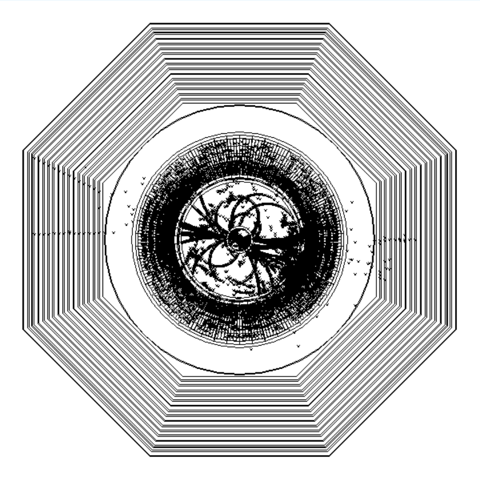
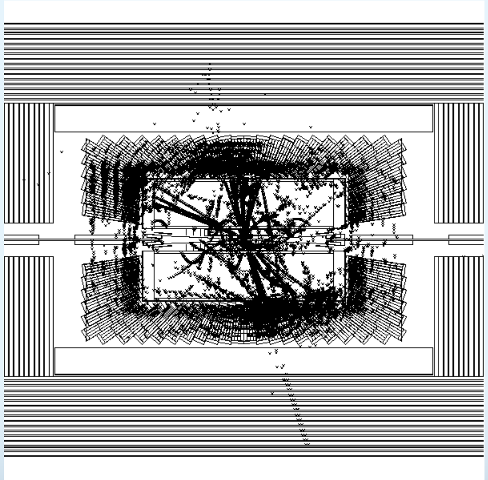
Linear collider muon detector: the LDC design





Marcello Piccolo
SNOWMASS Aug. 2005

Agenda

- The role of a muon system
- Muon identification and energy leakage
- Optimization
  - Thickness
  - Wide to small angle transition
- Conclusions

What do leptons buy for us

- Identifying leptons has obvious advantages in sorting out events characteristics:
  - e.g. direct identification of the W charge
  - direct fermion/antifermion type identification
  - direct flavor identification
- It can help out on the instrumental side too:
  - Semileptonic decays imply neutrino's presence, hence energy missing.

Electrons vs. muons

Both electrons and muons are identified calorimetrically:
- Electrons on radiation length scale
- Muons on interaction length scale
  - identification based on lack of interaction
  - energy loss just for ionization
  - need to follow the non-interacting candidate after a substantial # of interaction lengths.

No need to measure momentum. Track association is good enough to guarantee matching between TPC and muon detector.

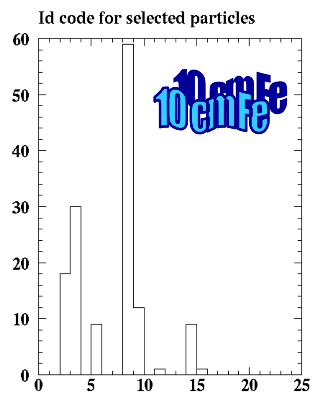
Single particle studies

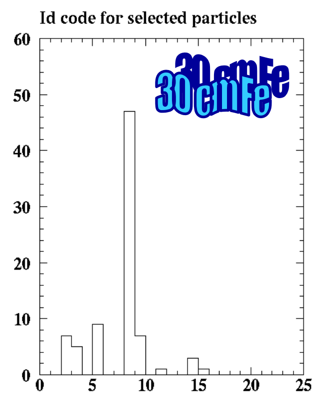
- Try to use simple events to design the hardware.
- Check afterward that more complicate events do not cause derated performances.
- Functionalities needed:
  - Muon id .
  - Measure energy leaking out of the coil.
- Simulation used: Brahms with the TDR default options.

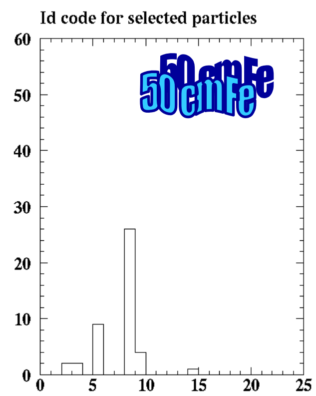
Single particle studies (cont.)

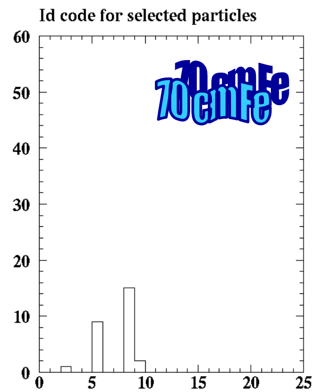
- Generated 10,000 single π with flat momentum and angle distributions.
- Looked at misid. probabilities and energy leakage.
- As mentioned before used as a baseline detector the TESLA-TDR muon system.
- The system consists of 12 active detector planes in the barrel, 11 in the end caps. Longitudinal segmentation 10 cm Fe 11/10 (barr/e.c). times + 1 plane after 50 cm. (total thickness 1.5 m Fe fixed by flux return considerations.

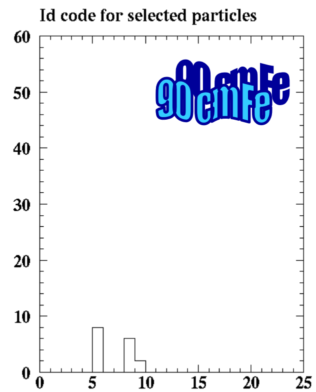
π Misidentification vs. thickness



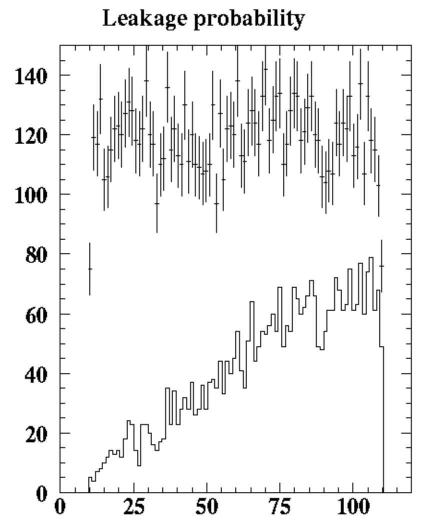


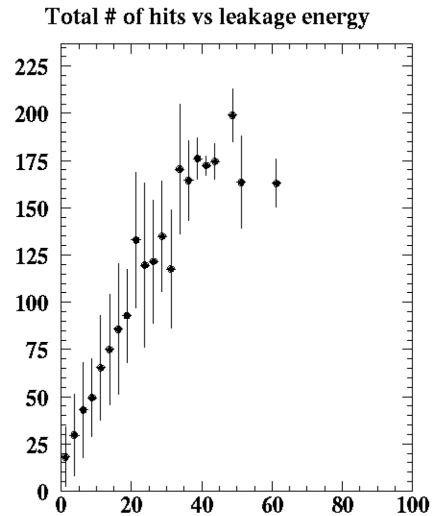


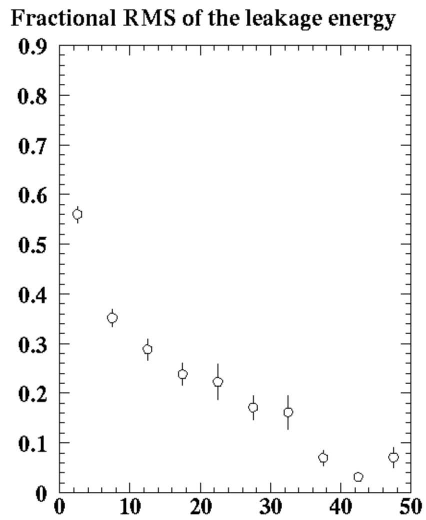




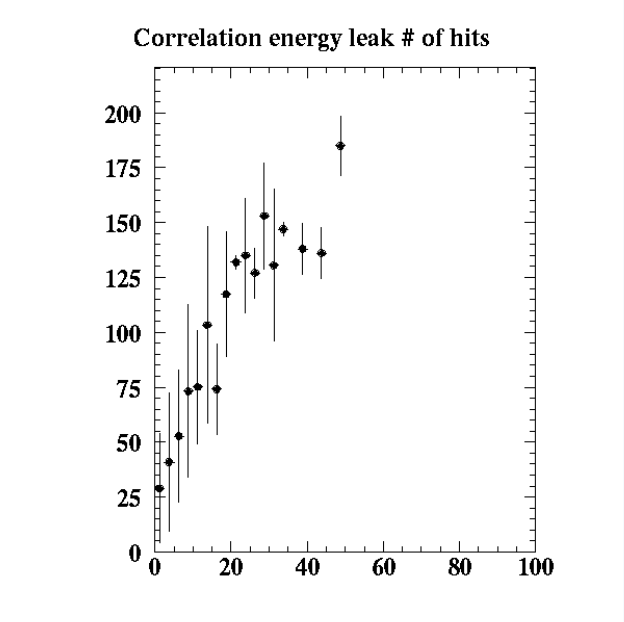
Energy leakage single π

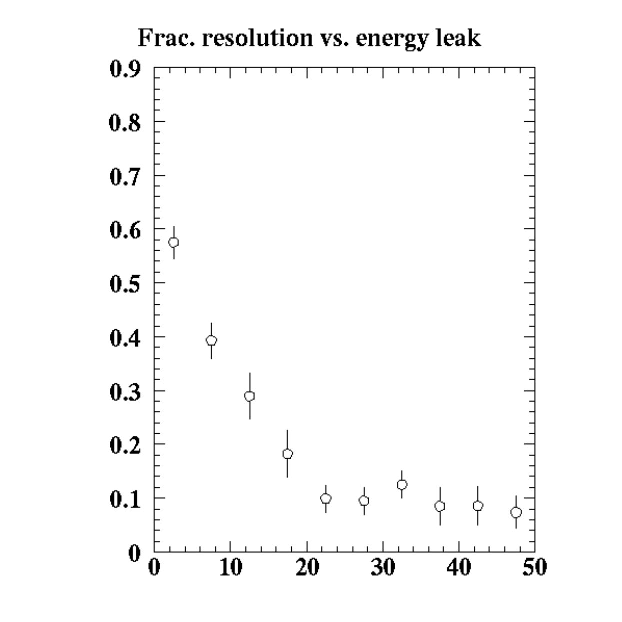






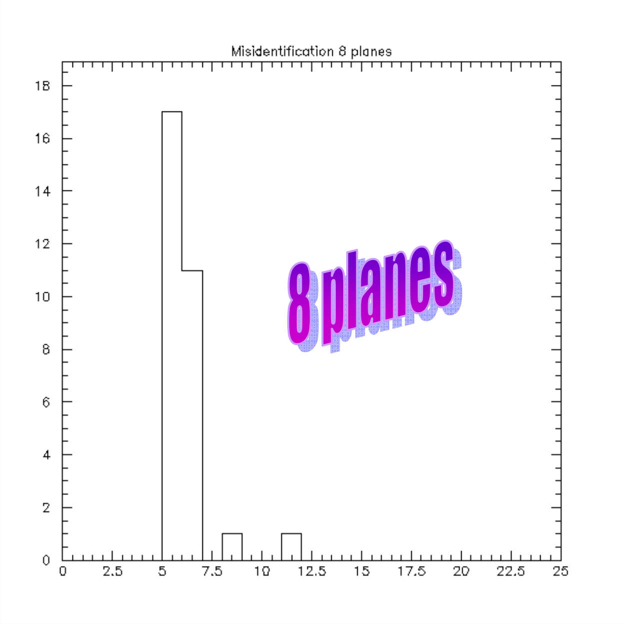
Energy leakage
Standard Model Mix

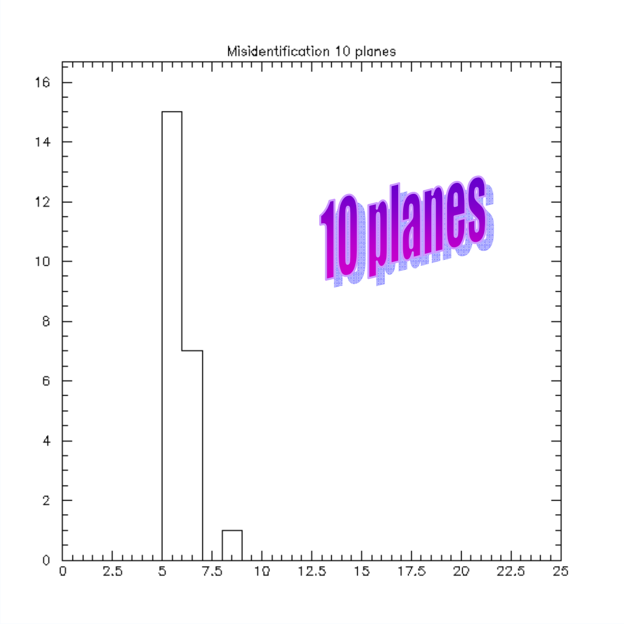




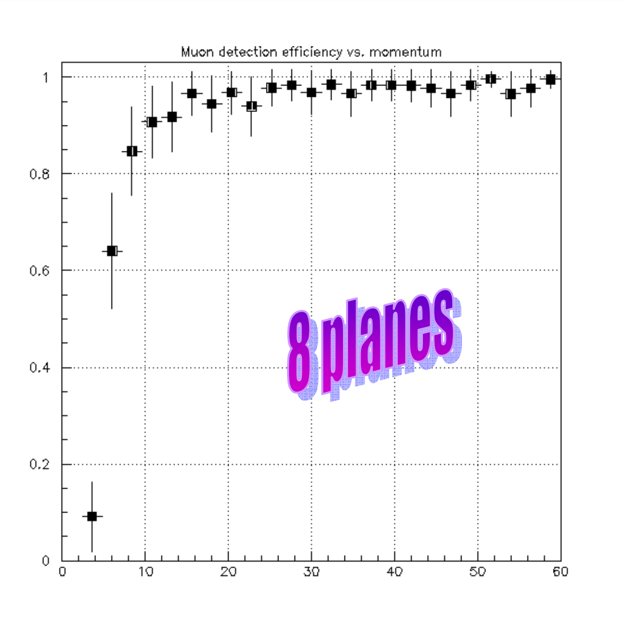
- 81% of the events cause (non-μ) hits in the muon system.
- 9.5% of the events drop more than 1 GeV in the muon system

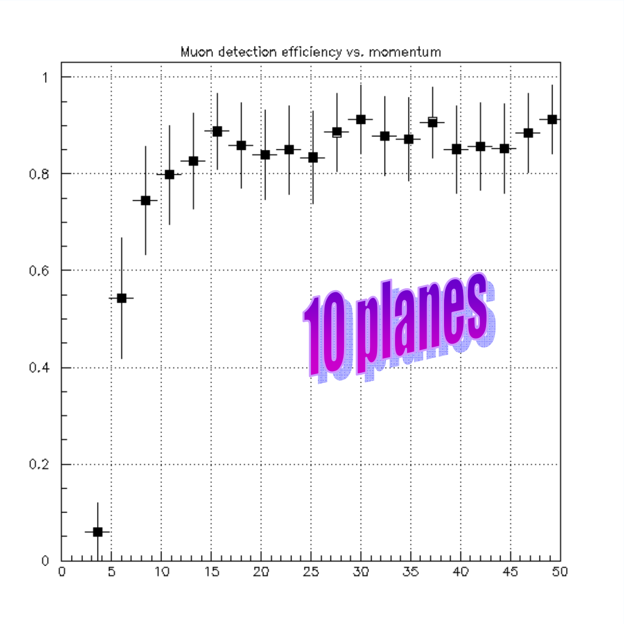
Misidentification Standard Model Mix





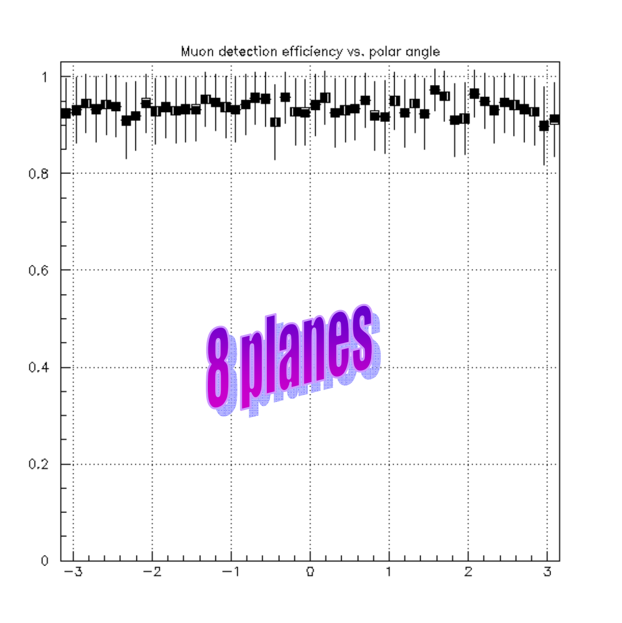
What about efficiency ?

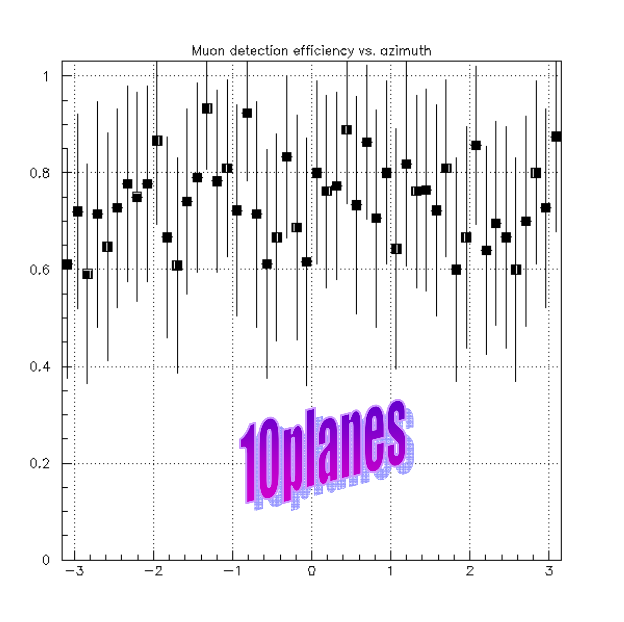




- Single μ detection efficiency vs. momentum

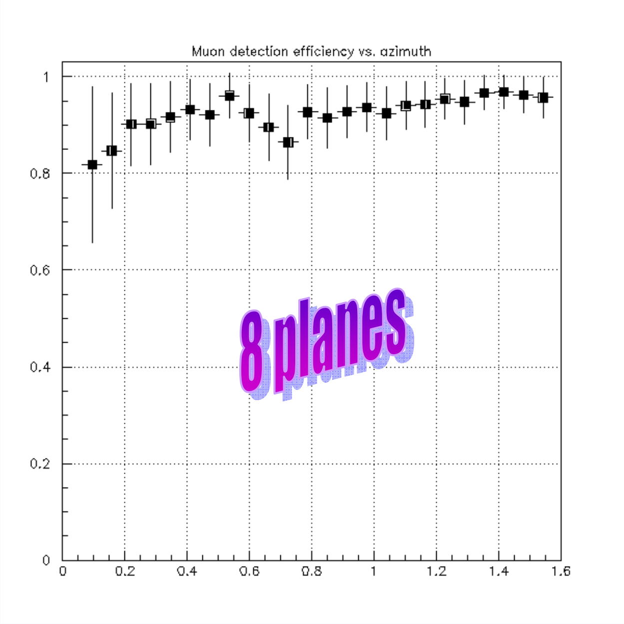
What about efficiency ?

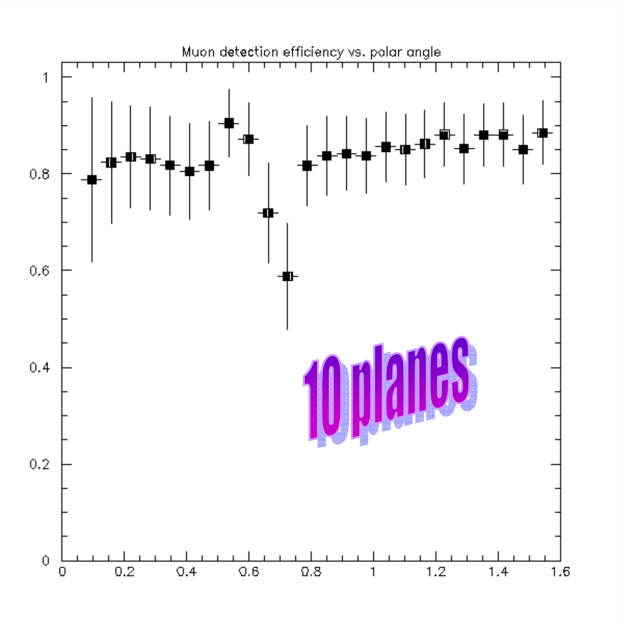




- Single μ detection efficiency vs. azimuth

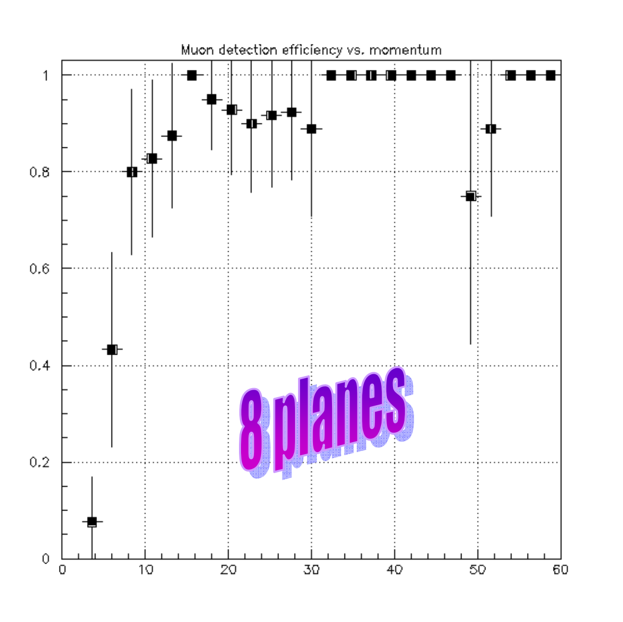
What about efficiency ?

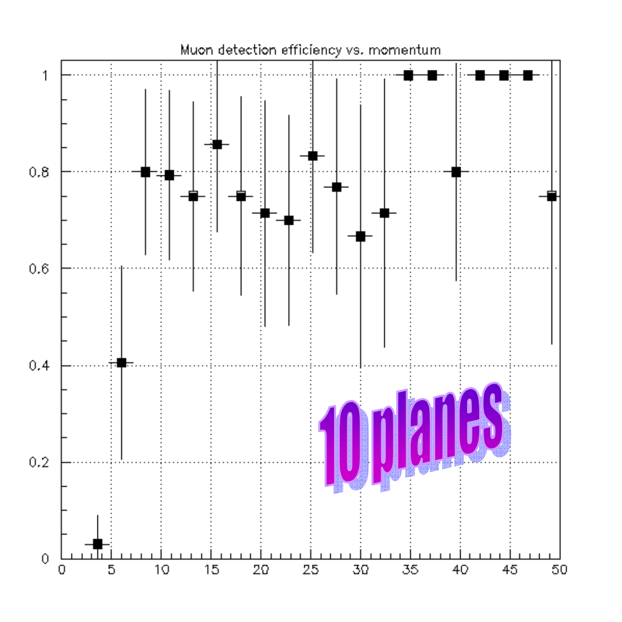




- Single μ detection efficiency vs. polar angle

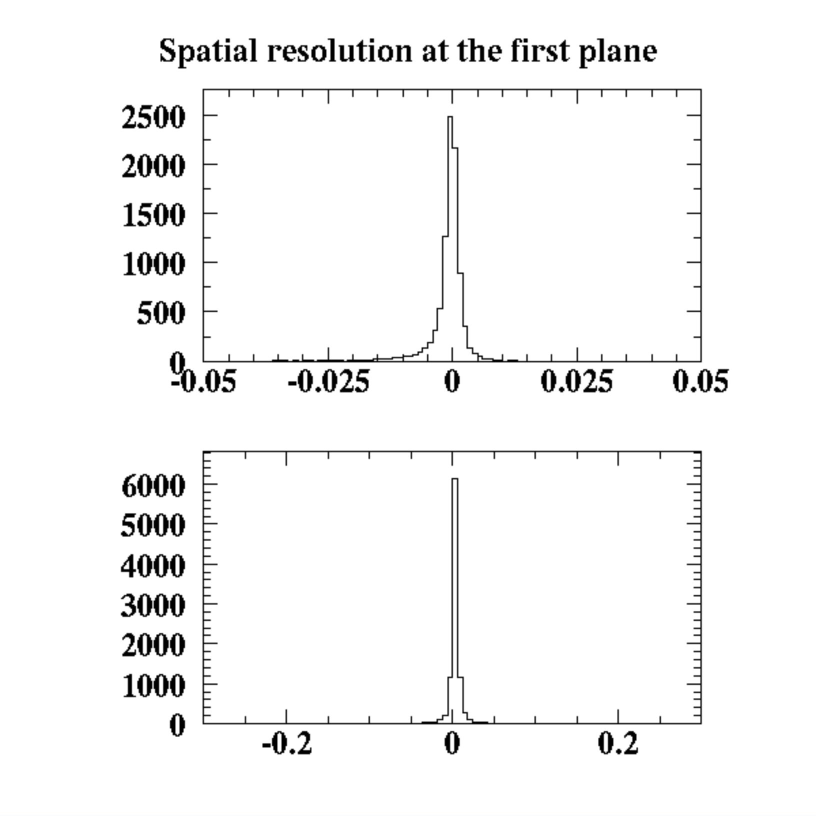
What about efficiency ?





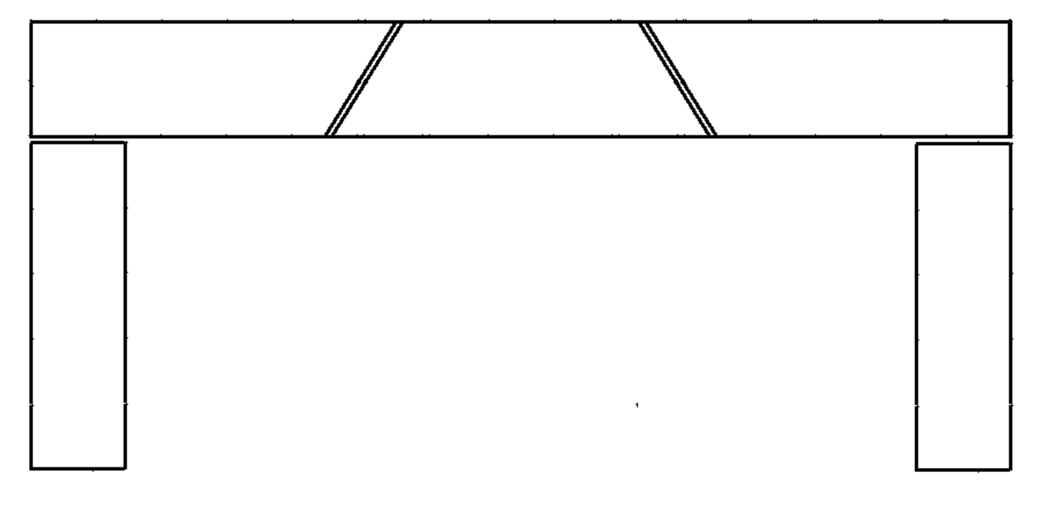
- Standard Model μ detection efficiency vs. momentum

Requirements on spatial resolution



- θ and ϕ r.m.s. at the first detector plane.
- The distribution width sets the spatial resolution scale for the detectors: working out the figures one gets 1.5-2.0 cm.

How do we break it down



- Barrel way to big to make it on piece.
- Break it in three pieces so minimizing transition region by slanting.
- If the barrel has to be long, then insert the end-caps in.
  - The aspect ratio for the end-caps less favorable
  - Detectors shape more complicated, so better if smaller…..

Conclusions

- The μ-system design from the TESLA-TDR seems to cope with the anticipated Physics program for the ILC.
- Muon detection efficiency and background contamination seem to be under control.
- Energy leakage behind the coil, seems to be not very important; it can, however, be measured to a meaningful level.

Backup slides