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Idea for an Upgrade of Forward Region at H1

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Plan

- Introduction
- Forward detectors in H1
- H1 and Forward magnets
- Main idea
- Simulation of the beamline
- Simulation results
- Summary

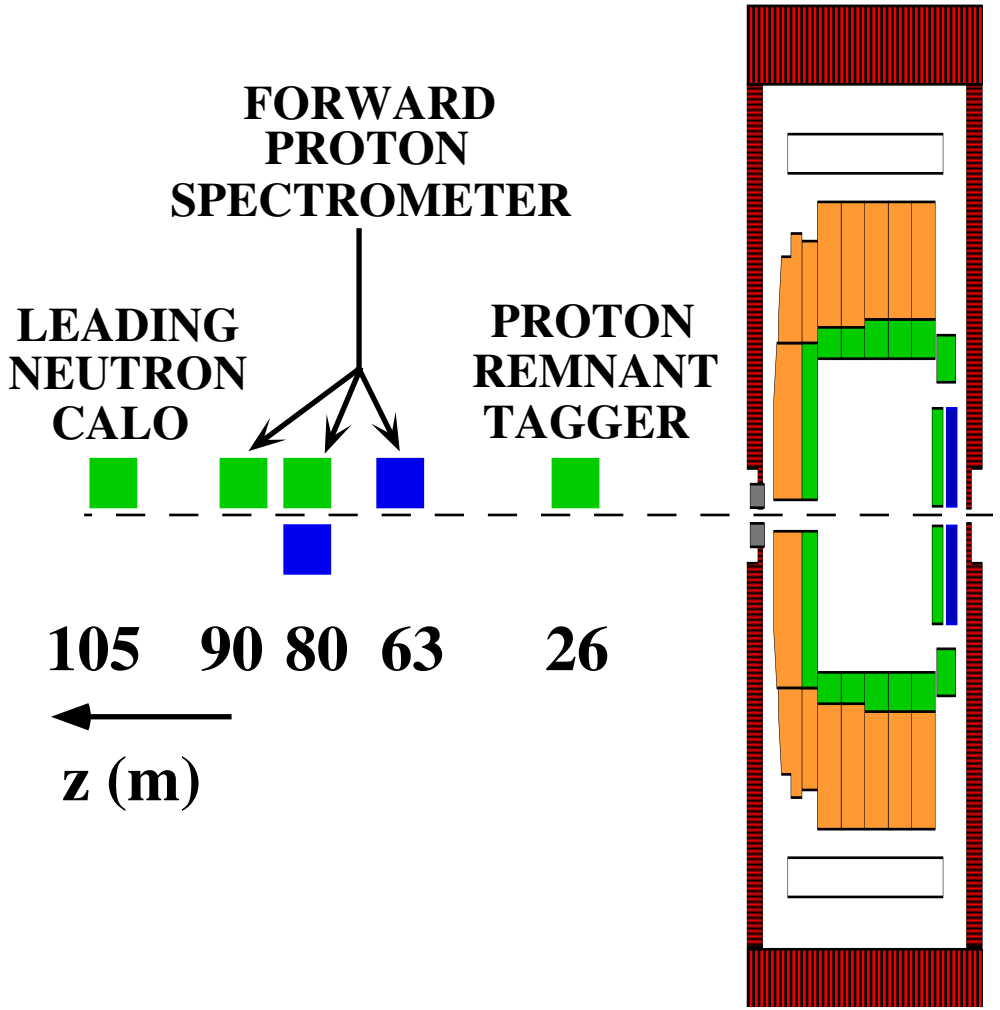
Inroduction

- Interest in very forward energy and jet measurements at high energies has been discussed a lot (low-x dynamics, parton branching, non-perturbative particle production, QCD vacuum, transition diffractive to non-diffractive regimes, etc..). Such measurements at HERA are limited by detector acceptance

- We investigate the technical possibility of increasing the acceptance for forward energy measurements in H1 up to $\sim$ 8 units of rapidity

- The ideas and methods studied here can be applied elsewhere (e.g. at LHC ?)

Forward Detectors in H1



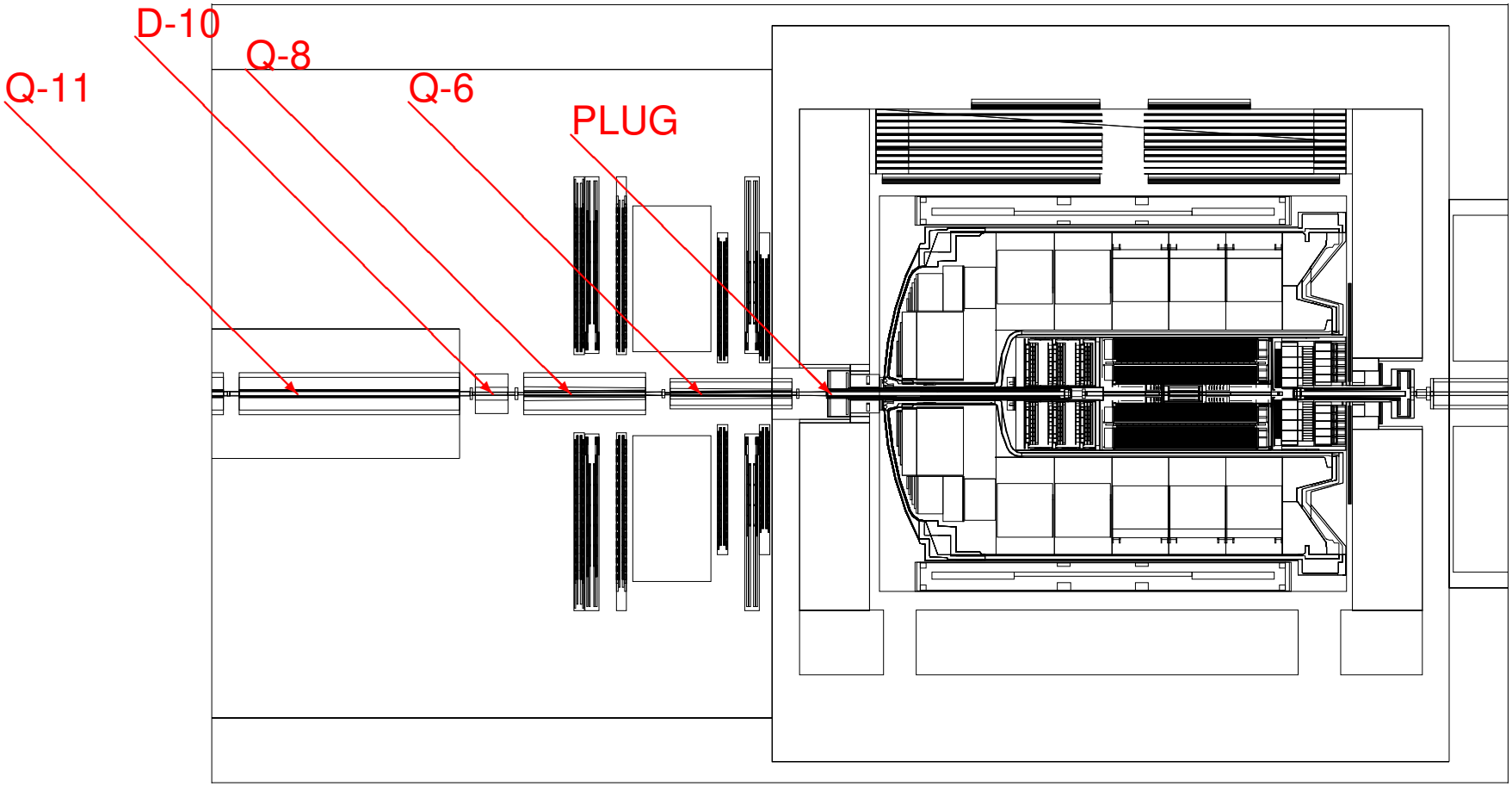
- Forward Proton Spectrometer (FPS and VFPS), based on the Roman Pot technology, scintillating fiber detectors with readout by positon sensitive photo-multipliers. Measure leading proton with low X_P = 1 - E'_p/E'_p.

- Forward Neutron Calorimeter (FNC) is placed on the position 105 m from Interaction Point. This is the lead-scintillating sampling calorimeter.
  Main goal is to measure the energy and angle of fast neutrons (with scattering angle up to $\sim$1 mrad) from reaction $ep \to enX$.

- Forward Tagging System (FTS) of H1 includes 4-stations of scintillating counters (on the 26-th, 28-th, 53-rd and 92-nd meters respectively).
  This system detects the proton fragments at very large rapidity with a good efficiency due to secondary interaction soft hadrons with the beam-line components (beam-pipe, magnets, collimators and etc..).
  And it allows to distinguish between high mass diffractive dissociating reaction and non-diffractive multi-hadron production.

- Hadron PLUG calorimeter is placed inside of H1 (4.8 m) in direction of the proton beam and covers the angle range 0.7$\div$ 3.4 degree.
  This calorimeter allows to measure jet energy flow along proton beam and to minimize part of total transverse momentum missed in H1. PLUG extends the acceptance of the H1 calorimeter system from 3.5 to $\sim$ 5.1 units of rapidity.

H1 and Forward magnets



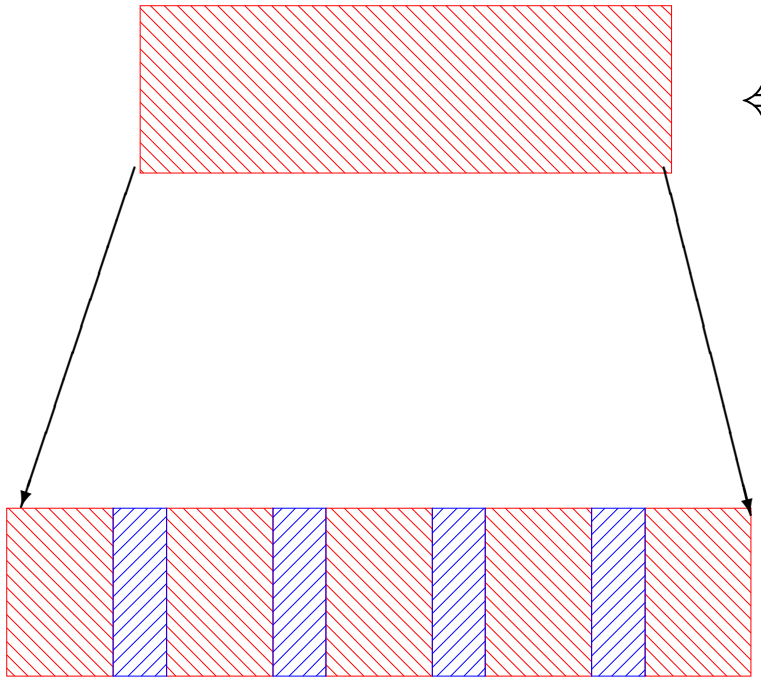
Main Idea

- we investigated several possible places for the installation of the new callorimeter in order to extend rapidity range ≥ 5.0

- result was not very promising :
  a) lack of free space between magnet elements in HERA tunnel;
  b) possible places for the calorimeter are shadowed by the magnets placed close to IP

- Main idea $\Rightarrow$ use magnet body (quadrupoles, in our case) as the "sensitive" calorimeter

- for example to split the magnet body (quadrupole) on the several pieces and put the sensitive elements between



⇐ conventional magnet

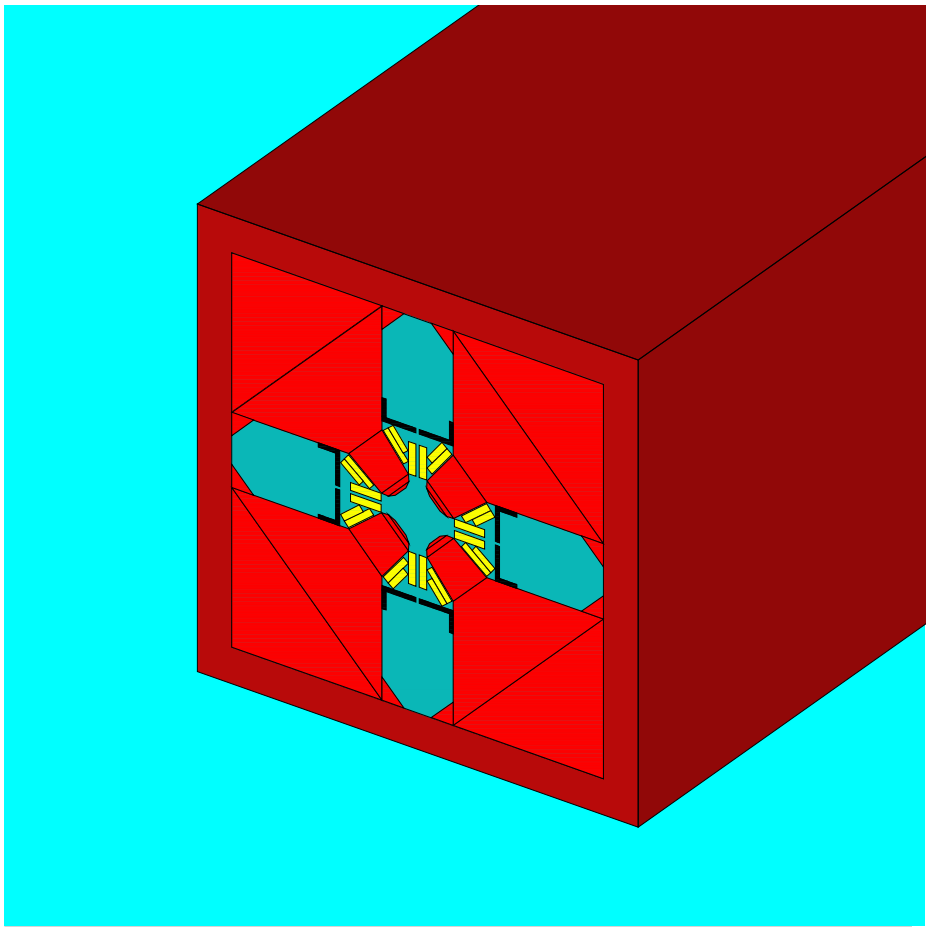
⇐ ”sensitive” magnet

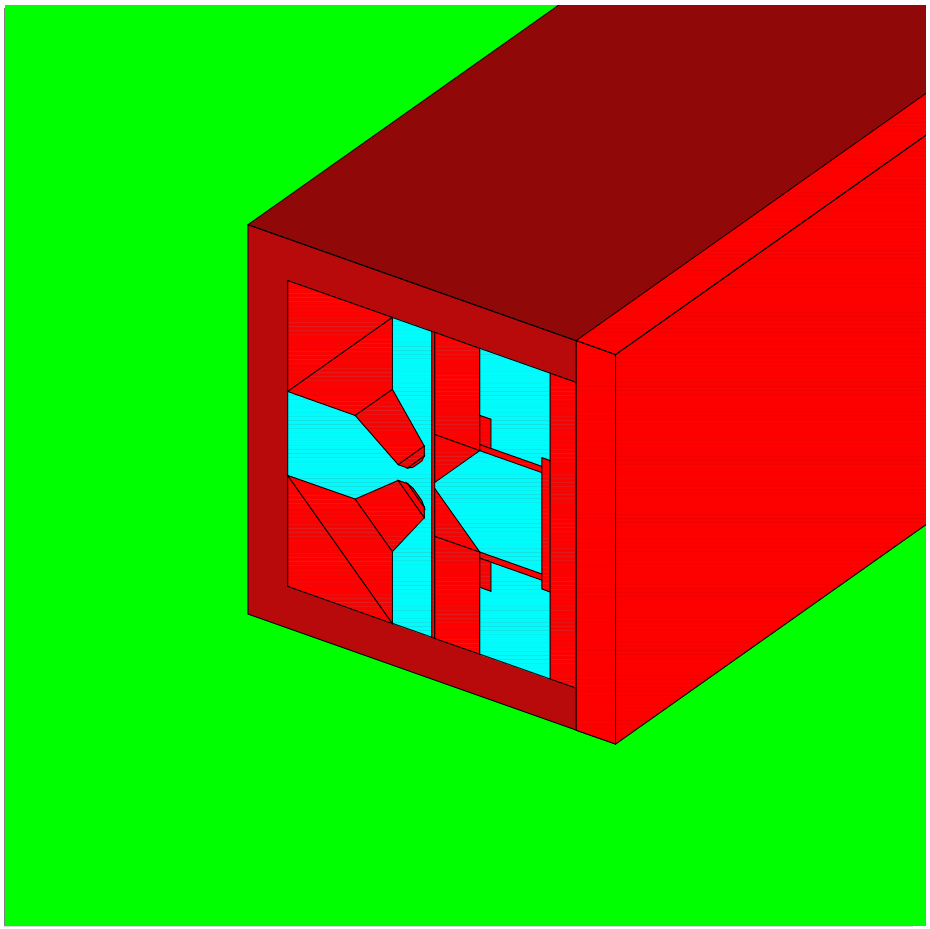
- experts say ⇒ yes, it is possible .

Simulation of the beamline

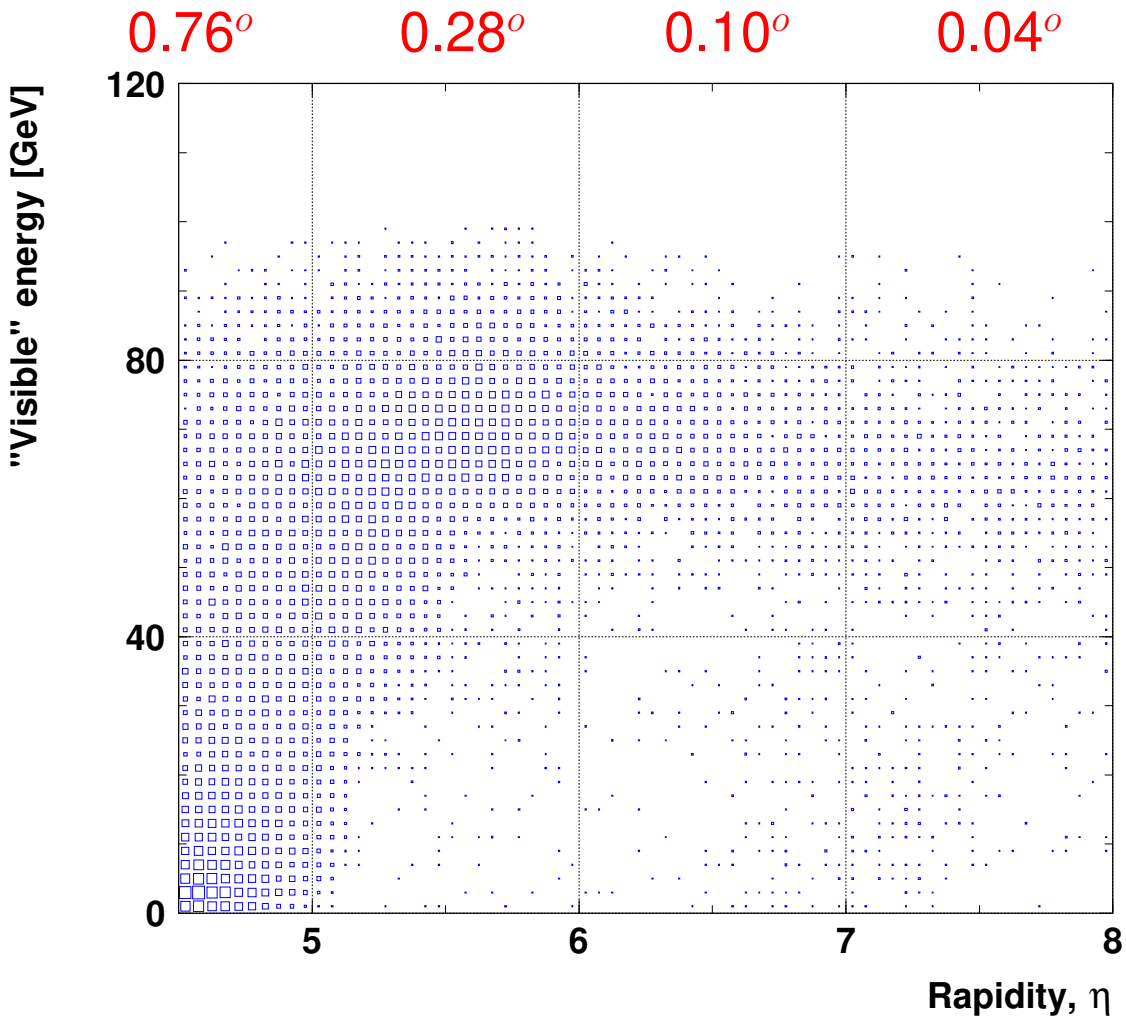
- Simulation was done with the H1SIM program (GEANT-3 based)
- This program includes the description of the main H1 detector and also the Forward and Backward beamline
- The description of the all present beamline detectors are also included
- The beamline components (quadrupoles, beampipe, flanches and etc..) are described in simulation sufficiently detailed. The simulation provides results close to reality

- Example of the quadrupoles description





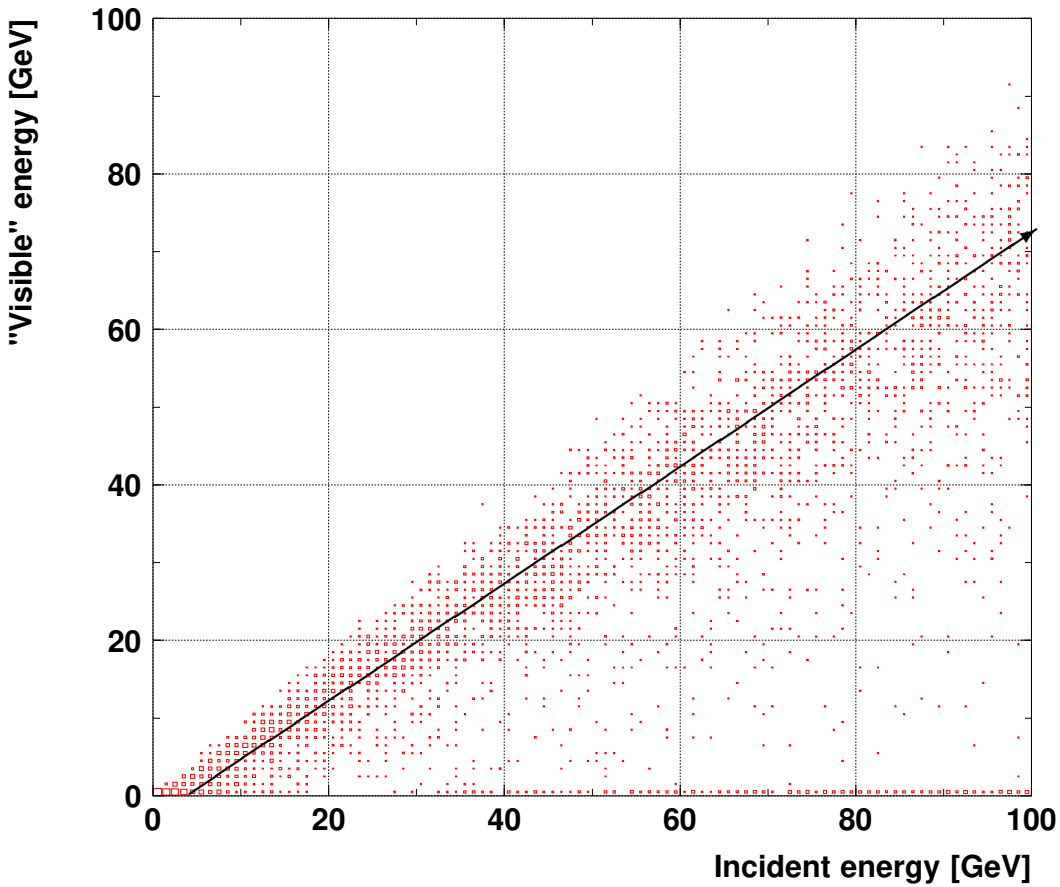
Simulation results



a) 100 GeV pions as incident particles,
polar angle $\theta = 0 \div 1.2^o$,
azimuthal angle $\phi = 0 \div 360^o$

b) investigate energy loss in the body
of 3 quadrupole magnets at 6-10 m

d) there is the rapidity range ($\eta \geq 5.2$)
where ”response” is almost constant



a) dependence ”visible” energy on the incident energy of pions

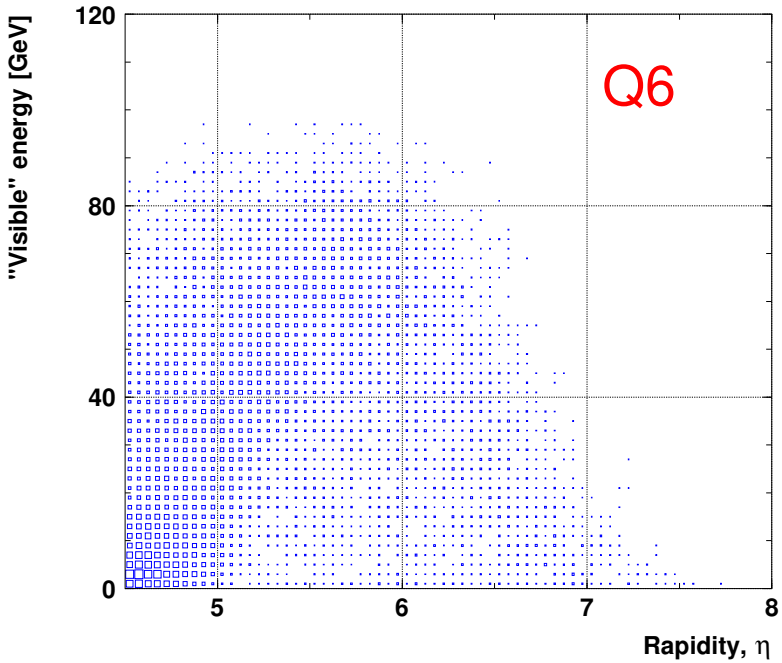
b) rapidity range $\eta \geq 5.2$ units

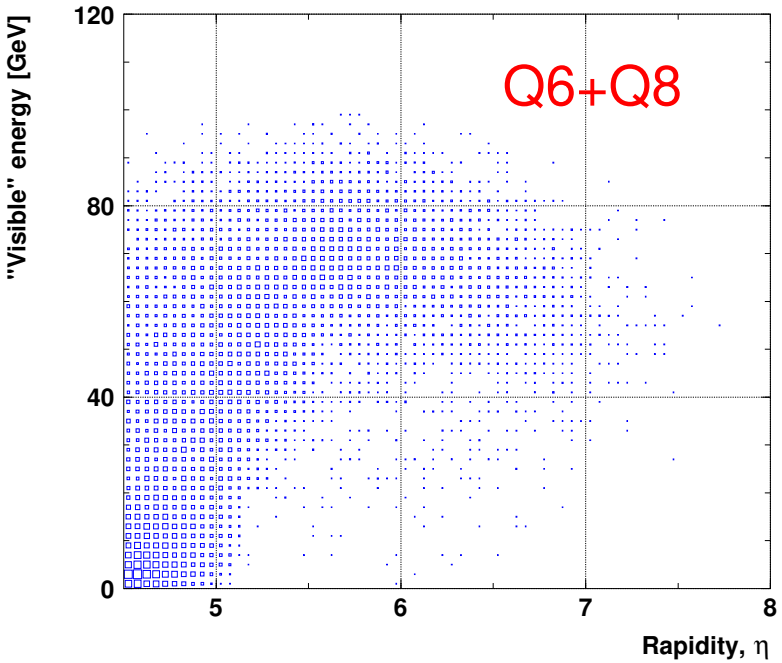
c) pions energy range 0÷100 GeV

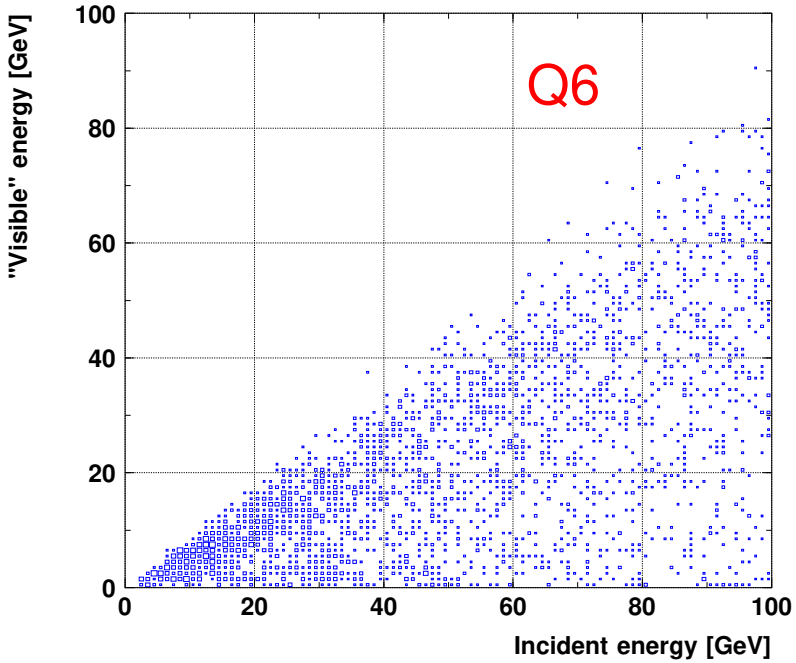
⇓

”calorimeter” response is almost linear

We can use such magnets as the calorimeter


Q6
"Visible" energy [GeV]
Rapidity, η
0
40
80
120
5
6
7
8


Q6+Q8
"Visible" energy [GeV]
Rapidity, η
0
40
80
120
5
6
7
8


Q6
"Visible" energy [GeV]
Incident energy [GeV]
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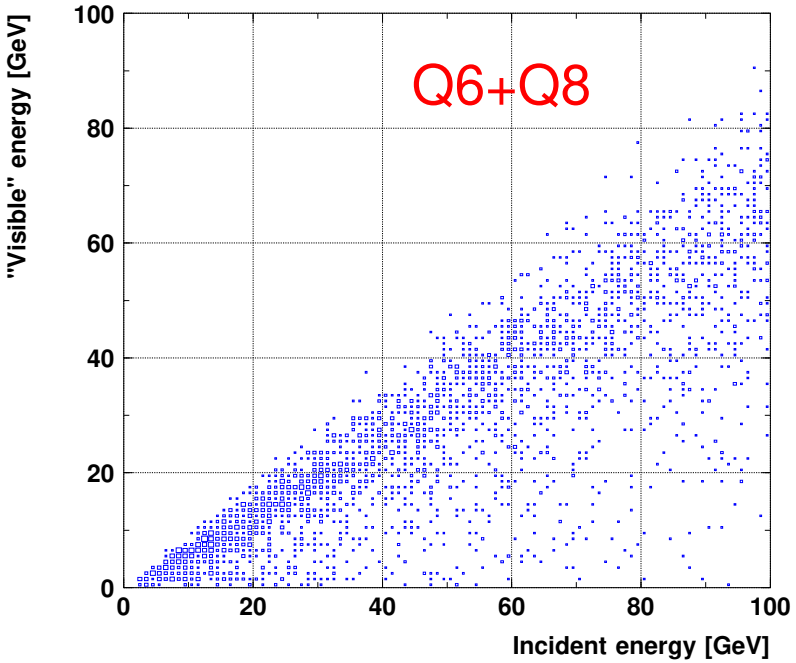
20
40
60
80
100


Q6+Q8
"Visible" energy [GeV]
Incident energy [GeV]
0
20
40
60
80
100

Summary

- We investigate the possibility of upgrade the H1 detector to increase the acceptance up to $\sim$8 units of rapidity
- Idea is to instrument the beam-line magnets with active elements
  Technically it is possible
- First simulation shows that the using of such instrumented magnets expends accessible rapidity range up to $\sim$ 8 units with a ”linear” dependence between incident and ”visible” energy
- We presented very preliminary studies, the investigation will be continued, and hopefully we can come out with a technical proposal
- This idea could be useful also for other machines and experiments
  (e.g. LHC ?)