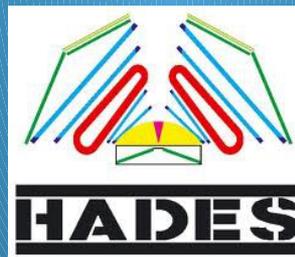


# Electromagnetic Calorimeter for HADES Experiment

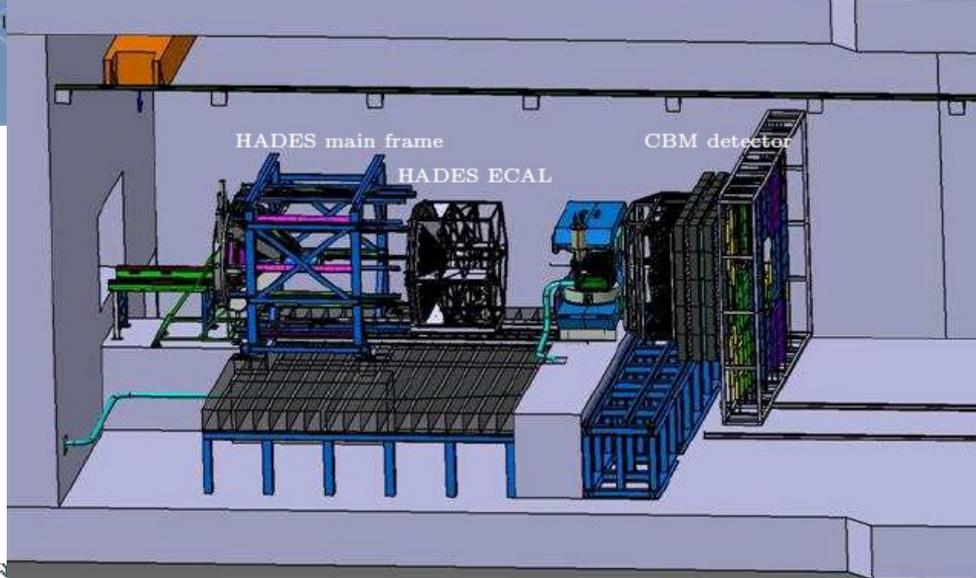
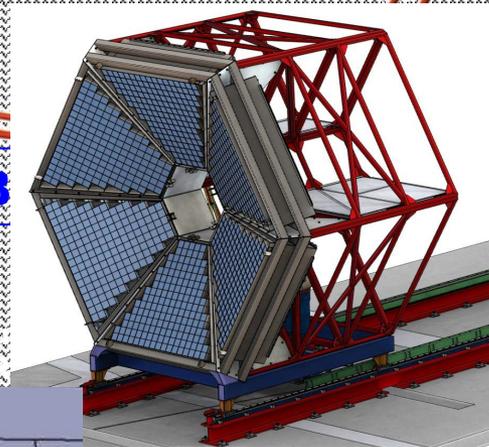
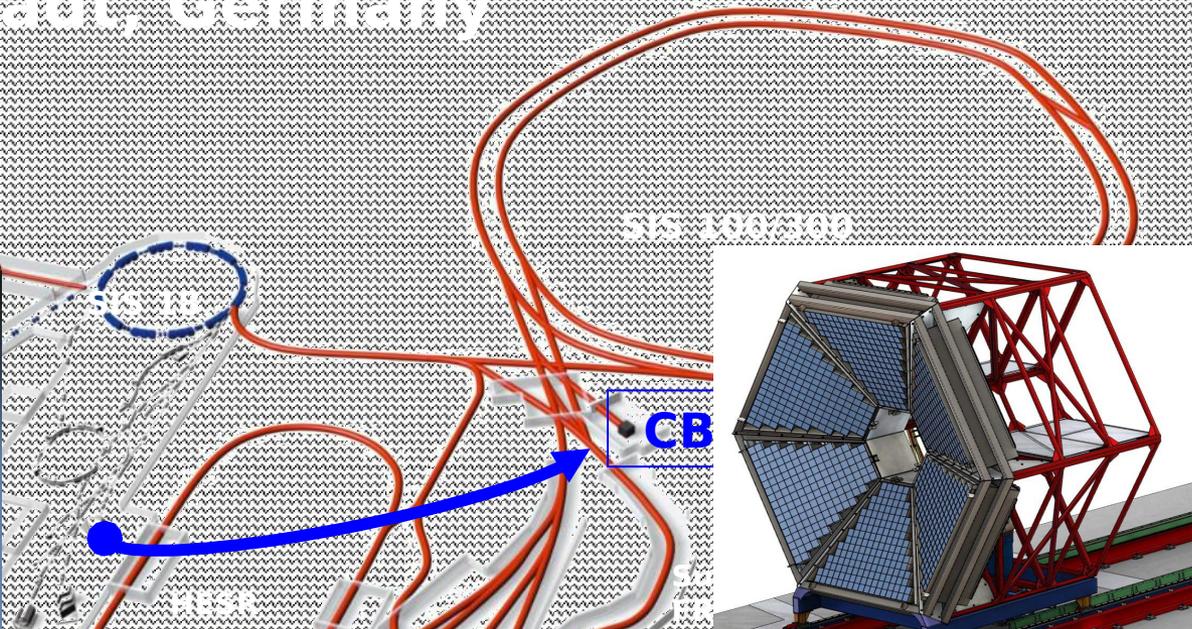
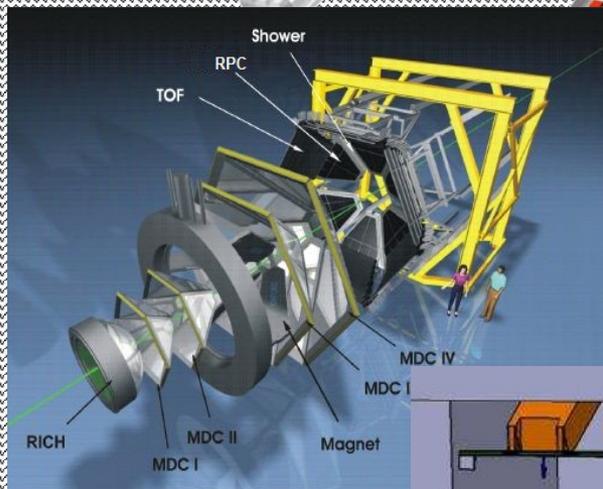
Ondřej Svoboda for the HADES  
collaboration

NPI Řež

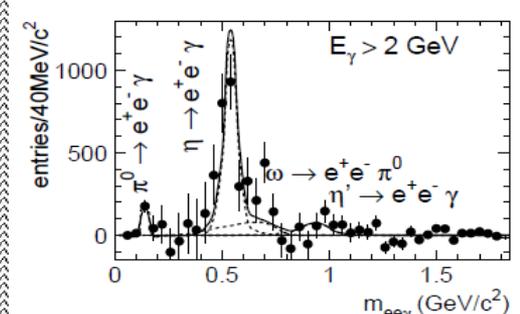
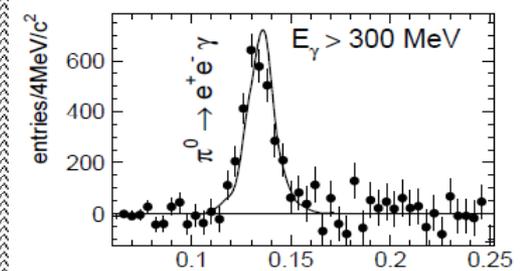
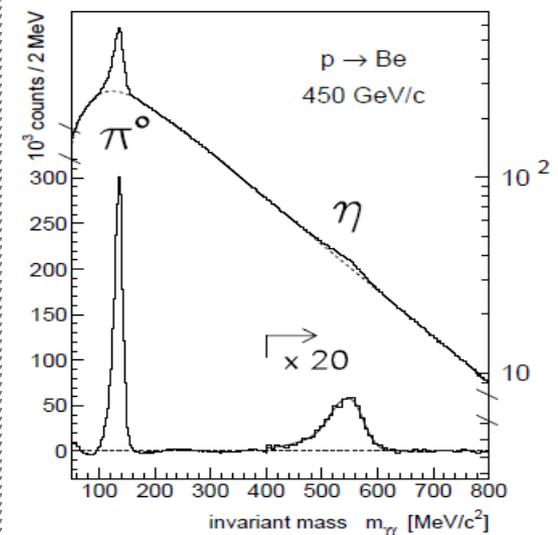




# FAIR@Darmstadt, Germany



# ECAL physics background



# Calorimeter module

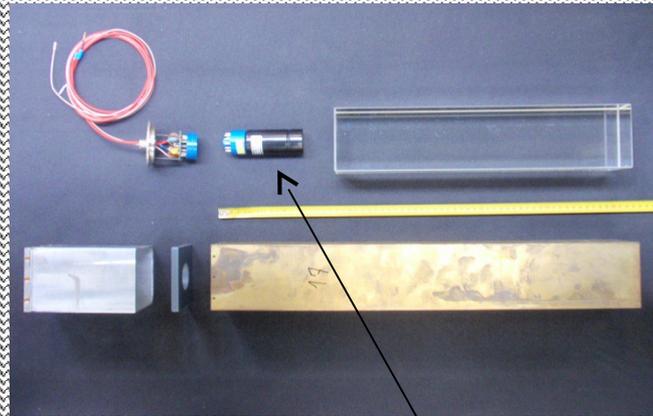
totaly needed **978**  
pieces

lead glass on lead from  
CERN

PIPA  
CERN

CERN 25

Inventory 02 52 426  
MC



1.5 inch EMI



Class properties:

Chemical composition  
51% PbO, 49% Bi<sub>2</sub>O<sub>3</sub>, 55% K<sub>2</sub>O, 2%  
Na<sub>2</sub>O, 2% CaO

density 8.35 g/cm<sup>3</sup>

refractive index 1.57

refractive index 1.56

refractive index 1.55

refractive index 1.54

refractive index 1.53

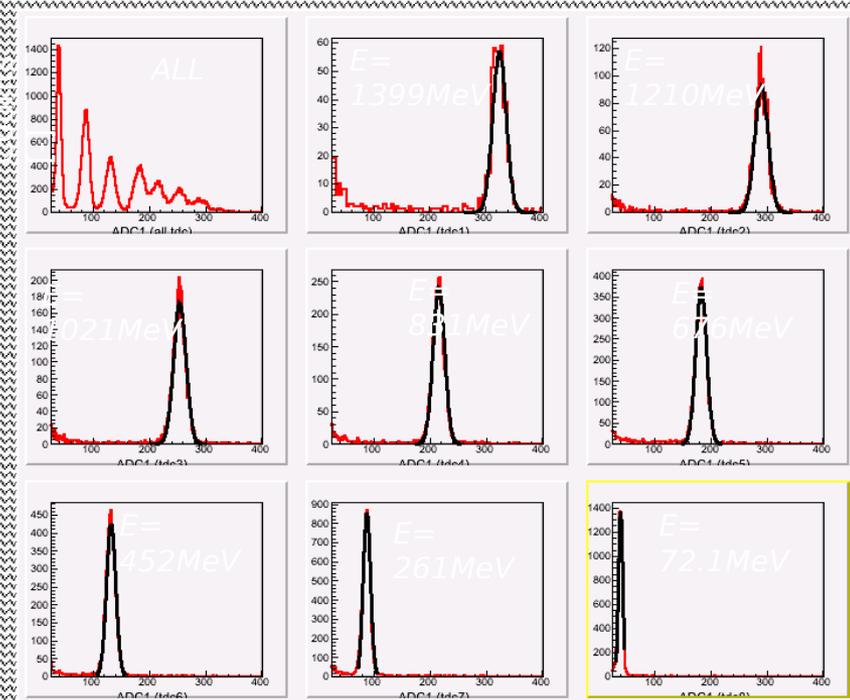
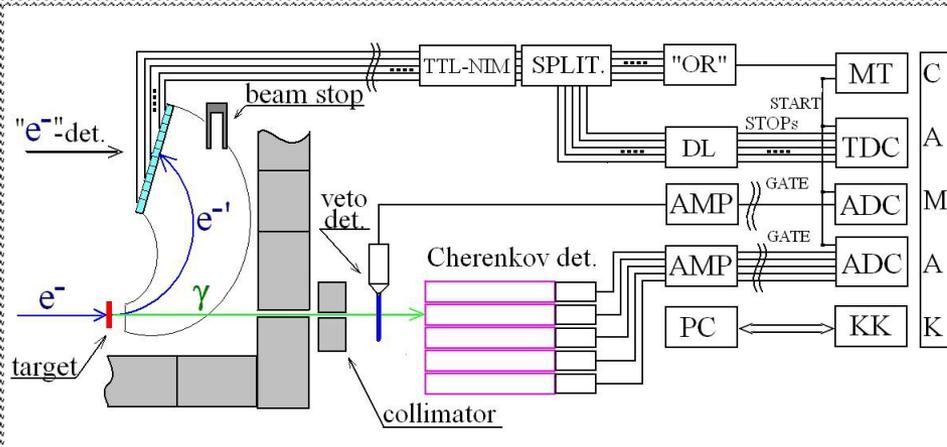
650 pieces from ALFA  
experiment (WASA) (vacuum  
calorimeter)

# Beam test at Mainz

**Purpose:** measure the energy resolution of the calorimeter for different  $\gamma$  energies and configurations. An electron at energy of 1500 MeV.

**Trigger:** OR of signals from Cherenkov detector, veto detector, beam stop detector,  $e^-$  detector,  $e^-$  detector. A signal from veto detector is used to gate the Cherenkov detector.

## Measured resolution for $\gamma$

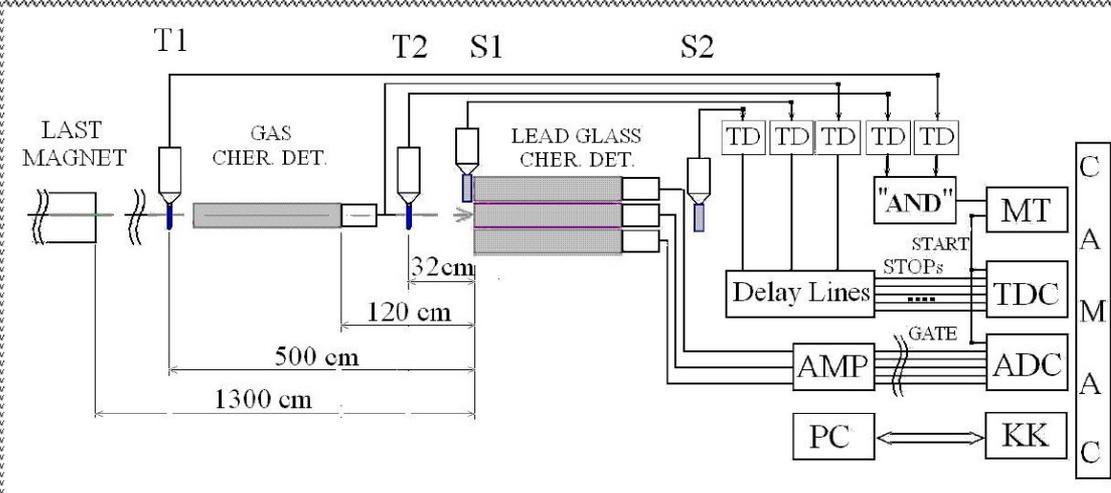


# Beam test at CERN – PS synchrotron – T10

## Beam line

Purpose: study particle identification, separation and energy resolution

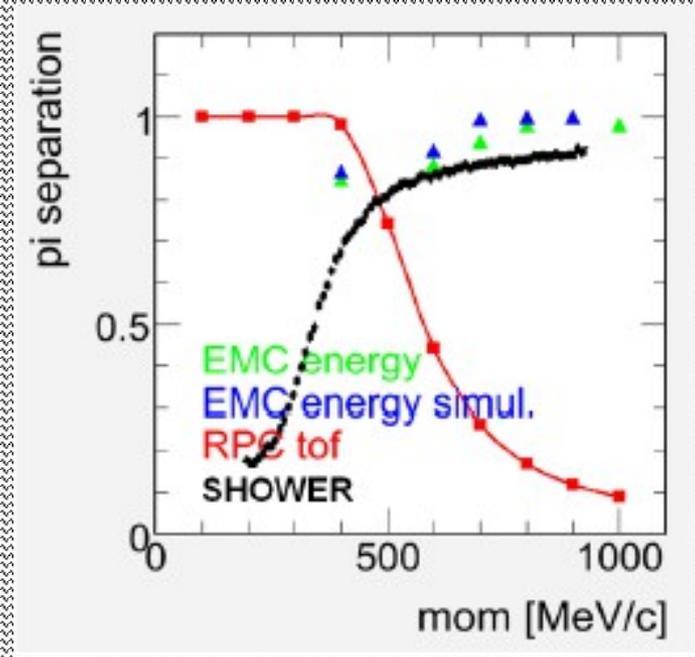
Used: gas and lead glass Cherenkov detectors



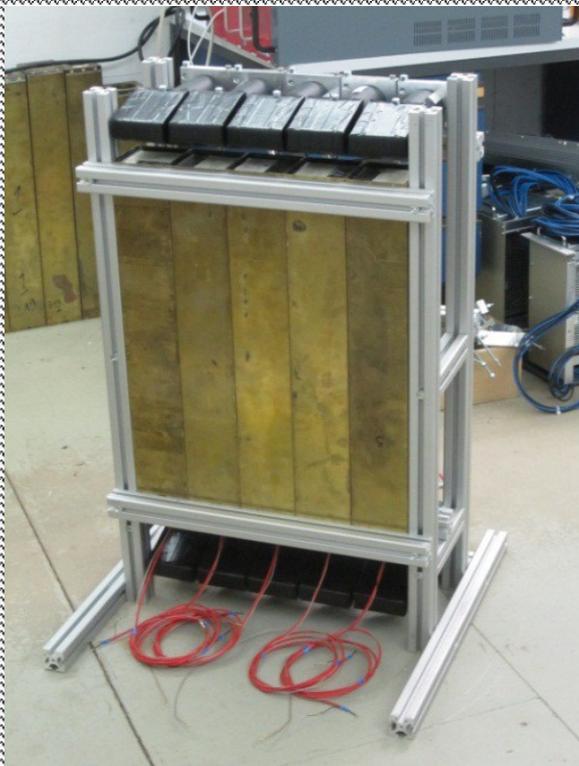
## Measured

Energy resolution: 6.2% for 1 GeV/e

Energy resolution: 6.9% for 1 GeV/e



# Setup for measurement with cosmic muons



## Cosmic muons:

- Energy:  $\sim 2\text{ GeV}$
- Cross section in air:  $\sim 200\text{ cm}^2$
- Shower depth:  $\sim 1000\text{ g/cm}^2$
- Flux:  $\sim 1\text{ cm}^{-2}\text{ min}^{-1}$
- Flux at sea level:  $\sim 1\text{ cm}^{-2}\text{ min}^{-1}$



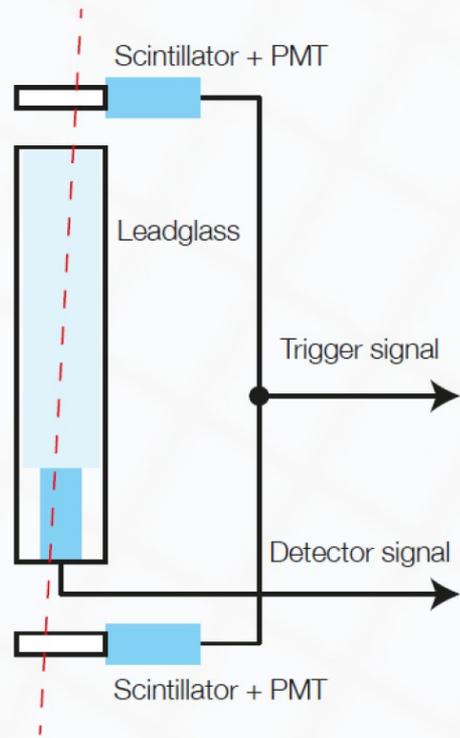
How such things can really be available: Friends under construction of a program/techniques will never be a real design concerning it.

# COSMIC MUONS MEASUREMENT

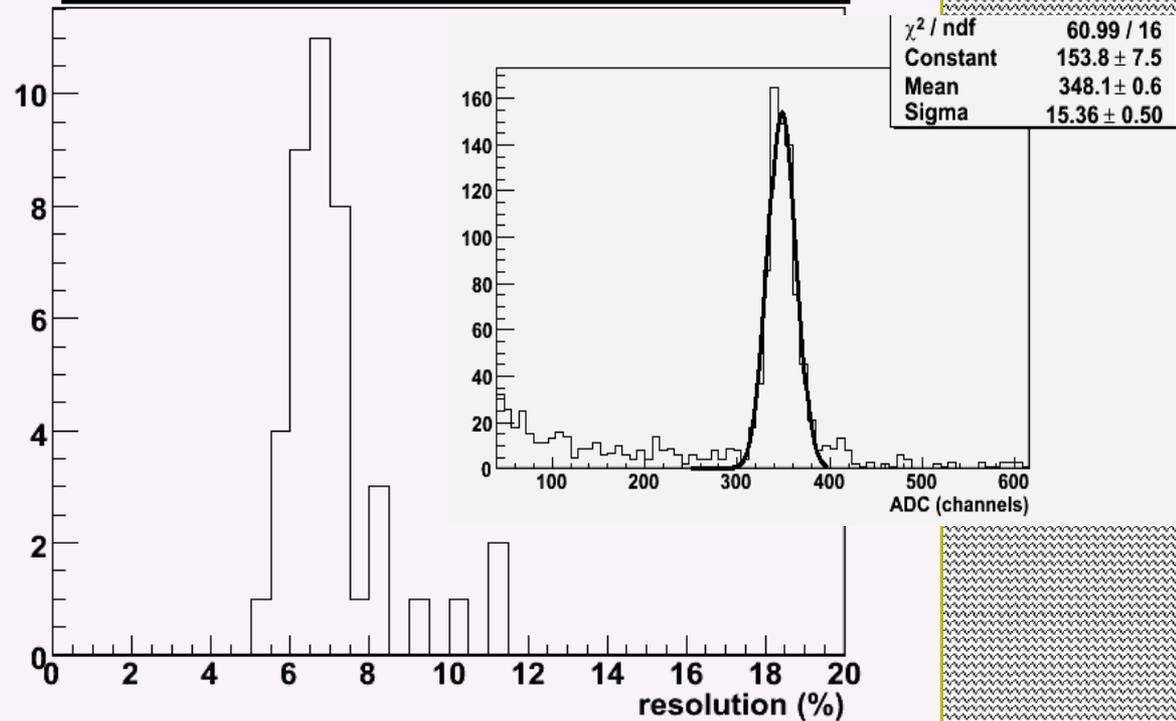
MAXI and Super-Kamiokande: Cosmic Muon Measurement

Yamamoto, Kobayashi, Kobayashi, Kobayashi, Kobayashi

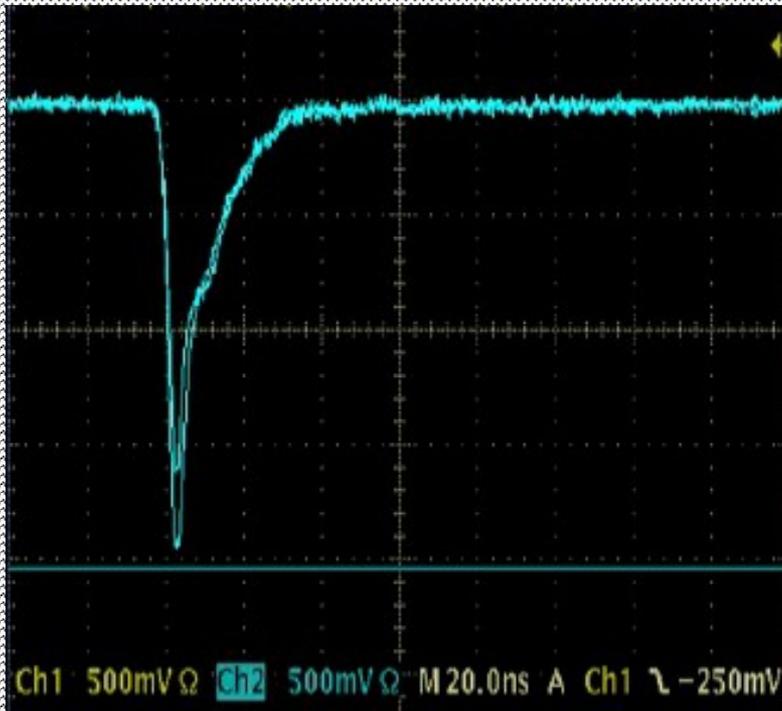
INDIAN



## cosmics: resolution of 41 EMC modules



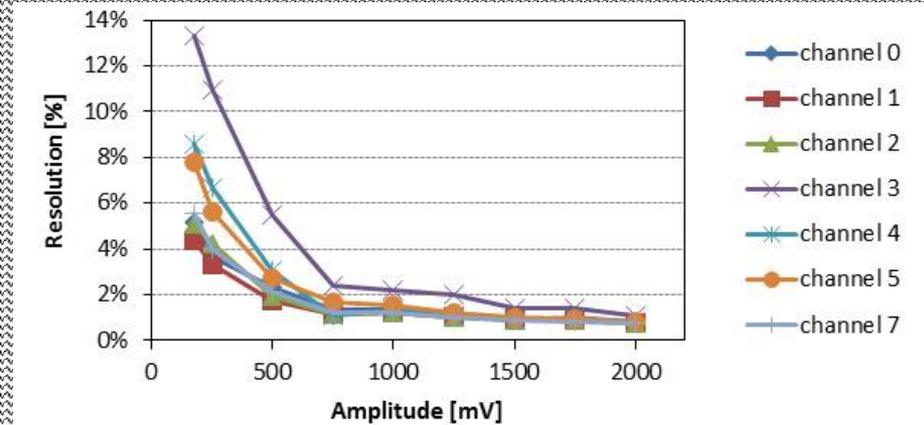
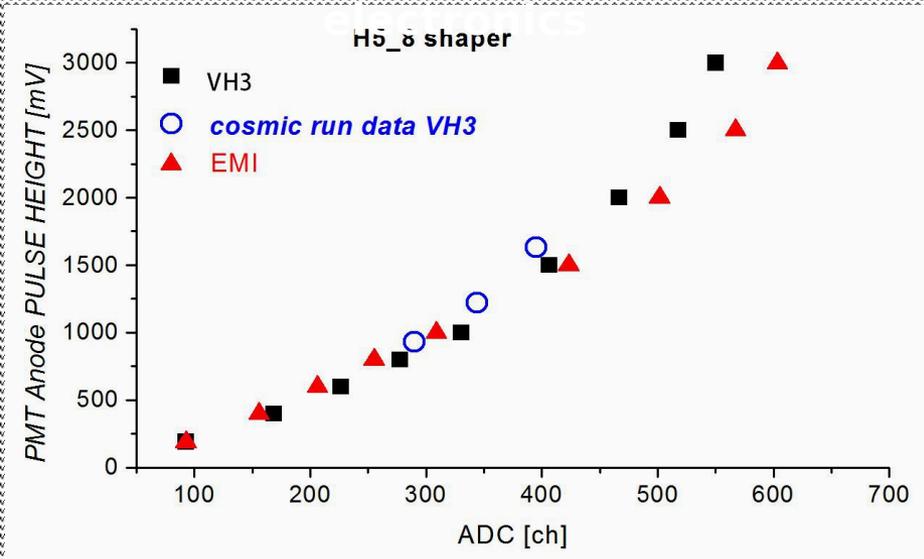
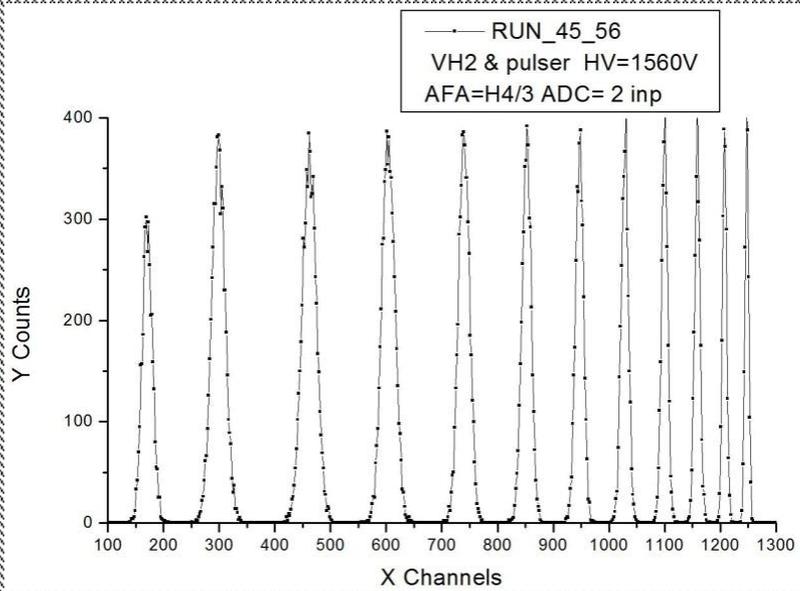
# Detector response & requirements on electronics



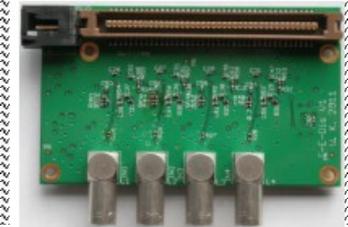
Signal parameters	
Rise time	3 ns
Fall time	50 ns
S/N ratio	> 12.5
Pulse amplitude at 20 MeV	50 mV
Pulse amplitude at 600 MeV	1.5 V
Expected hit rate	10 kHz / channel
Read-out parameters	
Time resolution	< 500 ps
Dynamic range energy	50 mV - 5 V
Energy measurement accuracy	5 mV
Final energy resolution	5%/sqrt(E), E in GeV



# Electronic tests using FED system



# Charge measurement with FPGA

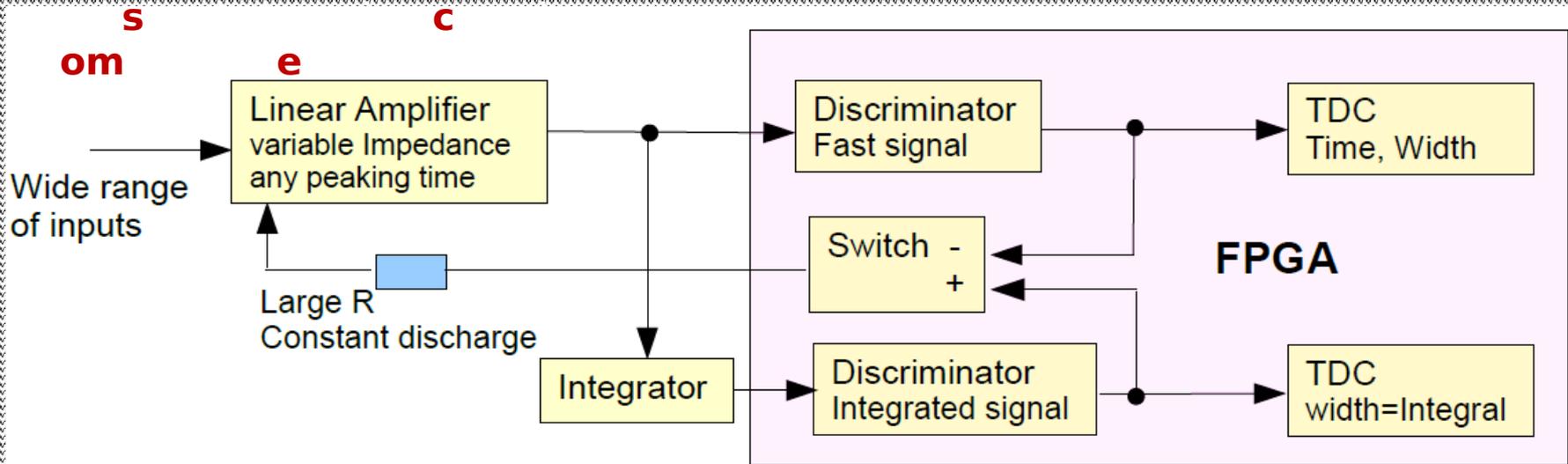
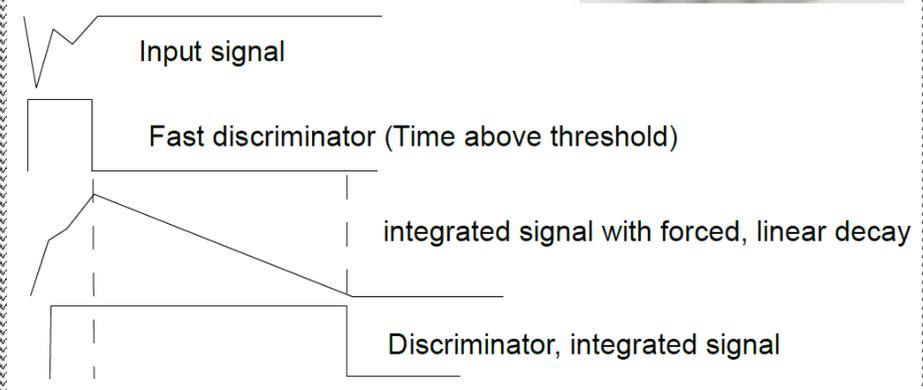


Idea: Measure with Analog-to-Digital

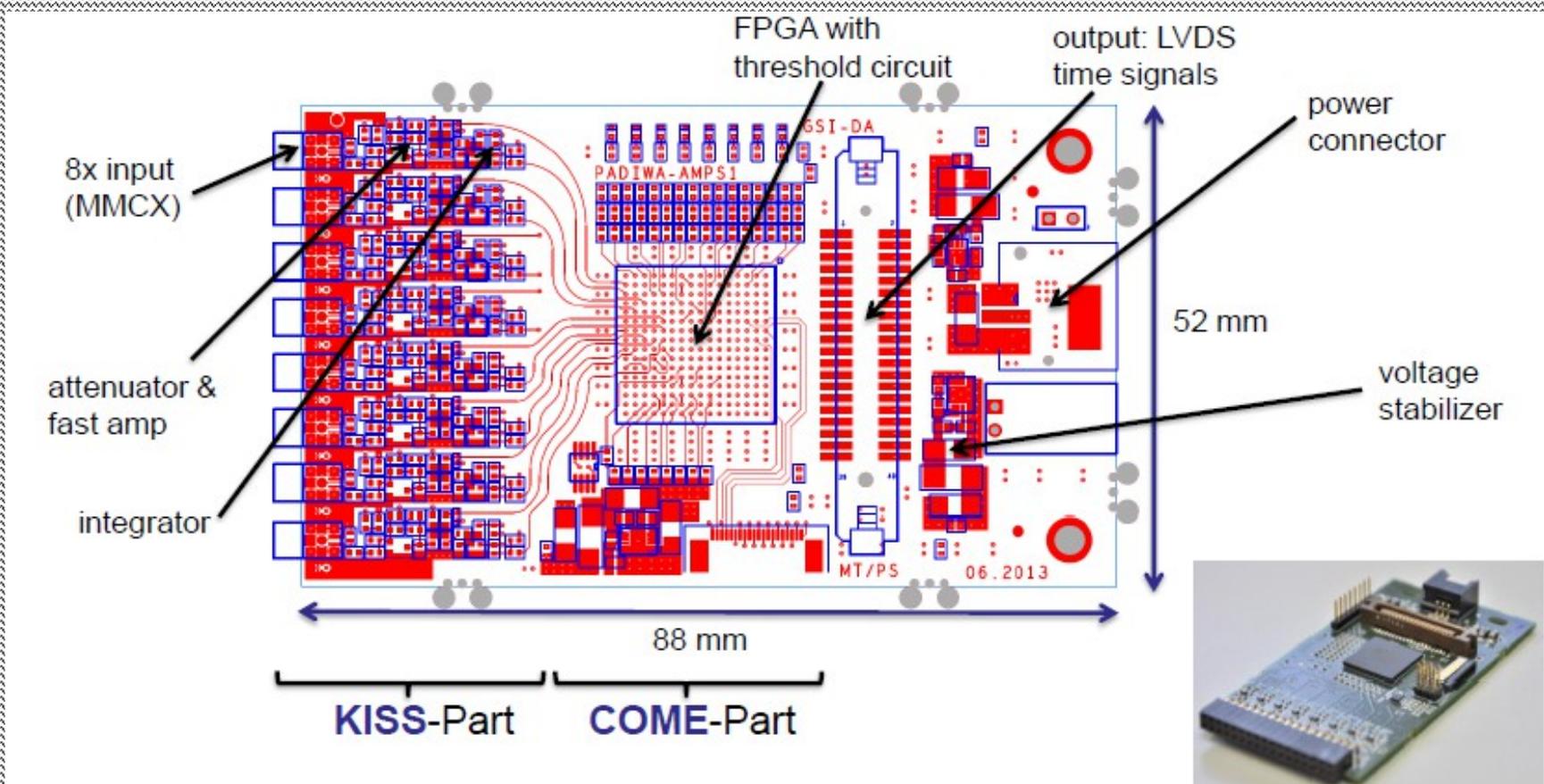
Fast discriminator  
Integrator

Discriminator  
Fast signal

Discriminator  
Integrated signal



# New PADIWA-AMPS1 layout with 02W (topside)



Basis: PaDiWa front-end board for TRBv3

# Time Schedule

		2014	2015	2016	2017
<b>PMTs</b>					
	order&delivery				
<b>HV</b>					
	order&delivery				
	bases production				
	cabling				
<b>Modules</b>					
	mechanics				
	assembly				
	tests				
	installation				
<b>Mainframe</b>					
	check of drawings				
	production				
	installation				
<b>Electronics</b>					
	FEE pre-production				
	FEE test				
	ADDON				
	FPGA programming				
	full test				
	production				
<b>Full system assembly</b>					
<b>Commisioning and tests</b>					

# Summary

## Motivation:

improved dilepton spectroscopy by HADES – lepton and photon pairs at the same time

## Current status:

• 100 modules successfully tested – 70 modules measured in detail  
• 1.5 and 3 inch photo multiplier – successfuly tested usage of 1 inch photo multiplier's under investigation

• Mechanical construction designed, simulations performed, drawings ready for production

• production of 100 HADES calorimeter systems is planned  
• delivery of calorimeter to FAIR in summer 2014

• IDA updated and submitted to FAIR management

## Plans:

• Finish calorimeter mechanical development  
• Repeat test in beam with this calorimeter  
• Install the calorimeter



**Technical Design Report  
for the HADES**

**Electromagnetic Calorimeter  
(ECAL)**

The HADES Collaboration



Compressed Baryonic Matter Experiments

May 2013

# ECAL workgroup

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