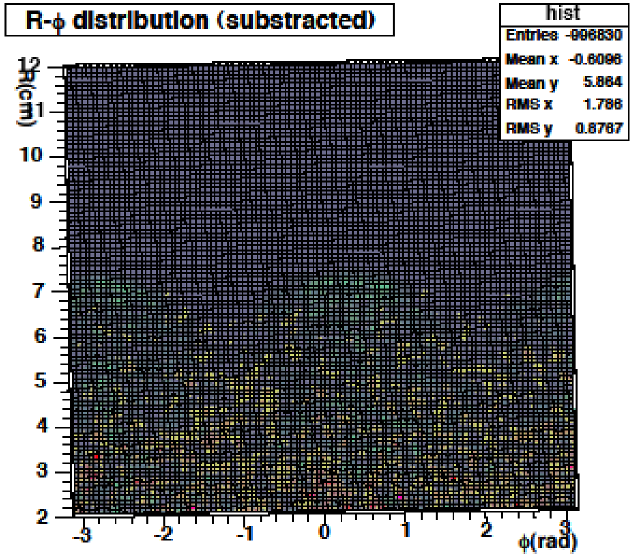
Parameters of simulation

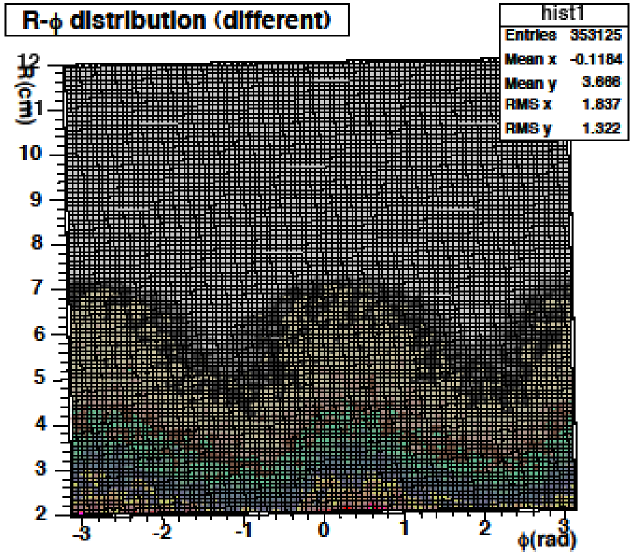
'TESLA-500'

E_{beam}	500GeV
N_{train}/s	5
$N_{\text{bunch}}/$train	2820
train length	950μs
$N_{\text{particle}}/$bunch	2×10^{10}
σ_x	554nm
σ_y	5.0nm
σ_z	300μm

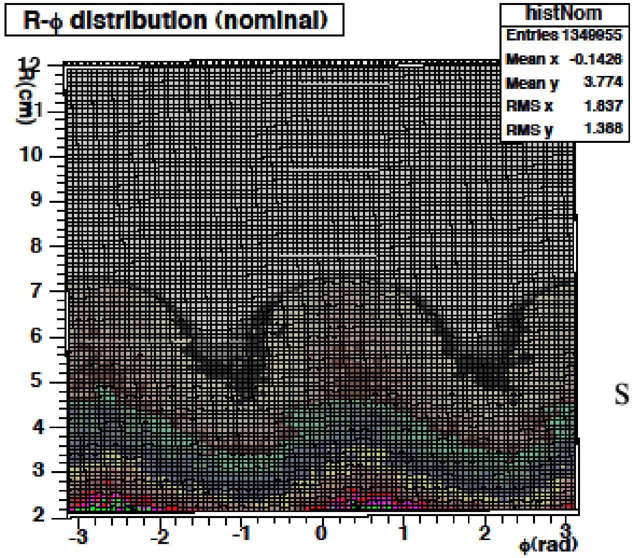
- At this time, assume uniform solenoid field. ($\vec{B}$ midway between two beams)
- Crab crossing used.
- CAIN + Analytic helical tracking of particles.

0mrad Xing, z=4m, B=3T



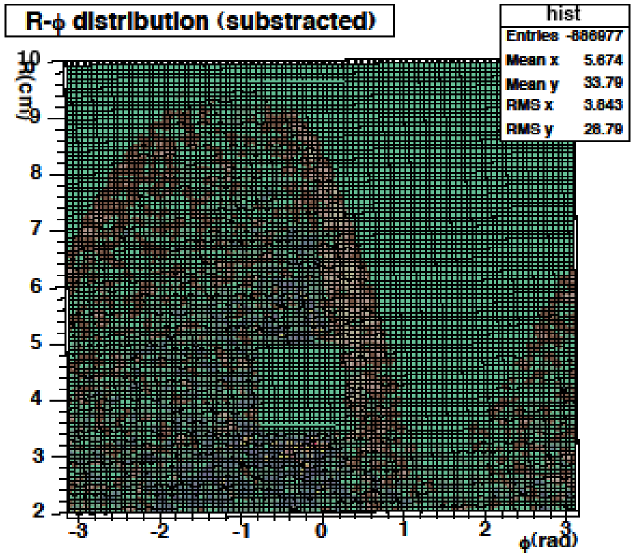


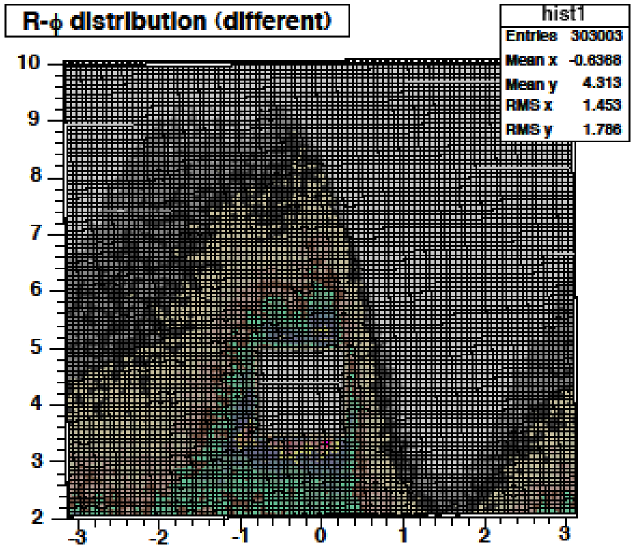
4 x sigma_y0



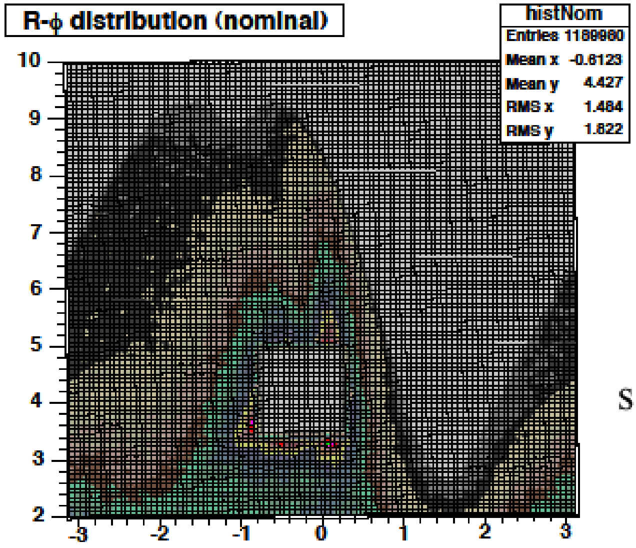
sigma_y0

20mrad Xing, z=4m, B=4T



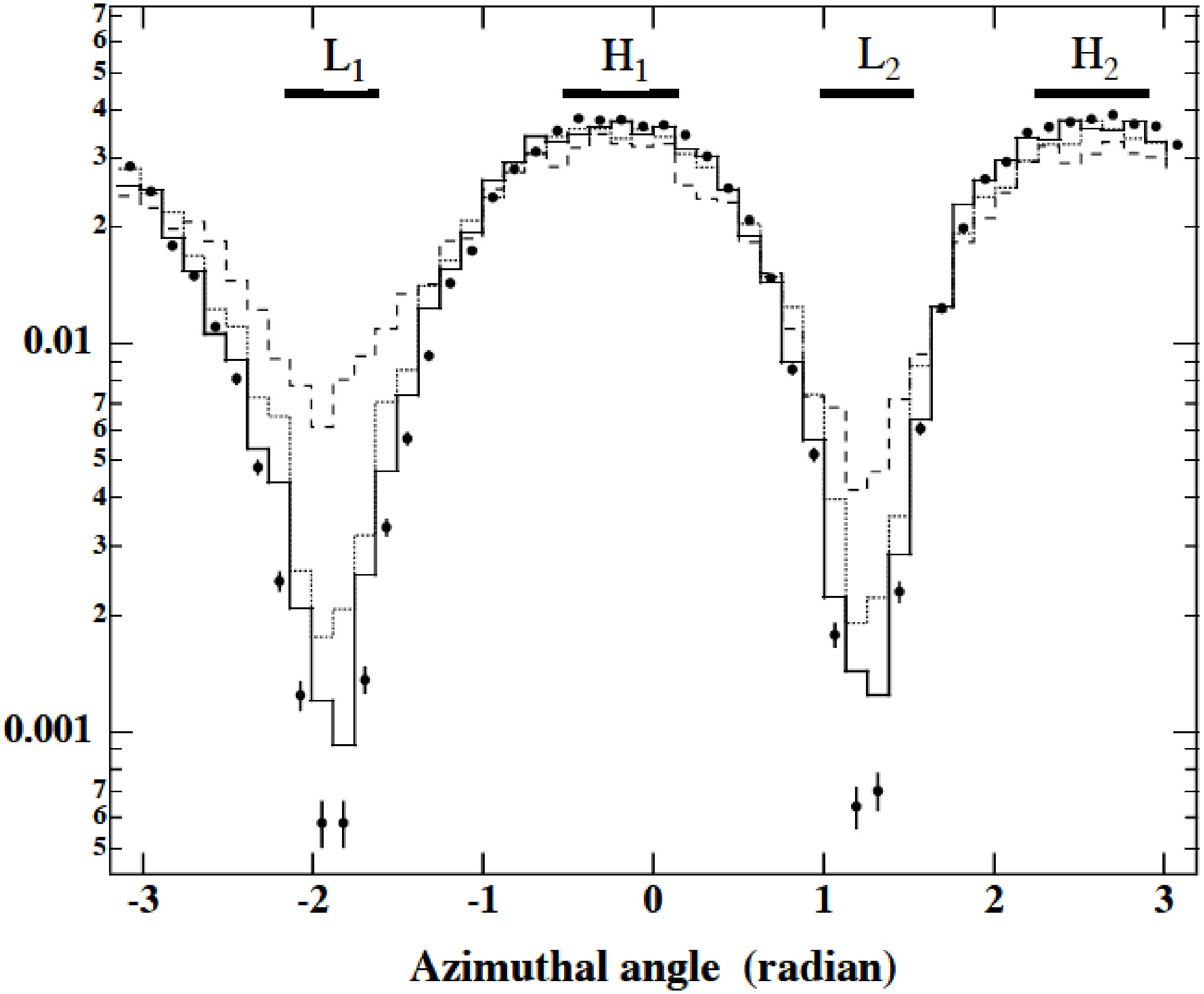


4 x sigma_y0



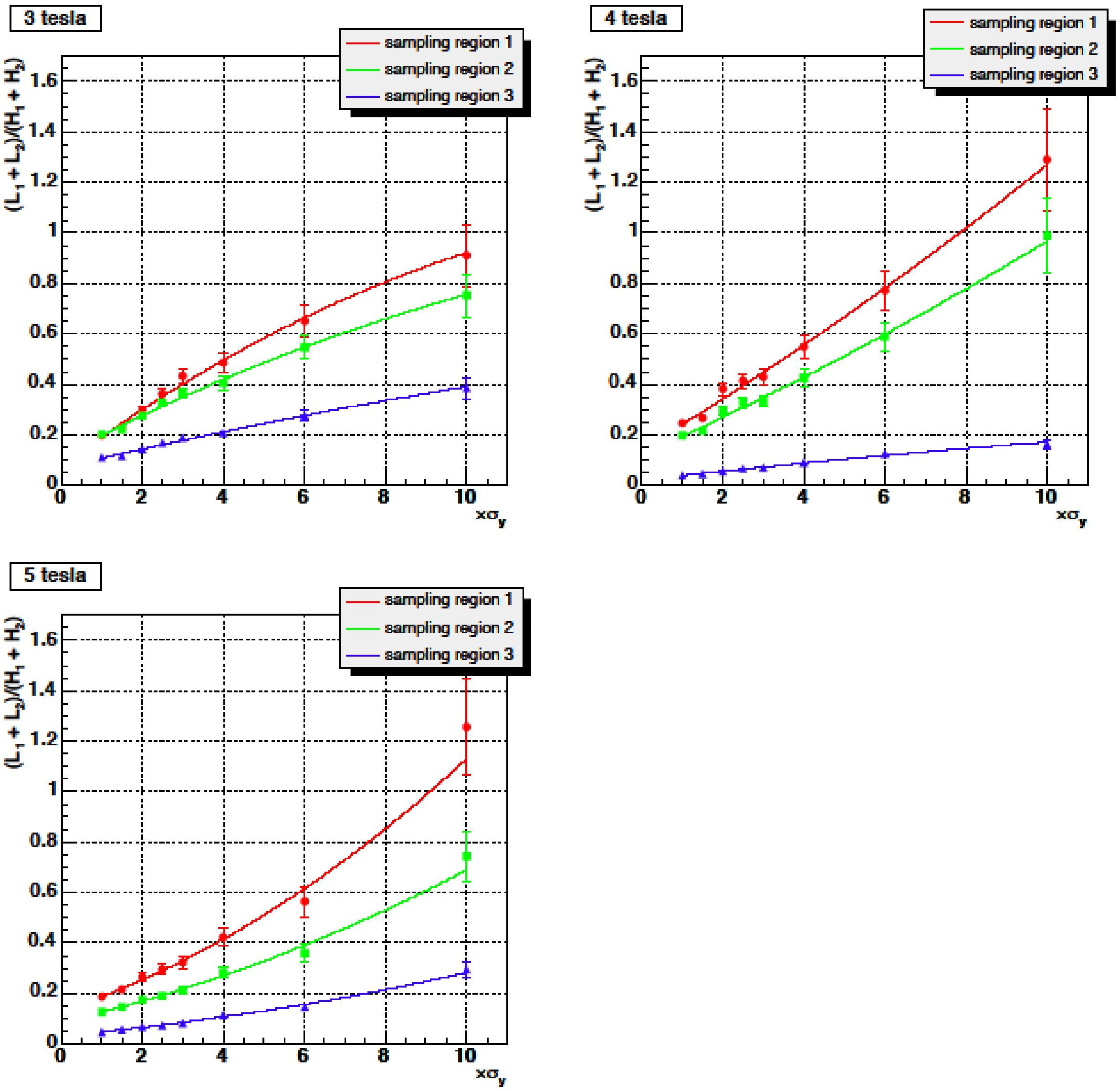
sigma_y0

Find regions where σ_y information exist



$6 < r < 7$cm, $\sigma_y = n \times \sigma_y^0 : n = 1, 2, 3, 10$ (GLC)

Xing = 0mrad, z = 400 cm



20 readings/train

Fix σ_x,

Vary $\sigma_y = n\sigma_y^0$

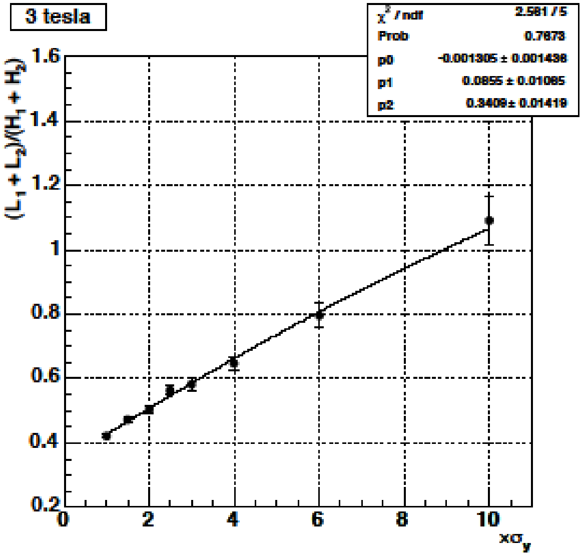
Form ratio

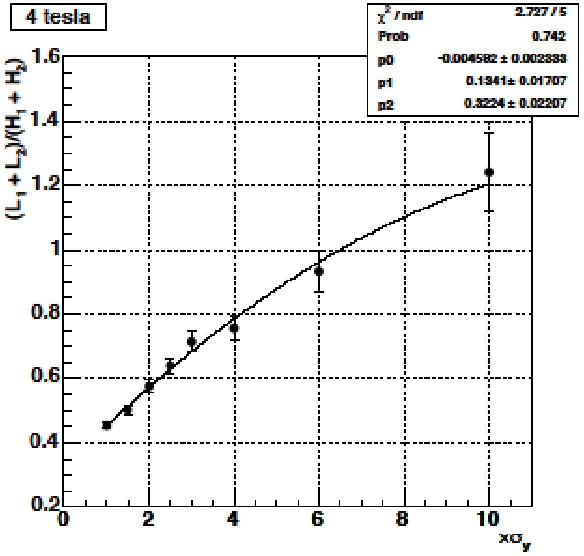
$$R_{\mathrm{pv}} = \frac{L_1 + L_2}{H_1 + H_2}$$

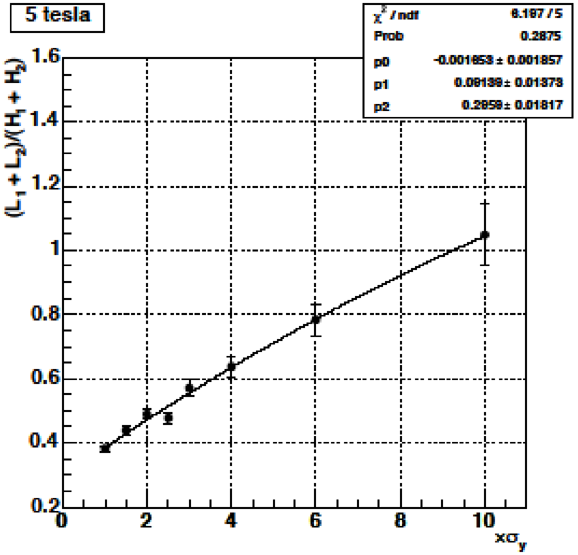
Try different

$L_{1,2}, H_{1,2}$ regions

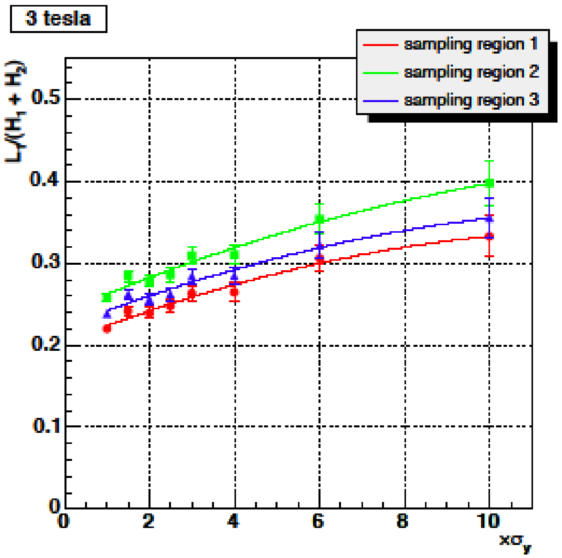
Xing = 7mrad, z = 400 cm

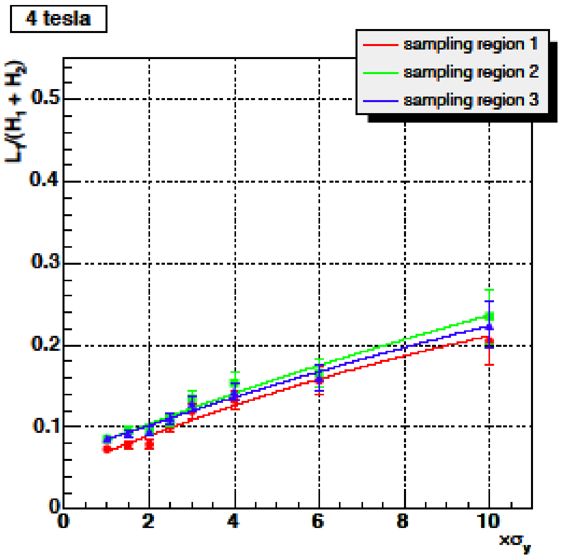


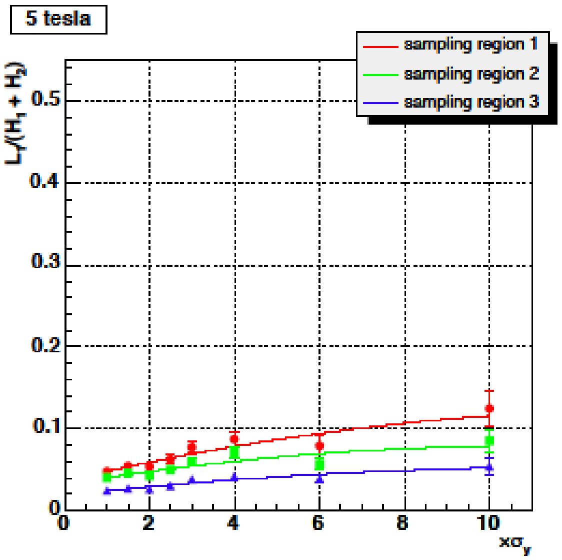




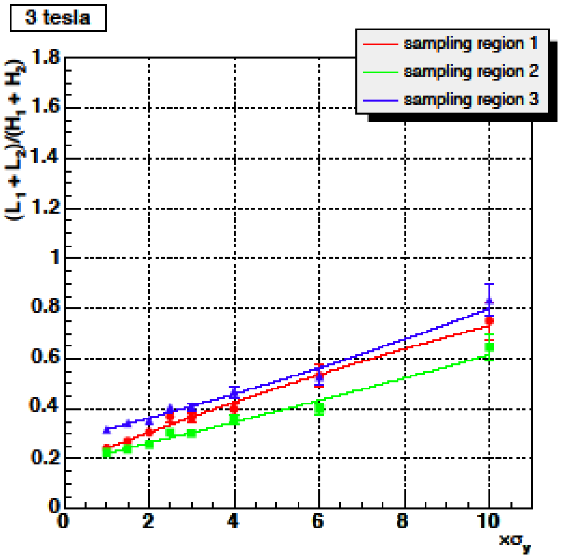
Xing = 20mrad, z = 400 cm

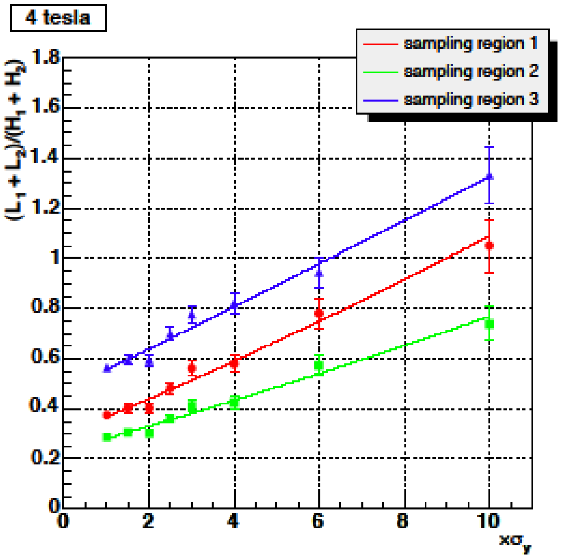


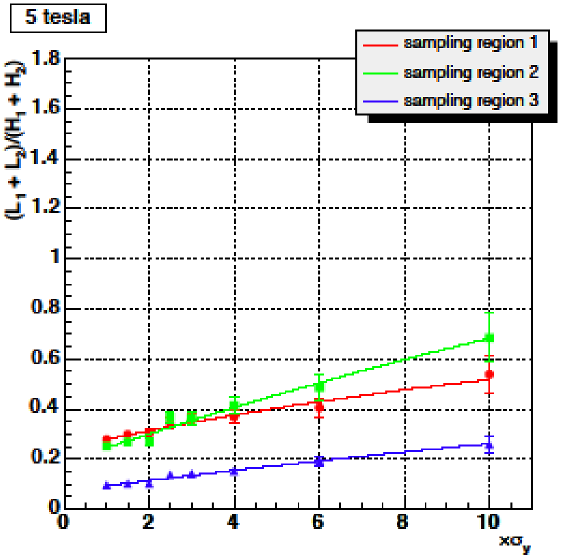




Xing = 20mrad, z = 176 cm


3 tesla


4 tesla


5 tesla

σ_y **resolutions**

Tesla-500 parameters, 20 readings/train
Average resolution of $2 \times \sigma_y$ and $4 \times \sigma_y$

		3T	4T	5T
z = 400cm	0mrad	11%	13%	13%
z = 400cm	7mrad	9%	11%	12%
z = 400cm	20mrad	22%	19%	28%
z = 176cm	20mrad	12%	15%	20%

Caveat : Resolution depends on the selection of sampling regions.

The σ_y resolution is worse when

- distance from IP is larger.
- B field is larger.
- crossing angle is larger.
  σ_y resolution ~same for $\theta_X = 1 \sim 7$mrad.

Things to do:

- Use correct B field
  (edge effect, Q-magnet, compensating coil etc.).
- More study of the pattern
  (location of information).
- Measurement of other beam parameters
  (σ_x, horizontal shift, azimuthal tilt of bunch etc.).
- Robustness of measurement
  (non-gaussian beam shape, tail, halo etc.)
- Better statistical treatment?