



CASTOR UPDATE

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1. Physics issues
2. Integration in CMS
3. Beam test analysis (2003)
4. Tasks in 2004

HERA-LCH workshop
CERN 26-27/03/2004
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Summary low-lumi Very Forward pp Physics

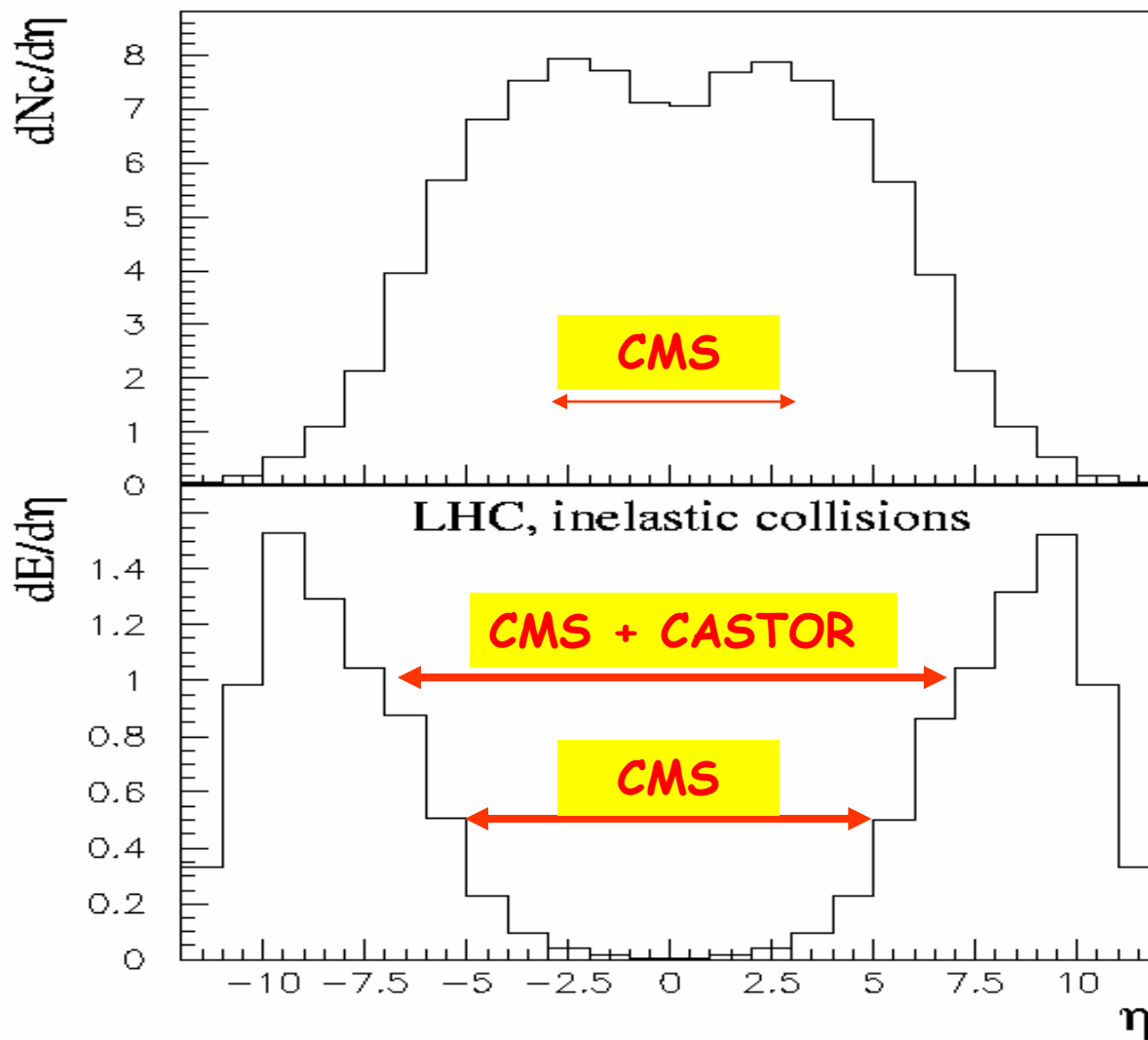
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- **Low x physics:** $x = 10^{-5} - 10^{-7}$
possible in CMS with CASTOR-T2 at $5.3 < |\eta| < 6.6$
- **BFKL searches:** Di-jets with large rapidity gaps
Color singlet exchange events
Forward J/ψ production
- **Diffraction:** Extended coverage for vetoing
Multi-gap detection
- **Forward energy flow for cosmic rays**
- **Exotics in the very forward region:** Centauro, DCC, ...
- **$pp \rightarrow pp + e^+e^-$:** Luminosity measurements



ACCEPTANCES: Multiplicity - Energy

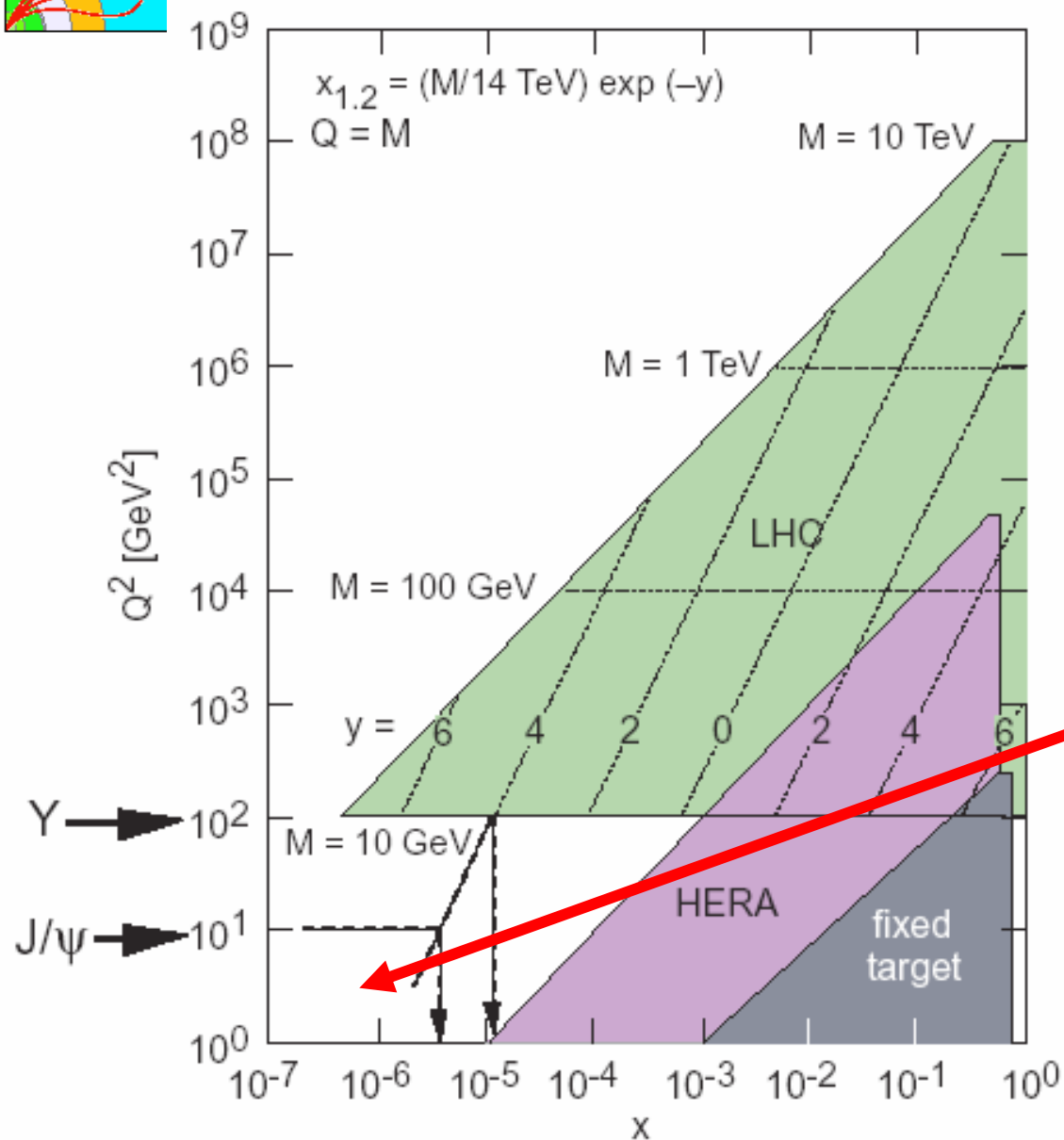
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Low-x at the LHC

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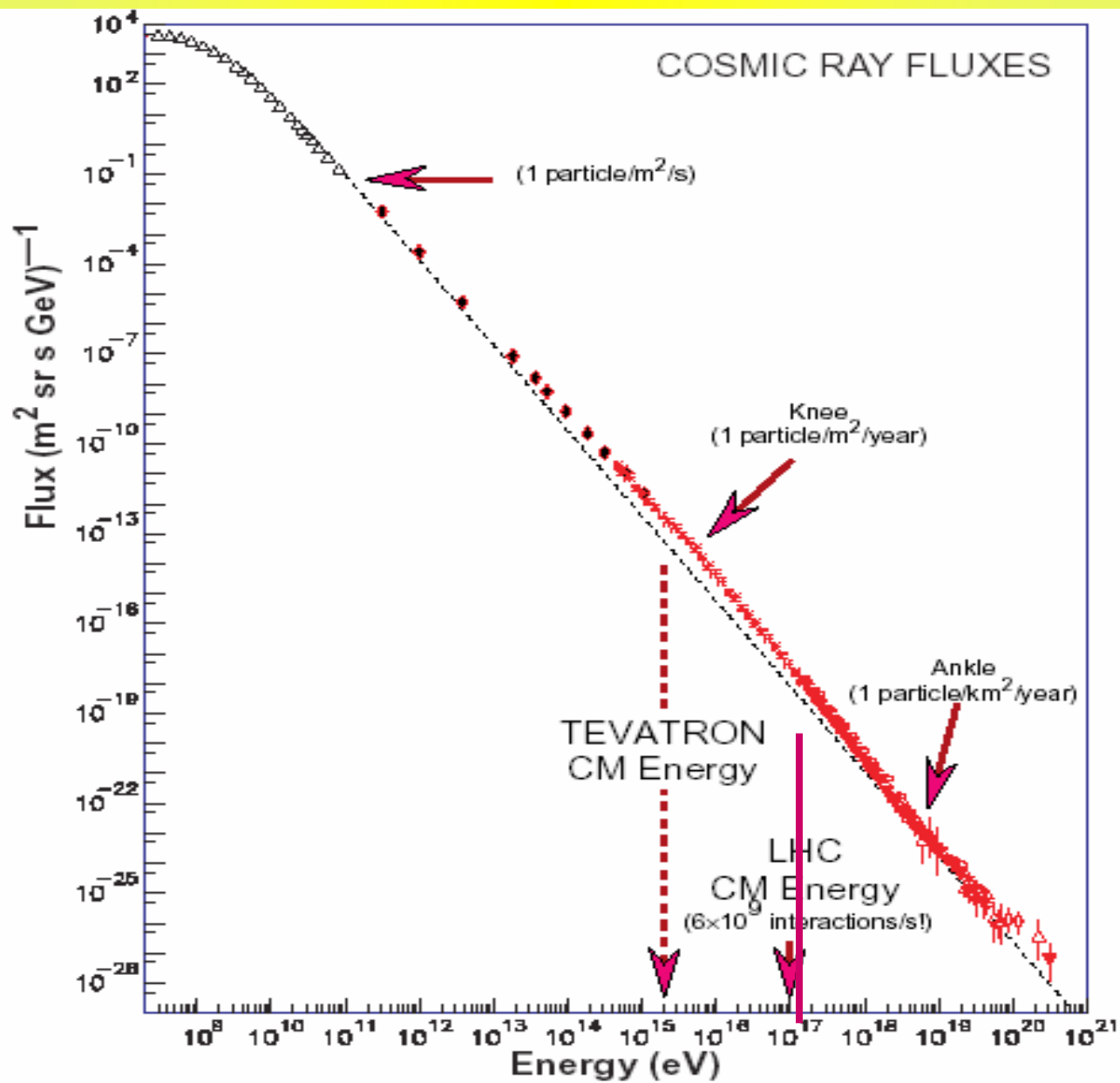


For rapidities below 5 and masses below 10 GeV
 $\Rightarrow x$ down to 10^{-6} - 10^{-7}



Forward energy flow for Cosmic Rays

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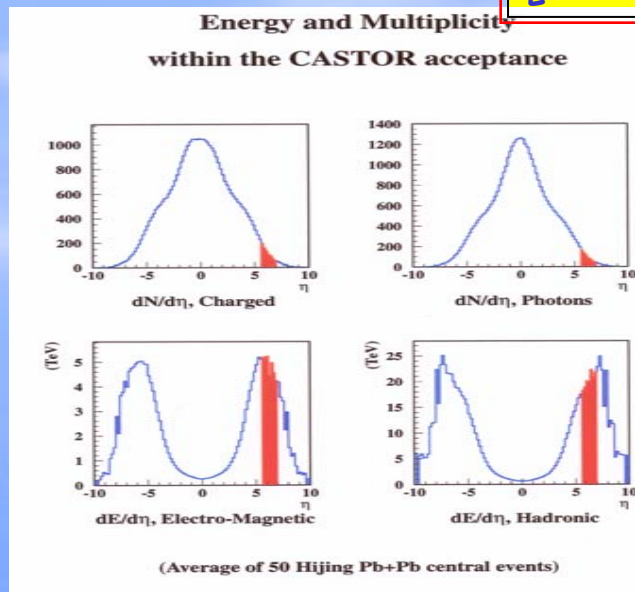




Summary Very Forward A+A Physics

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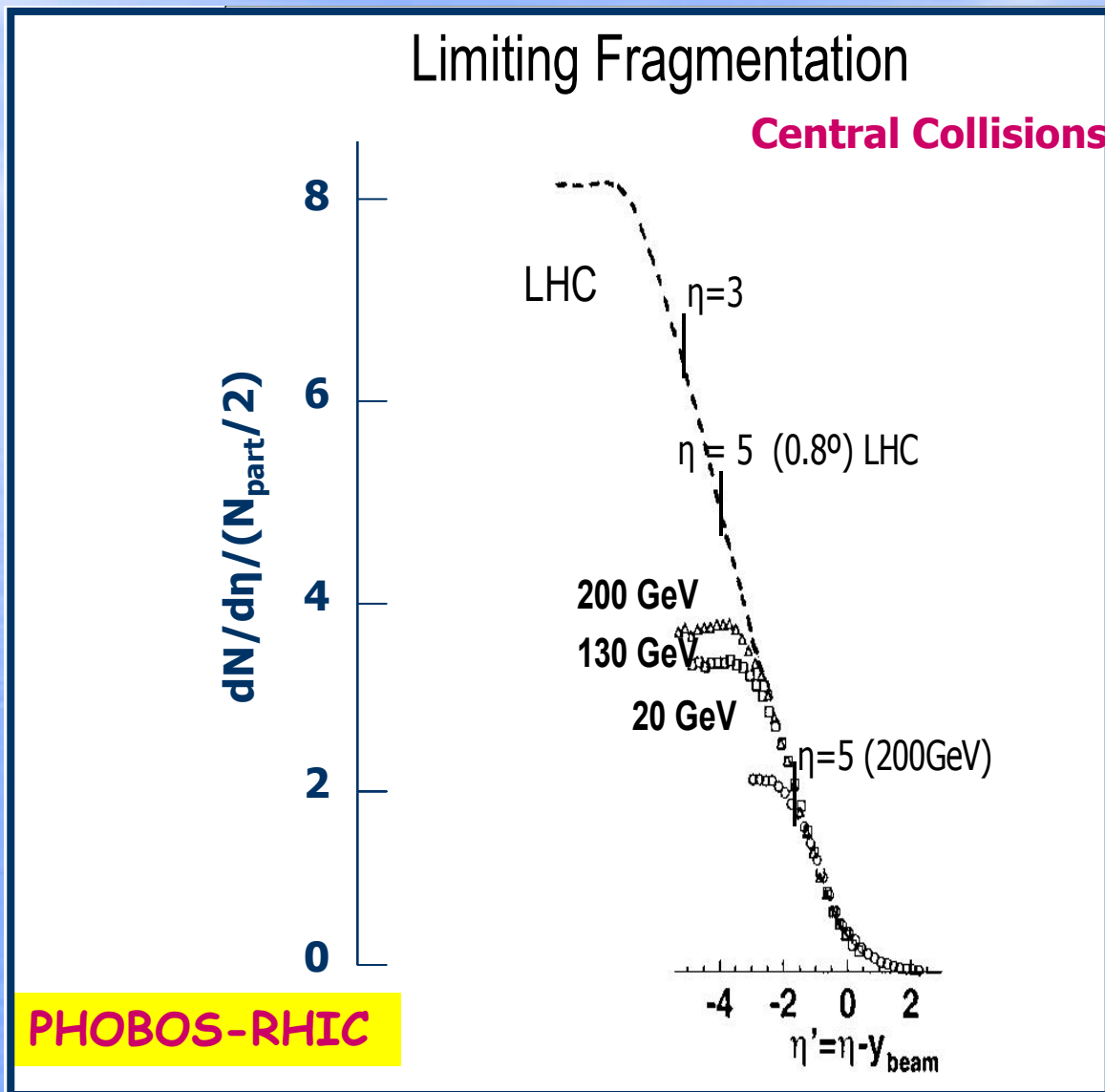
- Limiting Fragmentation studies
- Peripheral and ultra-peripheral collisions
- Total energy flow, E_T measurement vs impact parameter
- Hadronization of high-baryon density DQM fireball
- Exotic C-R events: Centauro, Long Penetrating hadrons=Strangelets?
- Other "new" Physics: Disoriented Chiral Condensate
Colour Glass Condensate





Limiting Fragmentation

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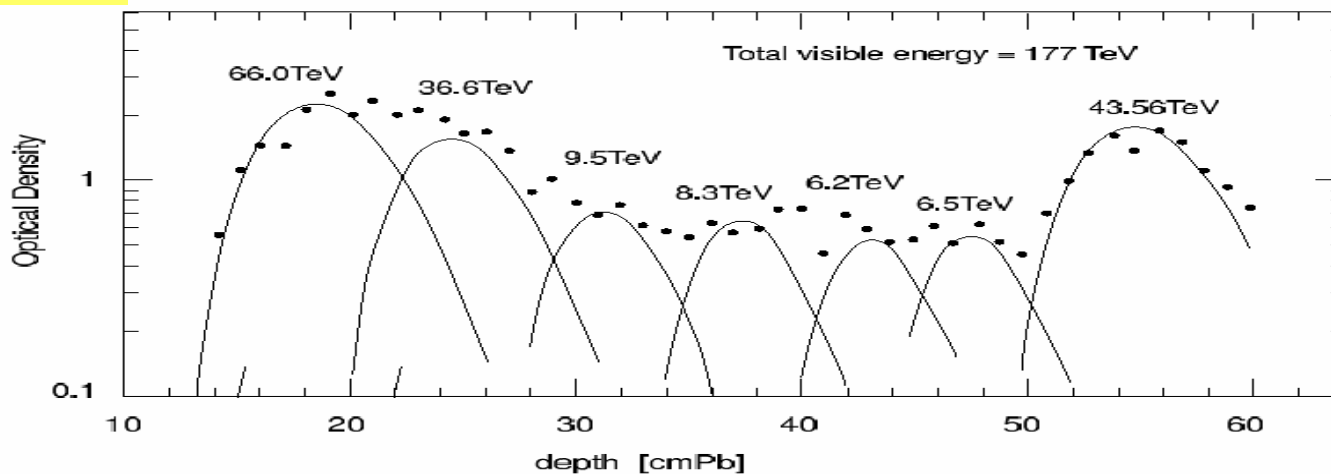
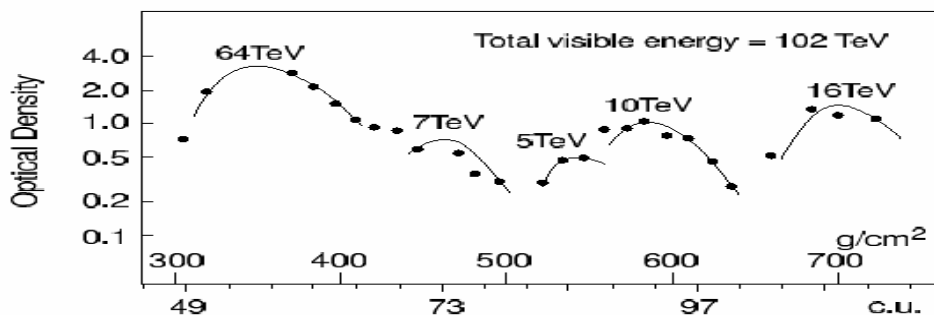
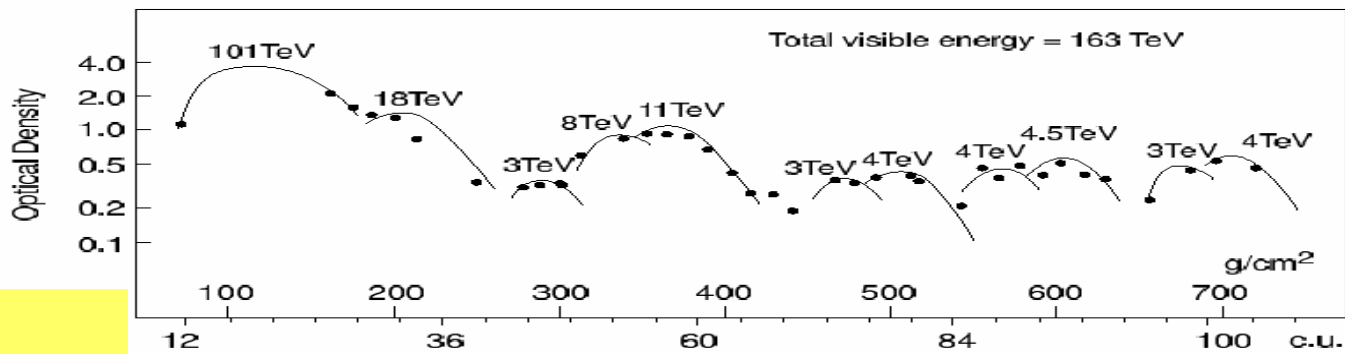




Long Flying Component (Strangelet ??)

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Long penetrating hadronic component observed in CR events

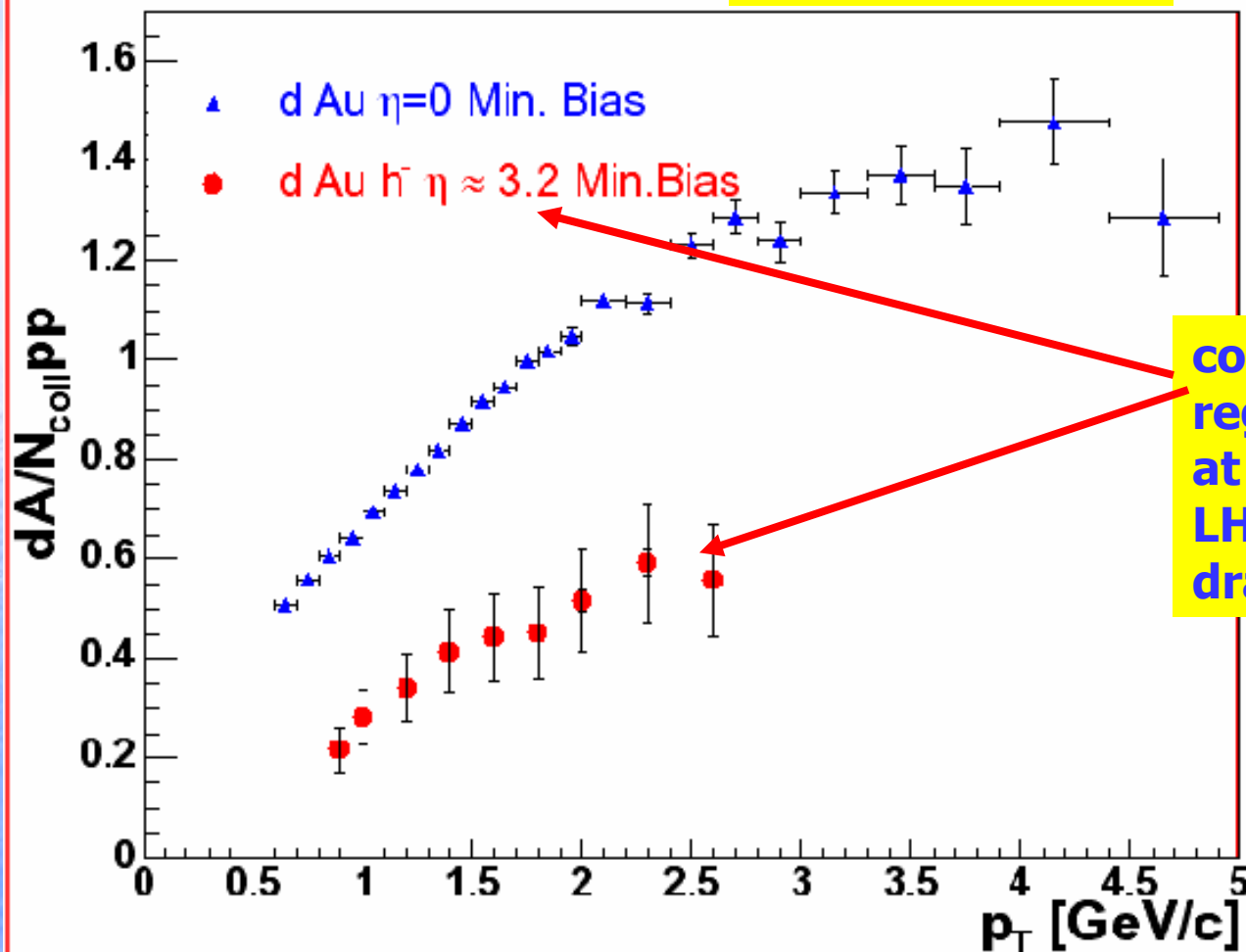




Colour - Glass Condensate

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BRAHMS - RHIC

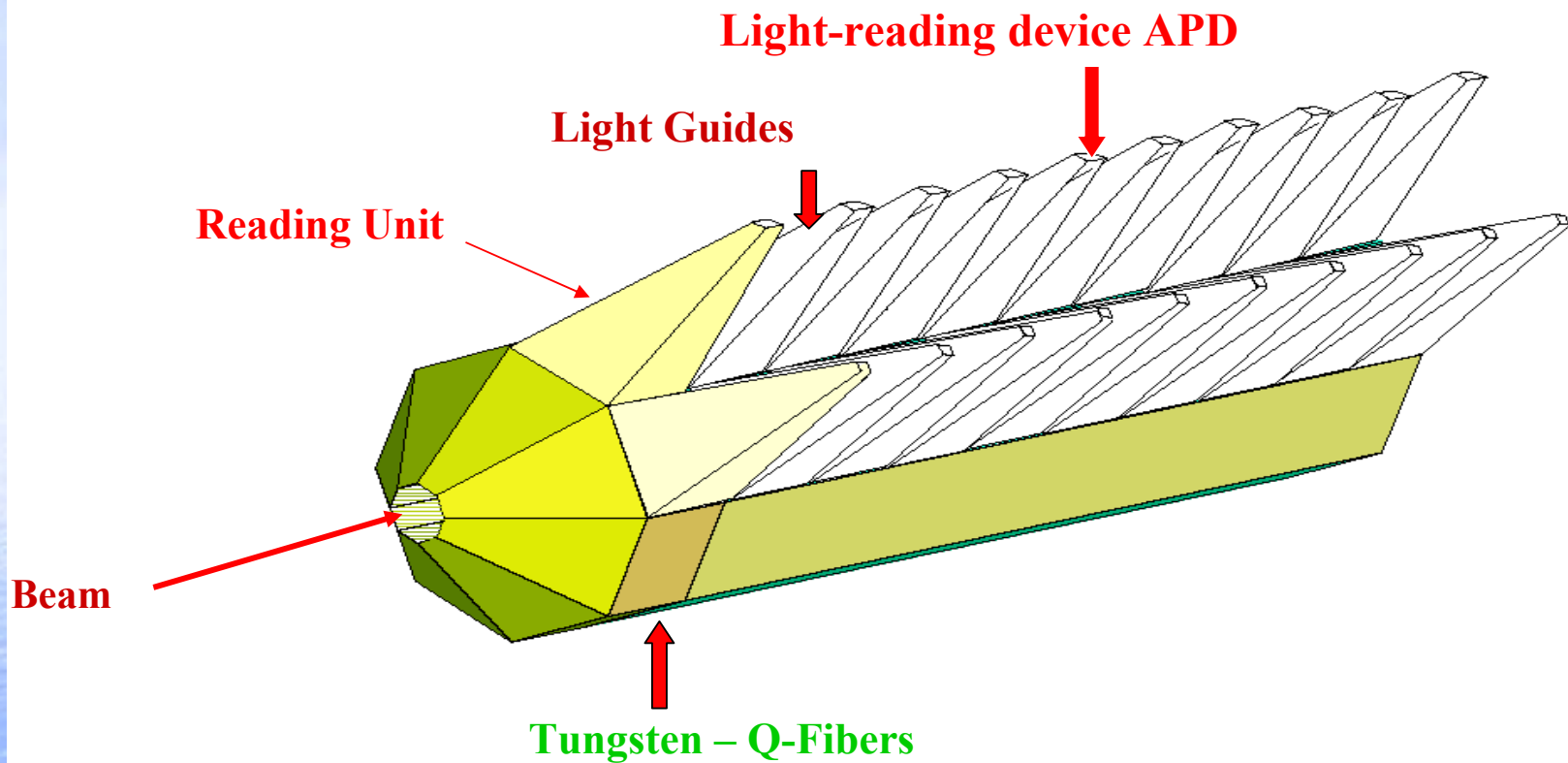


corresponds to \sim central region at LHC. The effects at $\chi \sim 10^{-6}$, attainable at LHC, would be much more dramatic.



CASTOR Calorimeter

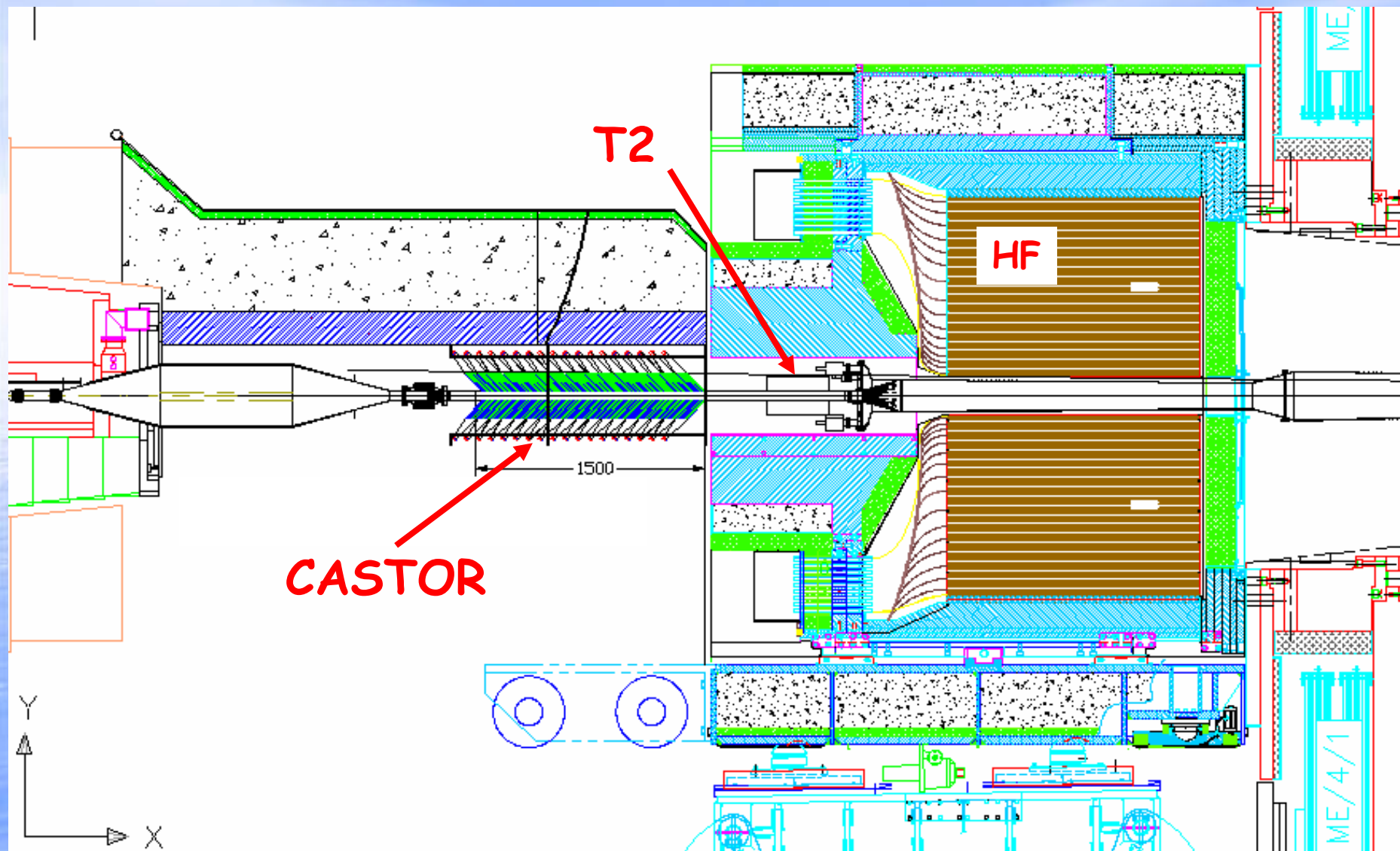
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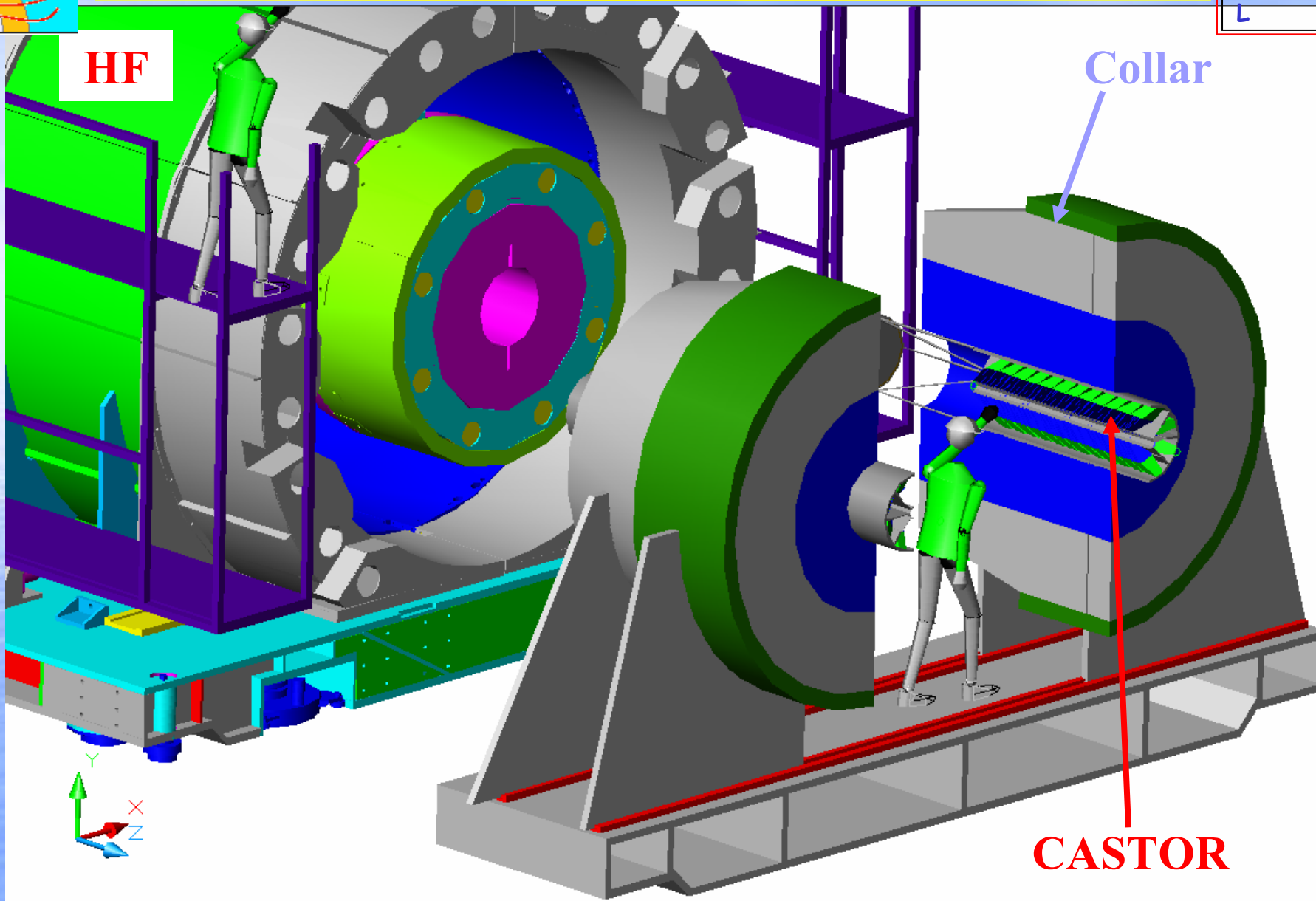
CASTOR - T2 Integration in CMS

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CASTOR Integration in CMS

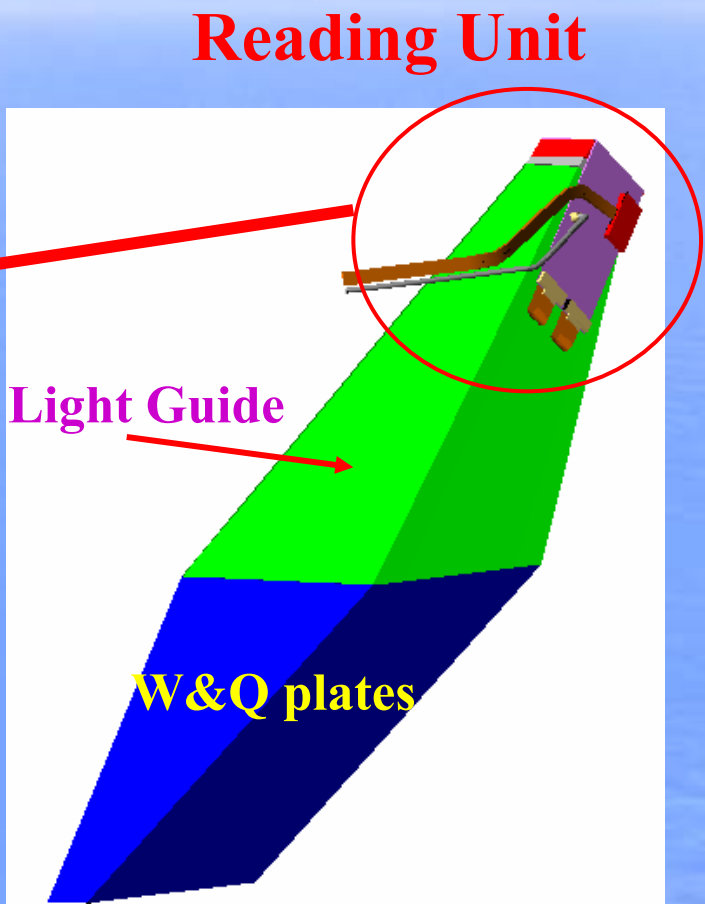
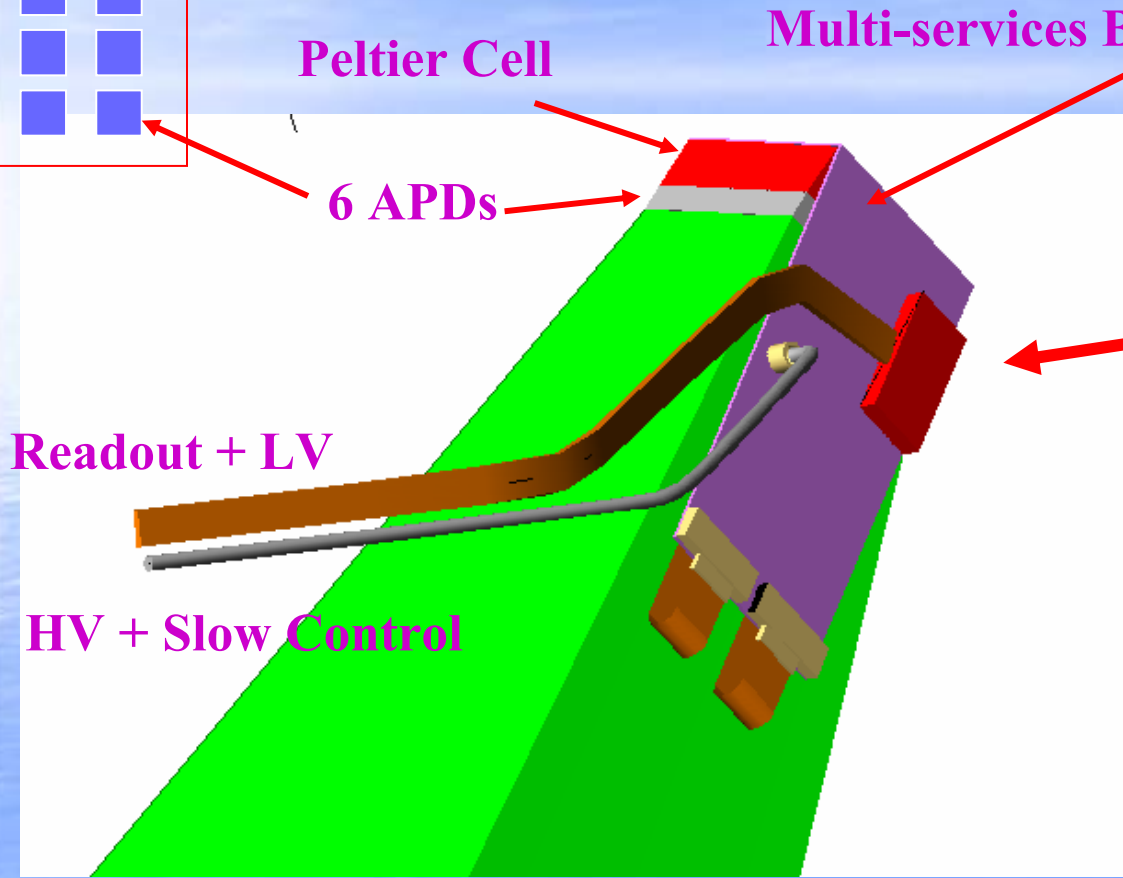
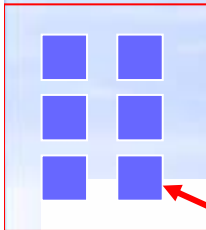
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CASTOR Readout Conceptual Scheme

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CASTOR in GEANT4-OSCAR

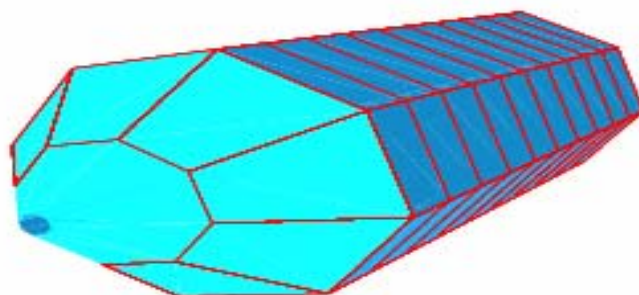
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Simulation of the CASTOR calorimeter in the CMS environment
GEANT4-OSCAR has started on 1/2/04.
A. Zhokin, P. Katsas (Athens)

- **Summary for geometry**

- ▷ **CASTOR geometry based on calorimeter prototype for simulation in frame of CMS detector is ready**



- ▷ **No new CASTOR geometry before the final design of the calo support and size is finish**

1) **the beam-pipe constrain:**
outer radius = 26mm + clearances for safety

2) **CASTOR integration in CMS:**
the outer active radius could be as large as needed to reach $\eta \sim 5.2$ at the center of the calorimeter

- ▷ **foreseen in final design**
 - the Quartz plates (no fibres)
 - Air lightguides (no bundle) in shielded Al casing



BEAM TEST OF PROTOTYPE

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Beam-test investigated the viability of options for several components of the calorimeter:

- Tested two APD's (Y. Musienko, Northeastern)
- Light production & spatial response with Q-fibers & Q-plate.
- Light-transmittance with 2 different reflectors.

Beam: electrons of various energies (20 - 200 GeV).

Beam test: June 25 - July 2, 2003



CASTOR PROTO BEAM TEST

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27/03/2004

UoA - Apostolos D. Panagiotou

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CASTOR PROTO BEAM TEST - JUNE 2003

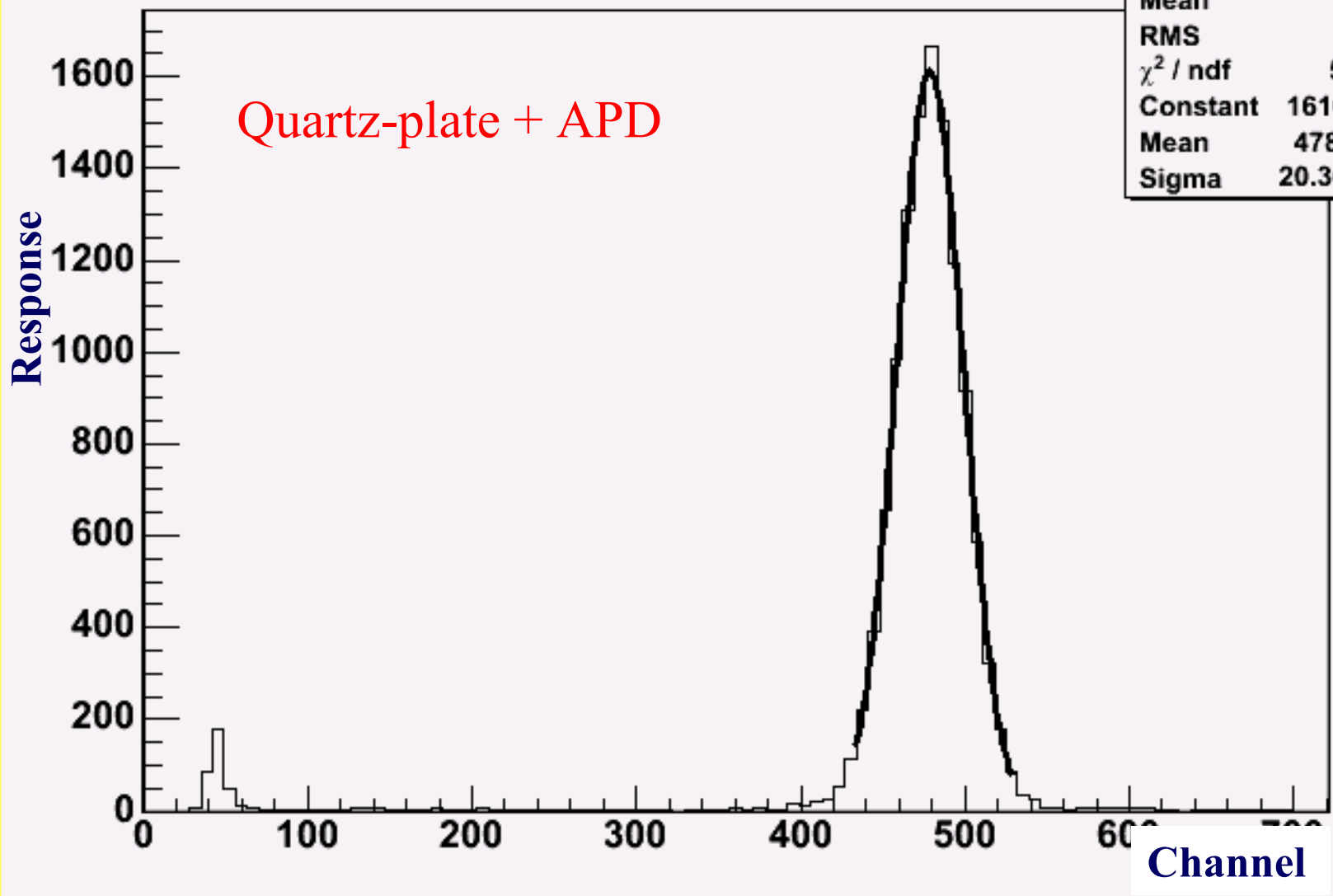
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adc.adc13 (X>7 && X<17 && Y>-12 && Y<-2 && adc13<700)

API APD, E=100 GeV

htemp	
Entries	12378
Mean	464.2
RMS	78.82
χ^2 / ndf	5.57 / 11
Constant	1610 ± 19.3
Mean	478.6 ± 0.2
Sigma	20.36 ± 0.17

Quartz-plate + APD

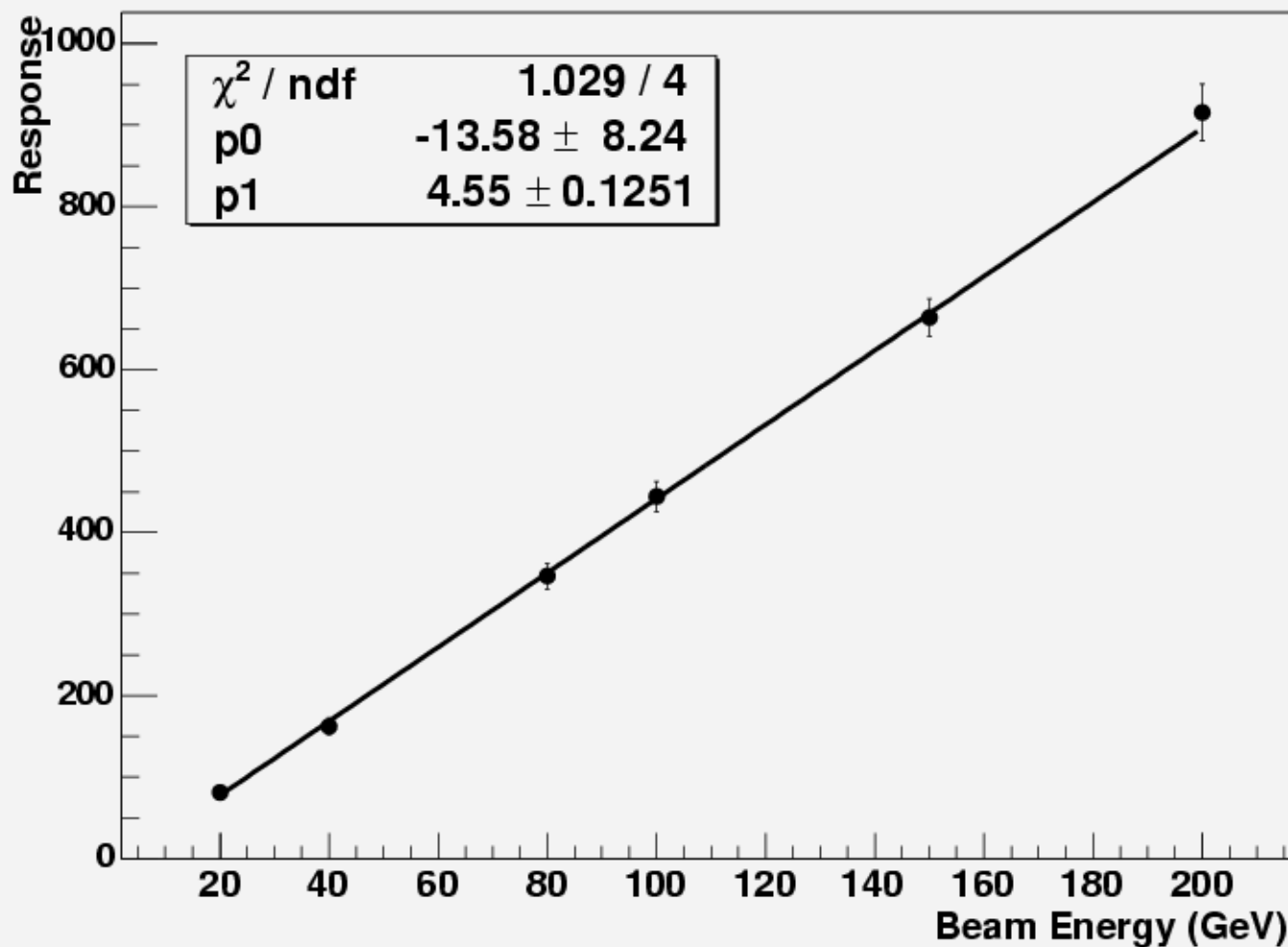




Energy Linearity of Q-Plate & APD

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Linearity of Quartz Plate (sector S1) APD2

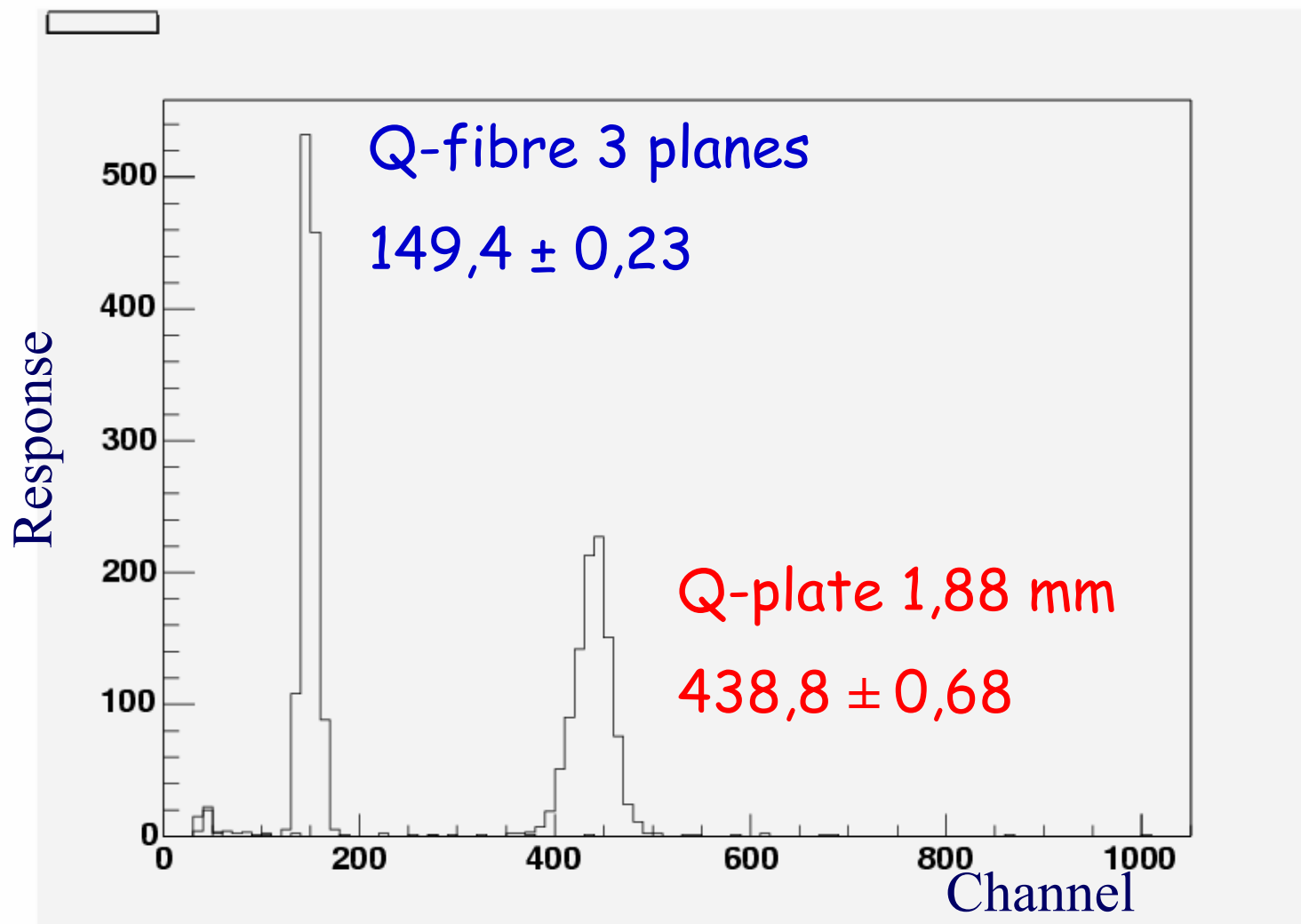




Light Production in Q-Fibre & Q-Plate (APD)

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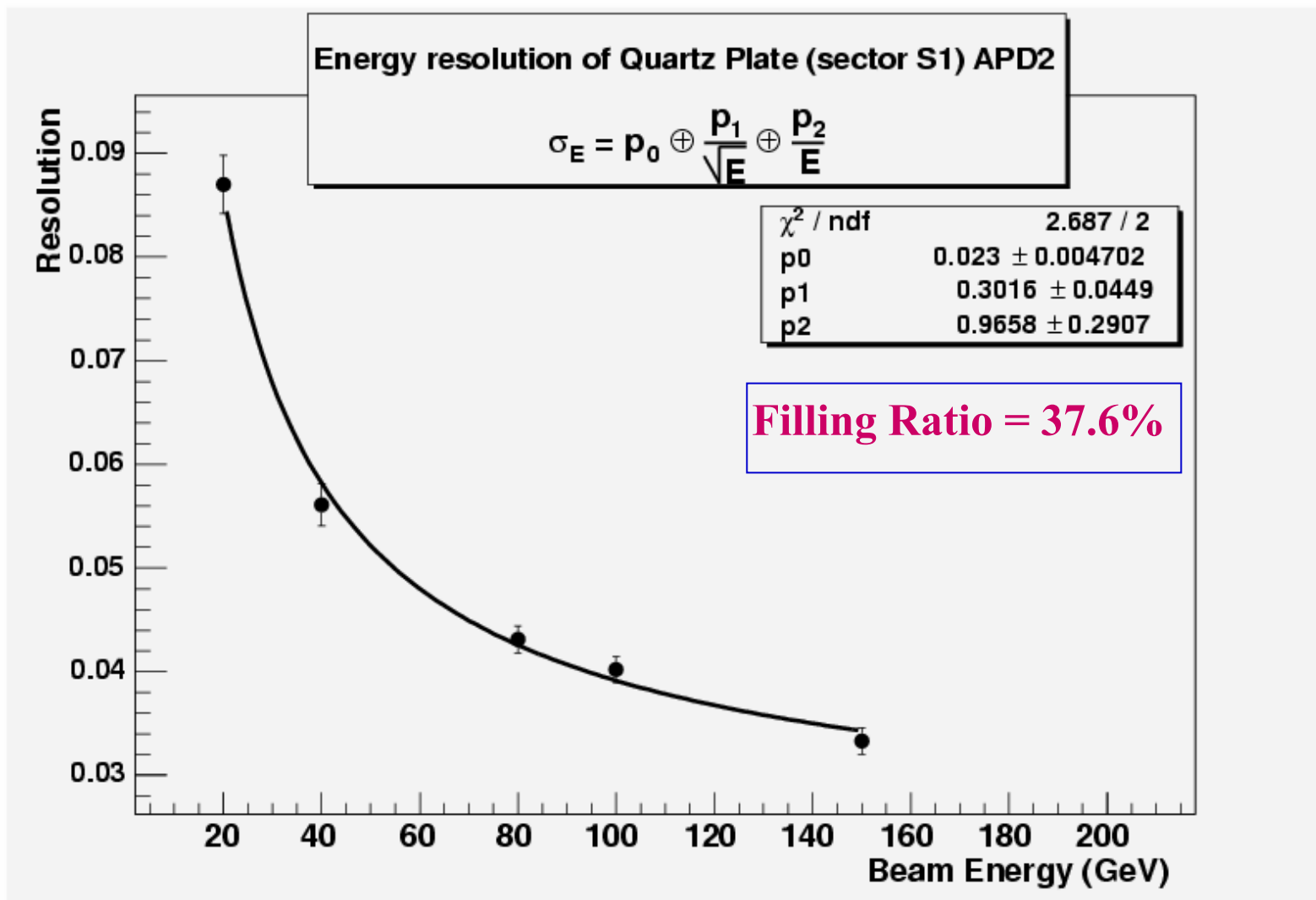
100 GeV





Beam-Test Energy Resolution of Q-Plate & APD

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APD Impact on Resolution

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• Resolution:
$$\frac{\sigma_E}{E} = p_0 \oplus \frac{p_1}{\sqrt{E}} \oplus \frac{p_2}{E} \quad (E \text{ in GeV})$$

p_0 : related to stability and reproducibility

gain variation with bias voltage and temperature

p_1 : due to intrinsic shower fluctuations

Photo statistics (area, QE) & excess noise factor

p_2 : noise contributions

capacitance as series noise and dark current as parallel noise

- Optimise these parameters to reach **CASTOR** design goal for the EM sector:

$p_0 \sim 1\%$, $p_1 \sim 10\%$, $p_2 < 1 \text{ GeV} \rightarrow \sim 1.3\% \text{ @ } 200 \text{ GeV}$



CONCLUSIONS FROM BEAM TEST

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1. APD's are an acceptable option for the light-reading device of CASTOR.
 - Needs more radiation-hardness/cooling tests
 - Electronics issues

Investigation within RD39-Northeastern

2. Q-plate is linear with energy.
Gives ~ 3 times the light of equal thickness Q-fiber planes
 - Needs more investigation and MC for the spatial resolution



Radiation Level @ CASTOR

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Location of APD's : $R = 30 - 32$ cm from beam

Neutron flux (> 100 KeV) = 2×10^{13} fb/cm²

Integrated Luminosity = 10 fb⁻¹ for pp Physics

Total neutron fluence = 2×10^{14} n/cm²

No permanent effects have been seen for neutron fluence of 2×10^{14} /cm² in the APD's for CMS Barrel

New irradiation tests up to 1×10^{15} n/cm²

Northeastern-RD39



Tasks in 2004

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1. Finish construction / support engineering design June
2. Construct 2nd calorimeter prototype & beam-test October
3. Complete GEANT4-OSCAR code for CASTOR in CMS
& run simulations and PRS with all forward detectors end 2004

The CASTOR Technical Proposal draft v1 is (almost) ready.

It can be found at:

http://cms.phys.uoa.gr/CASTOR/CASTOR_TDR1.pdf

Target: submit the final TP to CMS management by June 1st, 2004