Considerations for the Post Collision Line

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- Arnaud has worked on the ILC dump line and reported on that at the recent BDS meeting at CERN.
- Now we know how that works, but now we have to progress to the 1.5+1.5 TeV CLIC world.
- Hope to get guidelines and constraints for a design.

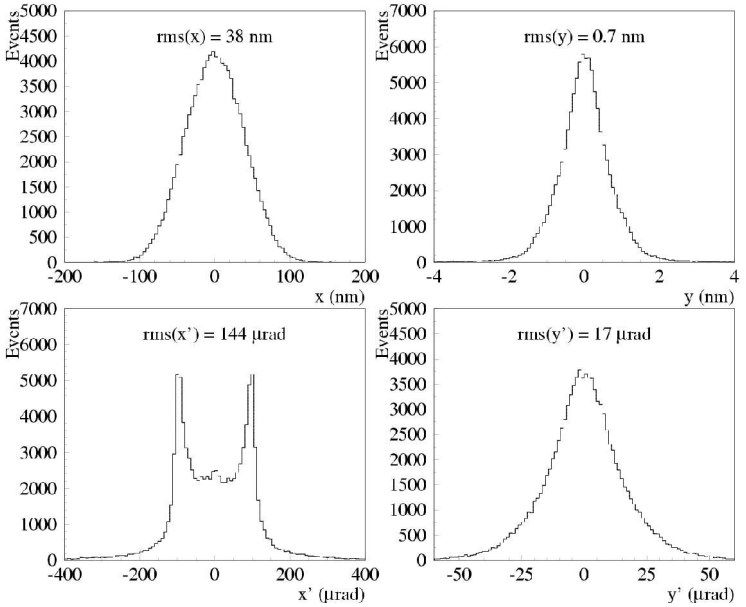
Mostly Questions

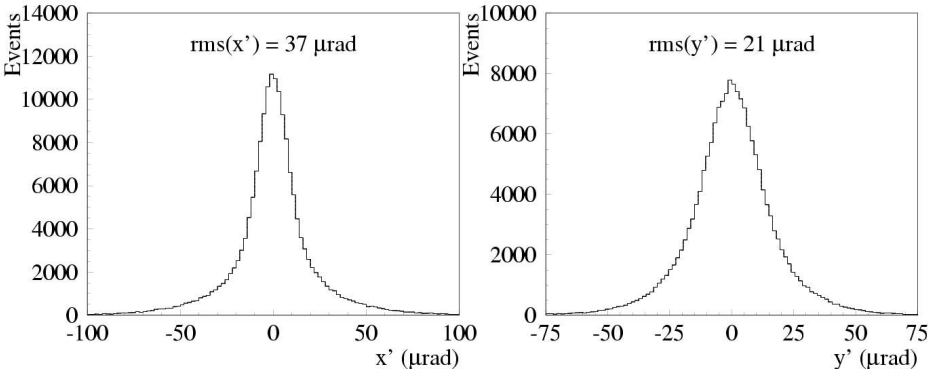
- Are there limits on the length of the post-collision line? (1 km ok? Bare angular divergence is about 6 μrad in both planes → 6 mm rms spot)
- What are the intensity and beam size limits for the dump window?
- Can we increase the beam size on the dump with a spoiler? (see below)
- What kind of chicane? (Bρ = 5000 Tm)
  - horizontal vs. vertical (**h** to move away from the opposing beam, v to avoid trouble with the coherent positrons bent into the opposing beam.)
  - C, S, or dog-leg? (Do we want separate dumps for primary beam and beamstrahlung? Minimize total bend angle? Dispersion on the dump window to measure momentum distribution?)
  - Combined function dipoles to shape the beam size?
- Can we afford to have quadrupoles in the beam line? (primary beam particles in the low energy are badly overfocussed and the high energy particles go straight no matter what.)

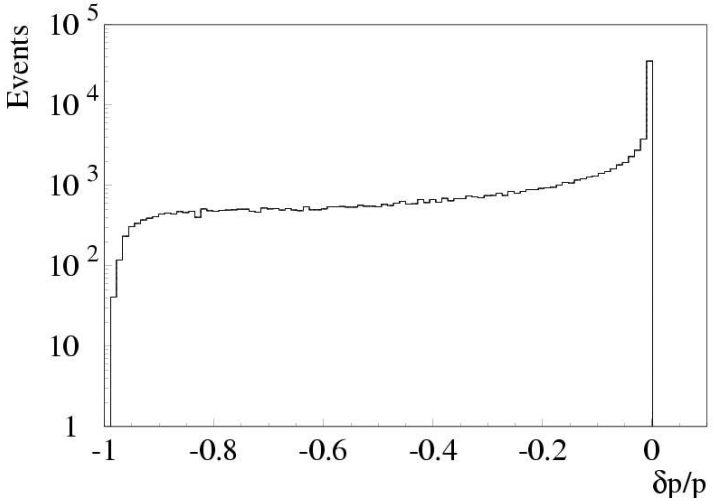
...and more questions.

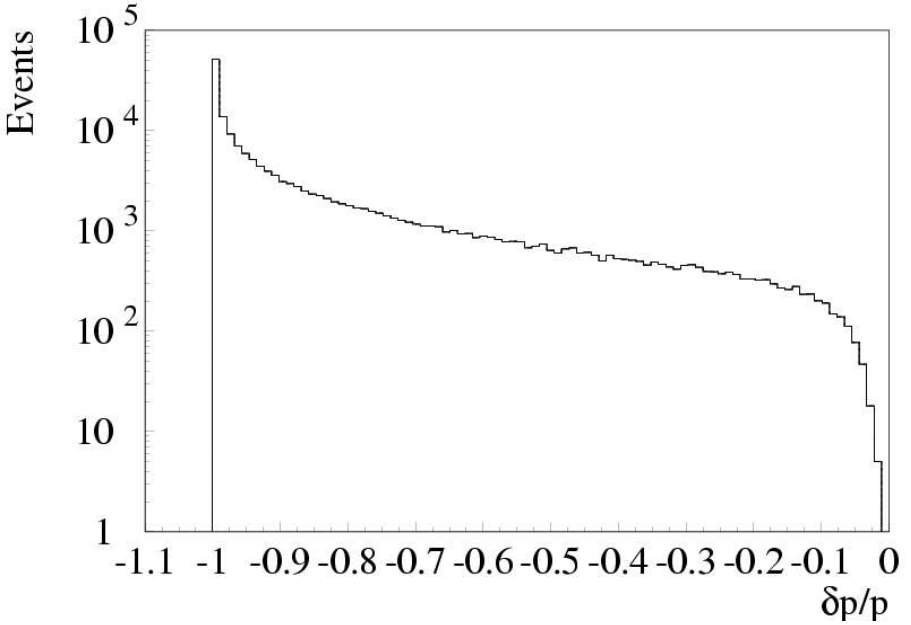
- How important is the polarization measurement?
- What diagnostic do we need? (beam size and angular divergence, luminosity, beamstrahlung intensity and profile)
- What signals are related to the luminosity
  - Beamstrahlung
  - Coherent pairs
  - Momentum spread
  - Beam size
- How fast are the signals, bunch-by-bunch or train-by-train or long averages?
- Can we extract signals from the dumps? (total power, beam size?)
- How many beam dumps? (1 x Primary beam, 1 x beamstrahlung, 2 x coherent pairs)

For reference: Disrupted Beam and Beamstrahlung (AF)









Blowing up the beam size and possibly measuring it

- Fill 1 km beamline before the dump with Argon gas at high, atmospheric, pressure.
- How much does the beam blow up?
- Can we reduce the pressure at the IP to 10^{-8} by differential pumping (12 orders of magnitude!)?
- How much does the background increase by e.g. additional neutrons?
- Will try to answer the first two questions.

Beam size blowup in Argon channel

- Radiation length for Argon (20° C, 1 atm)

$$\frac{1}{X_0} = \frac{4\alpha N_A Z(Z+1) r_e^2 \log(183 Z^{-1/3})}{A}$$

$\rho = 1.66\ 10^{-3}\ g/cm^3 \rightarrow X_0 = 117\ m$

- We're above the muon threshold, other effects, shorter?
- Multiple scattering (Rutherford)

$$\Theta = \frac{13.6\ MeV}{\beta pc}\sqrt{\frac{x}{X_0}}$$

$\Theta_0^2\ dz = (0.84\ \mu rad)^2/m\ dz$

Beam size blowup

- Position at dump window: x=(z-z') Θ(z')
- RMS beam size

$$\sigma_x^2 = < x^2 > = < \int_0^z dz' \int_0^z dz''(z-z')(z-z'')\Theta(z')\Theta(z'') >$$

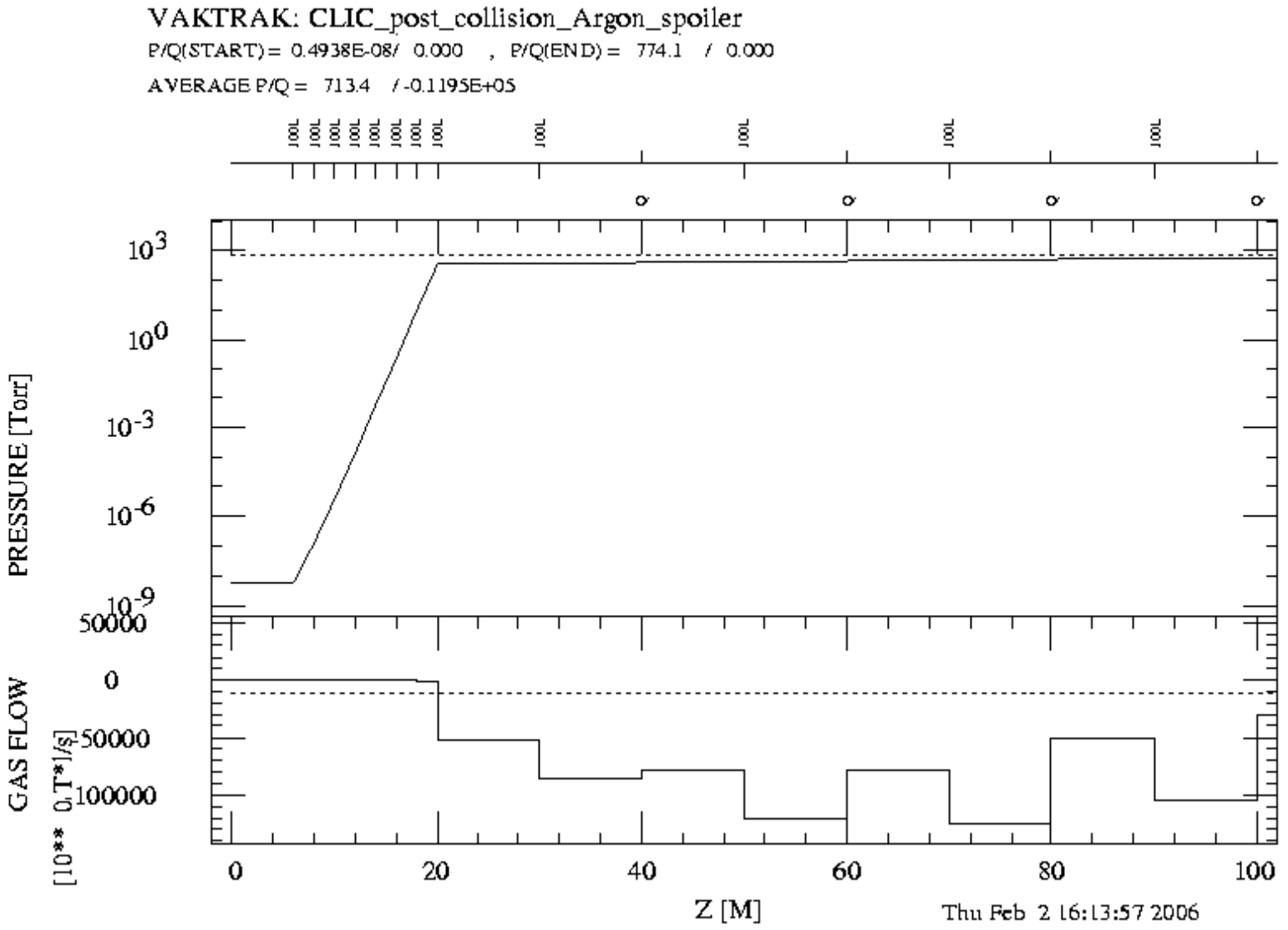
$$< \Theta(z')\Theta(z'') > = \Theta_0^2 \delta(z'-z'')$$

- Beam size on target

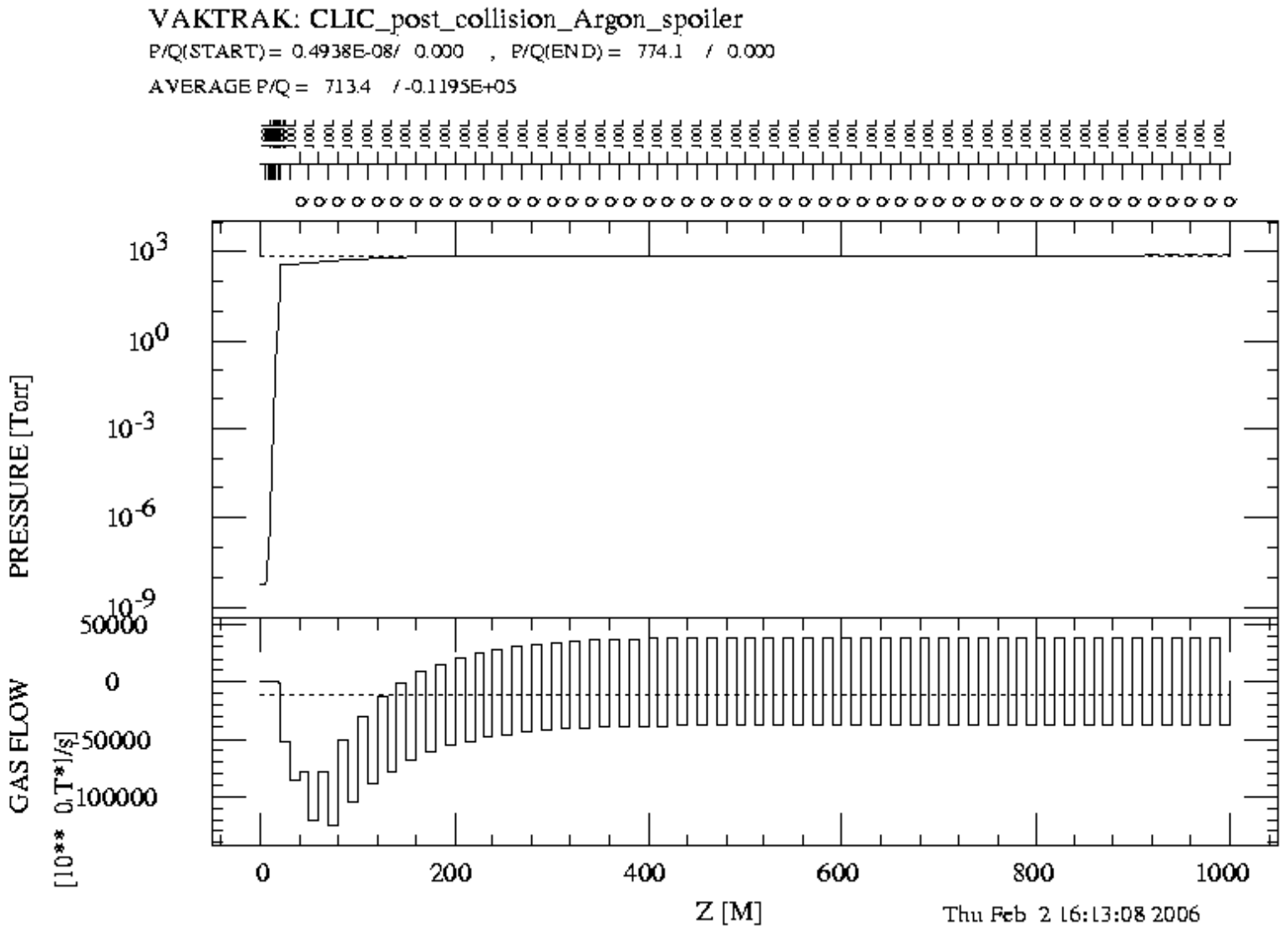
$$\sigma_x^2 = \Theta_0^2 \int_0^z dz'(z-z')(z-z'') = \Theta_0^2 \frac{z^3}{3}$$

- Plug in numbers: $\sigma_x = 1.5$ cm
- Increase pressure or make longer dump line.

...but can we handle the pressure?



The full pressure profile



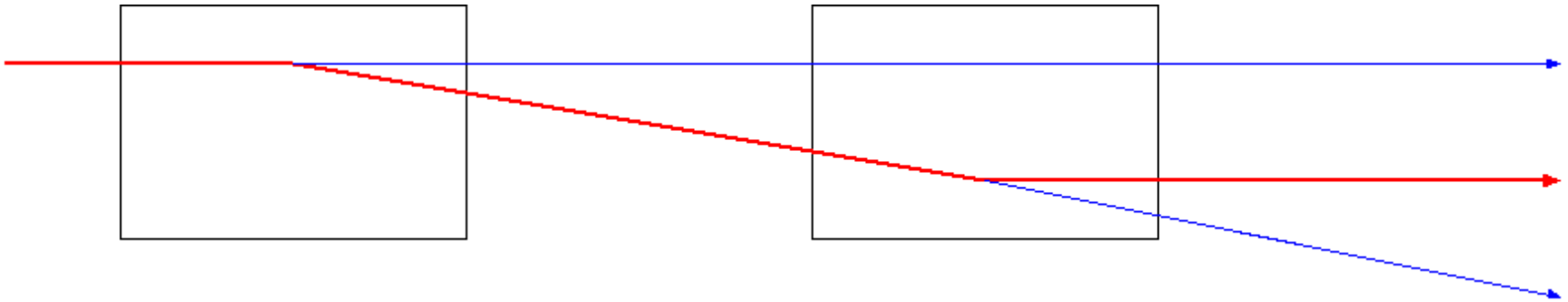
Argon spoiler, bits and pieces

- Differential pumping seems to work
- In the beginning r=2 cm pipe
- Later r=30 cm pipe
- An awful lot of Argon
- Radioactive isotopes?
- Suitable pumps?
- Background, back-scattering neutrons
- Natural beam size monitor early in the beam line, because Argon is fluorescent (I think).

MGPM beam size monitor

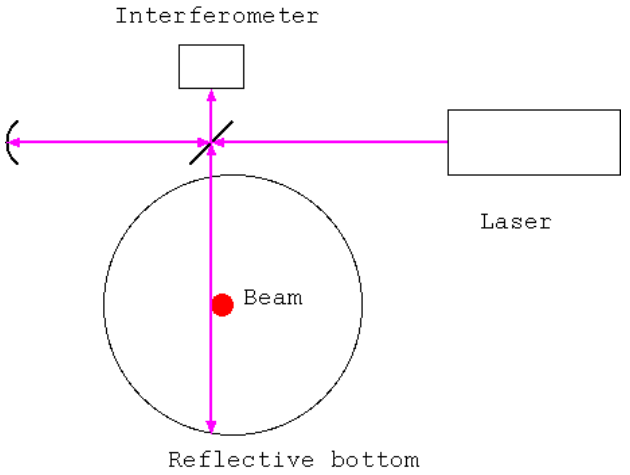
- We had a Magnesium jet profile monitor (MGPM) in CELSIUS that was built in Novosibirsk.
- Evaporate Magnesium and pass a thin stream through the beam in a sweeping movement.
- Magnesium is ionized and electrons are collected in a photo tube.
- Plot sweep angle (position) versus photo current results in beam profiles
- Slow: One scan per second maximum
- Get a profile from a few hundereds of trains

Synchrotron light stripe monitor



- In the dog-leg chicane two stripes are generated.
- Used to be in the SLC Final Focus.
- Separation of stripes is proportional to the energy.
- Accuracy?

Interferometric Thermometer



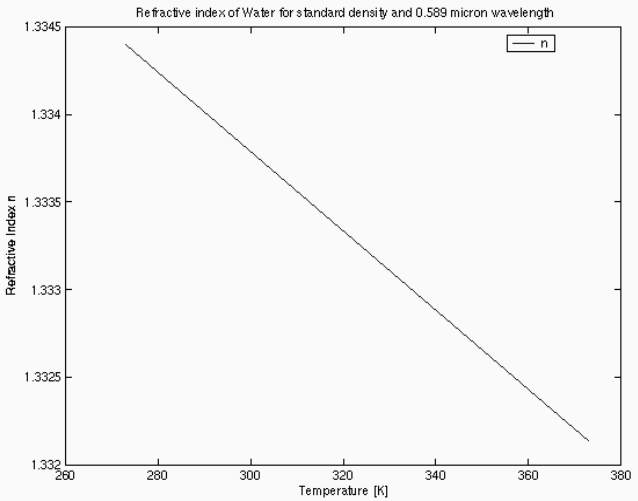
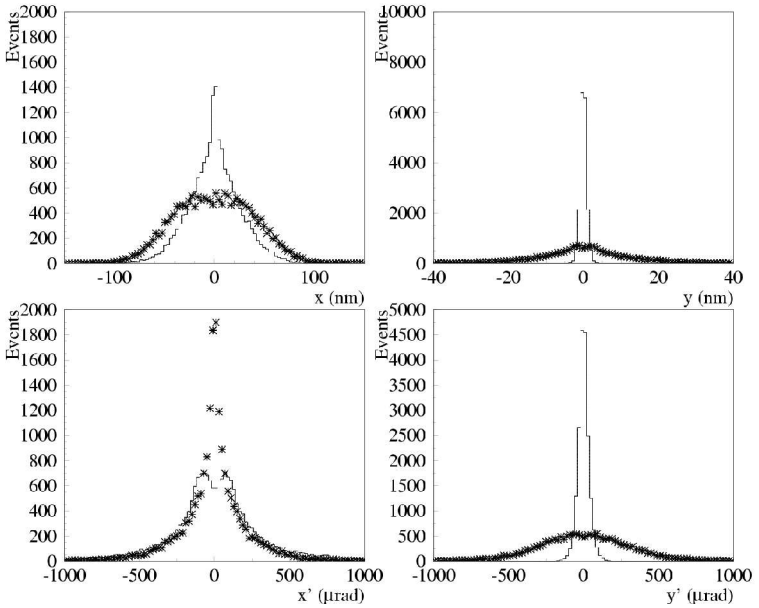
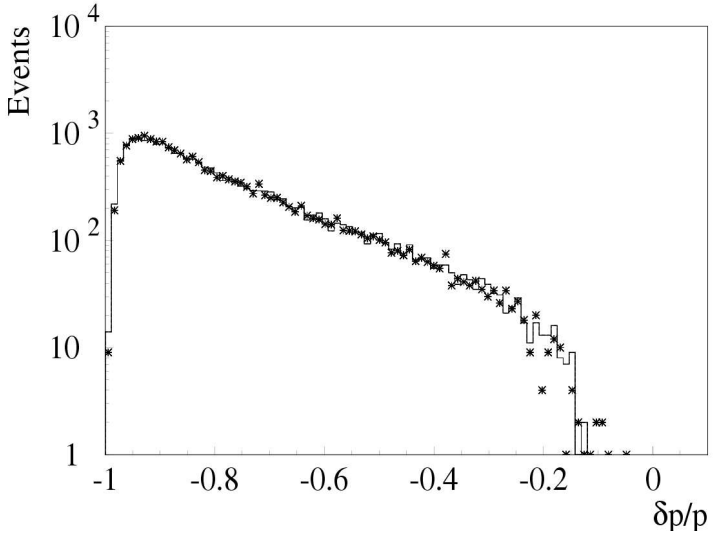


Figure 1: *The refractive index of water as a function of temperature at standard density and wavelength. A linear fit shows that the curve can be parameterized by* $n = 1.341 - 2.262 \times 10^{-5} T$.

- In the dump the water is heated, which changes the index of refraction.
- Using a Michelson interferometer with one arm looking into the water dump it should be possible to find out the temperature of the water

Coherent pairs





- Positrons are separated from the primary beam in the first dipole of the dump line to the “other side”.
- Related to luminosity
- Clean signal
- Space constraint by opposite beam line
- Separating from primary beam will be a problem
- Energy is peaked at about 0.1 x beam energy (500 Tm)
- Generate synchrotron light from it (time structure, fast)

Conclusions

- Lots of questions...

  ...and a few crazy ideas.

  (Argon spoiler, MGPM, Interferometric thermometer, Coherent pairs)

- any comments?
- Need to get input constraints for the design.