Pixel-TPC testbeam

Michael Lupberger

LCTPC-pixel meeting #16, November 20, 2014, Bonn

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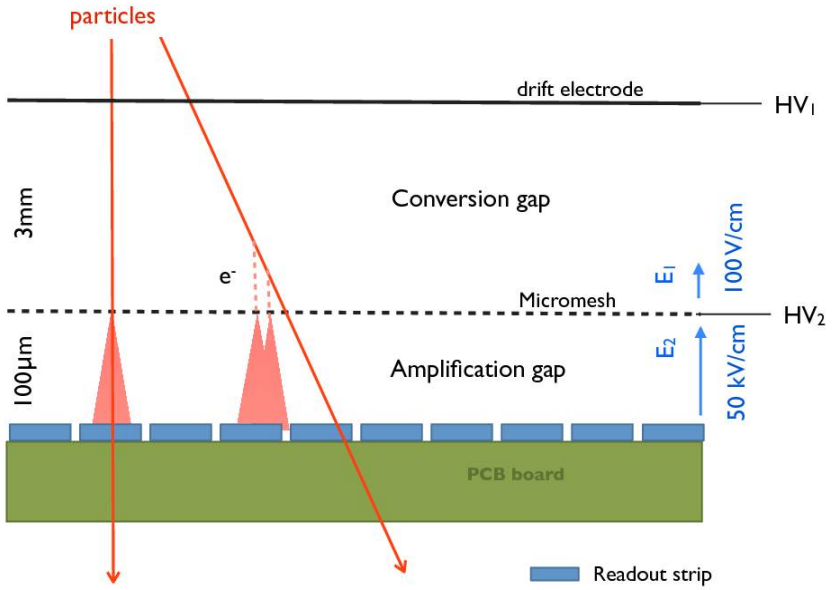
Detector concept

Micro-pattern gaseous detectors (MPGDs):

- Primary ionisation of gas molecules by particle (drift region)
- Charge multiplication (amplification region)
- MPGDs: amplification structure
  O(10 µm): GEM or Micromegas
- Charge readout:
  O(1 mm) pads/strips or O(10 µm) pixel



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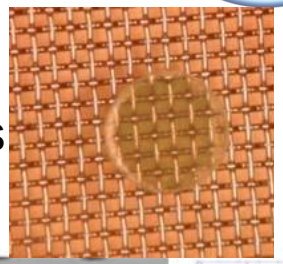
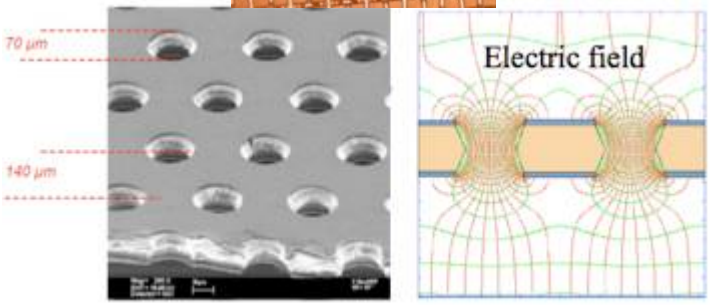
Problem

Gaseous detector development technology of today: MPGDs

Gas amplification stage:
- GEM
- Micromegas

Micromegas mesh





GEM

Anode to read out signal: Pads with size of 1x5 mm²

Structure of GEM/Micromegas: O(10 µm)

→ Spoil detector resolution

Solution: Readout of same size: Pixelated MPGDs

Padplane

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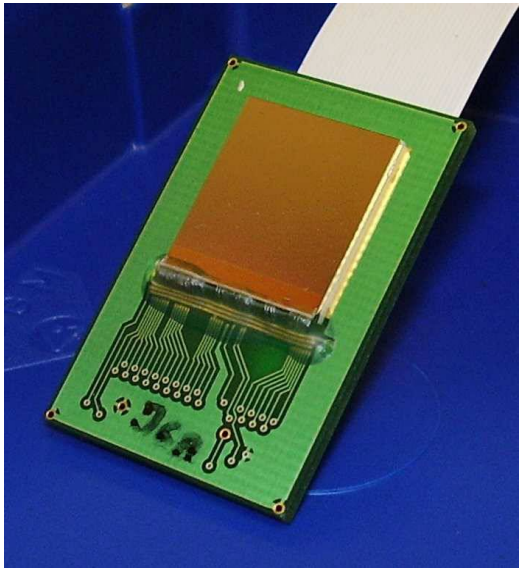
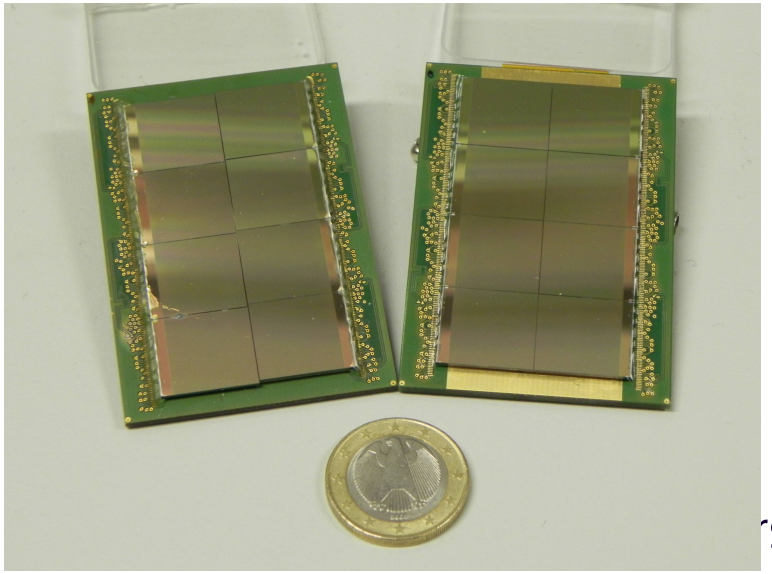
Timepix chip

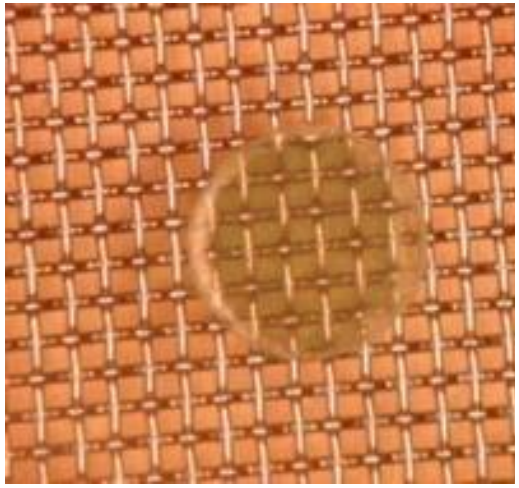
Properties:

- active surface: 1.4 x 1.4 cm²
- pixel size 55 x 55 µm²
- 256 x 256 pixel array
- 14 bit counter in each pixel (ToA or ToT)
- Noise threshold ~500e^- (ENC ≈ 90e^-)



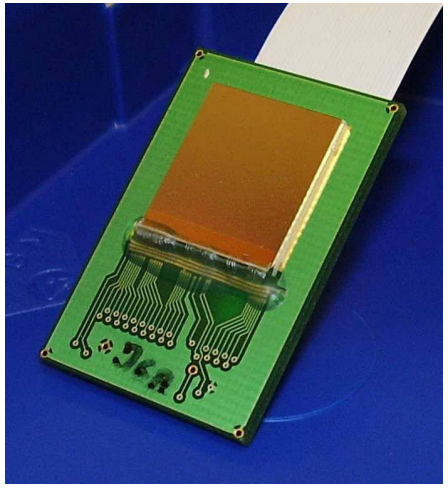


Micromegas mesh



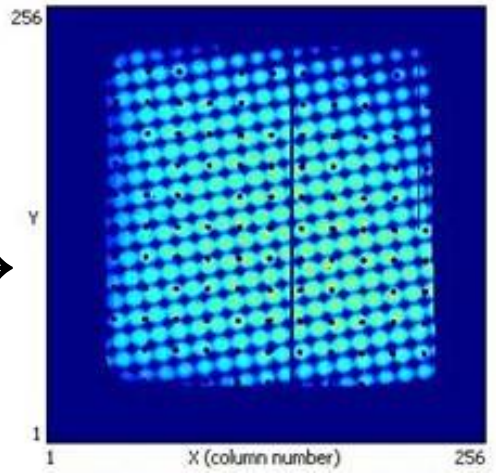
Micromegas mesh

+

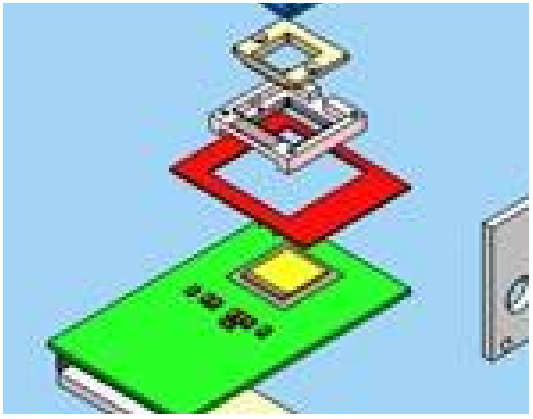


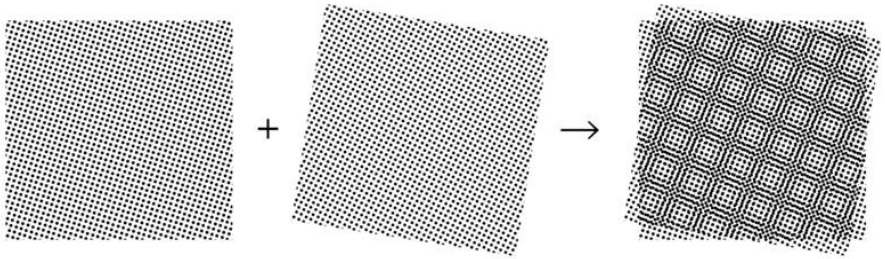
Timepix chip

→



Moiré pattern





The Detection of single electrons by means of a micromegas-covered MediPix2 pixel CMOS readout circuit

M. Campbell et al., Nucl. Instrum. Methods Phys. Res., Sect A 540 (2005) 295

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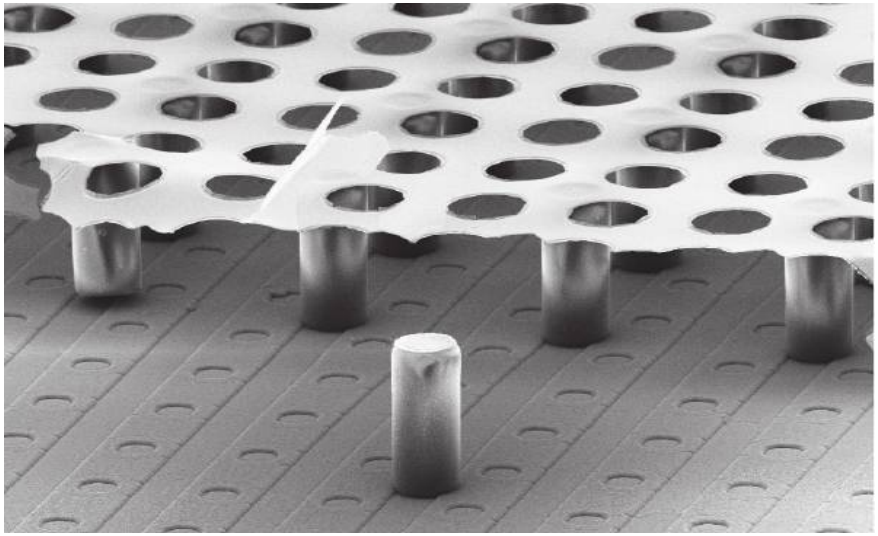
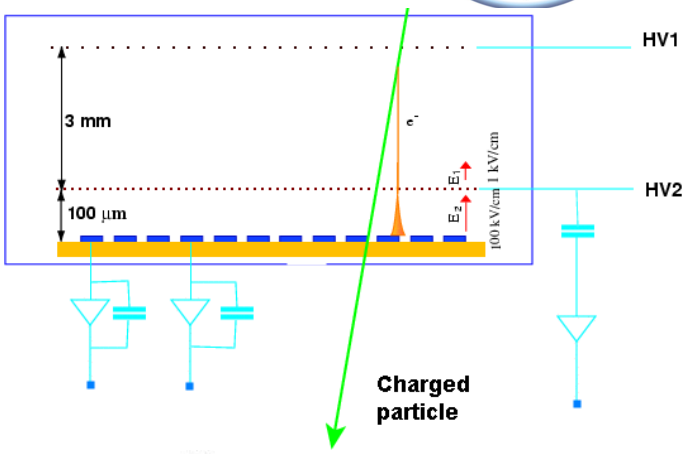
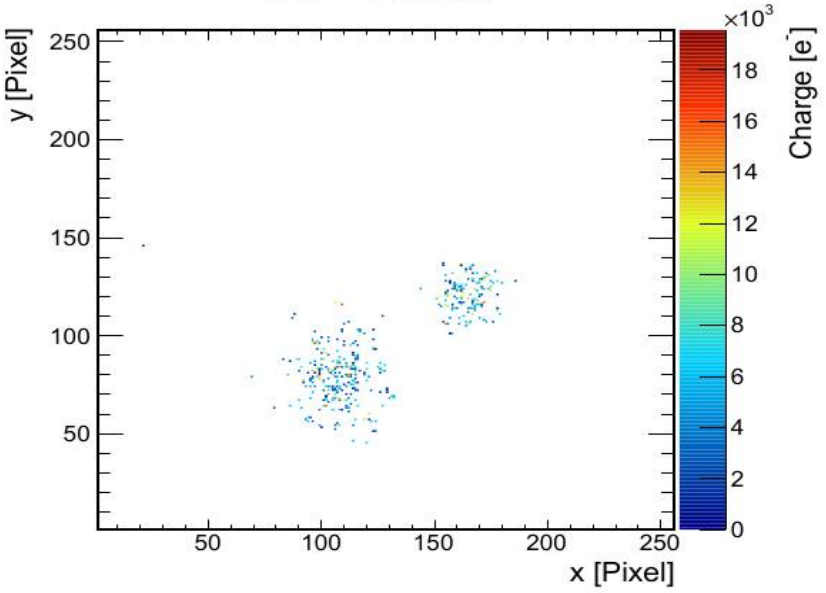
Timepix+Micromegas=InGrid

- Aluminium mesh on chip
  - Hole to pixel alignment
  - Pillar height uniformity







- Use photolithographic process
  - Pioneered and optimised by NIKHEF and University of Twente
  - Production on single chip basis

Problem

- One Timepix chip: 1.4 cm x 1.4 cm = 2 mm²
- ILD TPC: several m²

→ need many many chips!

- Demonstrate, that this is possible
  - Use modulatity: ILD TPC endplate build of modules
  - Show that one can build a pixelised module
  - Use InGrid technology

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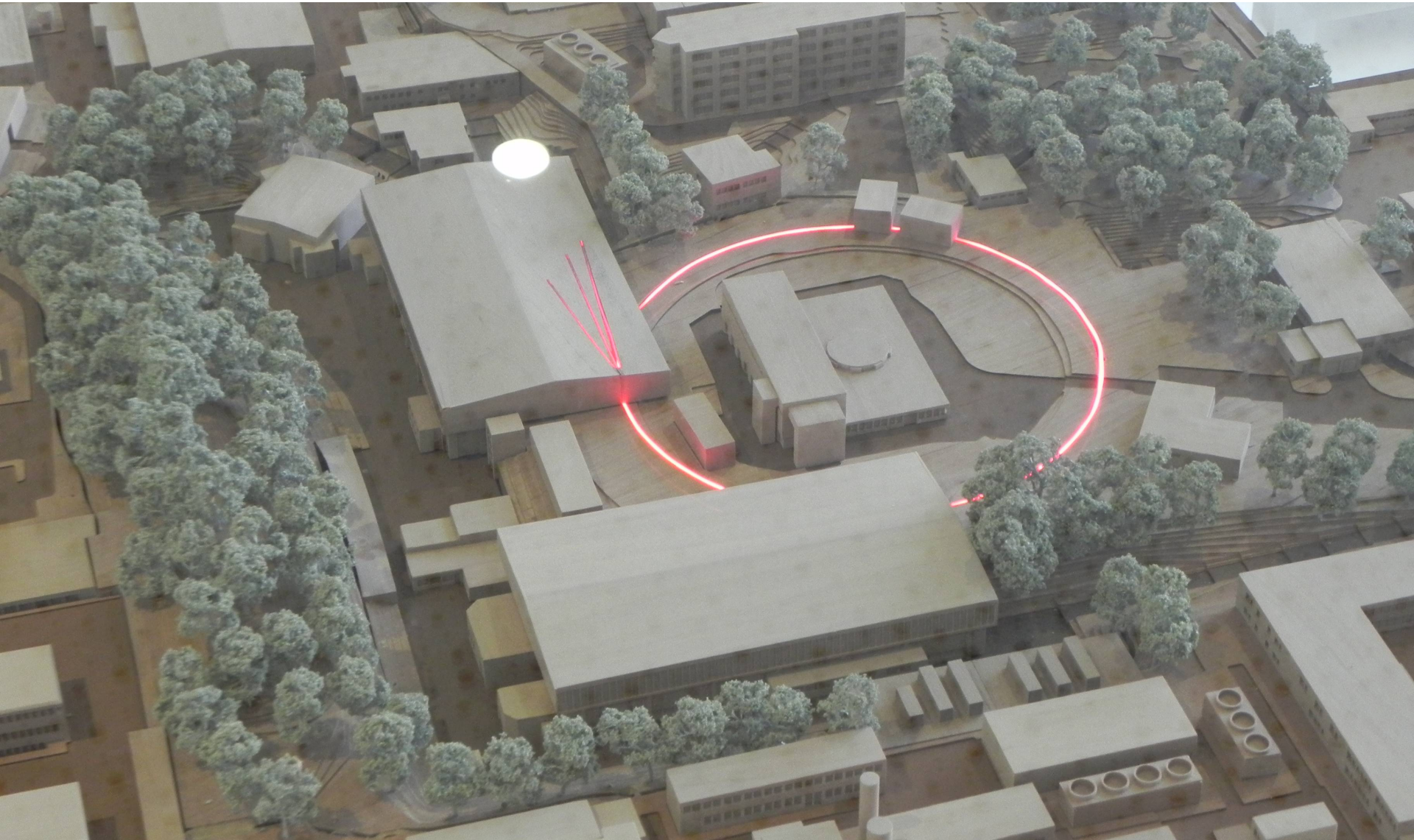
Testbeam: DESY II



Testbeam area T24/1

PCMAG (1T magnet) + TPC Prototype

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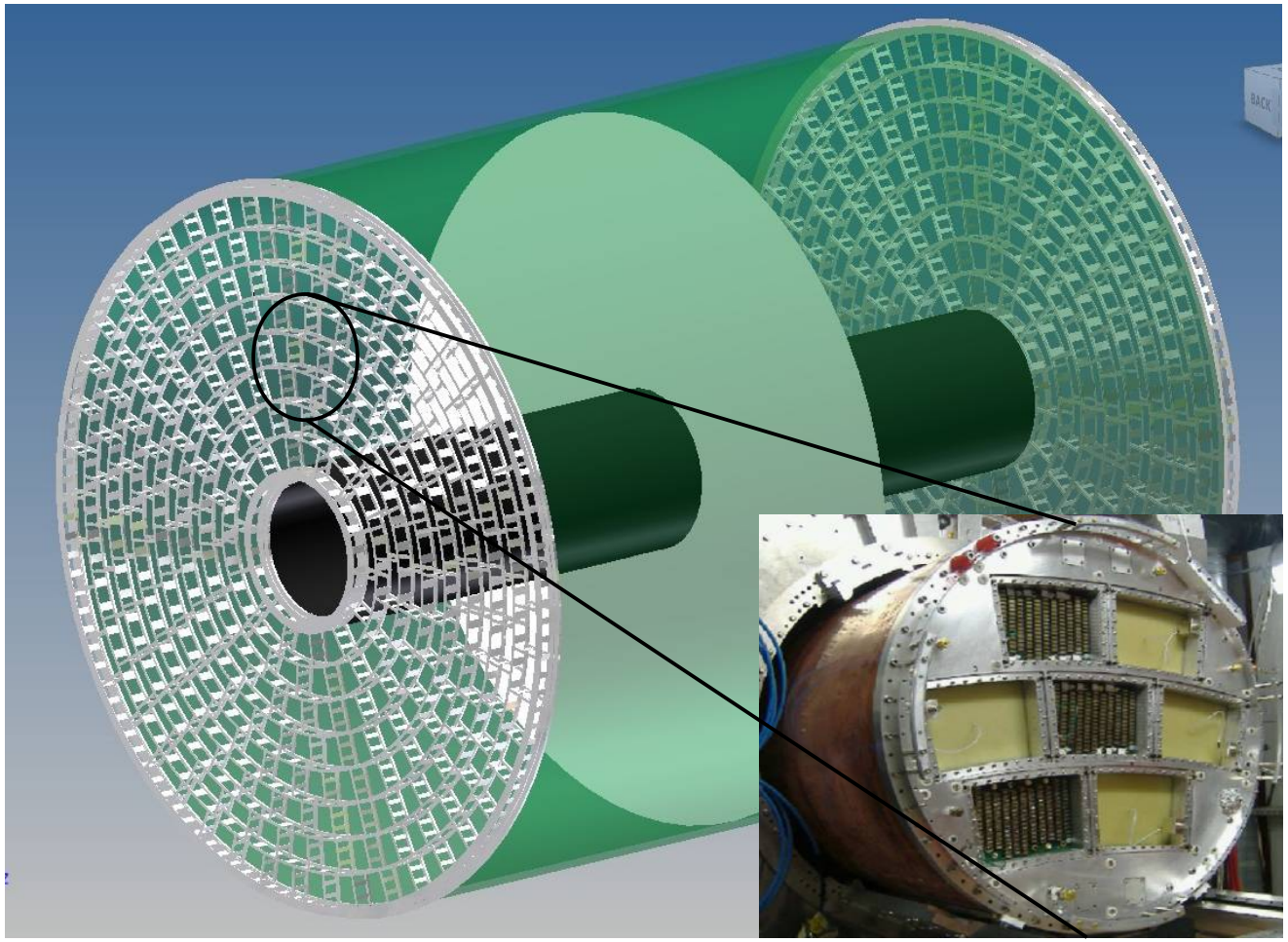
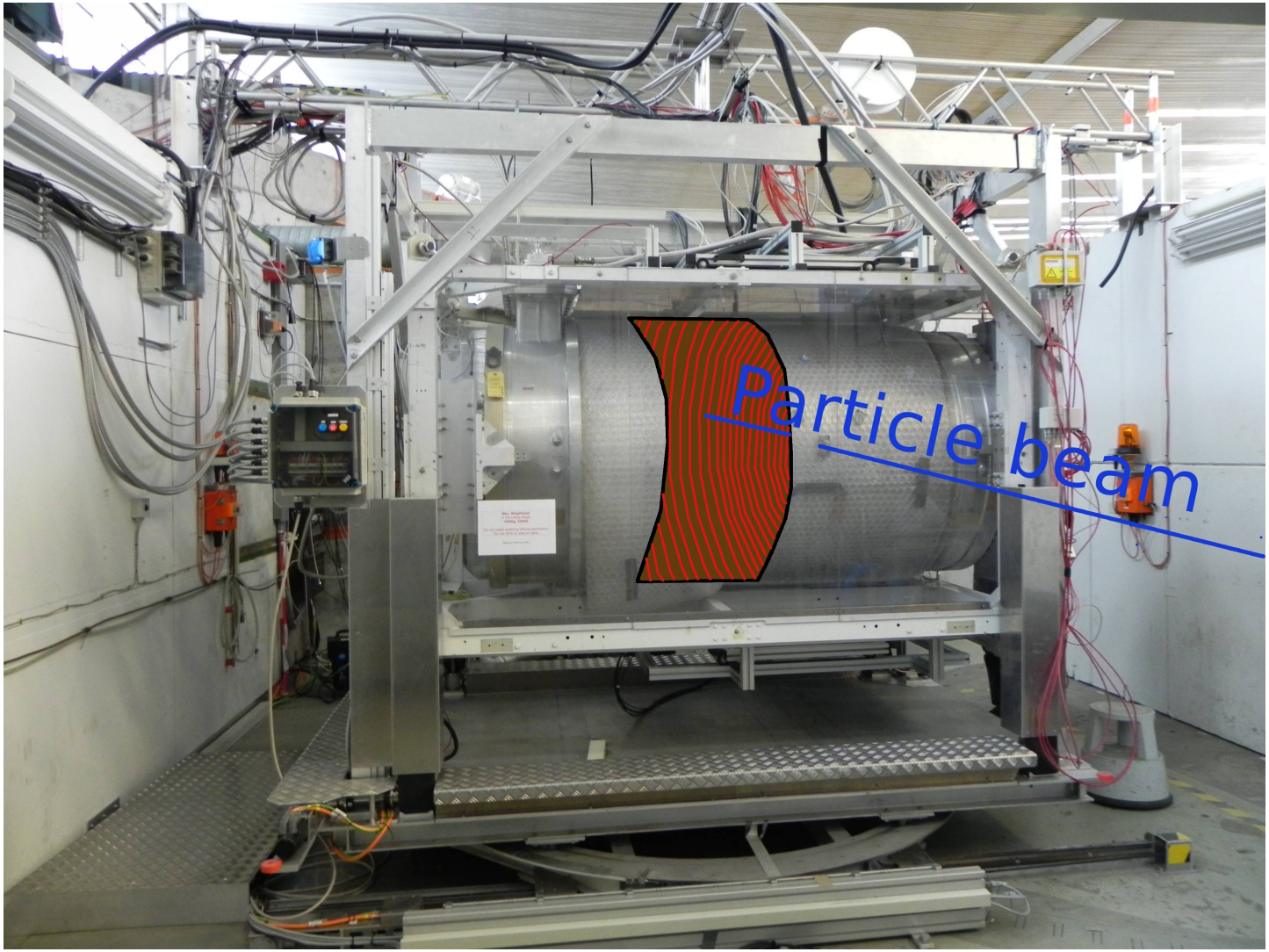
Testbeam area T24/1

PCMAG (1T magnet) + TPC Prototype



Prototype for ILD (Detector at ILC) TPC

TPC



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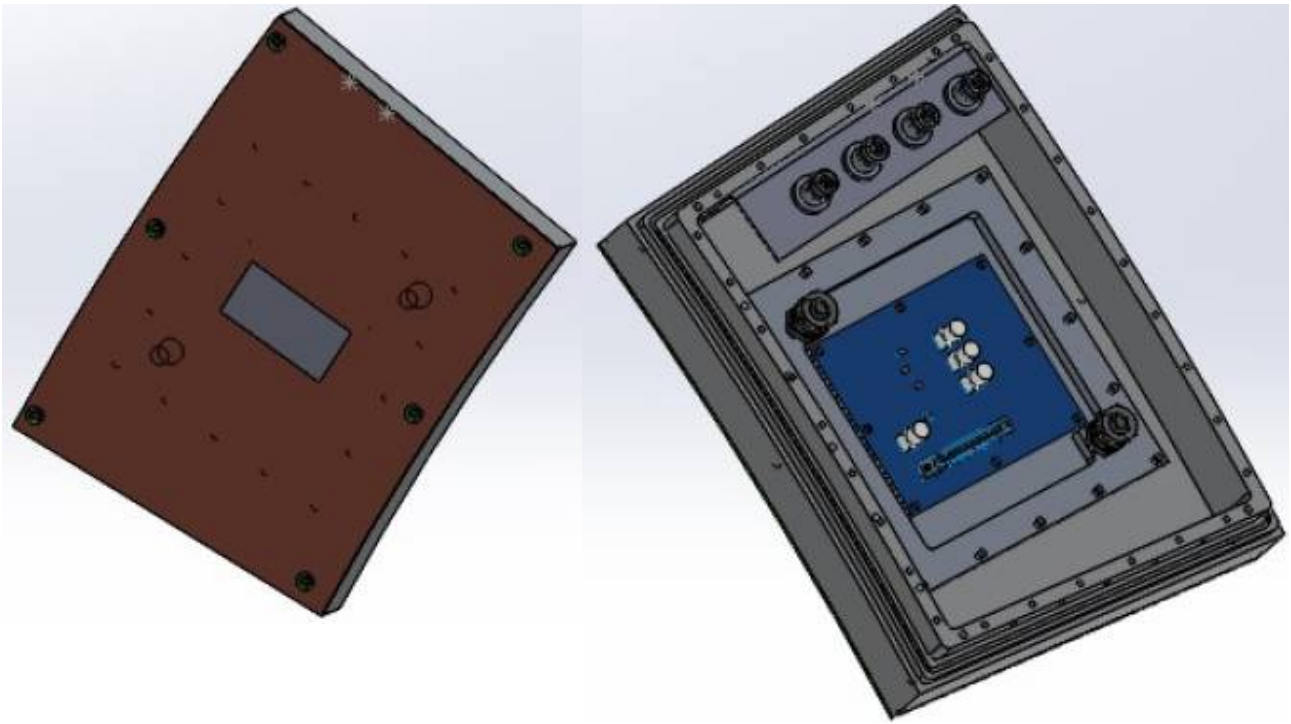
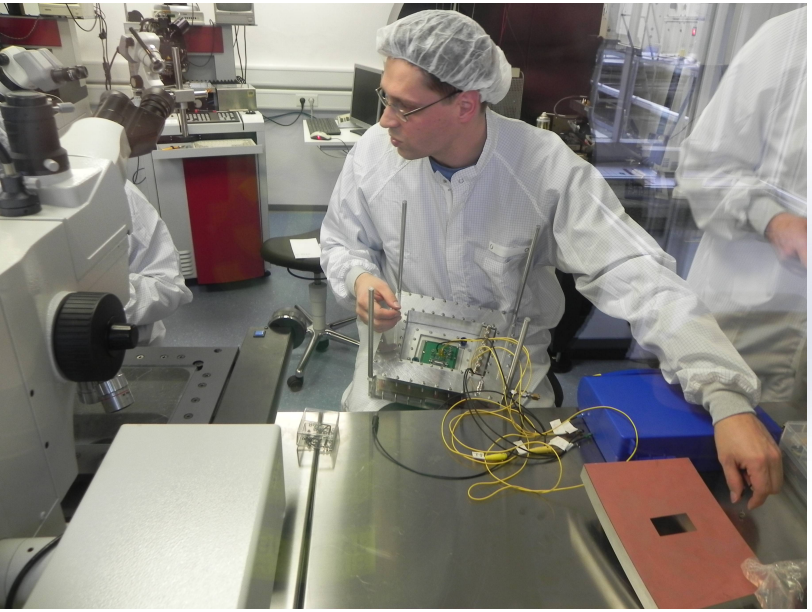
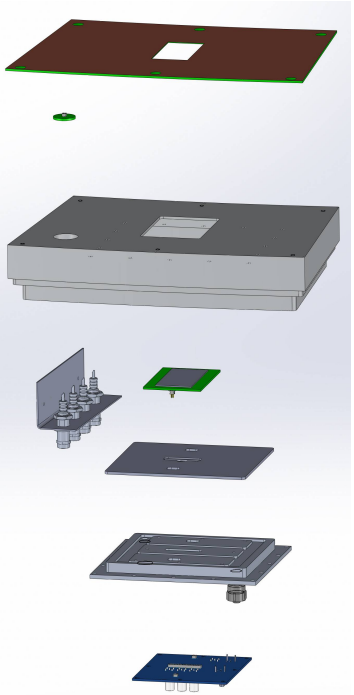
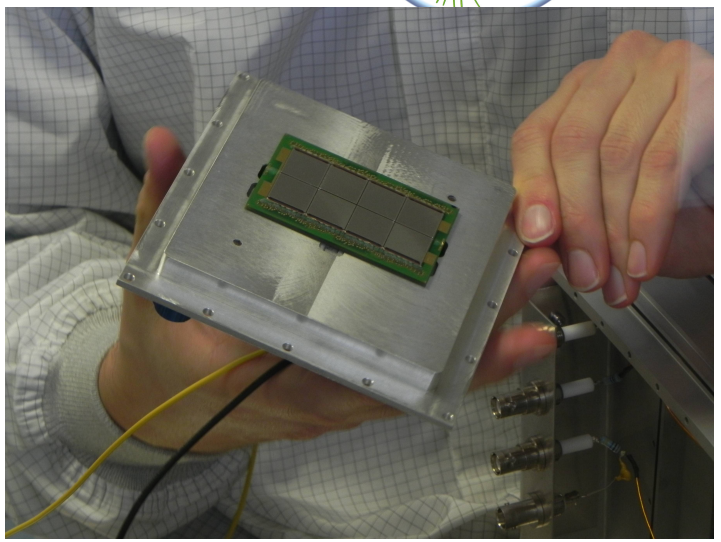
Testbeam 2013

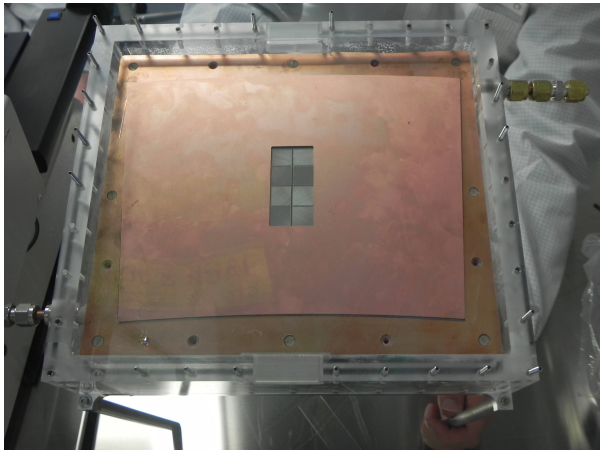


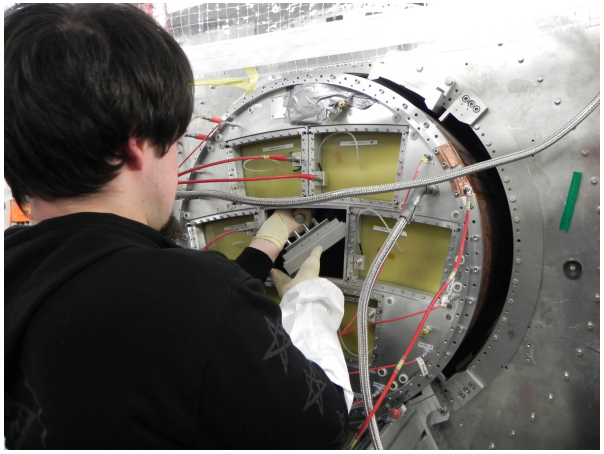
Testbeam 2013

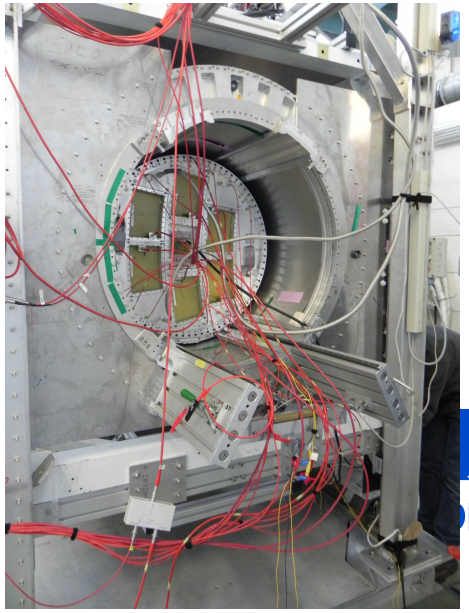




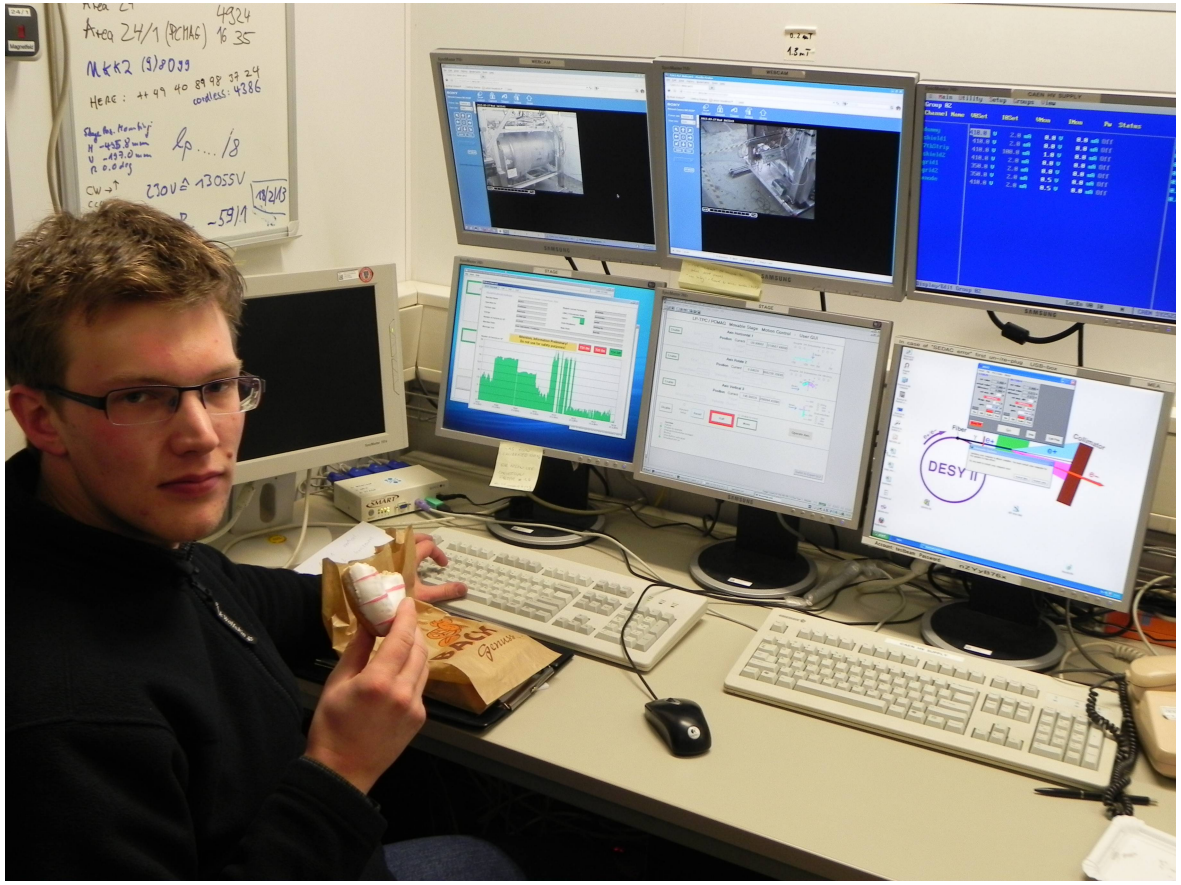








Testbeam 2013



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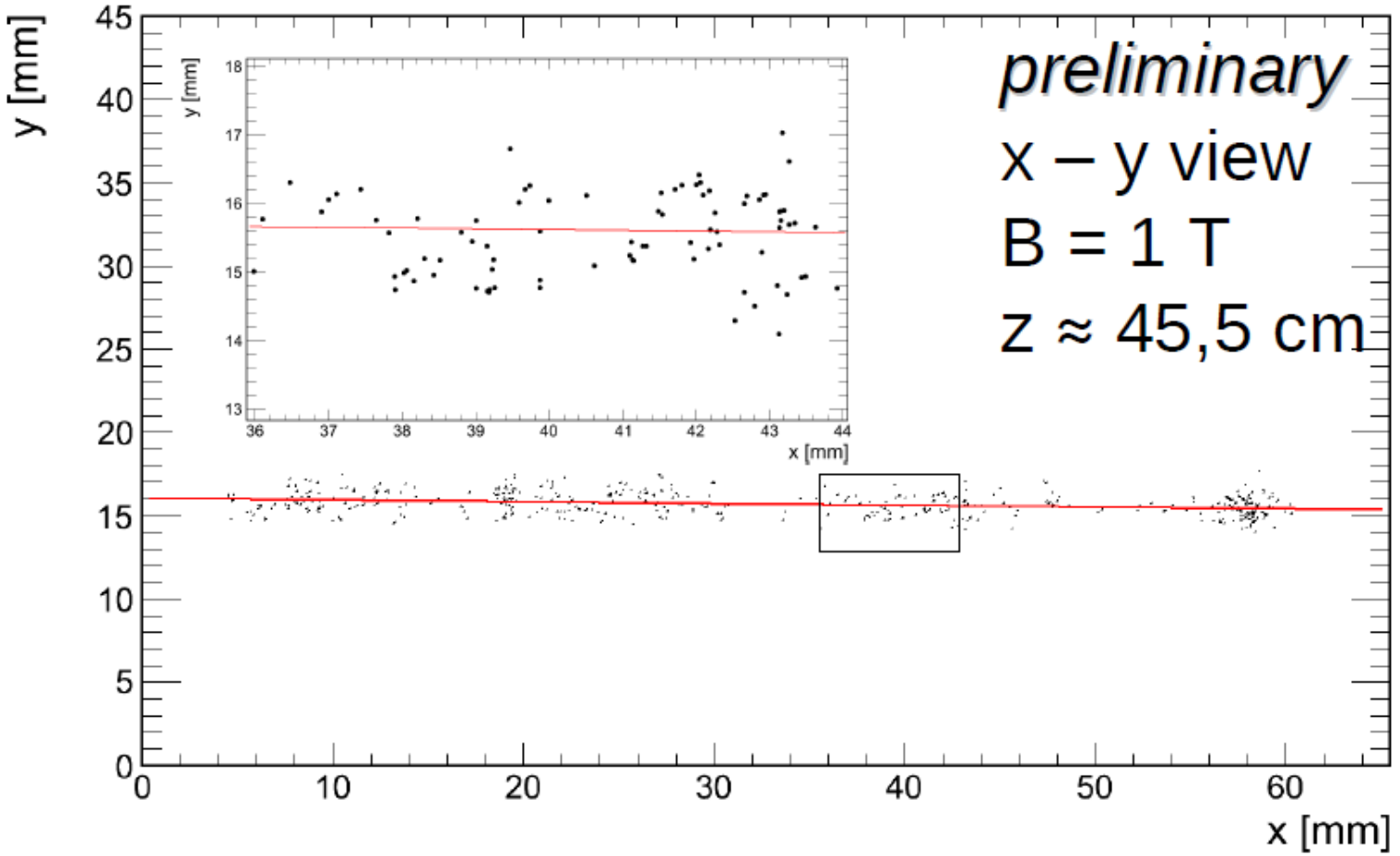
Testbeam 2013



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Testbeam 2015

DESY Testbeam Schedule 2015 - Version 1 - 16/11/2014

Ralf Diener, Norbert Meyners, Marcel Stanitzki - DESY Test Beam Coordinators

	Week		TB21		TB22		TB24/1		TB24	
			DATURA	none	ACONITE/DURANTA	none	EUDET in PCMAG	PCMAG	none	
5-Jan-15	2									
12-Jan-15	3		Startup		Startup		Startup			
19-Jan-15	4		CMS-Pixel-Ph1							
26-Jan-15	5									
2-Feb-15	6									
9-Feb-15	7		ALICE-ITS		CLIC-PiX					
16-Feb-15	8							LCTPC96-InGrid		
23-Feb-15	9				CALICE-AHCAL			LCTPC96-InGrid		
2-Mar-15	10							LCTPC-Micromegas		
9-Mar-15	11				Mue3			LCTPC-Micromegas		
16-Mar-15	12				ATLAS ITK Pixel				PICSEL	
23-Mar-15	13				ATLAS ITK Pixel					
30-Mar-15	14		ALICE-ITS		ATLAS ITK Pixel					
6-Apr-15	15		CMS-Pixel-Ph1							
13-Apr-15	16									
20-Apr-15	17		CMS-Pixel-KA		ATLAS-Strip-Module		LorentzAngle			
27-Apr-15	18				ATLAS-Strip-Module		LorentzAngle			
4-May-15	19									
11-May-15	20								SiPM	
18-May-15	21		CMS-TRK-EPi						SiPM	
25-May-15	22									
1-Jun-15	23				CALICE-AHCAL		LorentzAngle			
8-Jun-15	24						LorentzAngle			
15-Jun-15	25		CMS-Pixel-Ph1						PICSEL	
22-Jun-15	26									
29-Jun-15	27									

Announced

With this week: 14 weeks left (including Christmas and new year)

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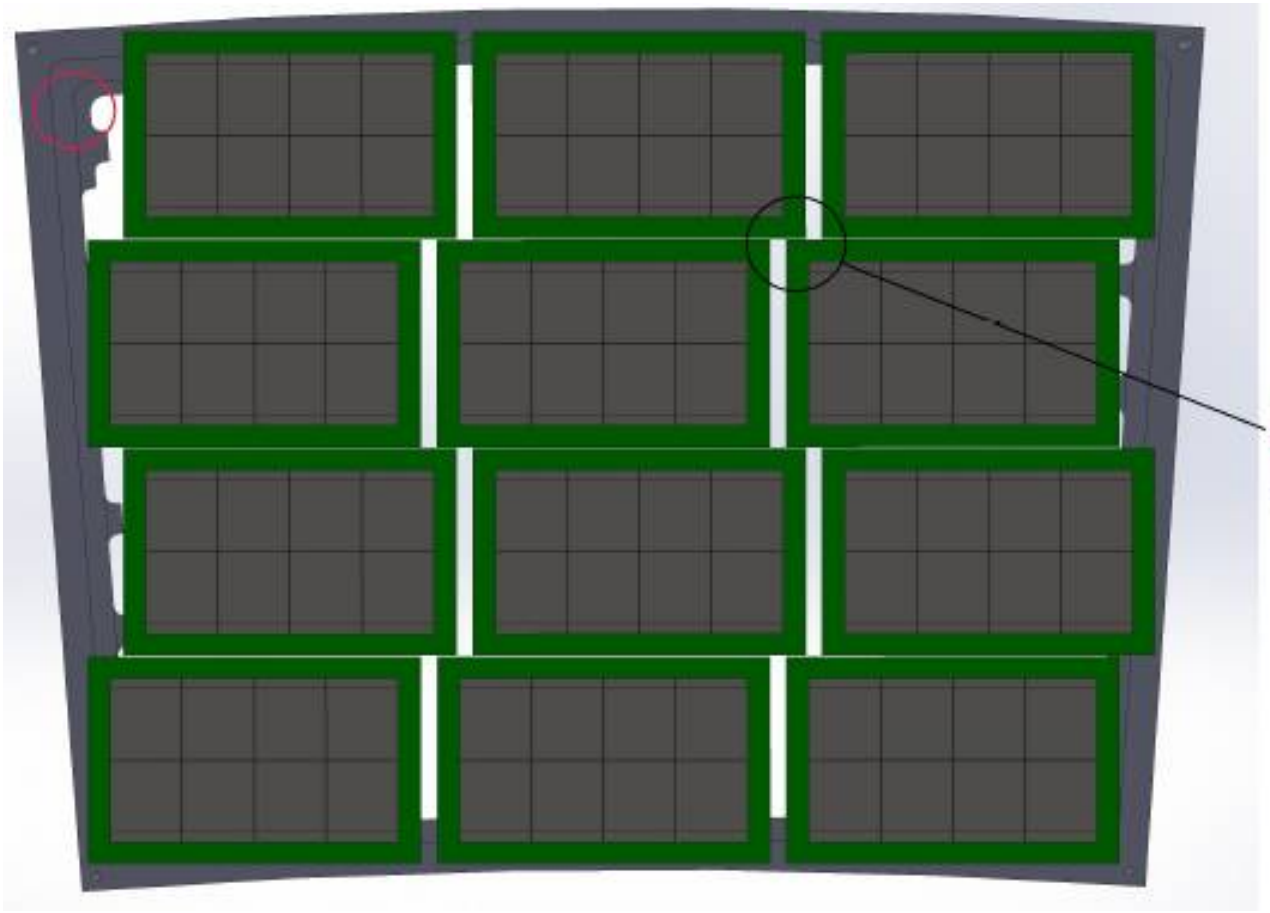
Setup

96 Chip module



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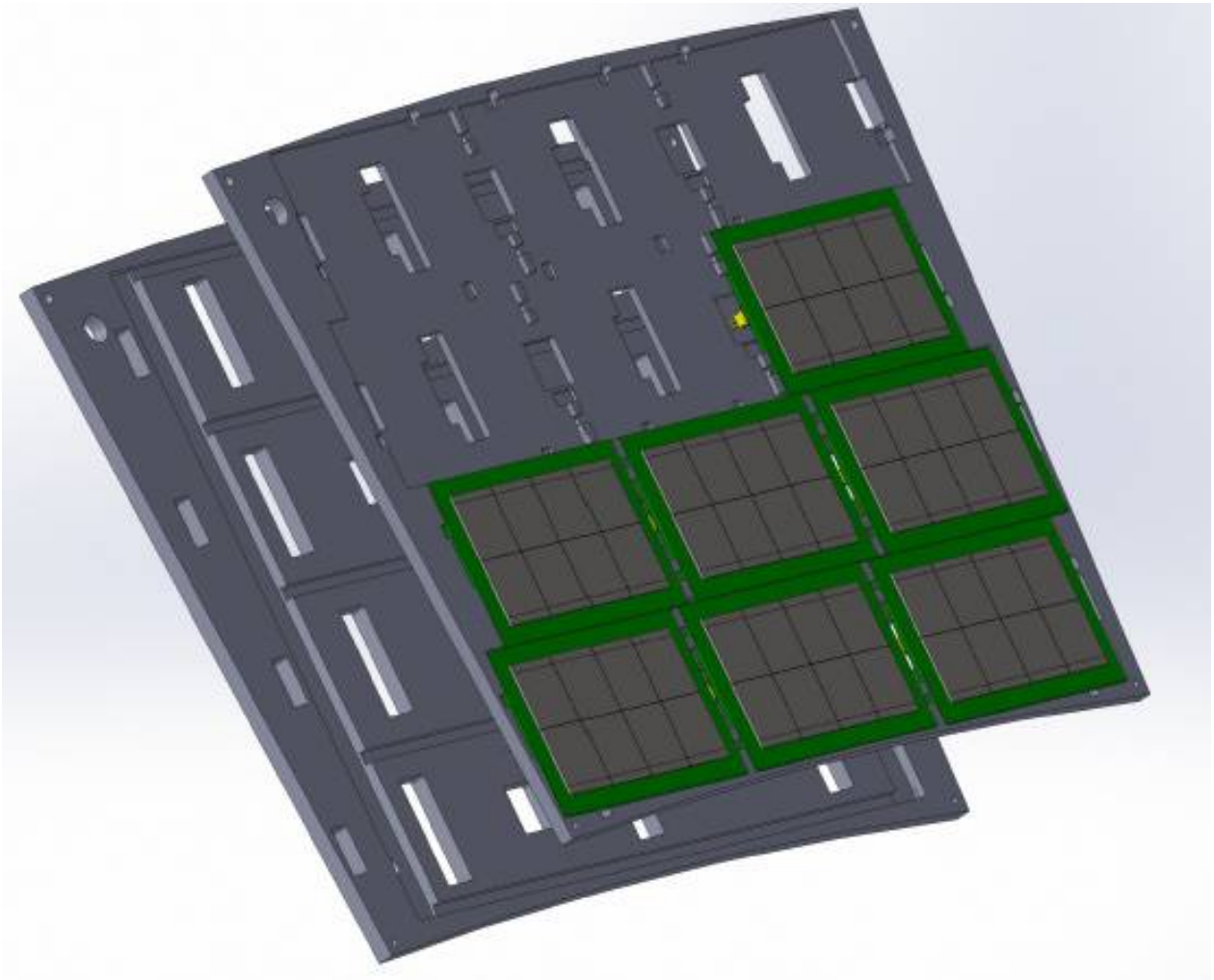
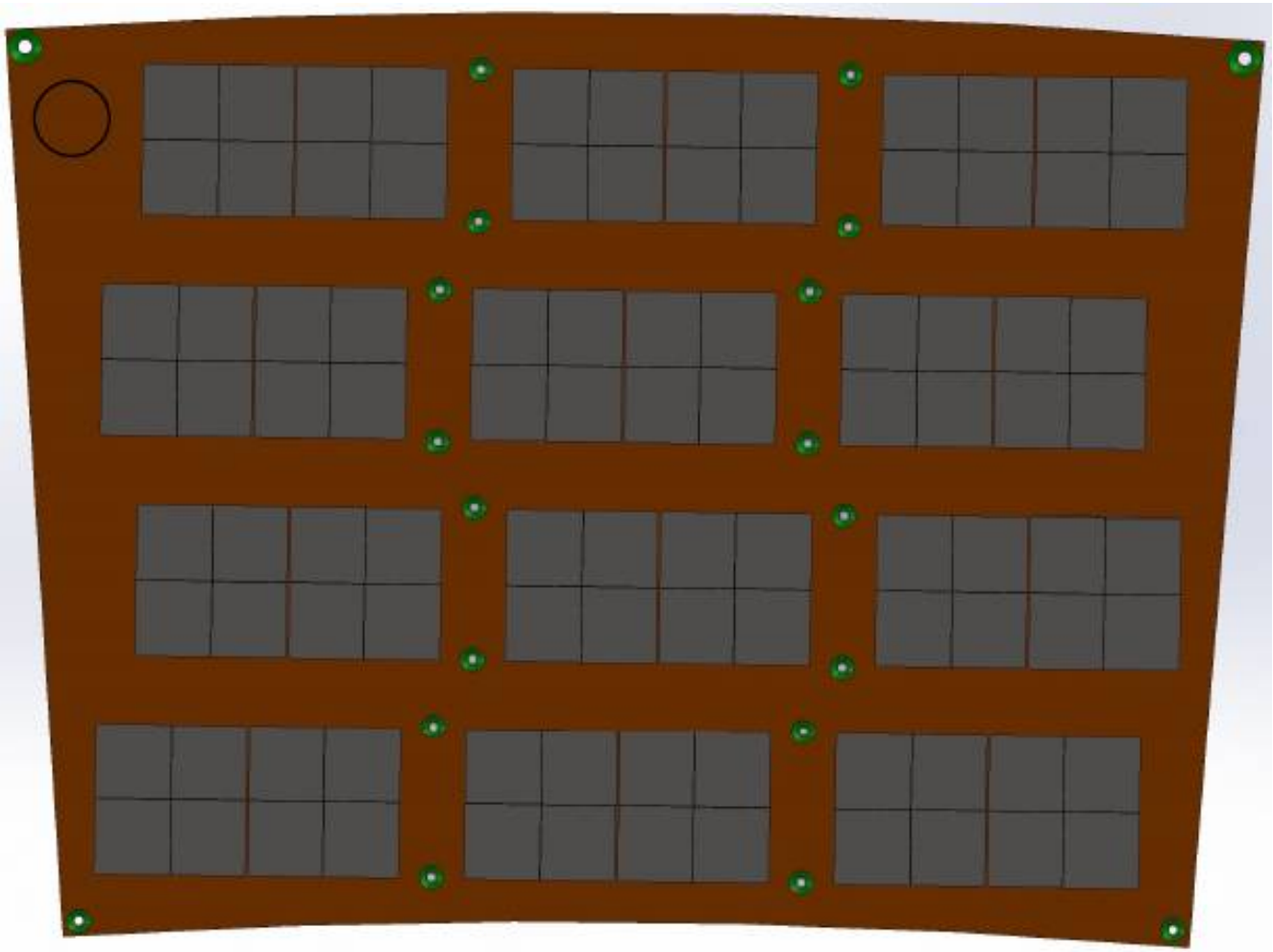
Setup

Support structure includes water cooling

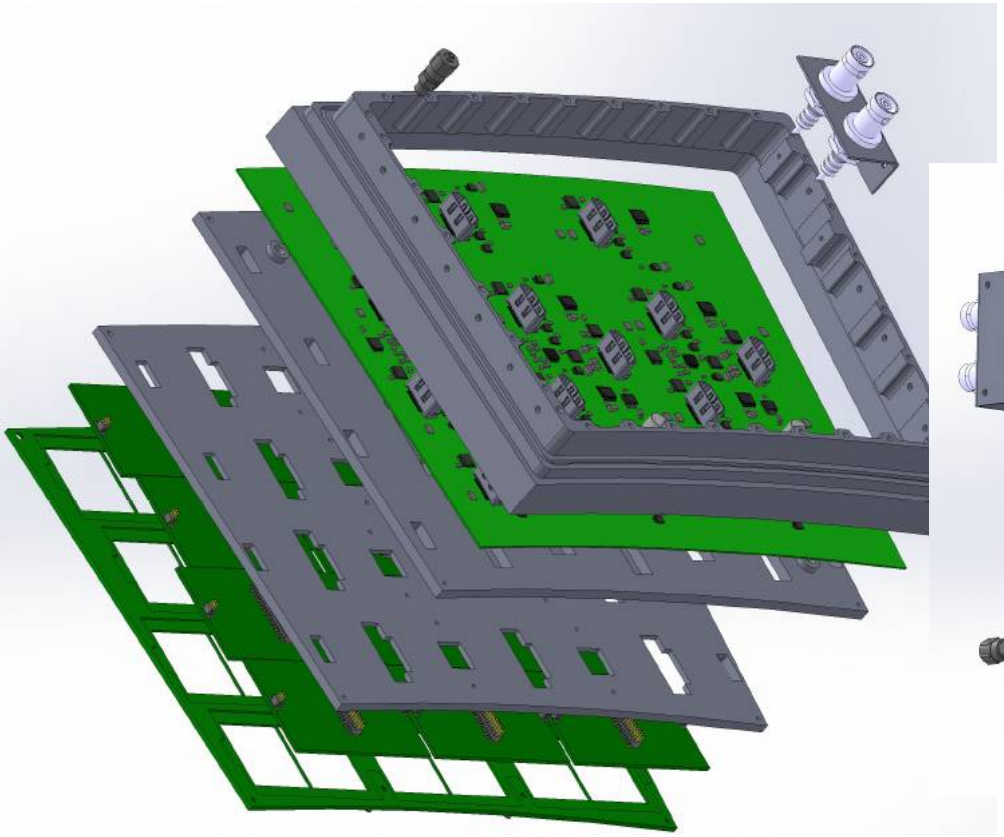


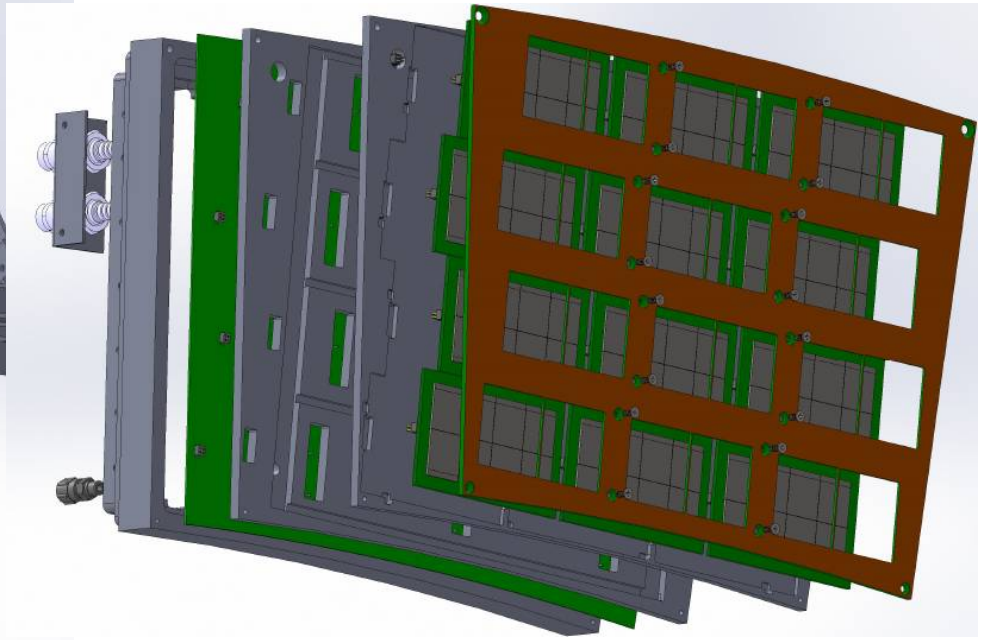
Setup

Anode plate



Setup





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Setup

- 1 module fully equipped with 96 InGrids
- 2 modules partly equipped with each 32 InGrids

- → 160 InGrids on 20 Octoboards

- 25 HDMI plugs
- 5 power boards

- Water cooling
- High voltage

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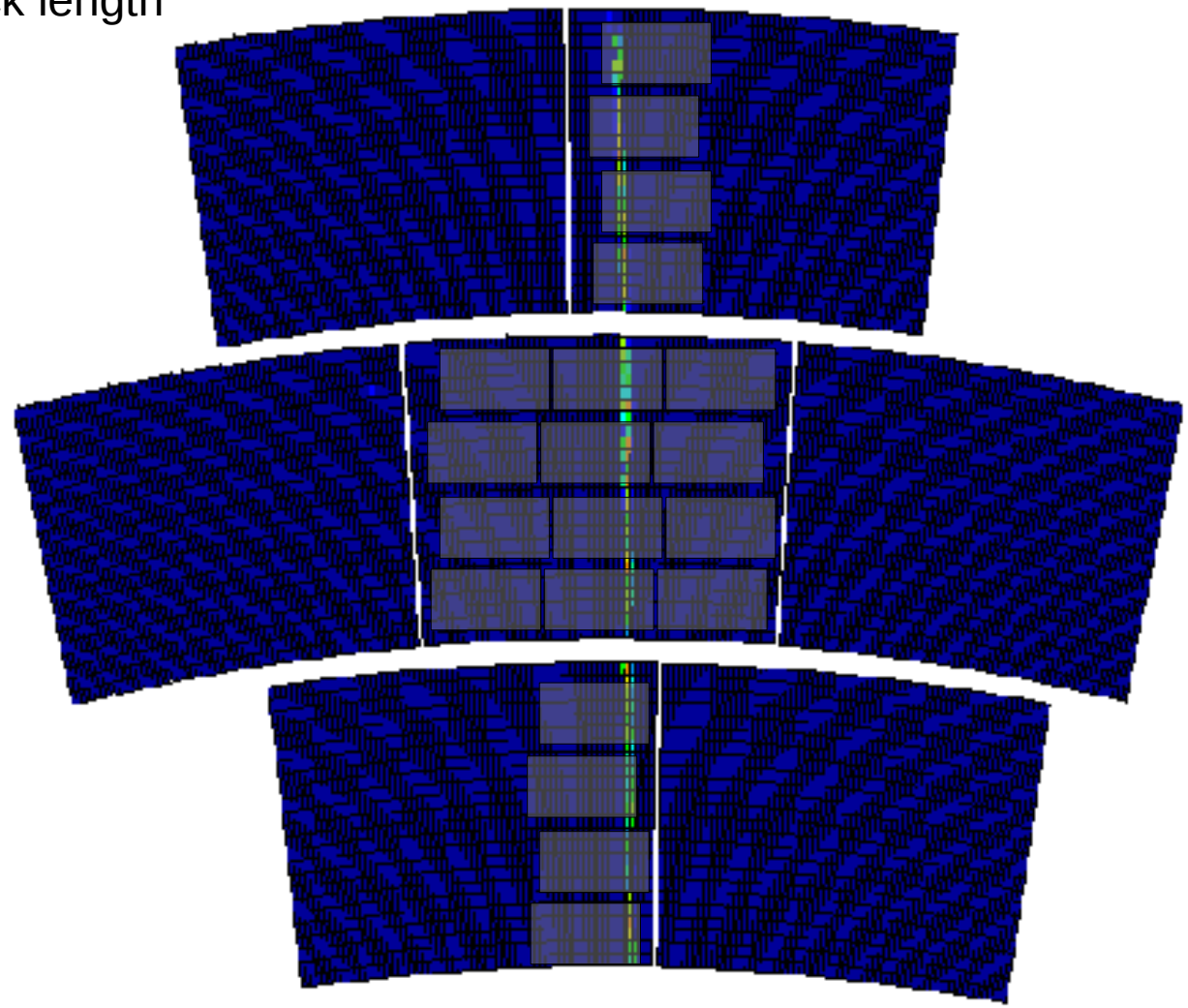
Setup

3 modules (one with 12 octoboards, 2 with 4 octoboards)

Full track length



What do we have so far

Week T-13

- 3/3 module frames
- 3/3 support structures at FZ Jülich for welding
  - Need to be post processed by our workshop
- 1/3 intermediate boards with components for one octoboard, plugs for 12/12 octoboards
- 1 test octoboard with plugs
  - Verify routing, then order 20 octoboards
- Readout FPGA firmware almost finished
- Readout software (command line based) will be ready soon

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Tasks

Week T-13

- Glue naked Timepix chips on octoboard
- Bond first chip, bypass others
  → Test octoboard → order final octoboards
- Finish power board
- Find out what is going on in Jülich
- Check FPGA firmware
- Work on software
- Order missing components for electronics
- Hope that Yevgen gets mask for InGrid cleaning

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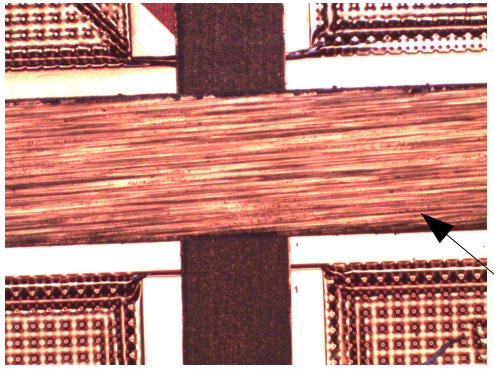
Schedule till testbeam



November 2014	
KW47 17.-21.	KW48 24.-28
See last slide	Expecting support struct. Expecting last components for intermediate boards Setup testing environment for single Ingrids and octoboards Equip 1st intermediate board Componets for 2nd ocoboard Test components for 2nd octoboard DAQ software

December 2014			
KW49 1.-5.	KW50 8.-12.	KW51 15.-19.	KW52 22.-26
Expecting InGrids	Octoboards arrive	Glue aluminium strips 1st octob	Chrstimas
Glue & bond InGrid to single chip carrier for testing?	Expecting power boards Place plugs on octoboards	Bond InGrids of first octoboard Testing of first octoboard	
Equip 1st intermediate board Componets for more ocoboards	Equip power boards Glue InGrids on first octoboard	Octoboard production Testing of power board	
Support structure in mechanics workshop for CNC milling			
DAQ software			
Michael at DESY	Jochen at CERN Michael at CERN		

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Schedule till testbeam

January 2015				
KW1 28.-2.	KW2 5.-9.	KW3 12.-16.	KW4 19.-23	KW5 26.-30
New year	Octoboard production: glueing, aluminium strips, bonding			
	Support structure finishing		Cooling	
	Octoboard testing			
	Equuip all intermediate boards			
	Verify DAQ software + firmware	Setting up whole system		

February 2014			
KW6 2.-6	KW7 9.-13	KW8 16.-20.	KW9 23.-27
Test whole setup in Bonn	Testbeam setup DESY	Testbeam DESY	Testbeam DESY

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