JÜLICH
FORSCHUNGSZENTRUM

Development of scintillation detectors at Julich

16. June 2017 | Ralf Engels

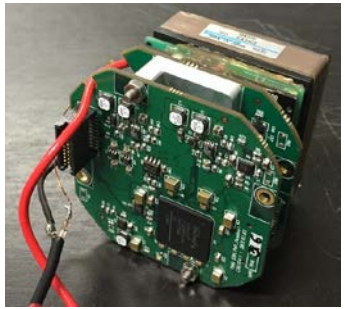
Outline

- The Start with the ROSMAP System
- System Overview
- Backend Board
- Preliminary Tests with a MaPMT
- New High-Resolution Anger-Neutron detector based on H8500 MaPMT
- Conclusions

Readout Electronics Evaluation System

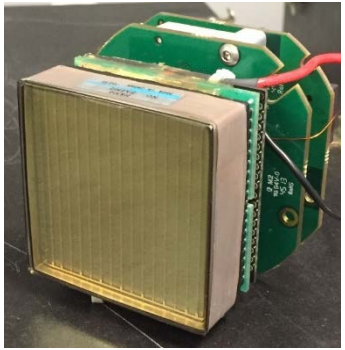
Required parameter for pulse processing: charge per neutron

- dependent on number of photons hitting photocathode, quantum efficiency, gain of MaPMT
- difficult to predict (reflective effects)
- adjustable to some degree by MaPMT gain

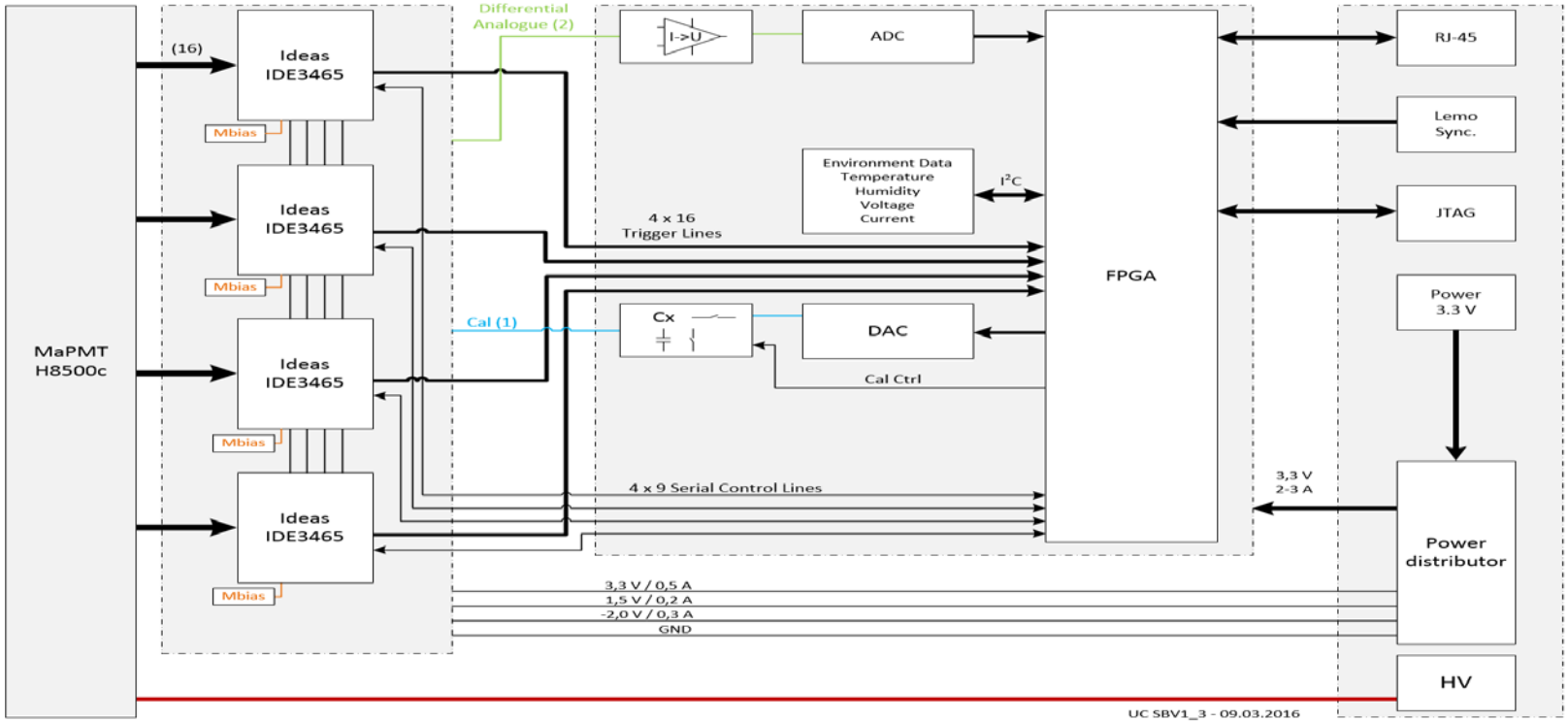


ROSMAP readout system for evaluation

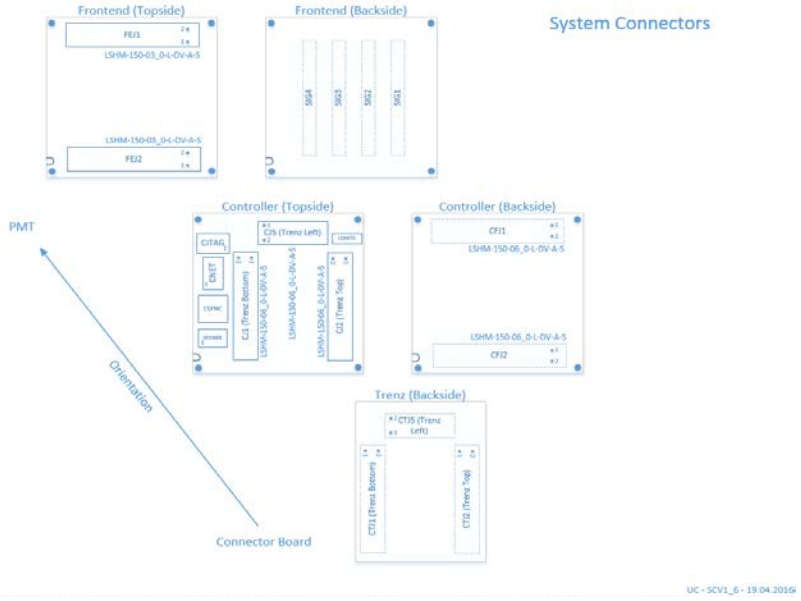
- digitization and counting mode available, but only digitization mode used for tests
- 2x VA32HDR14.3 ASICs for digitization of channels with 10:1 (changed to 3:1) charge splitter for measurement up to 200pC input charge
- trigger derived from PMT dynode signal
- 14 bit ADC, data values are delivered with 8 bit resolution via ModBus interface
- read out rate of ~50 Hz achieved for digitization mode (with python interface)
- external high voltage supply for MaPMT

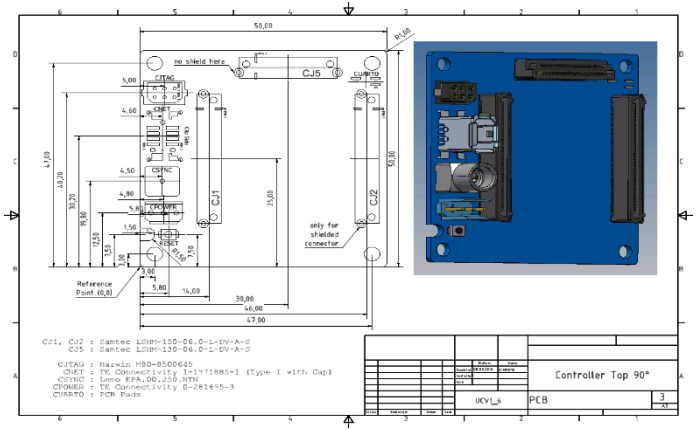


System Overview



System Overview





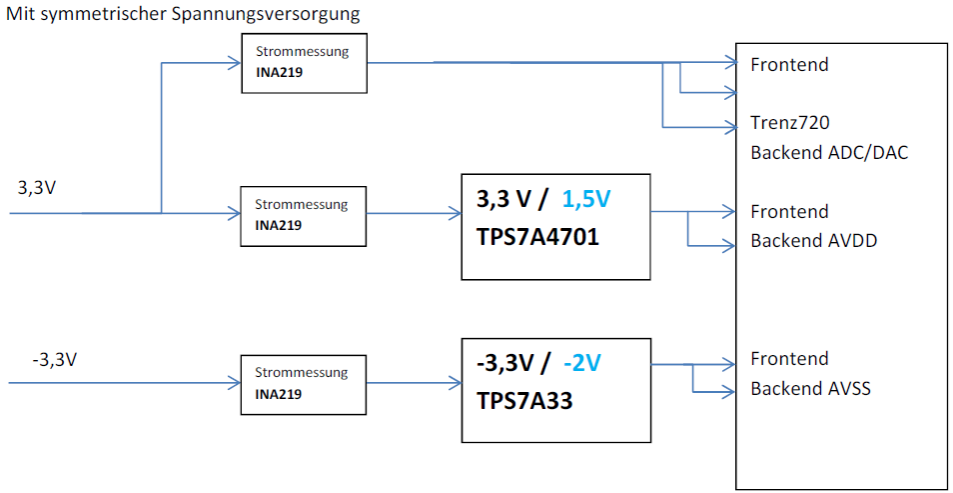
Trenz Electronic TE0720

- Xilinx Zynq SoC micromodule
- ARM dual-core Cortex-A9 MPCore
- 10/100/1000 tri-speed Gigabit Ethernet transceiver (PHY), SGMII accessible on a board-to-board connector
- USB 2.0 high speed ULPI transceiver
- 32-bit-wide 1 GByte DDR3 SDRAM
- 32 MByte SPI Flash memory (for configuration and operation)
- 4 GByte e-NAND (up to 32 GByte)
- Plug-on module with 2 × 100-pin and 1 x 60-pin connector
- 152 FPGA I/O's (75 LVDS pairs possible) and 14 MIO's Valid MAC Address and 2K serial EEPROM
- SHA-256 authentication chip with unique serial number
- …..

TE0720 Module

TE0720 L1IF (lower power consumption)

Backend and Frontend Power Distribution



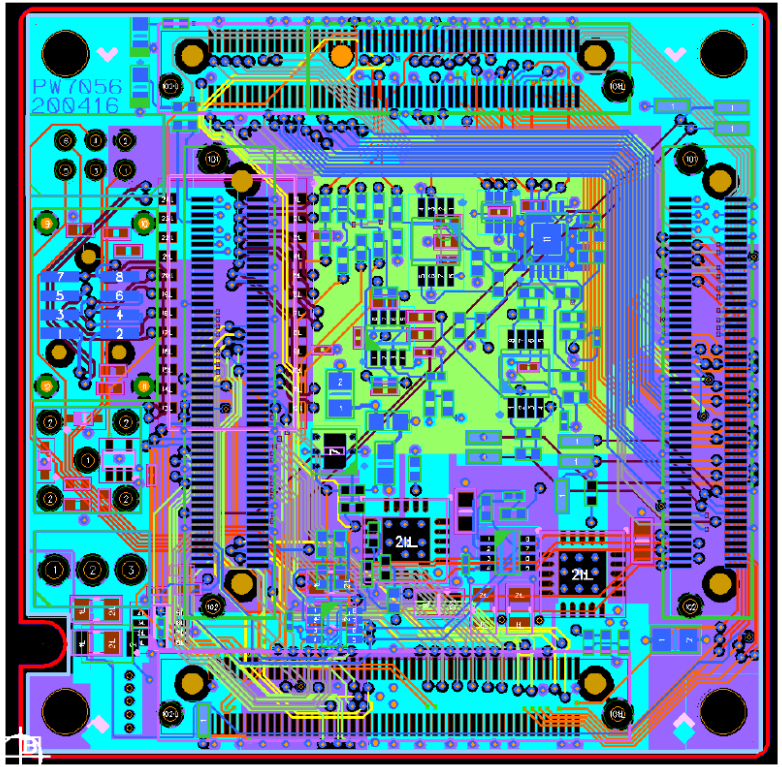
- Symmetric Power supply of +/- 3.3V needed
- Possibility to measure the current of the different power lines

Backend Board

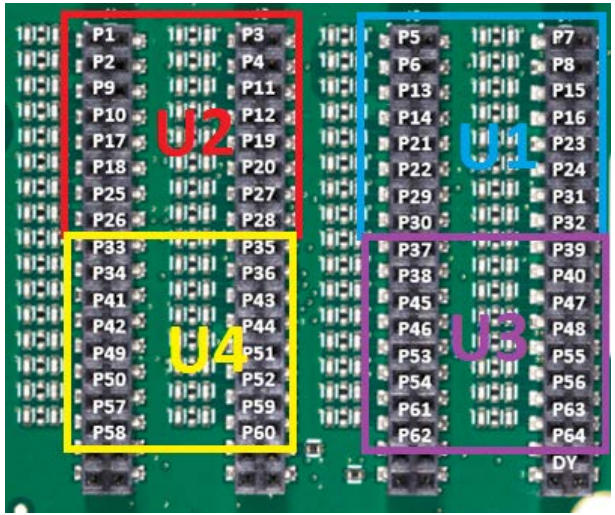
Realisierungsvorschlag					
Lage:			Stärke(µm) :	Mat.	
	Lötstopplack		20		
1		Cu-Folie	5 + 30 galv.Cu		Signal
	2 x 106	Prepreg	100	IS410	
2		Cu	35		Signal
		Laminat	300	IS410	
3		Cu	35		Signal
	2 x 1080	Prepreg	115	IS410	
4		Cu	35		Signal
		Laminat	300	IS410	
5		Cu	35		Signal
	3 x 1080	Prepreg	190	IS410	
6		Cu	35		Plane
		Laminat	300	IS410	
7		Cu	35		Signal
	2 x 1080	Prepreg	115	IS410	
8		Cu	35		Signal
		Laminat	300	IS410	
9		Cu	35		Signal
	2 x 106	Prepreg	100	IS410	
10		Cu-Folie	5 + 30 galv.Cu		Signal
	Lötstopplack		20		
		Stärke :	2210	+/- 10%	

Thickness of the board 2,2 mm

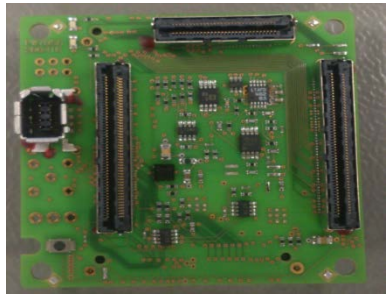
Screenshot of the 10 Layer board

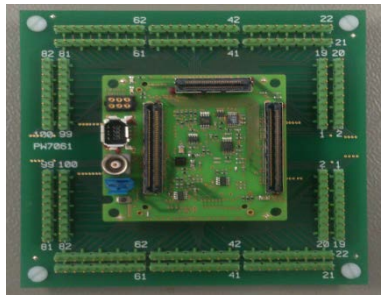


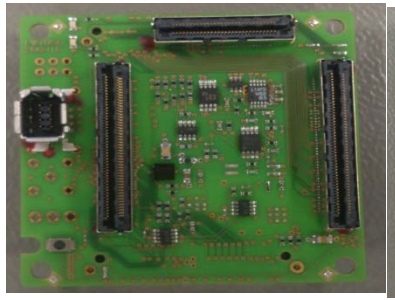
Backend and Test Board

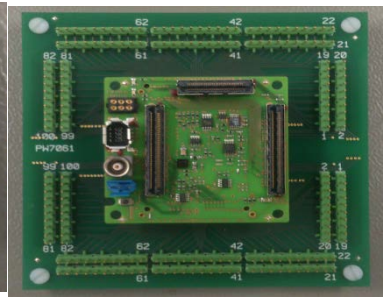


IDEAS ASIC Board MaPMT View







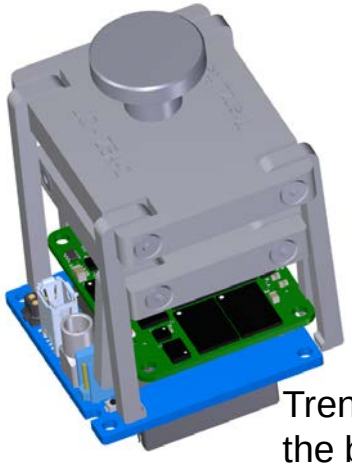


Backend board

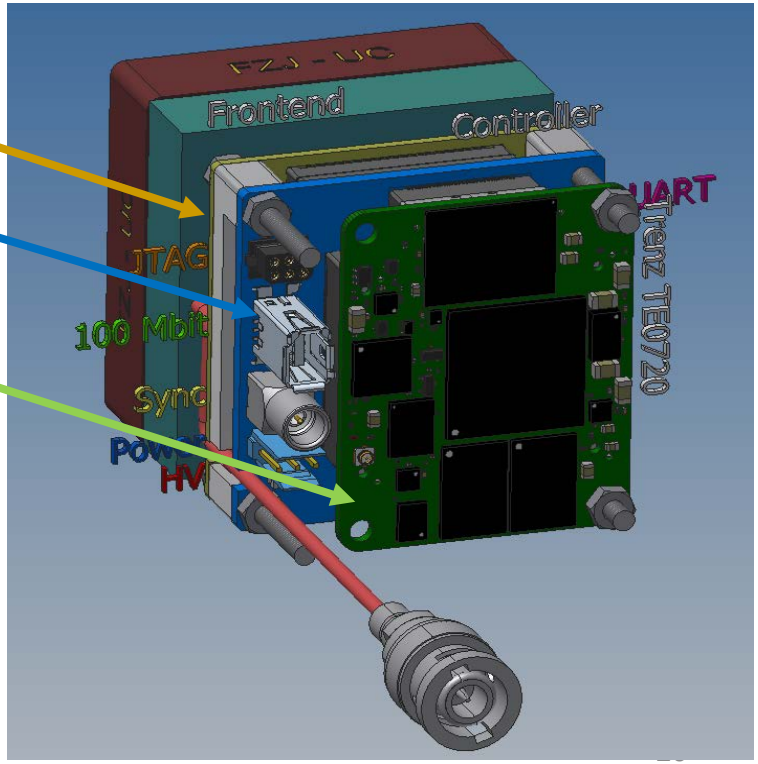
Backend board with Test Board

3D Model of one MaPMT Module and the Trenz-Lifter

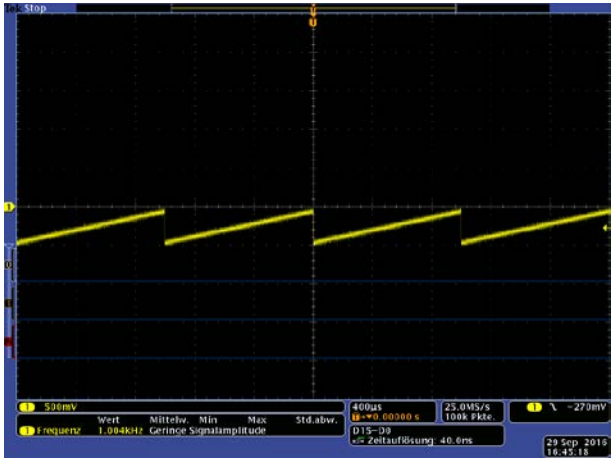
- ASIC Board with Aluminum housing
- Controller / Backend Board
- Trenz TE0720



Trenz – Lifter to remove safely
the board from the ASIC board



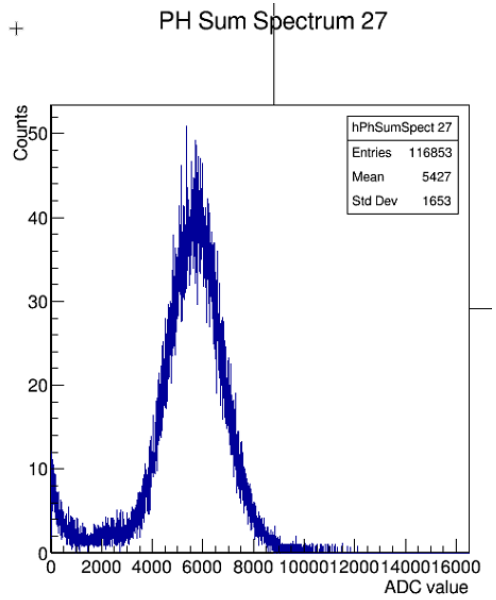
First electronic Tests with the System

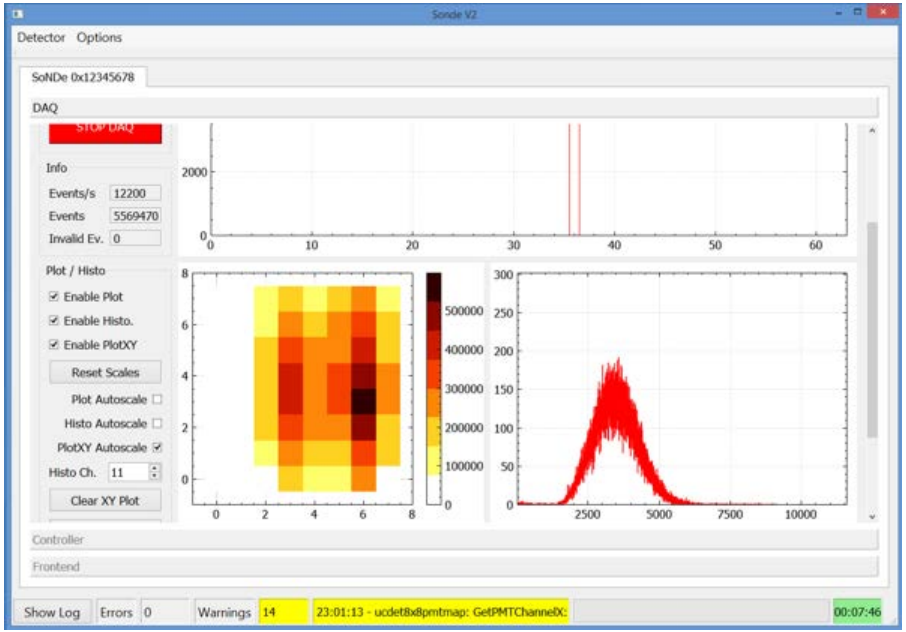


Saw pulse fed into the connector where usually the current output from the MaPMTs is

Test program showing one pixel where charge was injected

First results



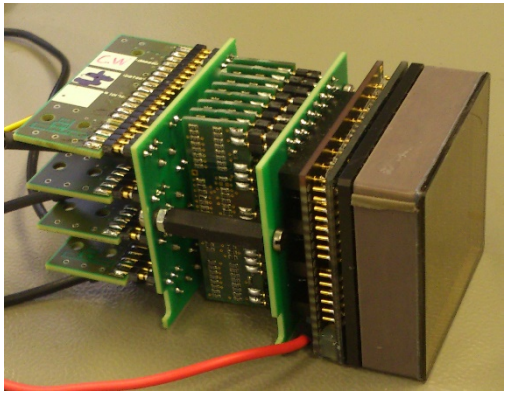


New High-Resolution Anger-Neutron detector based on H8500 MaPMT

Motivation:

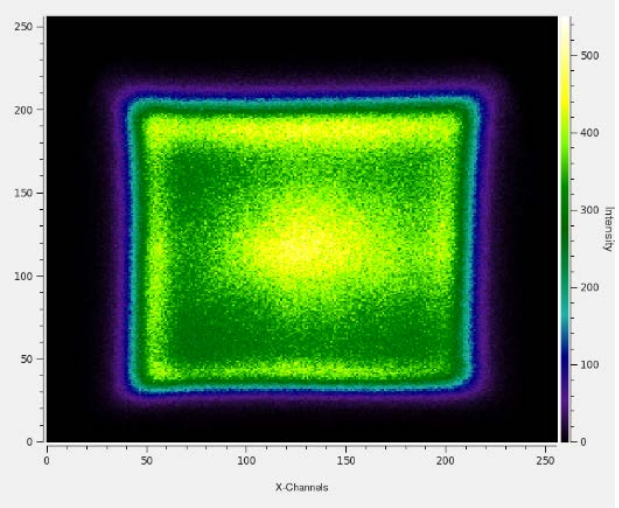
- Scalable design for larger detector size
- Higher resolution by smaller pitch size of neighboring light detectors
- Higher count rate by smaller detector units
- Replacement of Hamamatsu R3292 photomultiplier

→ Usage of H8500 MaPMTs from Hamamatsu

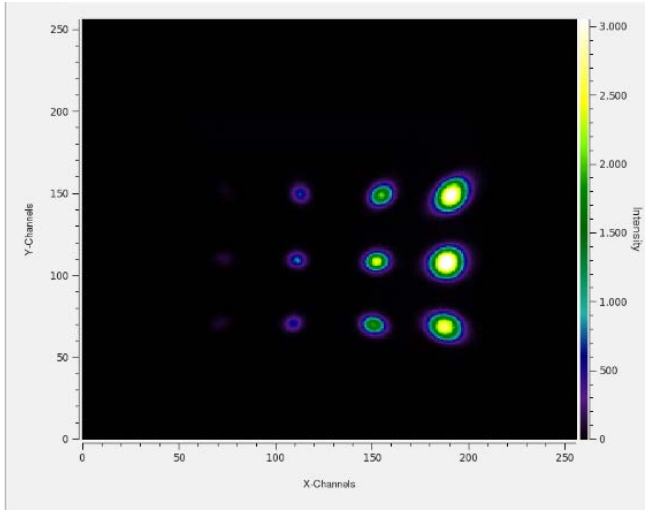


Neutron Measurements with a Prototype

- Single H8500 MaPMT with ^{6}Li-glass scintillator and Anger readout electronics
- Measurements at TREFF and at KWS-3

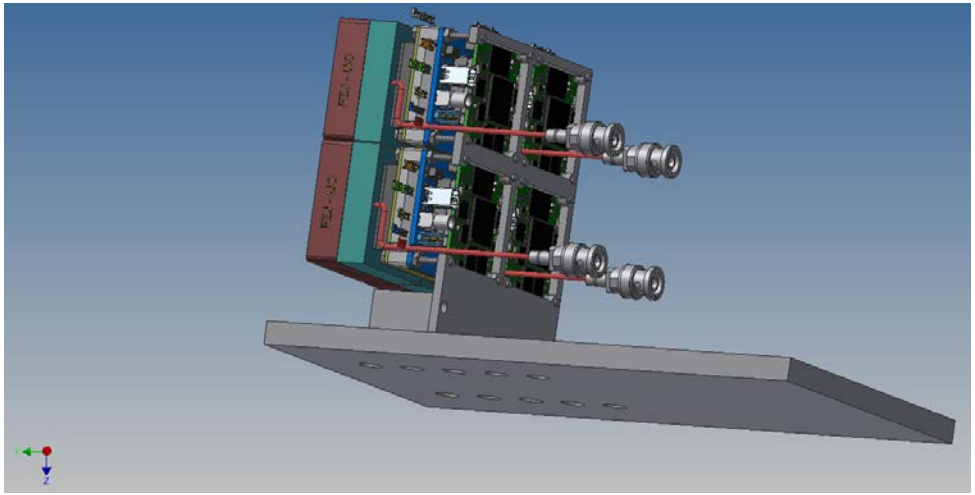


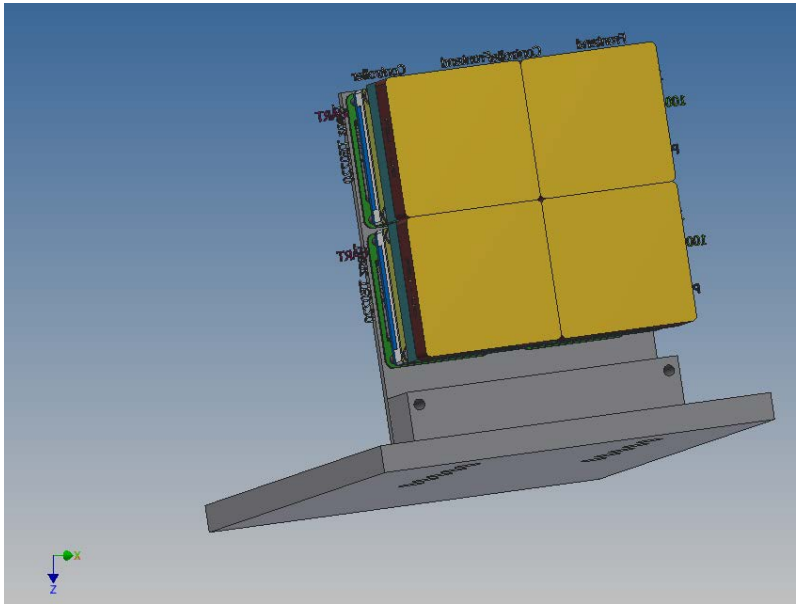
- Empty beam; no sample; open thresholds
- To be used for calibration and discrimination table



- Thin Cd and Boron Carbide Diaphragm in front of the detector
- Hole size 0.5; 1.0; 2.0 and 4 mm with 10 mm spacing
- => Spatial resolution < 0.7 mm FWHM

2x2 Demonstrator Test Setup





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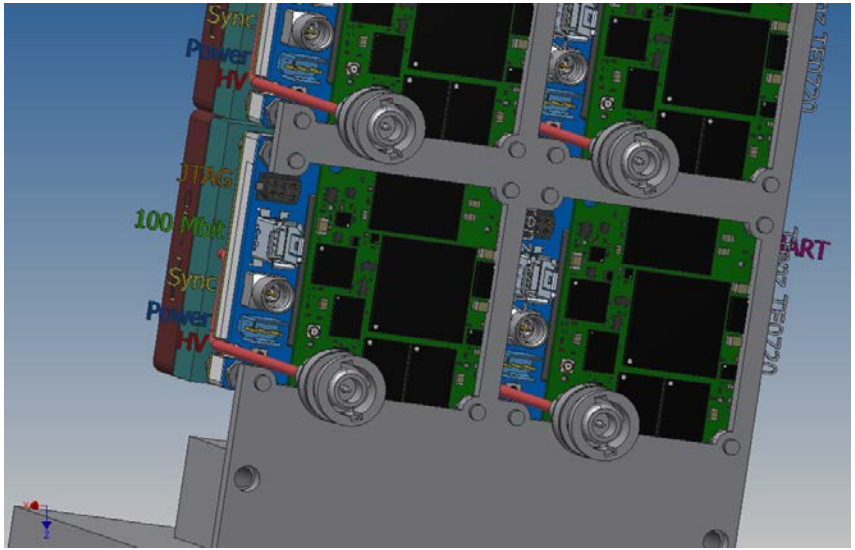
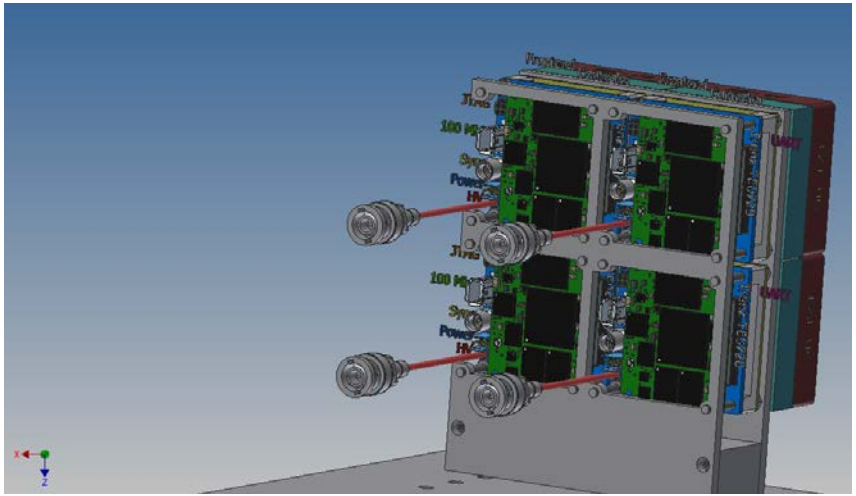
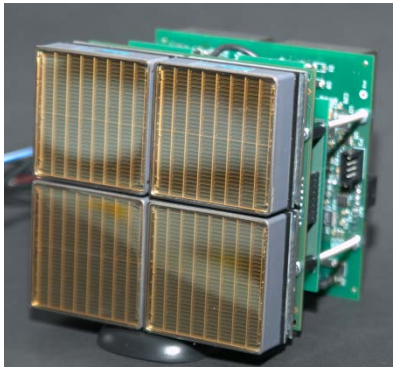




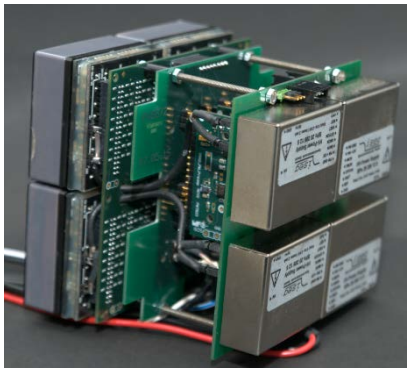
New Detector Modules with MaPMTs

Anger Mode

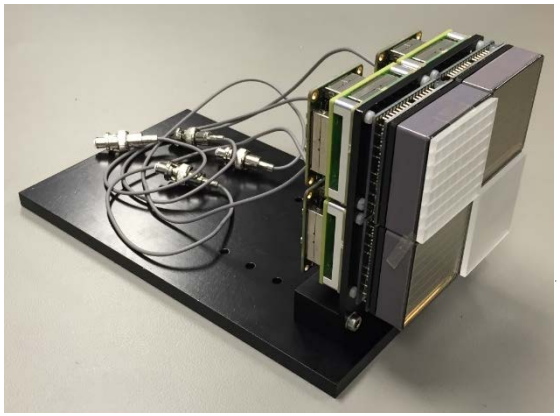


- Front View of four Modules mounted for the test system
- Airgap < 1.5 mm
- Sensitive area 10 cm x 10 cm

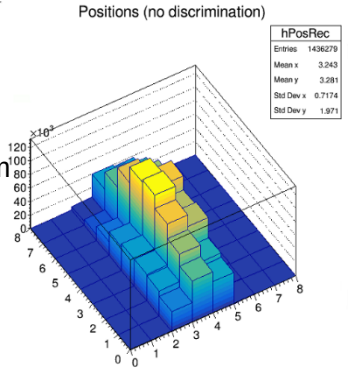
Rear View of four with electronic readout and HV modules per MaPMT



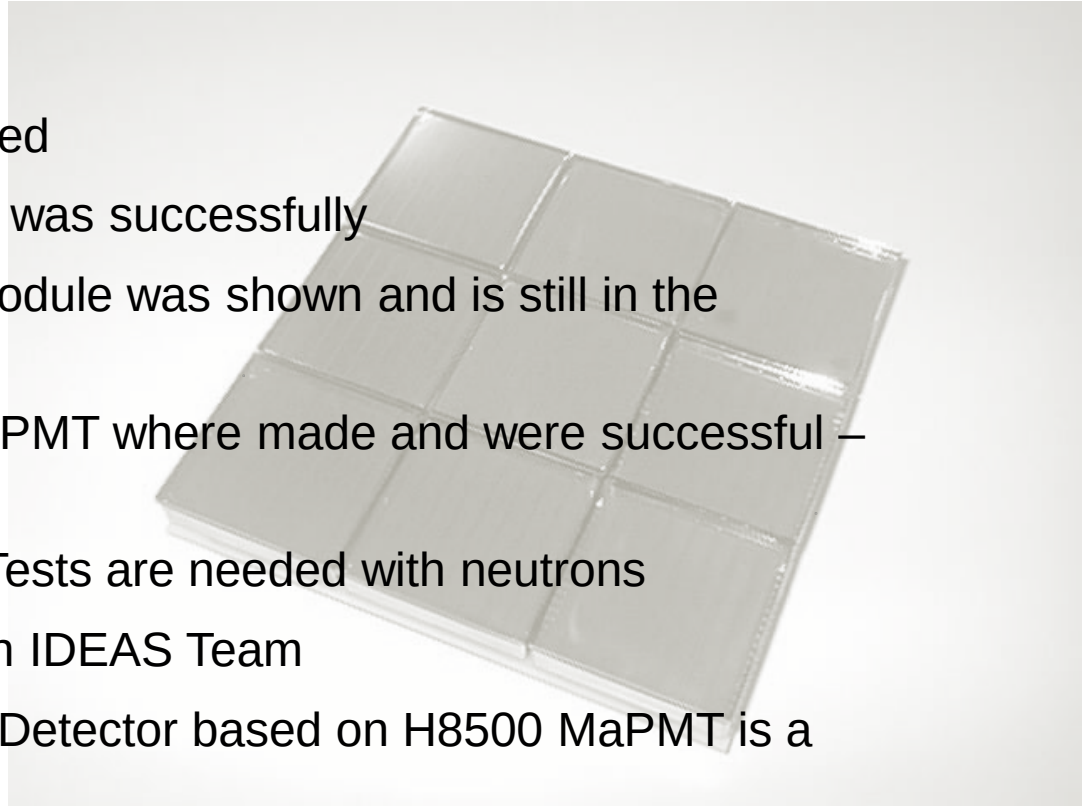
High-Rate Mode



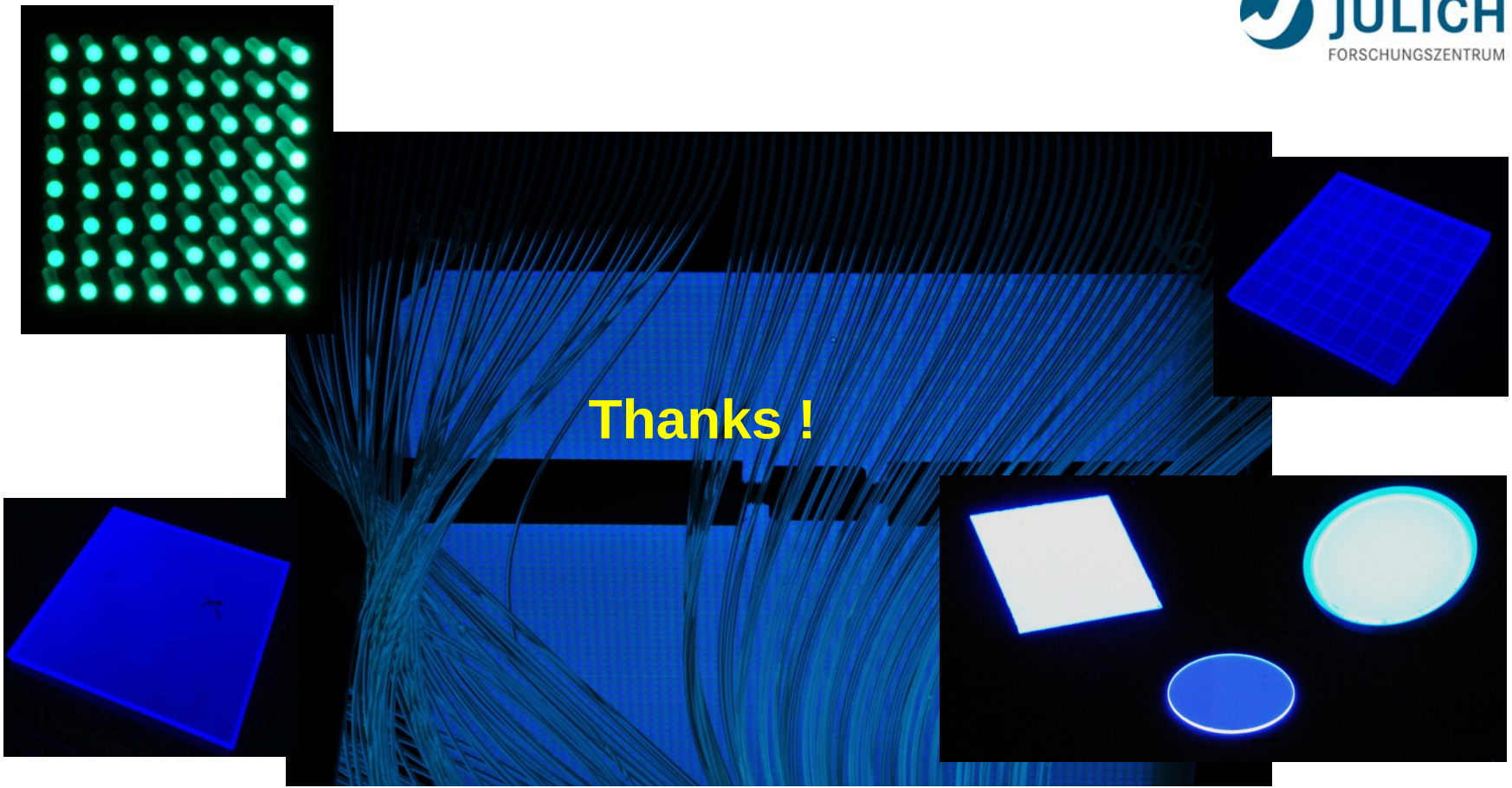
- Four Modules mounted for the test system
- Two different Scintillators are mounted
- High count rate per MaPMT modul
- Preliminary results measured ->



Conclusion



- Backend Board was designed
- Adaption to the ASIC board was successfully
- Electronic Tests with one Module was shown and is still in the commissioning phase
- Preliminary Tests with a MaPMT where made and were successful – however more is needed
- Further investigations and Tests are needed with neutrons
- Very good collaboration with IDEAS Team
- Neutron Scintillation Anger-Detector based on H8500 MaPMT is a great success


Thanks !