The D3 Session: Vertexing and Tracking

review by Ties Behnke, DESY

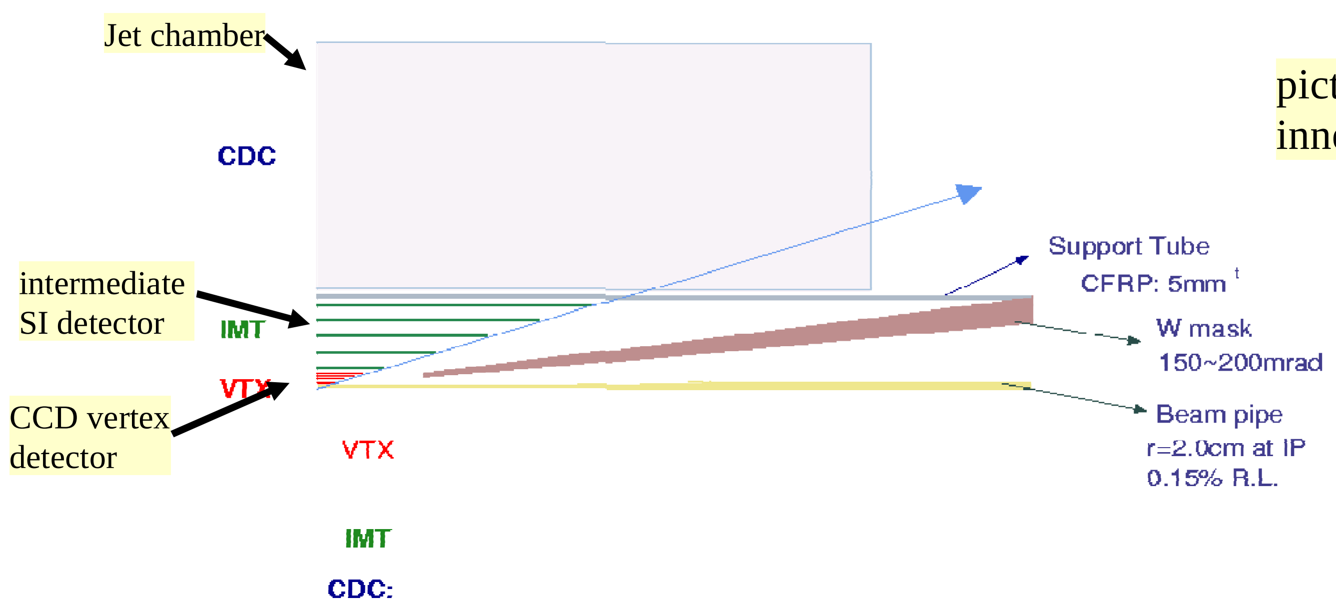
- Program of the second part of the D3 session:

Dean Karlen	Studies of GEM with hexagonal Readout
Markus Schumacher	TPC and GEM readout
Keistike Fujii	Central Tracker for Asian Studies
Klaus Moenig	Forward Tracking and Measurement of Luminosity Spectrum
Akiya Miyamoto	Performance of the JLC Tracker
Norman Graf	Pattern Recognition and Fitting in Central Trackers
Kristian Harder	Overall Track Reconstruction at TESLA
Ariane Frey	A Tracking Detector for CLIC
Francois Kircher	TESLA Detector Magnet Design

many thanks to the speakers for their help
in preparing this review

Tracking Systems for LC Detectors

- general trend:
  - people concentrate on the large detector version
  - layouts become rather similar:
    - high precision VTX detector (see J. Brau's review)
    - large volume gaseous tracker (Jet chamber, TPC)



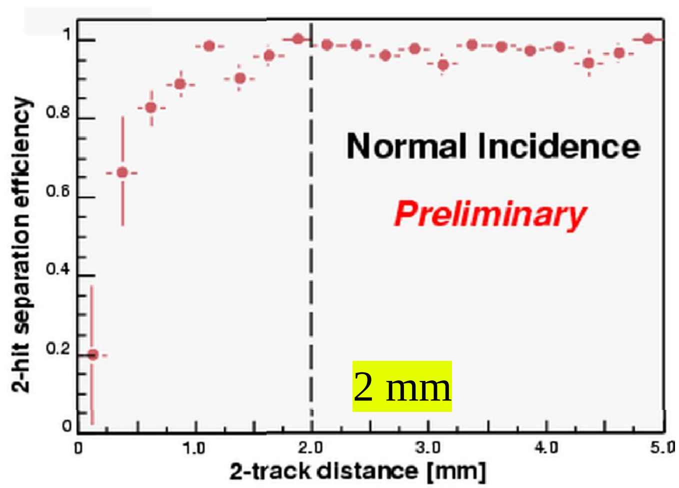
picture of the JLC detector inner tracking system

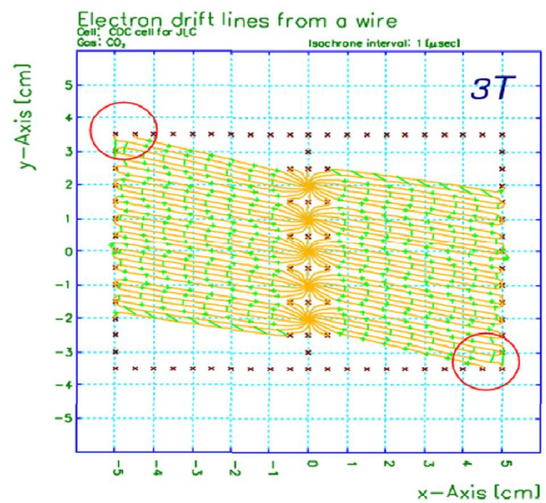
Keisuke Fujii
Akiya Miyamato

The JLC Jetchamber

- small−cell jetchamber
  - 5 sensewires/cell, 14k cells
  - stereo cells
  - 4.6m long
  - 0.45−2.3 m radial

- extensive R&D program:
  - Resolution 85 um
  - Lorentz angle
  - Two−track resolution
  - Magnetic field operation (2−3T)





special cool gas:
$CO_2 - C_4H_{10}$

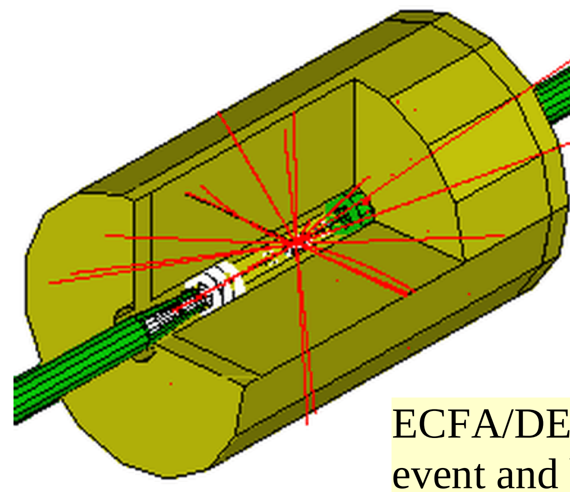
many basic questions have been answered:
- operation of such a big chamber is possible
- gravitational sag is controllable
- 3T operation seems feasible
- resolution looks ok

Dean Karlen
Markus Schumacher

The TPC Trackers

- Both US and ECFA DESY look at TPC as central tracking detector
- typical sizes:

inner radius	30 cm
outer radius	180 cm
length	400 cm
number of points	100−200
number of pixels	10^7



ECFA/DESY TPC with event and background hits

- main areas of development
  - readout method
  - readout electronics

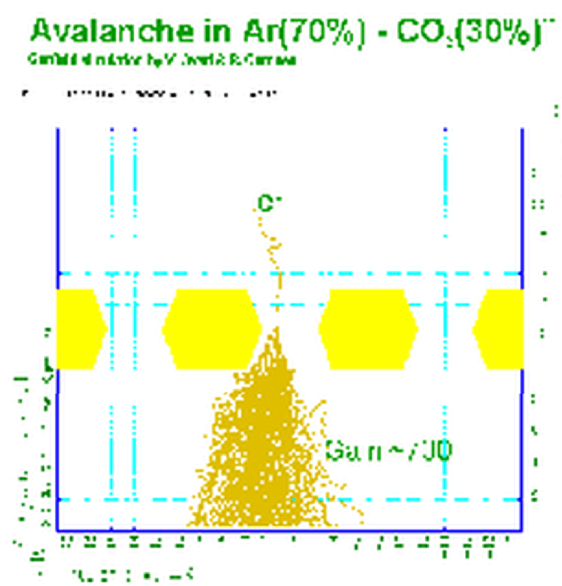
GOAL:
improve the resolution of the TPC
adapt the TPC to the small inter−bunch times at a LC: gating?
make the TPC thinner

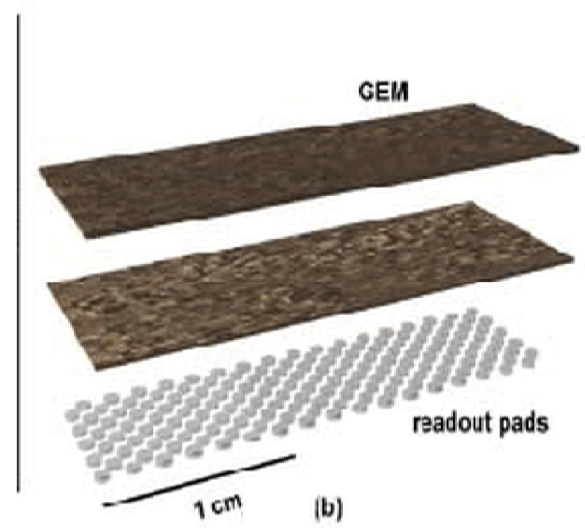
The TPC with GEM Readout

The basic idea of GEM based TPC

GEM TPC readout

potential advantages:
- true 2D readout
- better resolution
- thinner
- ion feedback suppression?



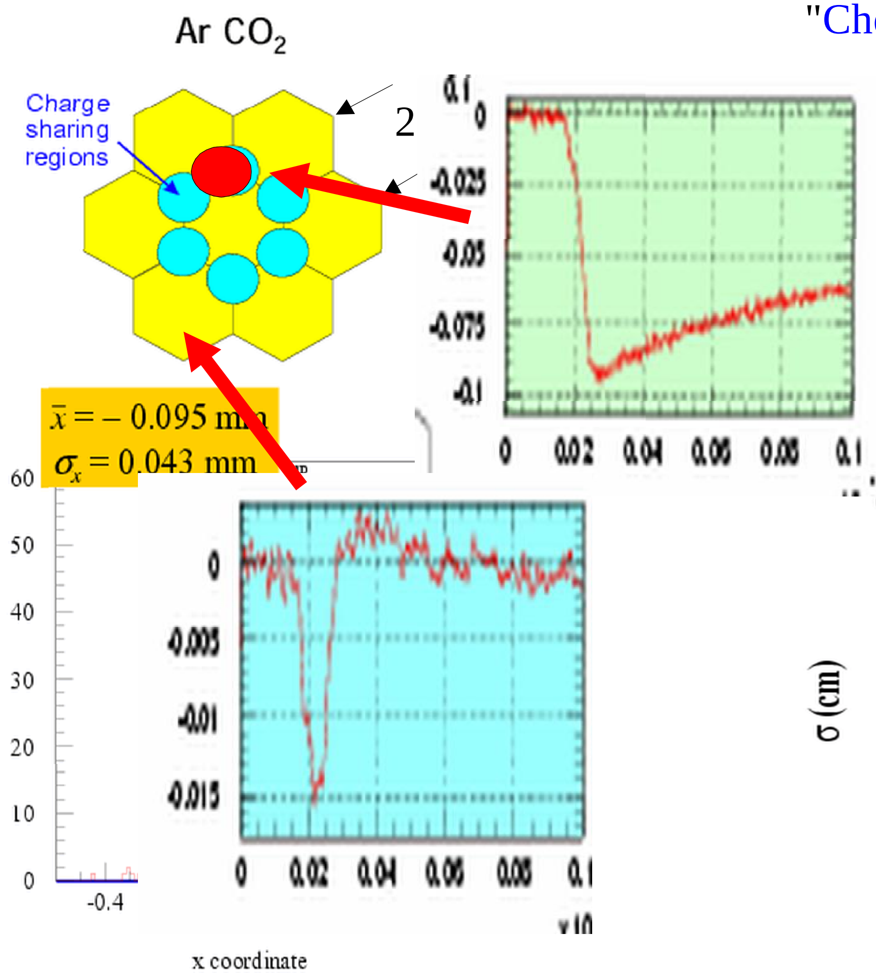


26 October 2000

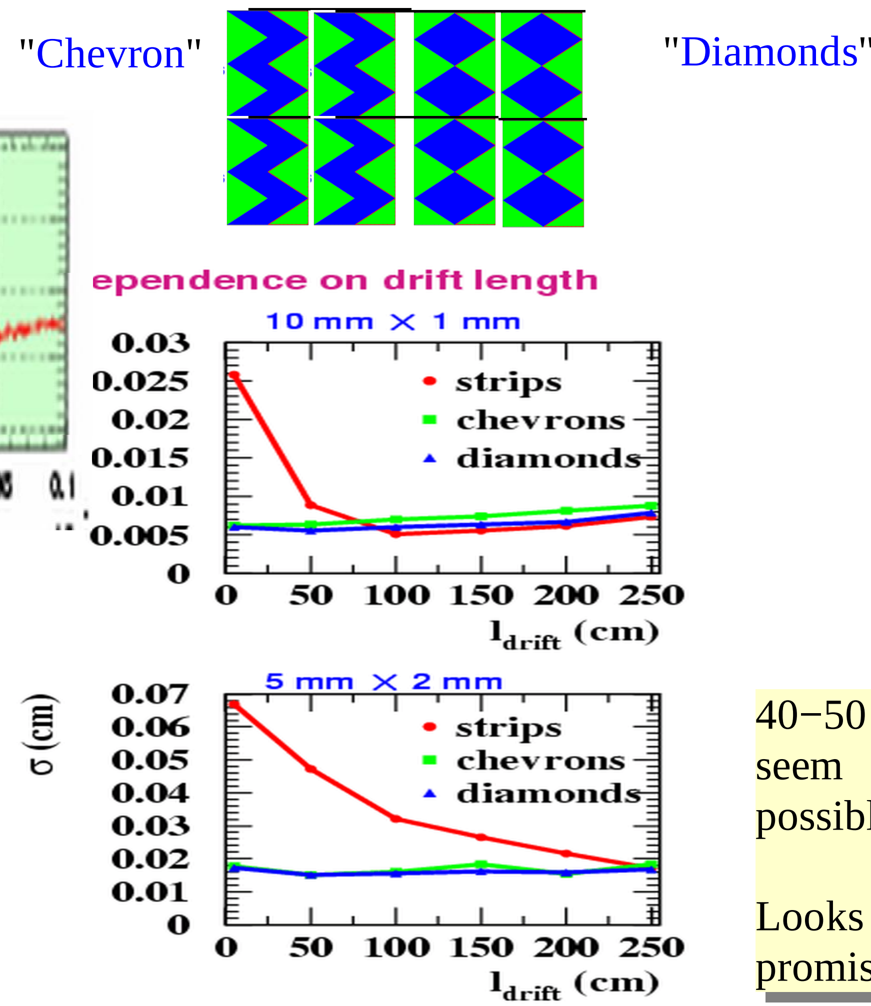
Dean Karlen / Carleton University

GEM and TPC studies

- Canada: hexagonal pads:



- Hamburg: "asymmetric" pads



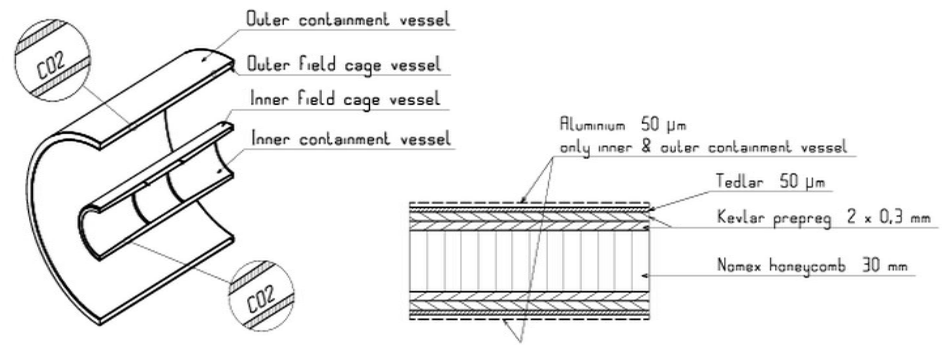
40−50 um seem possible

Looks promising

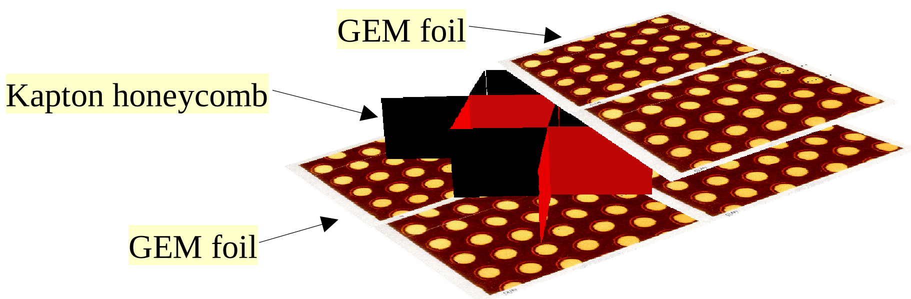
TPC System Design

- first ideas about endplate and field cage design:

The Star Fieldcage
thin: 3% X0
HV stable (100kV)



- honeycomb endplate design:



not to scale

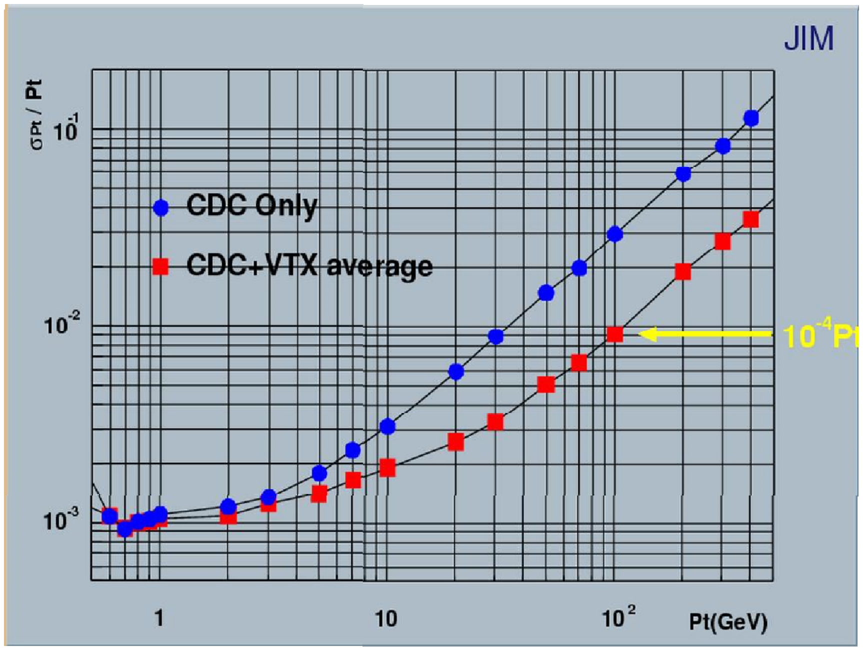
open question:
overall design?
Endplate layout?
Ion transparency?

Akiya Miyamato
Kristian Harder

Tracking System Performance

generally accepted requirement: Z−mass resolution
recoil mass resolution

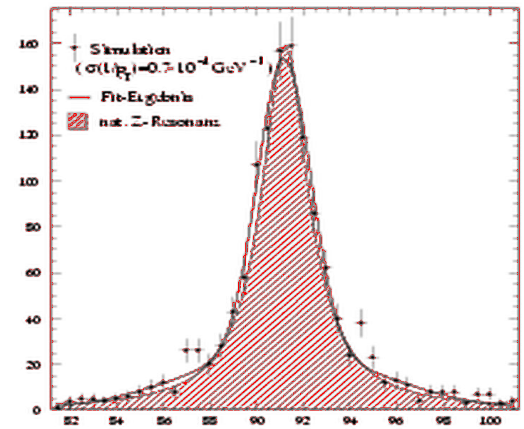
JLC detector:



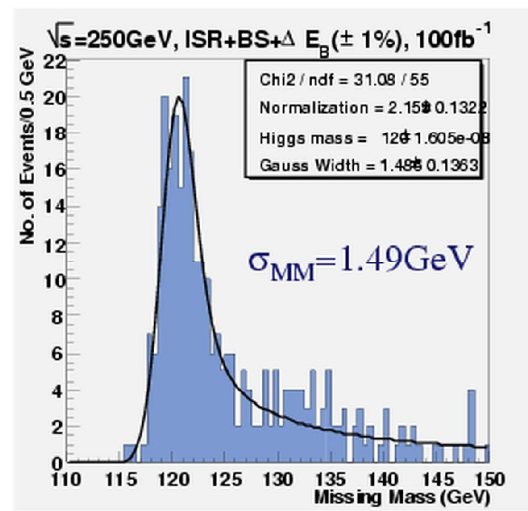
tracker only: 10^{-4} pt
system: few 10^{-5} pt

calibration?

TESLA: VTX+SIT+TPC



JLC: recoil mass resolution

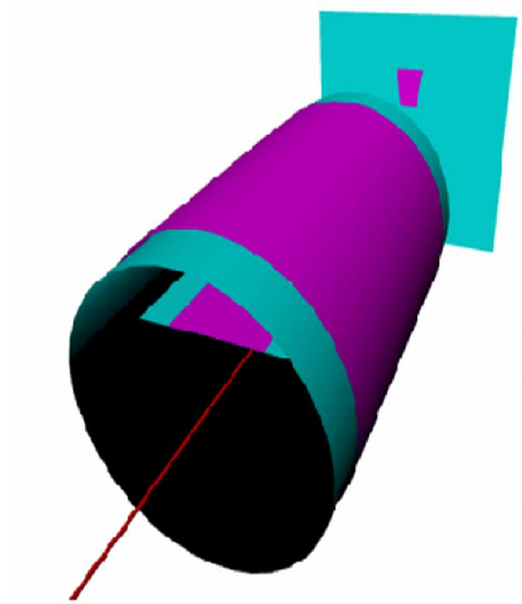


Norman Graf
Kristian Harder

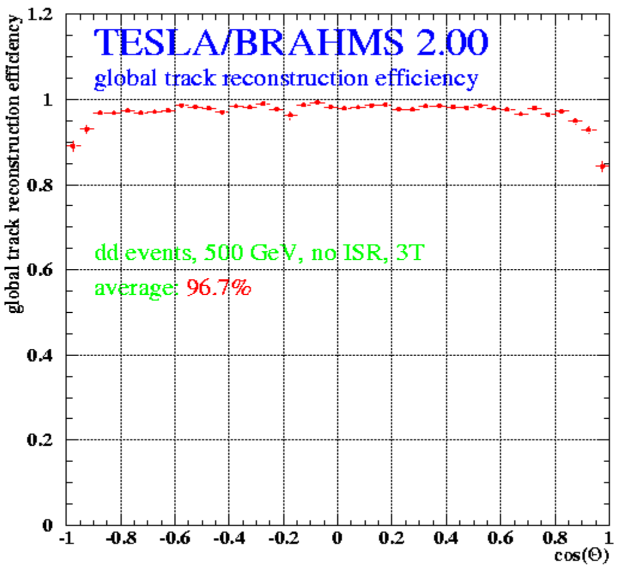
Track Reconstruction

US: development of a new framework (C++/ Java based) for tracking

detector is realised as layers (planes, tubes)
fit method is Kalman filter
- energy loss included
- outlier included



ECFA/DESY: adaptation of existing packages (LEP)

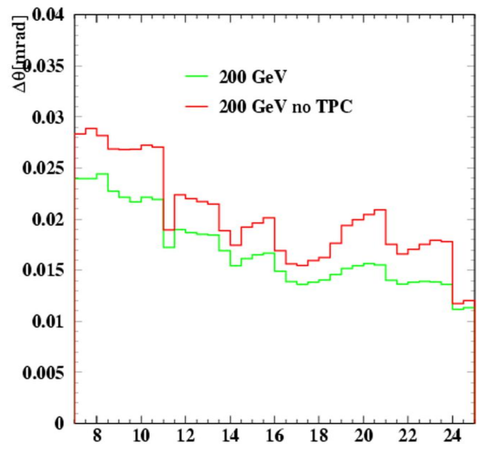


track reconstruction includes:
- track finding (TPC, VTX)
- fitting: Kalman fit
- merging (TPC−VTX−SIT)
- improving in second pass
- efficiency: 96.7% in MH events

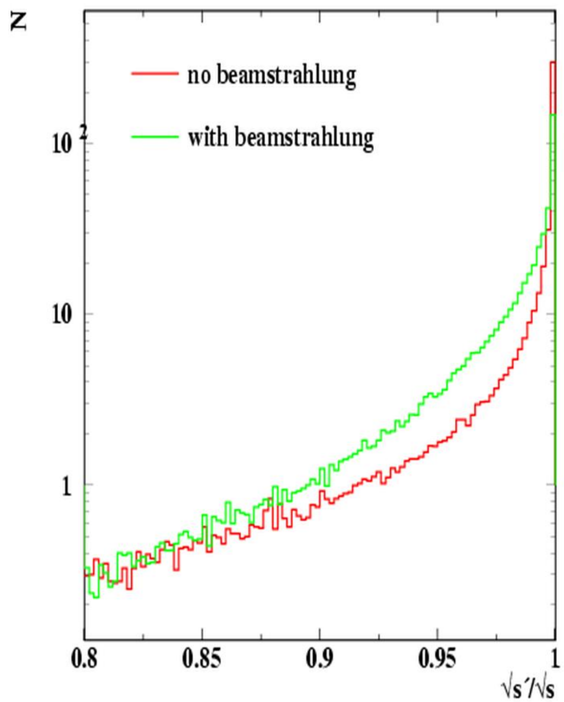
more details:
see the simulation session

Tracking Performance in Forward Region

resolution in forward direction:



luminosity spectrum



important to measure precisely the luminosity spectrum

- bhabha acolinearity
- fit for beamstrahlung
- (assume shape, fit normalization)

investigated:

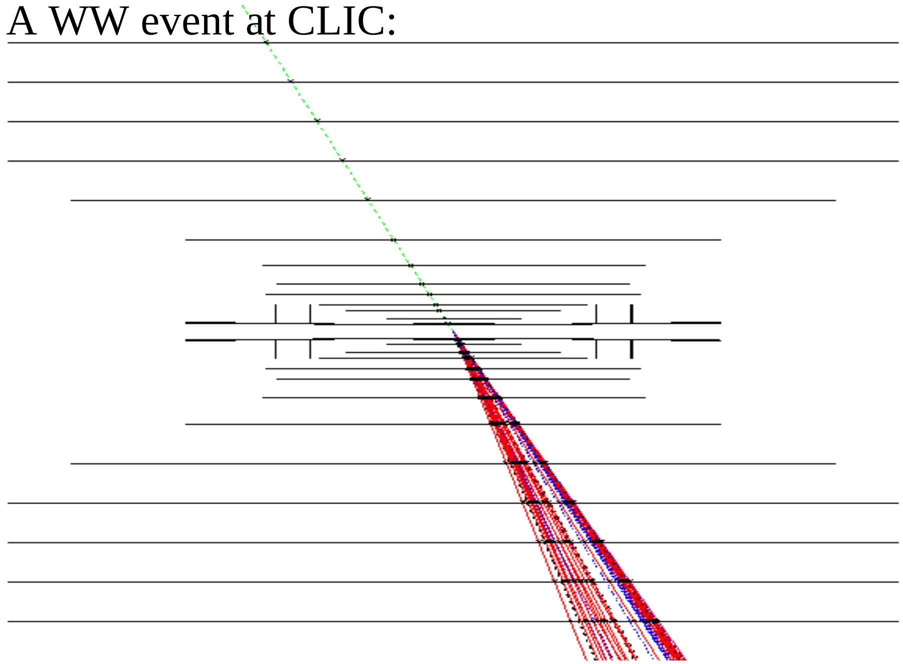
- detector resolution
- hemisphere correlations
- mismodeling of beamstrahlung

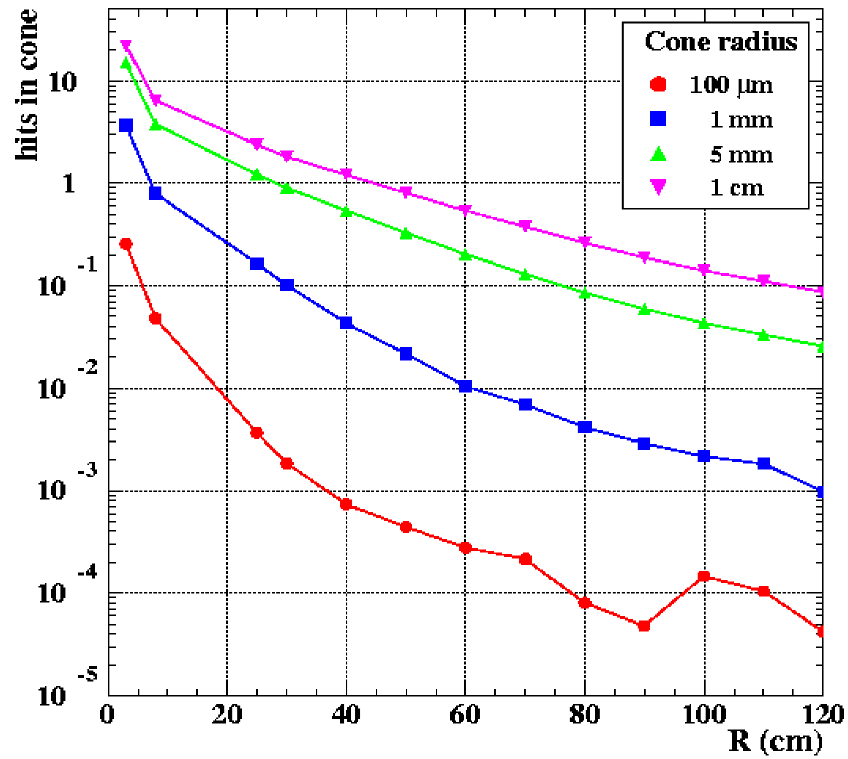
Conclusion:
with angular resolution of 0.01−0.02 mrad determination of lumi spectrum to 5×10^{-5} is possible

Ariane Frey

A Detector for CLIC

A WW event at CLIC:



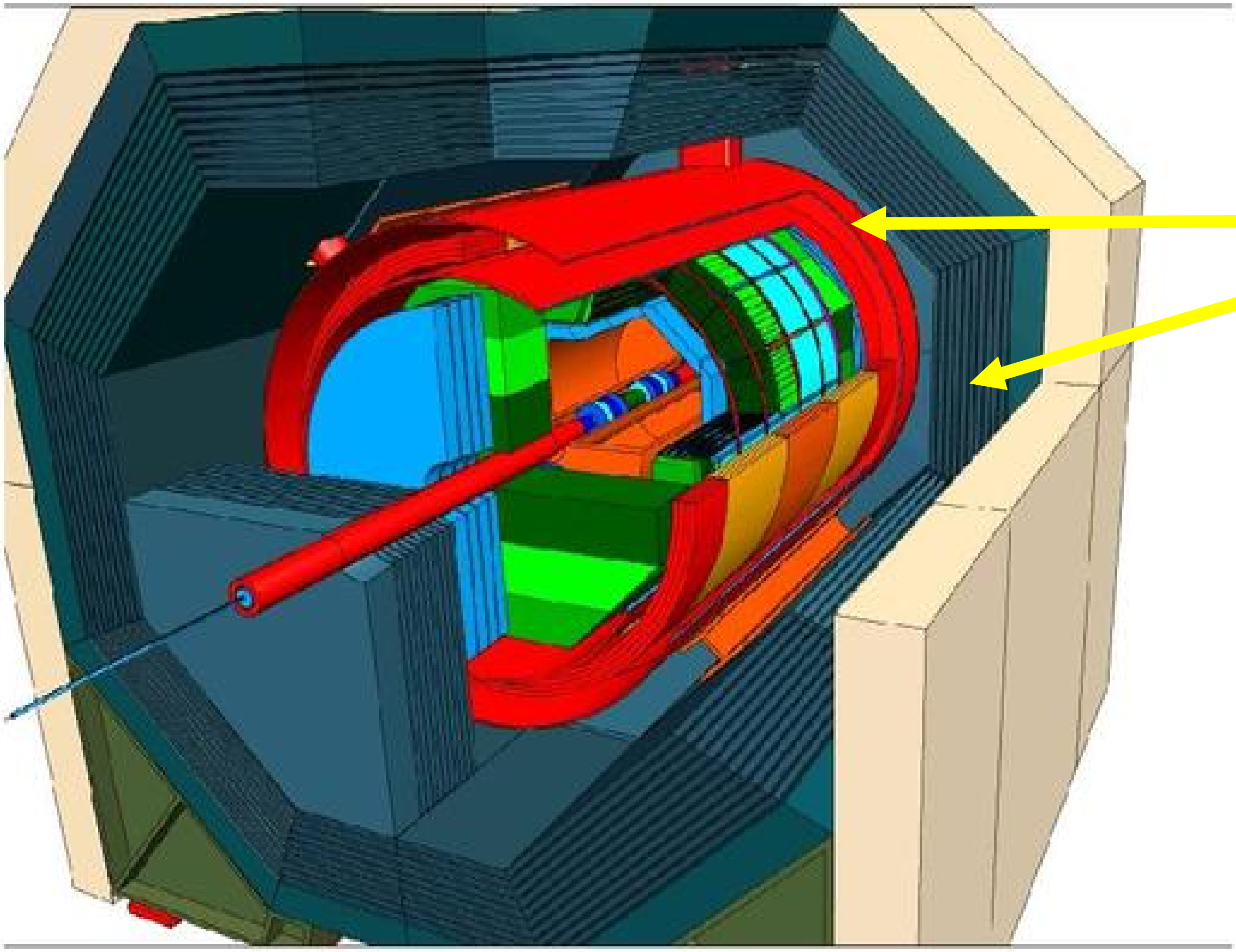


- Extremely narrow jets (large boost)
- large multiplicities
- multi (14..) jet final states

- Extremely challenging environment
- Backgrounds are much higher
- At the moment: look at all SI tracker

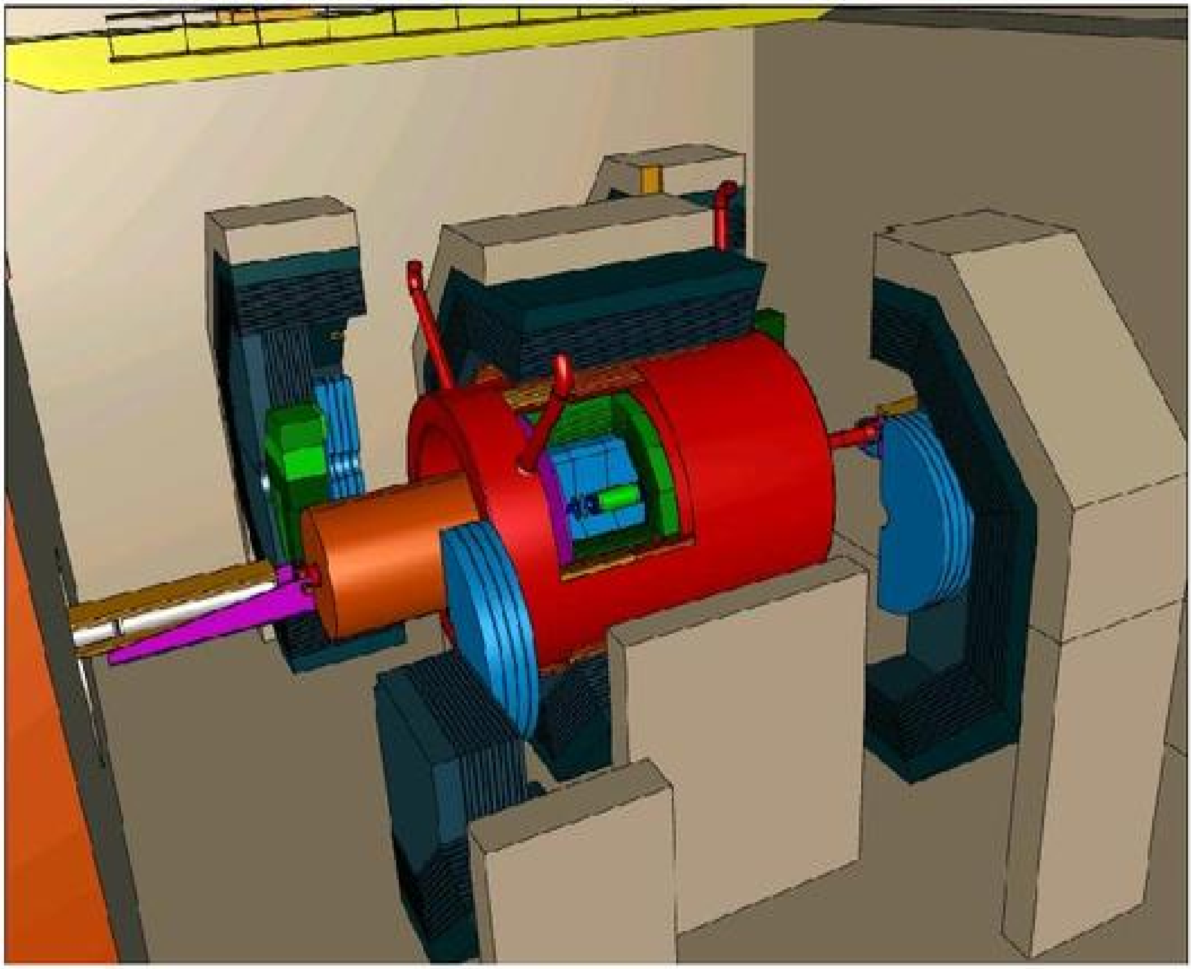
Francois Kircher

A Magnet for a Detector at the LC



Magnet system:
- Magnet
- Yoke

Yoke Design



Yoke:

- 3 modules in z
- central module supports detector
- end−modules movable for access

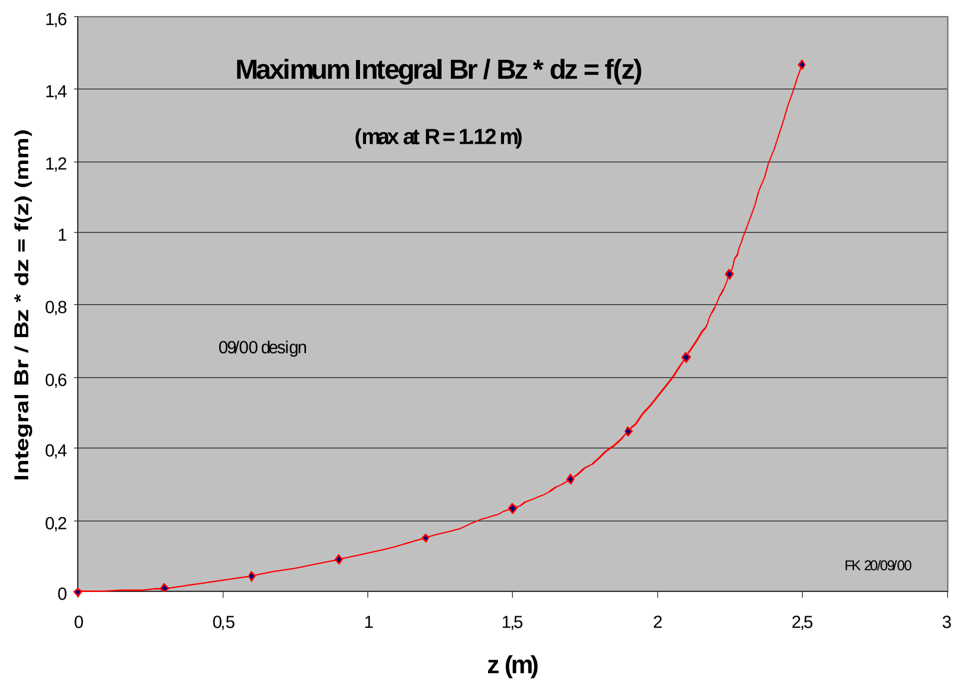
A Magnet for TESLA

Main magnet parameters:

- Magnetic field 4T
- Usable radius 3m
- Usable length 5m
- Very similar to CMS magnet

Cost in Y2000 Euro:
65 MEuro
coil, yoke,ancillaries,tests,
external manpower
no contingency
200 man−years from laboratory
over 6 years

Most stringent requirement:
field homogenity
achieved through correction currents in outer segments of coil



Magnet design seems quite realistic and doble

Conclusion and Outlook

- the design of the central region for LC detectors is converging
- large gaseous chamber (TPC, Jet) plus high precision vertex detector
- coverage of the largest possible solid angle desirable
- requirements on tracking detectors are high (approx 10 times better than at LEP) difficult but not unsurmountable
- significant R&D in detector technologies ongoing:
  - Japan: Jetchamber developments
  - US, Europe: TPC with improved readouts
- significant development of software: tracking systems, overall tracking, merging algorithms

  - Tracking will play an essential role at the LC
  - At least on paper we can build these devices

Questions:

- Calibration? Can we calibrate these detectors at the required precision?
- Mechanical construction
- Electronics

- Magnet looks very much under control

Overall exciting progress on many fronts, interesting new developments