

# Experimental Particle Physics at RWTH Aachen University

Lutz Feld

TWEPP-10

Aachen

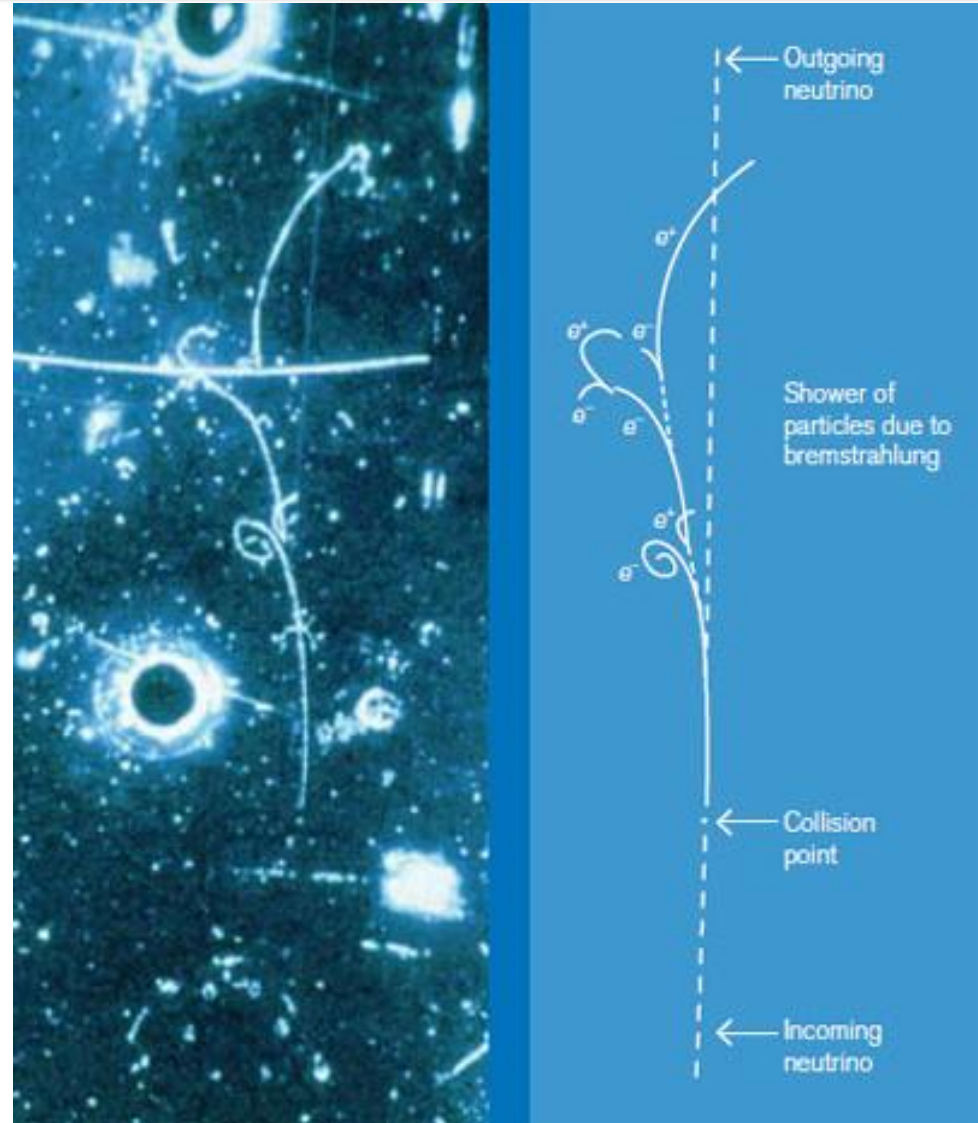
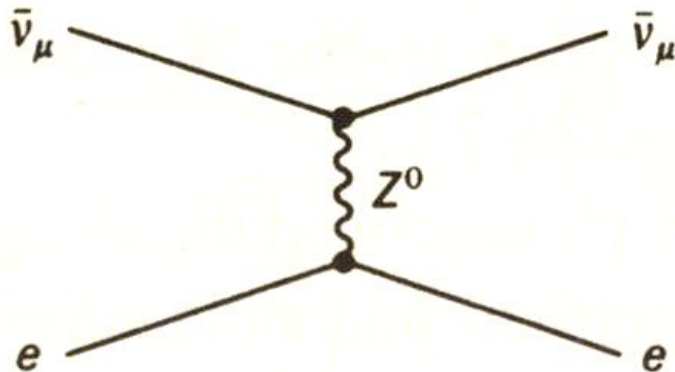
20. 9. 2010



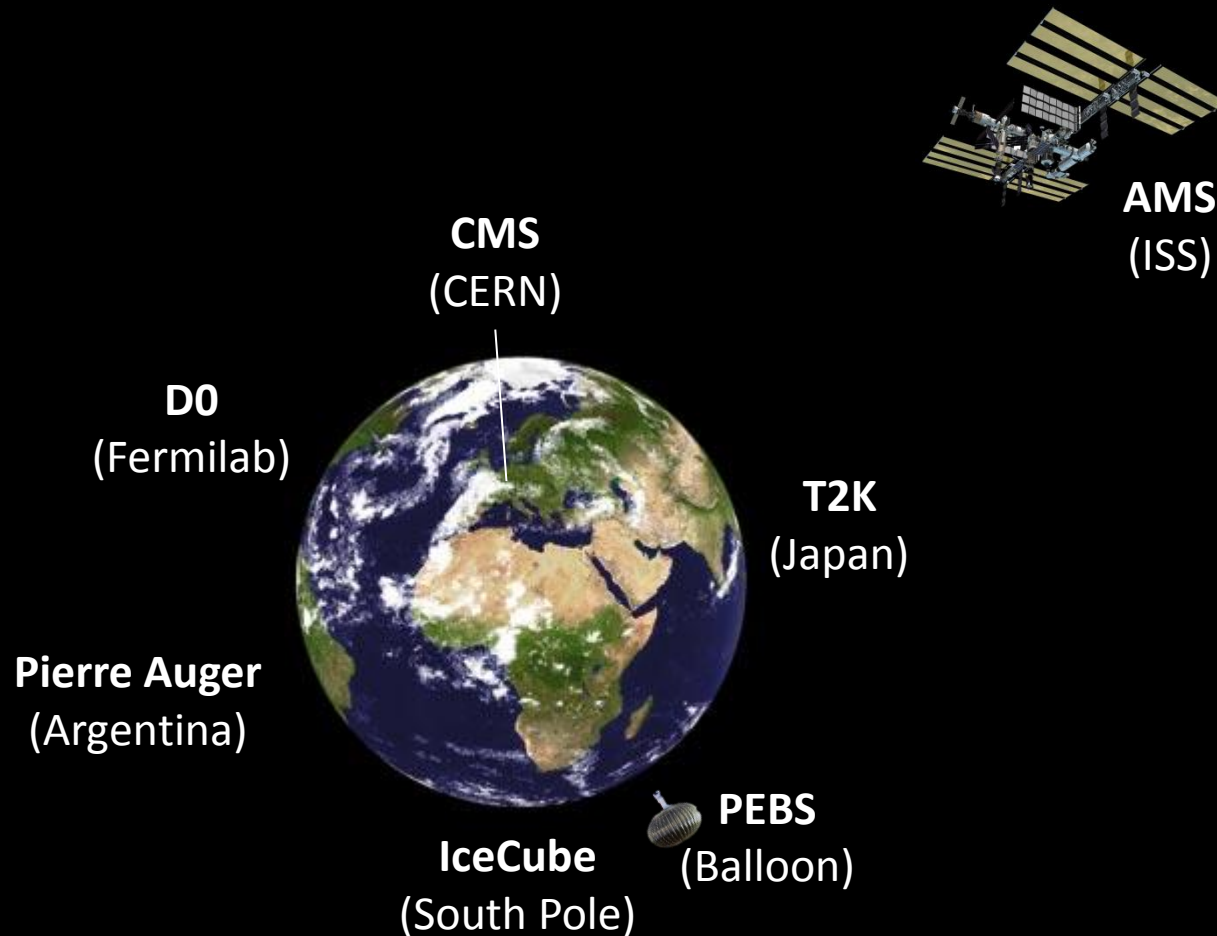


# History

1972 First Weak Neutral Current Event found in a Gargamelle bubble chamber picture by the group of Helmut Faissner at RWTH



# RWTH Particle (Astro) Physics Today



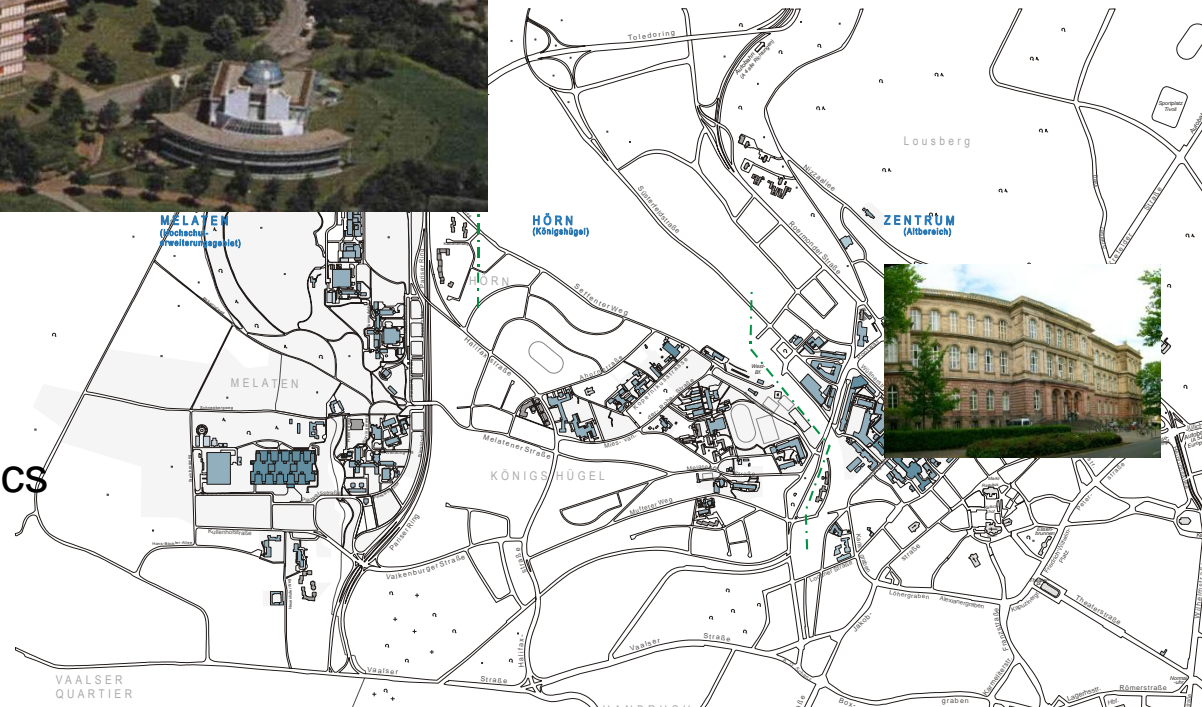
# Department of Physics



- 31 Professors
- 118 Academic Staff
- 70 Non-academic Staff

## Main Research Areas:

- Particle Physics
- Astroparticle Physics
- Condensed Matter Physics
- Nanophysics
- Biophysics



# Experimental Particle Physics Groups



St. Schael



L. Feld

## 1. Physikalisches Institut B

- CMS
- AMS
- Balloon Experiments



Th. Hebbeker



M. Erdmann

## 3. Physikalisches Institut A

- CMS
- D0
- Pierre Auger Observatory



A. Stahl



Ch. Wiebusch

## 3. Physikalisches Institut B

- CMS
- IceCube
- Double-Chooz, T2K
- Medical Physics



+ Theoretical Particle Physics and Cosmology

# Mechanical Workshop

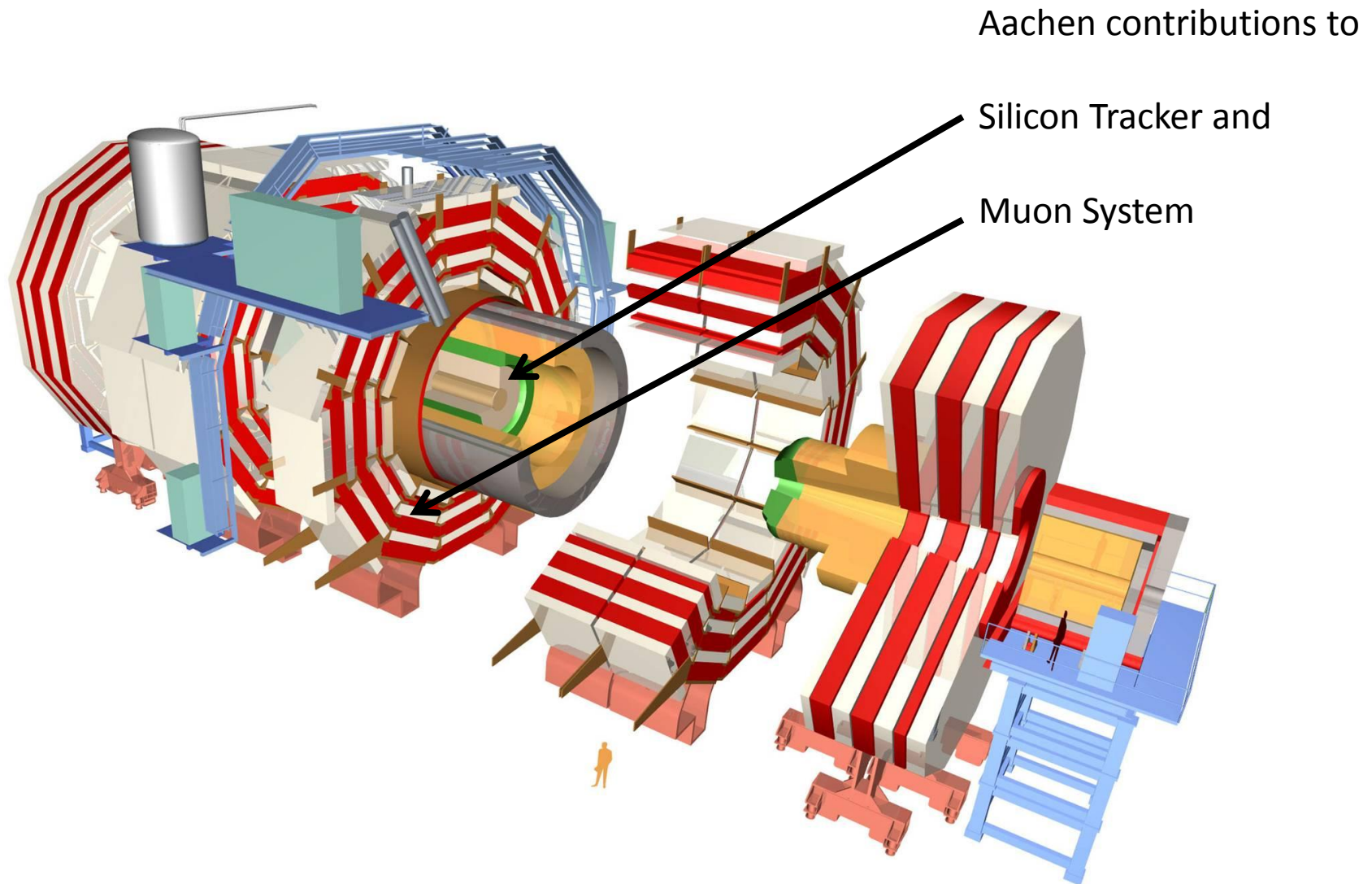


# Assembly Hall and 200m<sup>2</sup> Clean Room

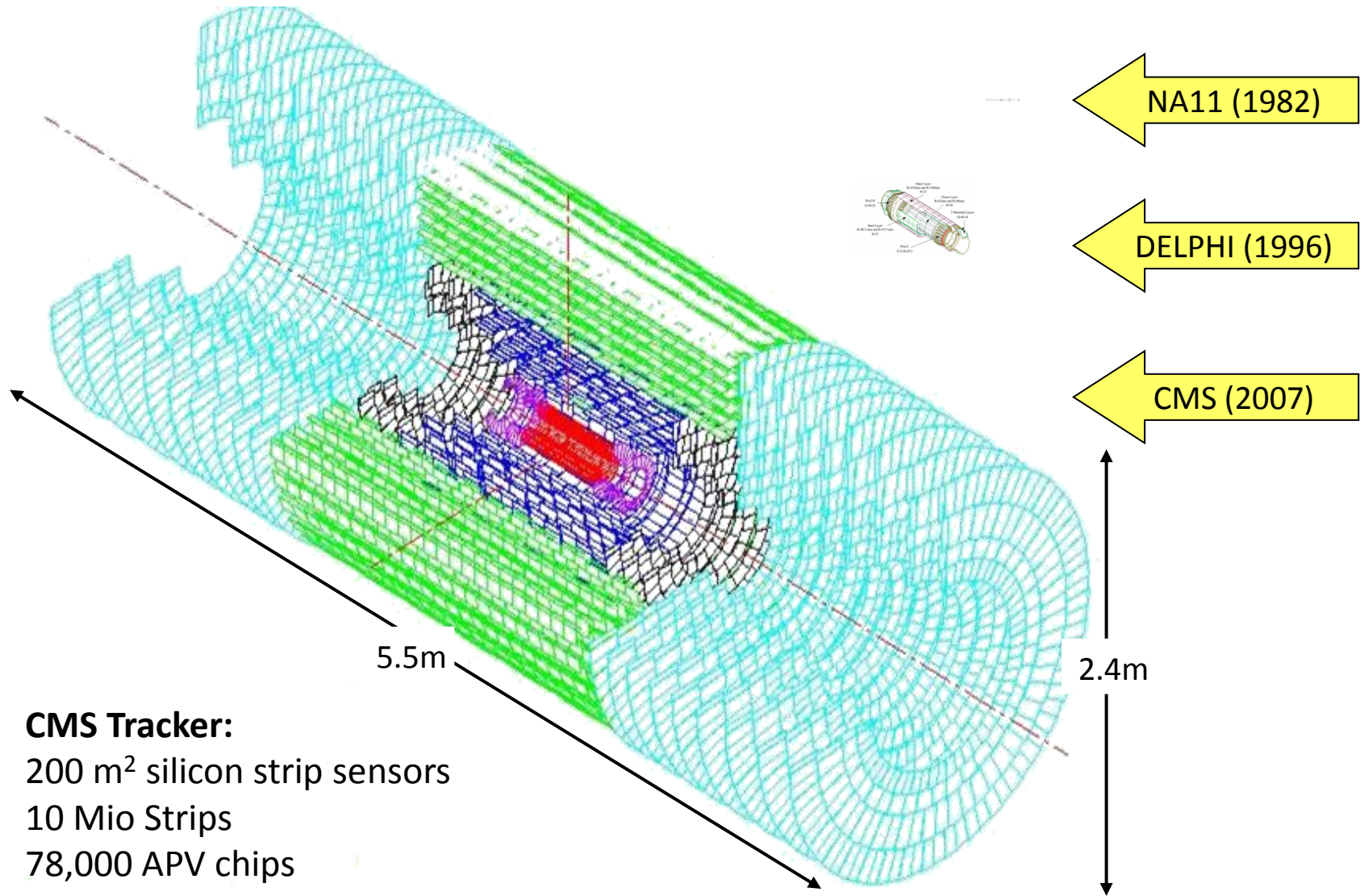




# CMS Experiment at LHC



# Evolution of Silicon Detectors

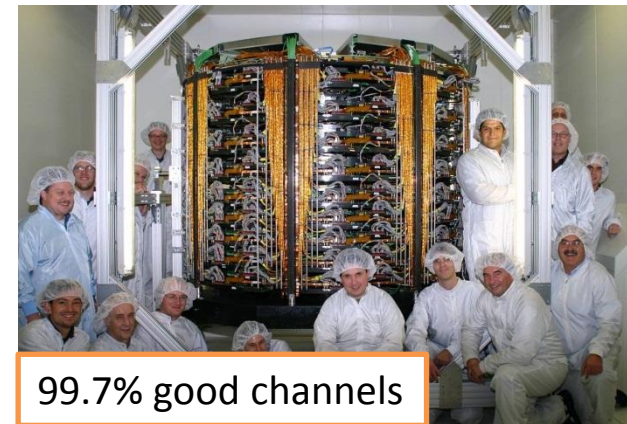
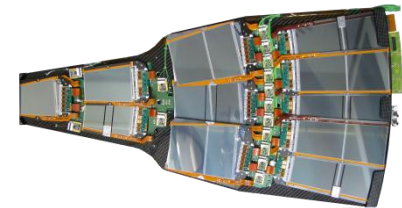


**CMS Tracker:**  
 200 m<sup>2</sup> silicon strip sensors  
 10 Mio Strips  
 78,000 APV chips

# Aachen contributions to CMS Silicon Tracker

(Feld, Schael, Stahl et al.)

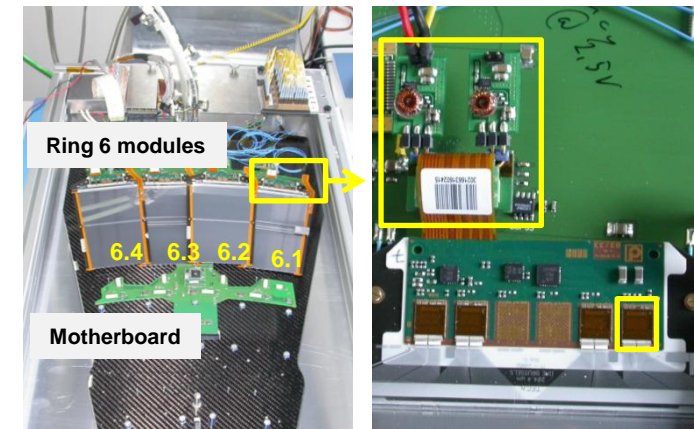
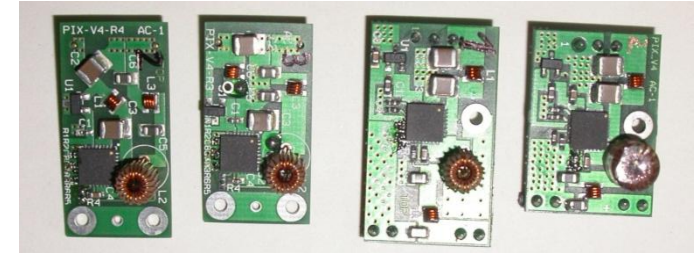
- design and construction of tracker end-cap structures
- petal concept, construction of 300 petals
- silicon module assembly and wire bonding, ARC test system
- integration of modules onto petals, QA
- integration and test of one full end-cap
- design and construction of laser alignment system
- data quality analysis
- R&D for pixel and strip tracker upgrade



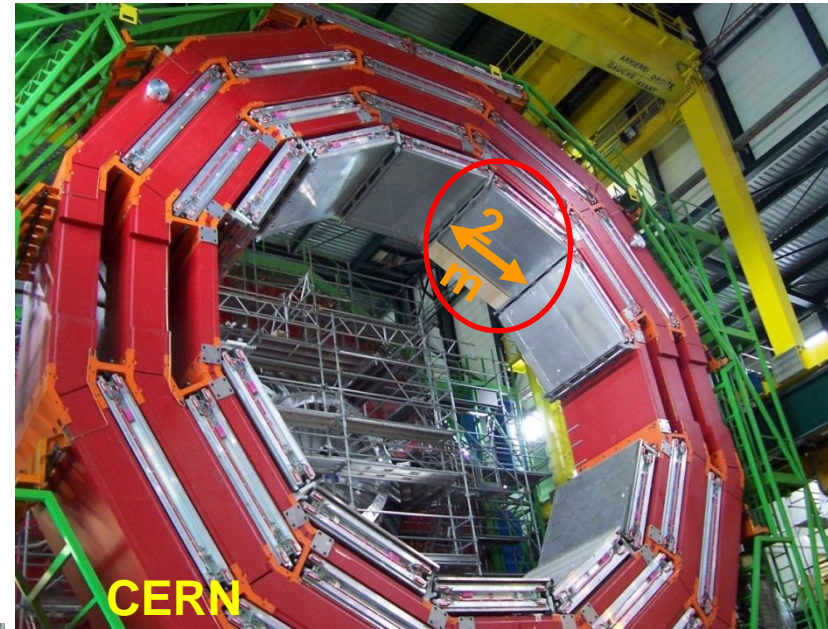
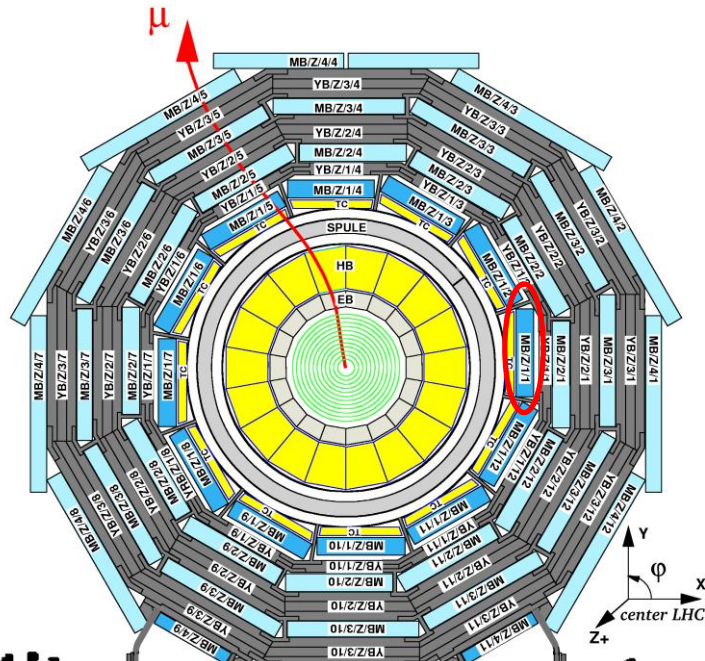
# CMS Tracker Upgrades

(Feld et al.)

- **new powering concept for pixel and strips**
  - DC-DC conversion close to modules
  - more power through thinner cables
  - collaboration with CERN (ASIC)
  - board and coil design, integration into CMS
  - system tests with CMS detectors
- **CO<sub>2</sub> Cooling**
  - heat removal by evaporation at high pressure
  - more cooling through thinner pipes
  - 500W recirculating CO<sub>2</sub> plant operational
- **Silicon Sensor Development**
  - optimal choice of material and geometry for short strips and long pixels



# CMS Muon System

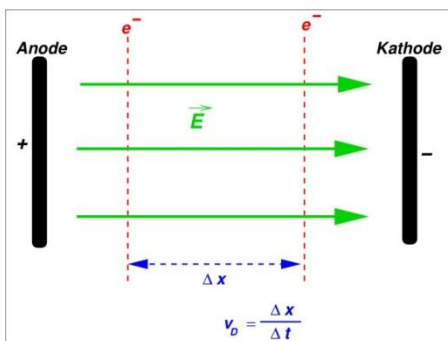


Aachen contributions (Hebbeker et al.)

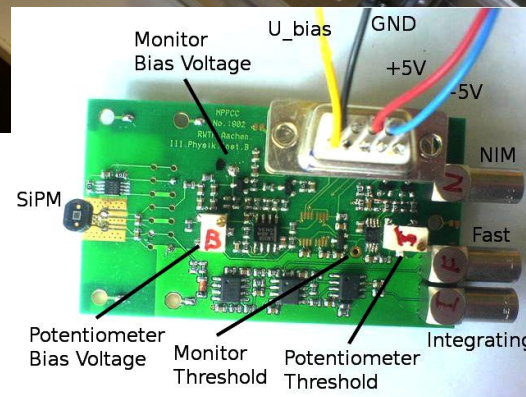
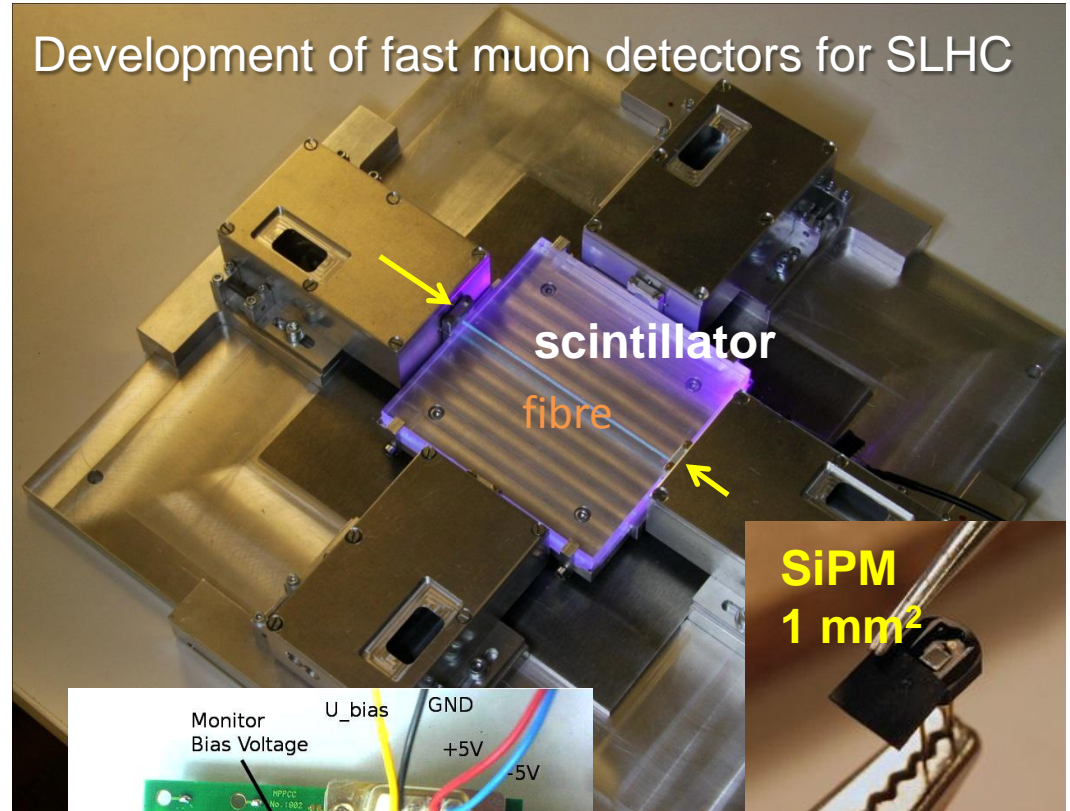
- construction and test of 75 inner muon chambers
- design and construction of drift velocity monitoring chamber

# CMS Muon System

Drift Velocity Chamber

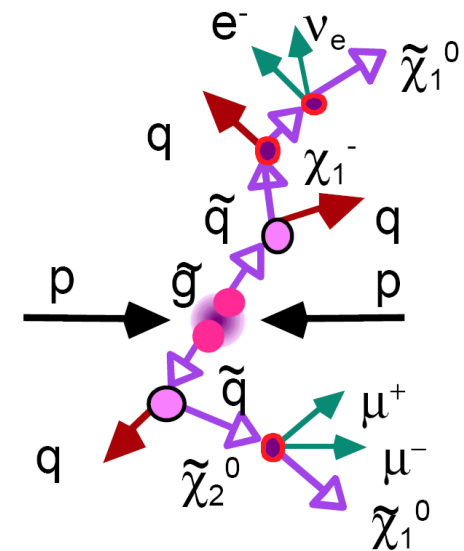
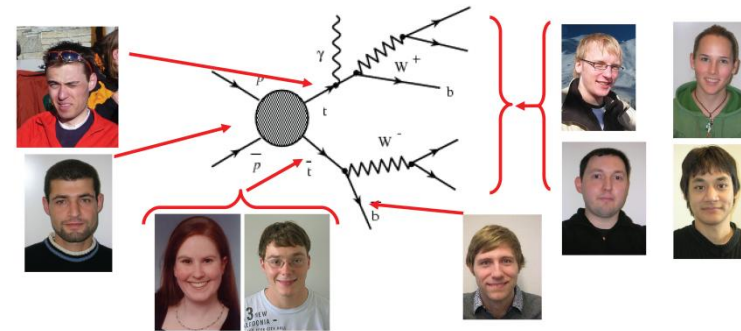


Development of fast muon detectors for SLHC



# CMS Physics @ Aachen

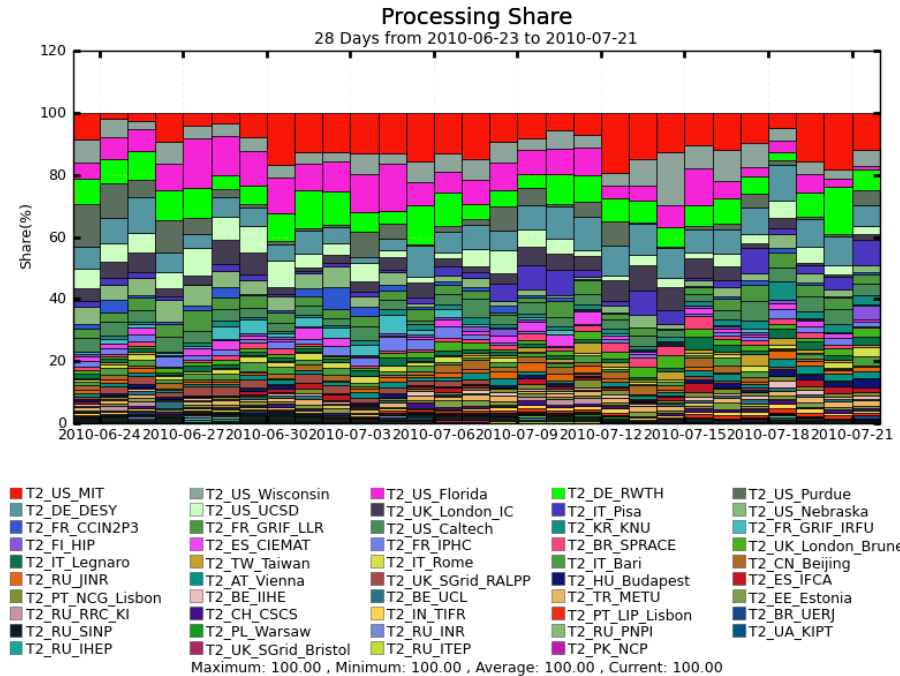
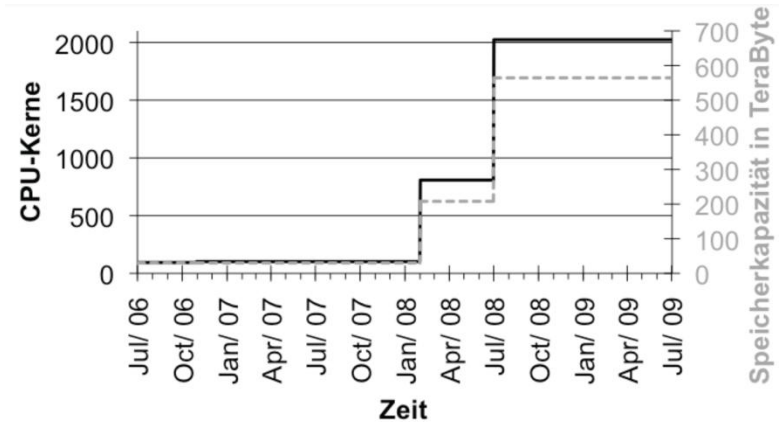
- Z cross section (luminosity)
- Top
  - top mass and cross section
  - coupling between top and photon (top charge)
  - spin correlations
  - resonances in top mass spectrum
  - decay length of B mesons
- Tau reconstruction
- SUSY
  - discovery in leptonic final states
  - reconstruction of cascade decays (mass spectrum)
  - parameter determination
  - SUSY-Higgs in di-muon final states
- (Other) Physics beyond the Standard Model
  - Large Extra Dimensions
  - Signature Driven Searches
  - ...
- Graphical Data Analysis



# CMS Grid Computing

## RWTH CMS Tier-2 (Stahl et al.)

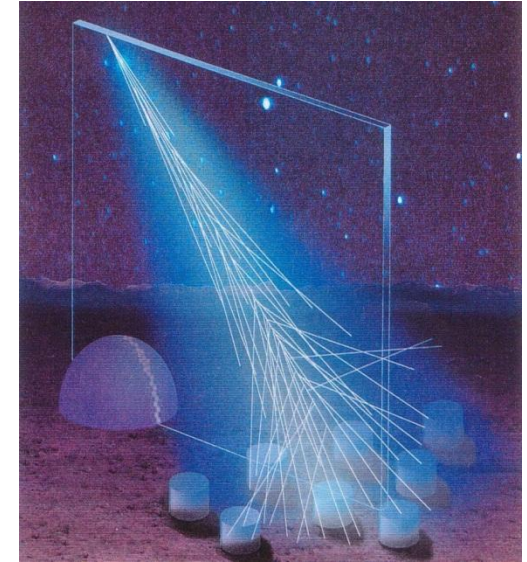
- 2000 cores
- 550 TB disk





# Pierre Auger Observatory

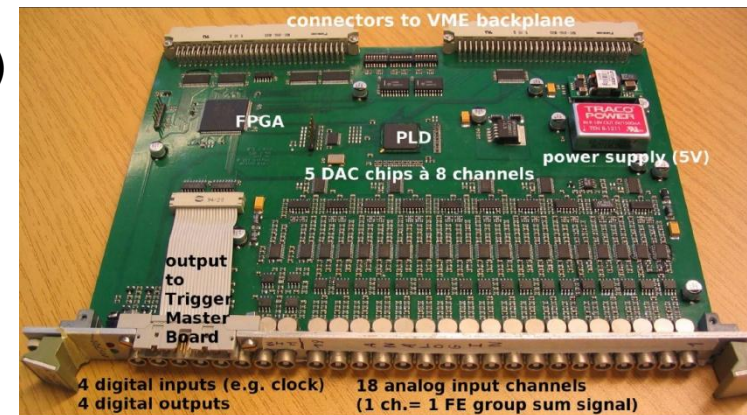
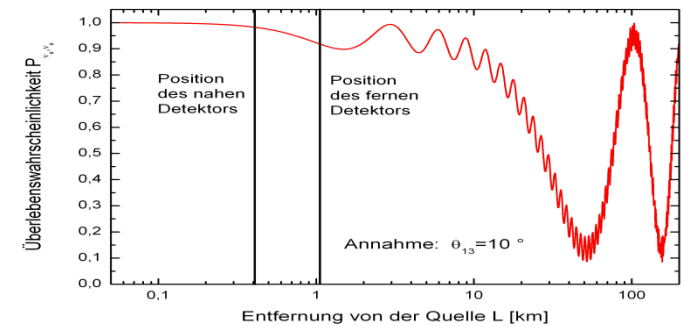
- 1600 water Cherenkov detectors distributed over 3,000 km<sup>2</sup>
- 24 fluorescence telescopes
- measure cosmic rays from 10<sup>9</sup> GeV beyond 10<sup>11</sup> GeV
- Aachen contribution (Erdmann, Hebekker et al.)
  - data analysis
  - new development with **radio detection**
    - deflection of relativistic e<sup>-</sup>/e<sup>+</sup> in geomagnetic field
    - frequency range 30-80 MHz



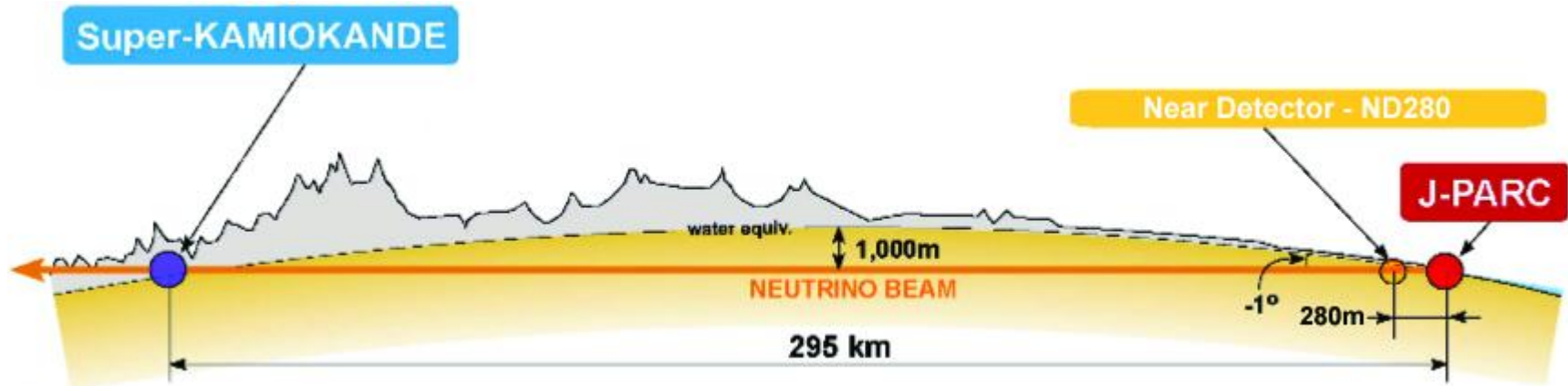
# Double Chooz



- measurement of disappearance of reactor anti-electron neutrinos
- determination of neutrino mixing angle  $\theta_{13}$
- Aachen contributions (Stahl, Wiebusch et al.)
  - trigger system
  - veto detector
  - data analysis



# T2K



- first measurement of electron neutrino appearance in a muon neutrino beam
- near detector ND280 measures initial beam



Aachen contributions (Stahl et al.)

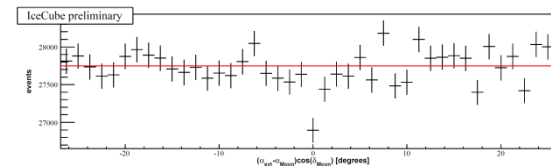
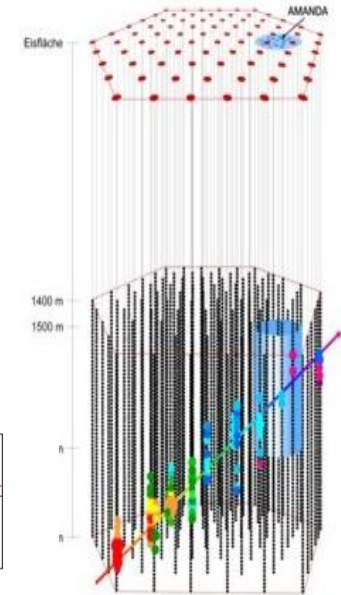
← monitor chambers for TPC

magnet moving system →

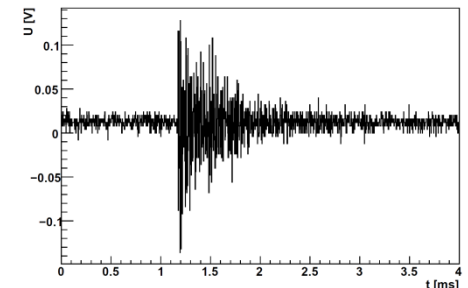


# IceCube

- detection of neutrinos in ice via cherenkov radiation of charged leptons captured by photomultipliers
- sensitive to high energy neutrinos 100 GeV to  $10^{12}$  GeV
- search for
  - extragalactic point sources
  - dark matter annihilation in the sun
  - neutrino oscillations
  - ...
- Aachen contributions (Wiebusch et al.)
  - data analysis
  - acoustic detection of neutrinos beyond  $10^{10}$  GeV (freq. few 10 kHz)



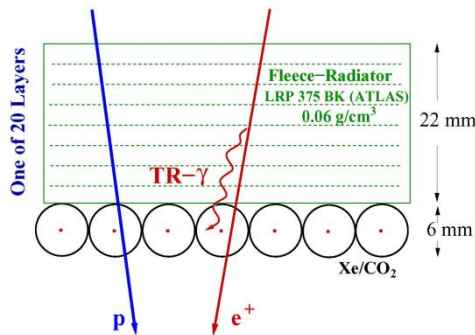
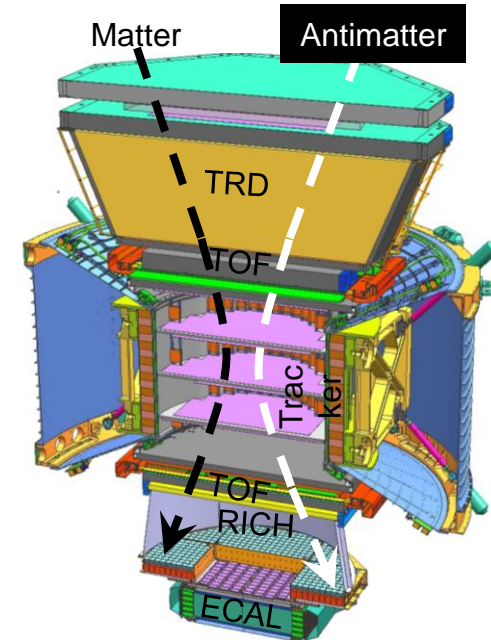
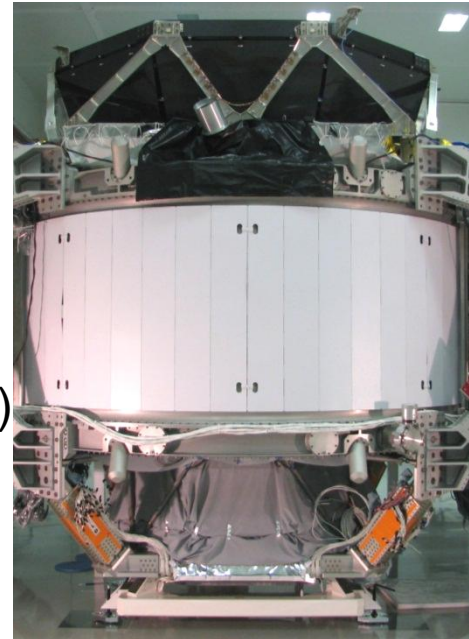
moon shadow



test of acoustic detection

# AMS

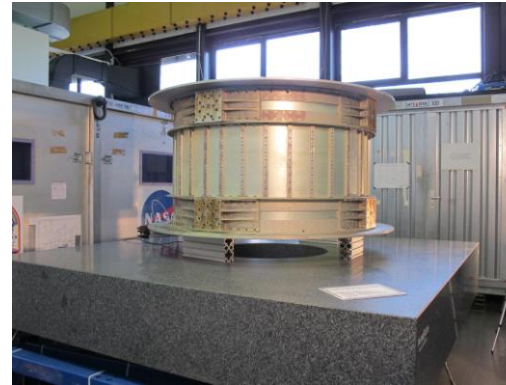
- spectrometer with particle ID on the ISS
- measurement of anti-matter in primary cosmic radiation
- search for dark matter
- Aachen contributions (Schael et al.)
  - transition radiation detector
  - anti-coincidence counter
  - laser alignment system
  - tracker mechanics
  - data analysis



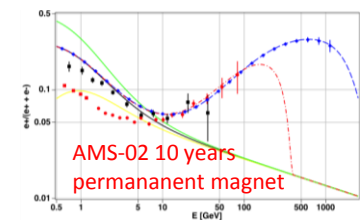
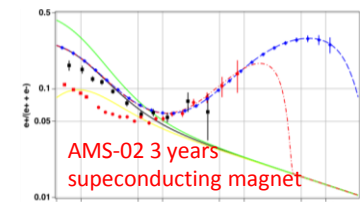
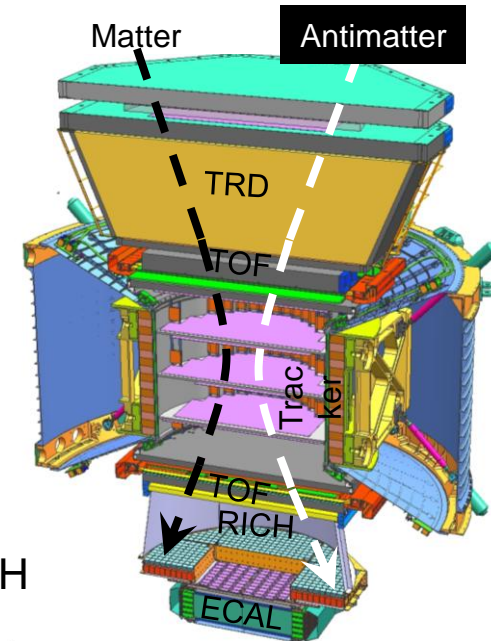
# AMS



launch to ISS in Feb. 2011



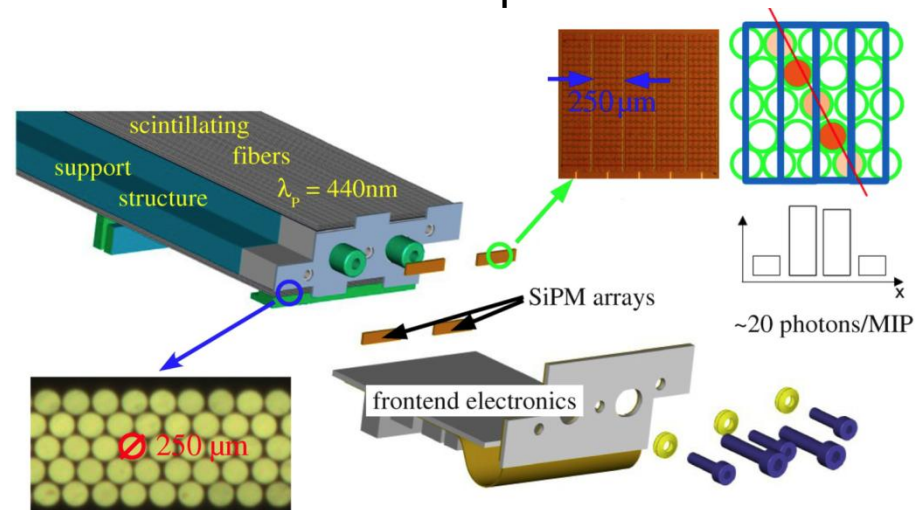
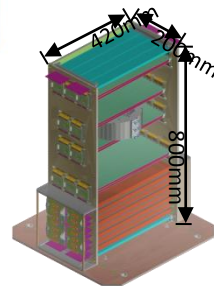
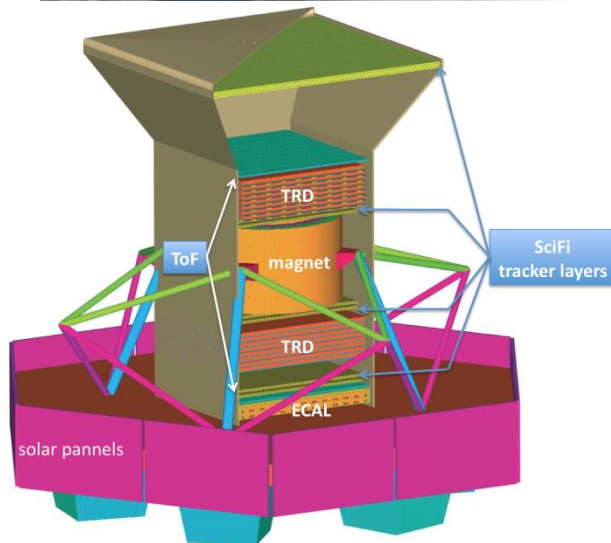
replacement of sc-magnet  
by permanent magnet at RWTH



# PEBS



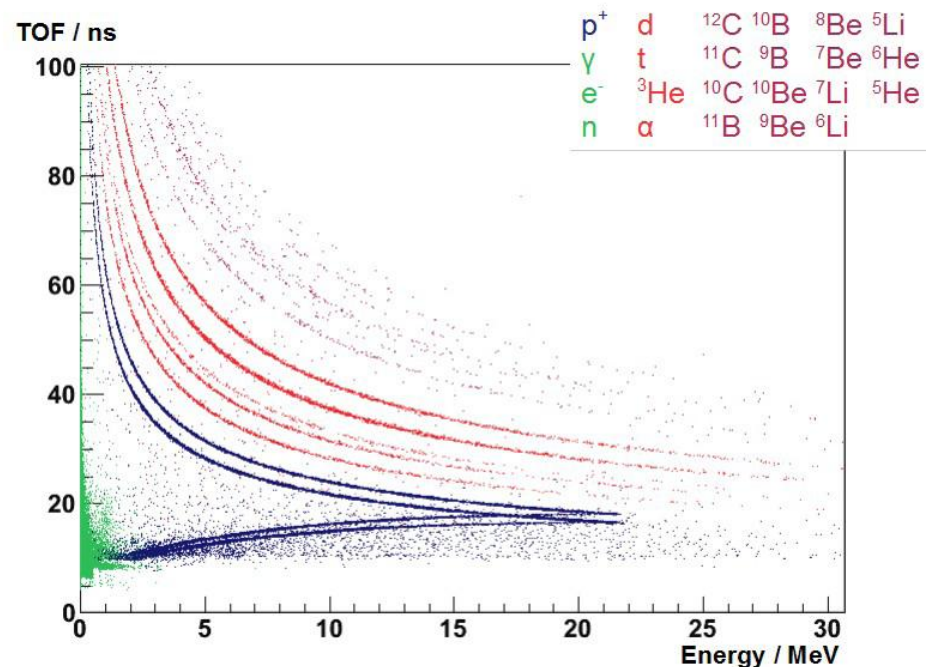
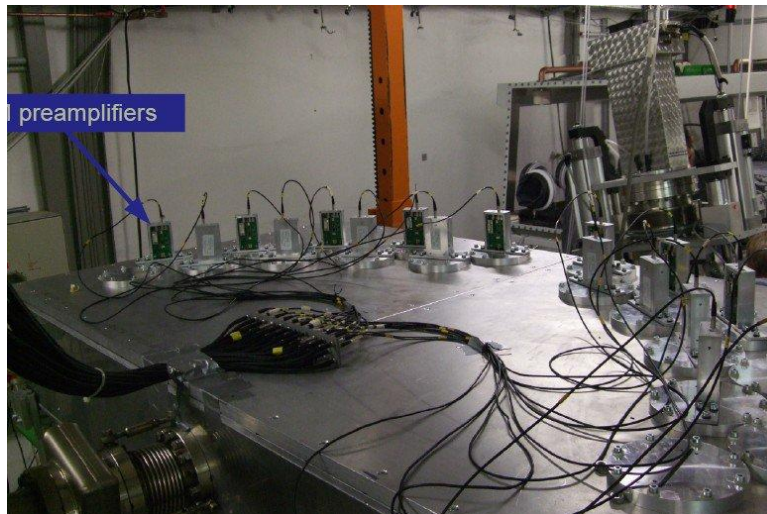
- proposal for a TeV positron measurement with the Positron-Electron-Balloon Spectrometer (PEBS) experiment (Schael et al.)
- measurement of the cosmic ray electron & positron flux
- spectrometer is based on a scintillating fiber tracker with SiPM readout and a permanent magnet



# Particle Therapy

- Irradiation of tumours with protons or carbon ions
- Idea: use GEANT4 for treatment planning (Stahl et al.)
  - Validation of GEANT4 for energies used in particle therapy (250 MeV protons)
  - Lack of cross section data for inelastic reactions
  - Measure these cross sections using TOF/E deposition measurement
  - Use scintillators with SiPM readout

Setup at COSY accelerator at FZ Jülich





# Summary

