- $E_e \lesssim 500\,GeV < E_p$ for beam separation after collision.

  both TESLA arms ! standing wave type cavities.

  may reduce gradient, double current in dedicated run.

- polarization high λ_e. λ_p?

- bunches. LC low duty cycle pulsed mode

  TESLA : 2800 . $\Delta t = 337\,ns \rightarrow 1\,ms/train$. can be matched

  HERA : 96 ns . 11/n . 352 ns for n = 3. SC. TESLA !

- $$\mathcal{L} = 1.7 \cdot 10^{31}\,cm^{-2}s^{-1} \cdot \frac{n_p}{10^{11}} \cdot \frac{P_e}{10^{8}W} \cdot \frac{0.3\,TeV}{E_e} \cdot \frac{\gamma_p}{1000} \cdot \frac{10^{-6}}{\varepsilon_p} \cdot \frac{10\,cm}{\beta^*}$$

  rough estimate $\sim 10^{30}\,cm^{-2}s^{-1} \leftrightarrow 10\,pb^{-1}/y$.

  - β^* limited by $\sigma_p \sim 0.1\,m$. HERA design is 0.02 m

    travelling focus with rf. quadrupole / Brinkmann, Dohlus 95

    $\beta^*/100$ but practically less due to low β quadr. apertures, chromat.

  - ε_p growing due to intra-beam scattering.

    flat beams ($\varepsilon_y \ll \varepsilon_x$). cooling. during ramping?

    500 MeV e ring? higher fill rate.

    precooling in PETRA ?

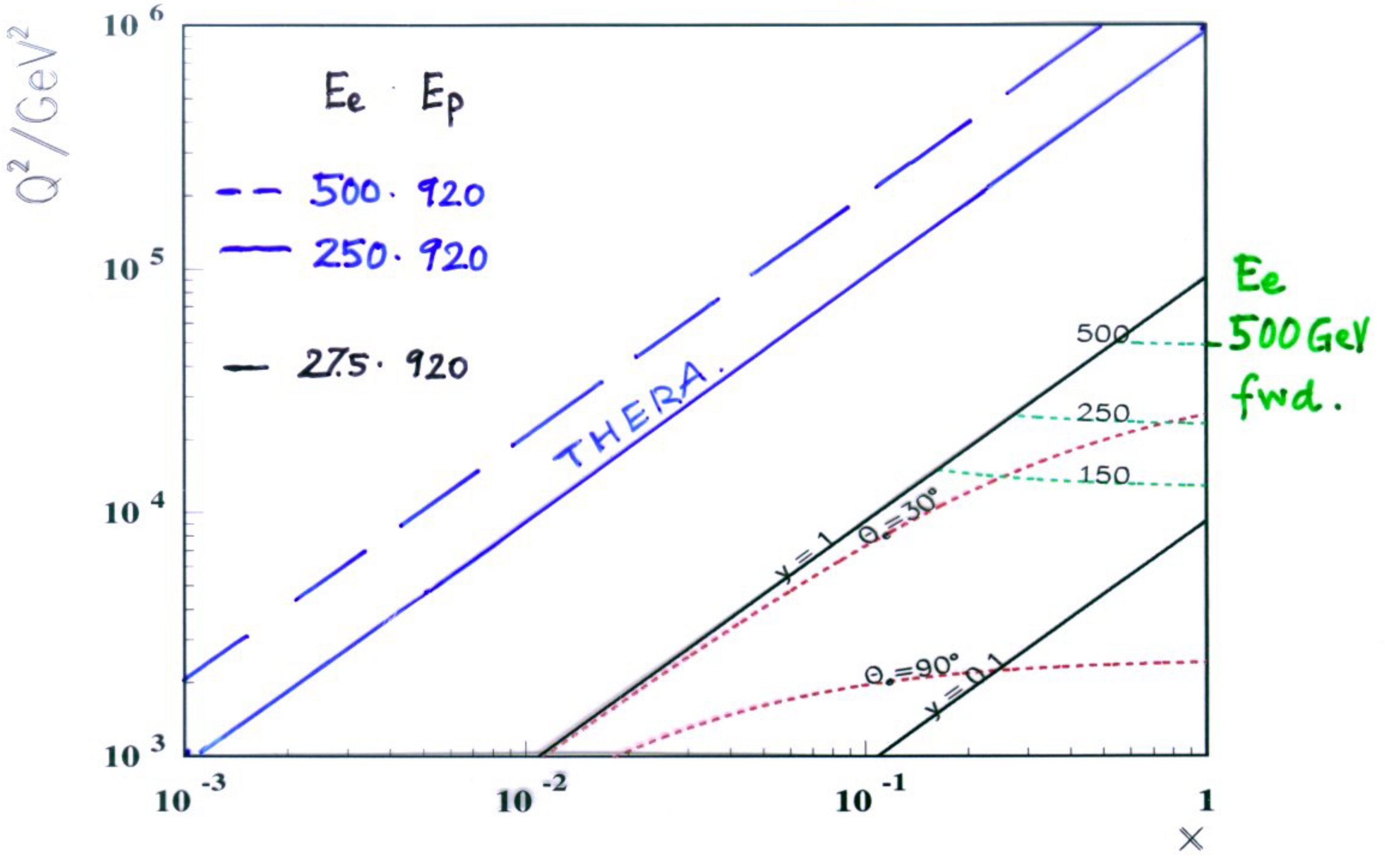
    / P. Wesolowski..

  - power upgrade.

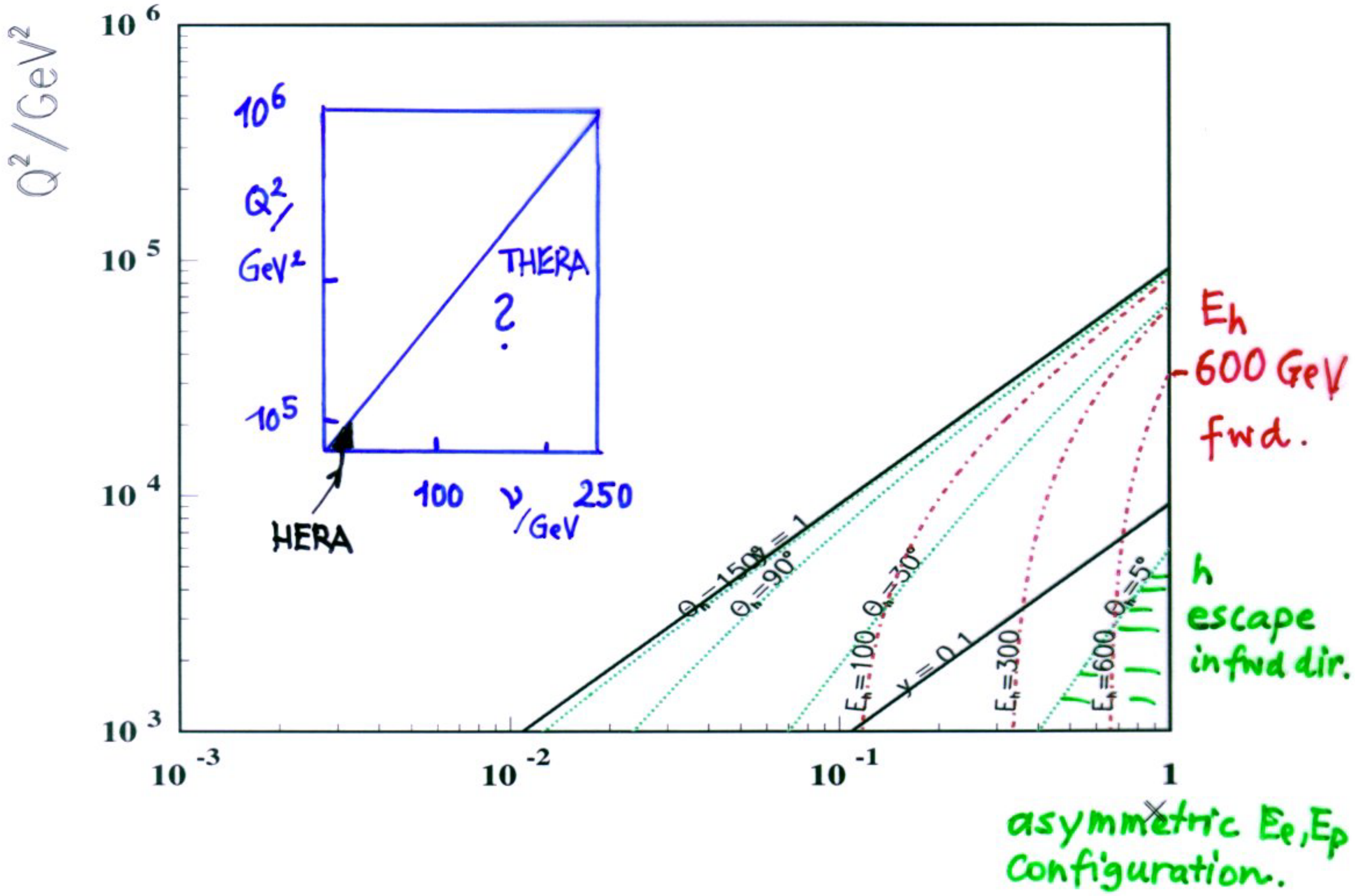
  - focussing magnet position.

$O(10^{31})$ may be reachable with dedicated R&D effort. !?

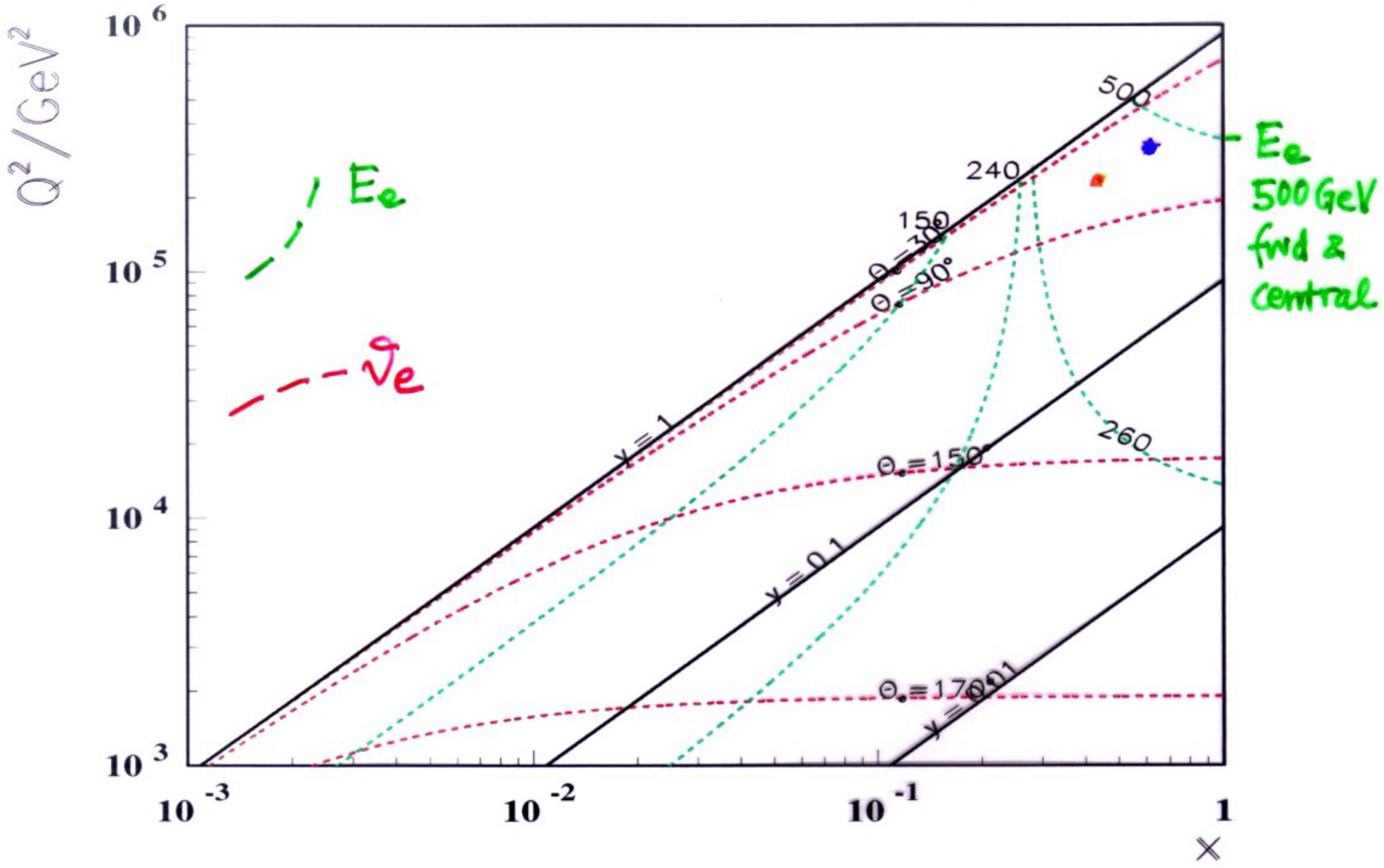
high Q^2 electron kinematics HERA



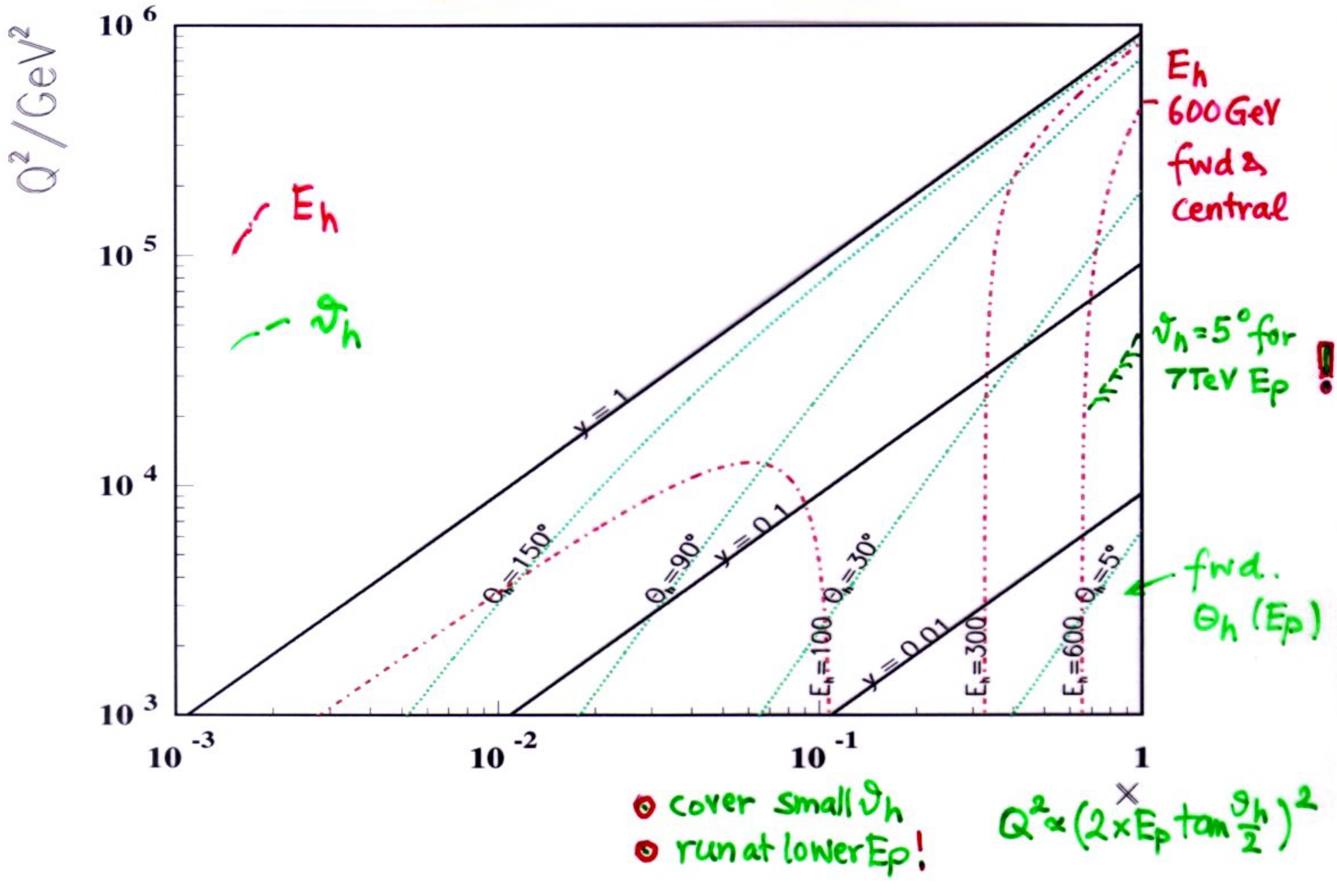
high Q^2 hadron kinematics HERA

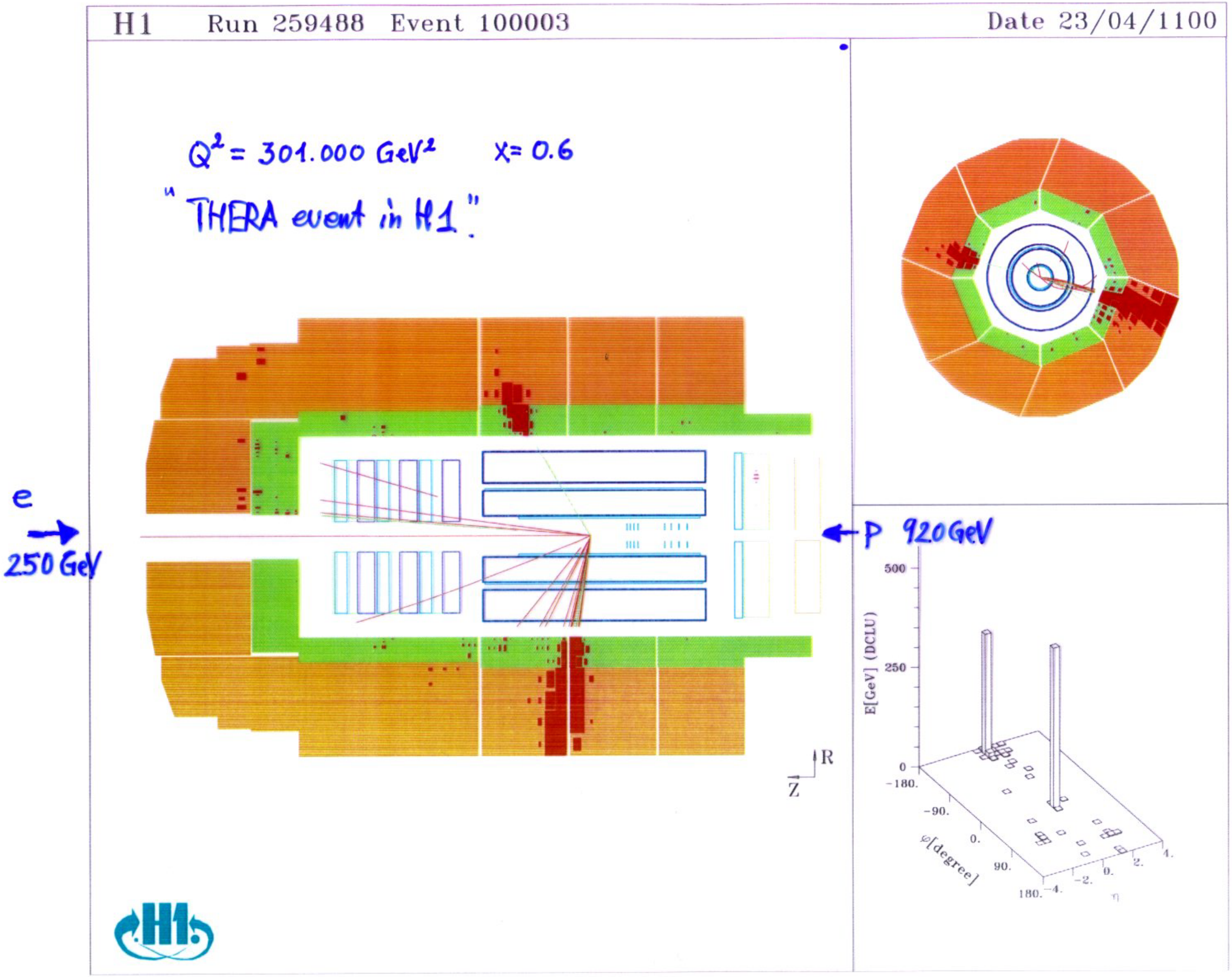


high Q^2 electron kinematics THERA $250 \times 920\ \mathrm{GeV}^2$



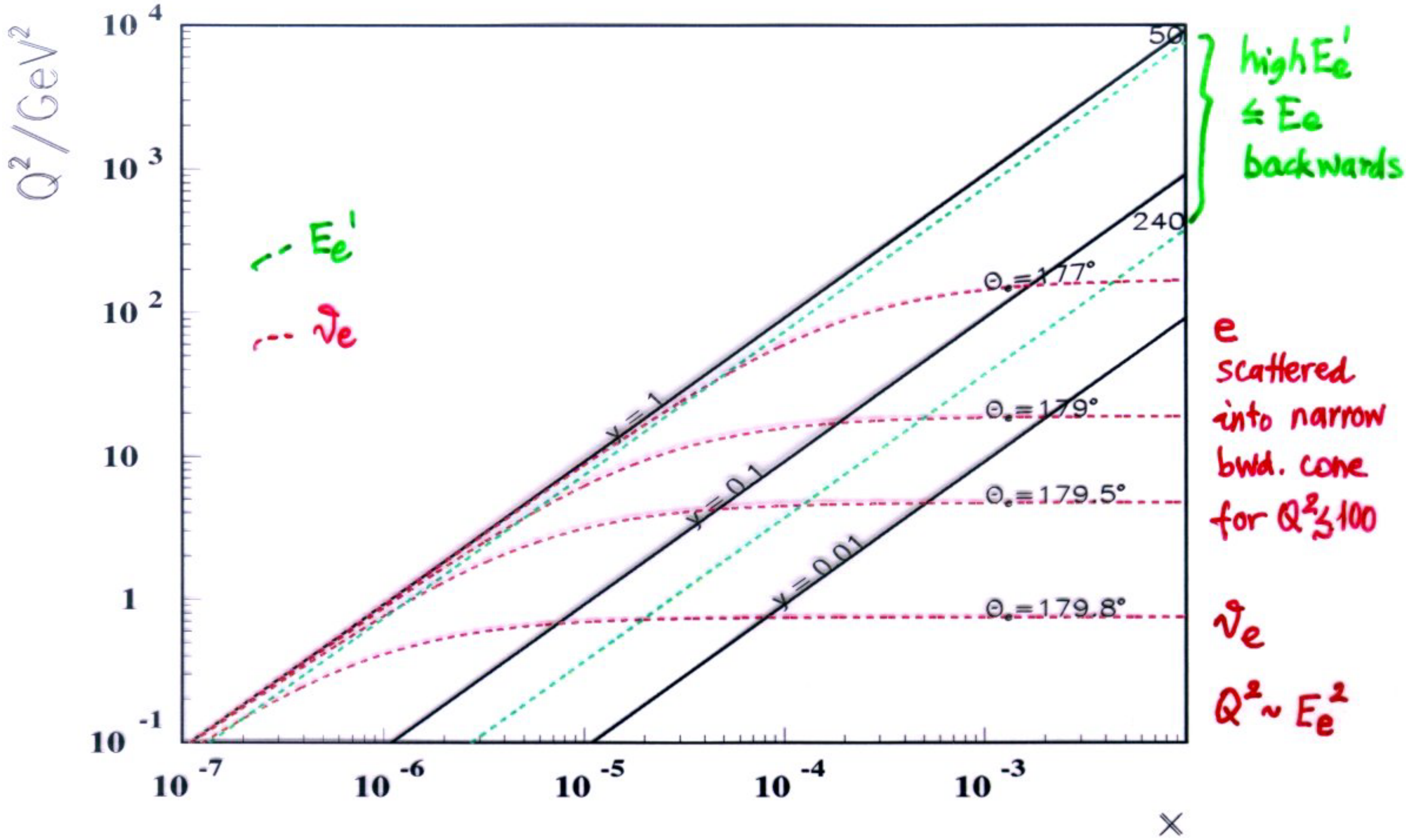
high Q^2 hadron kinematics THERA



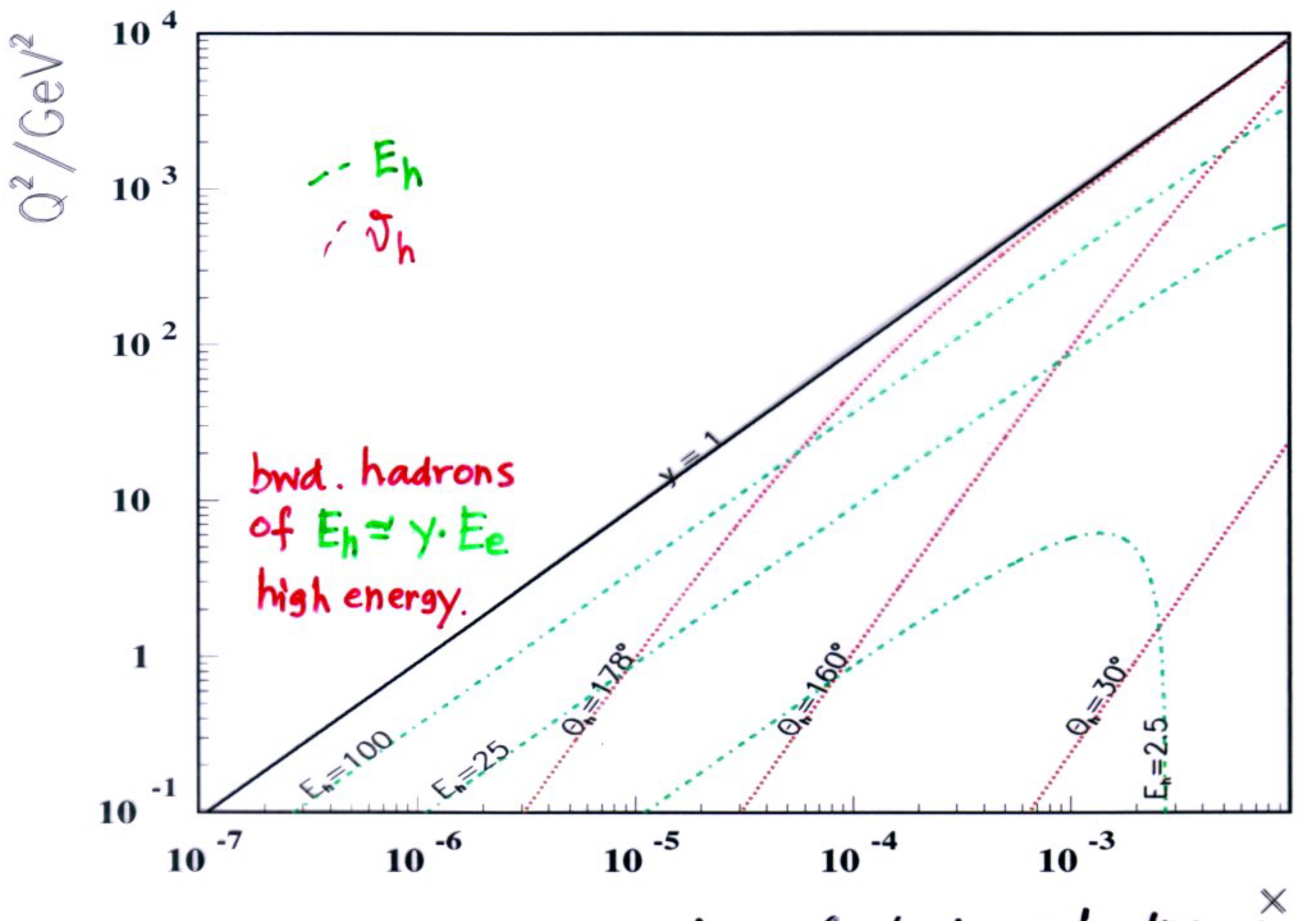


H1 Run 259488 Event 100003
Date 23/04/1100
Q² = 301.000 GeV² x= 0.6
"THERA event in H1"
e
250 GeV
P 920GeV
R
Z
E[GeV] (DCLU)
500
250
0
-180.
-90.
0.
90.
180.
φ[degree]
-4.
-2.
0.
2.
4.
η

low x electron kinematics THERA



low x hadron kinematics THERA



⟹ newly designed backward spectrometer (e, h and μ (Q))

DESIGN CONSTRAINTS

- GENERAL : + hermetic ($E-p_z$)
  + $\sigma_{E_e} \lesssim 15\%/\sqrt{E_e}$, $\sigma_{E_h} \lesssim 40\%/\sqrt{E_h}$. $E_h \leq E_p$!
  + tracking . $\sigma \sim 150\mu m \cdots 20\mu m$. $r_{pipe} \sim 2cm$!
  + μ_{ID} .
  + taggers (e, p).

- Low x & heavy flavour
  + eID and tracking down to 0.5°

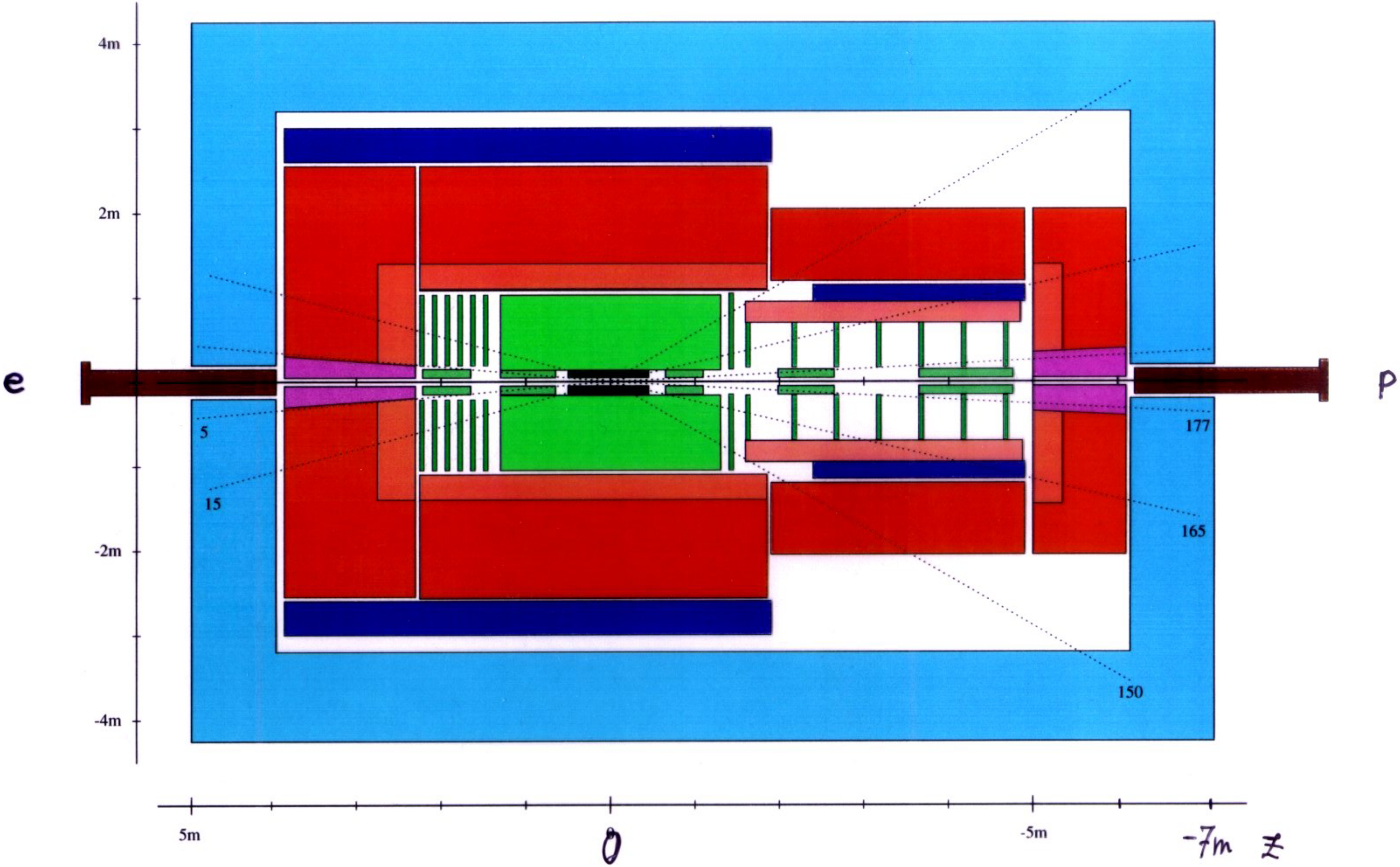
  [reverse the ϑ convention of HERA :
  Rutherford scattering is back scattering !]

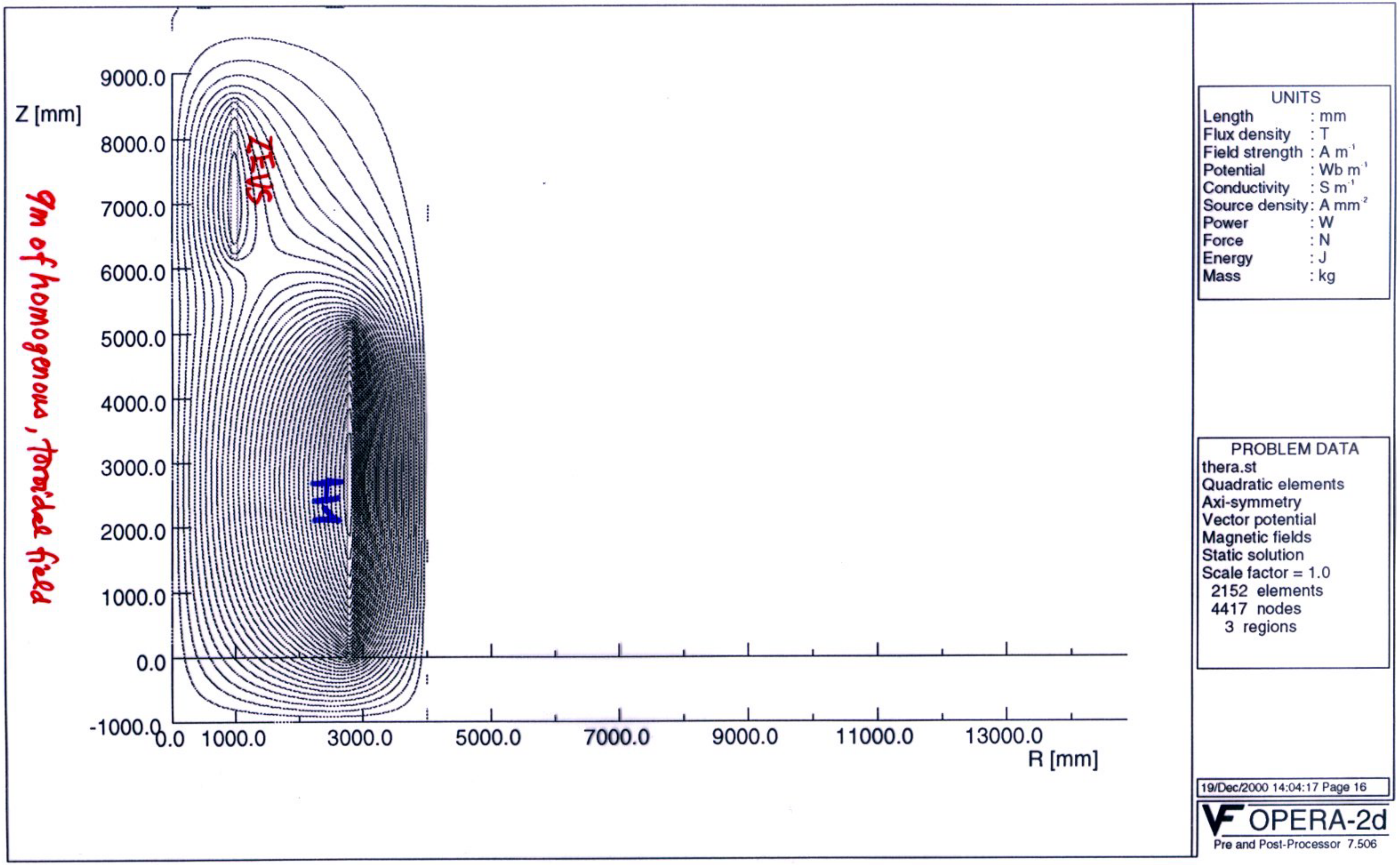
- BFKL (fwd jets) and diffraction
  + jets down to 1°
  & energy flow.

- two phases : low x & hi Q^2
  + modularity.

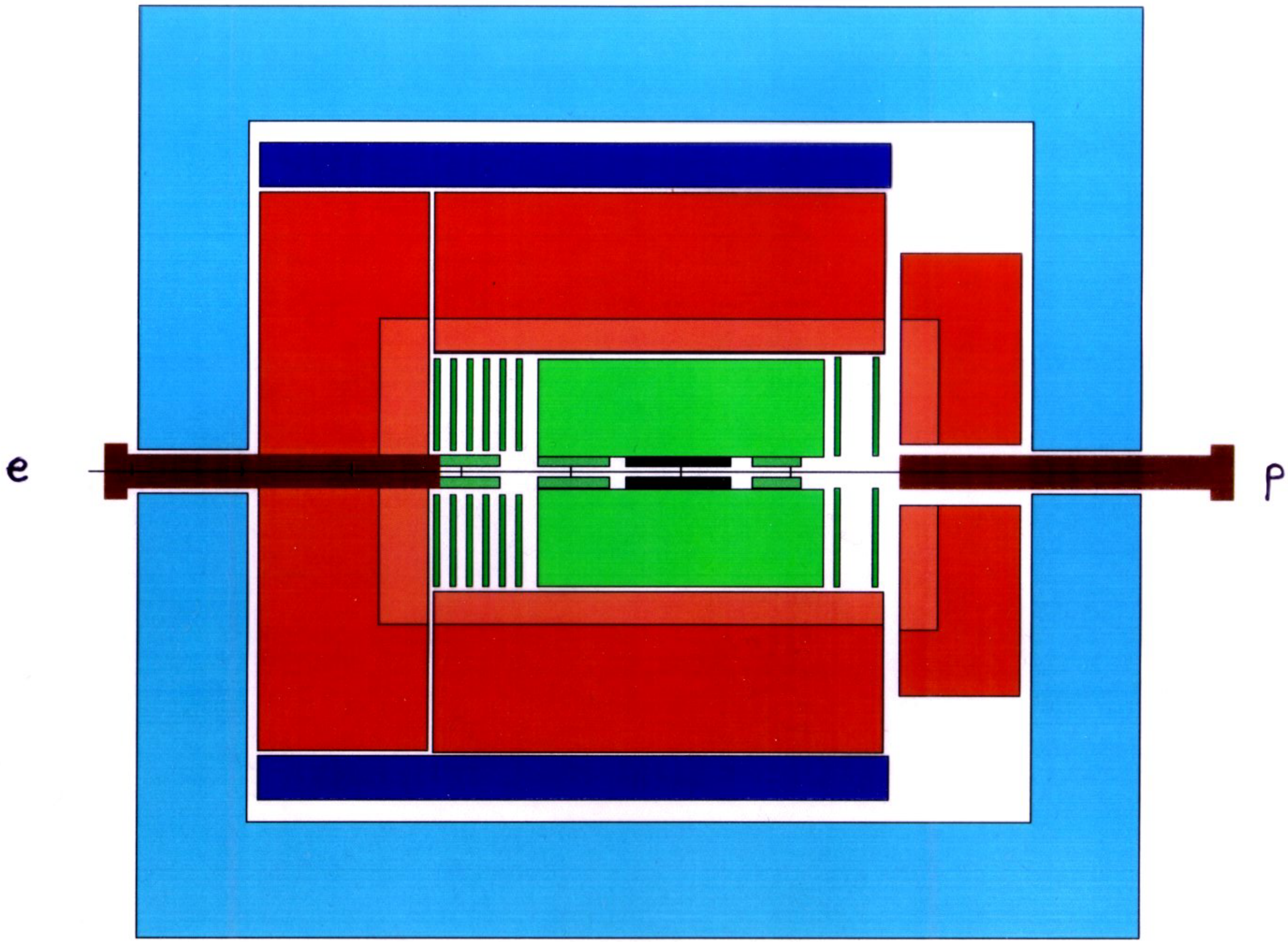
- early low x THERA run worth considering.
- hi $\mathcal{L}/Q^2$ needs time.

THERA DETECTOR





9m of homogenous, toroidal field
Z [mm]
9000.0
8000.0
7000.0
6000.0
5000.0
4000.0
3000.0
2000.0
1000.0
0.0
-1000.0
0.0
1000.0
3000.0
5000.0
7000.0
9000.0
11000.0
13000.0
R [mm]
ZEUS
H1
UNITS
Length : mm
Flux density : T
Field strength : A m⁻¹
Potential : Wb m⁻¹
Conductivity : S m⁻¹
Source density: A mm⁻²
Power : W
Force : N
Energy : J
Mass : kg
PROBLEM DATA
thera.st
Quadratic elements
Axi-symmetry
Vector potential
Magnetic fields
Static solution
Scale factor = 1.0
2152 elements
4417 nodes
3 regions
19/Dec/2000 14:04:17 Page 16
OPERA-2d
Pre and Post-Processor 7.506



high Q^2 & $\mathcal{L}$.

$10^\circ \lesssim \theta_e \lesssim 170^\circ$: $Q^2 \gtrsim 1000\ \mathrm{GeV}^2$

ep interactions with THERA at $\sqrt{s} = 2 \cdot \sqrt{E_e \cdot E_p} \simeq 1$ TeV

1 page

5.9.2000
M. Klein.

advance energy frontier, 3..4 · HERA
- E_e (TESLA) $\simeq$ 250 .. 500 GeV, E_p (HERA) $\simeq$ 300 .. 900 GeV
  $e^\pm$, high polarization.
  MAX E_e determined by separation of e/p beams after interaction

new low x field theory, LHC x10^{-7}, v astrophys.
- $\mathcal{L} \simeq 10^{30} cm^{-2} s^{-1}$ ↔ ~10 pb^{-1}/year for low Q^2/x physics:
  saturation: unitarity limit of rise of F_2 / xg, large phase space for forward jets (DGLAP → "BFKL"), diffraction (2g ↔ resolved IP), heavy flavour (beauty). theory in NNLO. $\delta \alpha_s$ = 1/2 % accuracy

new apparatus in West area
- detector: new backward apparatus design for $\vartheta_e \leq 179.5°$ and high elm. & hadronic backward energy $E \lesssim E_e$ (20 x HERA!)
  central and forward: resemble H1/ZEUS. energies limited by E_p
  e, p, γ taggers possible to be placed, needed for physics

operation parallel to TESLA ?
- use e^+ after e^+e^- collision or every second bunch.
  [dedicated mode: use both arms of TESLA / standing wave type cavities: advantage of sc Linac. get e^- of $2 \cdot E_e$]
  adjust bunch spacing of TESLA to 96 ns · 11/3 = 352 ns

accelerator aspects
- reverse p direction in HERA, passive transfer line TESLA → HERA, e beam dump on DESY site, focus: sc magnets ~10 m from i.a. point ..

options
- eA (high density parton i.a.'s), $\vec{ep}$ (at low x, large Q^2), γp with E_γ ~ 500 GeV

$\mathcal{L}$ upgrade accesses very hi Q^2
- $\mathcal{L}$ increase by: proton beam cooling, dynamic focusing, flat beams, TESLA power, p RF .. : p accelerator R&D.
  very high $Q^2 \leq 1$ TeV^2: proton substructure to $2 \cdot 10^{-19}$ m
  new phenomena ? LQ spectroscopy / polarized $e^\pm$ l.r.h. currents

" the one reason "

Veksler.

5 lines

research of lepton and hadron interactions
at TeV energy scale requires the ll and
hh machines to be complemented with a lh
collider. this is an opportunity at DESY
to remain at the frontier of strong i.a. physics.

- TDR - THERA appendix - being edited.
- thanks to many colleagues in machine, exp, thy
  & the directorate.