LHeC Detector Working Group Kick-Off

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First LHeC Workshop, Divonne

Program Tuesday Sept 2nd

DETECTOR SESSION Tuesday morning		
9:00h	PK,AP,RW	Introduction
9:15h	Norbert Wermes	Silicon Pixel Detectors for Tracking
10:00h	Michael Moll	RD50 and silicon hardness
10:30h		-coffee-
11:00h	Wesley Smith	Present and Future Collider Triggers
11:30h	Alex Cerri	Trigger and online displaced vertexing (CDF SVT)
12:00h	Andris Skuja	CMS Hadron Calorimeter
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COMMON SESSION DET/ACC/IR Tuesday afternoon		
14:00h	Tim Greenshaw	Instrumented Magnets
14:30h	Herman Ten Kate	Magnet options for LHeC detector
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18:00h		Open Discussion

Boundary Conditions

A few general remarks on boundary conditions:

from the detector side:

- Ideally, high luminosity, full (4π) detector acceptance
- and low background conditions

More realistic:

- High luminosity, as required for the physics program
- Good detector acceptance in forward and rear direction
- Acceptable background conditions

How should the LHeC Detector look like ?

- There are TeV leptons and jets to measure
- □ expect size of LHeC detector to be comparable to LHC detectors
- Tracking/Solenoid Size:
  - $R(m) = p_T(GeV)/(0.3 \cdot B(T))$
  - but less occupancy problems from low momentum loopers (from minimum bias)
  - $\Delta p/p \approx p \cdot \sigma_{hit} /(B_L^2 \cdot \sqrt{N})$
    LHC optimized on mass resolution $H \rightarrow ZZ \rightarrow 4$ leptons
    $\Delta p/p_{LHC} \approx 0.2 .. 0.4p(TeV)$

    What is LHeC detector physics benchmark ?

- Calorimeter inside or outside solenoid ?

A.Skuja, H. Ten Kate

Boundary Conditions: Experimental Environment

- We know:
  - Peak luminosity $10^{33}/cm^2/s$
  - Backgrounds likely (?) collision dominated (a la Tevatron, LHC) but sizable synchrotron radiation component
  - assume an LHC style environment minus minimum bias/multiple interactions plus synchrotron load
  - Need secondary vertex resolution and online triggering (s,sbar in the proton, charm and bottom physics, …)
  - Need to take into account electron – ion collisions □ occupancy!

A. Cerri
W. Smith

- We don't know (yet):
  - Exact details on the radiation field (n-equiv. fluence) – simply assume for now we will be able to "hide" behind (S)LHC rad hard R&D - but need to watch cost!
  - Exact details of synchrotron load, collimation etc.
  - Occupancy numbers from simulation

M.Moll,N. Wermes

Boundary Conditions: Detector Performance

- We know:
  - Need a detector capable of discovery (~ mass resolution) and of precision measurements (~ few % systematic uncertainty)
  - Really two physics themes:
    - high-Q^2 / high-luminosity / "low" acceptance (θ_e >10º, θ_h <170º)
    - low-x / low-luminosity / "high" acceptance (θ_e > 1º, θ_h <179º)

- We don't know (yet):
  - do we need an ILC style particle flow detector (≠ CMS, ATLAS) to achieve mass resolution we need ?

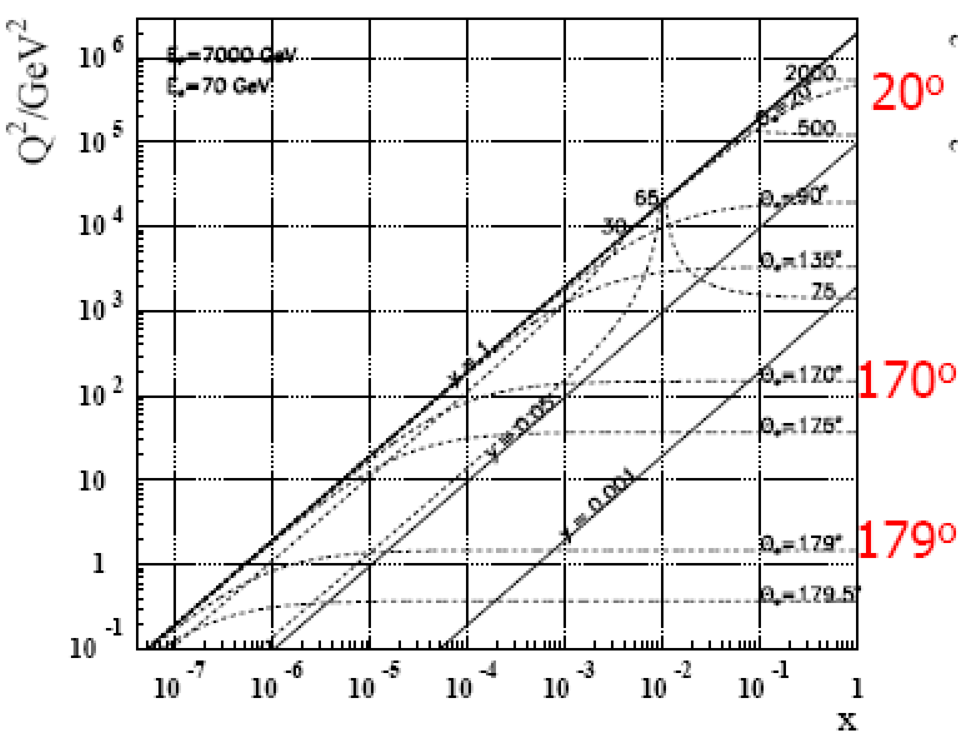
F. Simon

  - Will we be able to operate a gas based central drift chamber ?
    - □ likely not: state-of-art COT @ CDF-II @396 ns with ~ few 10^{32}/cm^2/s ppbar collisions - aging, occupancy, (no electron-ion collisions)
    - □ All-Silicon or other alternatives
  - How to reconcile the high-Q^2 and low-x programs – magnets inside the calorimeter to achieve high luminosity!

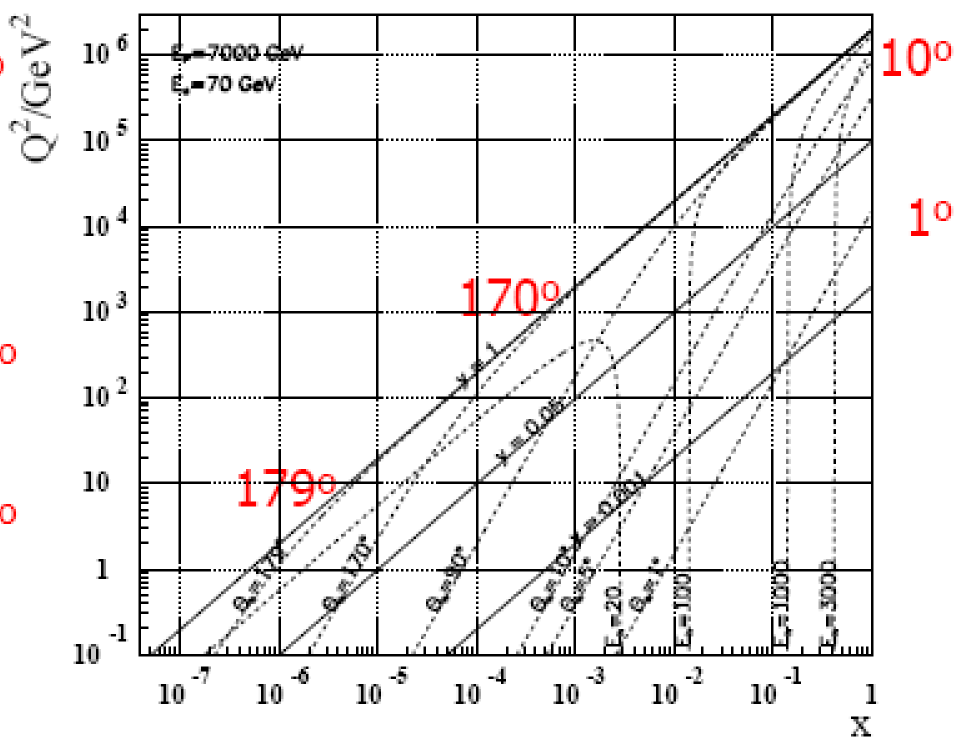
E. Koffeman

LHeC Kinematics

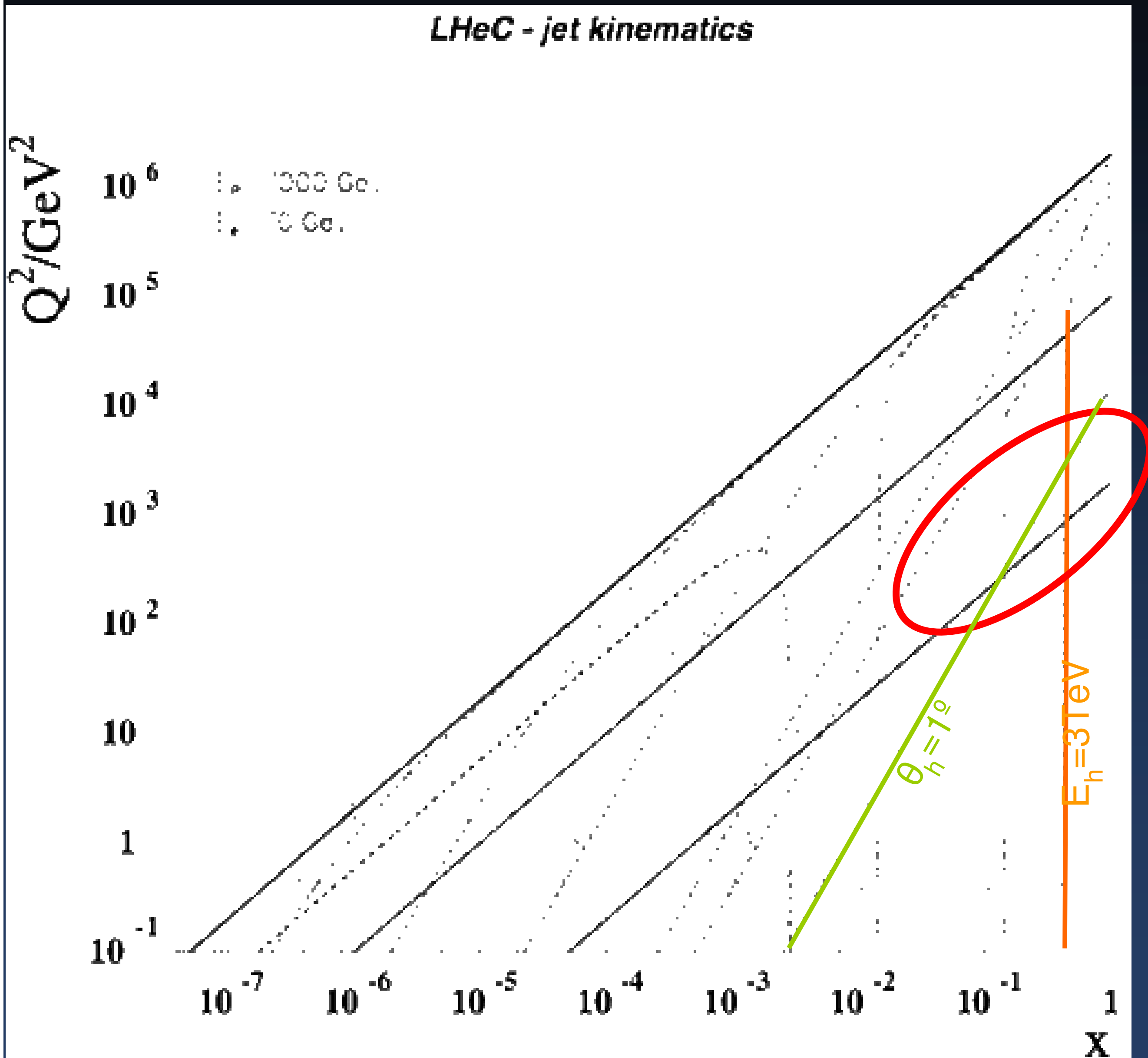
LHeC - electron kinematics



LHeC - jet kinematics



The Detector Challenge (1)

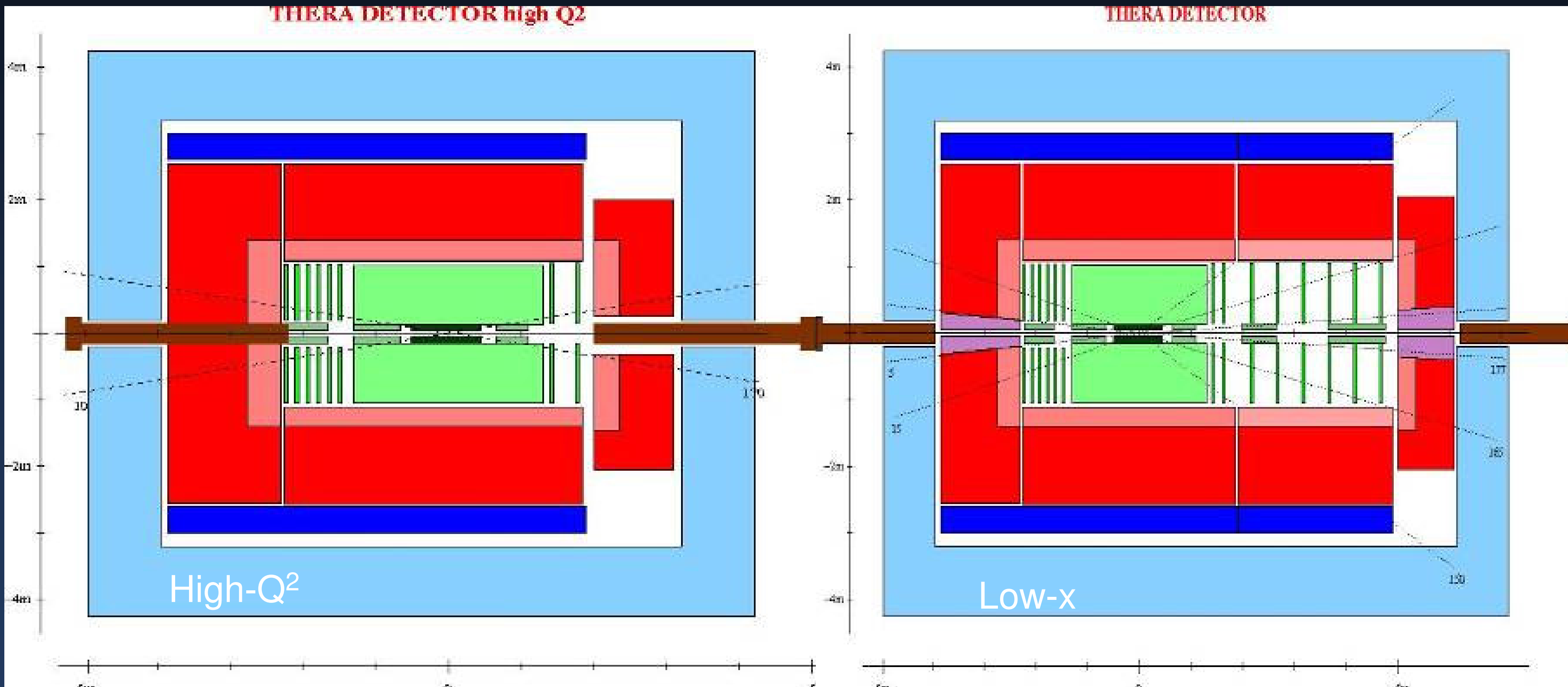


A challenge of another kind:
TeV jets at very fwd angles!
- instrumenting magnets
  inside calorimeter ?

Tim Greenshaw

The Detector Challenge (2)

- The THERA answer:



Thanks U. Schneekloth!

A “detachable” low-x spectrometer
Two solenoids ?

H. Ten Kate

Luminosity vs. Acceptance

- Luminosity and acceptance very much depend on physics program

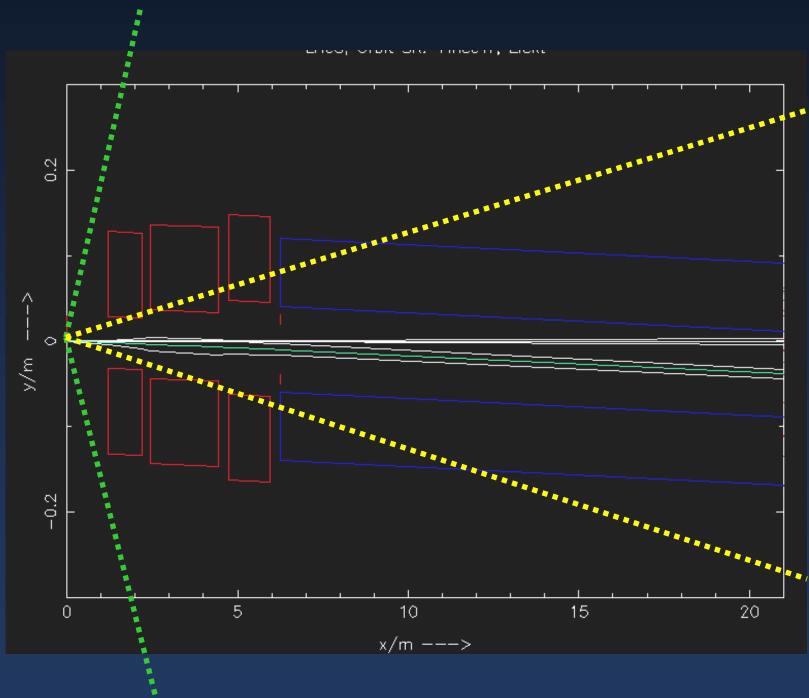
- From IR/ACC WGs we have heard:
  - high luminosity. Can be done with reduced acceptance (?)
  - Low Q2 physics (high parton densities, diffraction,…)requires good forward and rear coverage 1 – 179^o. Can be done with reduced luminosity.

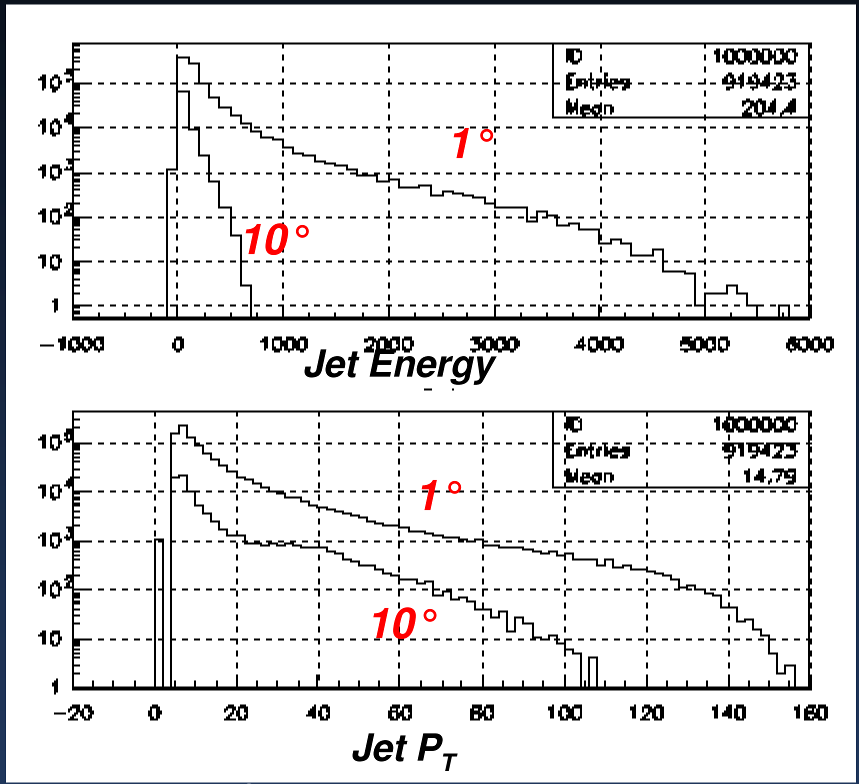
- Possible scenario two different interaction region setups

- L = 10^{33} cm^{-2} s^{-1}, $10^o < \theta < 170^o$
- L = 10^{31} cm^{-2} s^{-1}, $1^o < \theta < 179^o$

Detector Acceptance

From IR WG:
two options discussed at the moment:
10° / 1°





- RAPGAP-3.2 (H.Jung et.al.- http://www.desy.de/~jung/rapgap.html)
- HzTooL-4.2 (H.Jung et.al. - http://projects.hepforge.org/hztool/)
  first shot selection:
  for y_{jet}.ge.0.1 AND for y_{jet}.le.0.7 AND for q^2.gt.5.

- Need to push for highest acceptance !!!

compact magnet design required:
10° = 21 cm outer radius of Q1E quadrupole
1° = requires an alternative lattice , optics and luminosity

Agenda

Most of our speakers have tight timing constraits:

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