



# The Silicon TPC System

EUDET Extended SC meeting

31 August 2009

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NIKHEF

# JRA2 activity/task

- Silicon TPC readout (“SiTPC”)
  - development MediPix → TimePix chip
  - development diagnostic endplate module  
incl. DAQ

Purpose: a SiTPC based monitoring system

Partners:

ALU Freiburg, Bonn, CEA Saclay, CERN,  
NIKHEF

## SITPC Tasks:

- ✓ Develop the Timepix chip that allows to measure the 3<sup>rd</sup> coordinate (drift time)
- ✓ Implementation of Timepix together with GEM and Ingrid into diagnostic endplate system (with GEM working; with Ingrid in progress)
- ✓ Performance measurements in test infrastructure at DESY (analysis GEM+Timepix data in progress)
- ✓ Develop simulation framework (continues)
- ✓ Develop DAQ system and integrate in overall DAQ of EUDET infrastructure (first used in June'09)

“final” SITPC deliverable is endplate infrastructure consisting of (at least) one LP module with Timepix readout

- Original “due” date was month 36
- First delayed to month 38, later to month 42 (done June’09)

### Reasons:

- Difficulties with control and readout of 4 or 8 chips on multichip PCBs
- Difficulties with reliable production of integrated grids (INGRIDs) in ‘wafer’ postprocessing technology

Today: most of the difficulties overcome, although large quantities are still not trivial

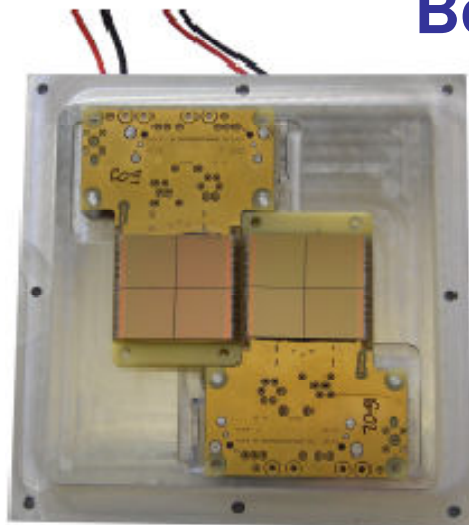
## Milestone/deliverable has 3 'legs':

- one LP endplate module with triple-GEM (Bonn/Freiburg) read out by system of 2x4 Timepix chips; operational June'09 in T24
- one LP endplate module with Ingrid, a Micromegas-like integrated grid (Saclay/Nikhef), with 8 Timepix chips; new PCB in production, 8 Ingrids available @Nikhef (30/8/09)
- One (or more) small detector(s) with 'Quad' Ingrids = "traveling infrastructure"; PCB with 4 Ingrids ready, detector ready soon

# Module with GEMs & Timepix



## Bonn/Freiburg



### Gas amplification stage:

3 standard CERN GEMS (60/70/140)

1 mm spacing between GEMs

### Readout:

2 quadboards (4 Timepix chips each)

Nikhef

anode plane

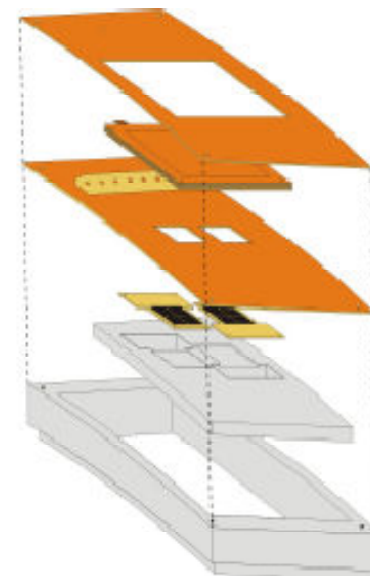
GEMs

readout plane

quad-boards

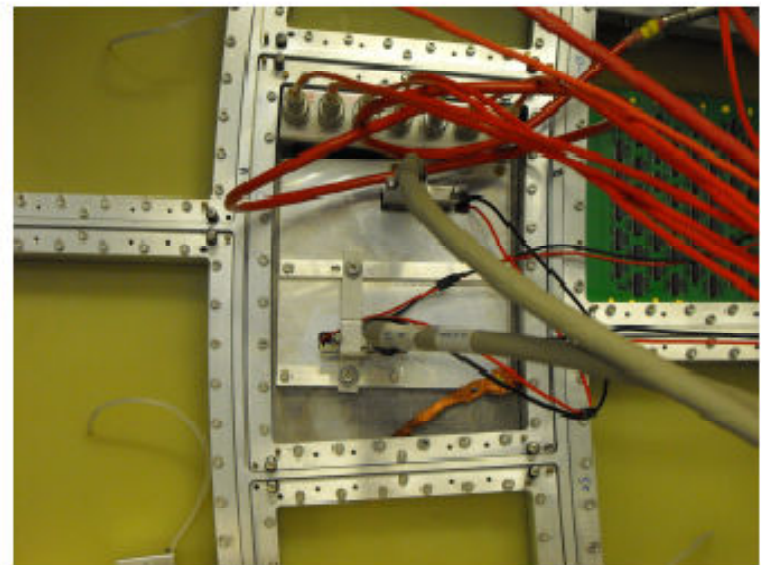
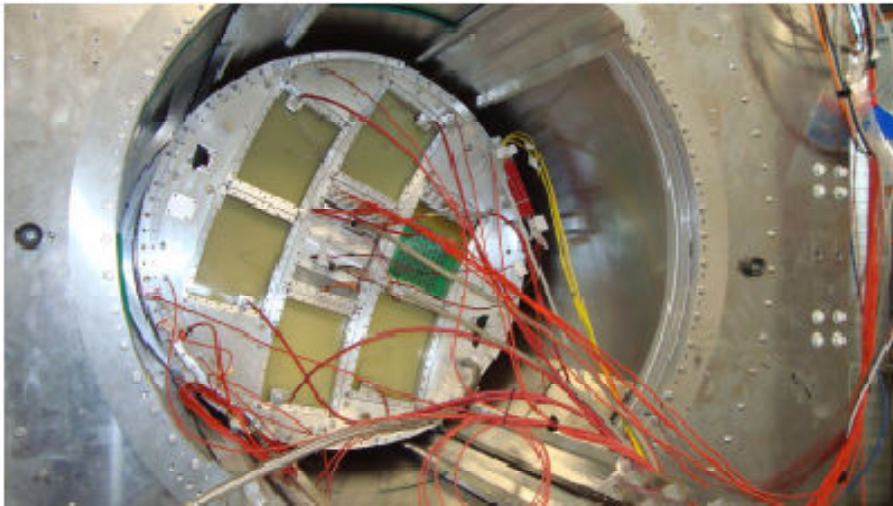
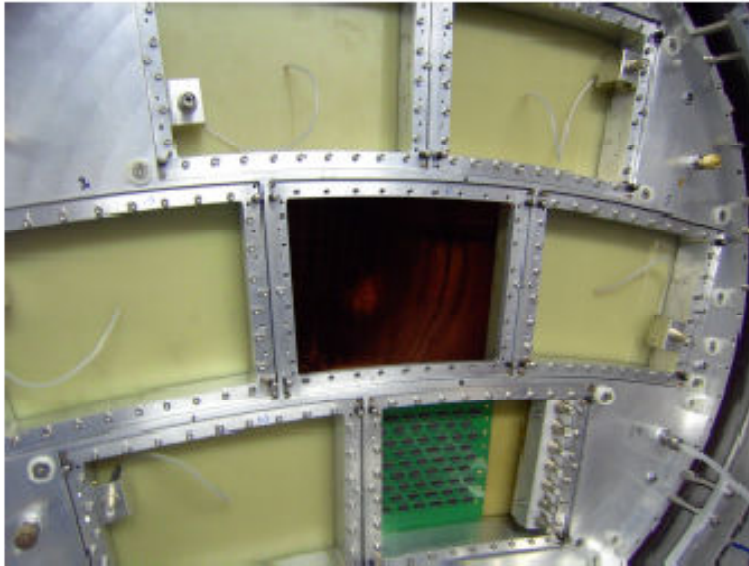
reinforcement of  
anode plane

redframe





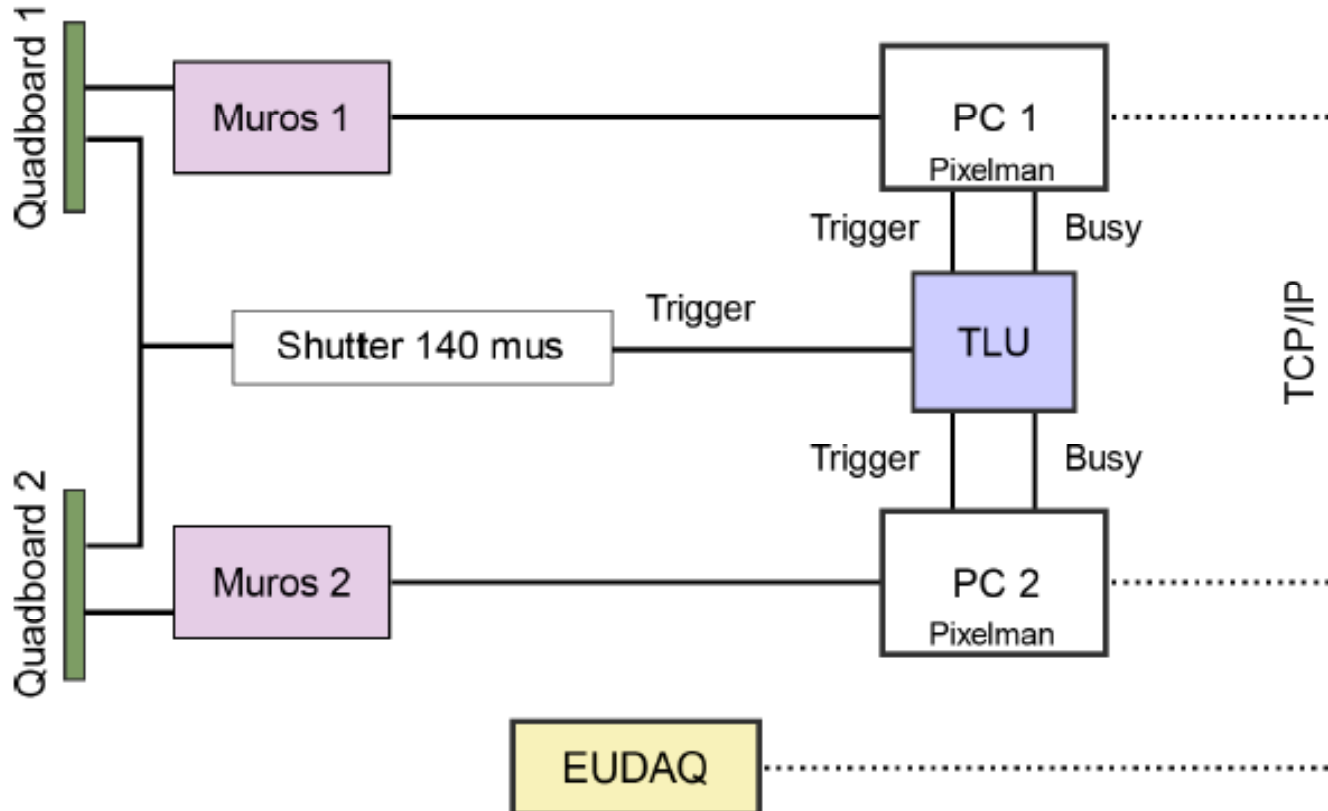
# Pictures from Installation



# Readout scheme



Using 2 Muros systems synchronized by TLU and EUDAq



Data is written directly in the LCIO format.



# EUDAQ: The Eudet Data Acquisition System

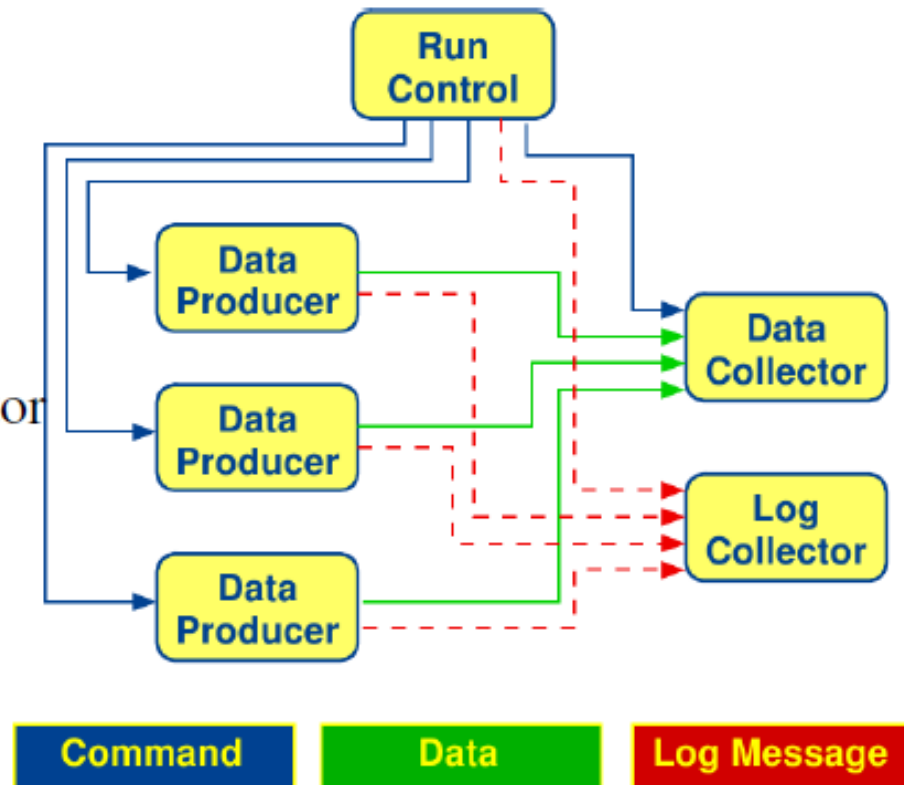


DataProducer: Pixelman plugin communicates with EUDAQ

- Receives commands from Run Control
- Sends data to Data Collector
- Sends messages to Log Collector

DataCollector:

- Receives raw data
- Performs event building
- New: Plugin mechanism
- LCIO converter plugin for every raw data format



# Data Sets

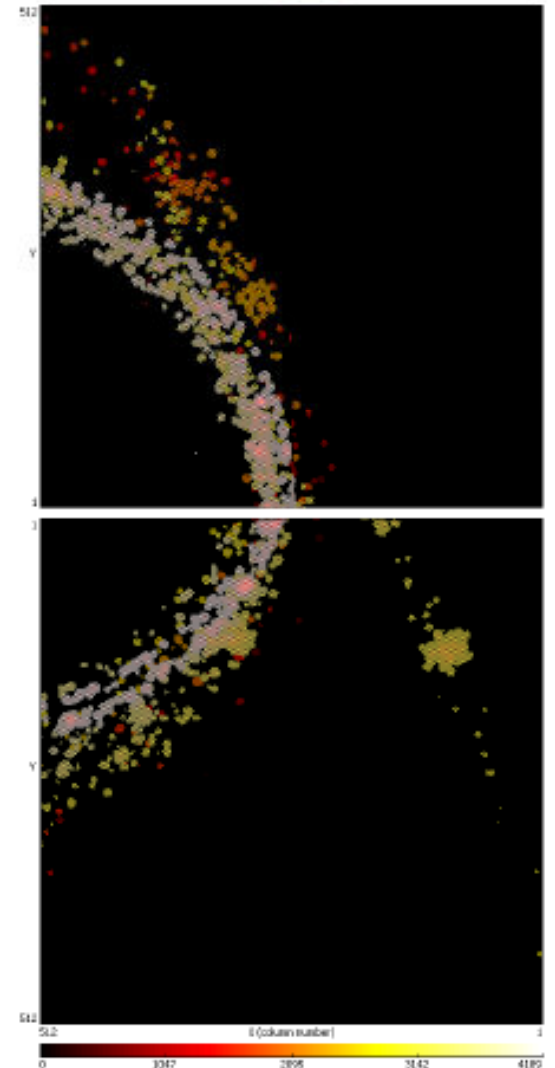


He:CO<sub>2</sub> 70:30:

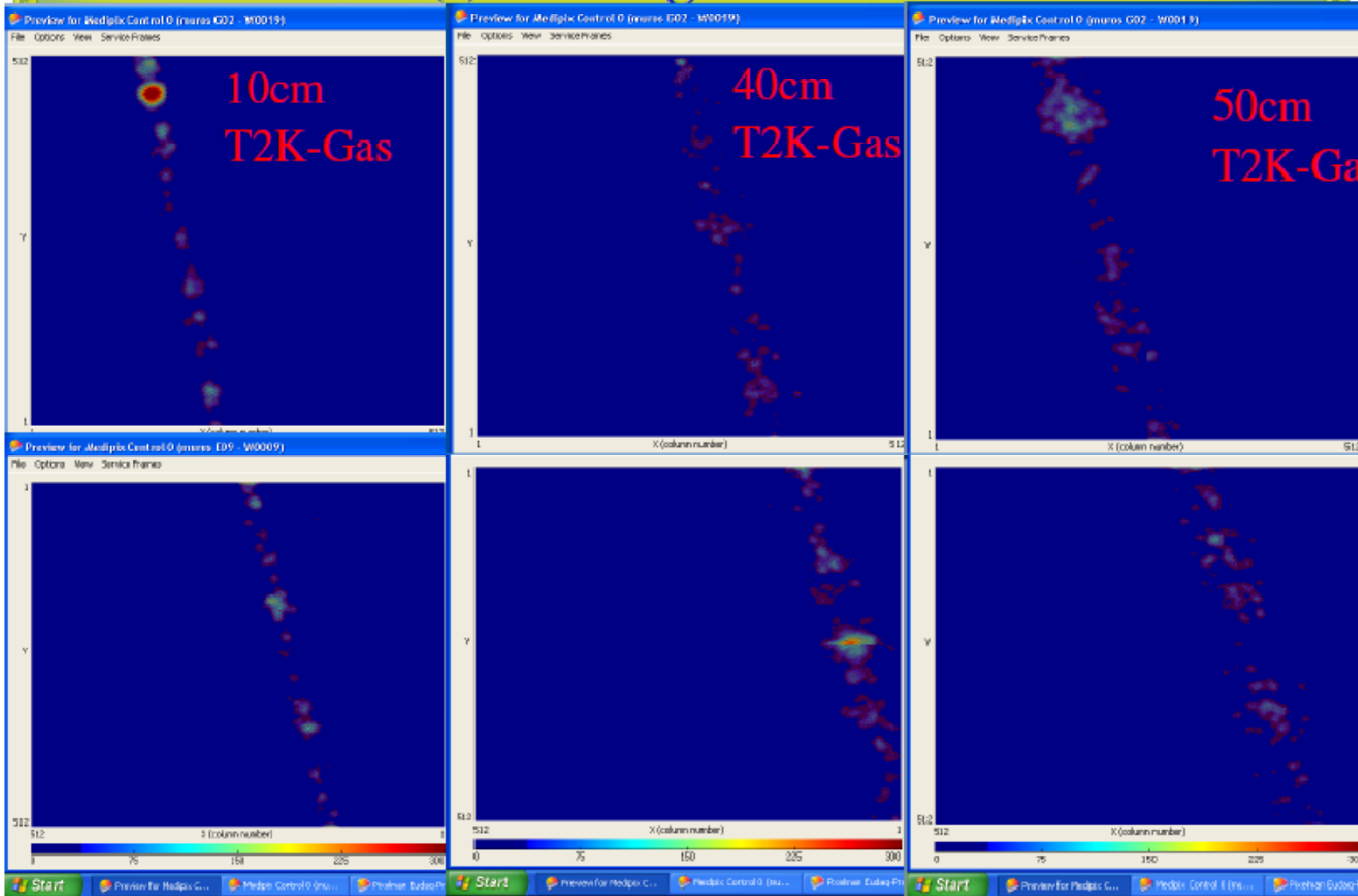
- Different drift distances
- Different angles
- Different particle energies
- Different GEM settings

T2K Gas:

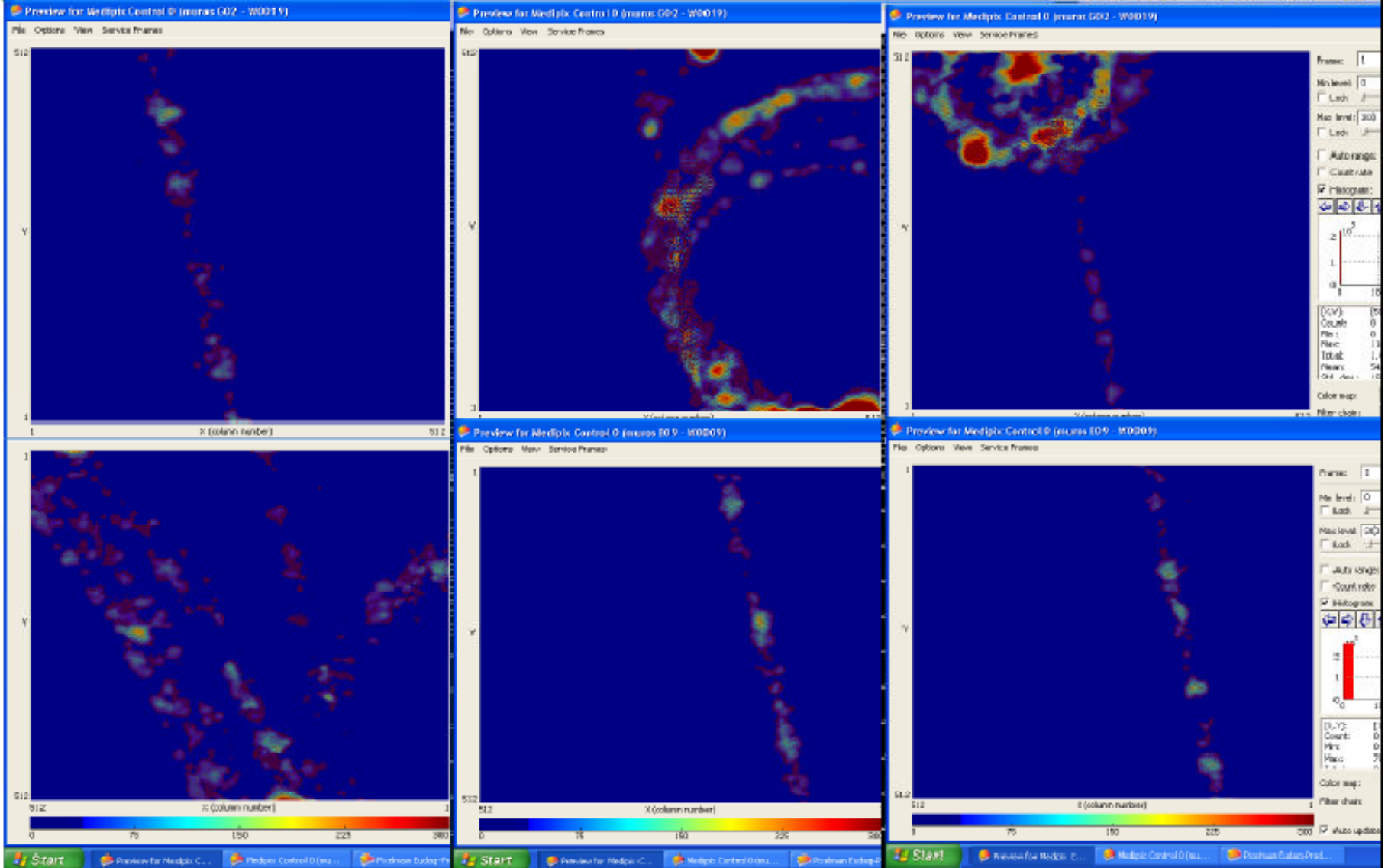
- Different drift distances
- Different angles
- Different particle energies
- Different GEM settings
- Laser dots



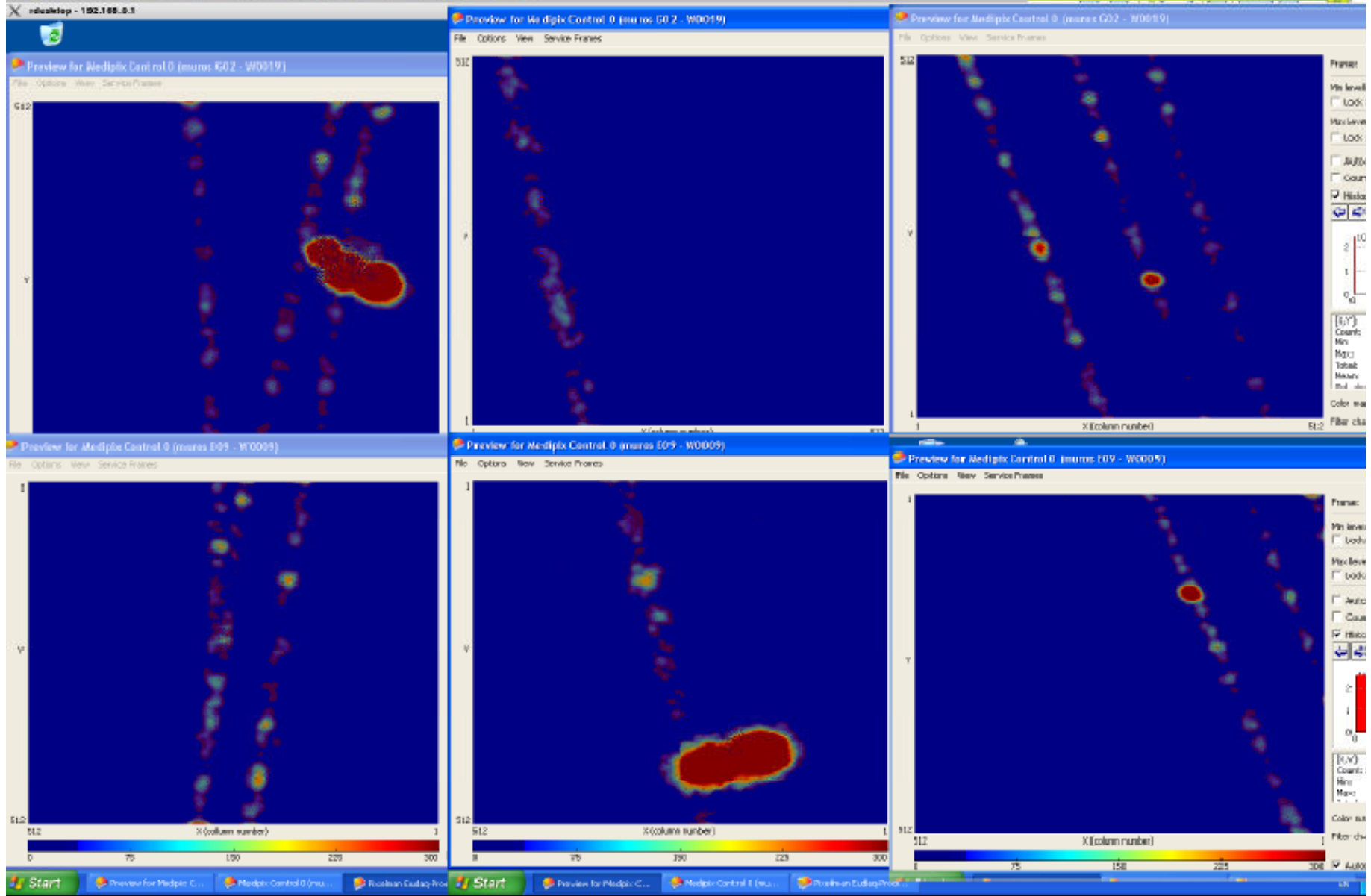
# Some Pictures (I) – straight tracks



# Some Pictures (II)

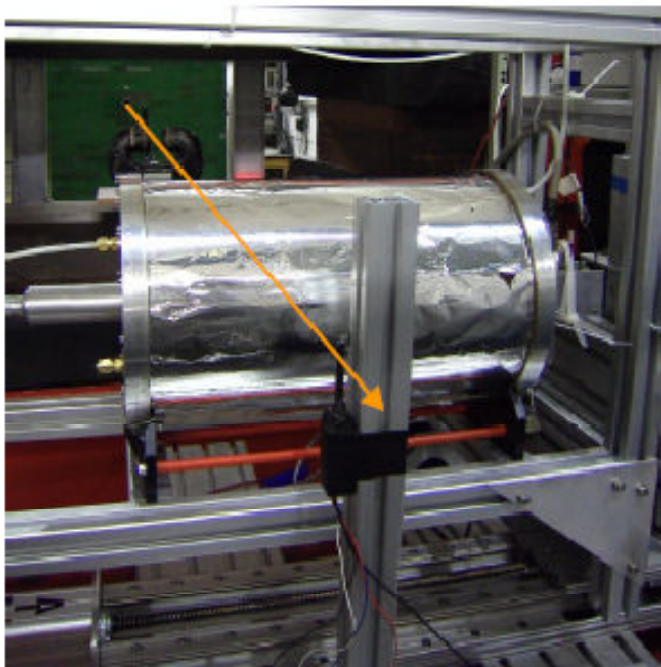
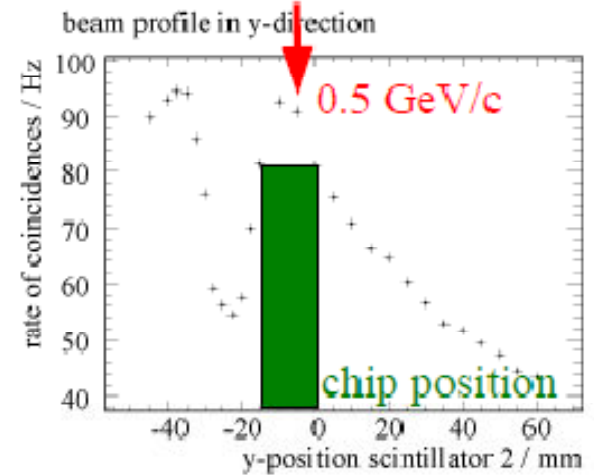
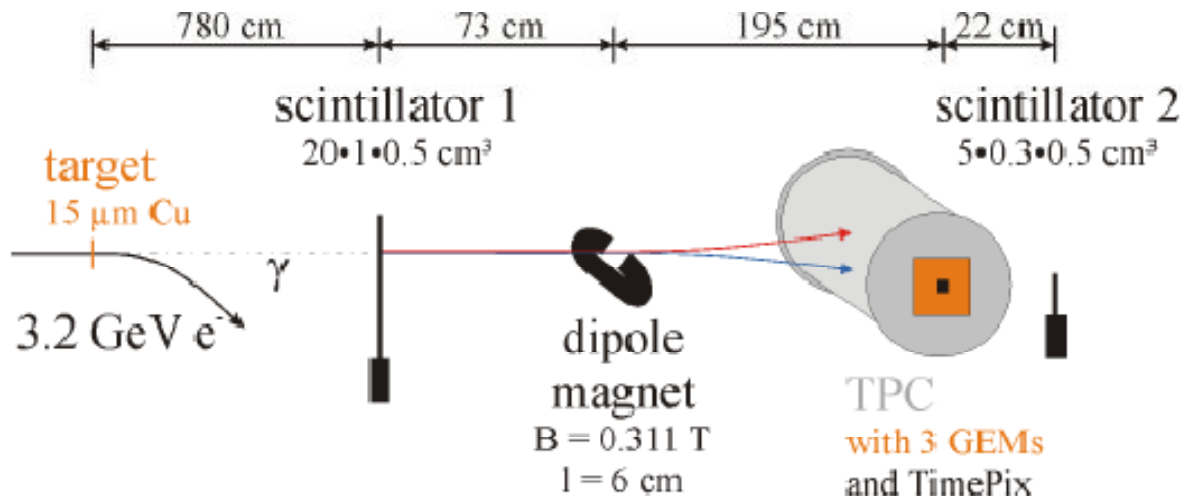


# Some Pictures (III)





# Test Beam Setup at ELSA, Bonn



- $\gamma$  were created at a target
- primary  $e^-$ -beam was dumped
- photons converted in scintillator 1
- dipole separated  $e^+e^-$
- coincidence of scinti 1 and 2 select single particle events



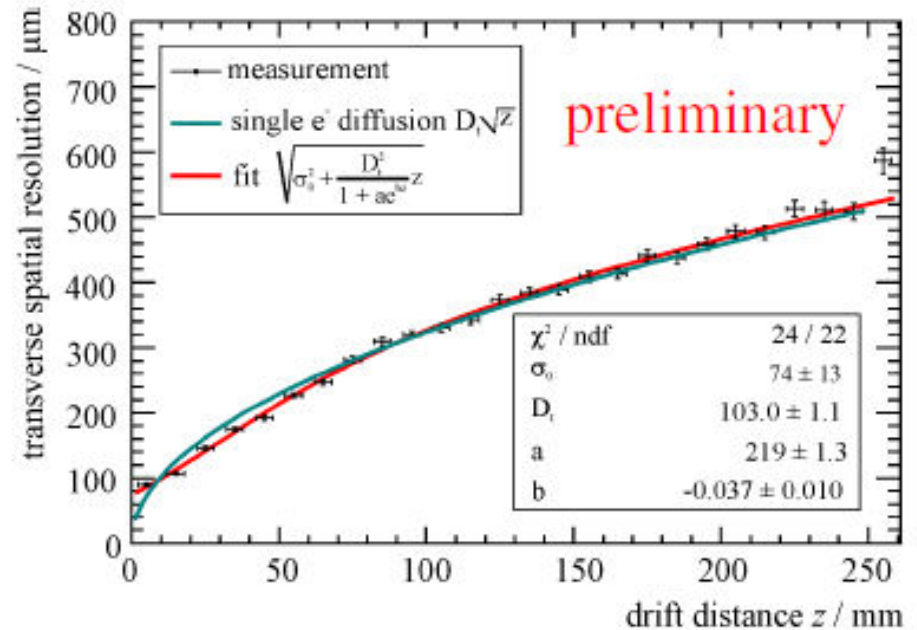
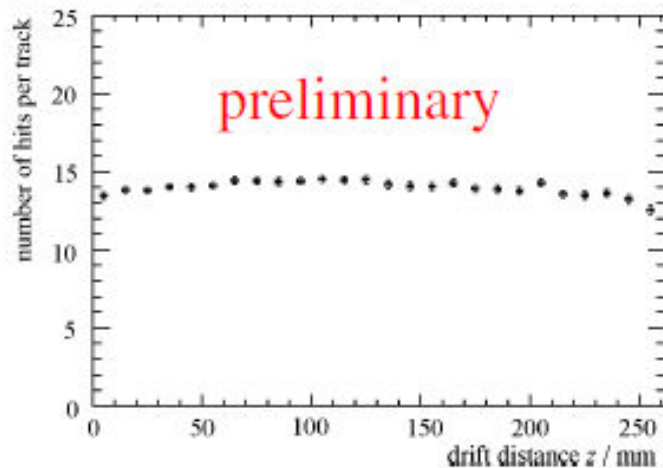
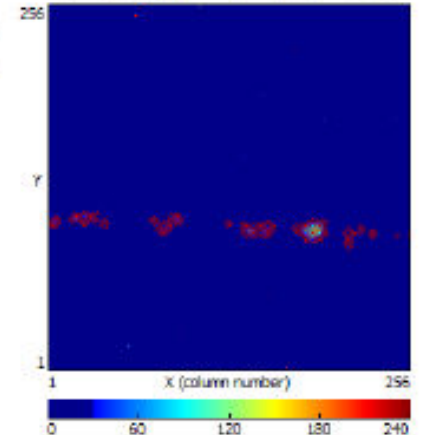
# High Magnetic Fields



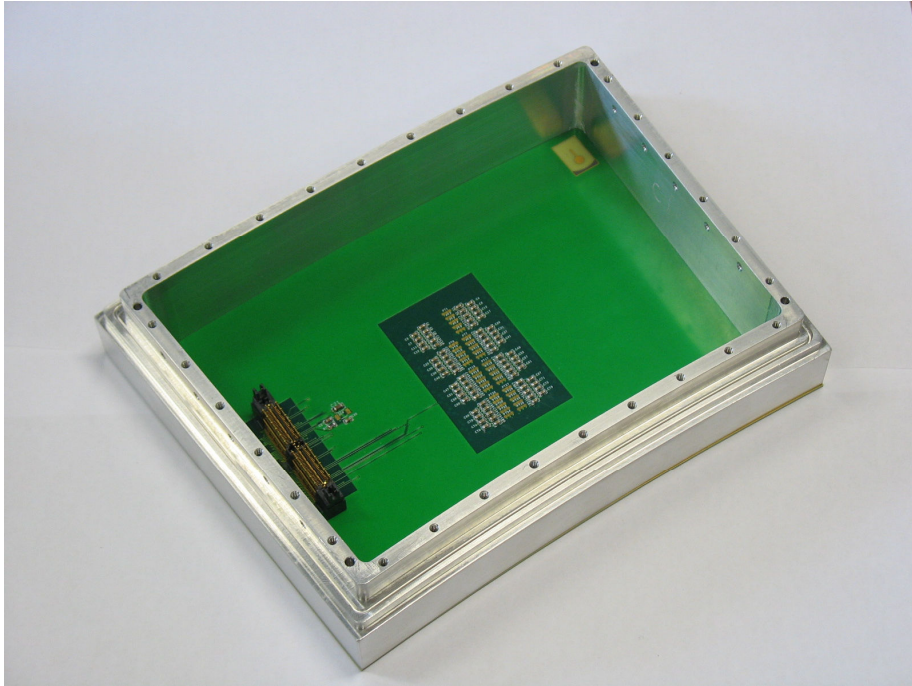
old ZEUS compensation magnet  
supraconducting solenoid  
reaches up to 5 T

detector is operated in magnet  
first results with low statistics

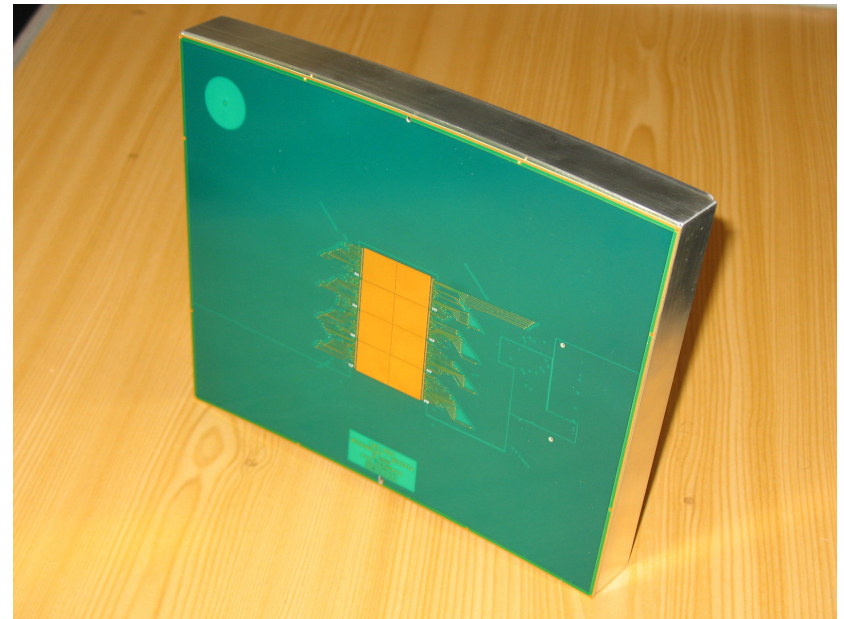
He:CO<sub>2</sub> 70:30  
at 4T



# Saclay

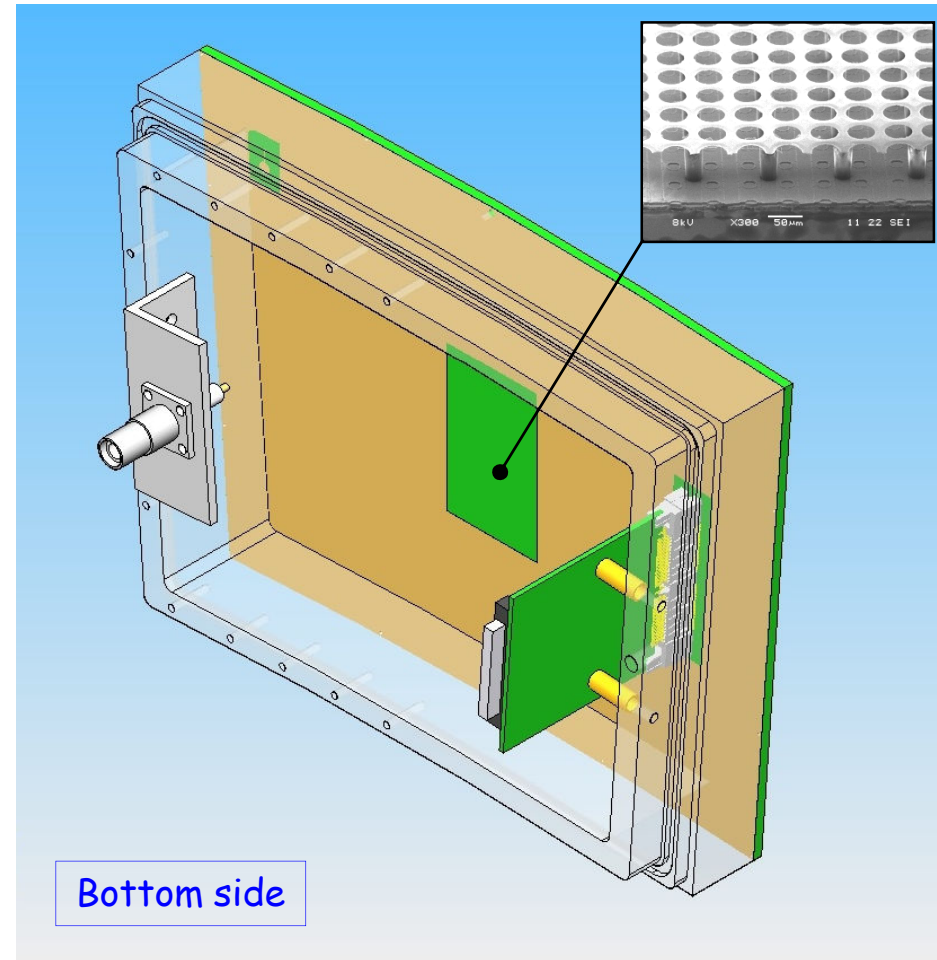
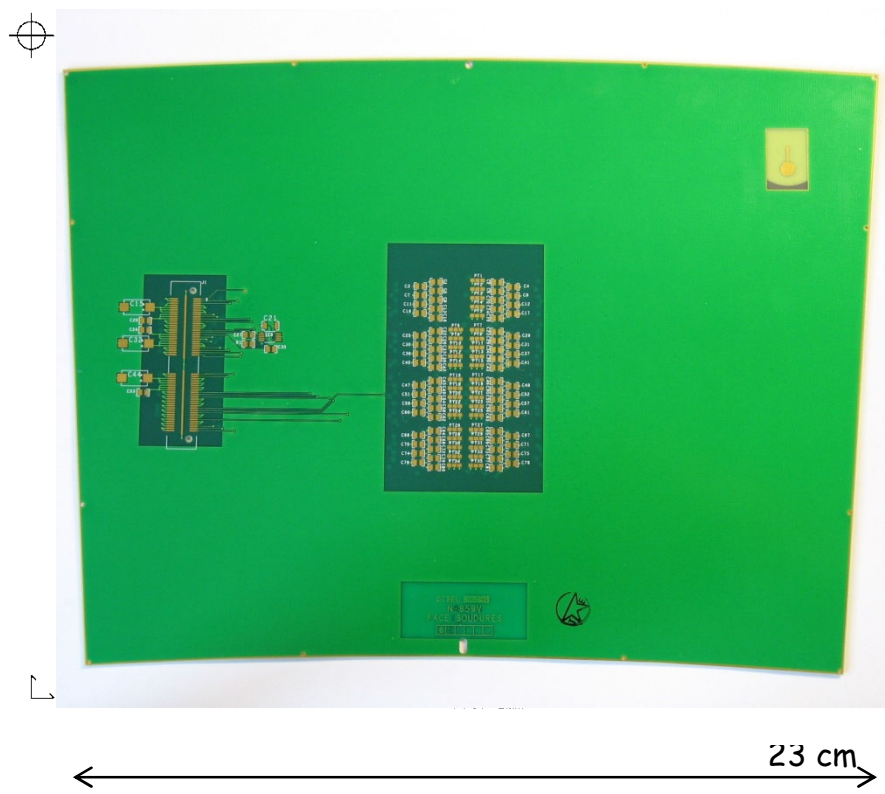


- 8 Timepix chips
- bug in Pixelman software fixed
- Now waiting for Ingrids from Nikhef/Twente
- Expect module for test in fall 2009



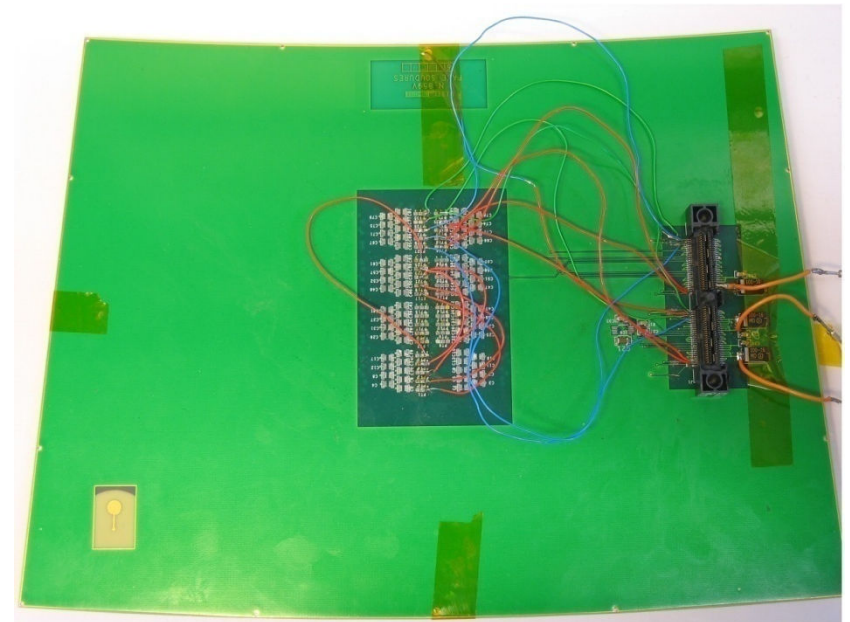
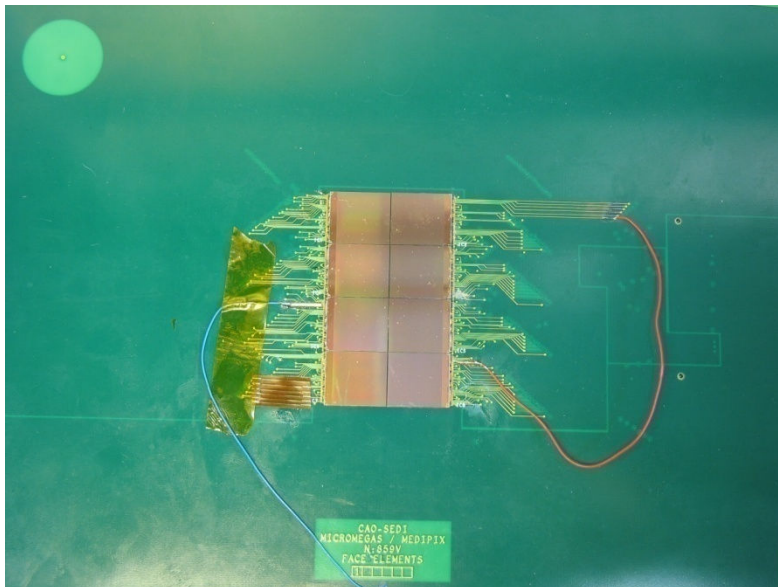
# TimePix/Ingrid Panel

- TimePix panel with a 2x4 matrix of TimePix chips + InGrids for the TPC Large Prototype
- 6-layers PCB
- Transfert card for VHDCI cable



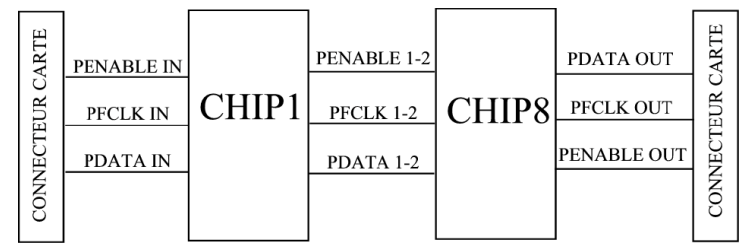
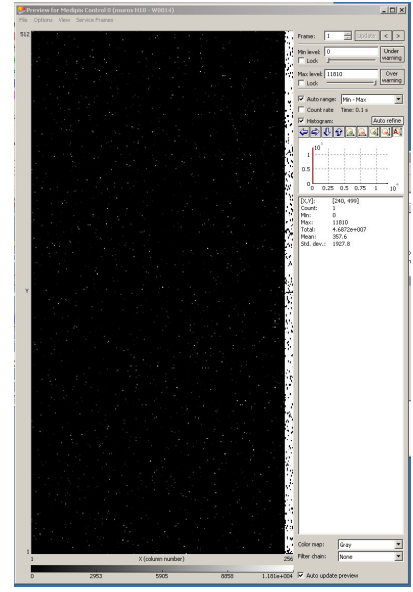
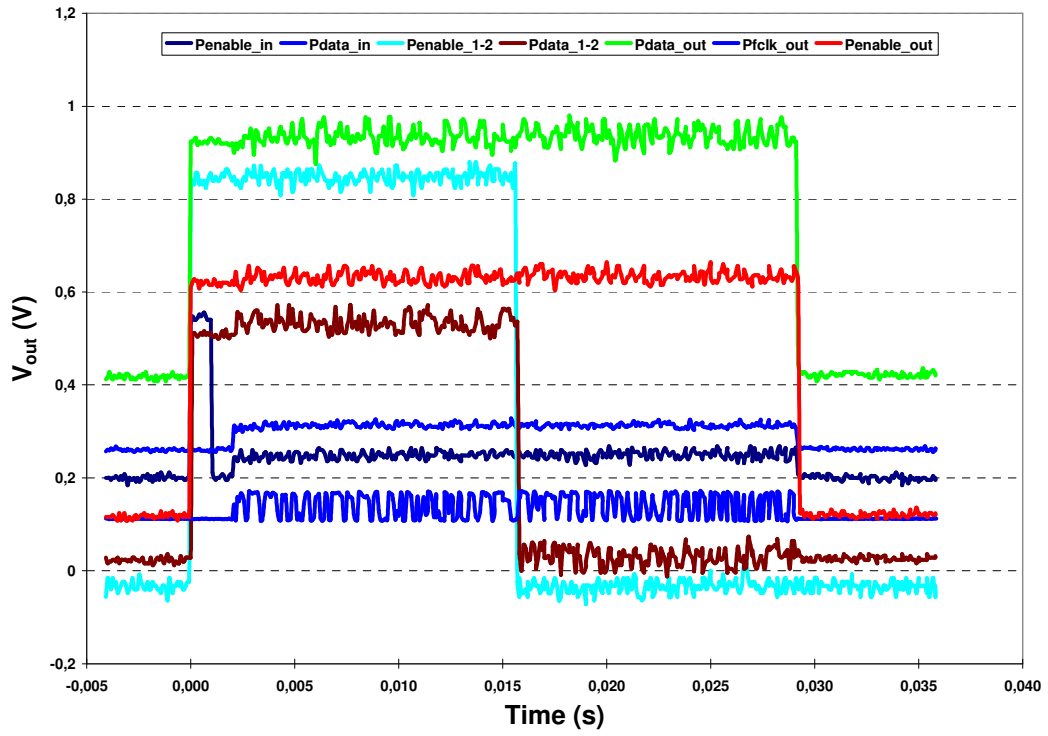


- 8 TimePix chips have been connected on the PCB
  - issues for the wire bonding
  - two chips were broken by the bonding factory
- Electrical test
  - an error of routing was found and corrected using external wires
  - power supply by MUROS only was insufficient (0.2 A per puce)
  - 3 voltage to stabilize (LV) to 2.2V



# Test with 2 chips

- The 8 chips were removed and replaced by only two
- New test at CERN (January 20<sup>th</sup>, 2009)
  - the hardware was validated
  - but, correction needed in the official software Pixelman

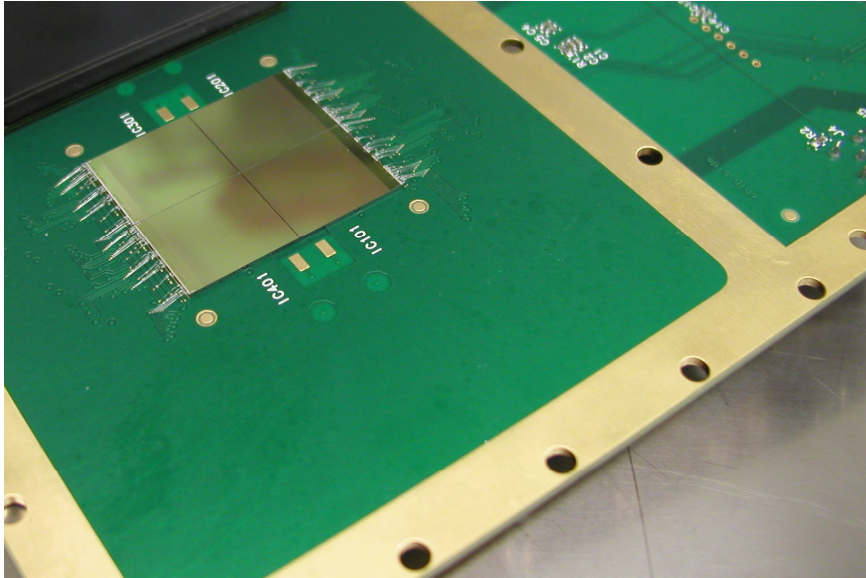


## New card in progress

- A new card was designed taking into account what we learn with the previous
- New design :
  - the 2x4 matrix is place on top a mezzanine to make easier the wire bonding
  - power regulators was implemented
- Waiting for Ingrid → a batch of 8 Ingrids is now ready at Nikhef
- Should be tested on the Large Prototype TPC by the end of this year

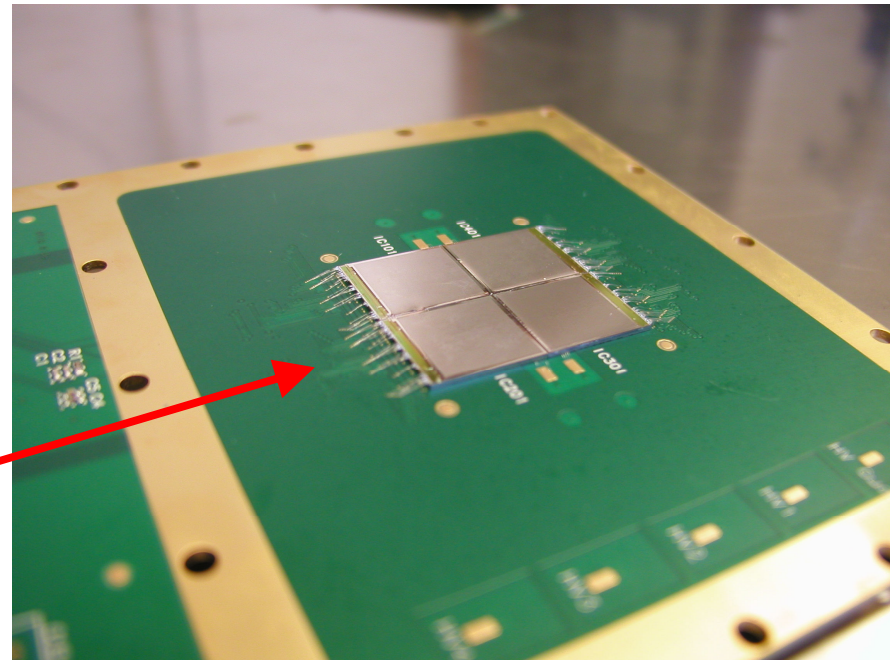


# NIKHEF: emphasis on Ingrids

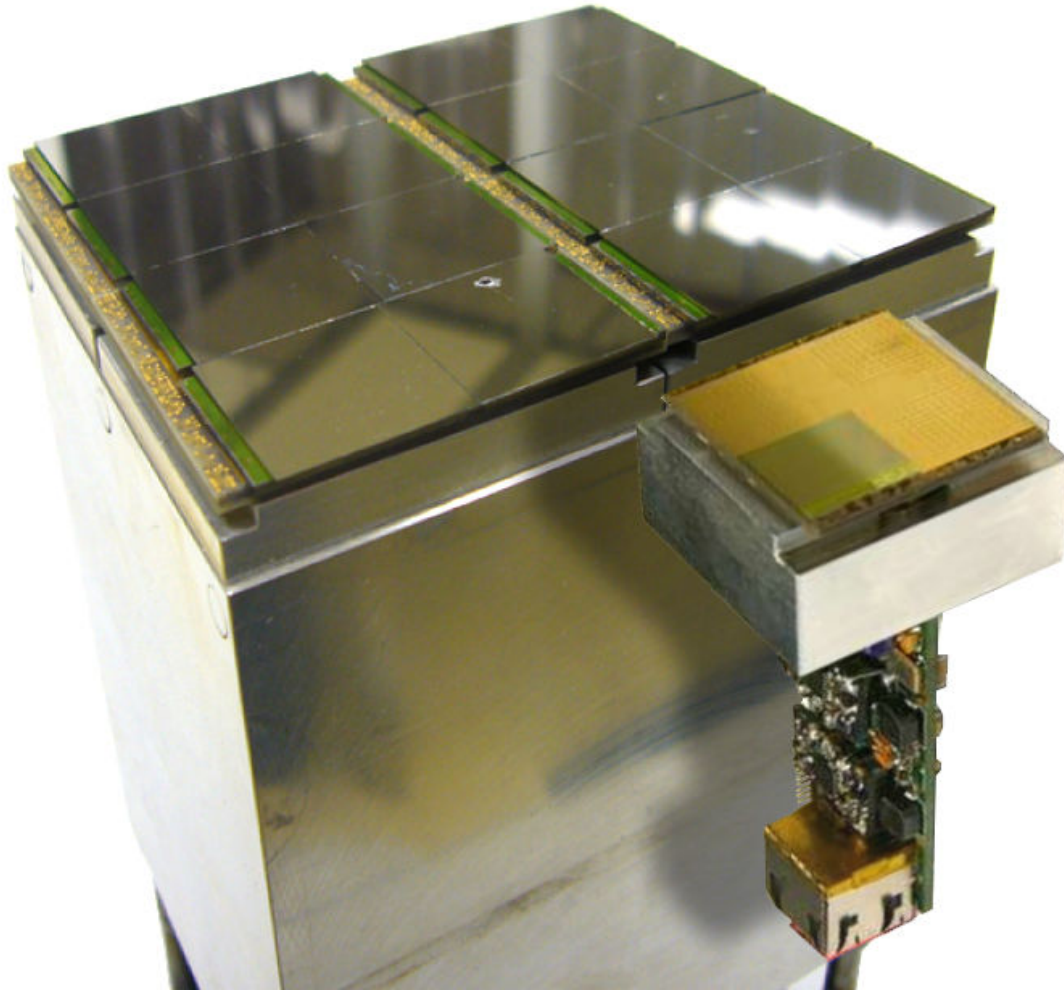


- within Relaxed project: 4x4 Medipix chips in compact mounting
- Will evolve in 8x8 Timepix chips for EUDET

- QUAD chips board tested OK in 2008
- Equiped with Ingrids in June '09
- Could become standalone "traveling" TA infrastructure



# NIKHEF



- within Relaxed project: 4x4 Medipix chips in compact mounting
- Will evolve in 8x8 Timepix chips for EUDET

Several single chip systems produced for:

- Test detector performance with different thickness of  $\text{Si}_3\text{N}_4$  protection layers (in DESY T22 beam)
- Test efficiency and resolution in Gossip-like geometry (only 1.5 mm gas layers) in CERN testbeam
- Data analysis in progress
- Sometimes still discharges that kill Timepix chips; some indication it is on the 'outside' edges of Ingrid/Timepix

All groups have established contacts with outside institutions for 8" wafer scale post-processing:

- Freiburg Metallforschungszentrum (pixel enlargement)
- IZM Berlin: Ingrid technology
- SMC (Scottish Microelectronics Centre) Edinburgh: Ingrid technology
- LAAS (CNRS) Toulouse (max. 6" wafers)

# Conclusions

- SITPC final infrastructure deliverable available (1<sup>st</sup> “leg”)
- Waiting for sufficient number of Ingrids to equip 2<sup>nd</sup> “leg”; 8 Ingrids available now
- Test of 2<sup>nd</sup> “leg” at LP before end 2009
- 3<sup>rd</sup> “leg” with Quad-Ingrid detector(s) ready for tests in few weeks.

# Backup slides



# SITPC TA plans

- **GEM + (2 x 4) Timepix in LP endplate module** (Bonn) under test in June 2009 @ DESY. Can be made available also with standalone gas testbox.
- **8 x (Ingrid + Timepix) in LP endplate module** (Saclay + Nikhef) under test (expected) in summer 2009 @ DESY. Can be made available also with standalone gas testbox. Unfortunately no longer 4T magnet available at Saclay.
- **4 x (Ingrid + Timepix) in small standalone detector(s)** @Nikhef (possible in 1T magnet) and elsewhere. Will be under test summer 2009.
- 64 x (Ingrid + Timepix) system planned @Nikhef; could eventually be made available for TA.