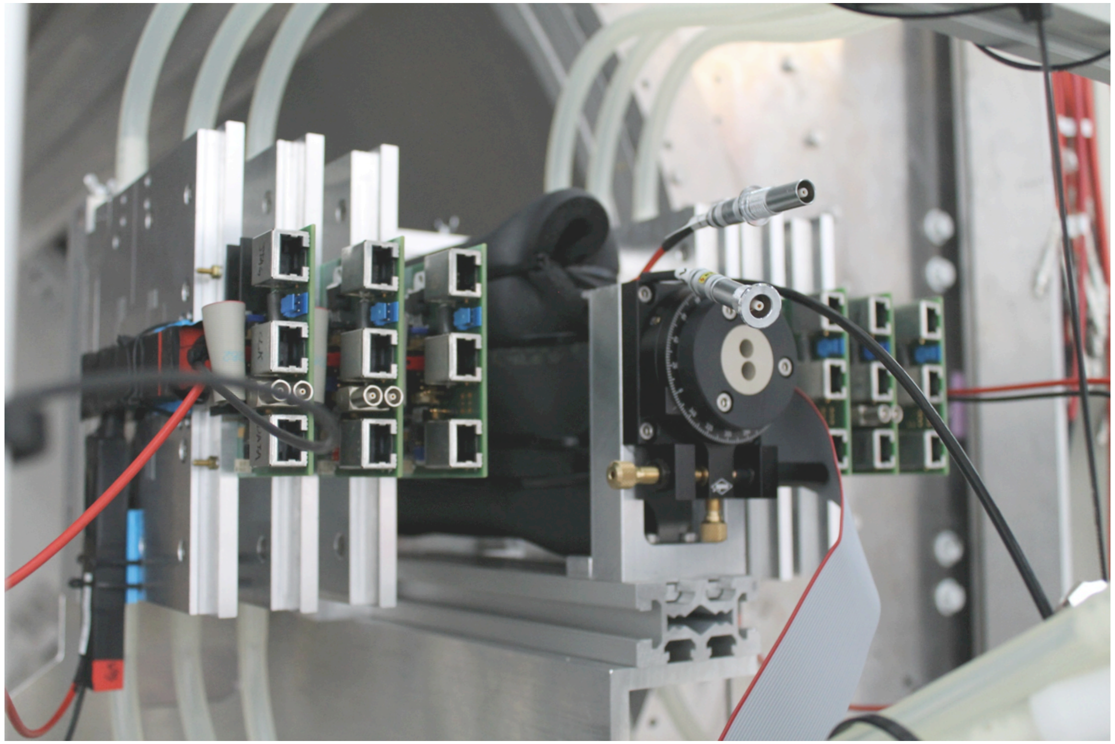
Integration of EUDET Telescope and ALIBAVA Readout in Solenoid Magnet at DESY

for Lorentz Angle Measurement



Eda Yildirim, DESY
Beam Telescopes and Testbeams
July 1, 2014

HELMHOLTZ ASSOCIATION

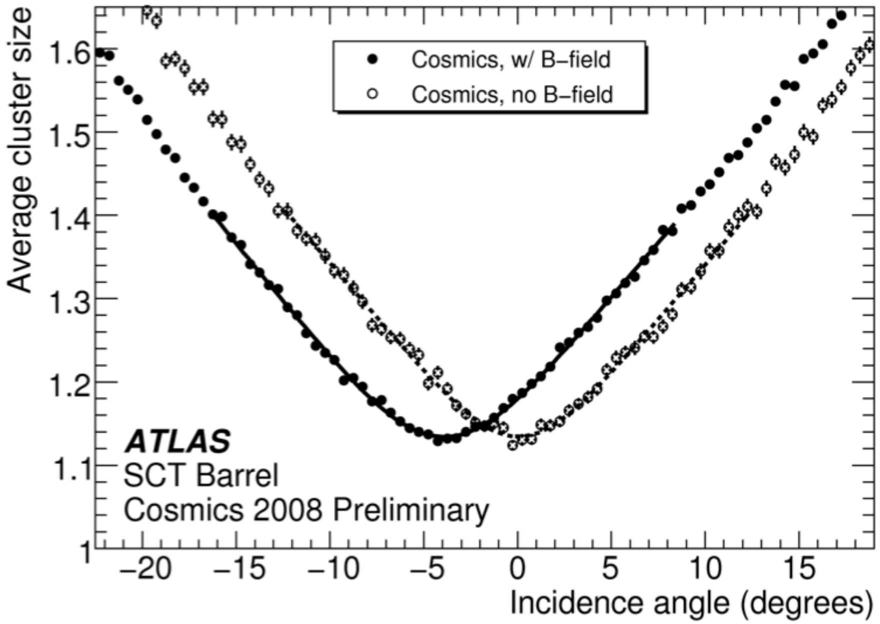
UHH

ATLAS

DESY

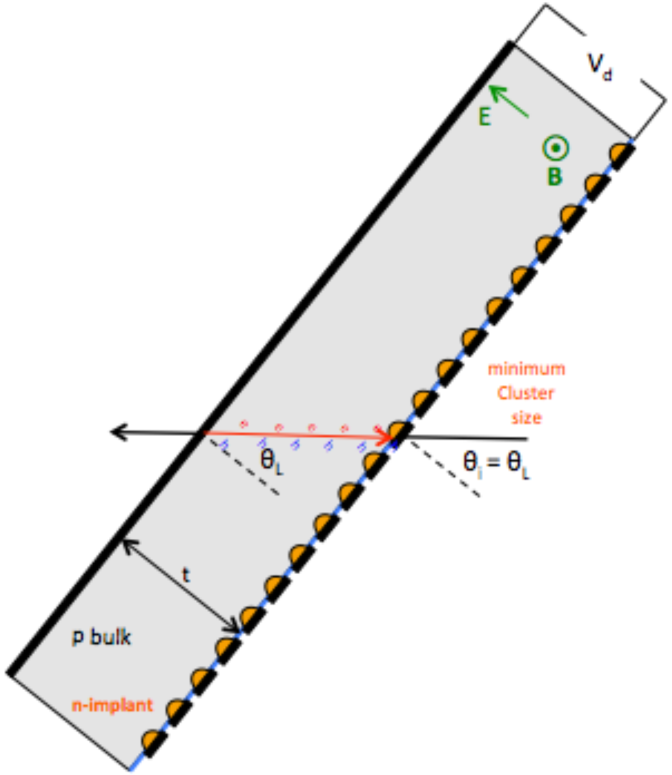
Motivation

- Lorentz angle measurement on irradiated silicon strip sensors
- Cluster size measured as a function of track incidence angle on the sensors



Lorentz angle measurement on ATLAS SemiConductor Tracker (SCT)
ATL-COM-INDET-2009-039

- Lorentz angle = incidence angle at minimum cluster size



Requirements for the Setup

Main Tools

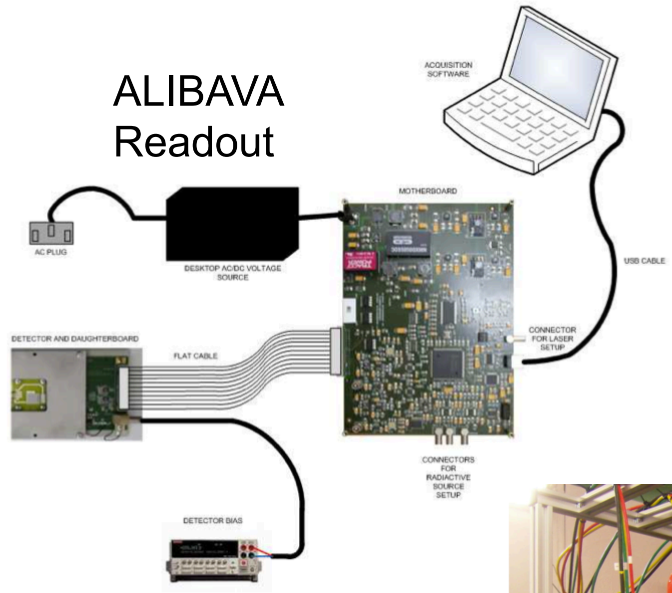
> A readout system for sensors:
  - ALIBAVA analog readout system

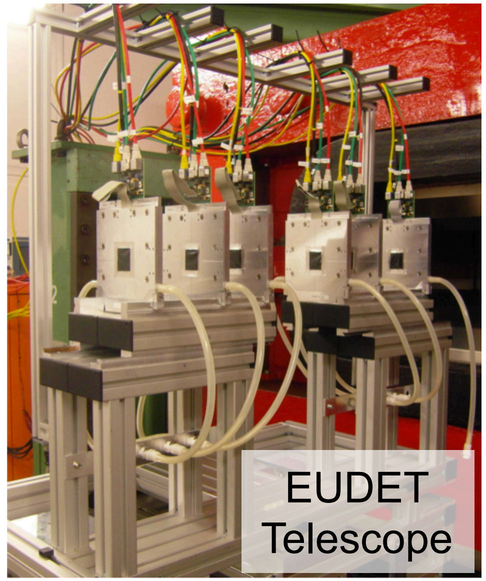
> Measuring incidence angle:
  - Tracking with EUDET Telescope

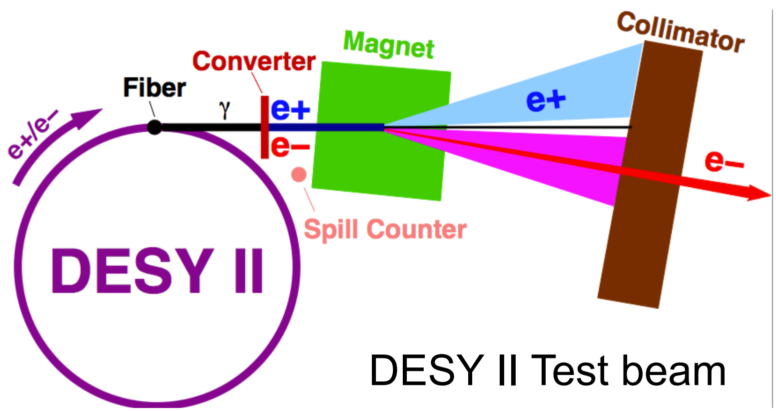
> Magnetic field
  - Solenoid magnet (PCMAG)

> Beam
  - DESY II test beam

ALIBAVA Readout

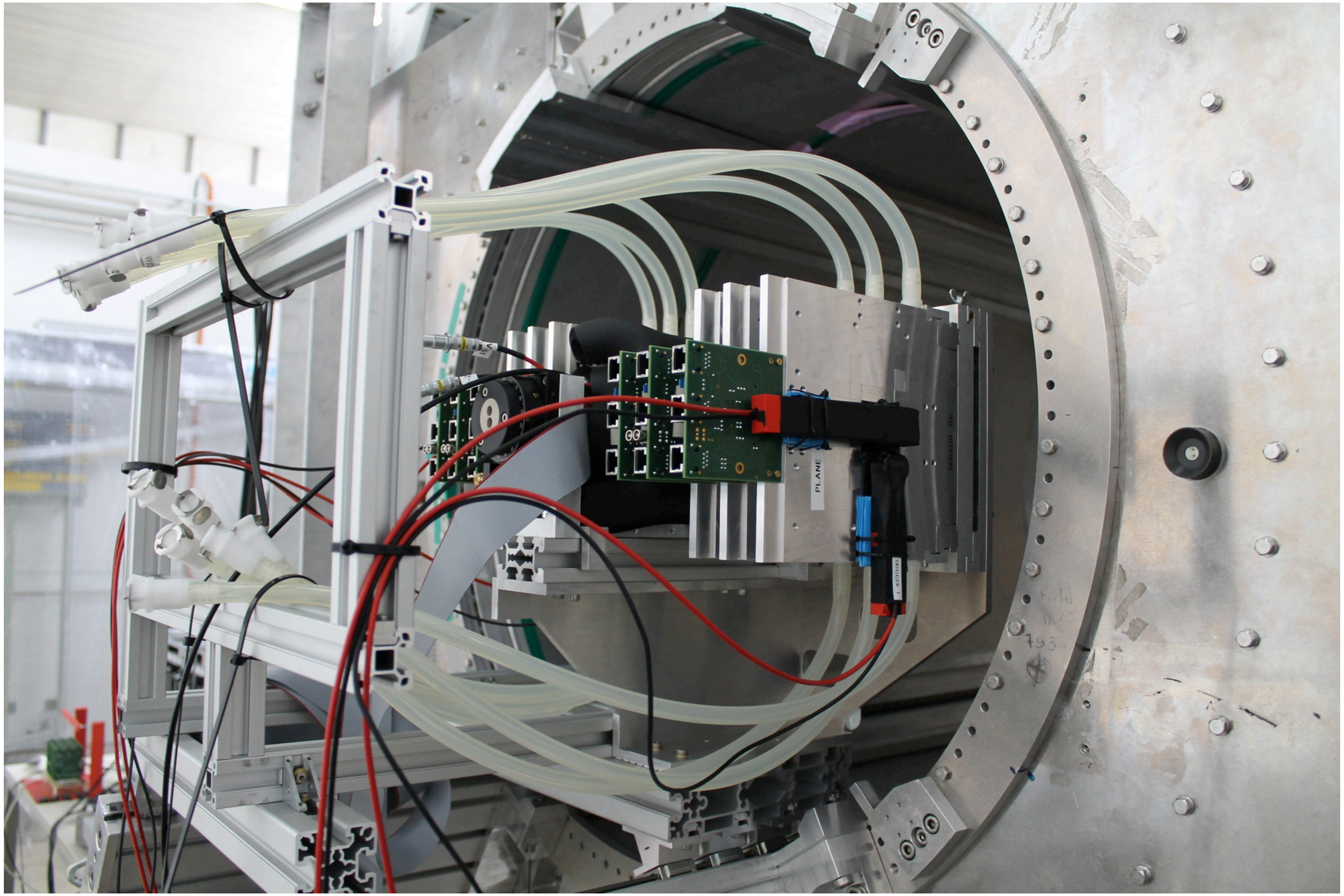






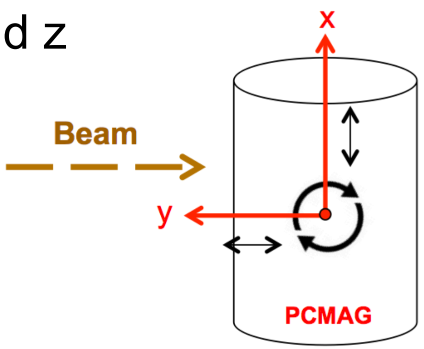
DESY II Test beam

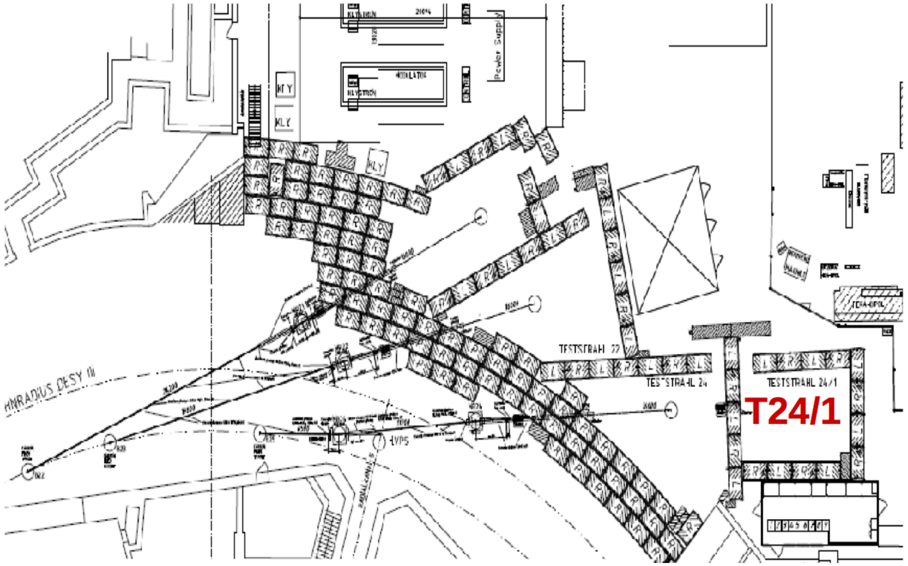
Setup

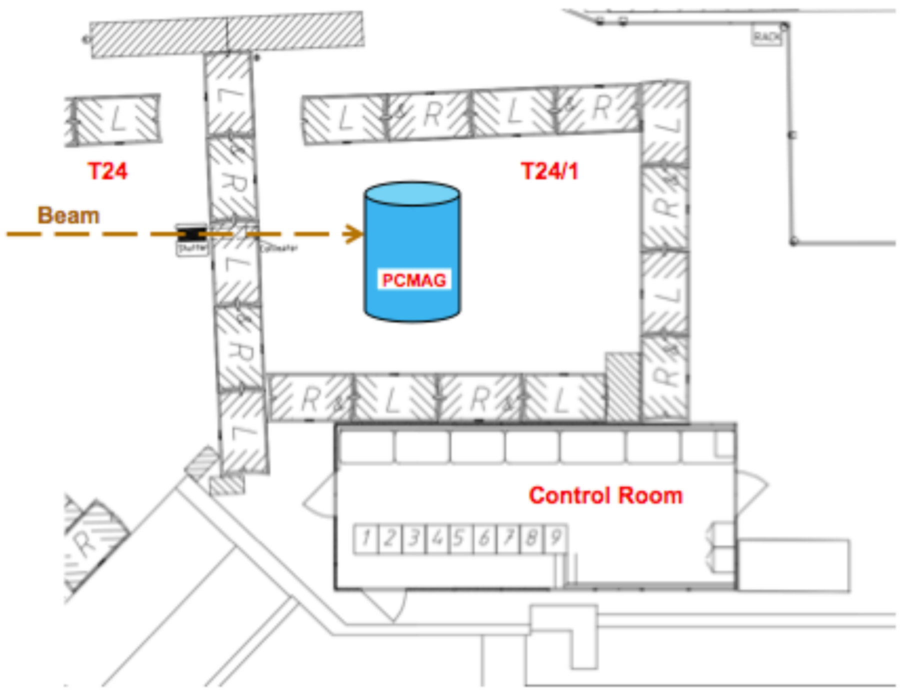


TB24 @ DESY II Test Beam

- There are 2 test beam areas
  - T24 and T24/1
- Both areas can be used at the same time
- T24/1 is accessible independently
- Solenoid magnet (PCMAG) in T24/1
- Magnet is movable and rotatable
  - Movable in x, y, z
  - Rotatable around z

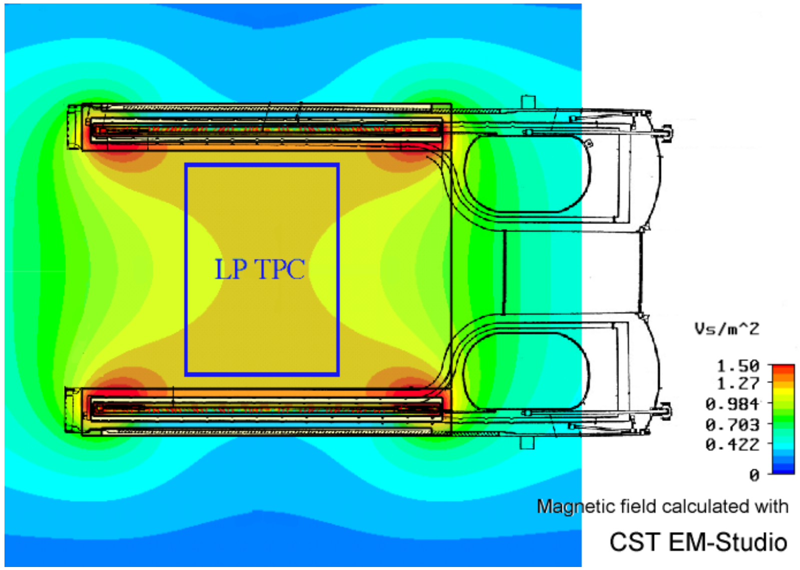






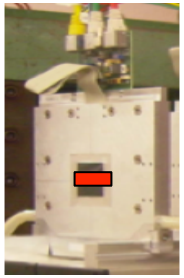
Solenoid Magnet (PCMAG)

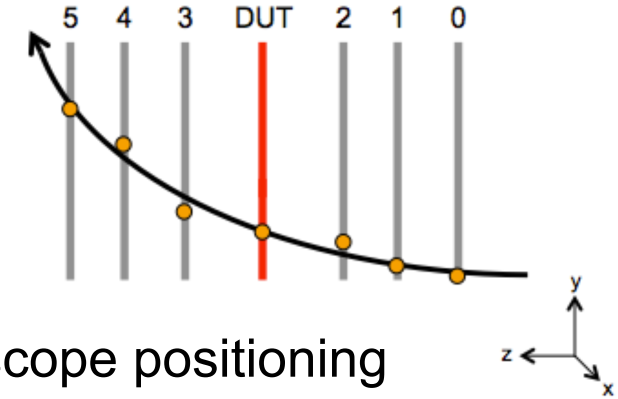
- Magnetic Field up to 1T
- Homogenous magnetic field in the middle
- Beam passes through the magnet
  - 20% X_0
  - Beam energy loss needs to be studied
- Diameter=85cm, Length=1.3m
- Cooled down to 4K using He gas
- Vibrates because of pumps needed for cooling
  - No difference seen in telescope alignment



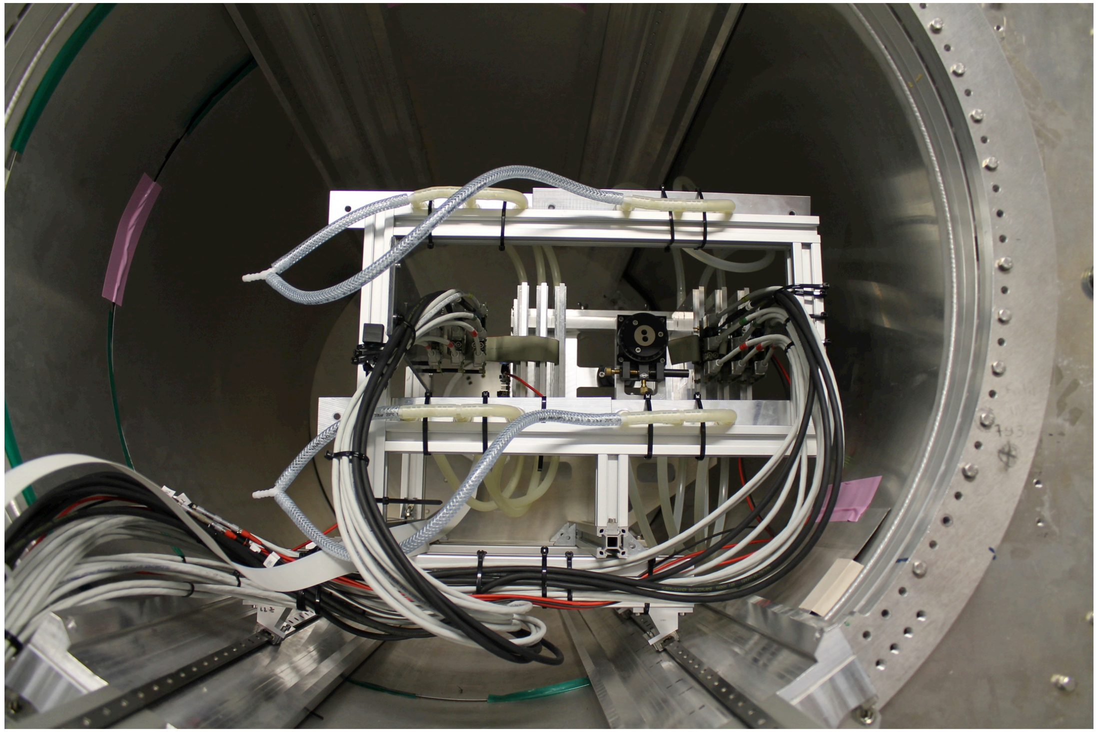
EUDET Telescope in the Magnet

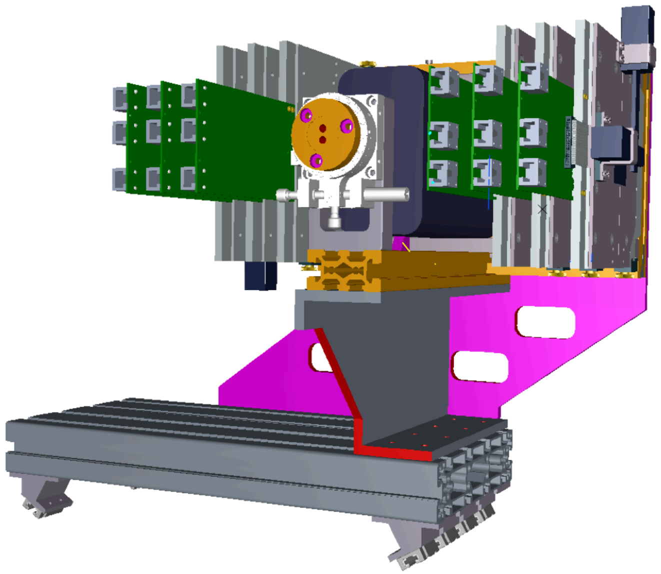
> Carriage* for telescope
  - Fits to the rails of PCMAG
  - Slidable
  - Support for cables





> Telescope positioning
  - Keep telescope short
  - Put telescope on its side

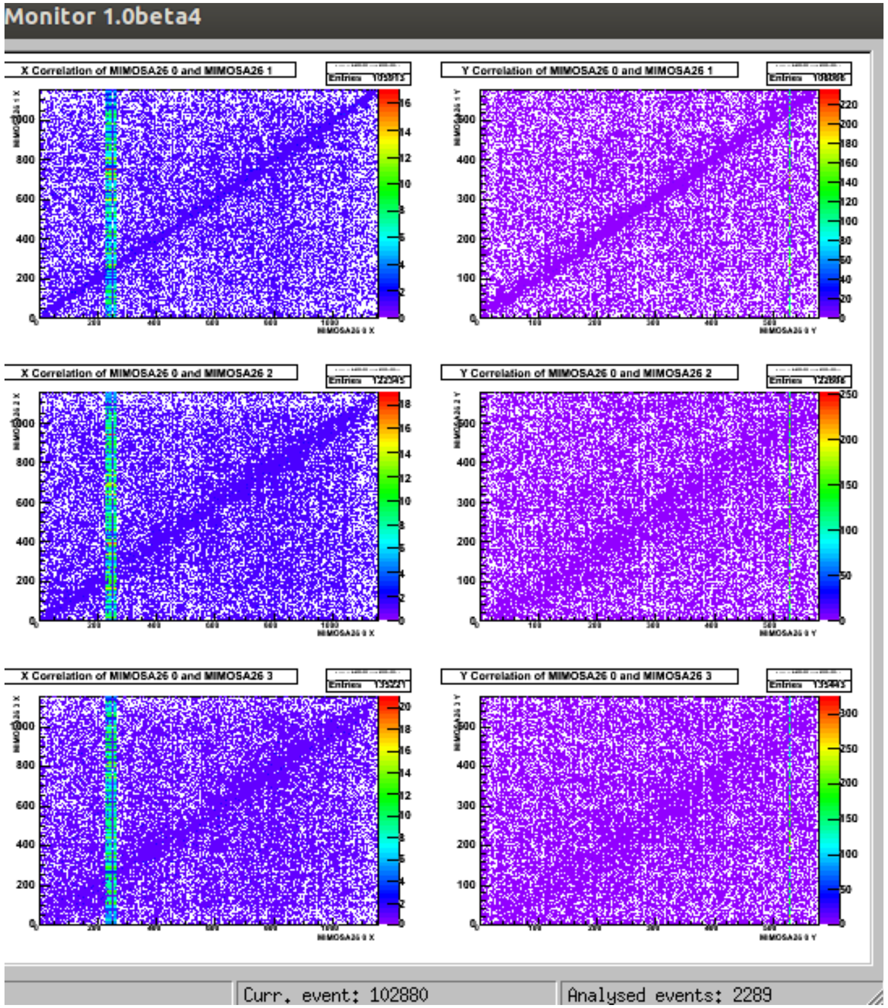




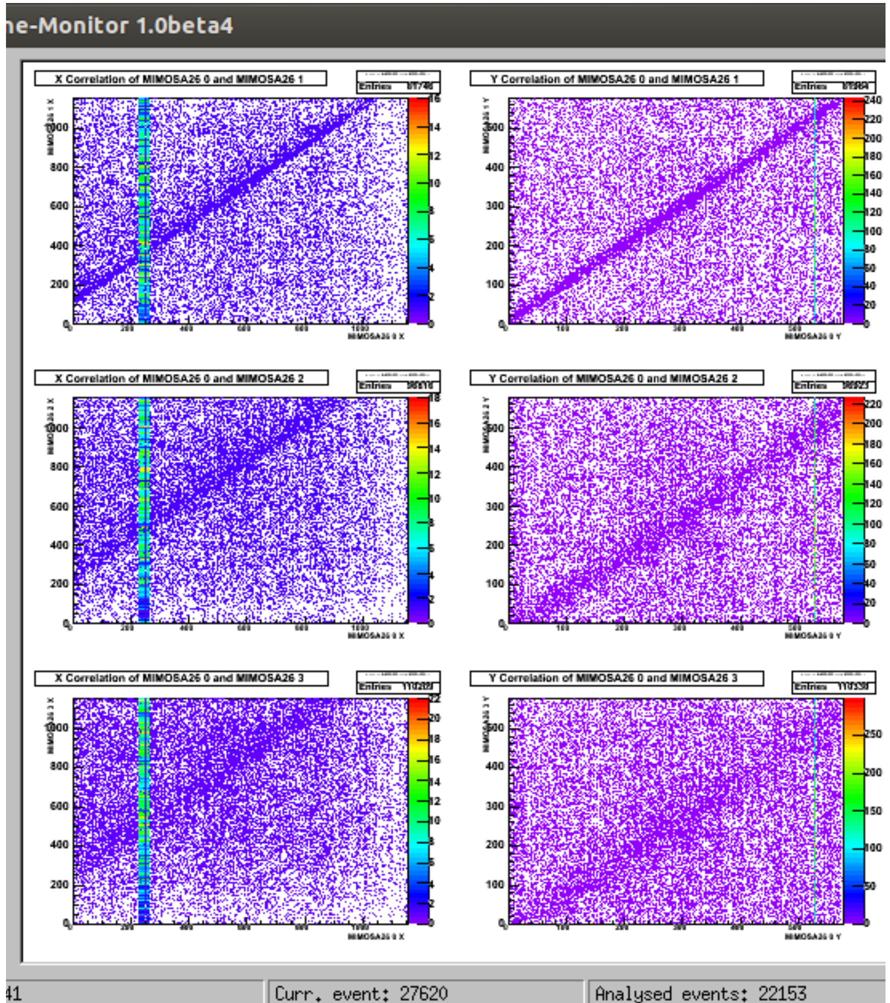
* Designed by Carsten Muhl, DESY-CMS

Telescope in Magnetic Field: Correlation Plots

E= 4GeV, B=0

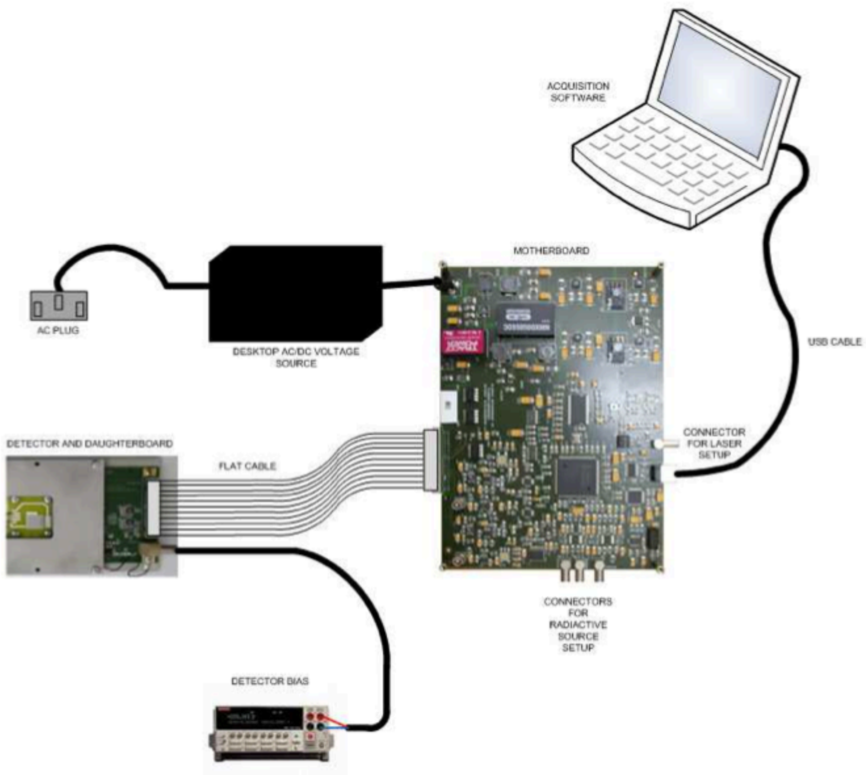


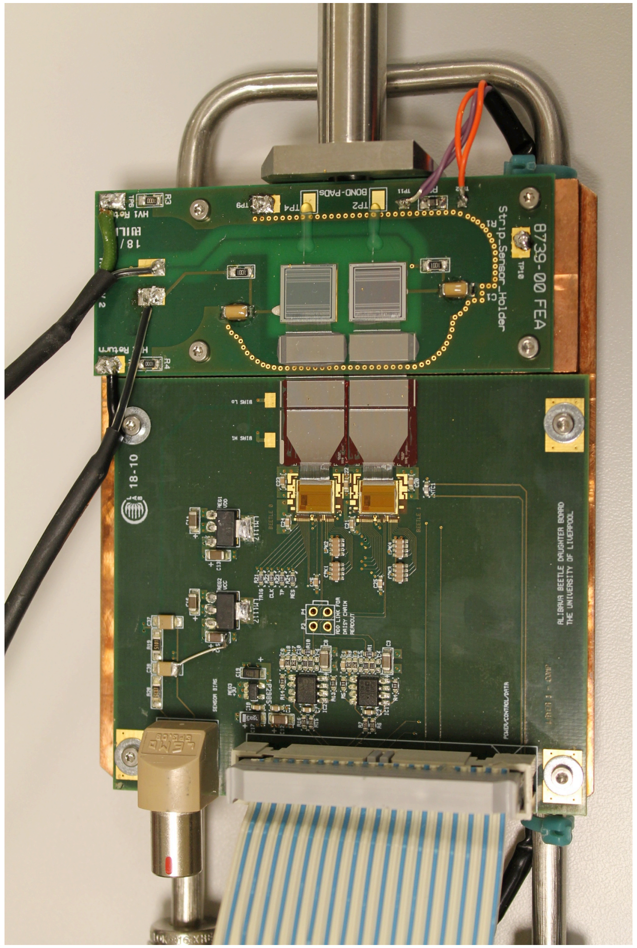
E= 4GeV, B=1T



ALIBAVA Readout System

- 2 Beetle chips, 256 channels
- Clock rate: 40 MHz
- Analogue output

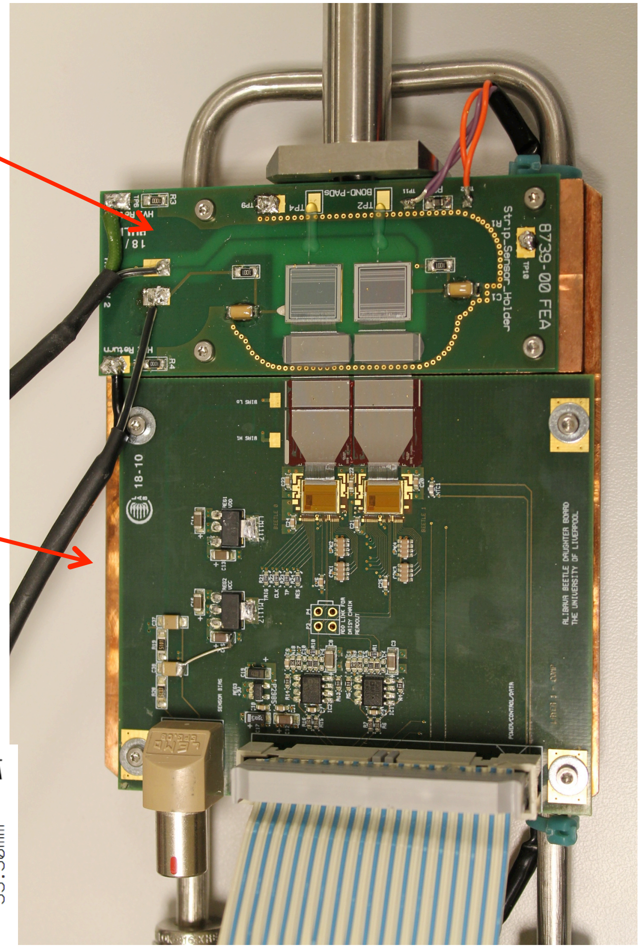


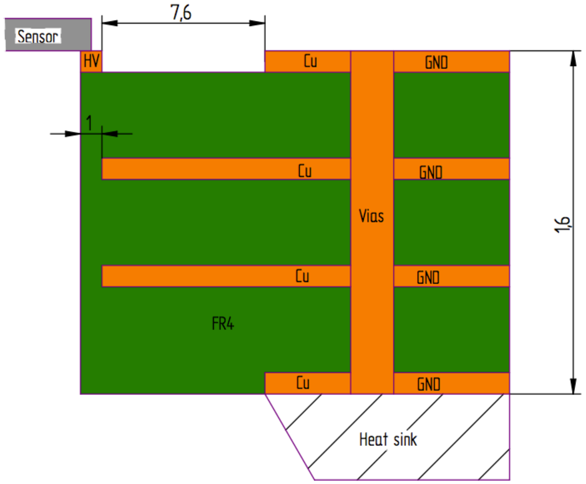


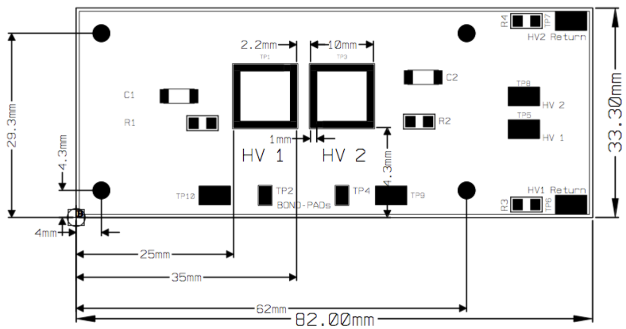
ALIBAVA Daughter Board

Cooling Sensors Under Test

- **Cooling:**
  - We use irradiated sensors
    - To avoid leakage current
    - To prevent annealing
    - Cooling down to - 25 degrees using silicone oil
- **Strip sensor holder***
    - Needs good thermal conductivity





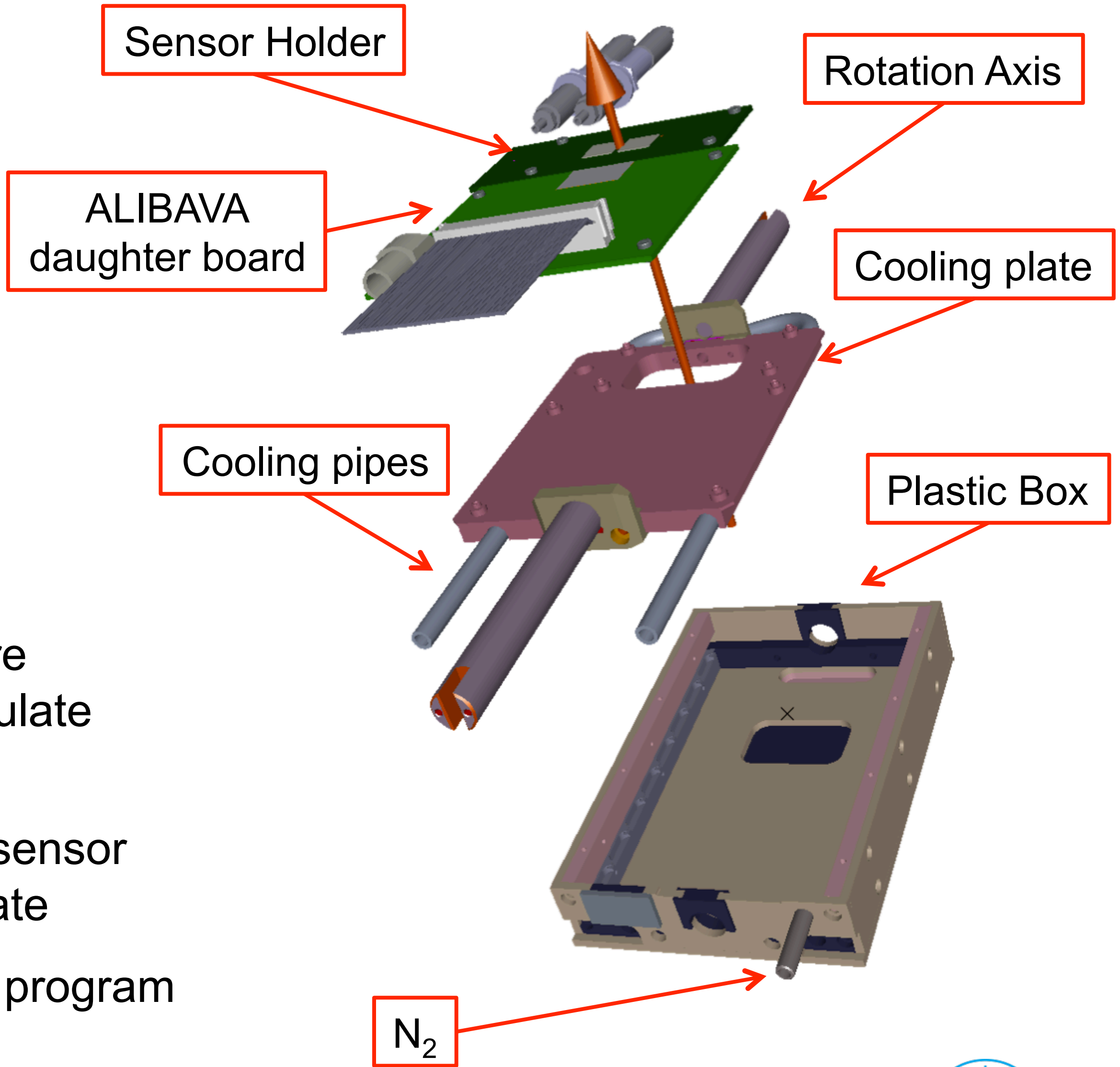


* Designed by Peter Goettlicher, DESY-FEB

Cooling Sensors Under Test

- Box*:
  - To avoid humidity
    - Flush inside with N_2
    - Cover with styrofoam
  - Is rotatable

- Monitoring humidity
  - Humidity and temperature sensor in the box to calculate dew point
  - Temperature sensor on sensor holder and on cooling plate
  - Monitored by a LabView program

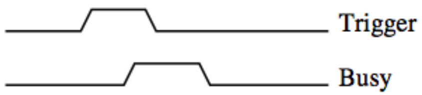


* Designed by Carsten Muhl, DESY-CMS

Synchronizing EUDET Telescope & ALIBAVA

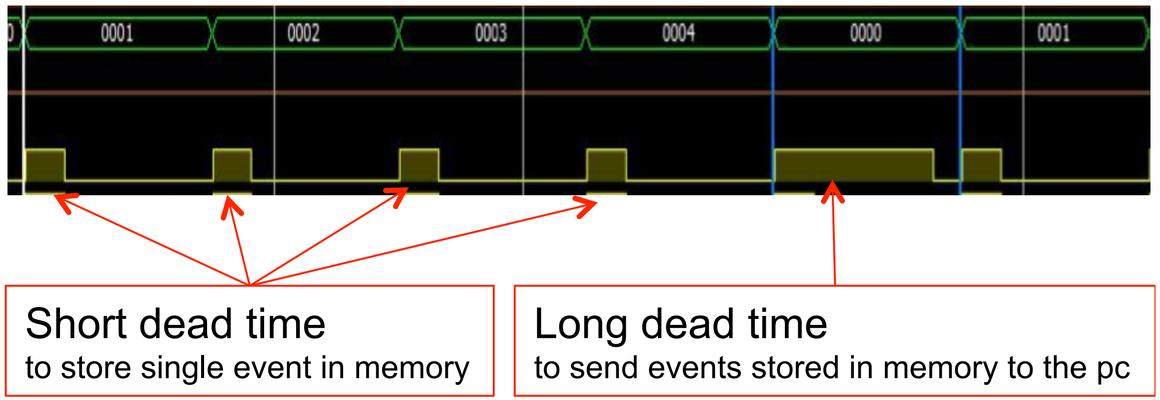
- ALIBAVA is designed for lab use:
  - No timestamp
  - No busy signal
  - Dead time is not constant

- EUDET Trigger Logic Unit (TLU)
  - Simple Handshake



- Alibava records N number of events in the memory and then send them to the pc

Example pattern of ALIBAVA dead times



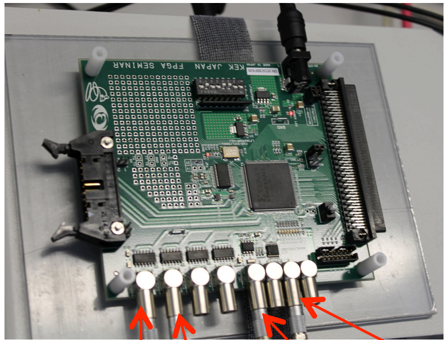
- Two options
  - Creating fake busy signals using FPGA
  - ALIBAVA firmware upgrade

Synchronizing EUDET Telescope & ALIBAVA

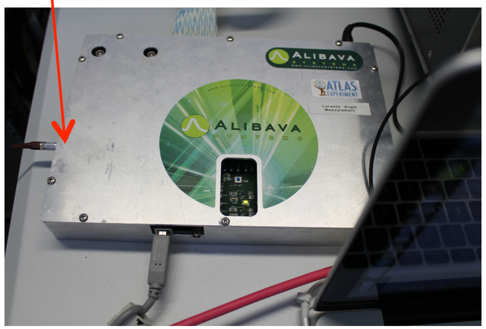
Using FPGA

- Count triggers up to N
- For each trigger < N
  - Sends short busy signal
- For Nth trigger
  - Sends long busy signal
- Designed for NIM signal
- Changeable settings
- ALIBAVA set to store 1000 events in buffer
  - 1ms short busy signal
  - 2s long busy signal
- Synchronization is good
  - Rarely looses sync
  - Low rate (~100Hz @ 4.4GeV)

Switch number	Pin number		0	1
0	33	Trigger IN	Internal	External
1	35	Length of alibava trigger	100us	50us
2	53	CLK selection	Internal	External
3	58	TRIG_MAX_COUNT	10k	1k
4	69	Short busy length	00=0.25ms	01=0.50ms
5	70		10=0.75ms	11=1ms
6	71	Long busy length	00=1.5s	01=2s
7	72		10=19s	11=20s



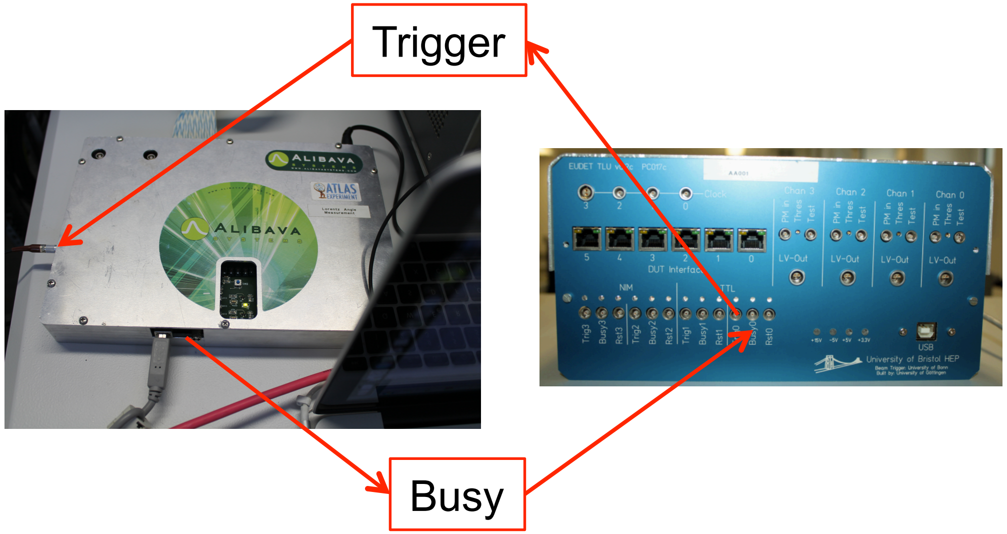

Pulse generator

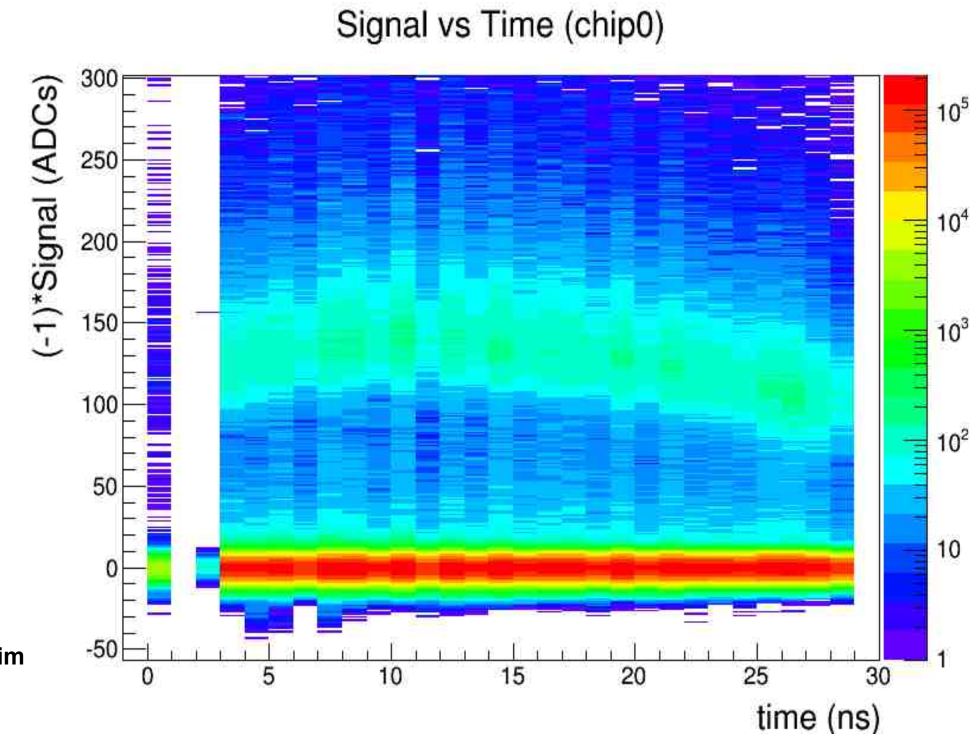


Synchronizing EUDET Telescope & ALIBAVA

ALIBAVA firmware upgrade*

- Now generates busy signal
  - Positive busy signal
  - Length of busy signals are shorter
- Rate is higher
  - ~250Hz @4.4 GeV
- Data taking efficiency is higher
  - Old ALIBAVA firmware samples the data within 100 ns after it receives trigger
  - Now reduced to 25ns



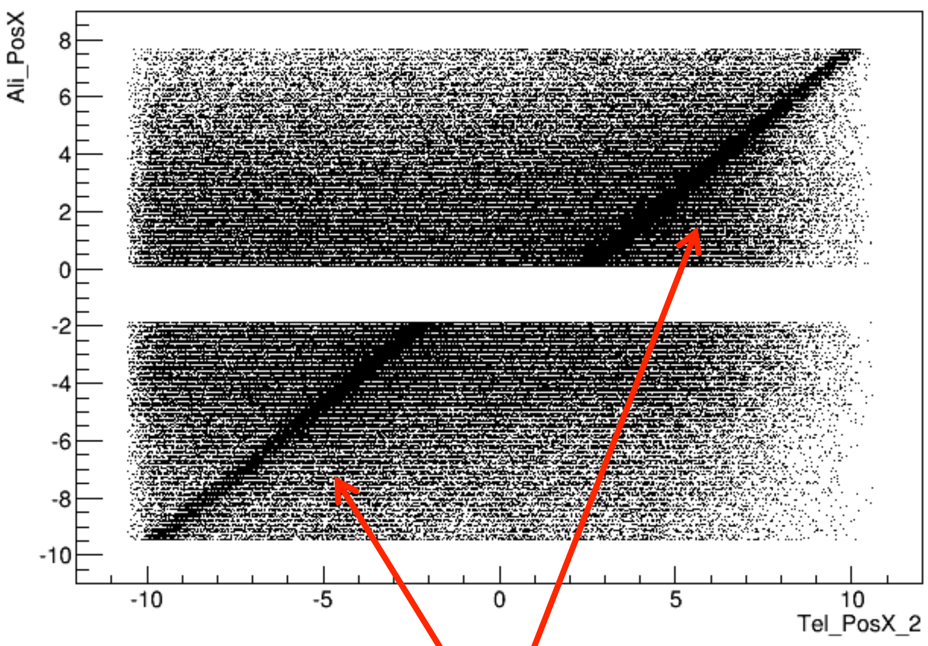


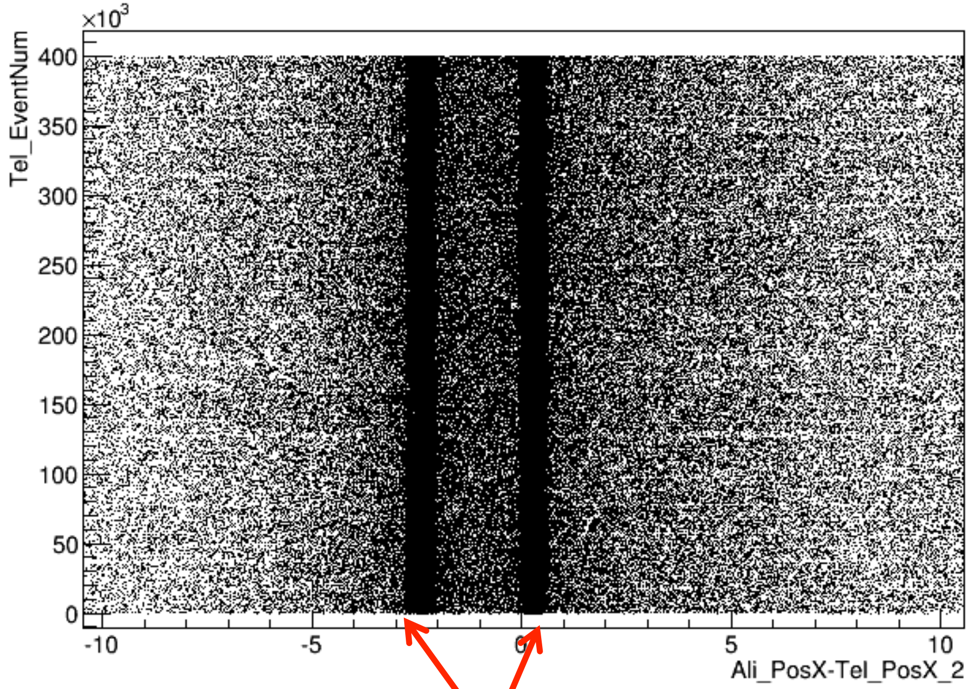
* by ALIBAVA Systems

Synchronizing EUDET Telescope & ALIBAVA

In sync

n^{th} Alibava event correlated with n^{th} Telescope event



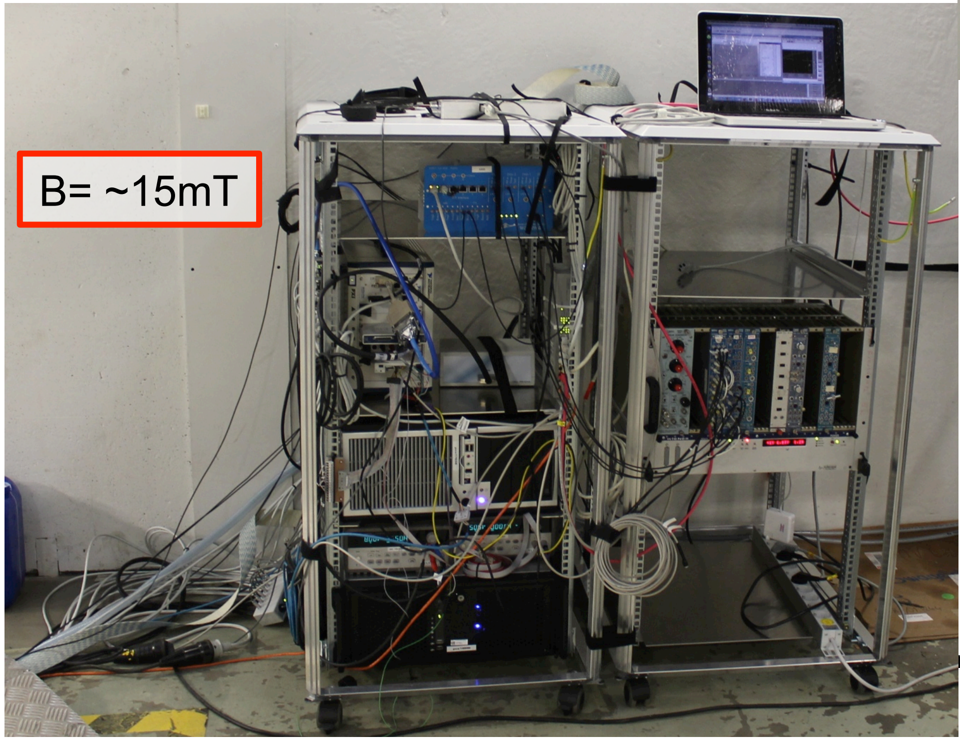


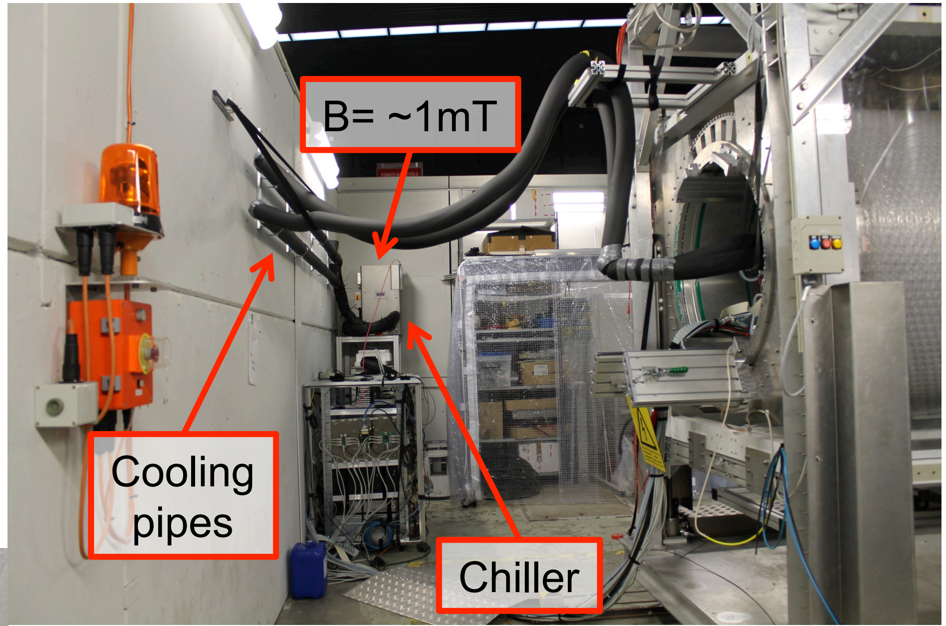
Two sensors

Two sensors

Working with Magnetic Field

- Triggering
  - Using SiPMs (not PMTs as usual)
  - V = -71.5V
  - Needs signal amplification
- All readout systems are far away from magnet





- Cooling
  - Problem because of long pipes
  - Chiller is put to a stage (same height with DUT) to decrease the pressure
  - Need powerful chiller

Cooling capacity > 0.6kW @ -40C

Summary

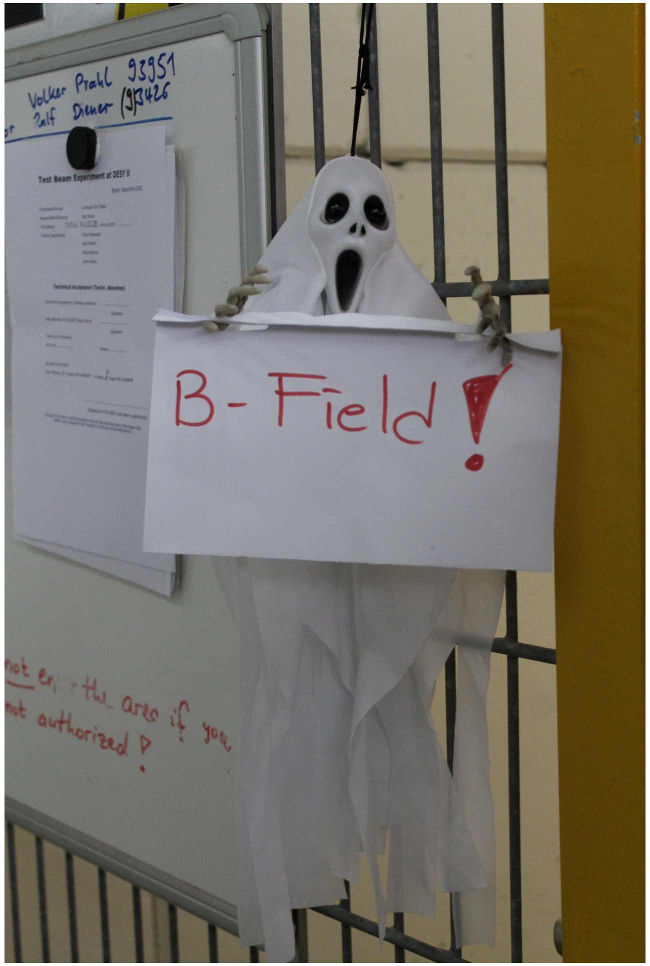
- Integration of ALIBAVA with EUDET Telescope can be done in 2 ways.
  - Firmware upgrade (v2a?) recommended*
- Working with magnetic field
  - All readout systems should be away from magnet
  - Temperature and pressure losses due to long pipes require powerful chiller

Data analysis:

- Using the EUTelescope framework and the newly implemented General Broken Line (GBL) algorithm for track fitting.
- Developing ALIBAVA data analysis tools for EUTelescope which can be used by other groups

* contact ALIBAVA Systems

Thank You !



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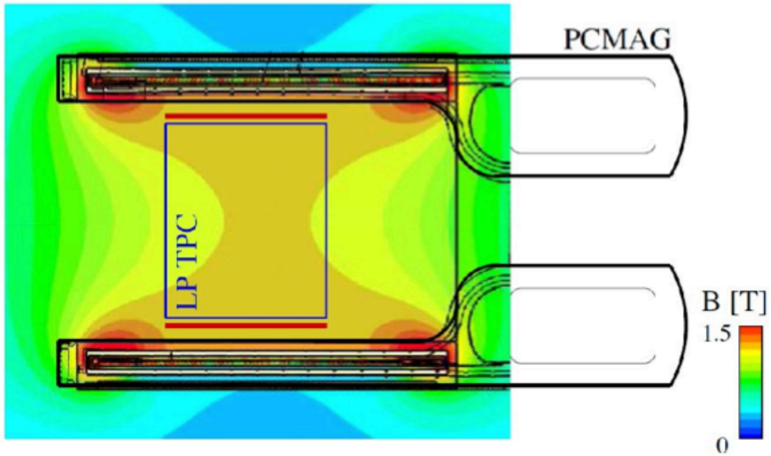
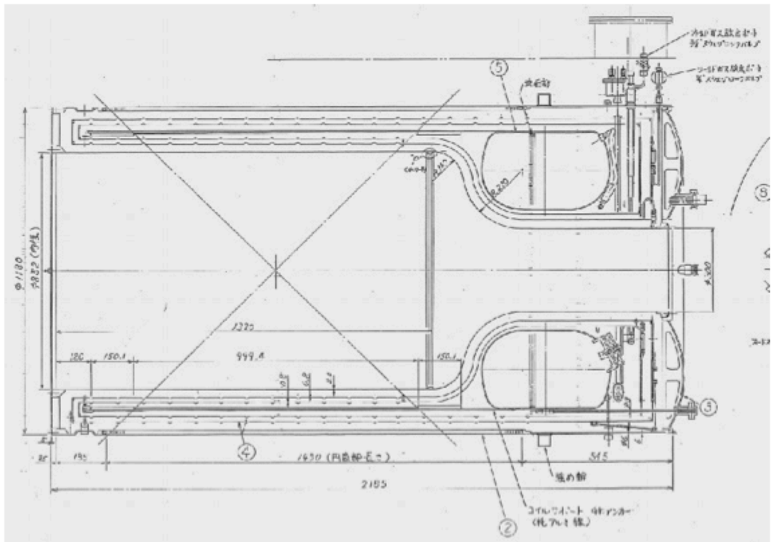
Backup

PCMAG

- PCMAG (designed for airborne experiments)
  - **P**ersistent **C**urrent, superconducting **MAG**net
  - Thin coil and wall ($0.2X_0$), no return yoke
  - Liquid Helium reservoir
  - Moved to DESY in Dec 2006
  - Tested and mapped in 2006-2007 (cooperation of DESY, KEK and CERN) Accuracy of 10^{-4}
- Dimensions and data:
  - Coil: ∅ 1.0 m, ↔ 1.3 m, weight: ~460 kg
  - Central magnetic field: up to 1.2T
  - Liquid He capacity: 240L (max. 10 days)
  - Operational current: ~430A (1T)

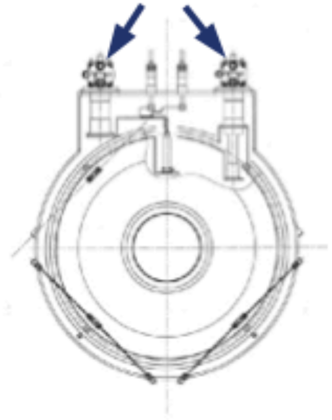


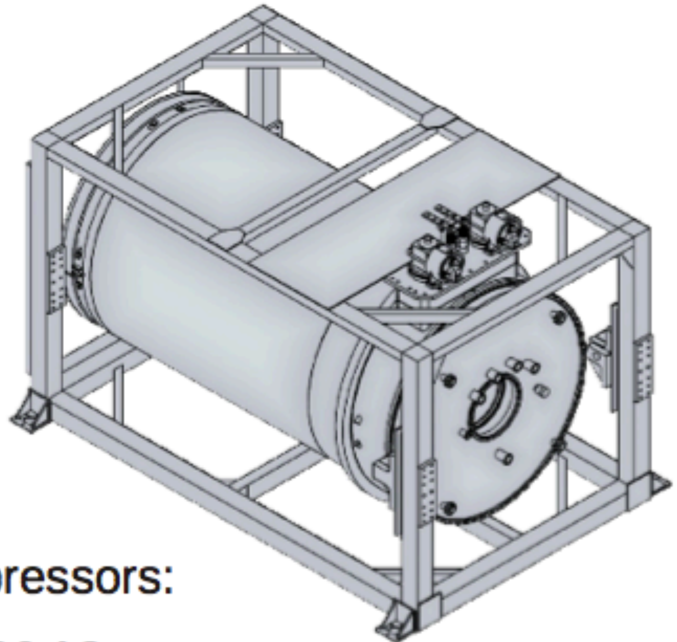


PCMAG Upgrade Details

- Two cryo coolers *(Gifford McMahon cycle)* have been added to vacuum vessel:
  - One two-stage cooler for the coil and the radiation shield (4 resp. 50 K)
  - One one-stage cooler for the current leads (50 K)

cryo coolers





- 2 Helium gas compressors:
  - Water cooled: 7-28 °C water, minimum 7 l/min @ 28°C
  - Power: 6.5-7.2 W (380 V, 13 A)

Screenshots from http://www.shicryogenics.com

SRDK-408D2 Specification Chart

Model		[illegible]
1st Stage Capacity	Watts @ 50 Hz	34 W @ 40 K
	Watts @ 60 Hz	44 W @ 40 K
2nd Stage Capacity	Watts @ 50 Hz	1.0 W @ 4.2 K
	Watts @ 60 Hz	1.0 W @ 4.2 K
Lowest Temperature 2nd Stage †		<3.5 K
Cooldown Time 2nd Stage †		<60 Min. (4.2 K)
Coldhead	Ambient Temperature	5~35 °C ‡
	Weight	18.0 kg (39.7 lbs.)
	Maintenance Interval	10,000 Hours

F-50 Indoor Water-Cooled Compressor

F-50	
Electrical Power†	3 Phase 200 V, 50/60 Hz [Low Volt] 380, 400, 415 V, 50 Hz or 440-480 V, 60 Hz [High Volt]
Ambient Temperature‡	5-35 °C (41-95 °F)
Minimum Cooling Water Requirement and Temperature Range*	4-28 °C (39-82 °F)‡ Min. 7 L/min (1.9 gal/min) at 28 °C
Weight and Dimensions	120 kg (265 lbs.) 591 mm x 450 mm x 588 mm (23.3" x 17.7" x 23.2") HxWxD
Maintenance Interval/ Adsorber Exchange	30,000 Hours