EMC – Workshop Rauischholzhausen

November 24-25, 2014

AGENDA

Subjects to be discussed:

- Crystals
- Photosensors (APD screening, Test procedure, VPTT?)
- Cooling and isolation
- Prototypes (PROTO120, Maxlab results,)
- Stimulated Recovery
- Electronics chain: PA, ASIC, Driver, SADC, Cables, …)
- Installation @ PANDA site (Rackspace, …)
- Status on Forward/Backward Endcaps
- Status on Barrel Mechanics
- Timelines

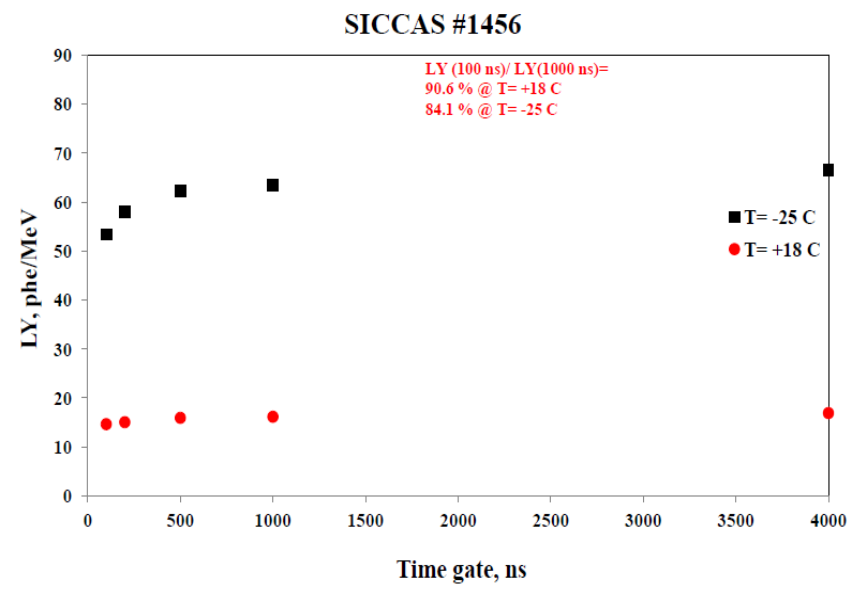
contributions:

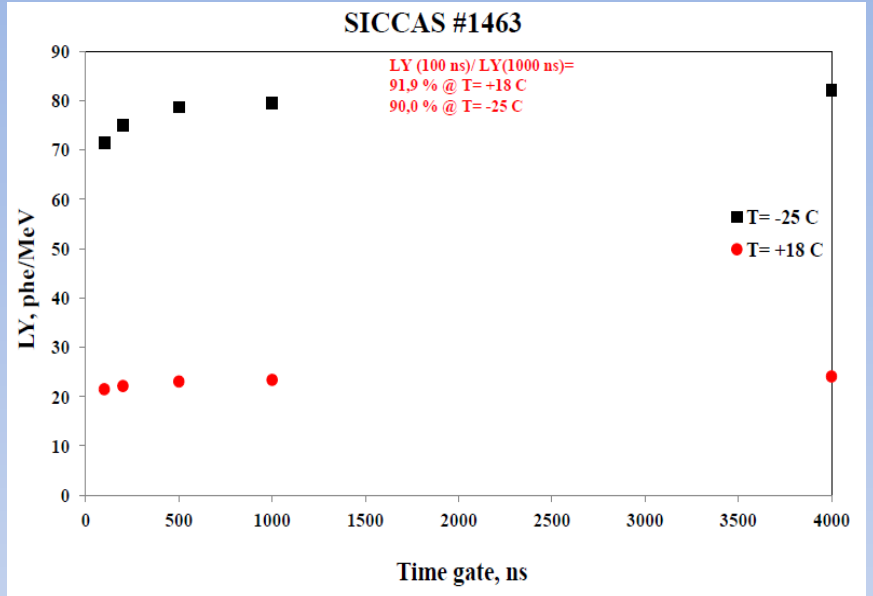
• Claudius Schnier:	**Cabeling, Voltage distribution etc. for FW Endcap**
• Tobias Triffterer:	**DCS fürs EMC: alarm system etc.**
• Christoph Rosenbaum:	**The status on PROTO 120**
• Stefan Diehl:	**Completion of PROTO 120**
•Till Kuske:	**Status on recovery**
• Rainer Novotny:	**News on crystals from SICCAS and CRYTUR**

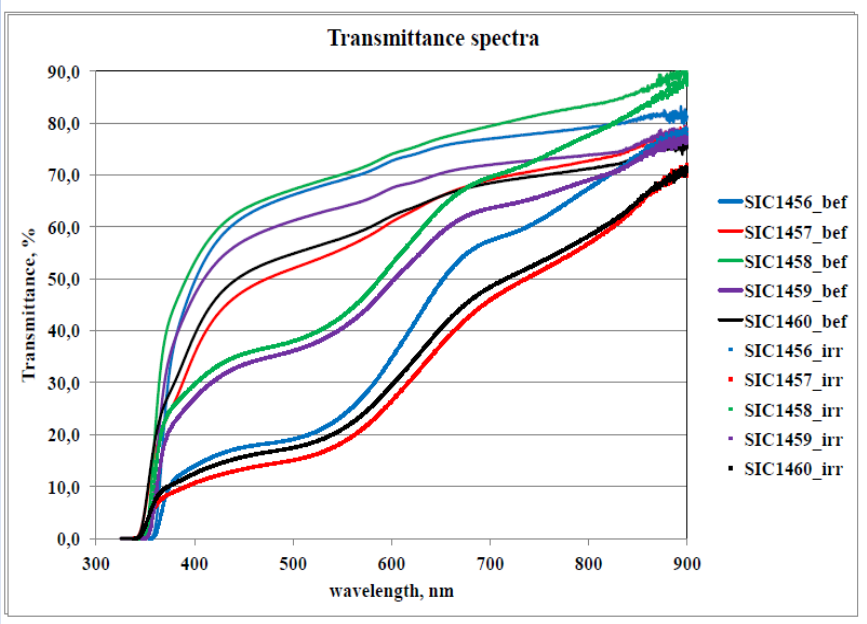
- **recent delivery from SICCAS (1)**

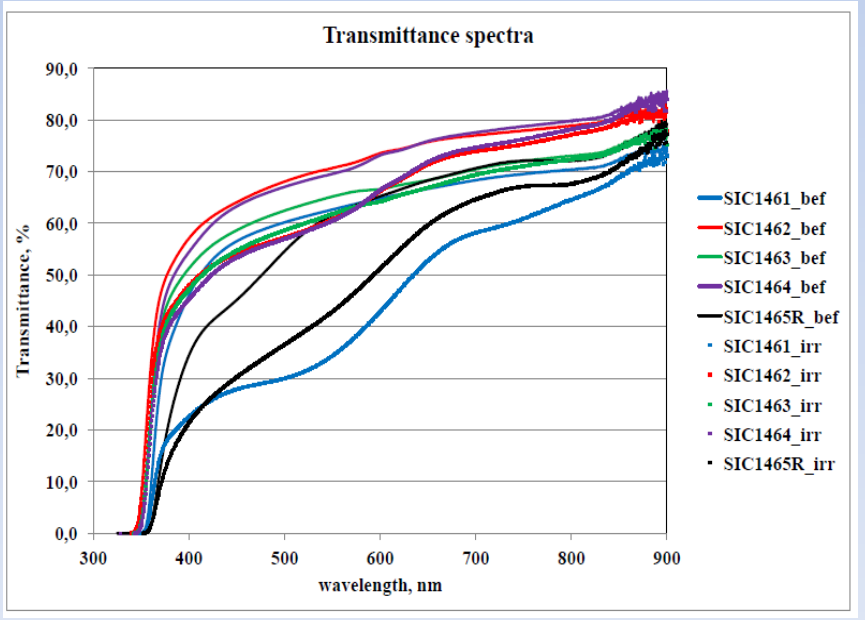
SICCAS ID	T(360	T(420	T(620	LY(T= +18 C, t=100	LY(100	dk(420 nm)	comment SICCAS	LY
	%	%	%	phe/MeV	at T=18C, %	m^{-1}		SICCAS
limits	≥ 35	≥ 60	≥ 70	≥ 16	> 90	< 1.1		
1451	19,0	58,8	73,8	22,3	94,1	1,92		
1452	25,2	62,9	74,2	22,3	94,1	0,72		
1453	23,2	57,8	75,3	11,1	90,4	3,94		
1454	35,0	67,2	77,8	26,9	93,7	0,69		
1455 rus	10,1	52,5	73,5	15,4	93,9	2,68		
1456	2,0	56,5	73,8	15,6	90,6	6,36	doping	17,1
1457	16,4	42,3	62,9	13,1 at -25 C	87,8	6,32	doping	13,4
1458	20,4	58,8	75,2	17,8	91,3	2,93	doping	22,0
1459	11,3	52,6	68,5	19,2	92,1	2,74	doping	21,1
1460	19,1	45,7	63,6	?	?	5,89	doping and raw materia	15,4
1461	8,8	52,0	65,6	19,7	91,7	3,59	doping and raw materia	20,5
1462	32,5	60,7	74,3	21,9	91,5	0,85	doping and raw materia	17,7
1463	22,9	55,1	67,3	21,5	91,9	0,38	doping and raw materia	19,7
1464	22,7	59,0	74,1	20,5	91,6	0,89	doping and raw materia	23,9
1465 rus	1,8	40,3	66,5	12,9	90,8	2,26		9,3

- **recent delivery from SICCAS (1)**

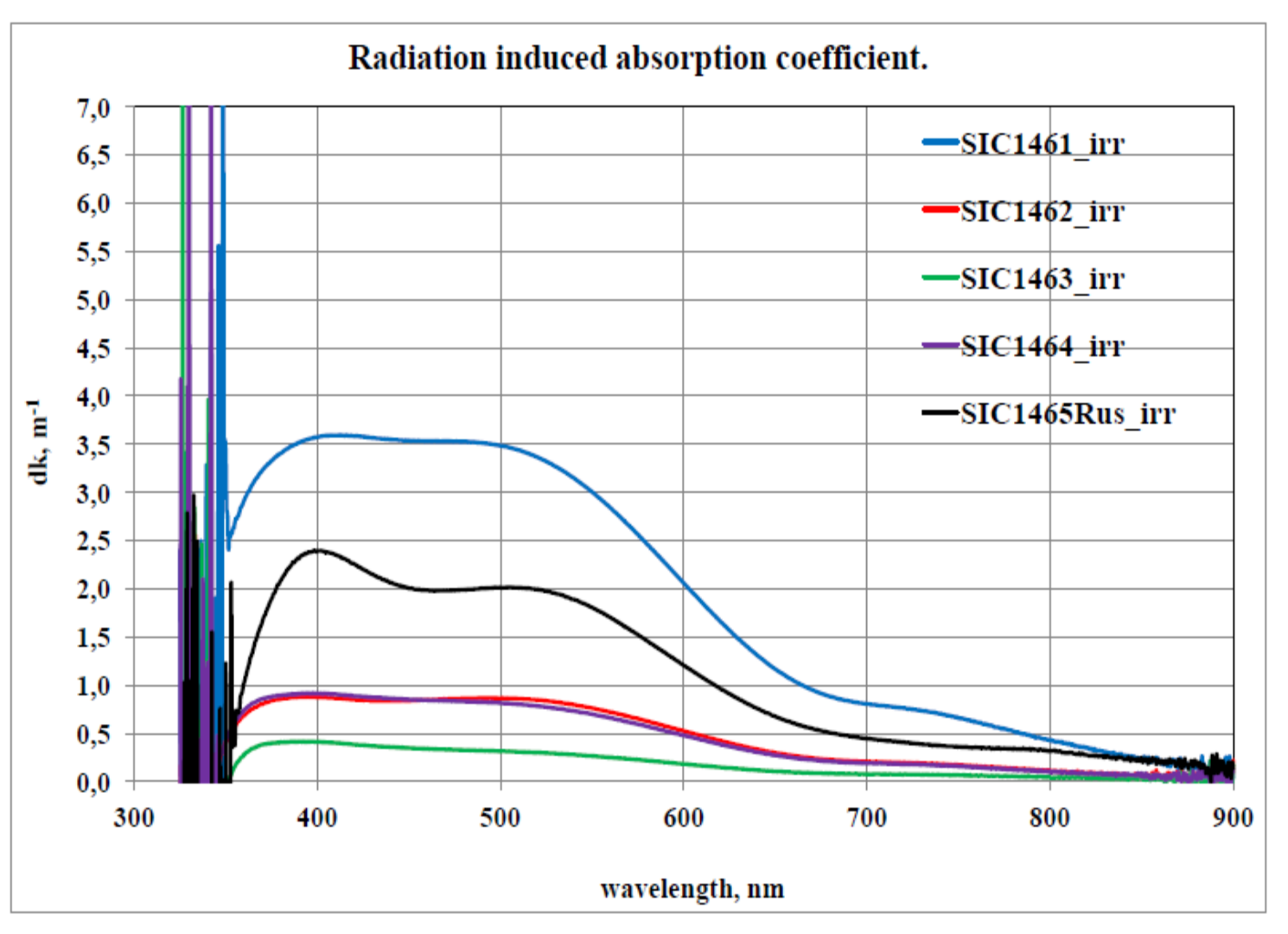




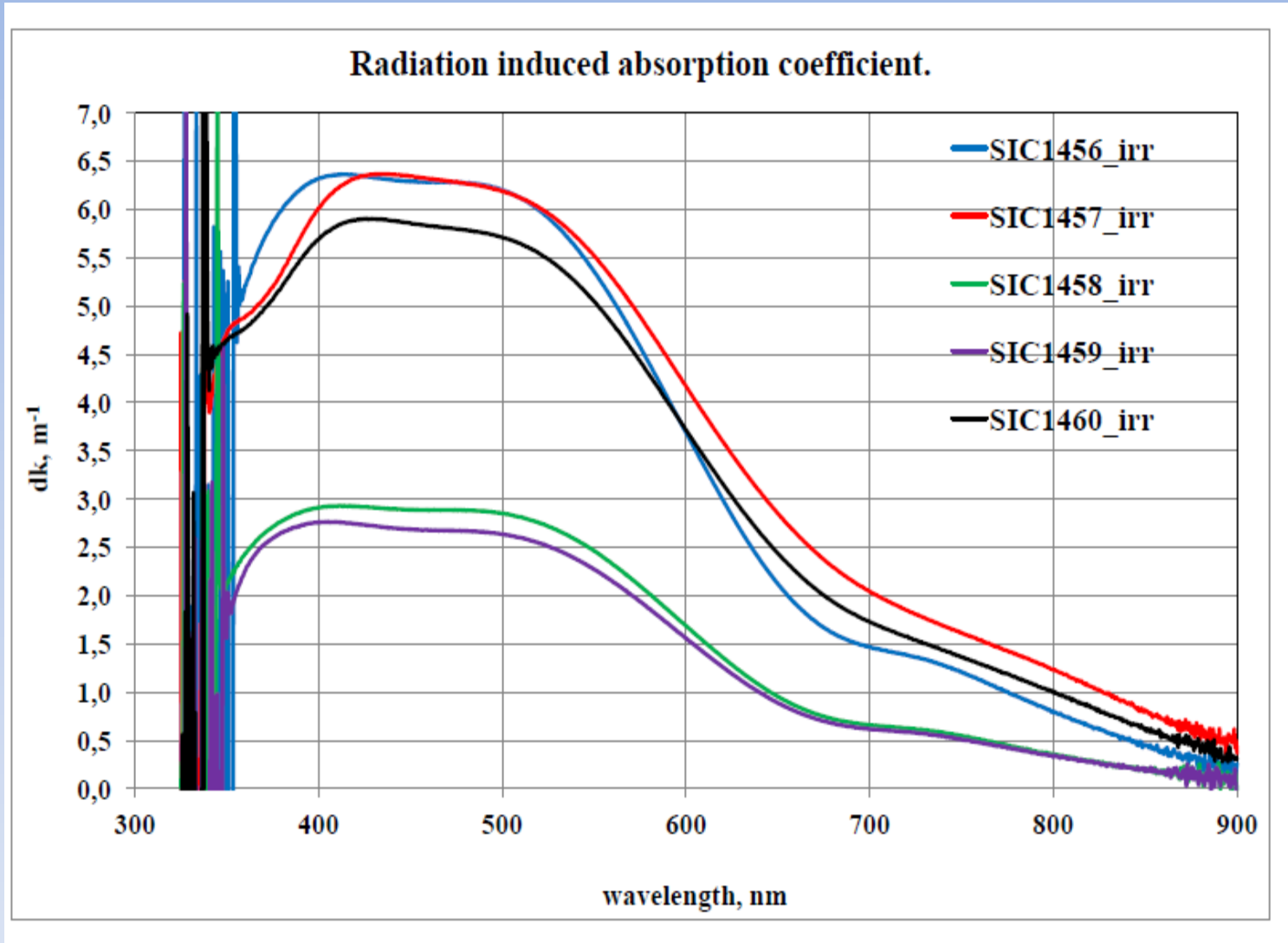




- **recent delivery from SICCAS (1)**



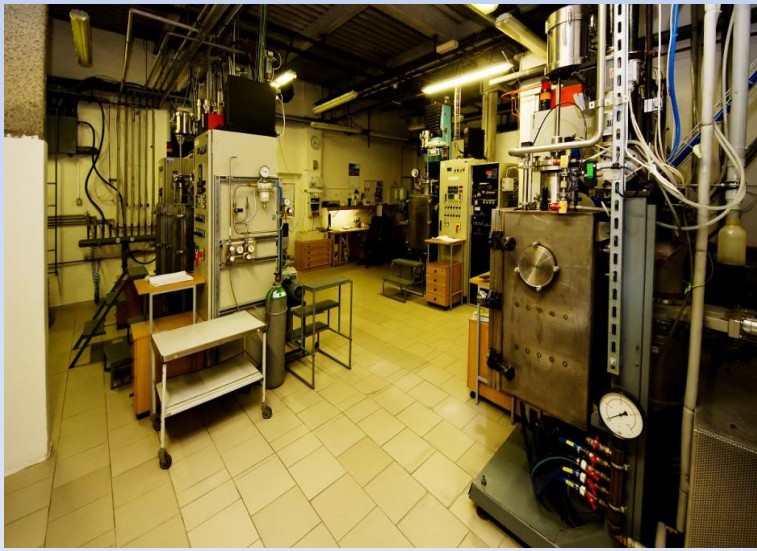
- **recent delivery from SICCAS (1)**



- **additional new PWO manufactur**

CRYTUR – Turnov, Czech Republic

- R&D phase just started (June 2014)
- Czochralsky technology (identical to BTCP)
- know-how and raw material still available



News (November 20, 2014)
- first good crystal grown
- test samples grown at Prague
- visit and discussion in December

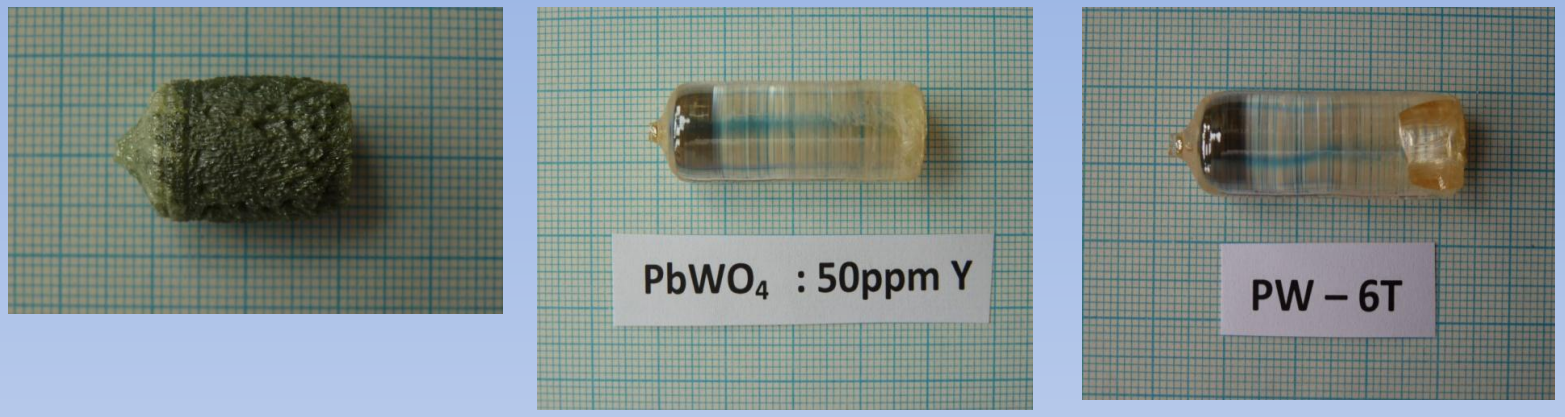


Fig. 1 (a) Photo of PbWO4 crystal grown in oxygen-free atmosphere.
(b) 50 ppm Y doped grown in air;
(c) La+Y doped grown in N2+0.1%O2 atmosphere

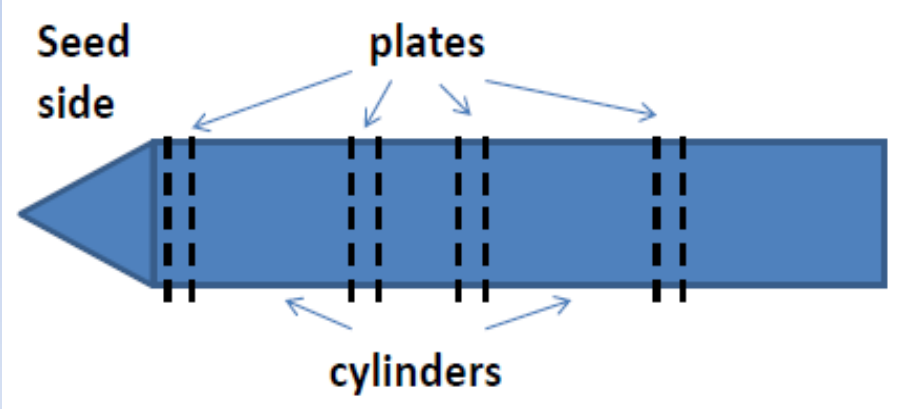
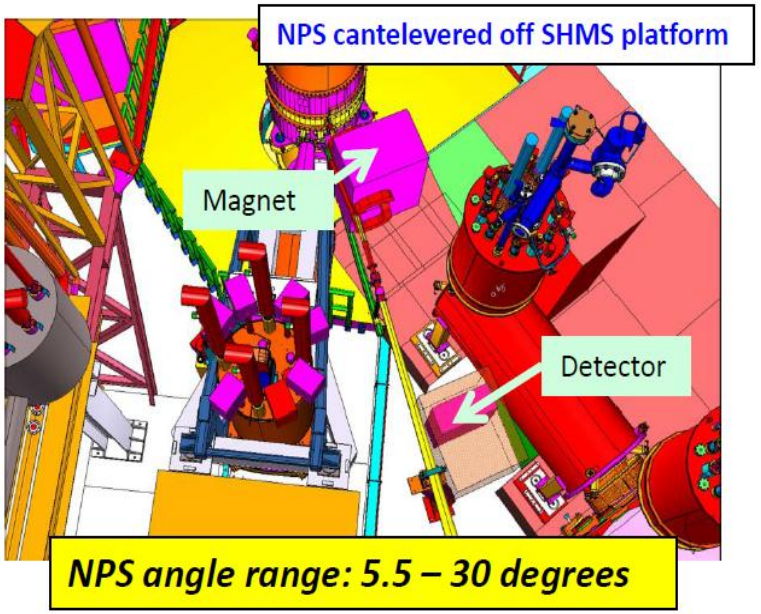
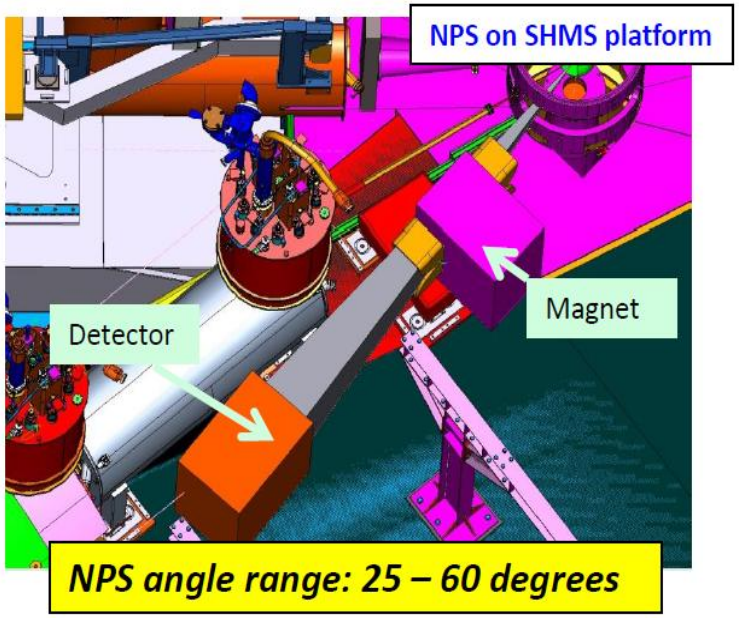


Fig. 2 Sketch of the PbWO4 crystal cut

The Neutral-Particle Spectrometer (NPS)

The NPS is envisioned as a facility in Hall C, utilizing the well-understood HMS and the infrastructure of the new SHMS, to allow for precision (coincidence) cross section measurements of neutral particles (γ,π^0).

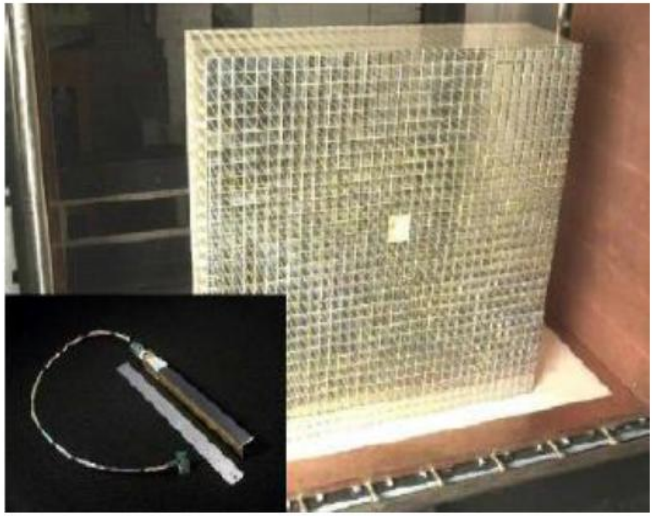




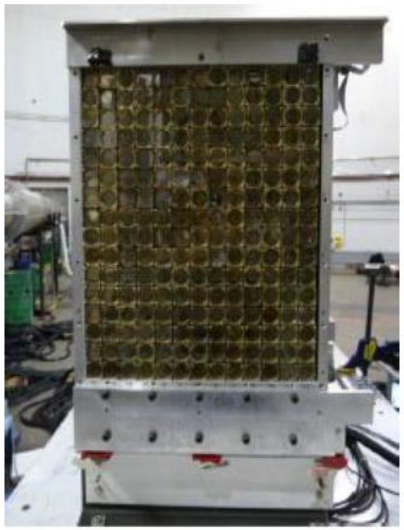
Scientific Program:

- E12-13-010 Excl. Deeply Virtual Compton and π^0 Cross Section Measurements (***approved*** by PAC40)
- E12-13-007 Measurement of SIDIS π^0 production as Validation of Factorization (***approved*** by PAC40)
- PR12-13-009 Wide-Angle Compton Scattering (WACS) at 8 &10 GeV Photon Energies
- LOI12-13-003 Exclusive Photoproduction of π^0 mesons at large angles (positive comments at PAC40)

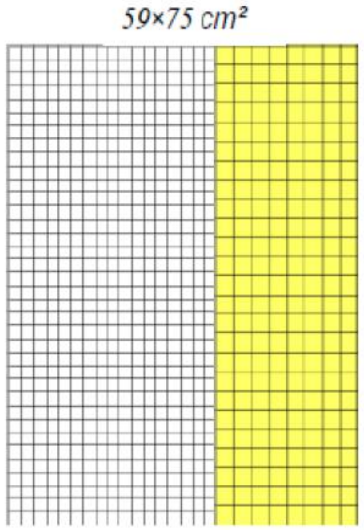
NPS Crystal Matrix



High resolution $PbWO_4$ part from HyCAL

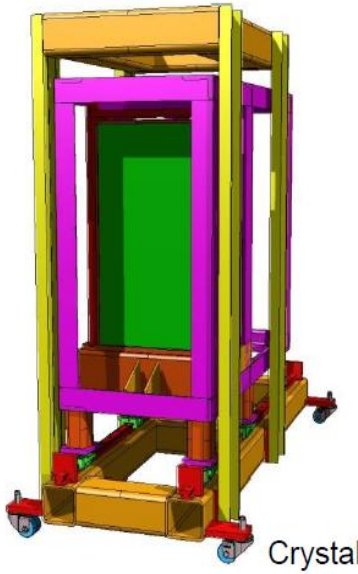


DVCS/Hall A PbF_2 calorimeter



612 $PbWO_4$ + *200* PbF_2

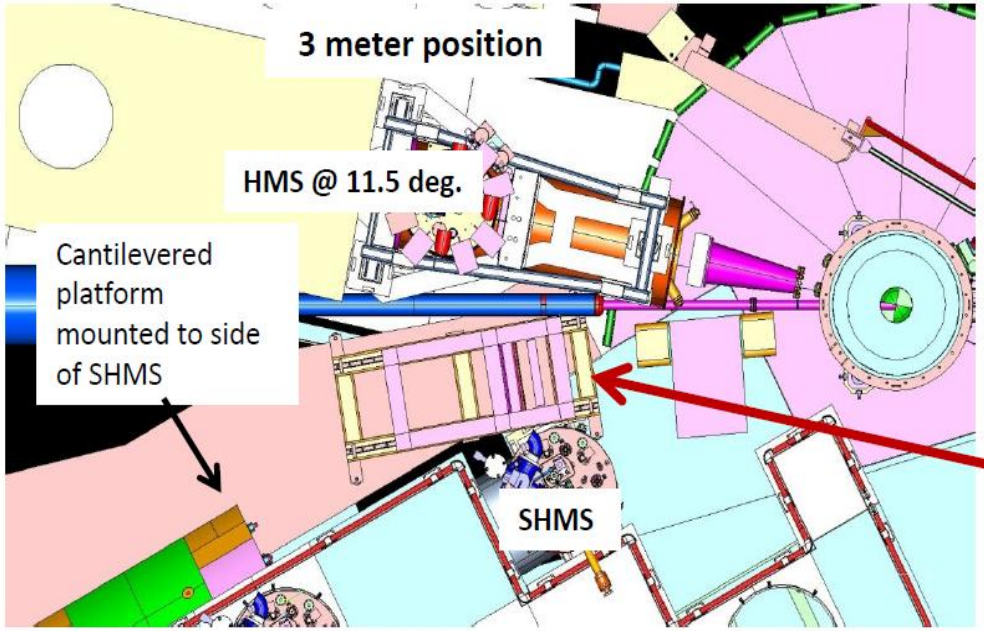
NPS hybrid crystal matrix



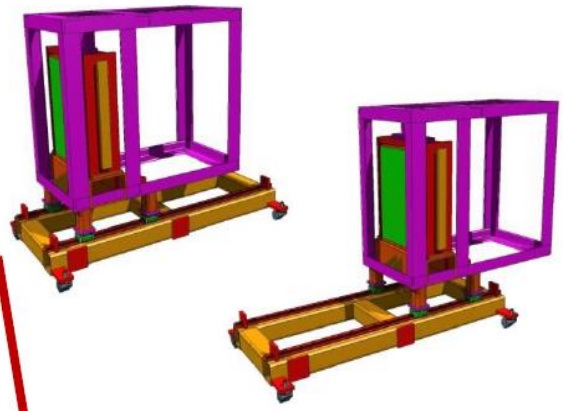
Crystal matrix in NPS frame

- In ideal conditions would start with brand new $PbWO_4$
- Taking advantage of existing $PbWO_4$ crystals from HyCAL, one arrangement is in a 36x30 matrix covering 25 msr at distance of 4 m from target (~1100 crystals)
- Could use PbF_2 crystals from DVCS/Hall A to fill out solid angle if only ~600 $PbWO_4$ available

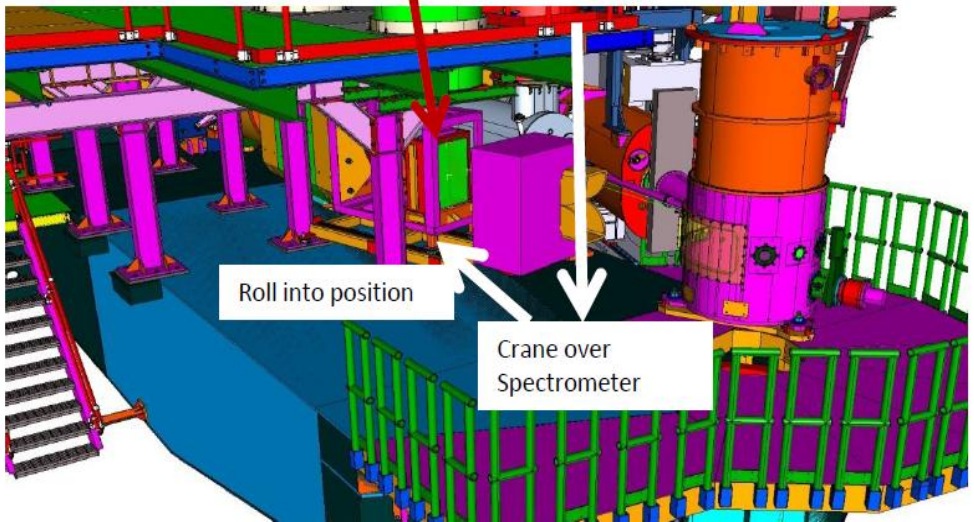
NPS Frame



- NPS frame mounted on base frame with rail system allowing for movement in *z* to positions between 3 m and 12 m from the target

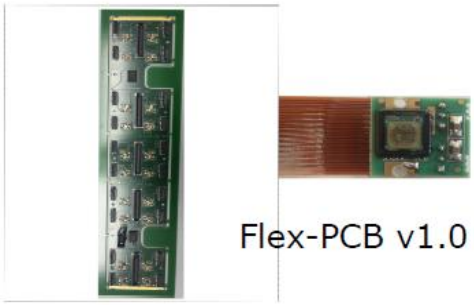


- For experiments like Wide Angle Compton Scattering requiring angles >=25 degrees NPS can be installed on the other side of the SHMS



Readout Electronic – PCBs

2012



Flex-PCB v1.0

Backplane v1.0

Backplane v1.0:

- Design: 2 x 10 ASICs
- Fits to the Proto 120 geometry
- Complex programming structure
  → Chip ID 1 ..16

Flex-PCB v1.0:

- Not shielded rigid flex PCB
  → pick-up noise
- One HV for both channels
- Only one GND!
- No HV blocking on the flex PCB

2013/2014

Flex-PCB v2.0

Backplane v2.0

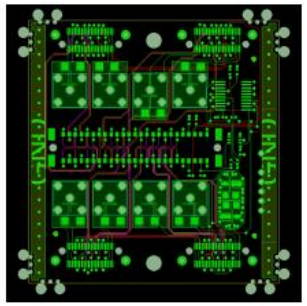
Backplane v2.0:

- Design: 2 x 4 ASICs
- Not forseen for the Proto 120 geometry
  → only for lab tests
- Simple programming structure
- One HV for two channels

Flex-PCB v2.0:

- Bouth side shielded rigid flex PCB
- One HV for both channels
- Only one GND!
- HV blocking close to the APD region

2014/2015



Flex-PCB v2.1

Backplane v3.0

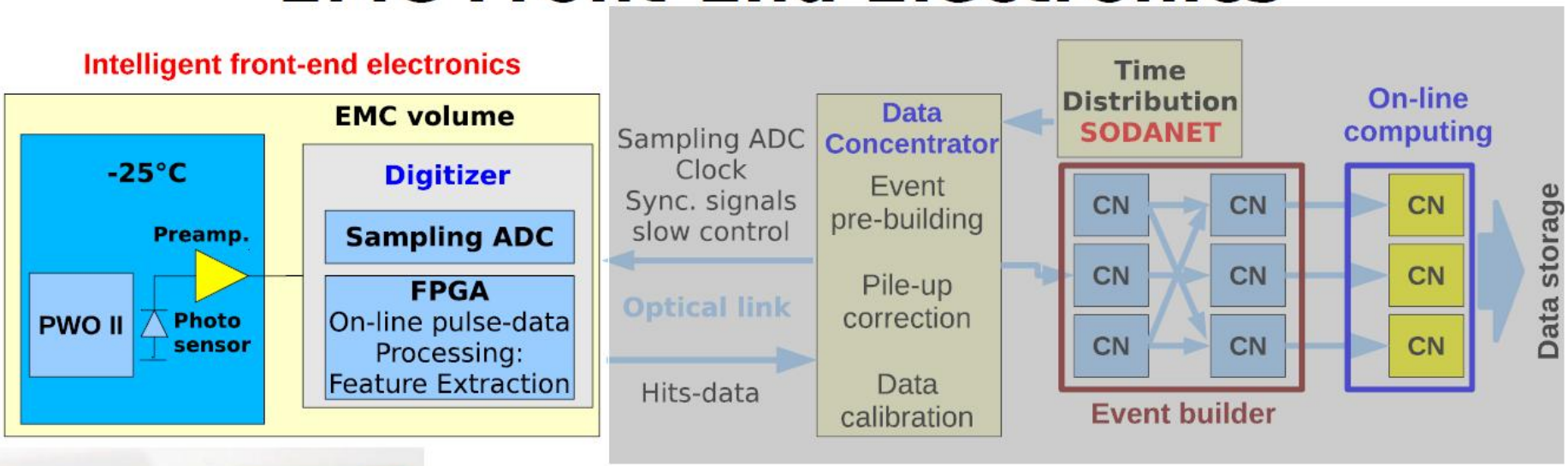
Backplane v3.0:

- Design for only 2 x 2 ASICs
- Fits to the Proto 120 geometry
- Simple programming structure
- One HV for each channel!!!
- Separate HV GND

Flex-PCB v2.1:

- Double side shielded rigid flex PCB
- HV separate for each channel
- HV blocking close to the APD region

EMC Front-End Electronics



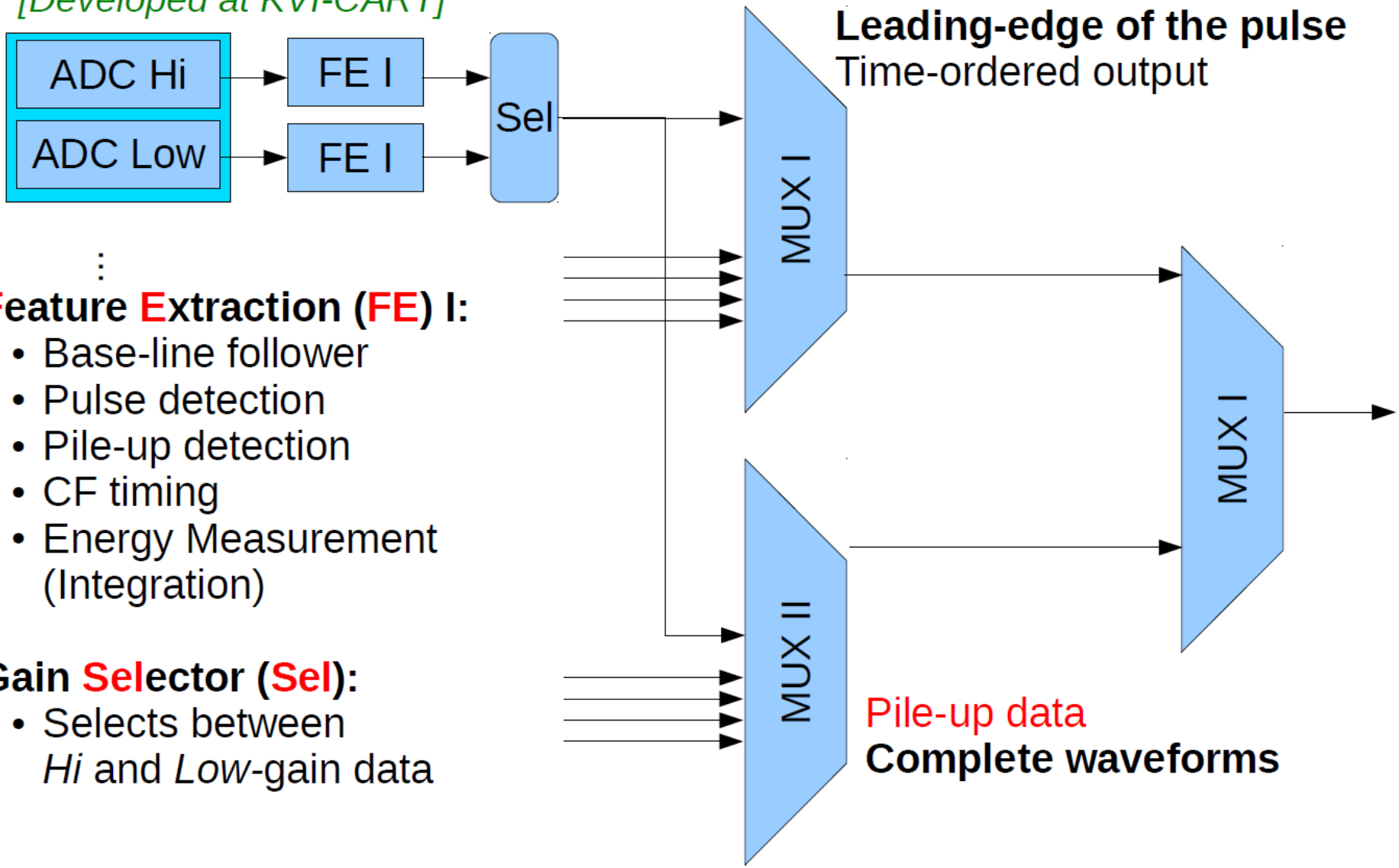
EMC digitizer:

- 64 ADC channels (32 dual-gain readout channels)
- 14 bit resolution
- 80-125 MHz sampling rate
- On-line detection of hits, extraction of hit information, pulse pile-up recovery by two Xilinx Kintex-7 FPGAs

Digitizers are located in radiation area → precautions have to be taken against configuration changes and SEU in FPGAs

Feature-Extraction Algorithm

[Developed at KVI-CART]



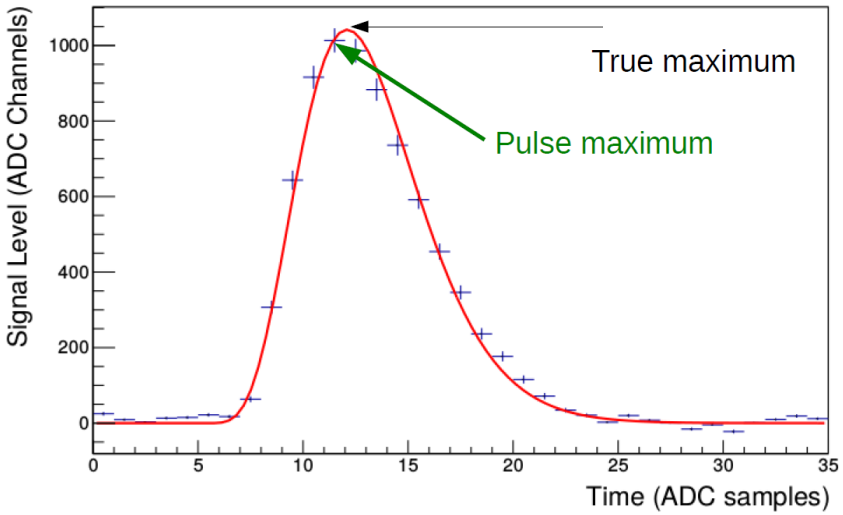
Feature Extraction (FE) I:

- Base-line follower
- Pulse detection
- Pile-up detection
- CF timing
- Energy Measurement (Integration)

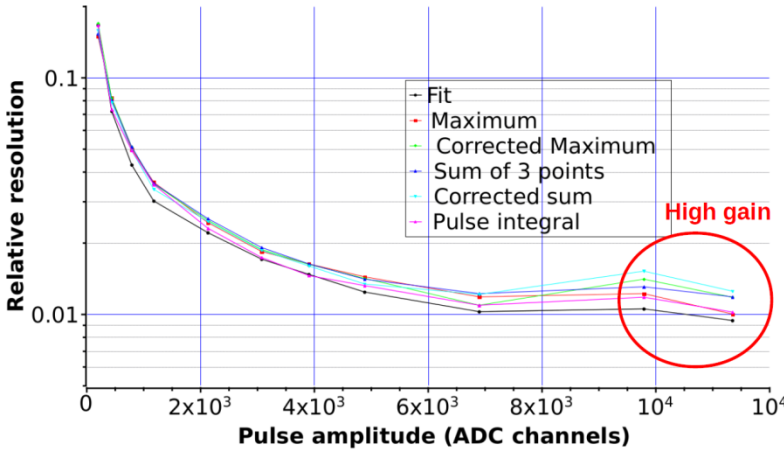
Gain Selector (Sel):

- Selects between *Hi* and *Low*-gain data

Precise Amplitude Measurement

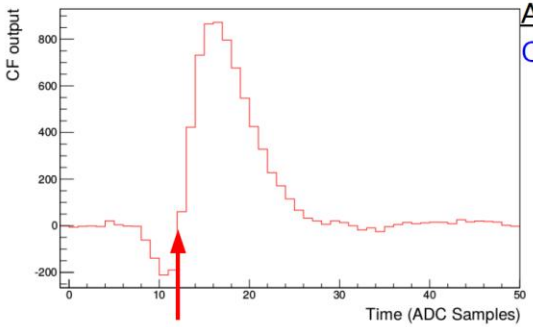


The Best "Energy" Measurement



Integration – the best option?

Time Measurement



Analogue-like implementation:

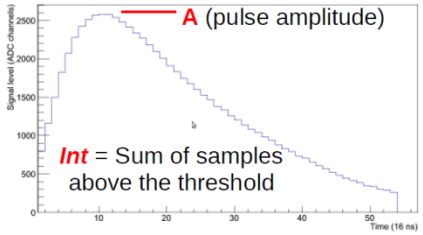
$CFT(n) = MWD(n\text{-}d) - R \cdot MWD(n)$

- Delay d = signal rise time
- Fraction R – to select most linear part of the signal leading edge (**R=1/4**)
- N – number for the linear regression
- Symmetry against zero level

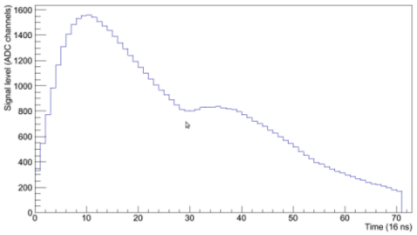
Time stamp: zero-crossing (linear regression)

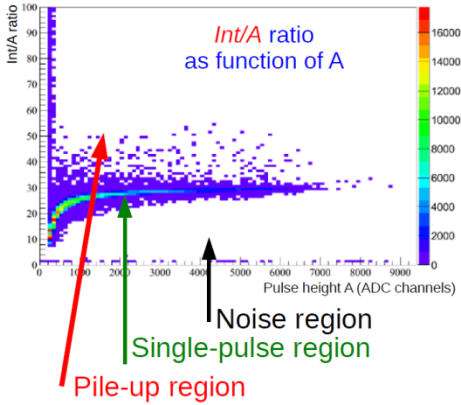
Pile-up Detection

If samples above threshold satisfy ***Int/A*** criterion → Pulse is detected



Pile-up event identified on-line





Pulse-detection works properly:
- Detection of single pulses

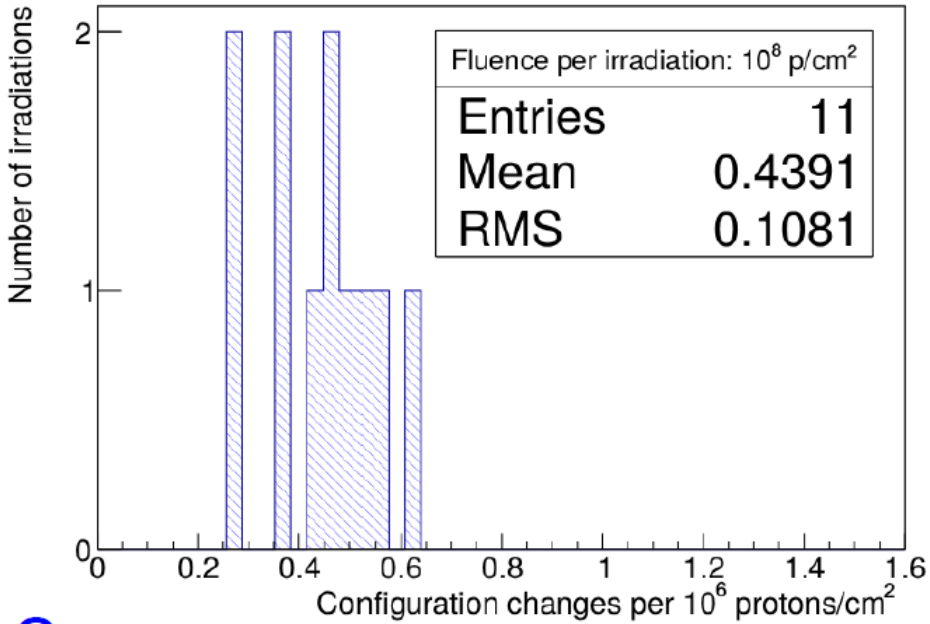
Detection of pile-up structures

Irradiation of Kintex-7 (XC7K325T)

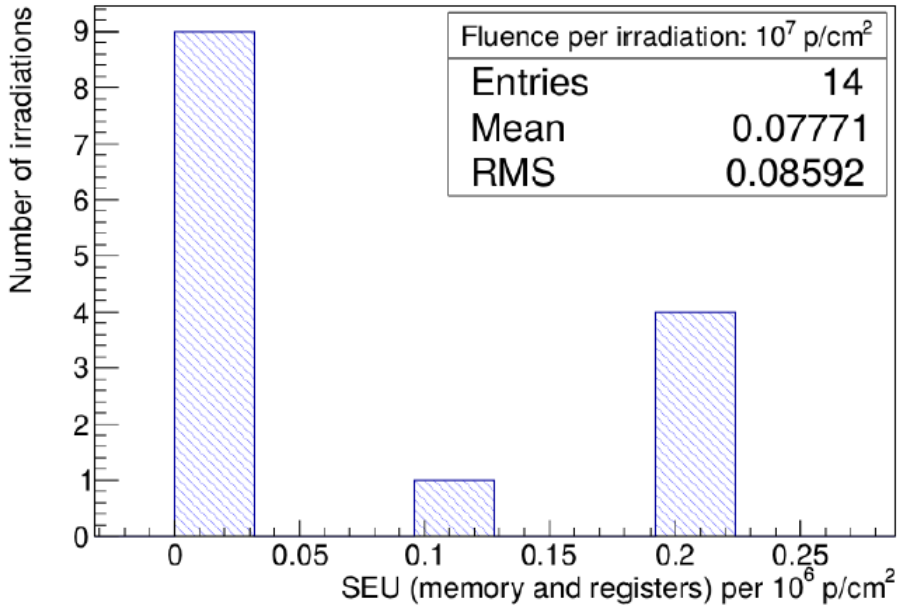
150 MeV protons, homogeneous field

Resources involved in the SEU test: Registers: **54%** (=$2.2 \cdot 10^5$)
Block RAM: **86%** (=$1.4 \cdot 10^4$ kb)

Configuration changes per 10^6 /cm^2



SEU per 10^6 /cm^2



On average:

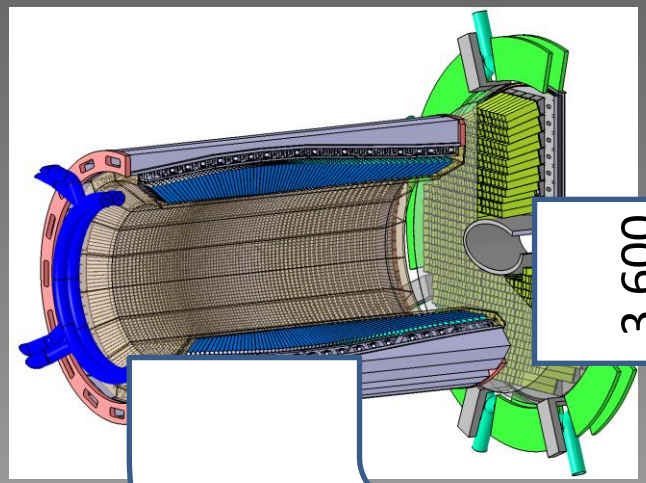
configuration changes:
0.44(11) per 10^6 /cm^2

SEU events:
0.08(8) per 10^6 /cm^2

➔54 min operation without reconfiguration (incl. safety factor 10)

ADC for EMC

- PANDA EMC Readout System



3,600

11,952

Photosensor VPTT

Preamplifier Basel

Photosensor APD

Preamplifier APFEL (GSI)

14400

47,808

ADC 64-ch, 14-bit 80-MSPS

Ca. 1,000

Data Concentrator 16-ch

65

Compute Node

ADC for EMC

- SADC development for PANDA

2008
16-ch, 12-bit
160 MSPS ADC
Used for the first tests, sold to WIENER

2010
16-ch, 2GBit/s
Optical Data Concentrator
Used in many experiments including WASA, KLOE2

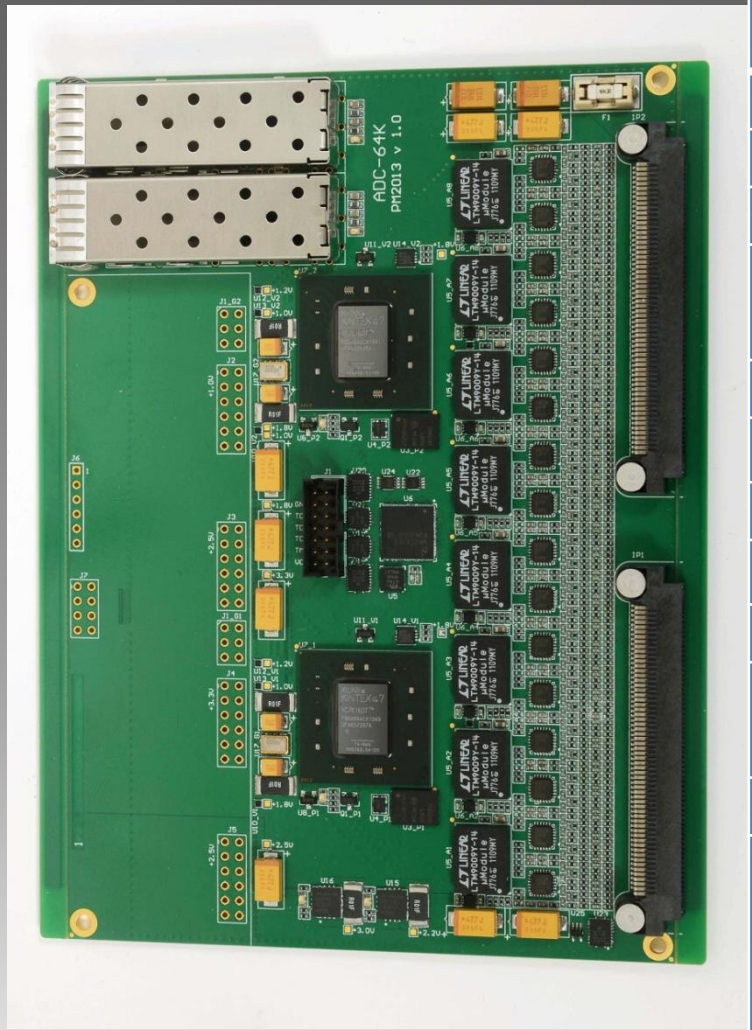
2011
16-ch, 14-bit
125 MSPS ADC
Virtex-5
Used for evaluation of DSP algorithms

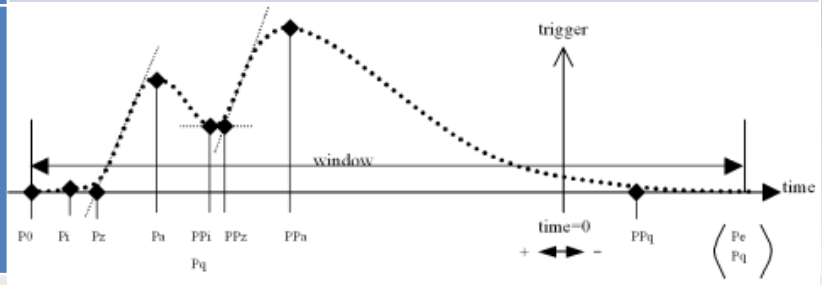
2012
32-ch, Dual-range, 14-bit
80 MSPS ADC
Virtex-6
Used for first data taking and durability tests

2013
64-ch, 14-bit
80 MSPS ADC
Kintex-7
Close-to-final prototype

UPPSALA UNIVERSITET

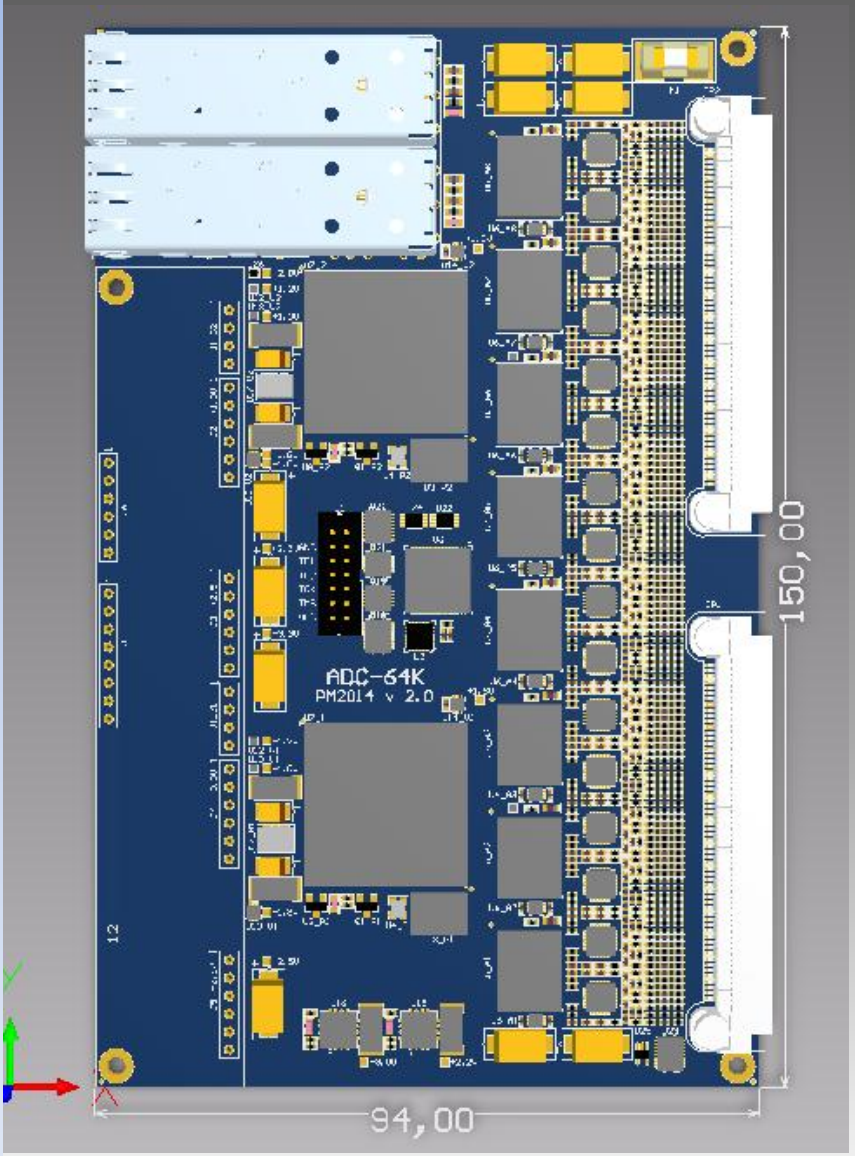
ADC for EMC
- ADC_64K



ADC Model	ADC_32DR	ADC_64V	ADC_64K
No. of channels	32 (64)	64	64
Sampling rate	80-125 MSPS		
Input coupling	DC, positive, negative, diff		
Resolution (ampl)	14-bit dual range	14-bit	
Input Connector	uFL	Samtec	
Baseline	0V		
Input range (dual)	±1.0V, ±60 mV	±1.0V, ±100 mV	
Noise	100uV		
Data retention/ch.	25us		
Input filter	Active-filter/Amplifier	CR-passive	Active filter/Amplifier
Interface	Optical, SFP, LC-type, 2 Gbit/s		
Feature extraction:			

- ADC_64K_2

ADC_64K_2



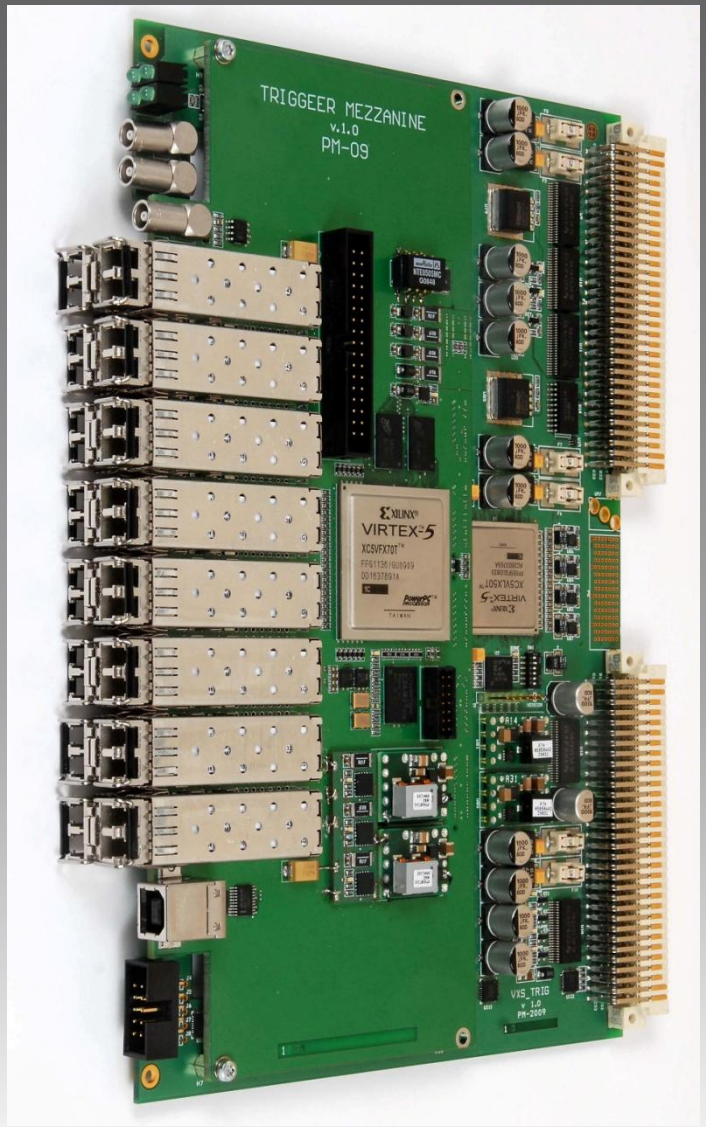
List of recent changes/improvements

1. Overall error correction
2. Input can be galvanically de-coupled from the ground
3. Improved analog/digital ground separation
4. All low-voltage power supplies can be distributed via backplane connectors
5. Space optimization
6. Baseline shifting (?)

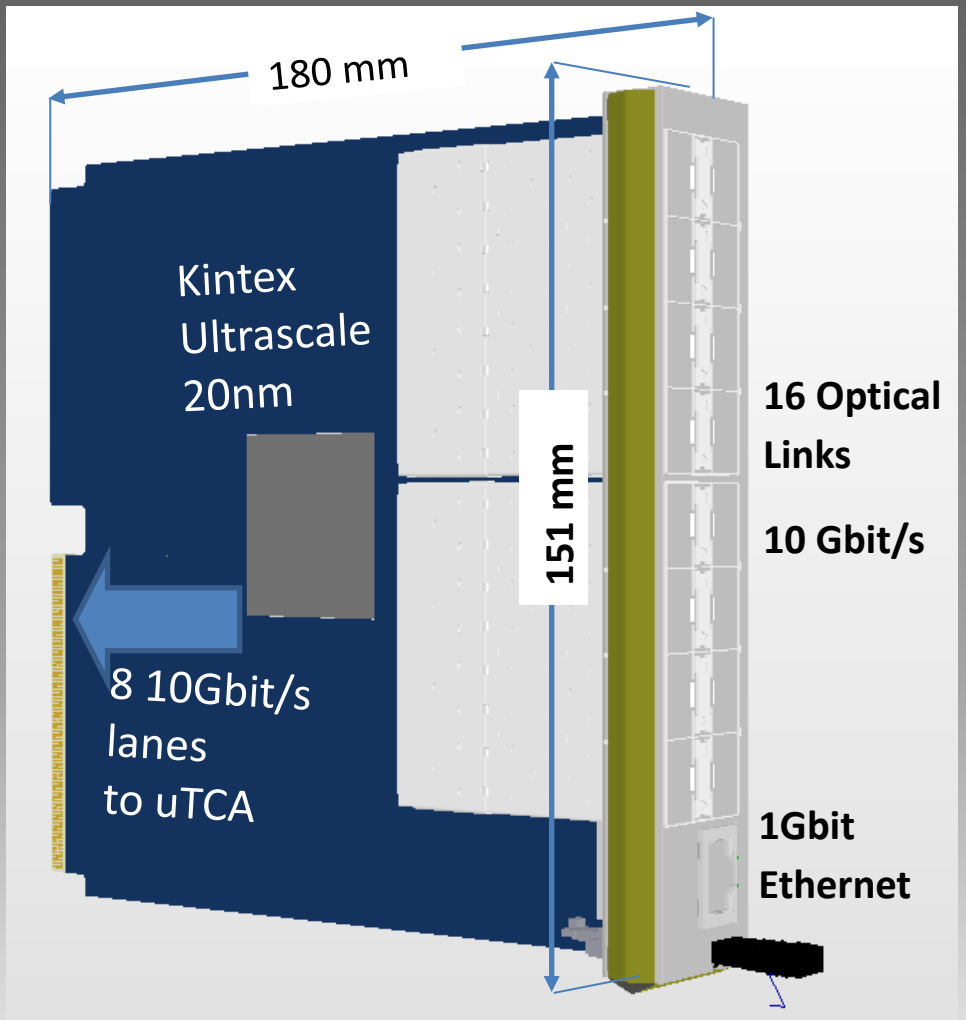
ADC for EMC

- Data Concentrators

VME64x



AMC (uTCA)

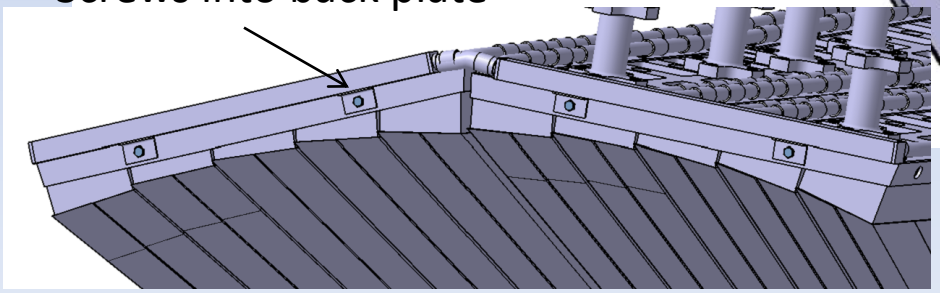


Forward extremity

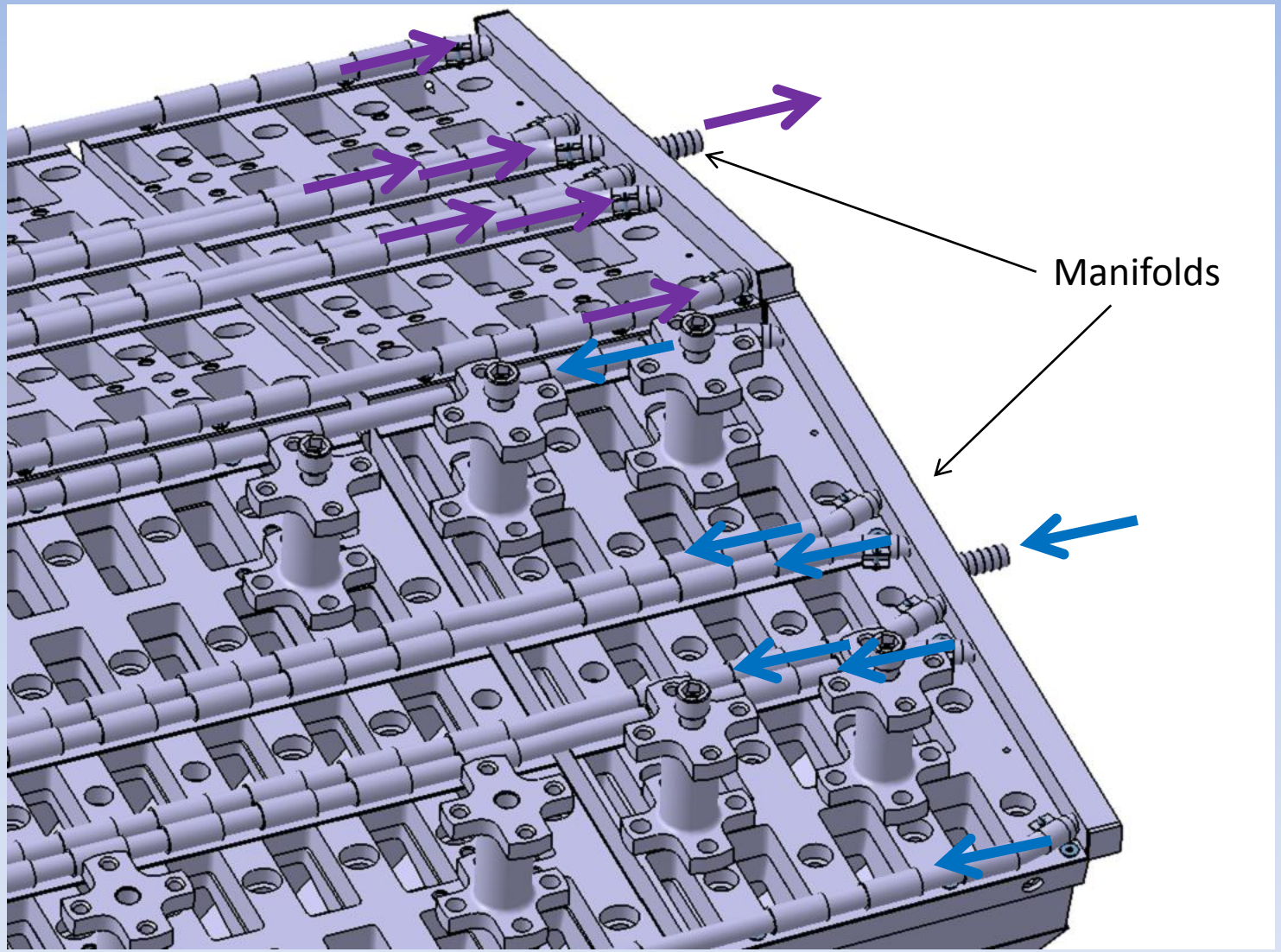
6 cooling tubes PA diam 6/8 by slice

Manifolds

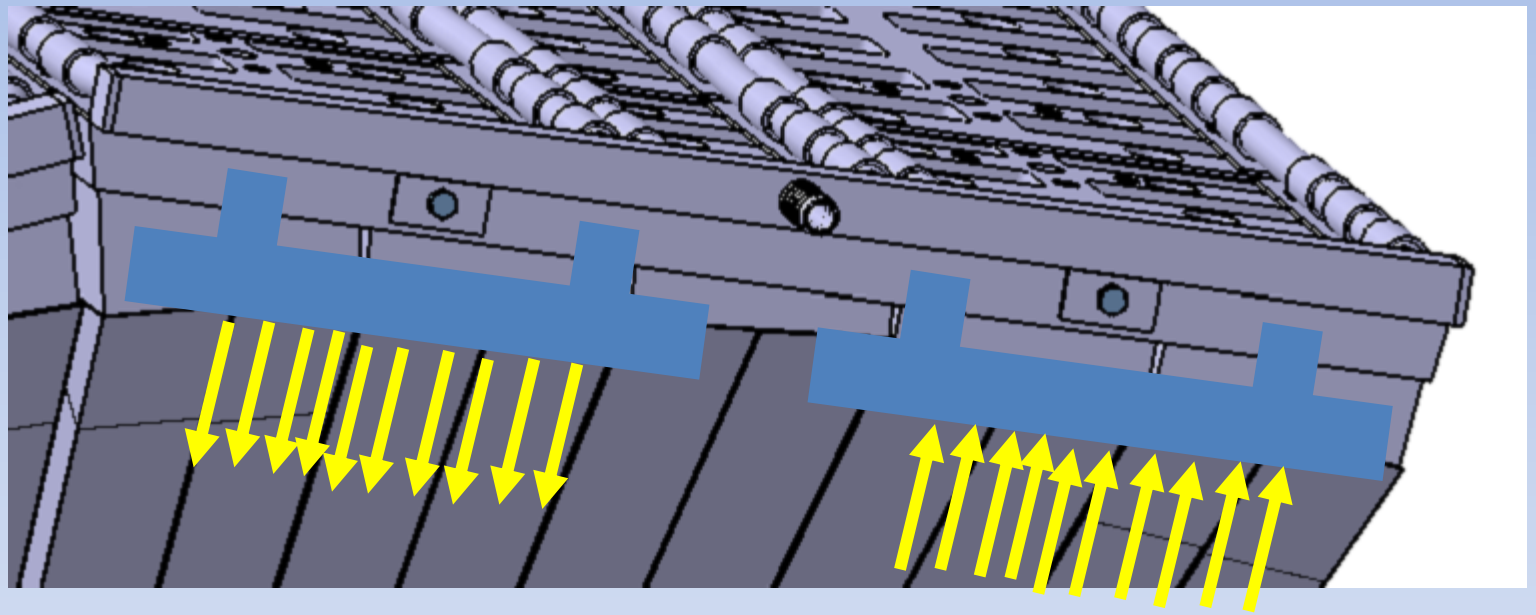
Screws into back plate



Backward extremity

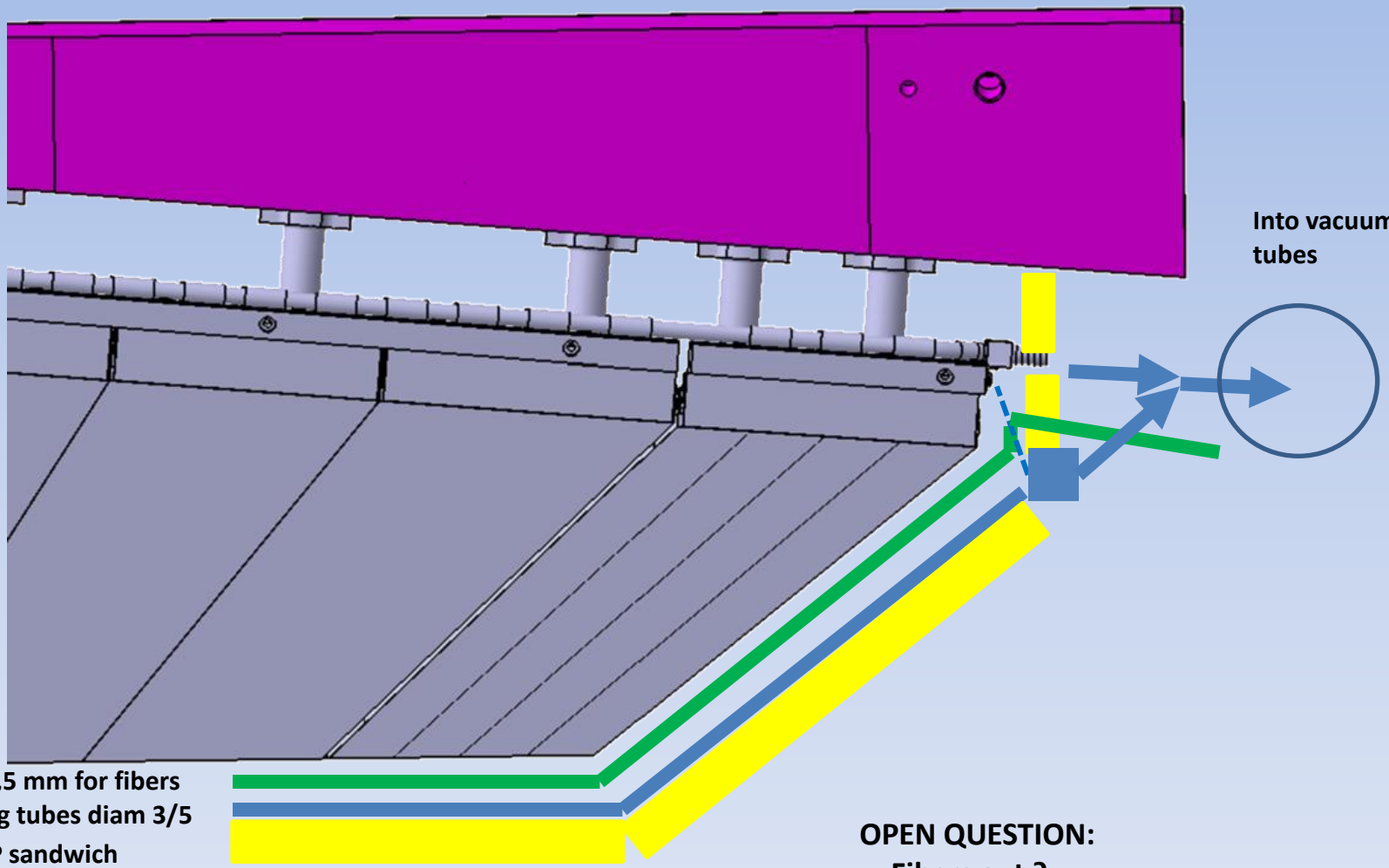


Backward extremity



Manifolds for front crystals cooling fixed also on back plate
2x10 cooling tubes PA diam 3/5

Backward extremity



2,5 mm for fibers

20 cooling tubes diam 3/5

VIP sandwich

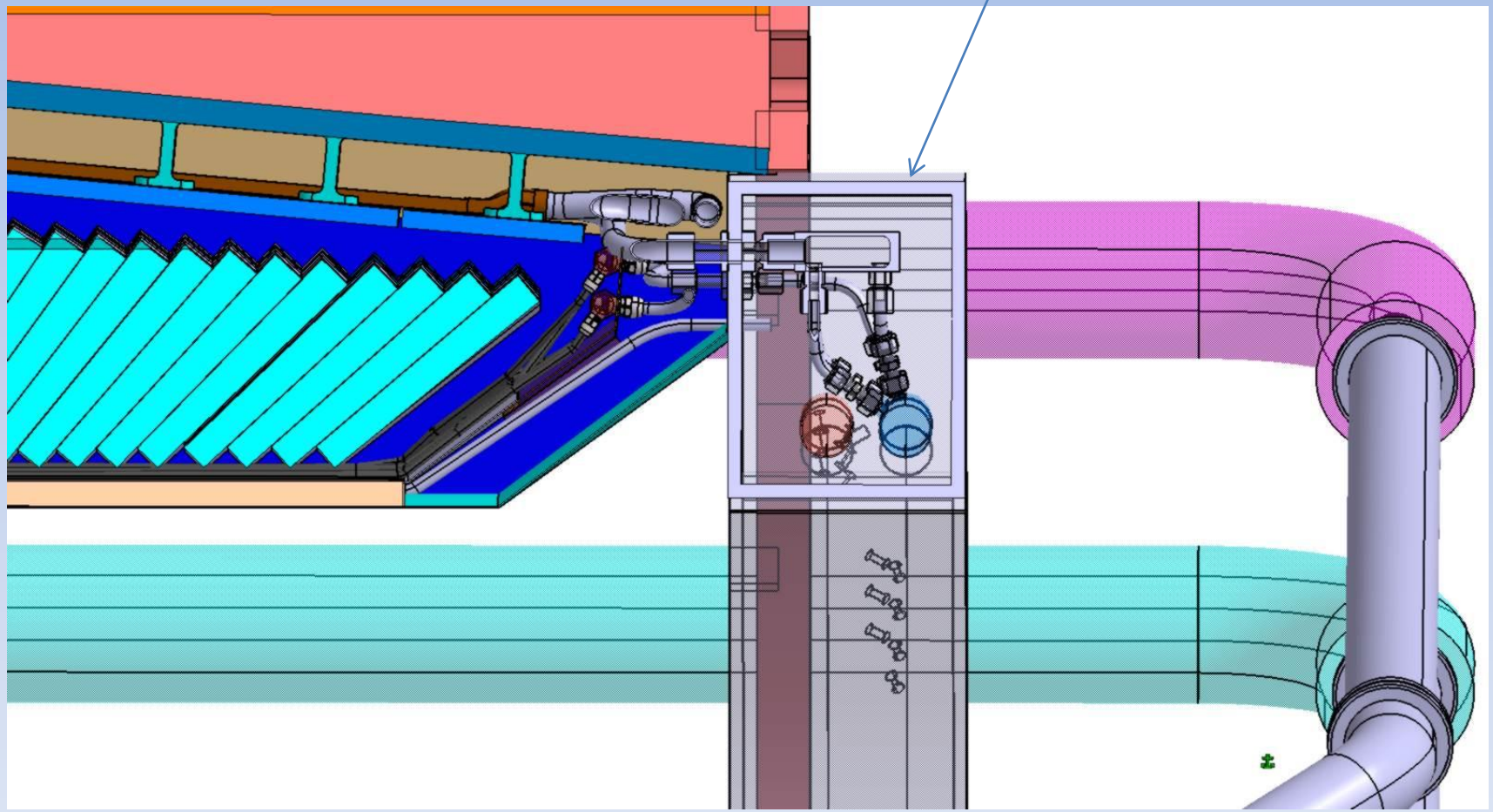
1 mm thermal resistance in front – 0,5 mm aluminium – 15 mm VIP – 0,5 mm carbon – 5 mm tubes

OPEN QUESTION:

- **Fibers out ?**
- **Thermal sensors out ?**

Vacuum box for cooling tubes going out of the barrel

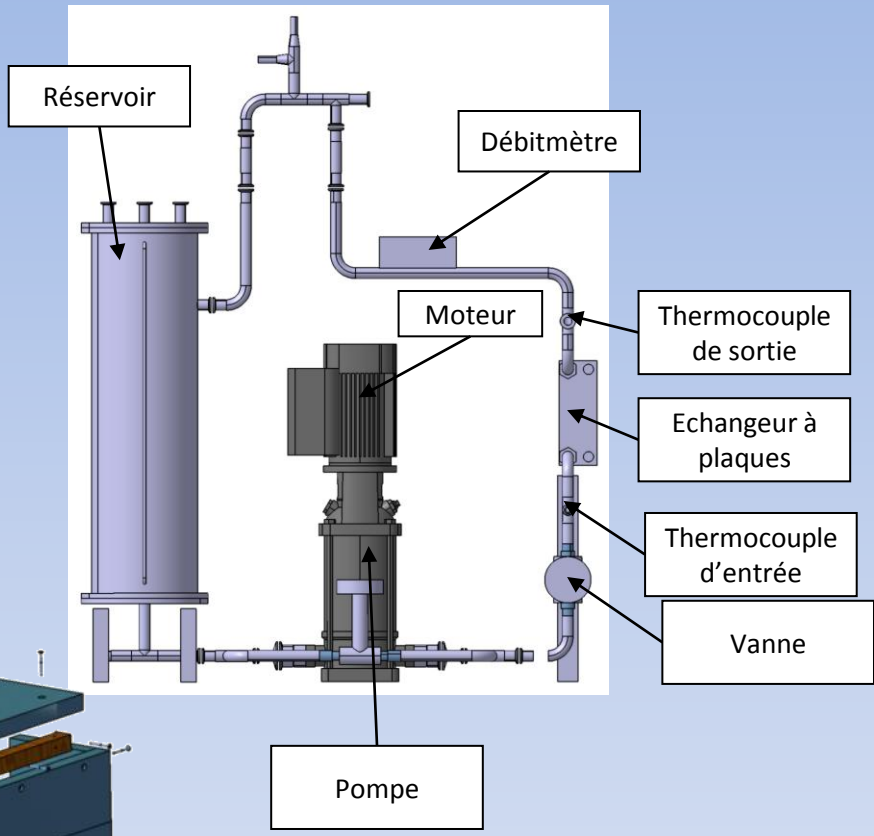
To be defined in spring (other training student (Christopher paid by Giessen)



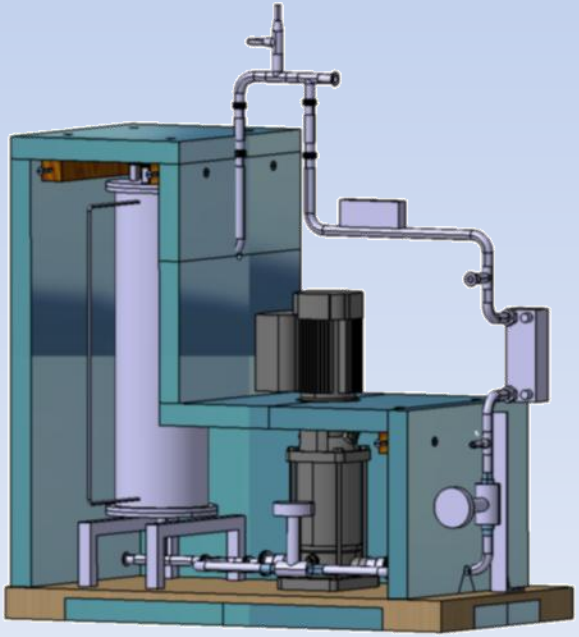
Pump insulation

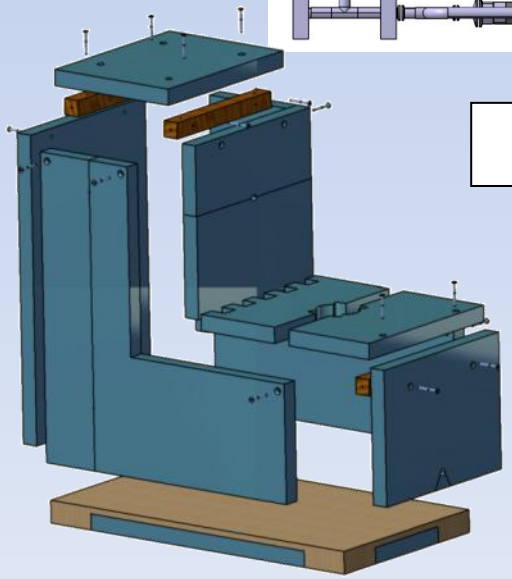
(with flowmeter – vacuum – tank – manometer – 1,5kW heater)

But : Isoler l'ensemble pompe réservoir déjà existant.

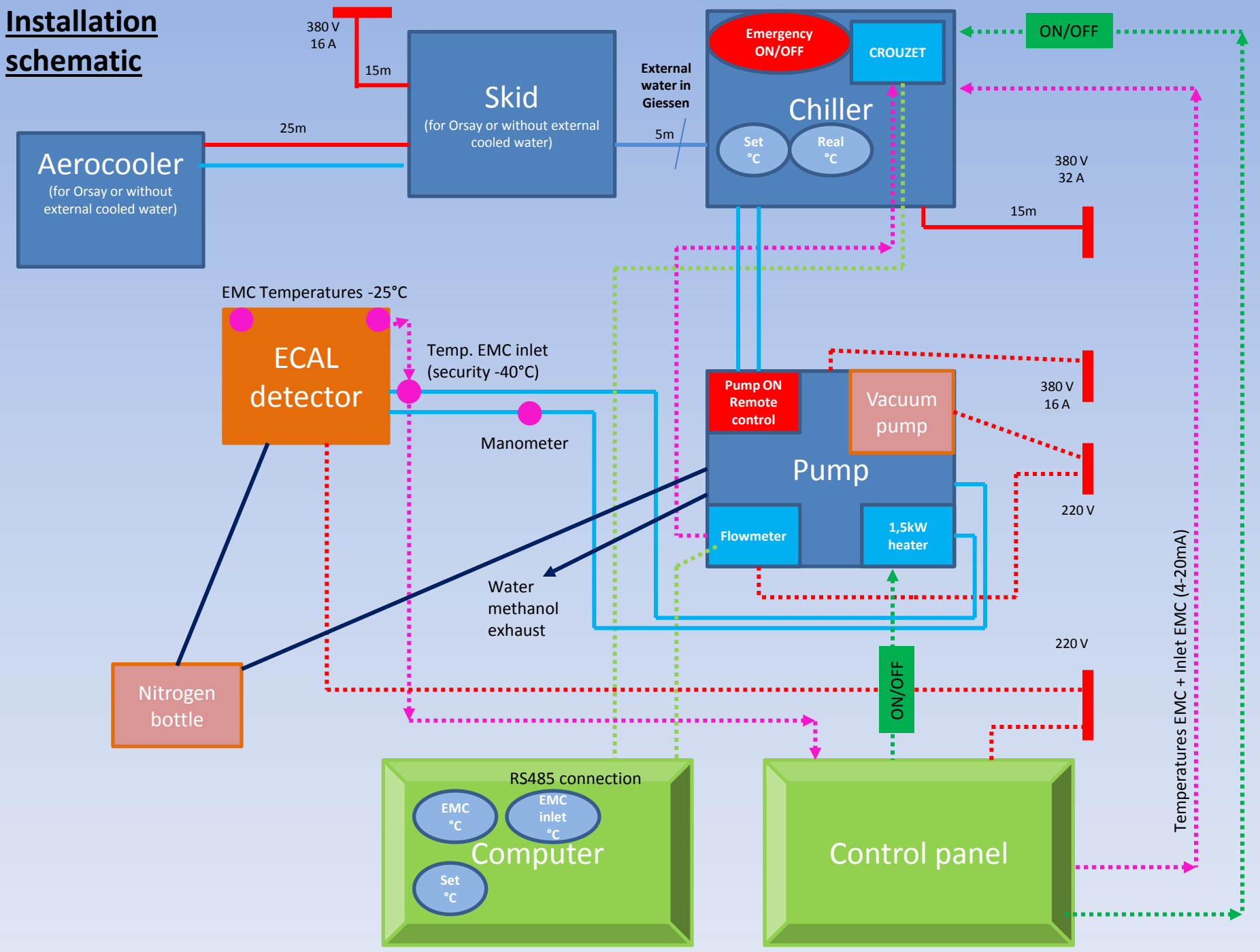


Dessiner l'enceinte en Roofmate.





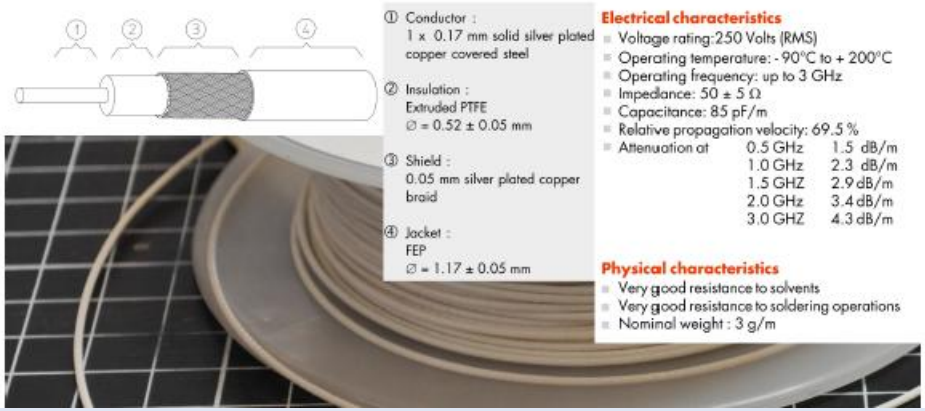
Installation schematic



Cables

Cables
from patch panel
PCB to the outside:

- Huber+Suhner Enviroflex (HV)
- Nexans Filotex (signal) yields attenuation of preamp pulses by 0.18 dB/m
- Ribbon (sensor) + LV cables



Summary

Measured cable length:

- HV (Huber+Suhner Enviroflex): 13606 m $\rightarrow$ 16 km ordered
- Ribbon cable: 423 m
- Signal (Nexans Filotex): 11554 m $\rightarrow$ 12 km ordered

Work in progress:

- Finalize LV cables + routing
- Design of backplate frame cable feedthrough

To do:

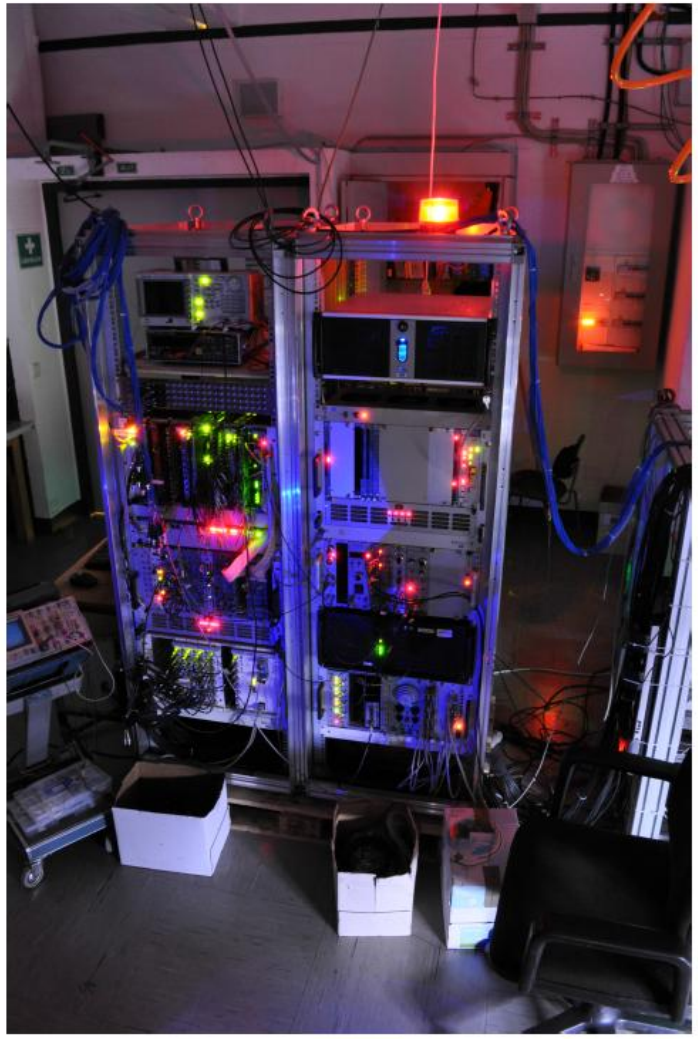
- Fix crate positions

Alarm notifications for the $\overline{\text{P}}$ANDA Detector Control System

Tobias Triffterer

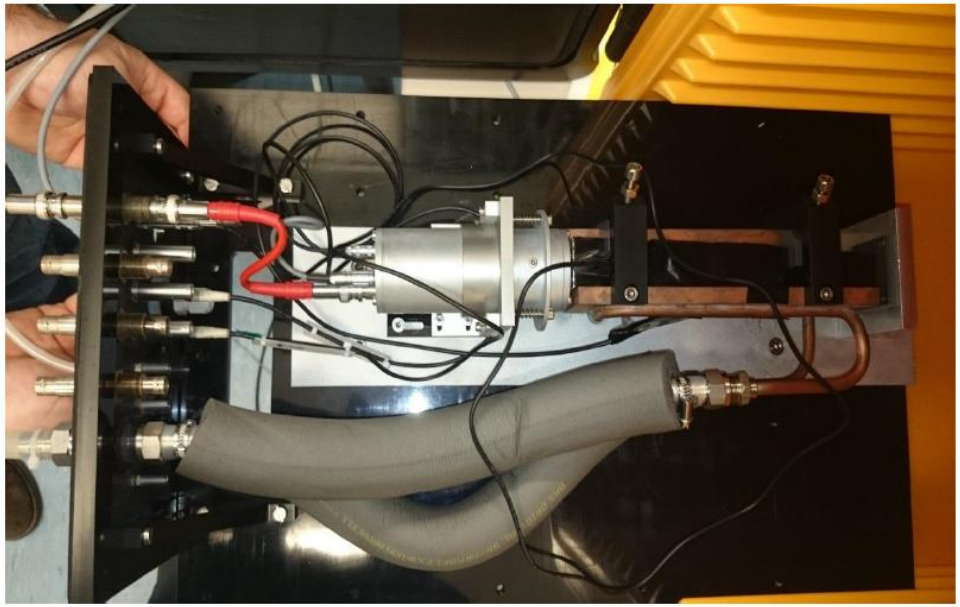
Experimentelle Hadronenphysik
Ruhr-Universität Bochum

EMC workshop
$24^{\text{th}} + 25^{\text{th}}$ November 2014



Stimulated recovery

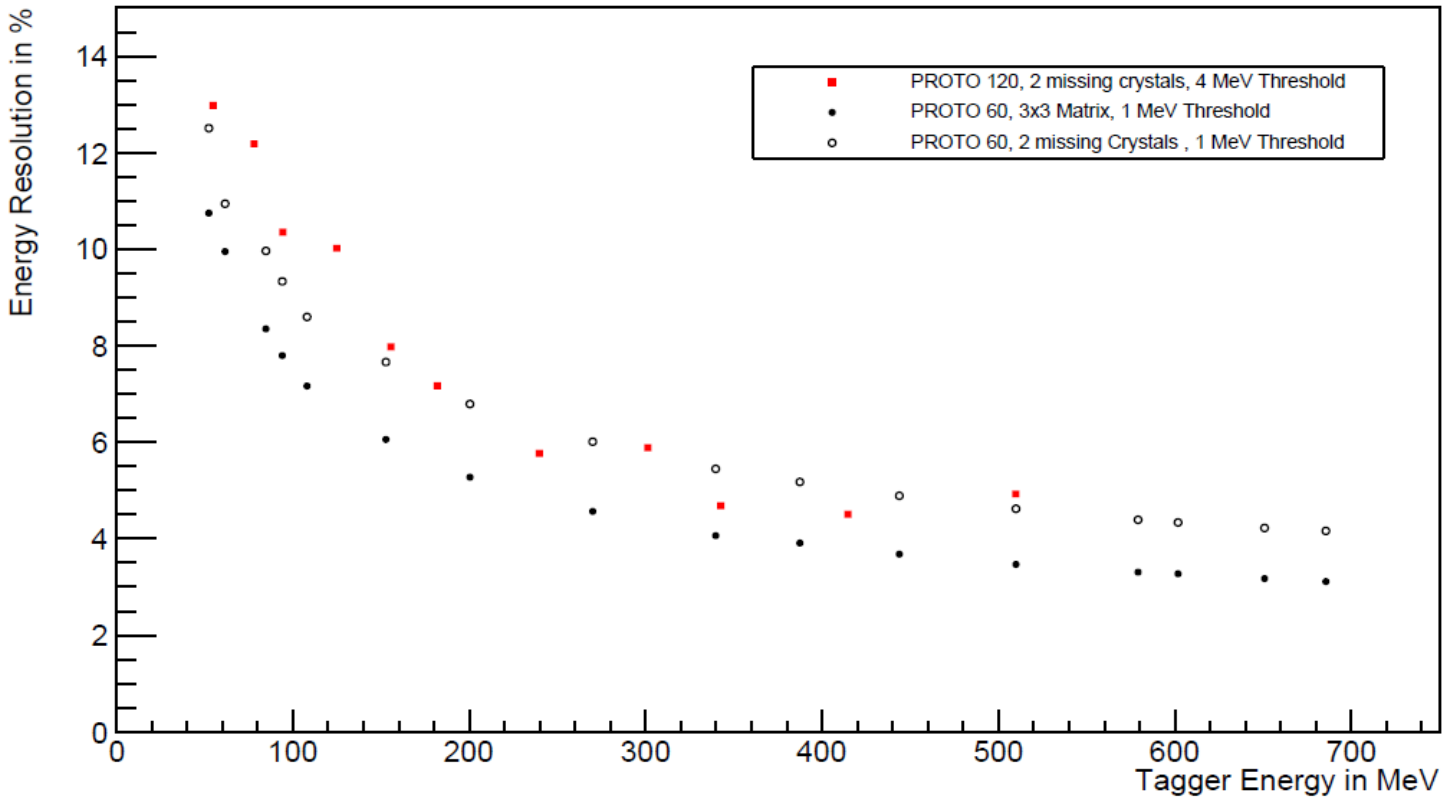
T. Kuske



- T = - 25°C
- no ice formation
- VPT readout
- light pulser

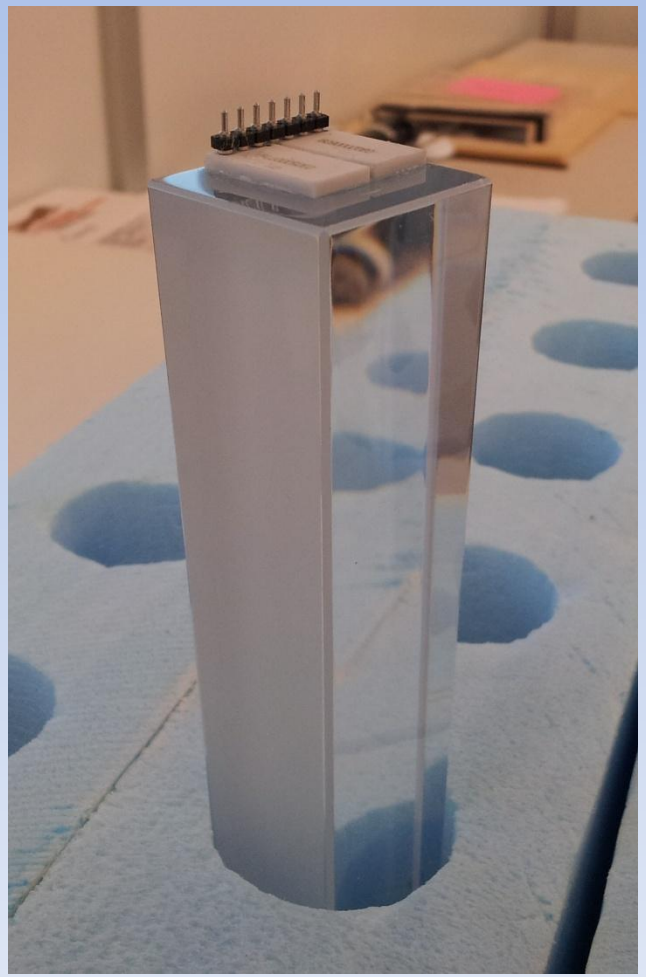
Combined energy resolution

1. Crystal with highest energy → central crystal
2. Threshold for central crystal
3. LG-information for central crystal and HG-information for peripheral crystals

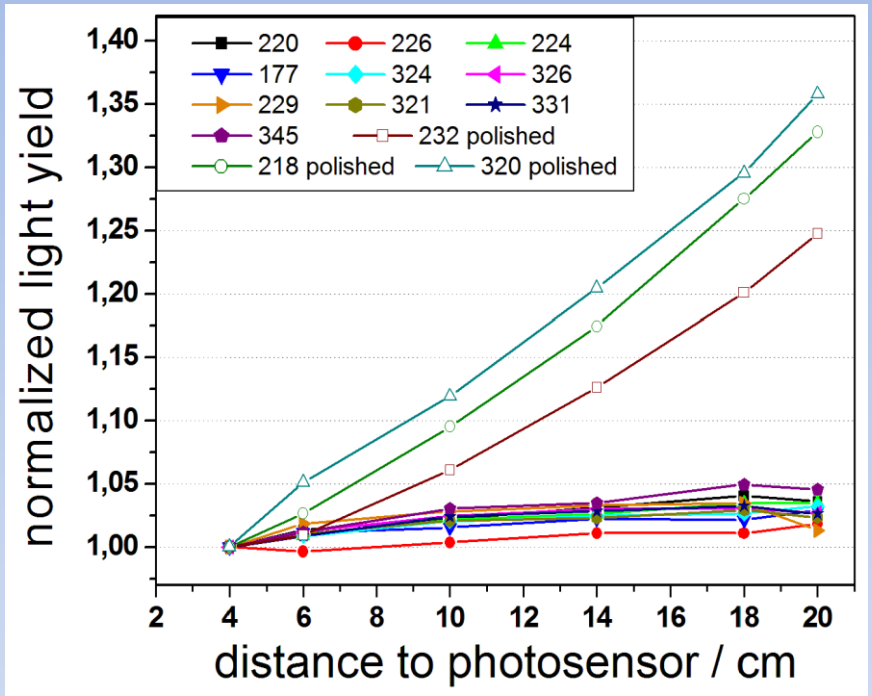


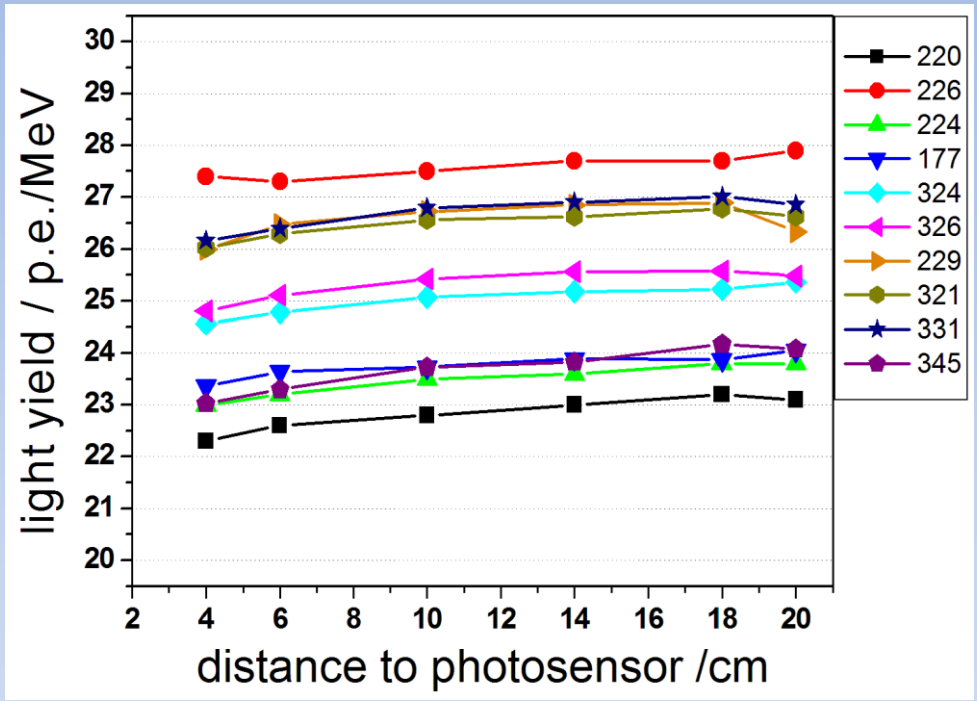
Implementation of 9 depolished crystals in PROTO 120 (3x3 matrix)

- 9 type 2 crystals depolished at CERN with the setup used for CMS
- One lateral side depolished with R_a = 0.3 µm (value calculated from CMS data)
- All other sides still polished
- NUF has been measured for all depolished crystals



NUF and LY of the depolished crystals





#	LY [p.e./MeV] polished	LY [p.e./MeV] depolished	change
220	29.0	23.1	20.3 %
226	31.7	27.9	12.0 %
224	27.9	23.8	14.7 %

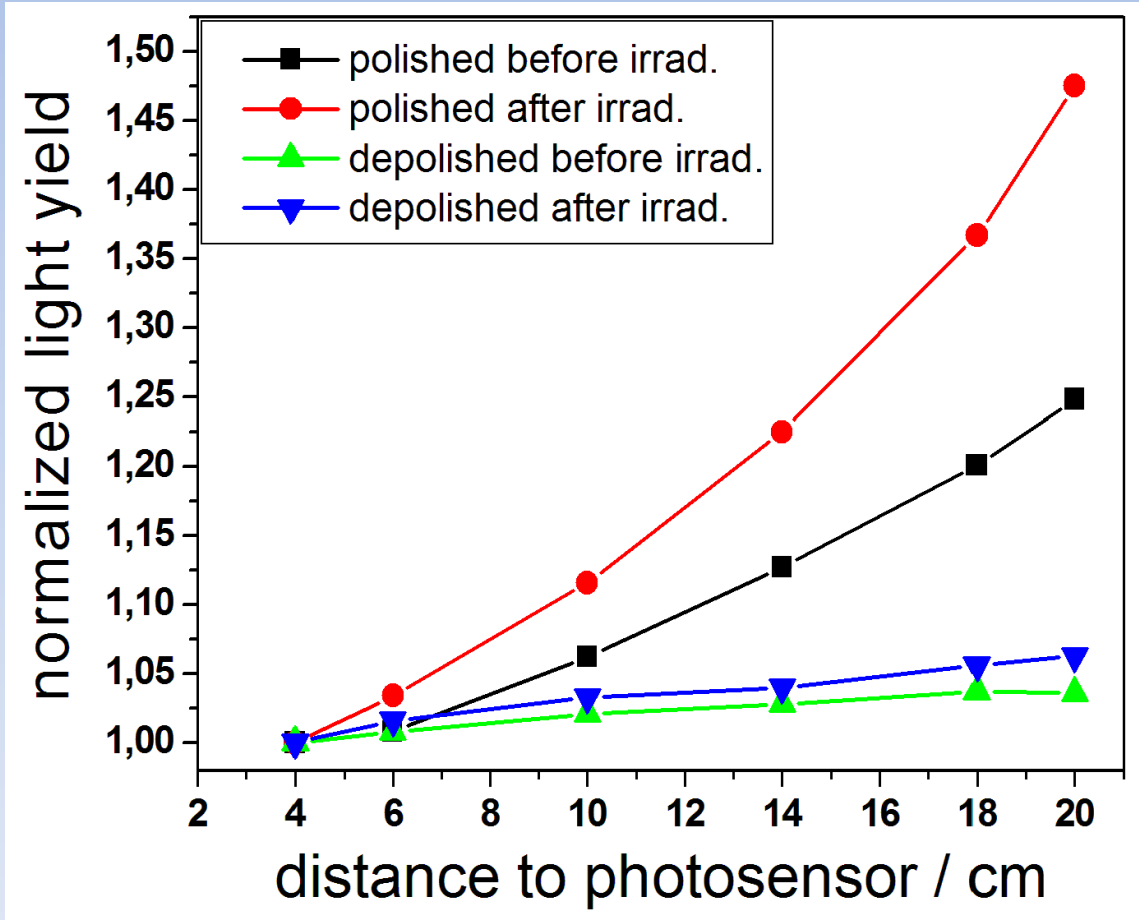
^{137}Cs source on top of crystal

measured by S. Nazarenko, V. Dormenev

T = + 18 °C, time gate = 1 µs

NUF and LY of the depolished crystals

- Depolishing also decreases the influence of radiation damage (30Gy ɣ) on NUF



measured by
S. Nazarenko, V. Dormenev

A. Wilms: Status on APD-screening

delivery rate by Hamamatsu: 350 /week
quality check: parameter limits @ 20°C

S11048 2014.11.14 Test Data
No.0814008257-No.0819008647

Type No.	Serial No.	Position	VB(V)	M=100 VR(V)	M=100 ID(A)
S11048	0814008257	D05	418	389,7	4,30E-09
S11048	0814008258	H06	421	392,6	3,60E-09
S11048	0814008259	C04	420	391,0	4,90E-09
S11048	0814008260	E02	422	392,7	3,10E-09
S11048	0814008261	B03	417	389,4	3,40E-09
S11048	0814008263	D15	418	392,5	1,58E-08
S11048	0814008264	C08	418	389,9	3,00E-09
S11048	0814008265	B09	422	393,9	3,30E-09
S11048	0814008266	C10	421	392,9	3,40E-09
S11048	0814008267	F14	425	396,7	5,20E-09

required for final application: HV for gain 150-200 @ -25°C

set of measurements at ≤ 5 temperatures before **and** after irradiation (^{60}Co @ GI)
comparison: DC **and/or** pulsed light source ???
selected parameters: **QE, C, …**

request for a detailed quantitative status of the present capabilities.