Forward Region, Energy Spectrometer, Polarimeter

Klaus Mönig

DESY

LABORATOIRE DE L'ACCÉLÉRATEUR LINÉAIRE

MDI questions related to this talk

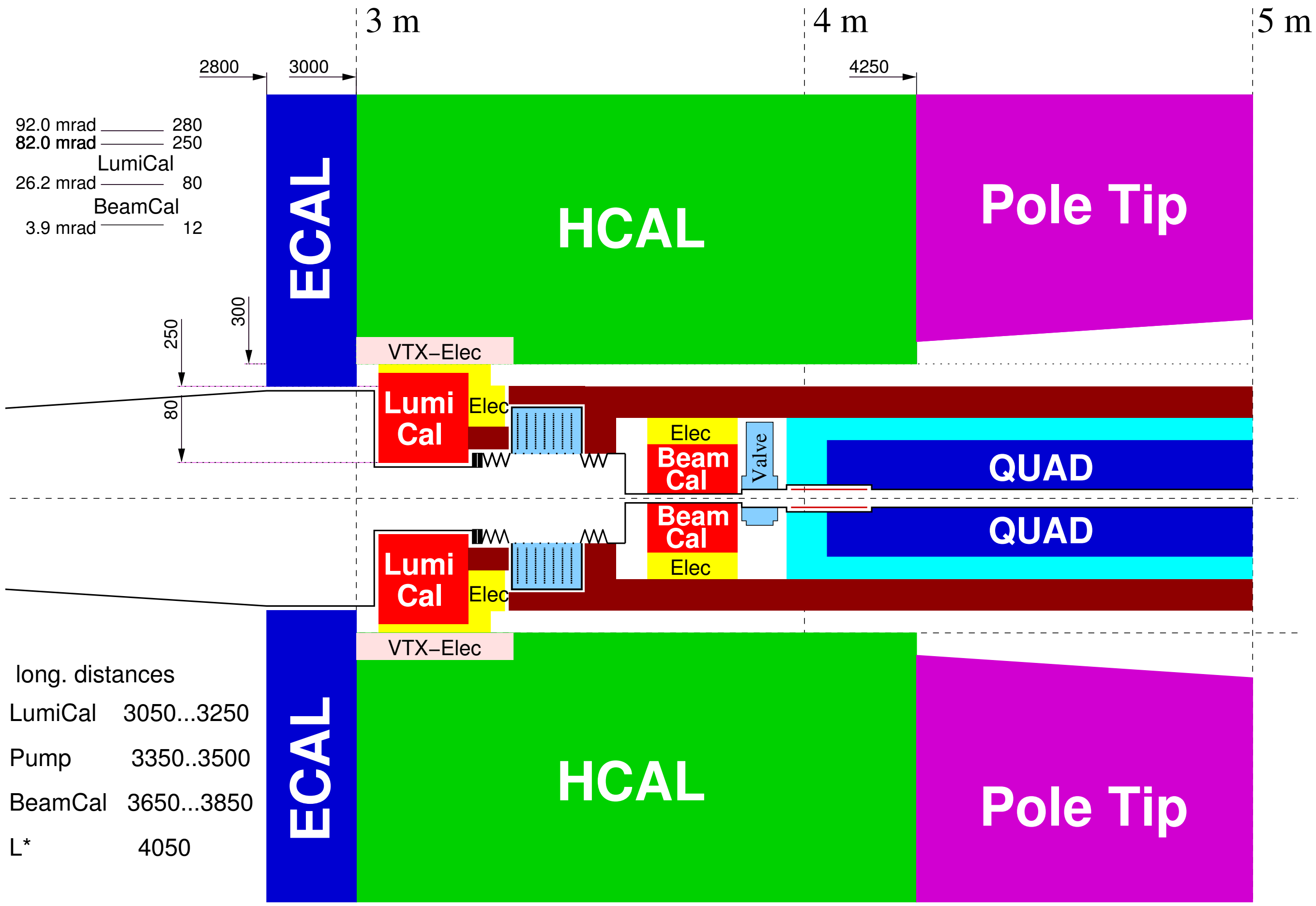
9) Is a 2 mrad crossing angle sufficiently small that it does not significantly degrade your ability to do physics analysis, when compared with head-on collisions?

10) What minimum veto and/or electron-tagging angle do you expect to use for high energy electrons? How would that choice be affected by the crossing angle? How does the efficiency vary with polar angle in each case?

14) Do you anticipate a need for both upstream and downstream polarimetry and spectrometry? What should be their precision, and what will the effect of 2 or 20 mrad crossing angle be upon their performance.

The forward region

Example: The LDC design



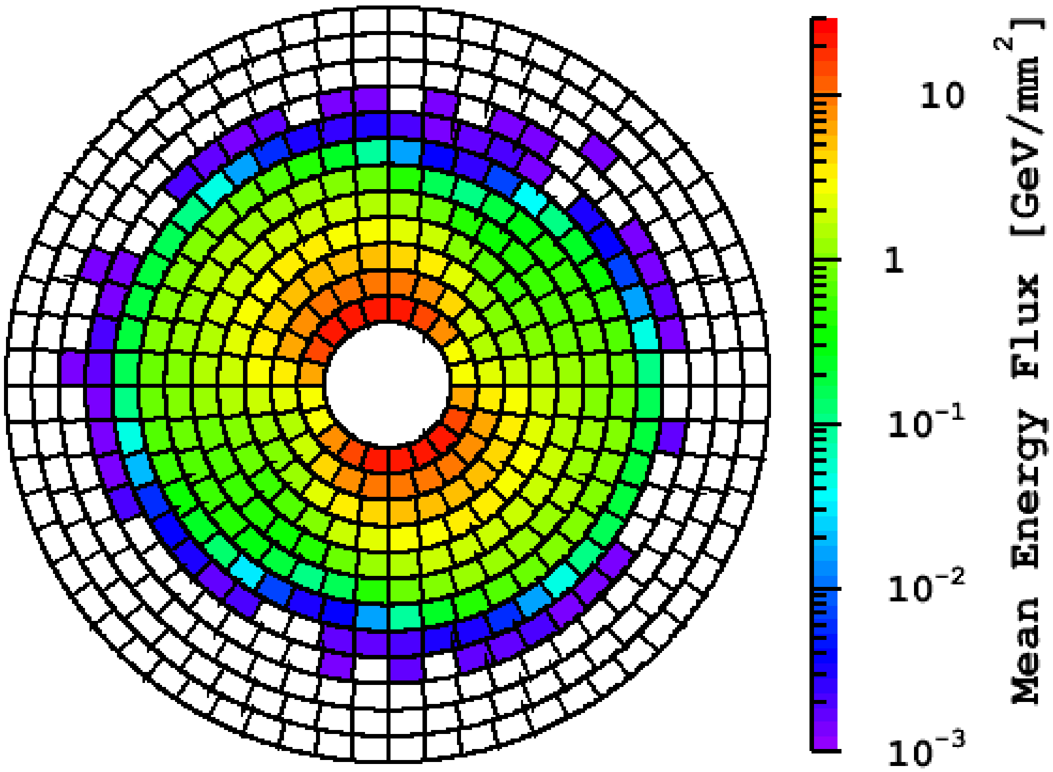
LumiCal:

- relatively clean
- used for precision luminosity measurement

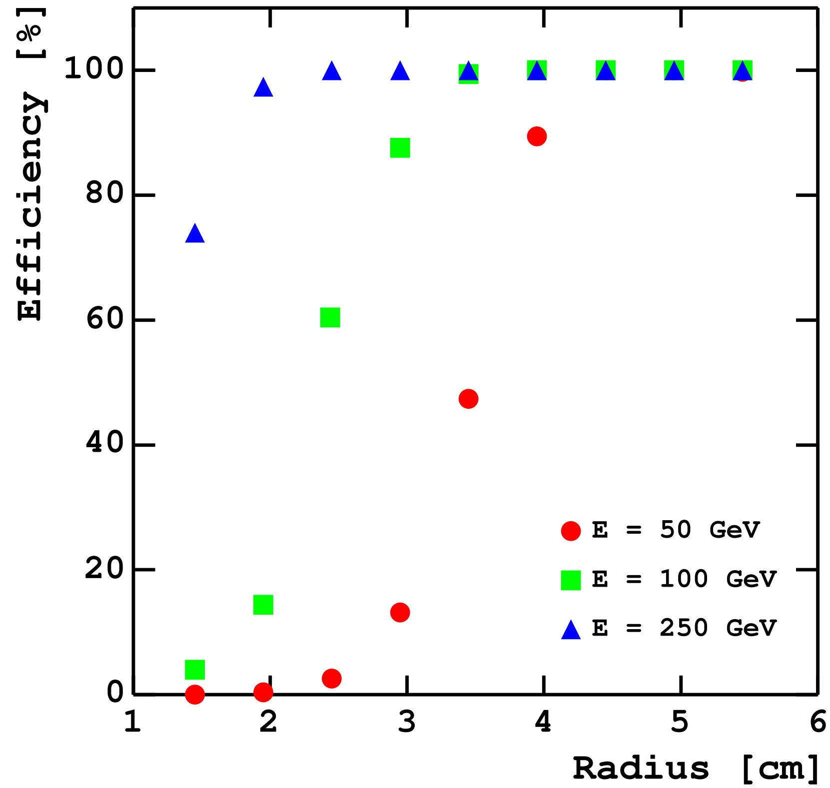
BeamCal:

- several TeV of e^+e^- pairs/bx
- used for electron veto
- also useful for beam parameter determination

Energy deposited in BeamCal for zero crossing angle

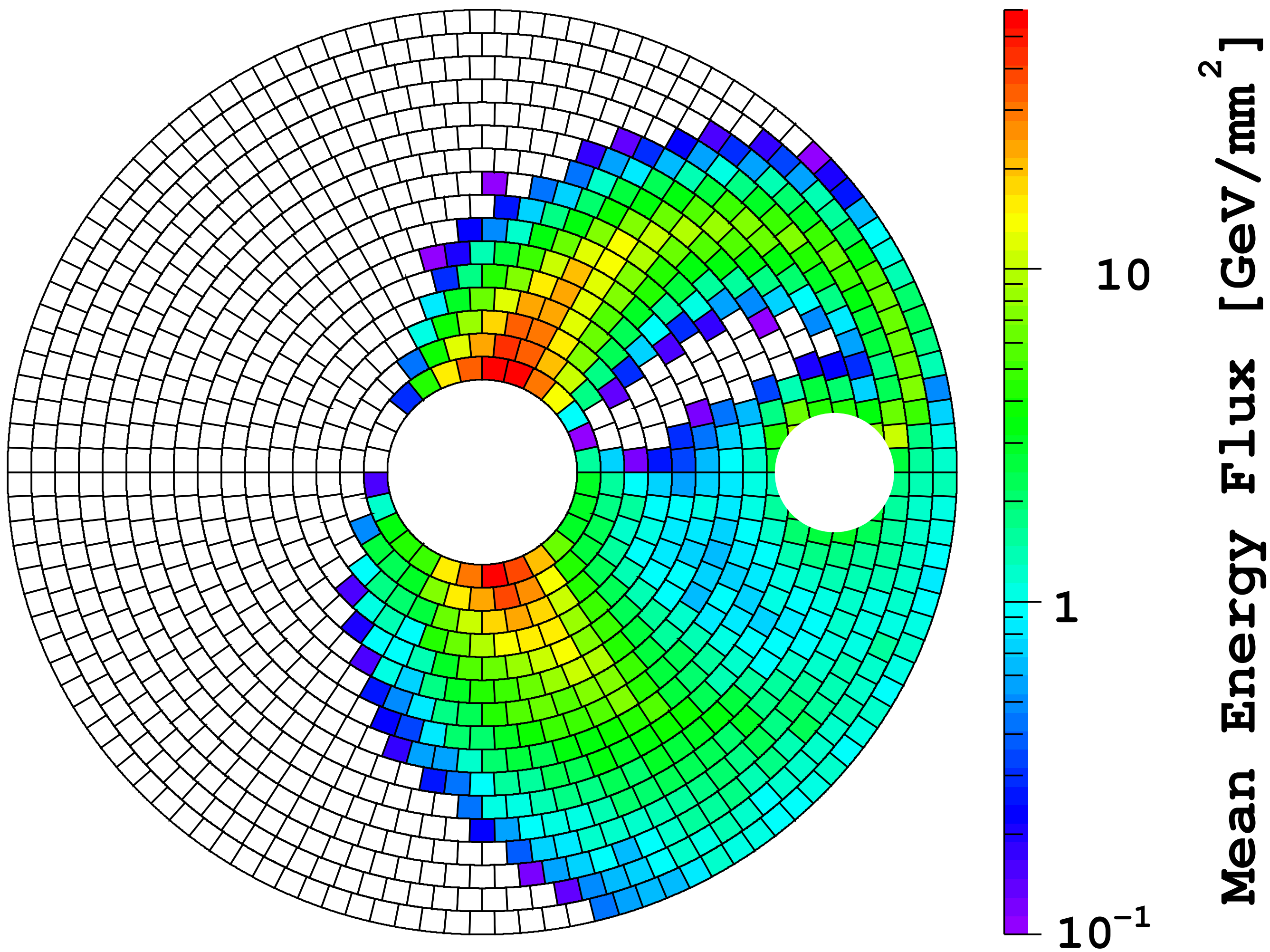


Reconstruction efficiency foe electrons in BeamCal



- Although in BeamCal is designed as a mask device in the head-on case it is pretty efficient to tag electrons ($\tilde{\tau}$ analysis needs $>$ 99.9%!!)
- Detailed studies for 20 mrad are under way

Energy distribution in BeamCal with 20 mrad and DID



9) Is a 2 mrad crossing angle sufficiently small that it does not significantly degrade your ability to do physics analysis, when compared with head-on collisions?

All studies up to now indicate that there is no difference to head-on collisions as long the beam exits through the entrance hole.

However a detailed simulation of the final focus quadrupole is needed for a final answer

10) What minimum veto and/or electron-tagging angle do you expect to use for high energy electrons? How would that choice be affected by the crossing angle? How does the efficiency vary with polar angle in each case?

- WMAP allowed coannihilation region goes down to zero mass difference $\Rightarrow$ like to go as low as possible
- Example analysis $\tilde{\tau}$ pairs with $\Delta m = 5\,\mathrm{GeV}$ (LC-PHSM-2004-016) need momentum dependent lower veto angle between 3.5 and 9 mrad with very low inefficiency (possible with LDC head-on design)
- For 20 mrad crossing angle the horizontal plane has to be rejected by analysis cuts $\Rightarrow$ 30% lower efficiency for same purity
- A detailed simulation of the efficiency loss due to the additional background in the BeamCal is still needed but probably ok
- In general 20 mrad crossing angle may give unacceptable ($\mathcal{O}(10\%)$) efficiency loss due to dead-region between holes

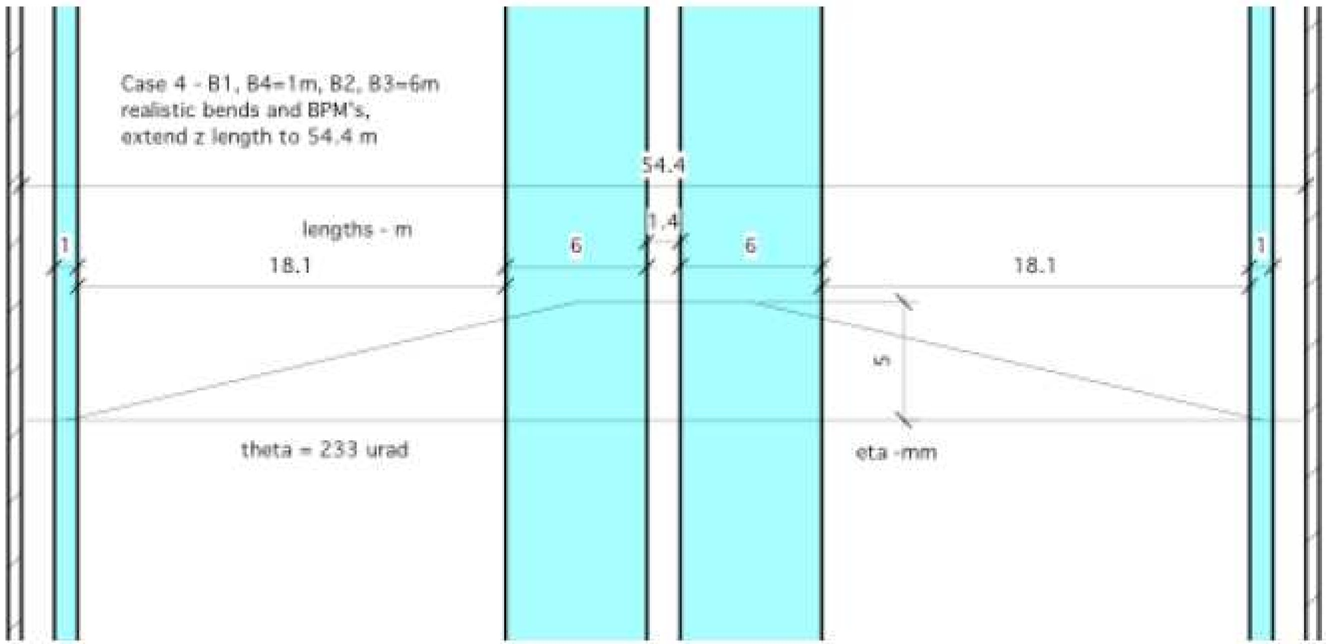
Side remark: beam parameter reconstruction

- In the head-on case the shape of the pair distribution in BeamCal can be used to reconstruct beam parameters like beam size, offset etc. (See C. Grah, MDI workshop at SLAC, also work by H. Yamamoto, G. White)
- Due to the transverse B-field this will be more difficult in the crossing angle case
- Preliminary studies indicate similar results with 20 mrad.
- Is the beam parameter reconstruction important enough that we include it in the crossing angle discussion?

The Energy Spectrometer

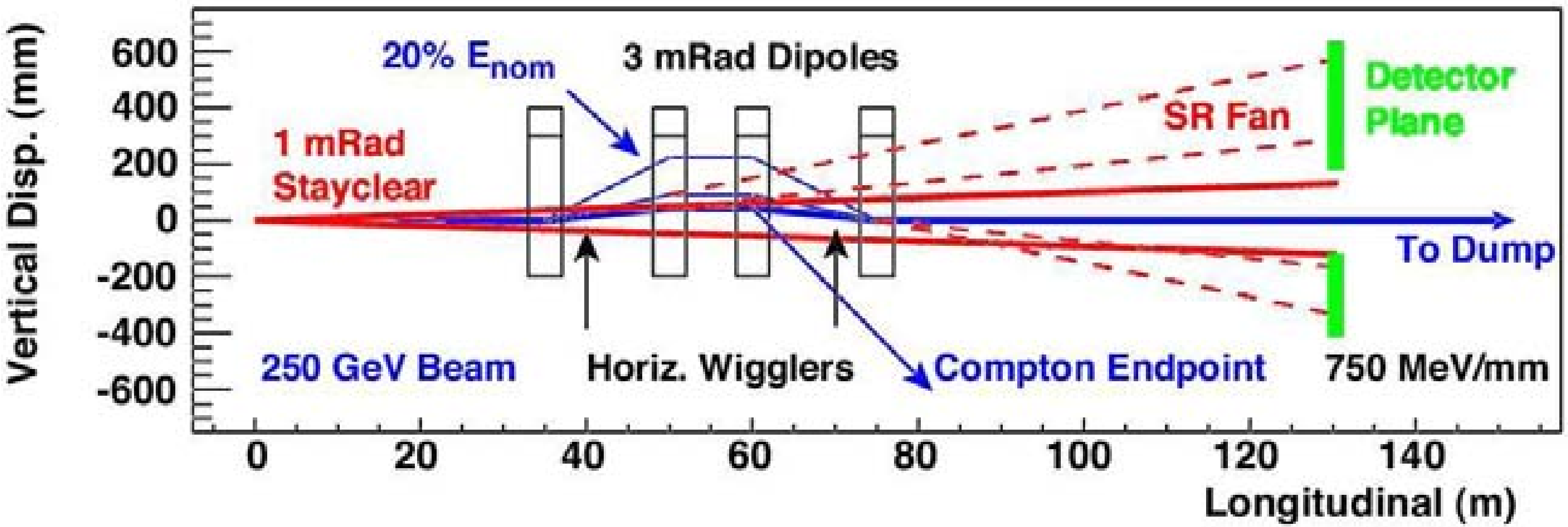
Two designs

1) upstream spectrometer



- magnetic chicane with bpms
- measures mean energy of incoming beam
- probably more precise than downstream spectrometer on single pulses

2) downstream spectrometer



- measures synchrotron radiation fan in magnetic chicane
- probably less precise, however more robust
- however also sensitive to beamstrahlung of outgoing beam

Some considerations

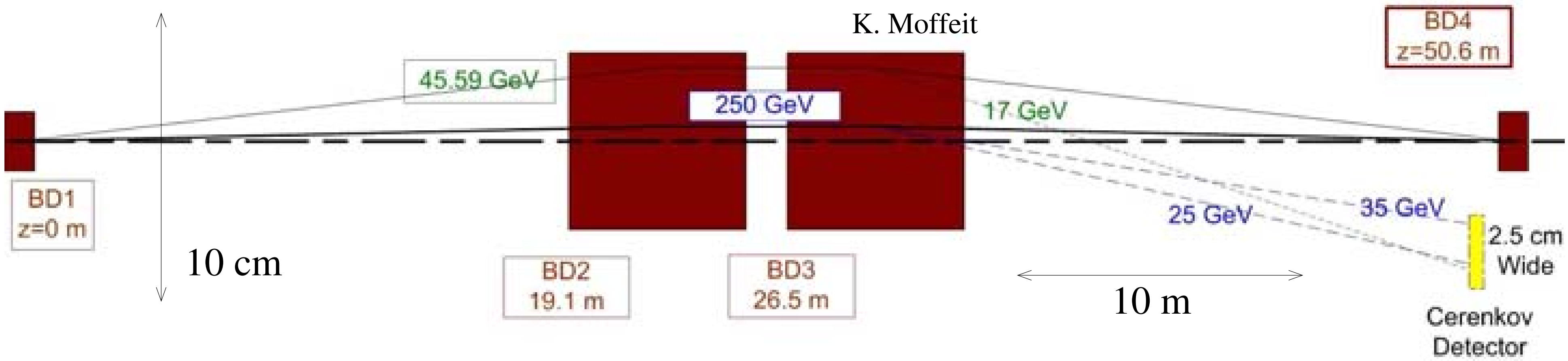
- Upstream and downstream spectrometer have largely complementary systematics
- Total precision should improve considerably from the combination of the two
- The beamstrahlung of the outgoing beam is unequal to the beamstrahlung of the colliding particles
- In principle beamstrahlung can be measured precisely with the acolinearity of Bhabha events
- However correlations between the beamstrahlung of the two beams need to be taken from simulation
- Any possibility to test the simulation will thus be useful

Polarimetry

In all cases assume that beam in polarimeter is strictly parallel to beam at IP

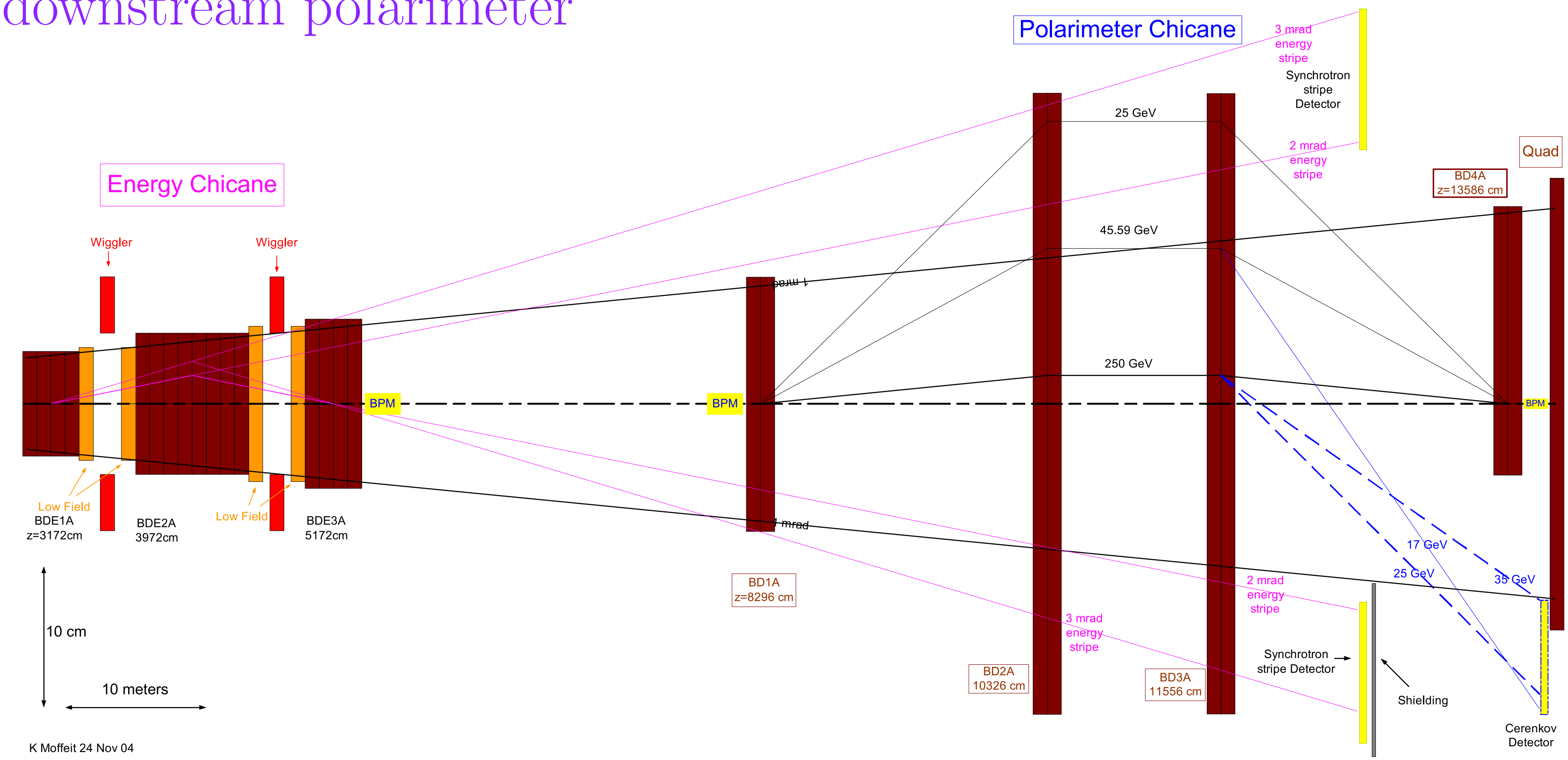
Also here two designs

1) upstream polarimeter



- Compton polarimeter in magnetic chicane
- Measures polarisation of incoming beam
- Low background allows measurement of every bunch

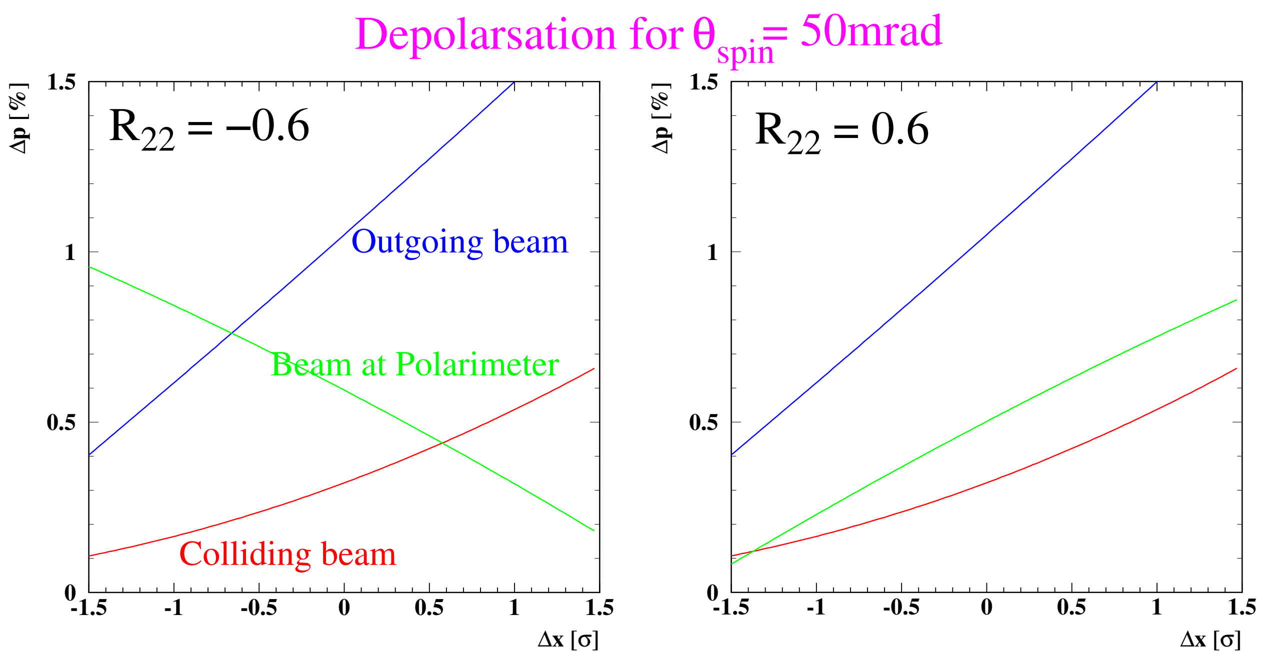
2) downstream polarimeter



- Compton polarimeter in magnetic chicane
- Measures polarisation of outcoming beam after some focusing elements
- Undisturbed beam can be measured outside collisions
- High background allows measurement of one bunch/train
- Can get energy dependence from laser scan

Peculiarities of downstream polarimetry

- Depolarisation is mainly due to BMT from beam deflection
- Since depolarisation is quadratic the depolarisation of the colliding beam is $\sim 1/4$th of the outgoing beam (0.3%/1.2%)
- With some focusing elements in the extraction line the depolarisation at the polarimeter can be identical to the colliding beam
- The slope transfer matrix in the horizontal plane should be positive



Side remark: annihilation measurements

- Polarisation, beam energy, beam spectrum can be measured also with annihilation data
- These measurements are largely complementary to the spectrometer and polarimeter measurements
- Especially for the beam energy (radiative return events) and beam spectrum (low angle Bhabhas) the detector has to be designed with very small systematics on the angle measurements
- To my mind these measurements are equally important to reduce systematics as the upstream and downstream ones

14) Do you anticipate a need for both upstream and downstream polarimetry and spectrometry? What should be their precision, and what will the effect of 2 or 20 mrad crossing angle be upon their performance.

The ILC is for a machine for precision measurements. Therefore all cross checks should be made possible. The upstream and downstream devices have different systematics and test different aspects. Thus both systems are felt to be needed.

The desired precision (outside GigaZ) is $\frac{\Delta\mathcal{P}}{\mathcal{P}} = 0.25\%$ and $\frac{\Delta E}{E} = 10^{-4}$

The performance for 2 mrad and 20 mrad crossing angle has to be evaluated by the spectrometer/polarimeter groups in collaboration with the team designing the extraction line. The results will affect the choice of the preferred crossing angle

The detector concepts wish the smallest possible crossing angle compatible with downstream polarimetry and spectrometry
(Incompatible with $\gamma\gamma$)