Linear Collider detector overview

ECFA-DESY study group

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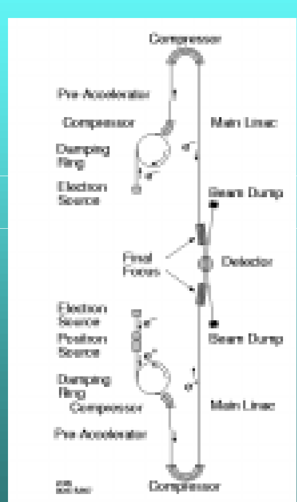


Agenda

- A quick review of Physics topics
- Relation with detector components
- Different options
- Simulation results
- New direction , upgrades…..
- Conclusions

Main Physics topics

- **Top physics @ threshold and high energy**
- **Higgs studies (discovery if needed)**
- **New (s)particles discovery and study**
- **Precision studies of gauge bosons**
- **Searches for exotica**

What is needed

- **Detector vs physics**

	Miss. E	*Jet- Jet recon.*	*Lepton ID*	*VXD and Tracking*	*Forward Directn*
Top	*	**		*	*
Higgs	*	*	*	***	*
Gauge Bosons	*	*	*		**
Supersym.	**	*	*	*	*

Simulation structure

- **Two MonteCarlo's in use:**
  - **The fast one SIMDET mostly used for physics studies: parameterized detector responses , fast, reasonably accurate to be tuned with data and/or full simulator.**
  - **The GEANT based full blown one. As realistic as possible; all geometric and material details:** BRAHMS.
- **Beam interactions: Guinea_pig**
  - **generate secondaries in HEPEVT format: Brahms can read the file and propagate particles through detector and beam-line components**

General considerations

- VXD as good as possible (if it is the best …. I want a better one)
- Jet handling extremely important: e^+e^- environment demands Z/W discrimination. (Energy flow)
- Missing E $\Rightarrow$ new Physics
- Tracking (p_t resolution / tracks ident.)

General Considerations (cont.)

- VXD technology and/or implementation is a sense detached from the overall optimization.
- Tracking and calorimetry interlaced…
- Two alternatives emerge :
  - Large detector with moderate B field
    - continuos tracking , (part of) cal. inside coil
  - Small detector with high B field
    - discrete high res. tracking , cal. outside coil

Detector optimization

- Once the VXD is defined main points left are:
  - Tracking technology
  - Calorimetry
  - B-field
  - Overall dimensions

but….

- All the physics performances bear on energy flow measurements.

How do you do energy flow?

- **Poor man approach :**
  - **use just charged tracks,**
- **Calorimetric approach**
  - **use calorimeter vectors both for charged and neutral… don’t try to disentangle.**
- **Use tracking for charged and subtract those from calorimetry.**

Exploiting energy flow

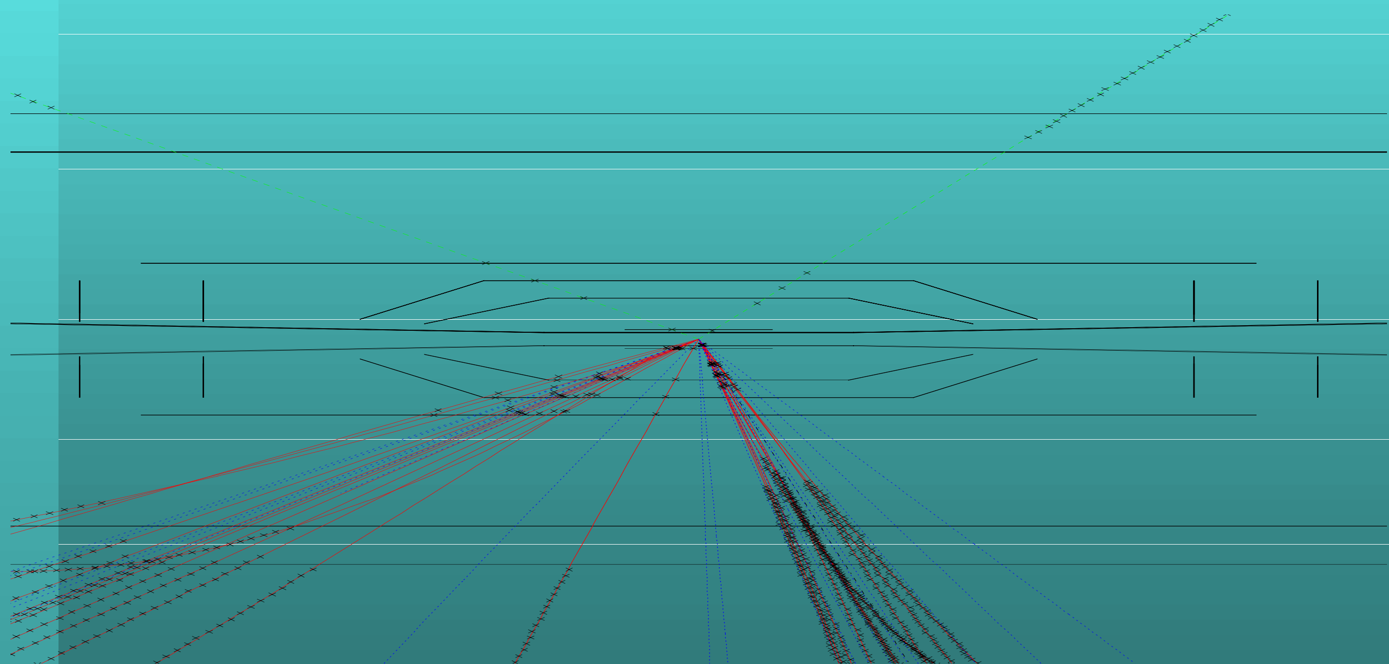
- The very best energy/angular resolution for jets comes with complete tracks/energy cluster disentangling….

$$\Downarrow$$

- Need both high B and long lever arm to move charged prongs away from neutral energy clusters….
- In the nominal Tesla detector geometry (CDR) a 20 GeV/c π moves away (in angle) from the original direction by ~70 mrad.
- One would like to be away at least two or three Moliere radii in order to do a correct accounting of energy between charged prongs and neutral cluster.

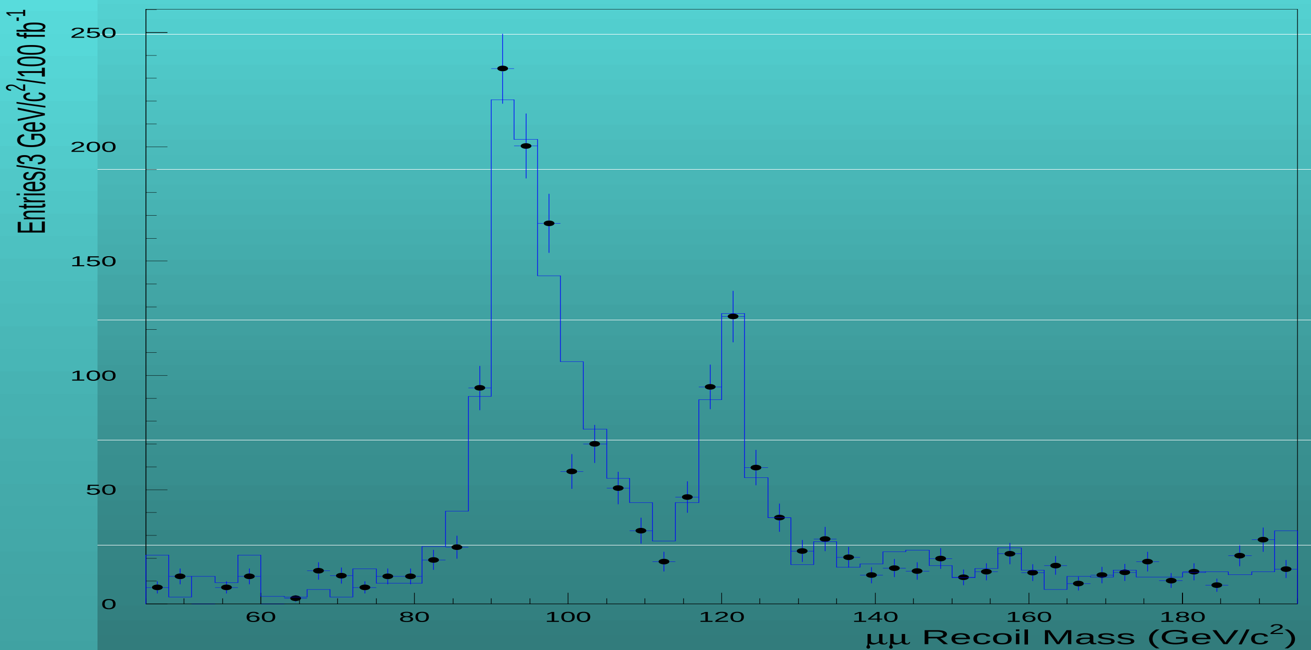
Performance requirements

- **VXD : *b*-tagging and *c*-tagging require few μm acc. and thickness' below 1% X_0.**



Tracking

- **Higgstrahlung sets the performance scale $dp_t/p_t \sim 510^{-5}$**



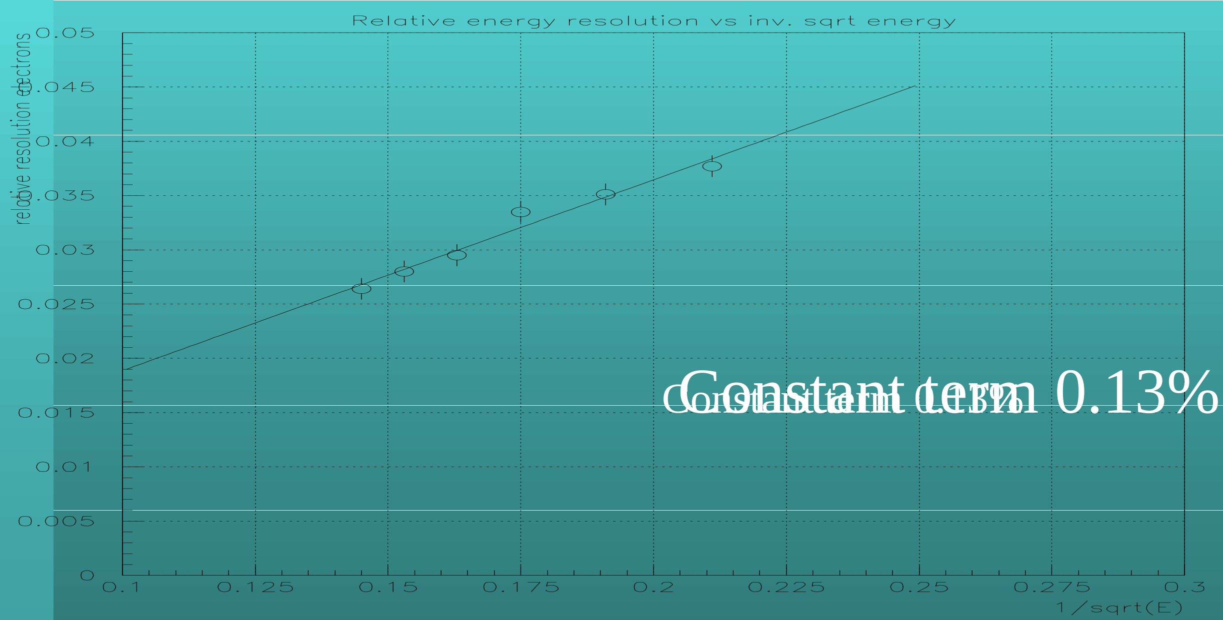
Calorimetry

- Various modes of operation of the full Monte-Carlo:
  - No cal : tracks and neutrals die in cal-vacuum.
  - Smearing cal: tracks propagate and interact through cal. material, but no stratigraphy simulated.
  - All the gory details: test beam type.

An example: single electron resol.

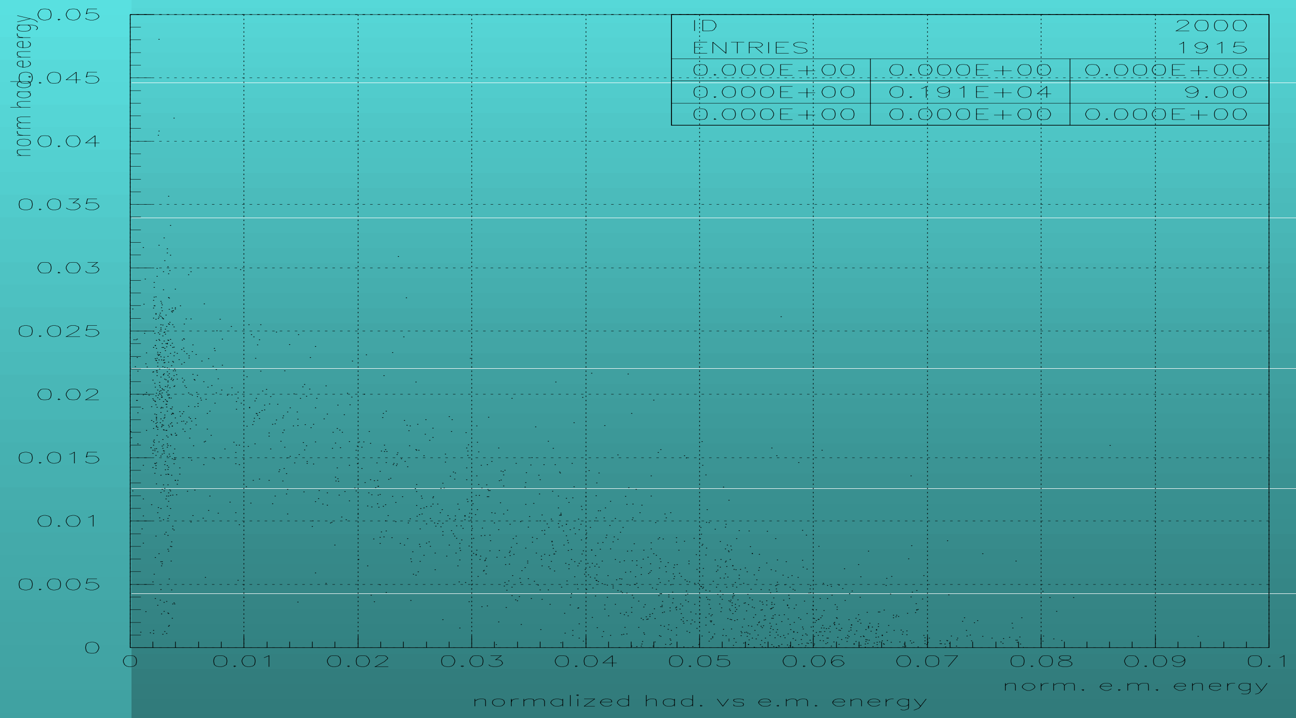
- **Brahms run : test beam mode.**

Constant term 0.13%



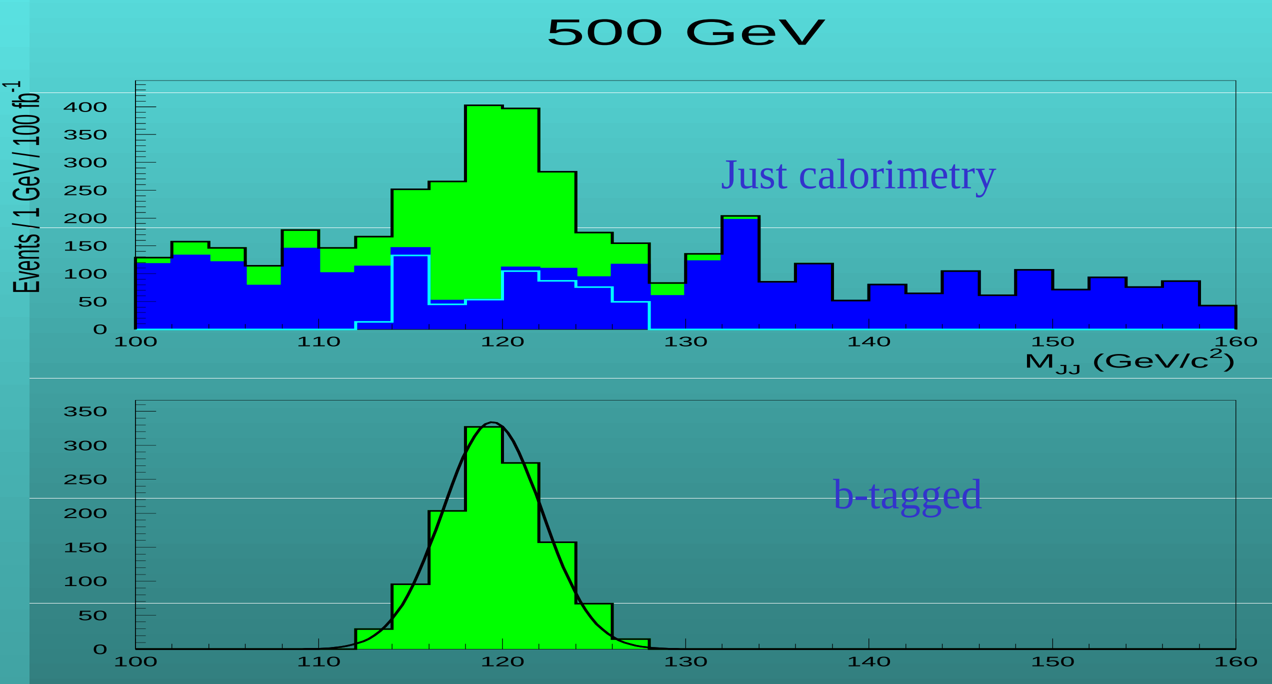
Energy sharing : hadrons

- **Hadronic vs e.m. energy for π^{+}'s; <E>= 15 GeV**



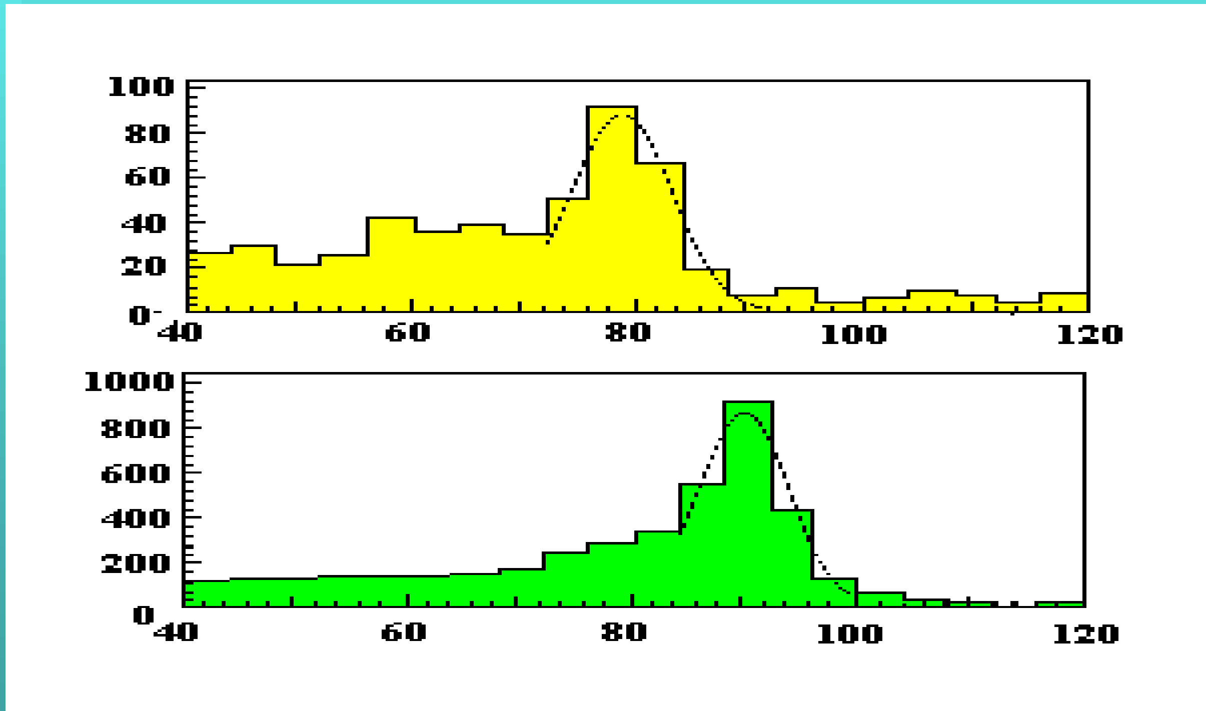
Jet-Jet mass resolution

- **Mass plot for a 120 GeV/c² S.M. Higgs (higgstrahlung) produced @500 GeV**



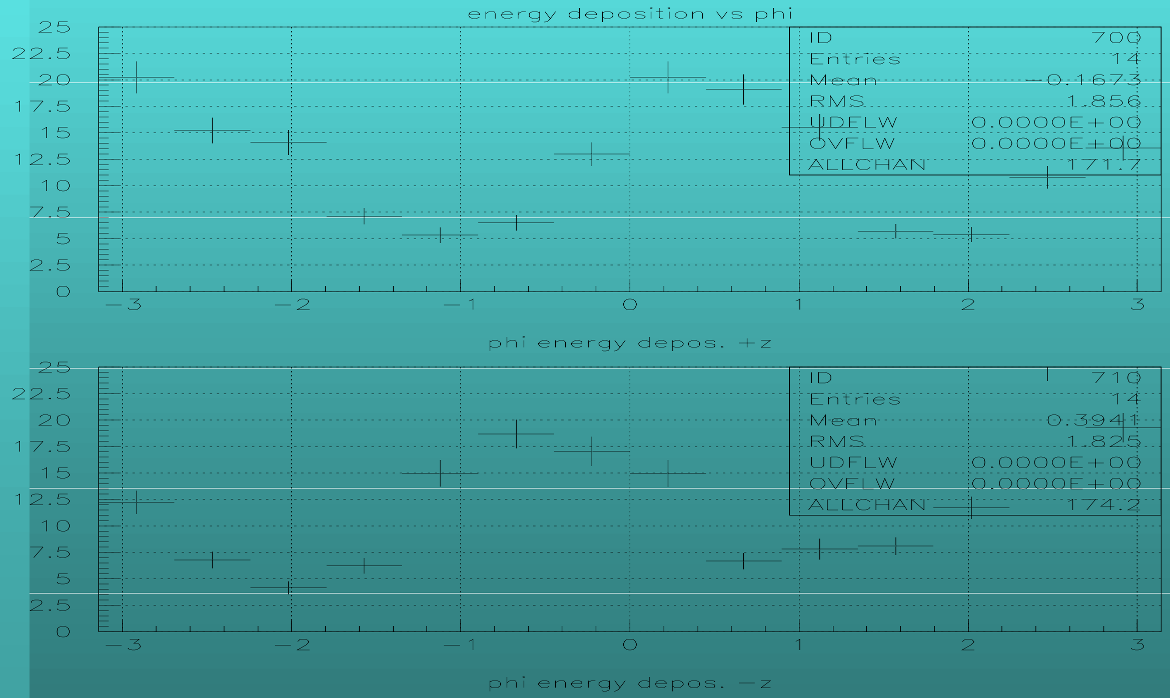
Generic jet-jet inv. mass

- **W and Z di-jets inv mass distributions**



And for what the lumi cal...

- Nominal situation TESLA_HIGH



Developments

- The situation will evolve as we approach to the coming deadlines:
  - up to now we tried to stick with the CDR design (for Brahms), but will change things as we'll decide modify design parameters (from expt'l proposals)
  - more modern/more sexy (OO) languages will come into use.
  - Already some calorimetric simulations were run with GEANT 4.

Conclusions

- The detector optimization is a delicate process that requires lot of manpower: the Tesla study group is, as of now, moving on the road of the large detector.
- We are at the moment building tools and facilities which will allow to explore much of the phase space available between now and the completion of the TDR.