Beam Profile Monitor

- Crossing angle, z location, B-field, and readout electronics -

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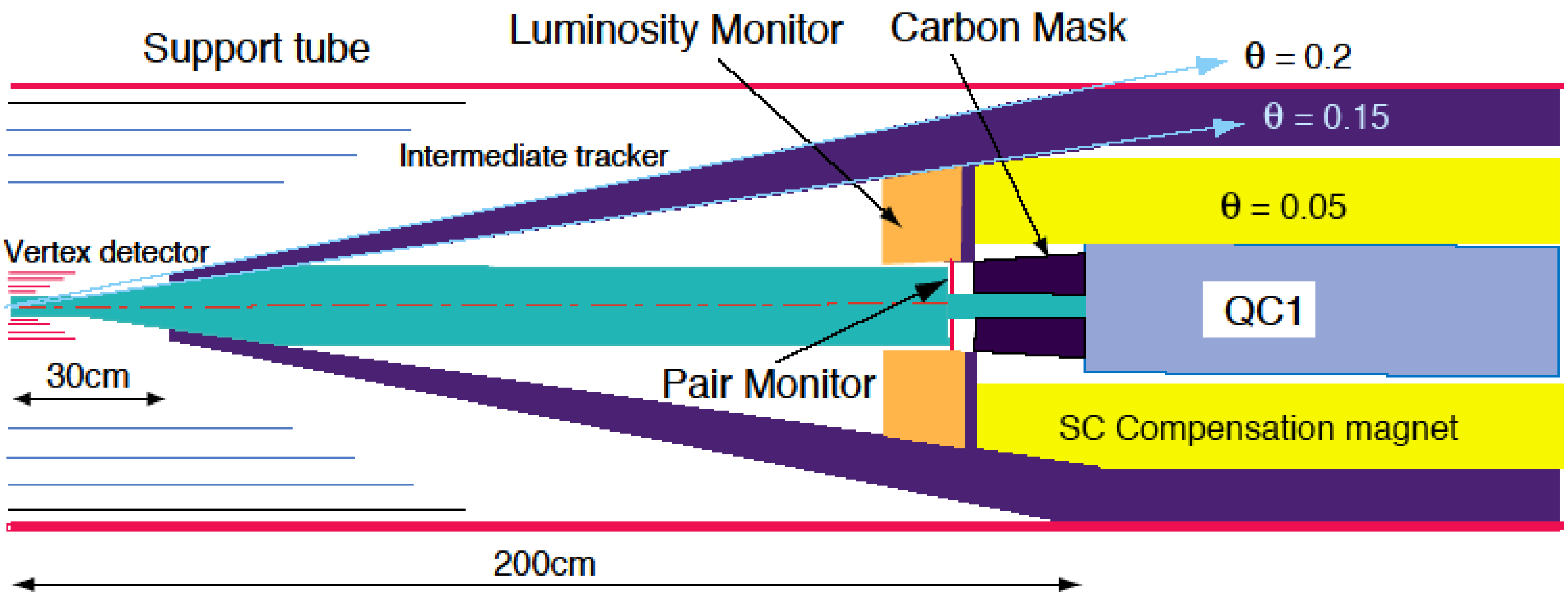
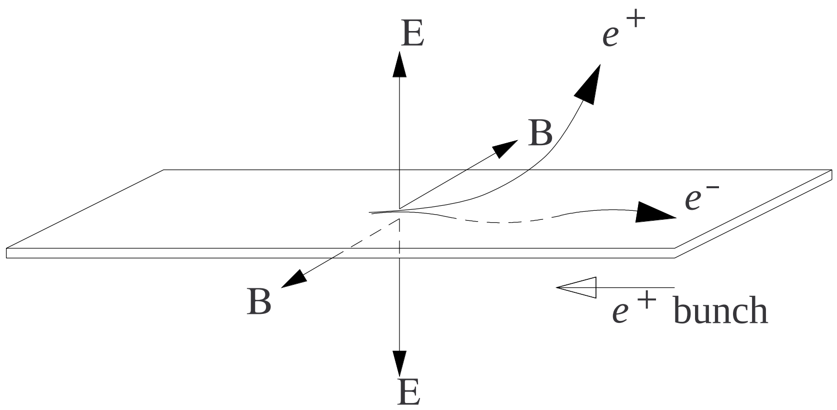
Example of IR configuration

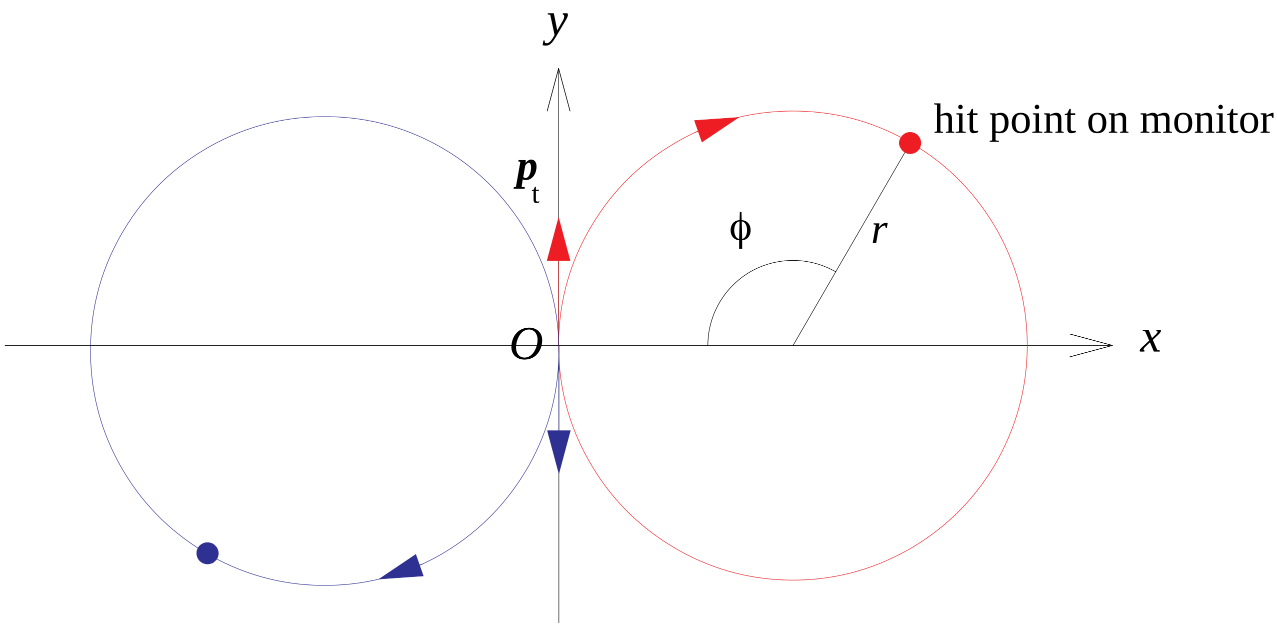


Kinematic Configuration of Pair 'Background'



- $|E| = |B| \rightarrow$ 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

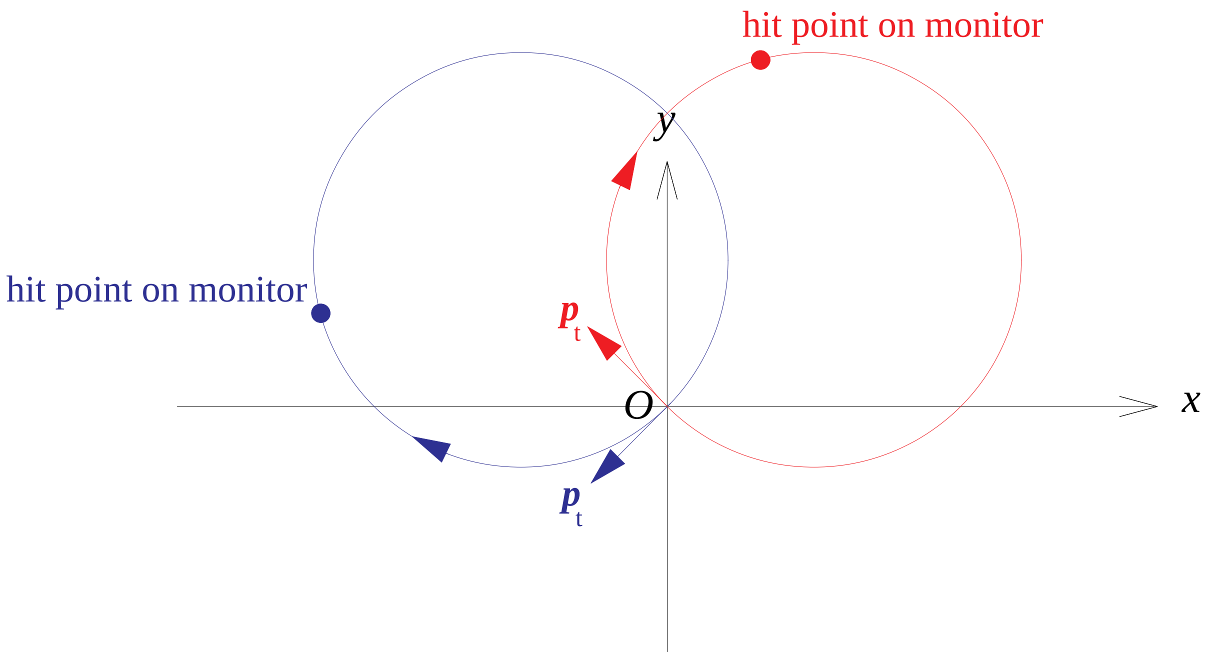


$$\rho(\text{cm}) = \frac{p_t(\text{MeV}/c)}{3B_0(\text{Tesla})}, \quad \phi = \frac{3B_0(\text{Tesla})L(\text{cm})}{p_z(\text{MeV}/c)}$$

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 $\theta_X \sim$ 30mrad).
- The focused paritcles get horizontal $p_t \longrightarrow$ hit the monitor (more hits on monitor).

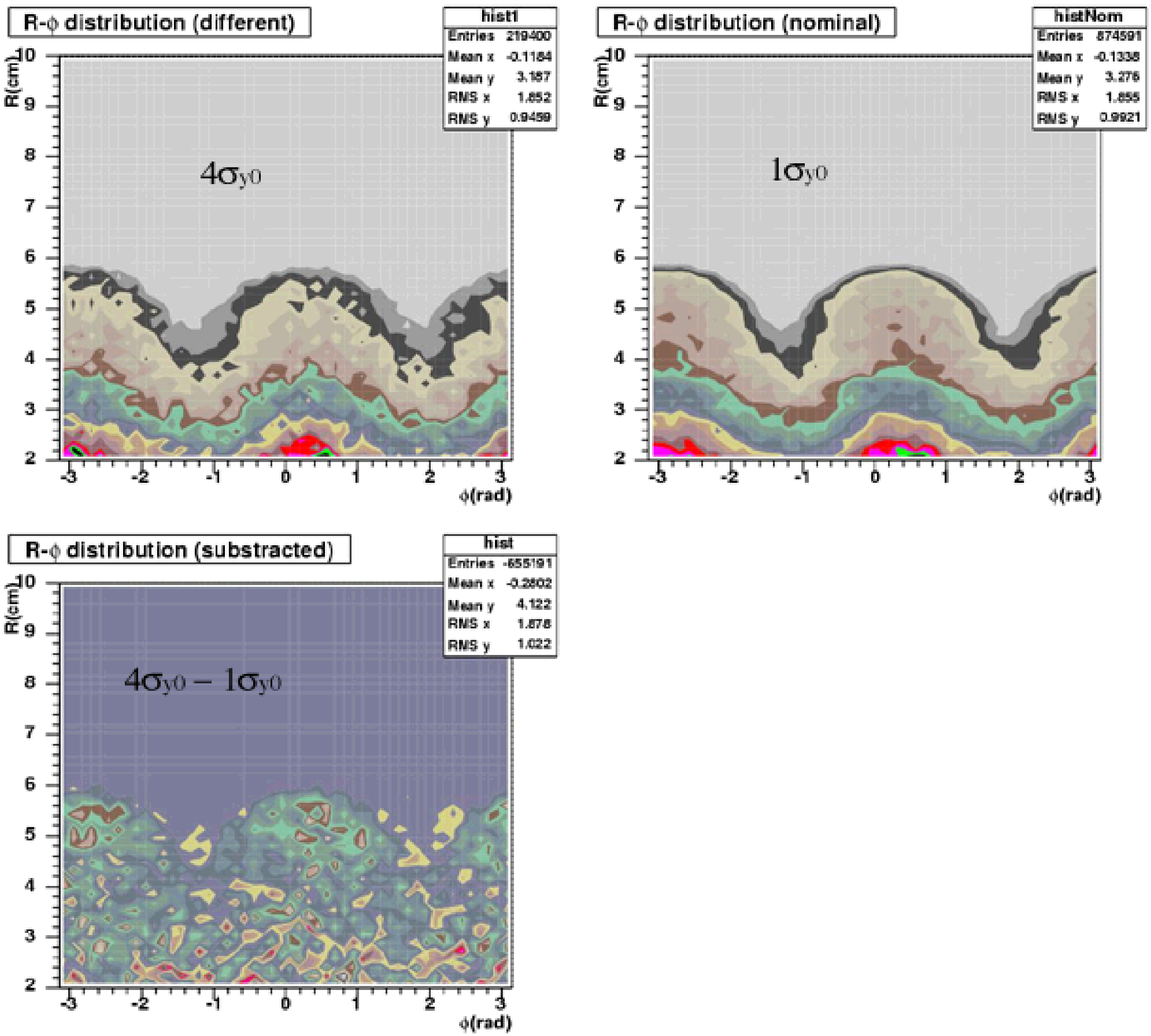
Parameters of simulation

'TESLA-500'

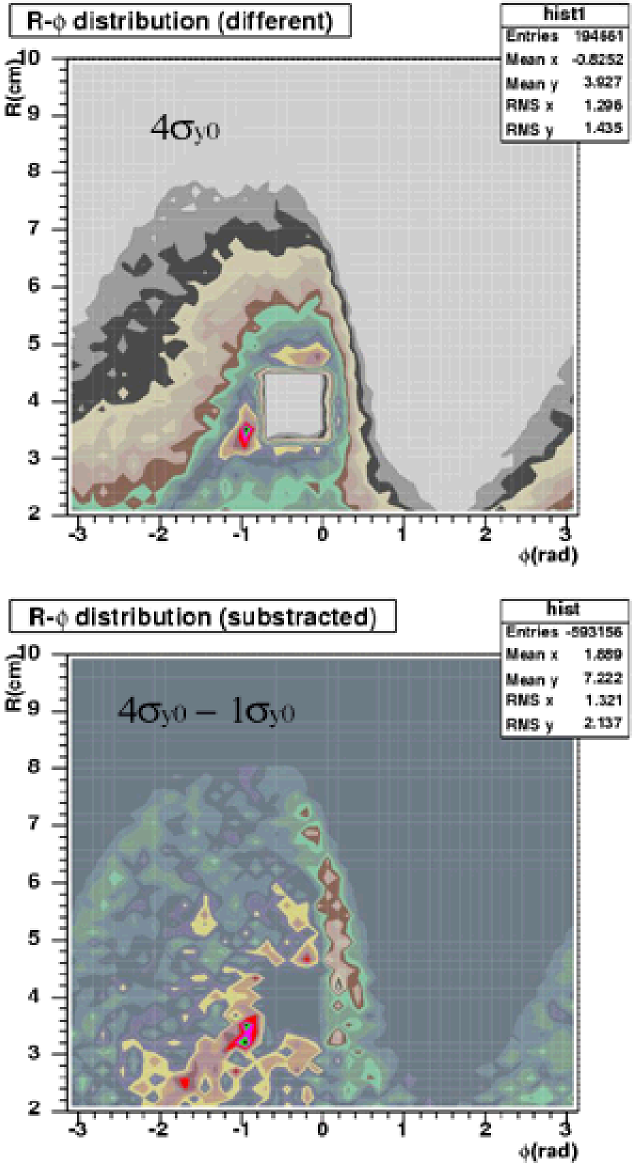
E_{beam}	500GeV
N_{train}/s	5
N_{bunch}/train	2820
train length	950μs
N_{particle}/bunch	2×10^{10}
σ_x	554nm
σ_y	5.0nm
σ_z	300μm

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

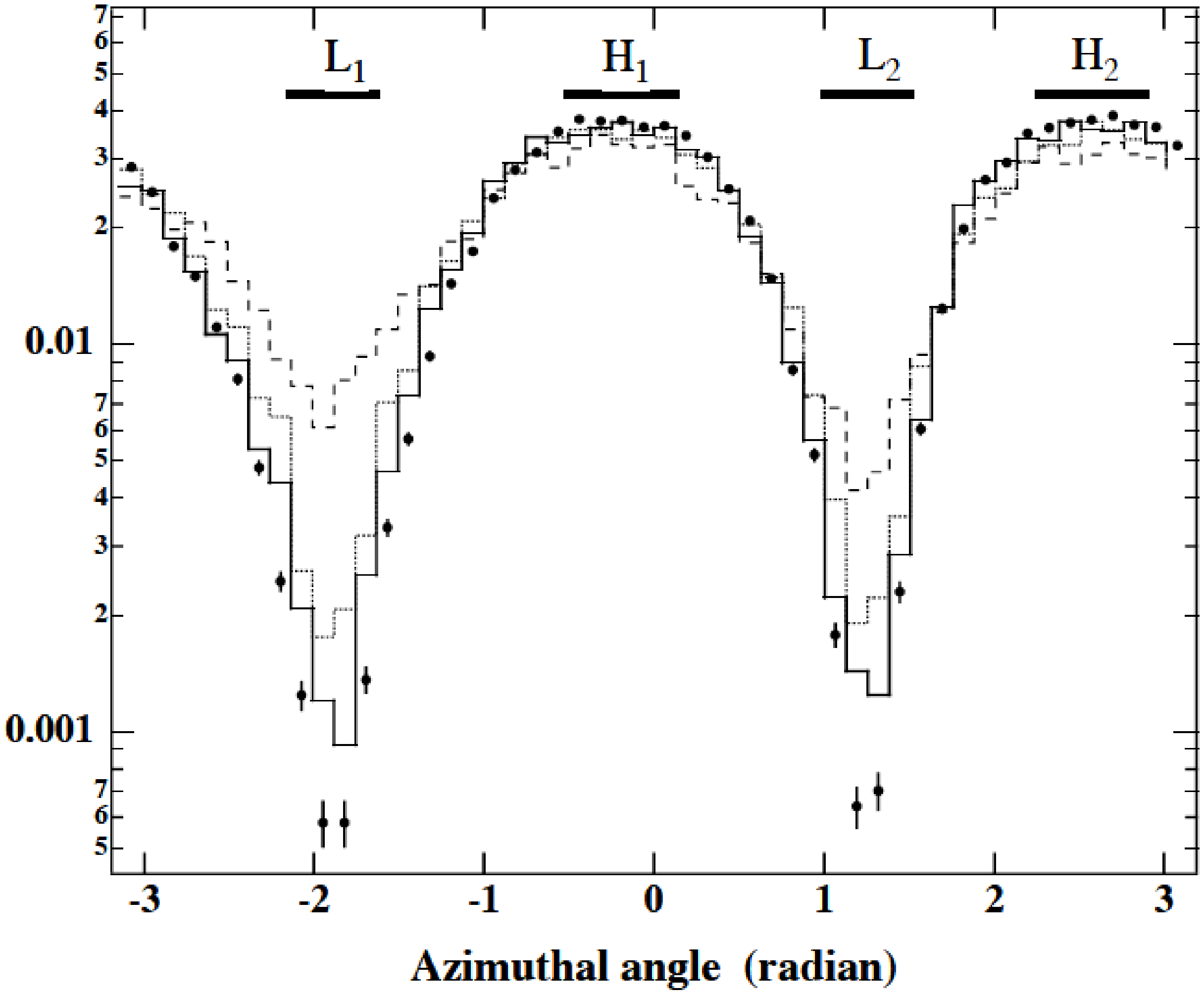
0mrad Xing, z=4m, B=4T (ILC params)



20mrad Xing, z=4m, B=4T (ILC params)

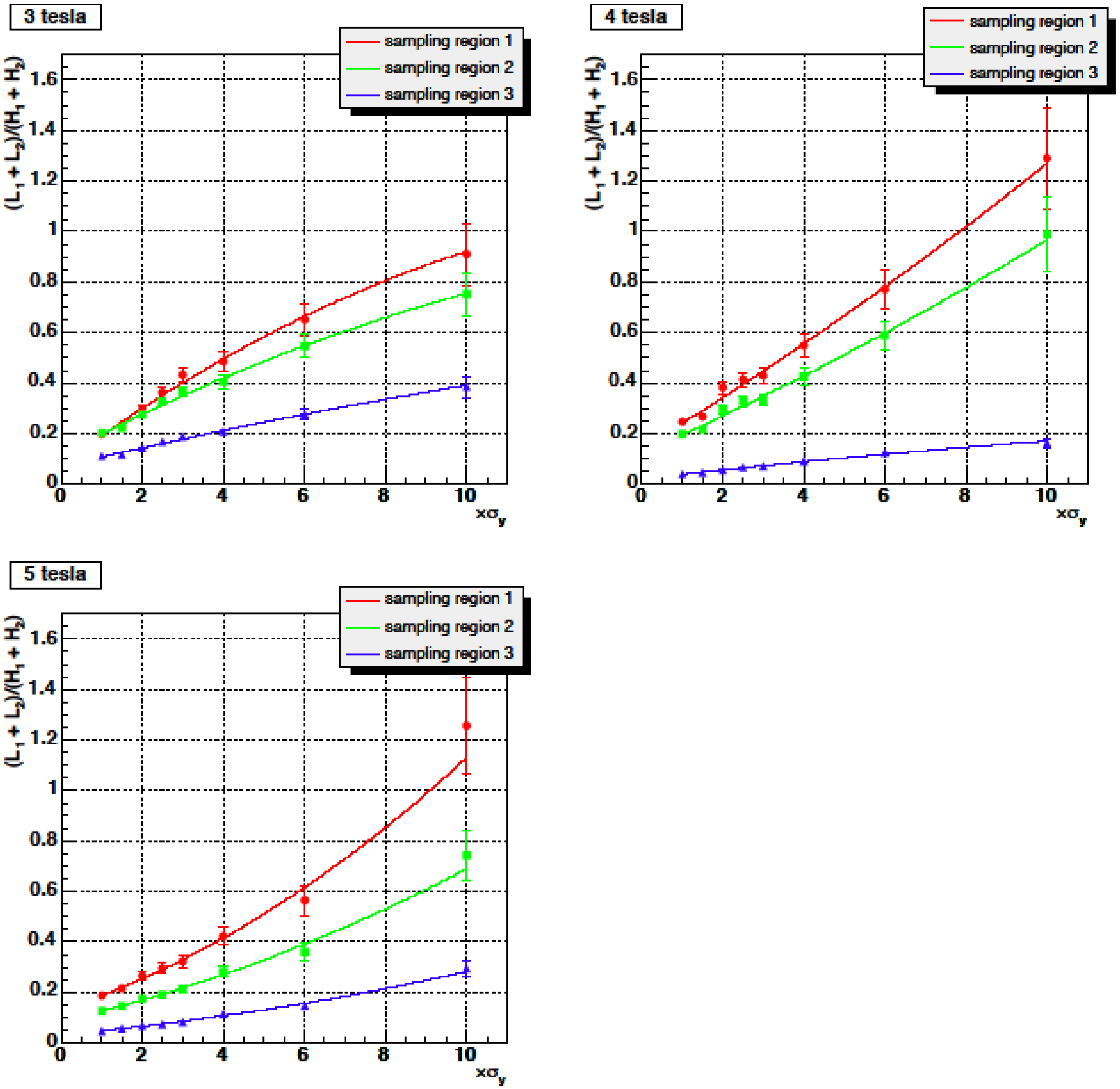


Find regions where σ_y information exist



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

Xing = 0mrad, z = 400 cm



20 readings/train

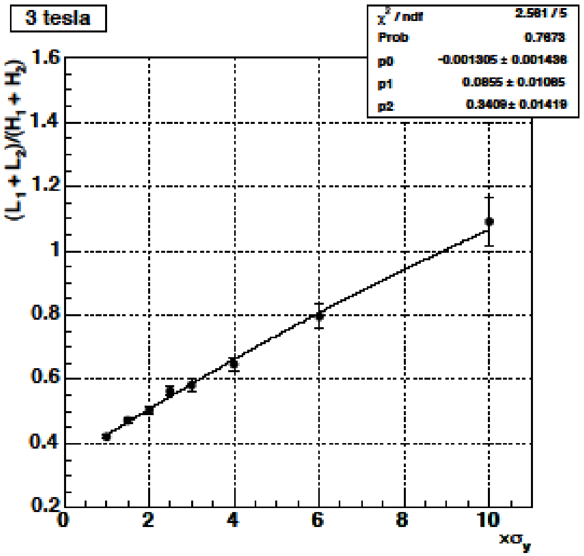
Fix σ_x,
Vary $\sigma_y = n\sigma_y^0$

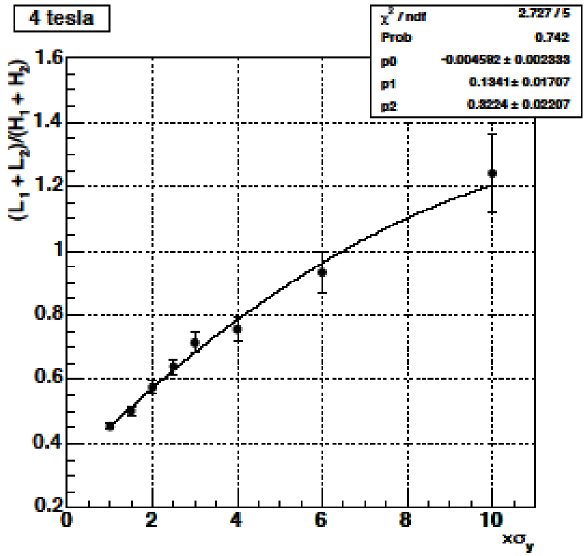
Form ratio

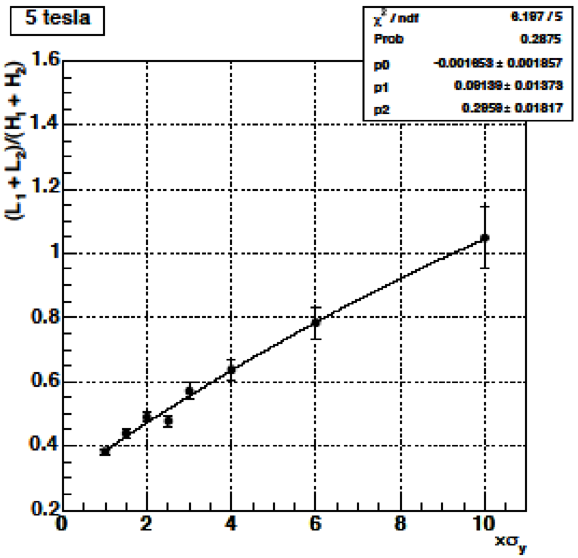
$$R_{\text{pv}} = \frac{L_1 + L_2}{H_1 + H_2}$$

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

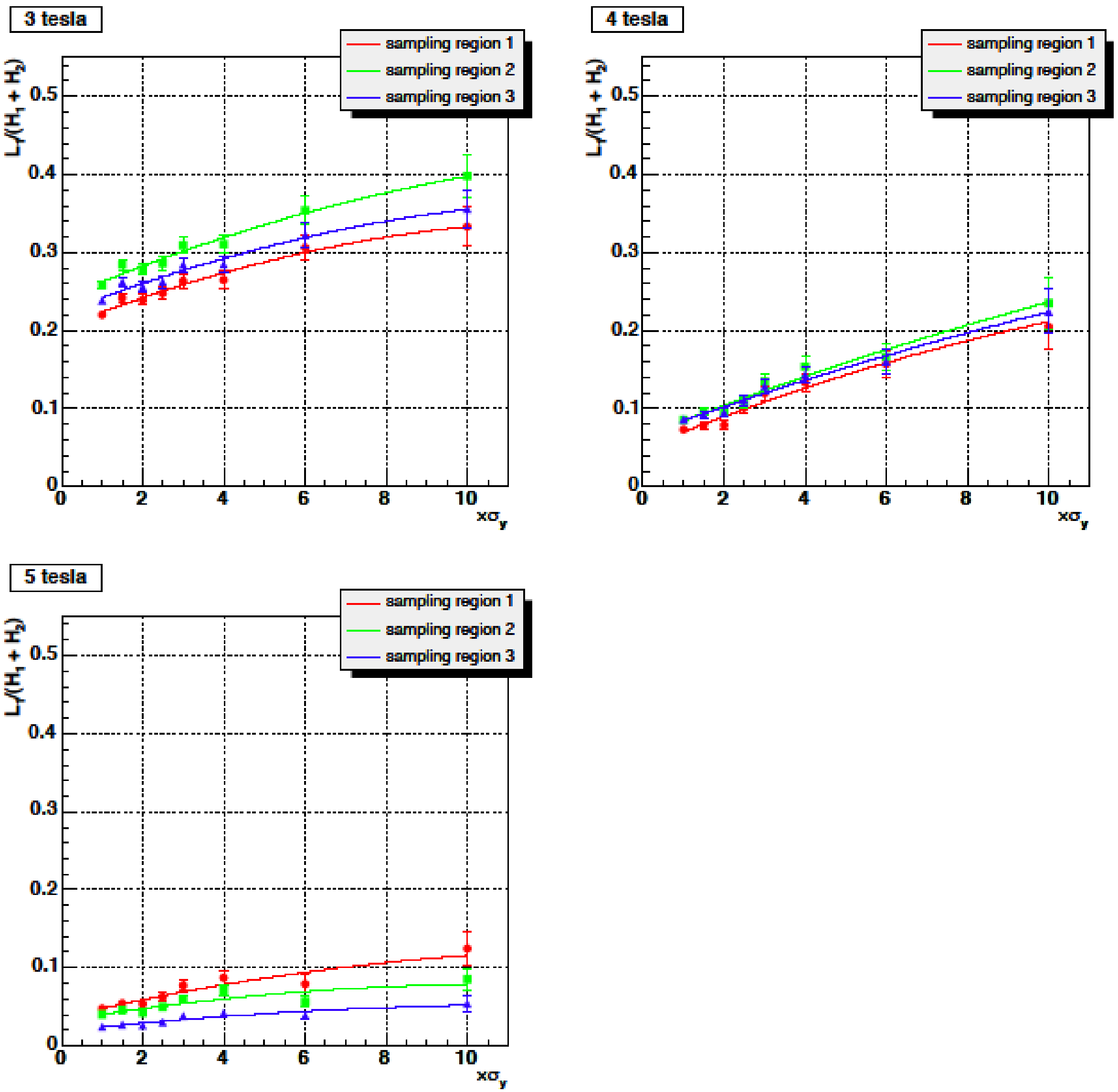
Xing = 7mrad, z = 400 cm



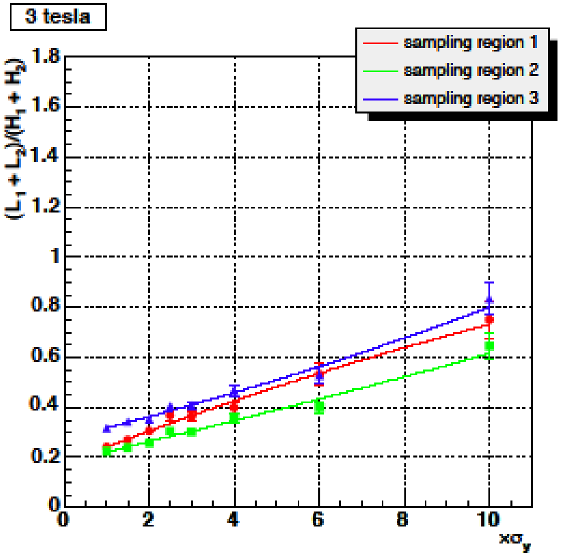


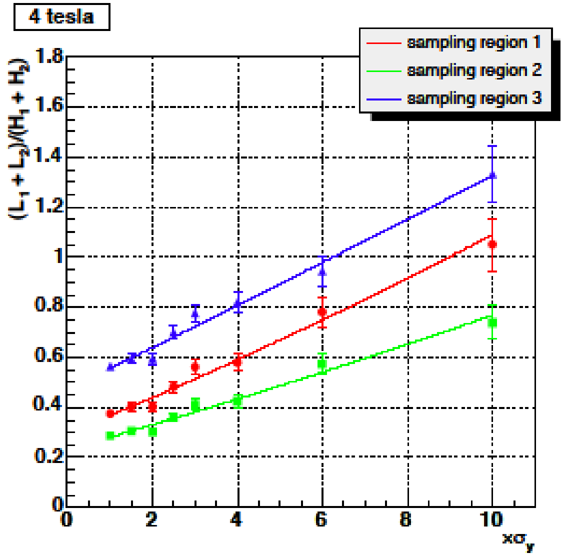


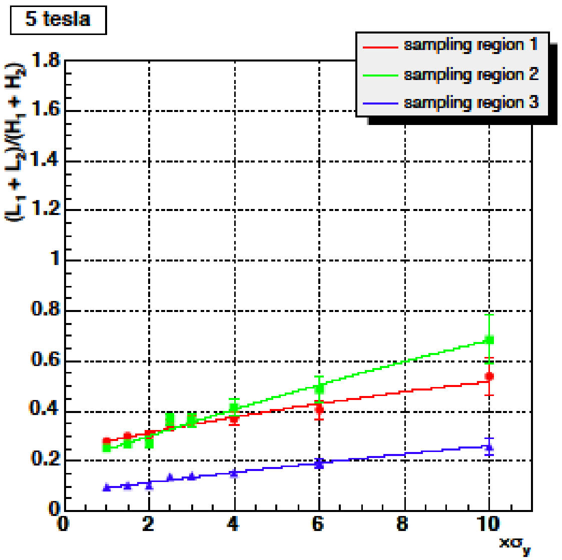
Xing = 20mrad, z = 400 cm



Xing = 20mrad, z = 176 cm







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.)

Pixel Readout Electronics

Pixel electronics for warm machine

- Measure time and pulse height of each hit.
- 4-point sampling (250ns apart).
- $\sigma_t \sim$ 30ns achieved ($\sim$goal).
- Survived $\sim$2MRad (goal).

Cannot be used for cold machine, since

- For warm machine, hit rate$\sim$0.5 hits/pixel/train.
- For cold machine, it will be $\sim$15 hits/pixel/train.
- $\rightarrow$ too much.

Solutions

- Count the number of hits and store it locally on each pixel.
- Read out in train gap (or during the train if possible).
- Threshold is applied $\rightarrow$ insensitive to X-rays etc.
- Digital read out $\rightarrow$ insensitive to RF pickups.

Readout electronics for cold LC

1. pixel : 0.4x0.4 mm^2.
   3D pixel sensor is being designed/fabricated.

2. TMSC has 2.54 by 1.27 cm^2 chips : sensor size.

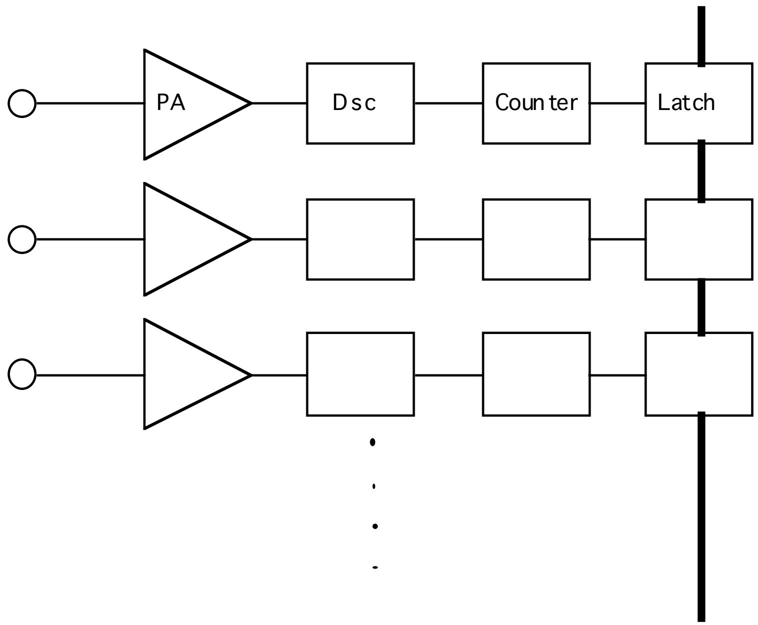
3. 27 by 54 pixels/sensor.

4. 8-bit gray code counter.

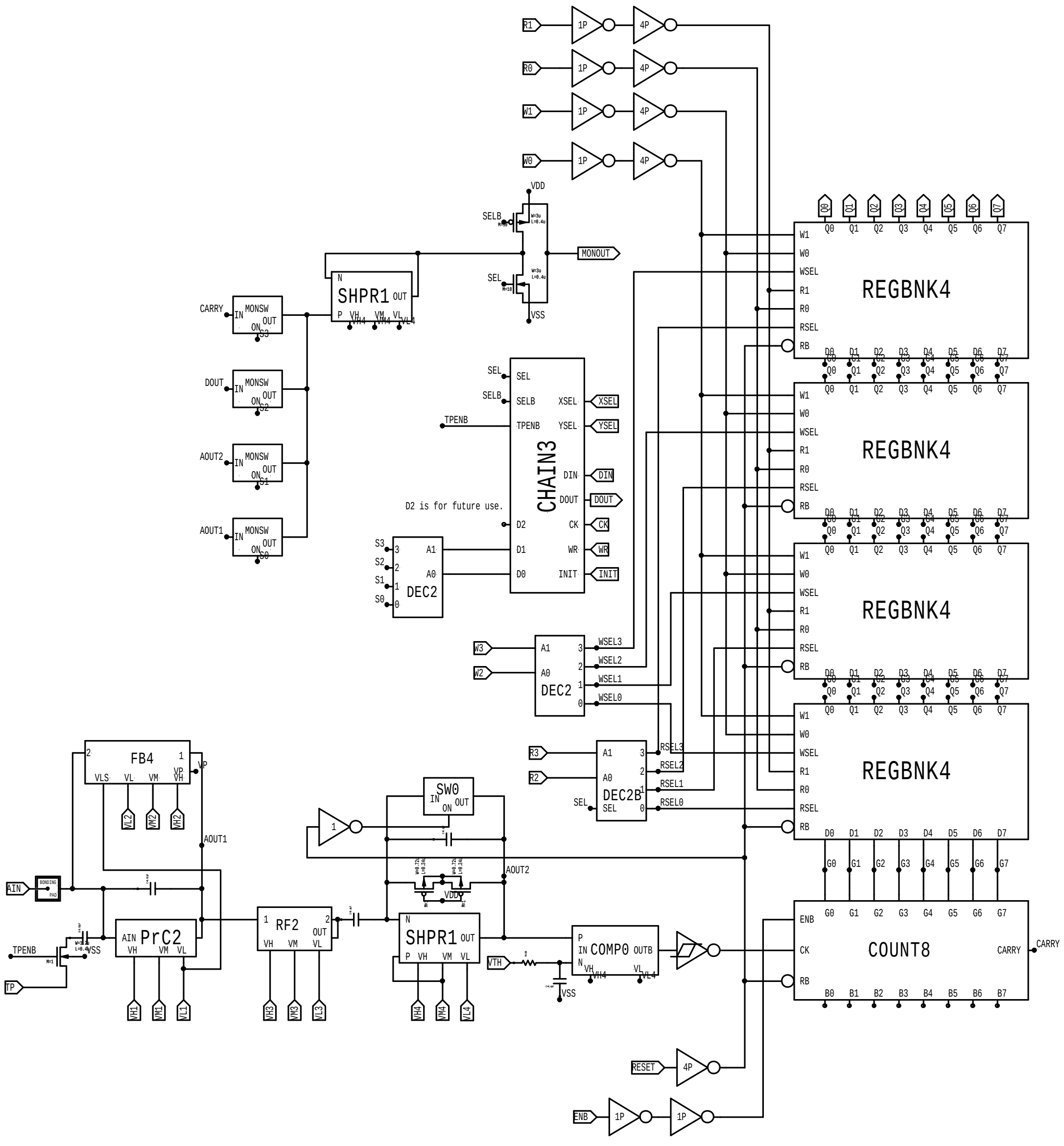
5. 9 parallel outputs/sensor $\rightarrow$ 1728 bits/line

6. 40 MHz transmission $\rightarrow$ 43 μs/readout
   ($\rightarrow$ 20 readouts possible during train, in principle)

Pixel electronics (readout)



Pixel circuit



Readout electronics status and plan

1. Conceptual design completed. (Ikeda + 2 students)

2. Basic simulations and noise estimations done.

3. Finish circuit design by end summer 2005.

4. Layout by outsourcing.

5. Submit for fabrication (MOSIS) end 2005.

6. Test the circuit 2006 spring.

7. Bump bond to prototype sensor (company?).