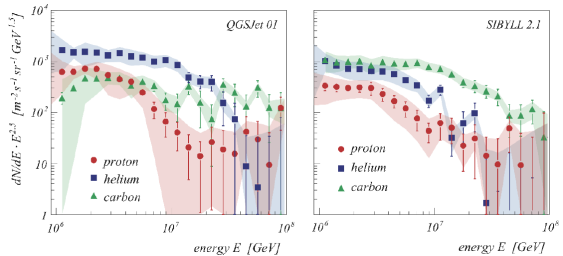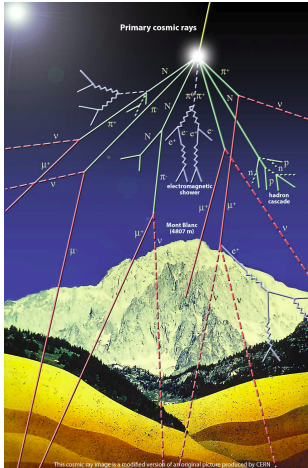# A Limited-Streamer-Tube muon telescope to characterize the CASTOR calorimeter

Sebastian Baur
KIT - IEKP

ASTROTEILCHENSCHULE OBERTRUBACH 2014

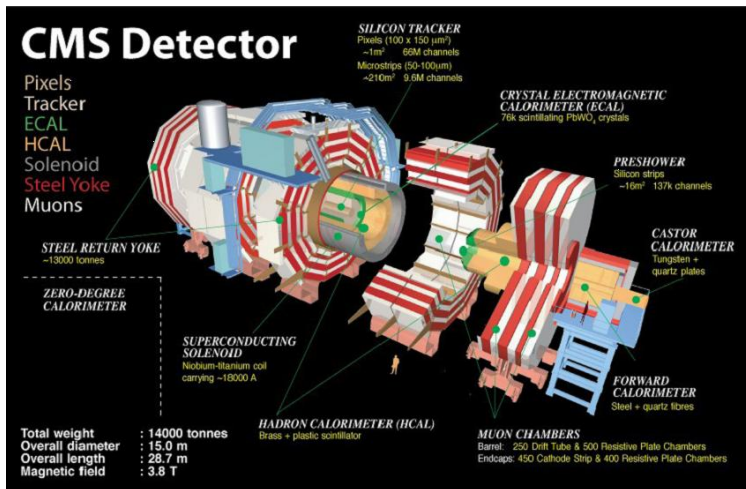# Forward physics at LHC and astroparticle physics

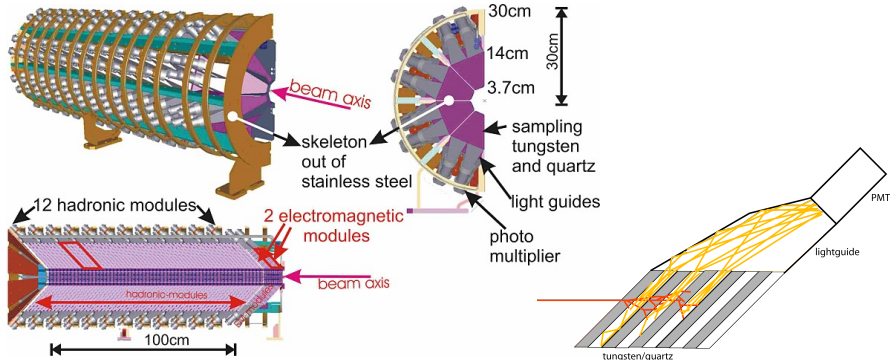arXiv:astro-ph/0505413v1
Astroparticle Physics 2005(24)

- good hadronic interaction models are important for interpretation of UHE astroparticle phenomena
- models can be probed and improved by forward particle production at LHC
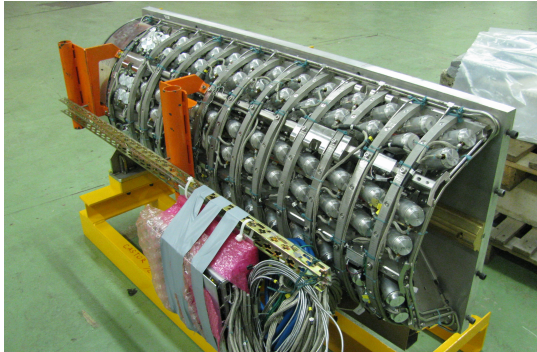
Compact Muon Solenoid (CMS)

The CASTOR Calorimeter

- CASTOR: unique, very forward calorimeter in CMS
  ($-6.6 < \eta < -5.2$ / $0.16° < \Theta < 0.63°$)

- 14 modules along z (2 em, 12 had); 16 sectors in ϕ

- Absorber: tungsten; active material: quartz

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New calibration idea

- problems during testbeam calibration
- difficult in situ calibration and characterization
- new calibration characterization and test with the *Cosmic Setup*

Myonen Teleskop
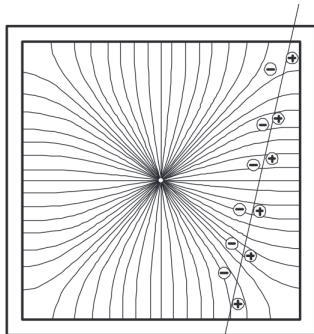
CASTOR Kalorimeter
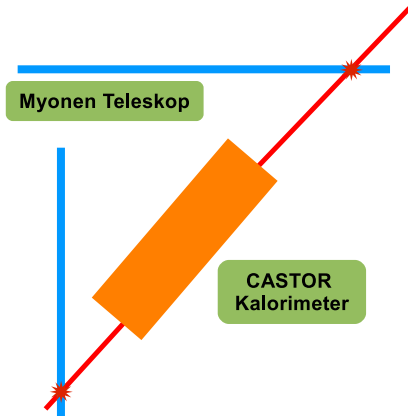
- search for dead or faulty channels
- intercalibration
- testing of new equipment (Lightguides, PMTs,...)
- geometric characterization

LST Muon Telescope

Muon Tracking-Detector from KASCADE-Experiment:

KASCADE

LHC Point5

KIT

CERN/CMS
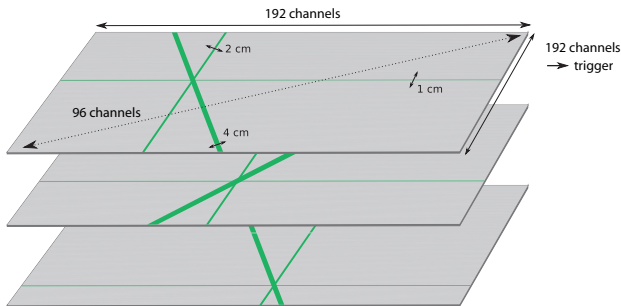
P. Doll et al.
NIM A, Vol. 488-3

LST principle
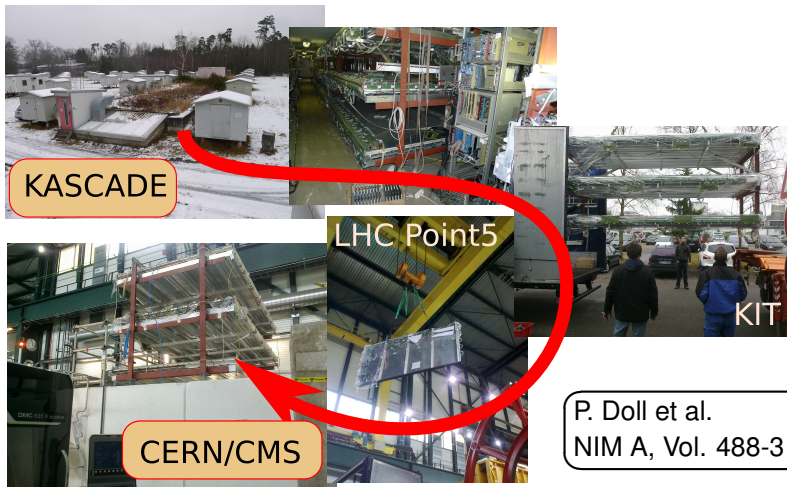
Limited Streamer Tubes: localized gas discharge

- ionization amplified by high electric field (4-5 kV)
- direct charge signal at the center wire
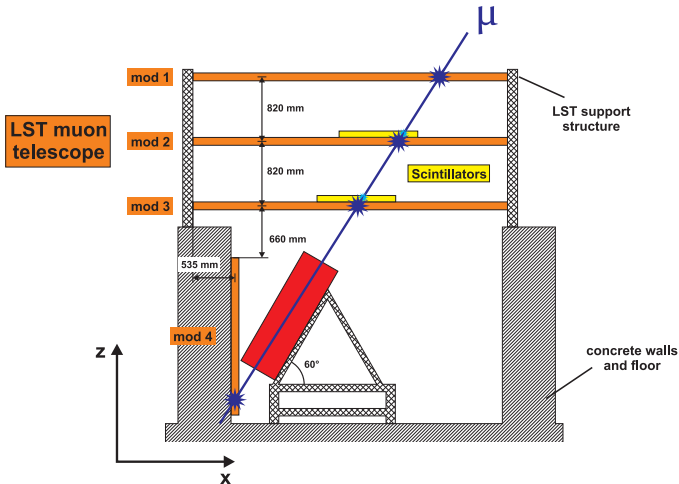- inductive signal outside the cell by *pickup strips*

192 tubes
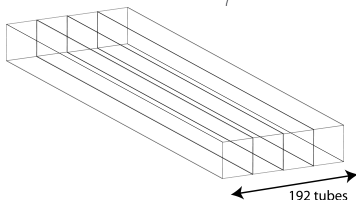
LST Muon Telescope
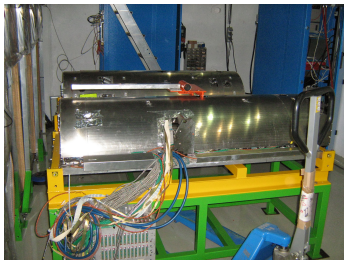
- used gas mixture: CO_2 and Ar
- 4 layers with an active sensing area of $384 \text{ cm} \times 192 \text{ cm} = 7.37 \text{ m}^2$
- ideal: 3 active channels per muon and layer

Combined Setup

Combined Setup

Track Reconstruction

- unambiguous signal in at least three layers
- χ^2-like minimization of hit-track distance

$$\vec{r} = \begin{pmatrix} P_0 \\ P_1 \\ 0 \end{pmatrix} + t \times \begin{pmatrix} P_2 \\ P_3 \\ 1 \end{pmatrix}$$
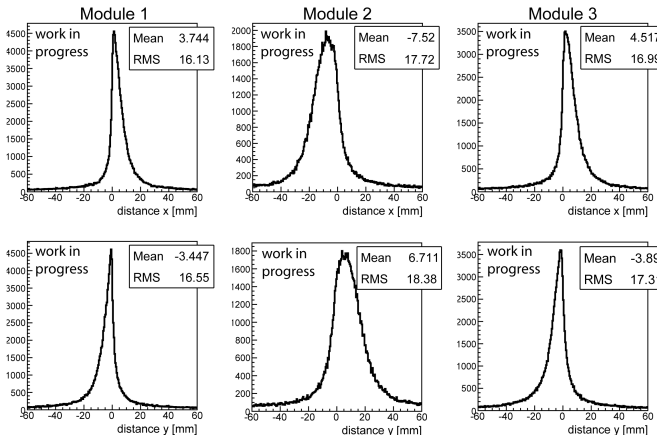
$$Q^2 = \sum_{i=0}^{3} \left(\frac{\Delta x_i}{\epsilon_i} \right)^2$$

- possible improvements
- $\rightarrow$ exclude layers from reco $\Rightarrow$ higher fit quality
- $\rightarrow$ allow multiple hits per layer $\Rightarrow$ more reconstructed events

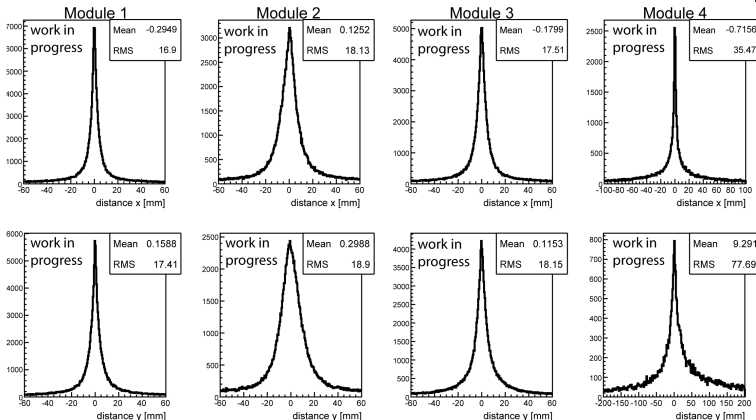# Track Reconstruction: example

Event 7937
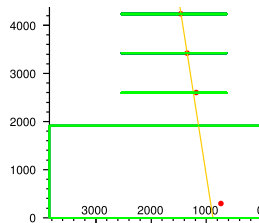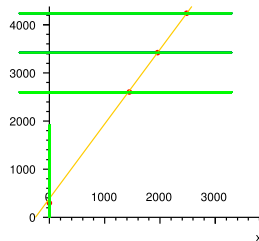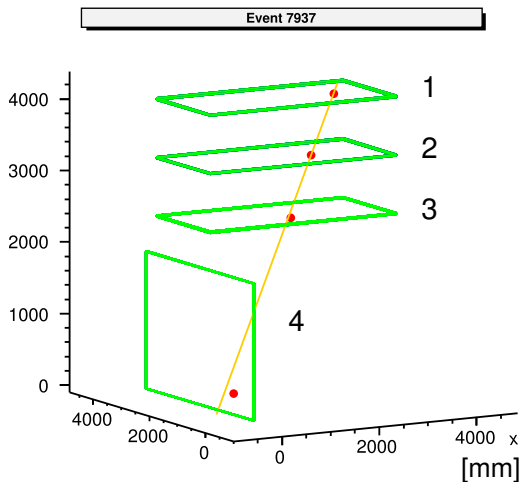
Alignment

Event selection: hit in layers 1-3

⇒ correction of the relative positions

Alignment II

- Resolution in layers 1-3 is very good
- Layer 4: not fully understood (geometric effects, multiple scattering, internal alignment)

Efficiency Studies (Examples)

Trigger and track reconstruction with modules 2 and 3
$\rightarrow$ check if module 1 records a hit within alignment RMS
Parameters scan: trigger threshold, high voltage, gas mixture

Efficiency of Module 1
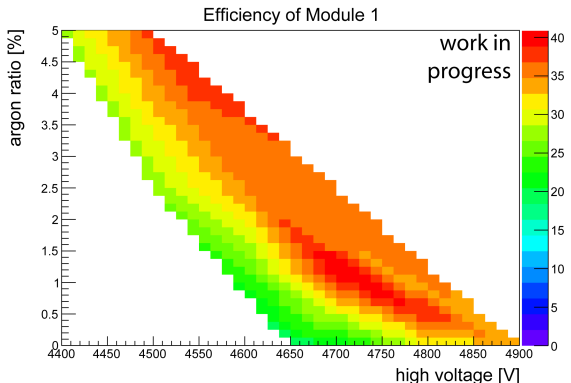
best parameter choice: trigger 100mV, HV 4700, 1.2% Ar

Summary

- System installed, commissioned and ready for remote operation
- LST telescope suffered from aging and transport
- Detector alignment improved
- Detector settings optimized
- Quality of the first data is promising
- Combined data has been taken, investigation in progress
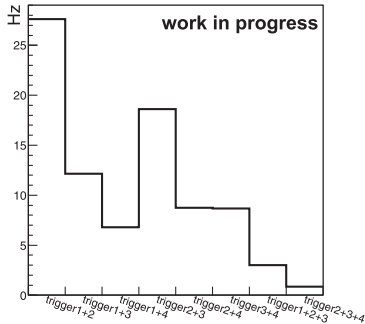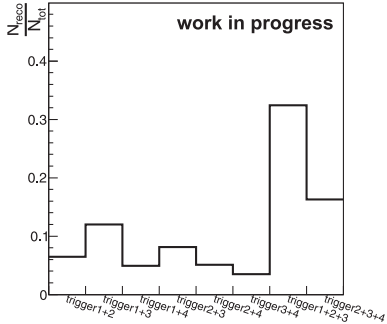
Trigger Threshold
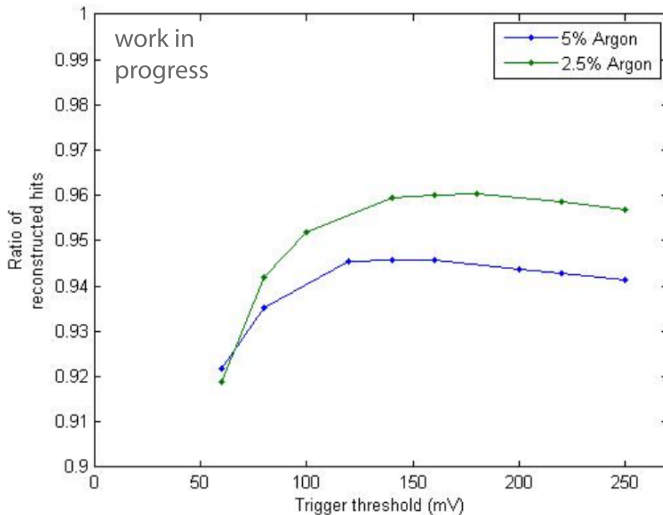
Trigger Choice

Event Rate (10000 events)

Anteil rekonstr. Spuren

- Priority on high track quality
- High trigger rate less important
- ⇒ 3-layer coincidence

Efficiency Module 1

Efficiency of Module 1, with trigger