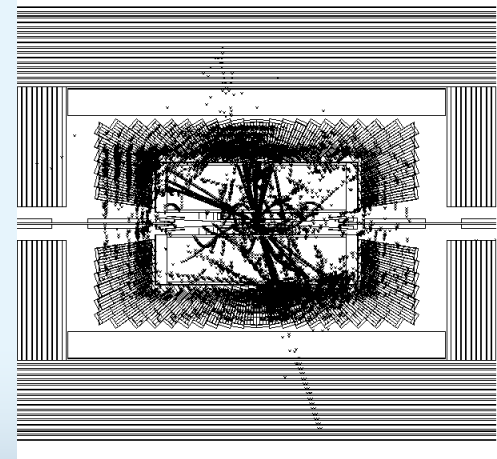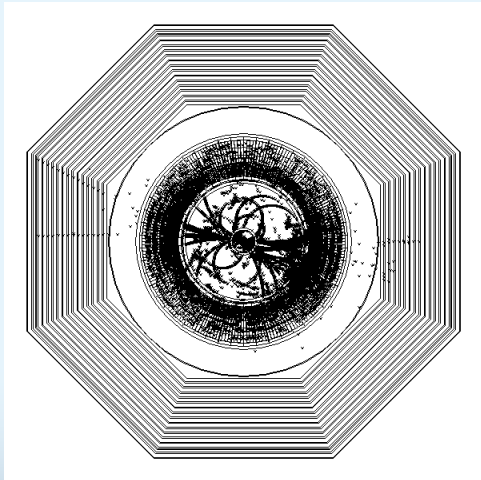# Linear collider muon detector: the LDC design

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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.
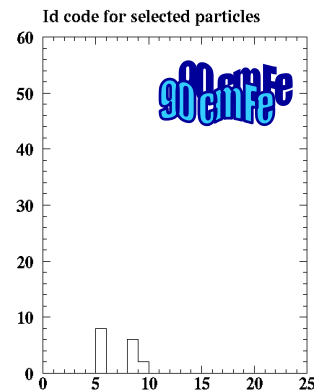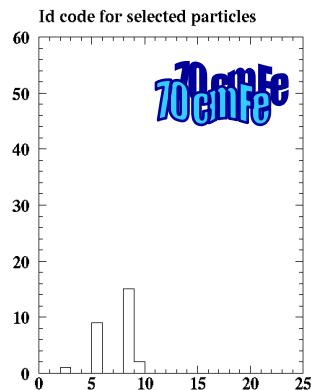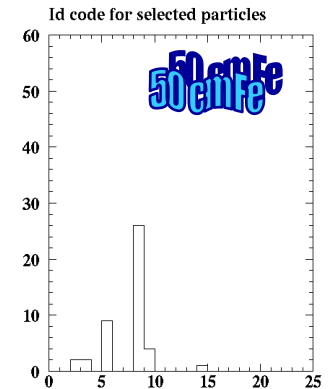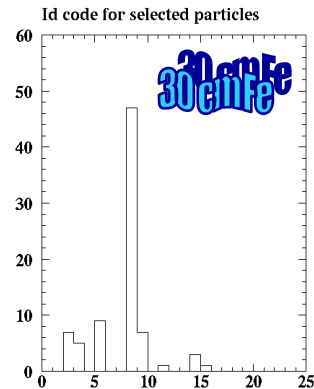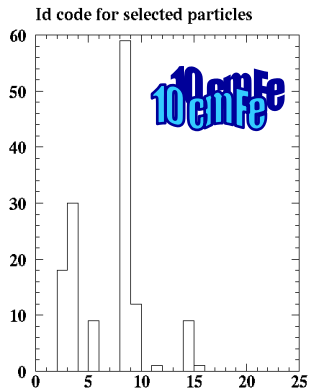
Single particle studies

- 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.
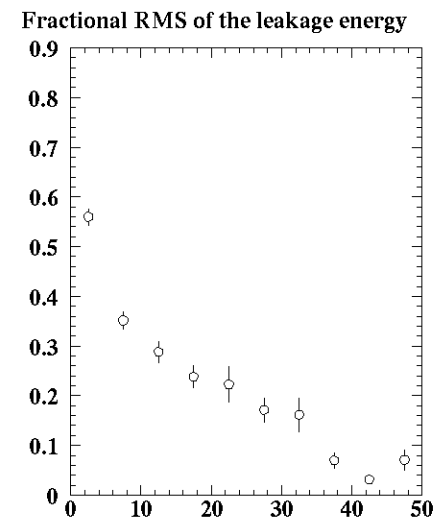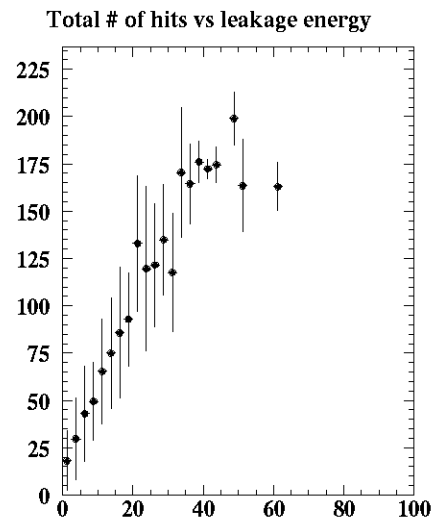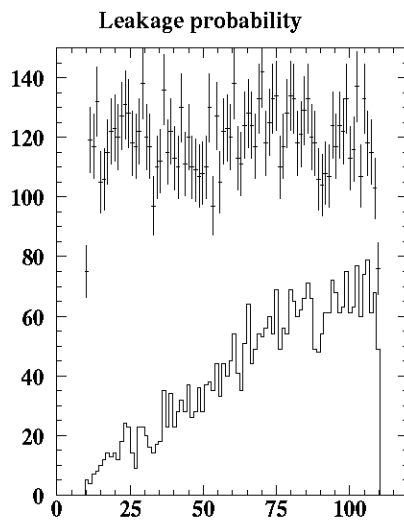- Simulation used: Brahms with the TDR default options.

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.
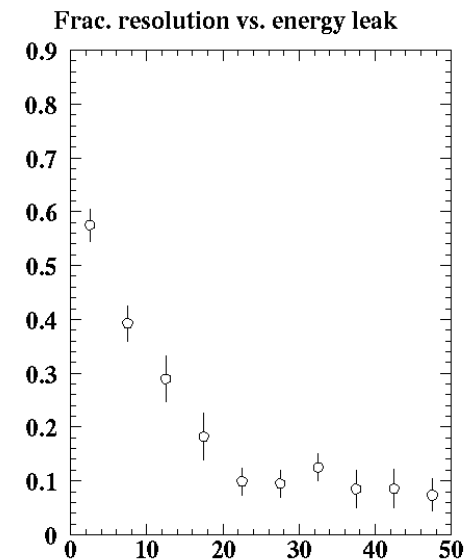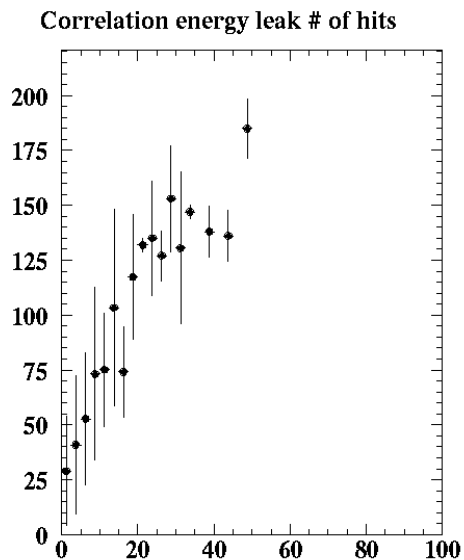
# π Misidentification vs. thickness

Energy leakage single π

Leakage probability

Total # of hits vs leakage energy

Fractional RMS of the leakage energy

Energy leakage
Standard Model Mix

Correlation energy leak # of hits

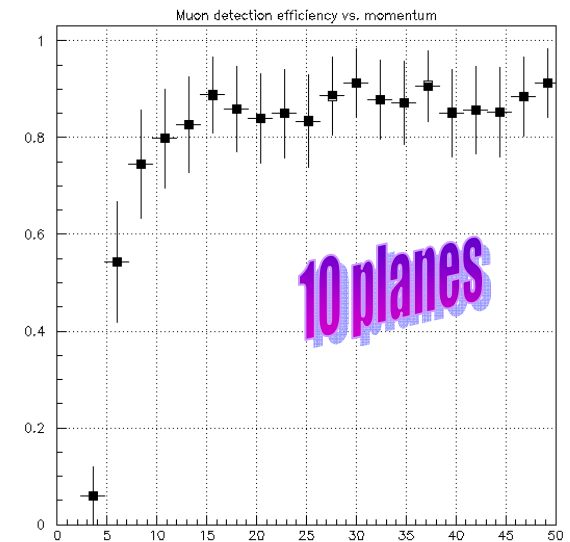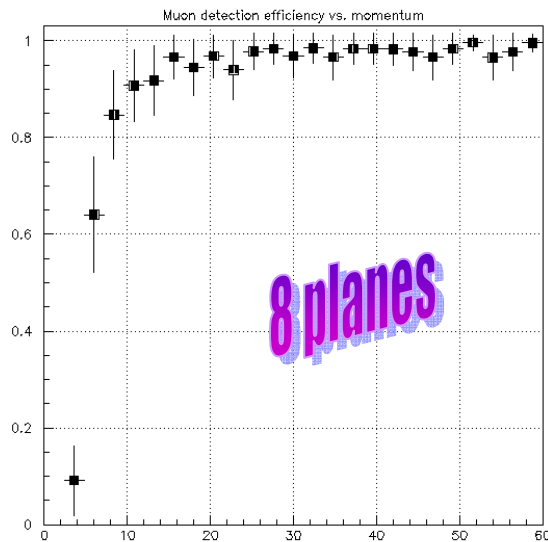**Frac. resolution vs. energy leak**

- 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
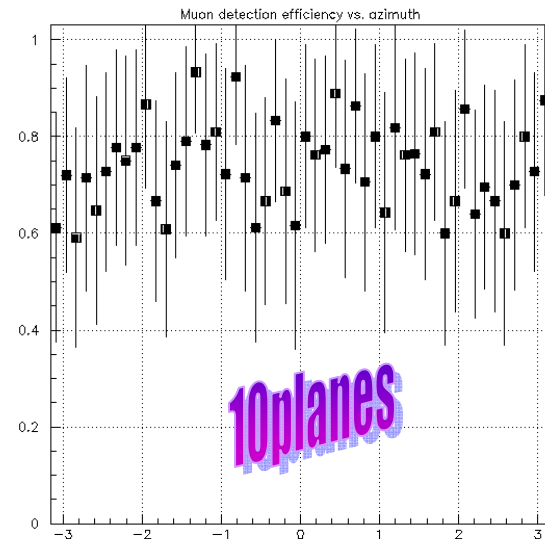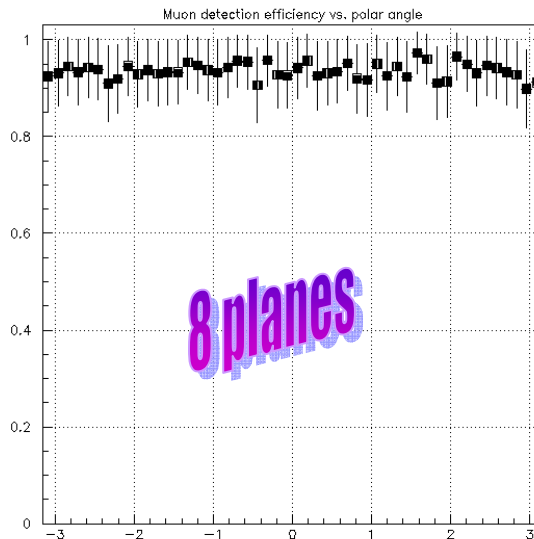
Misidentification Standard Model Mix
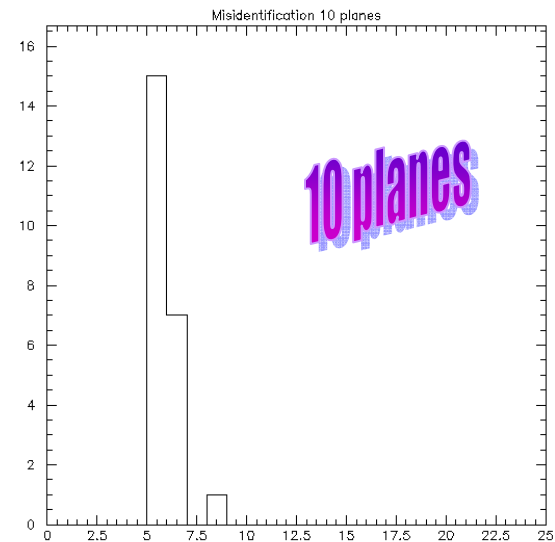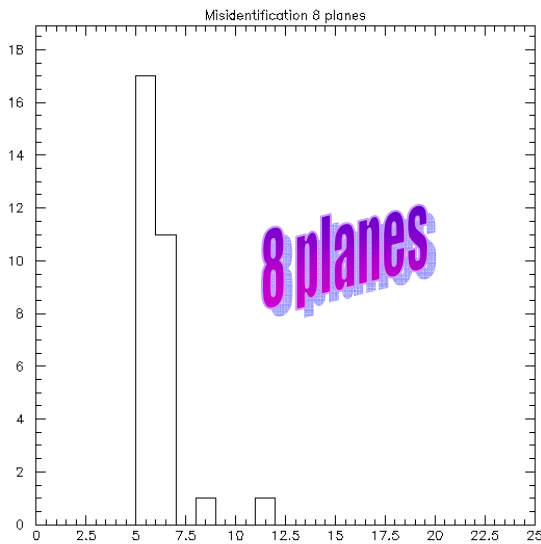
What about efficiency ?

- Single μ detection efficiency vs. momentum

What about efficiency ?

Muon detection efficiency vs. polar angle

8 planes

Muon detection efficiency vs. azimuth
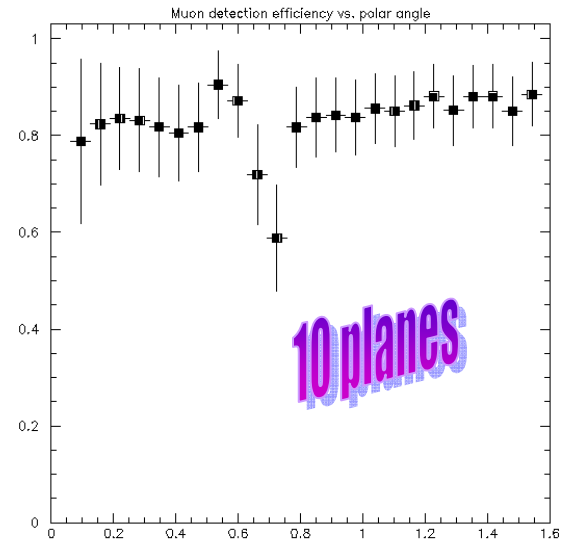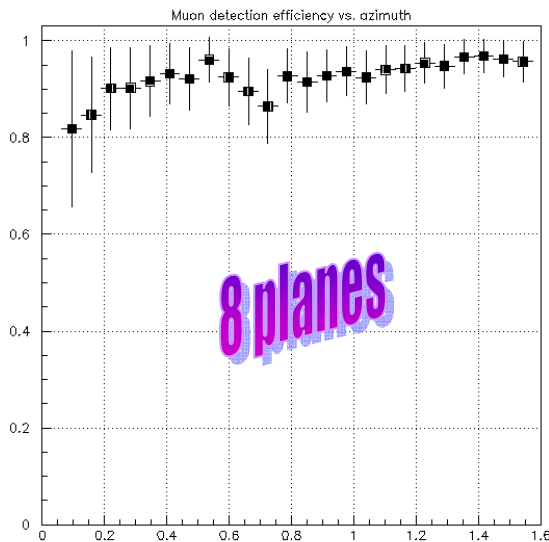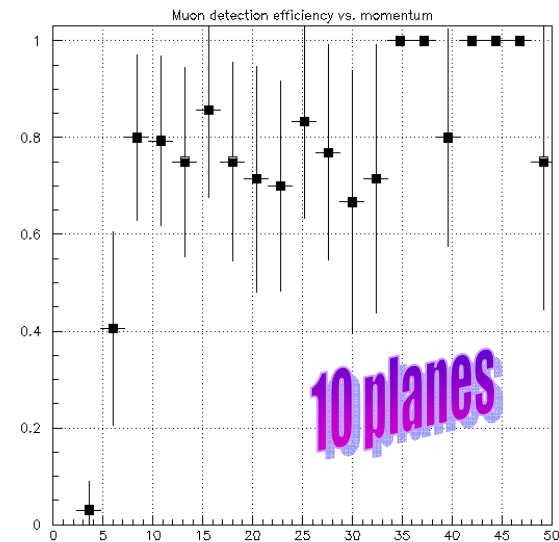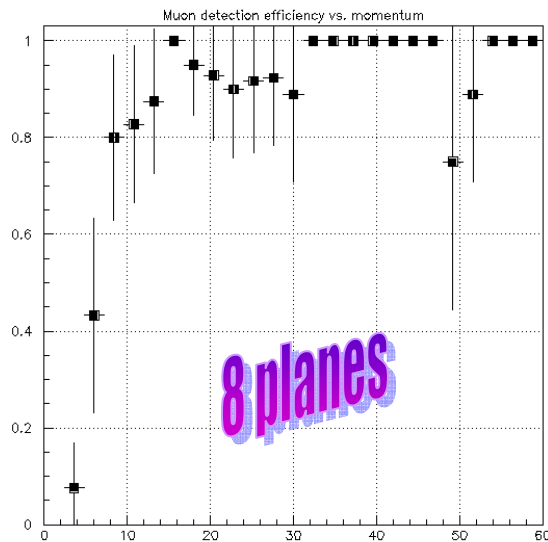
10 planes

- Single μ detection efficiency vs. azimuth

What about efficiency ?
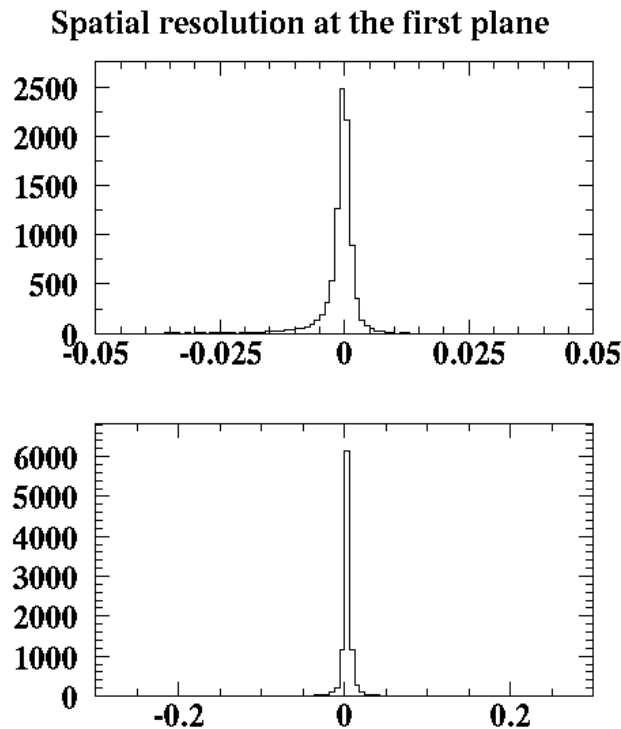

- Single μ detection efficiency vs. polar angle

What about efficiency ?

- Standard Model μ detection efficiency vs. momentum

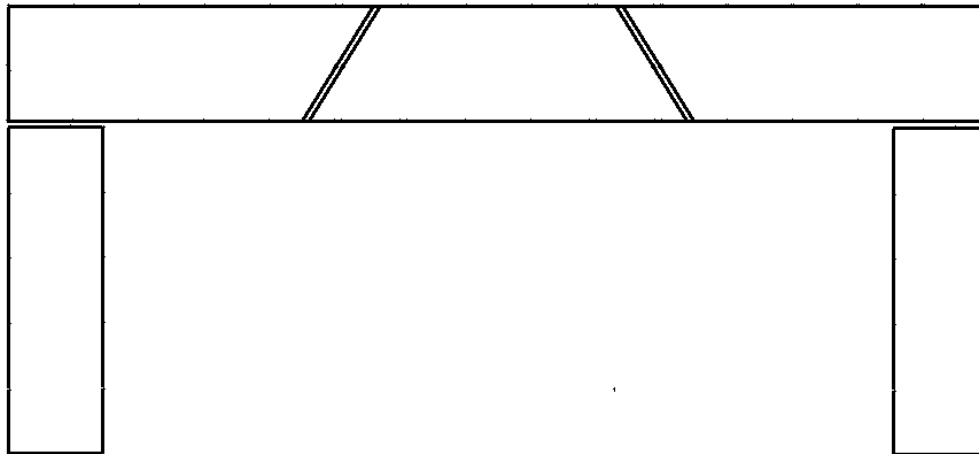# Requirements on spatial resolution

Spatial resolution at the first plane

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

Particle Id. for snark muon classification

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