PANDA Plenary Meeting, Vienna, December 3, 2015
G.Alexeev (for muon group)

Muon System Status Report

* Software (Muon System in PANDAroot):

- Barrel, End Cap, Muon Filter, Forward Range System –> PANDAroot
- Digitization -> to be further tuned with prototype experimental data

* Hardware:

- Full assembly of Range System Prototype (wire & strip R/O, analog & digital FEE)
- Upgrade of T9/PS/CERN beam line diagnostics (time-of-flight, Čerenkov)
- R&D @ test stand in JINR (ageing, high rate effects, new FEE ASIC chips etc.)

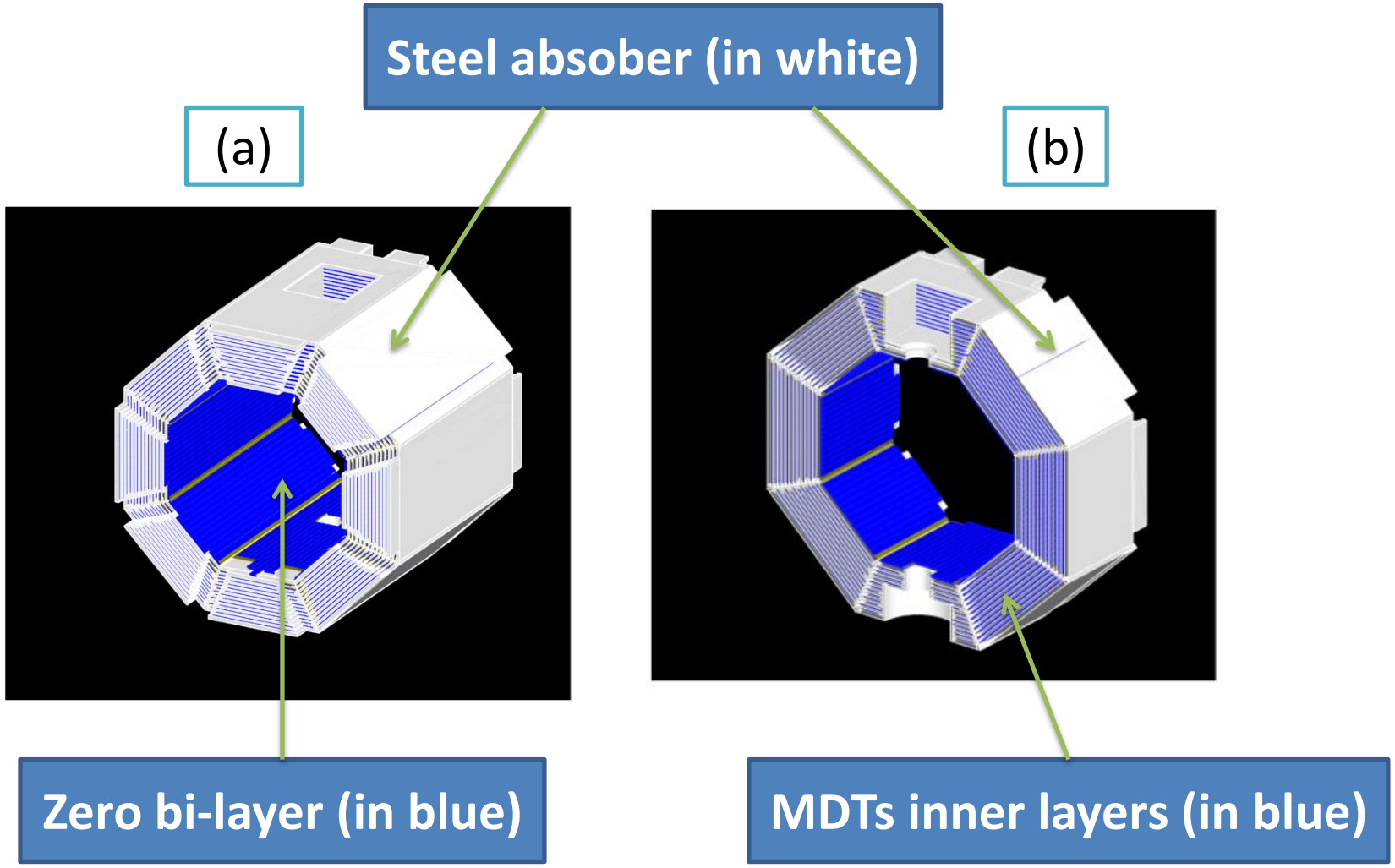
* Preparation for mass production:

- Contacts with main producers (MDTs components, FEE ASIC chips, …)
- Processing/promotion of Muon System project (at JINR & FAIR)

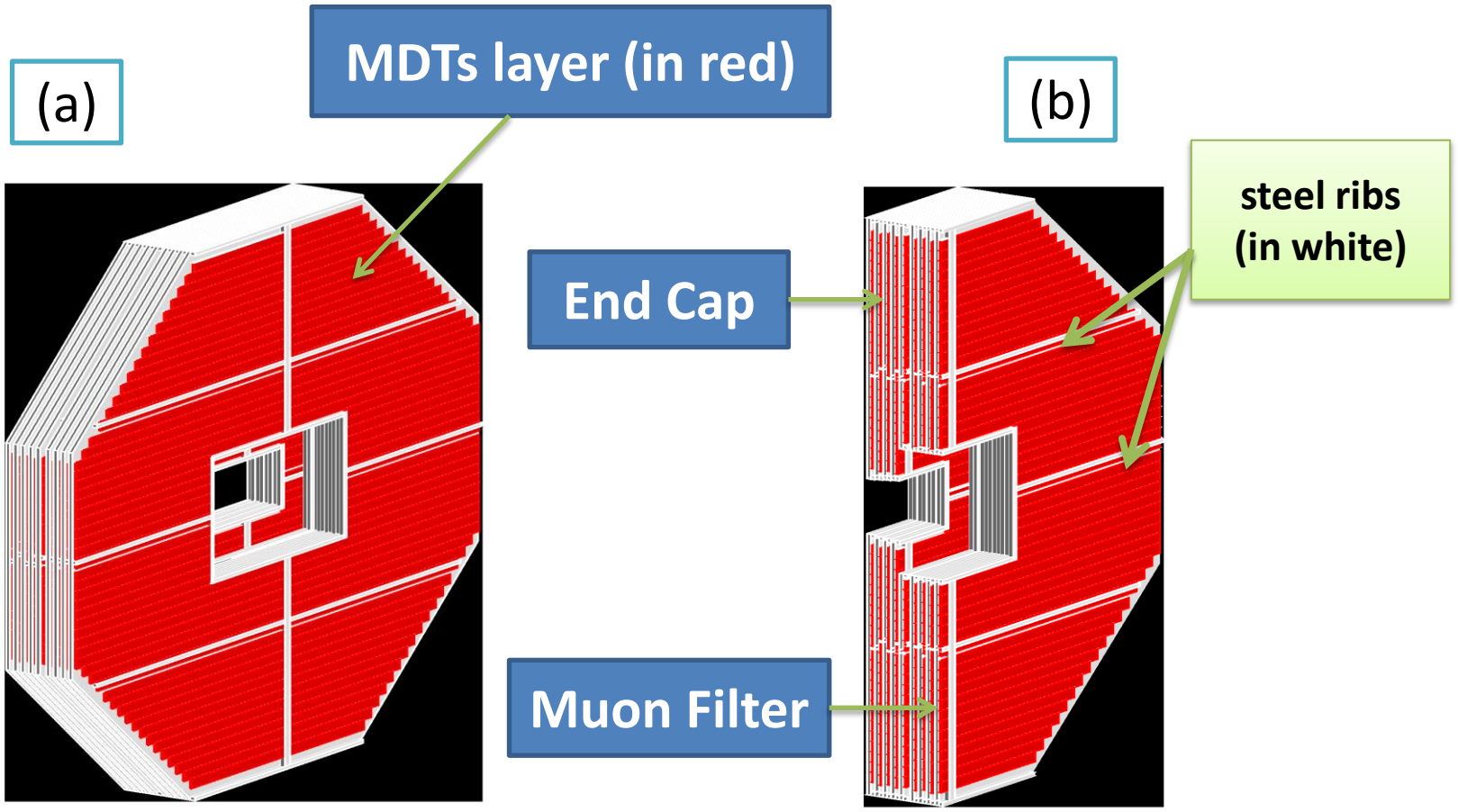
* Plans for 2016:

- Preparation/signing of the FAIR-JINR contract (available budget ?!)
- Muon System in PANDAroot – digitization, pattern recognition (in cooperation with ?...)
- Range System Prototype – put in full operation (cosmic, beam test with PID upgrade)
- Installation of T9 beam line diagnostic equipment (ToF -> spring 2016, Čerenkov –> autumn 2016)
- R&D @ test stand in JINR (new FEE ASIC chips, digital/Xilinx etc.)

Geant4 view of Barrel (a) and its cut at target zone (b)



Geant4 view of End Cap and Muon Filter (a) and its vertical cut (b)



Geant4 Computer Model for the Muon System

* Geometrical description

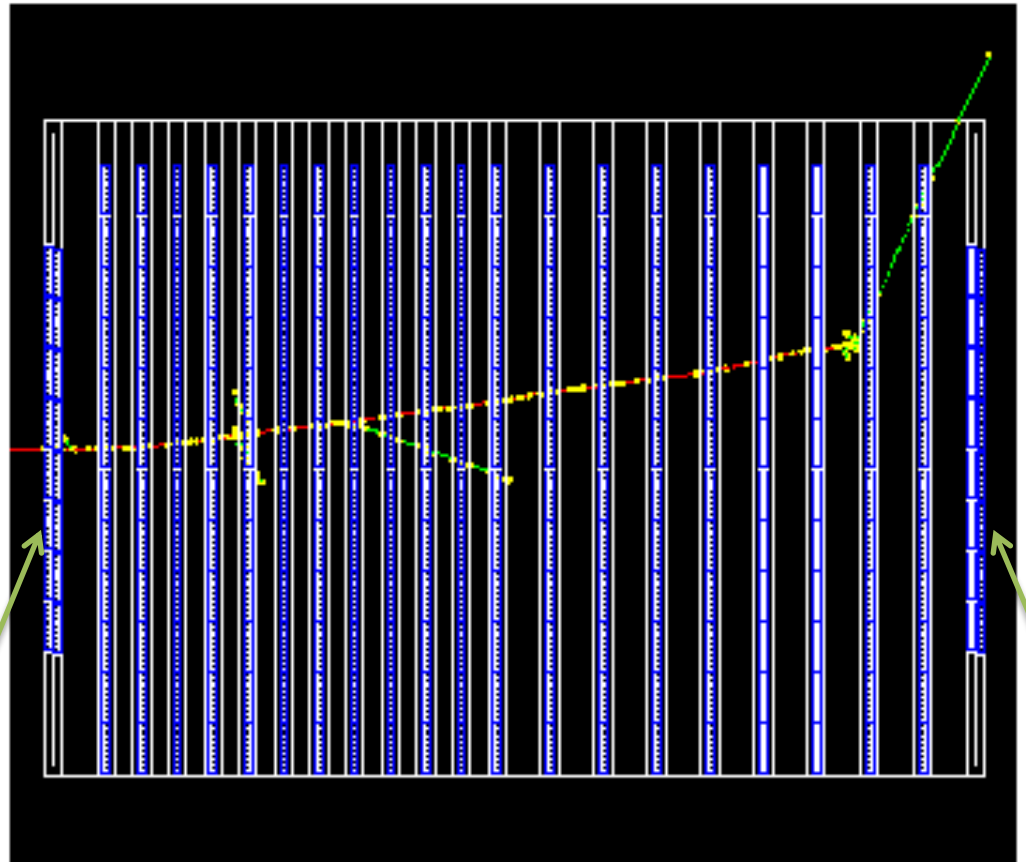
- *Geant4 geometrical description of the of **Muon System** is ready*
- *Description of the **Range System Prototype** (to be placed on PS T9 beam line) is ready*

* Simulation of signals from the MDTs (digitization)

- *Algorithm based on our experience with **Range System Prototype** (CERN) is being implemented ; presently used algorithm results from GARFIELD simulation.*

RSP model and data collected at T9/PS/CERN run 2012 are being used to tune digitization algorithm

The Range System Prototype Geant4 simulation



Example with 1GeV muon entering from the left

All hits generated by Geant4 are shown

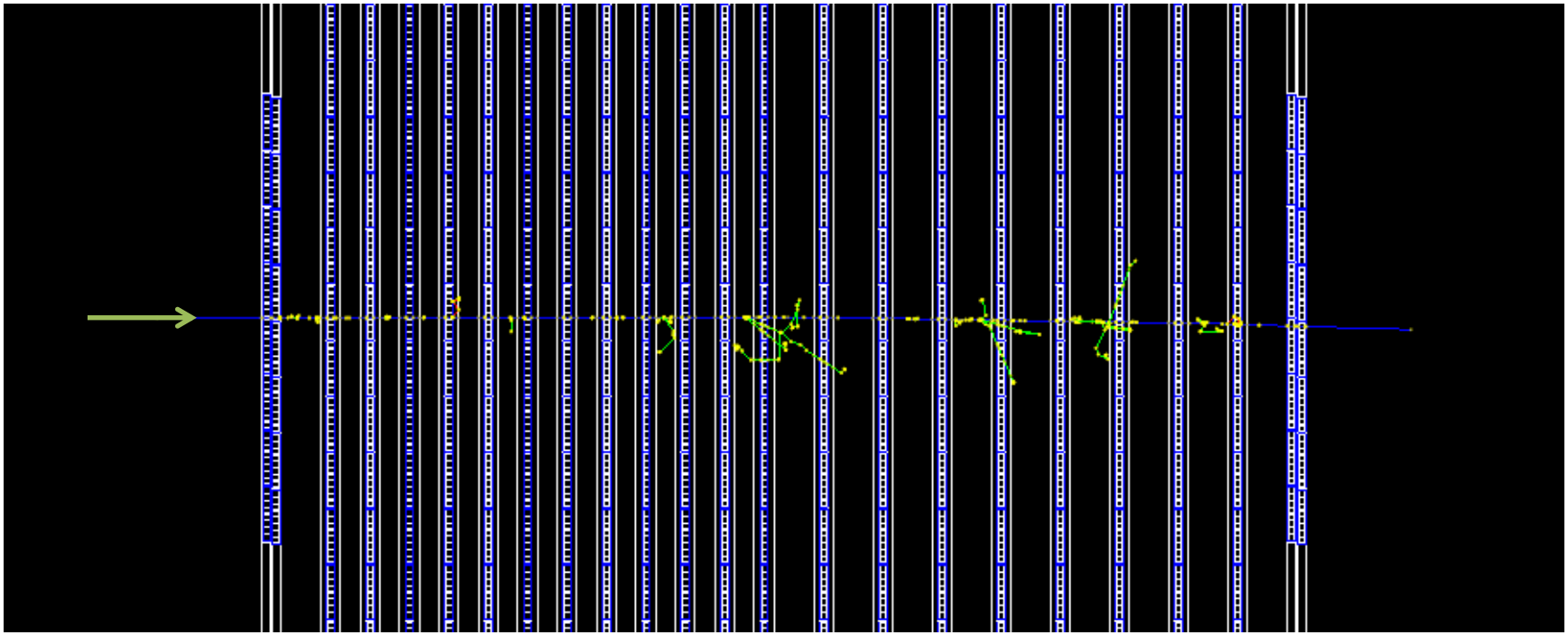
Our task is to analyze them and simulate the signals from MDT wires (and also strips, later…)

digitization

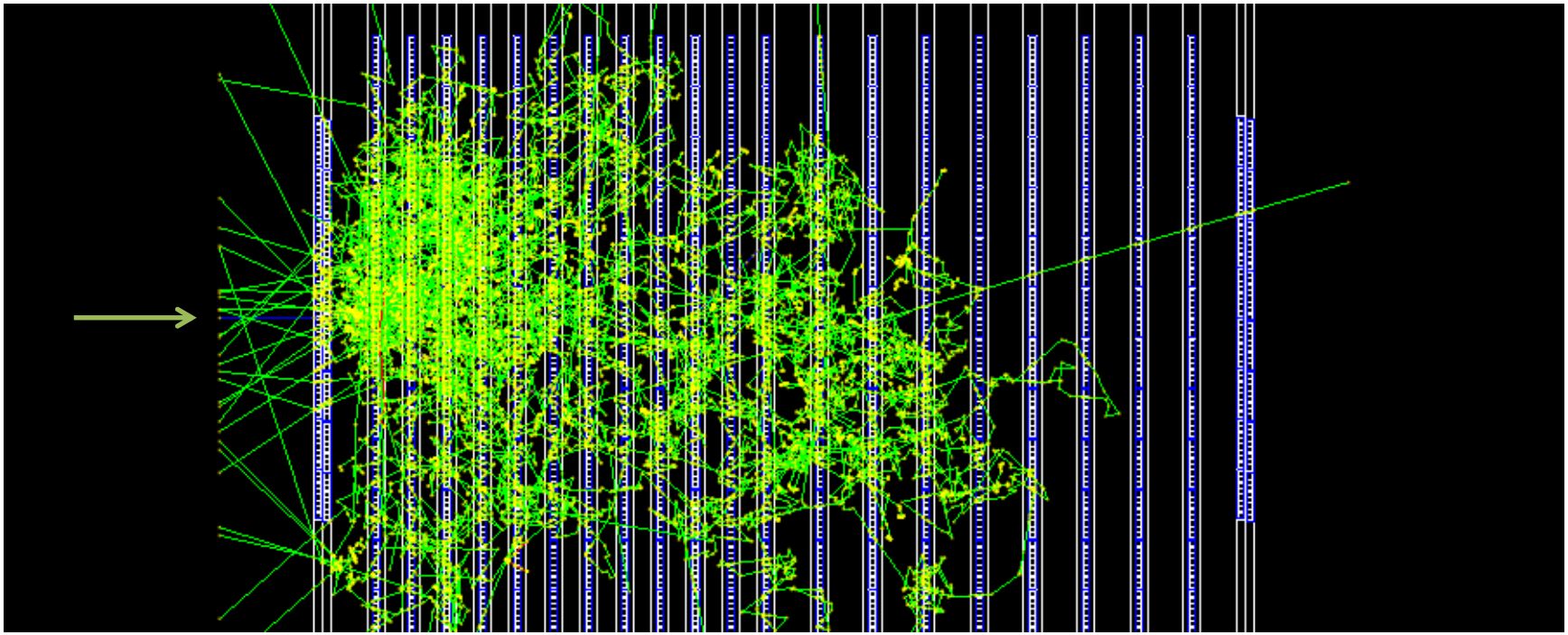
'chess board' zero bi-layer

'standard' bi-layer

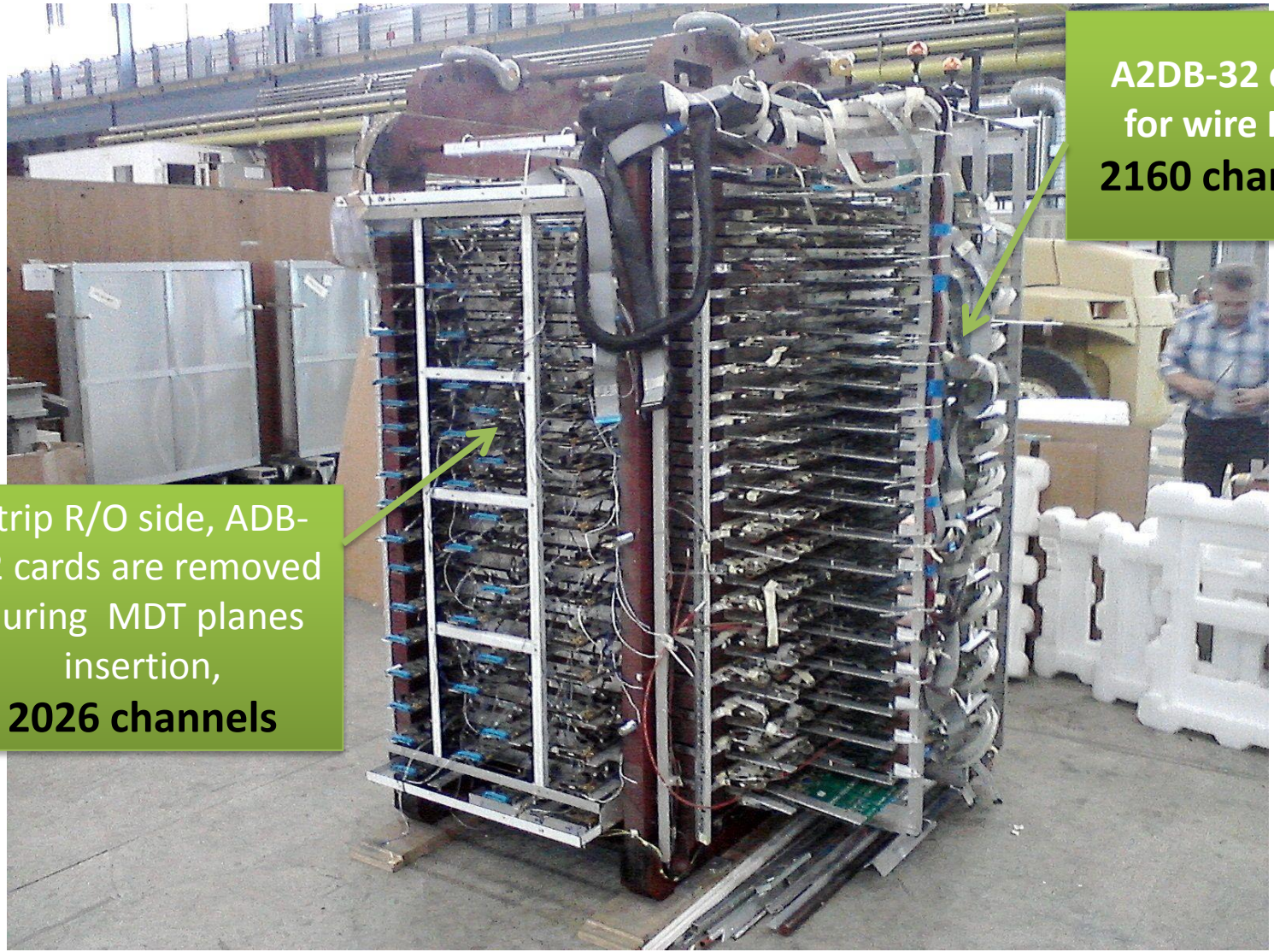
5 GeV muon generated in RSP



5 GeV pion generated in RSP



RSP equipped with all detectors and big portion of ‘on chamber’ FEE in vertical position (for cosmic tests)

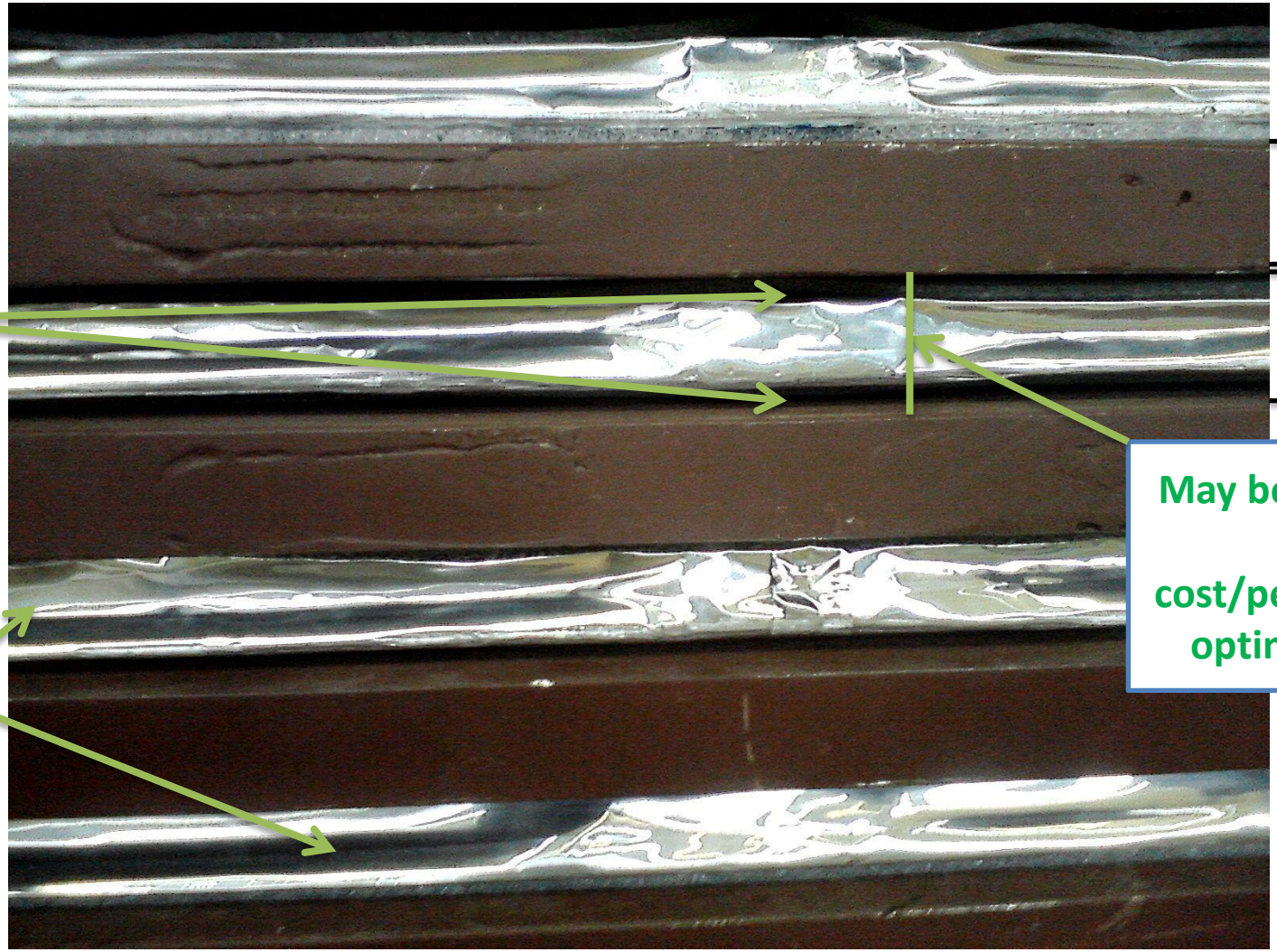


RSP in vertical (cosmic test) position

'bottom side' (for RSP position on beam) is pictured

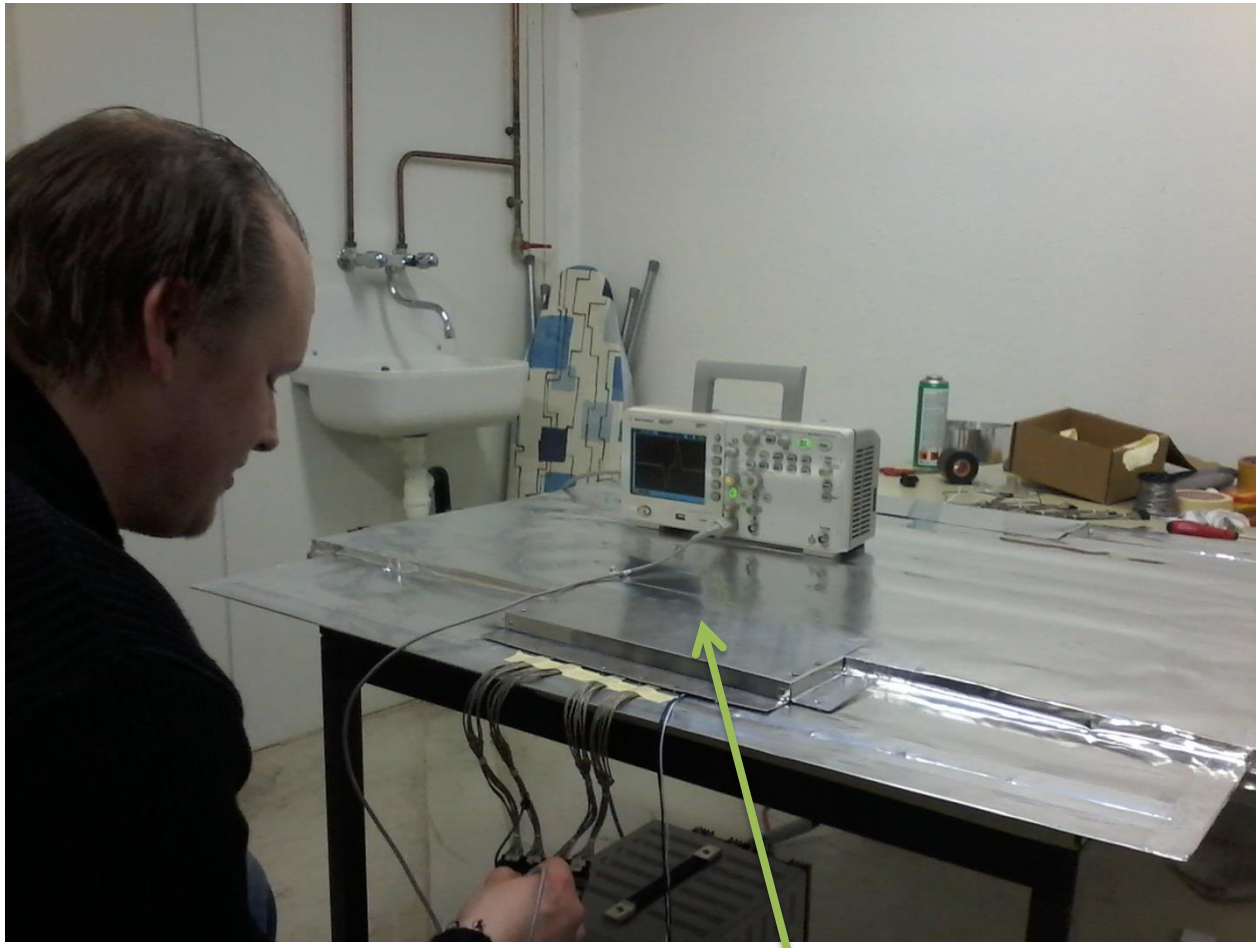
Fragment of RSP 'bottom side'

Barrel structure (Fe/30mm + gap/30mm)

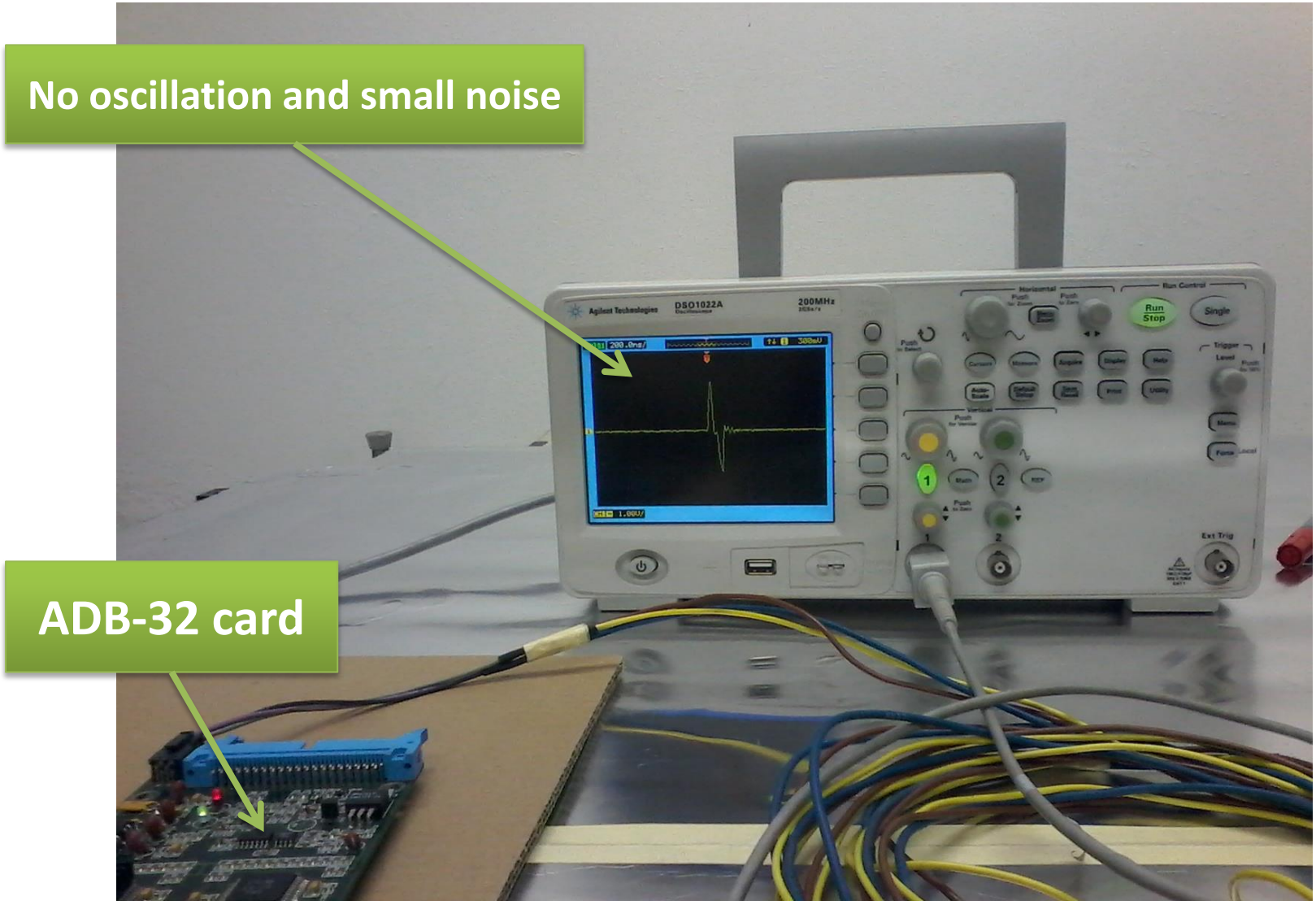


Putting second MDT layer on ‘chess board’ zero bi-layer

Test of ‘chess board’ zero bi-layer fully screened with aluminum foil (~ 0,1 mm thick)

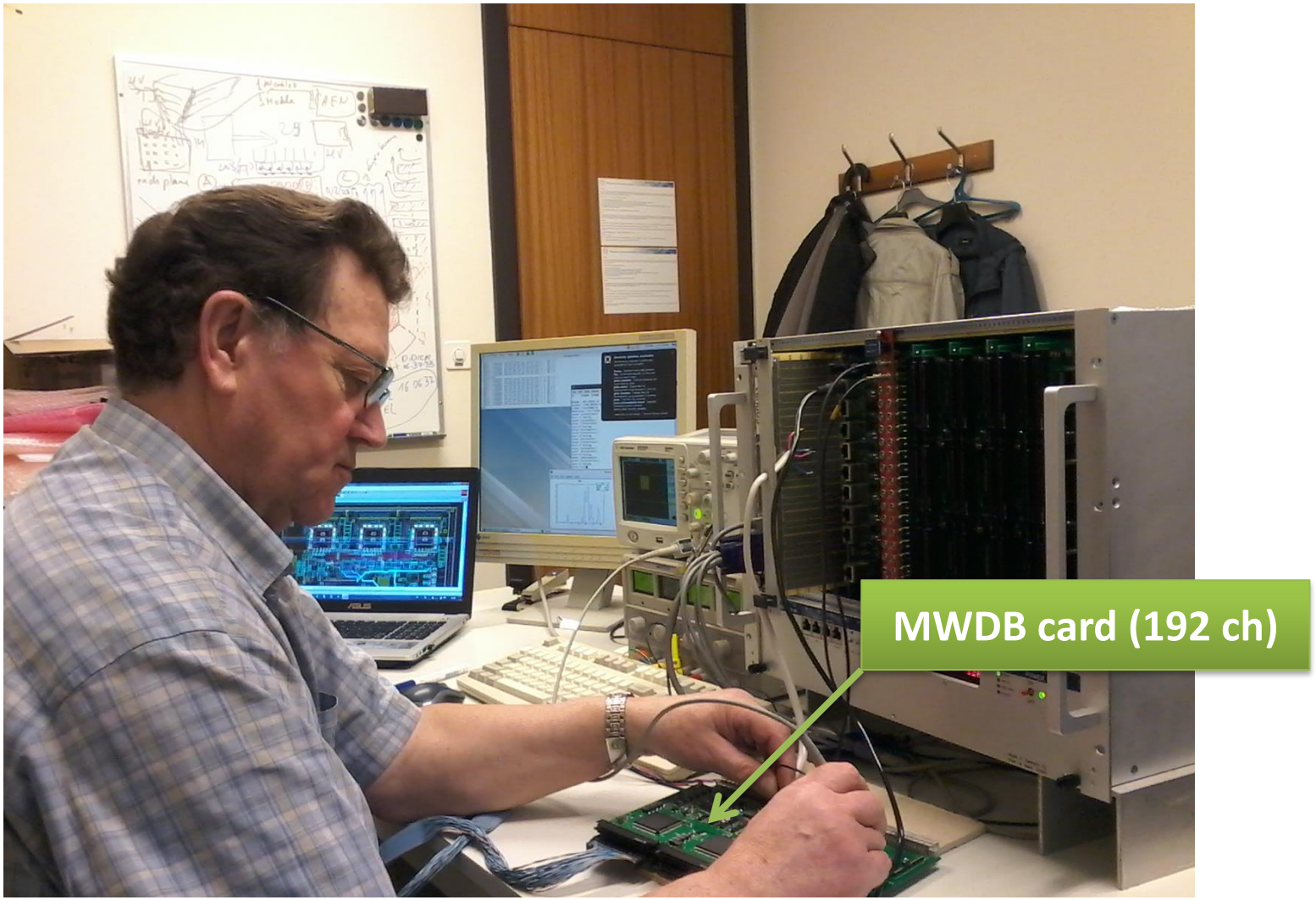


Test pulse from strips as seen after A-32 and ADB-32 amplification (capasitively induced by positive pulse on MDT wire)



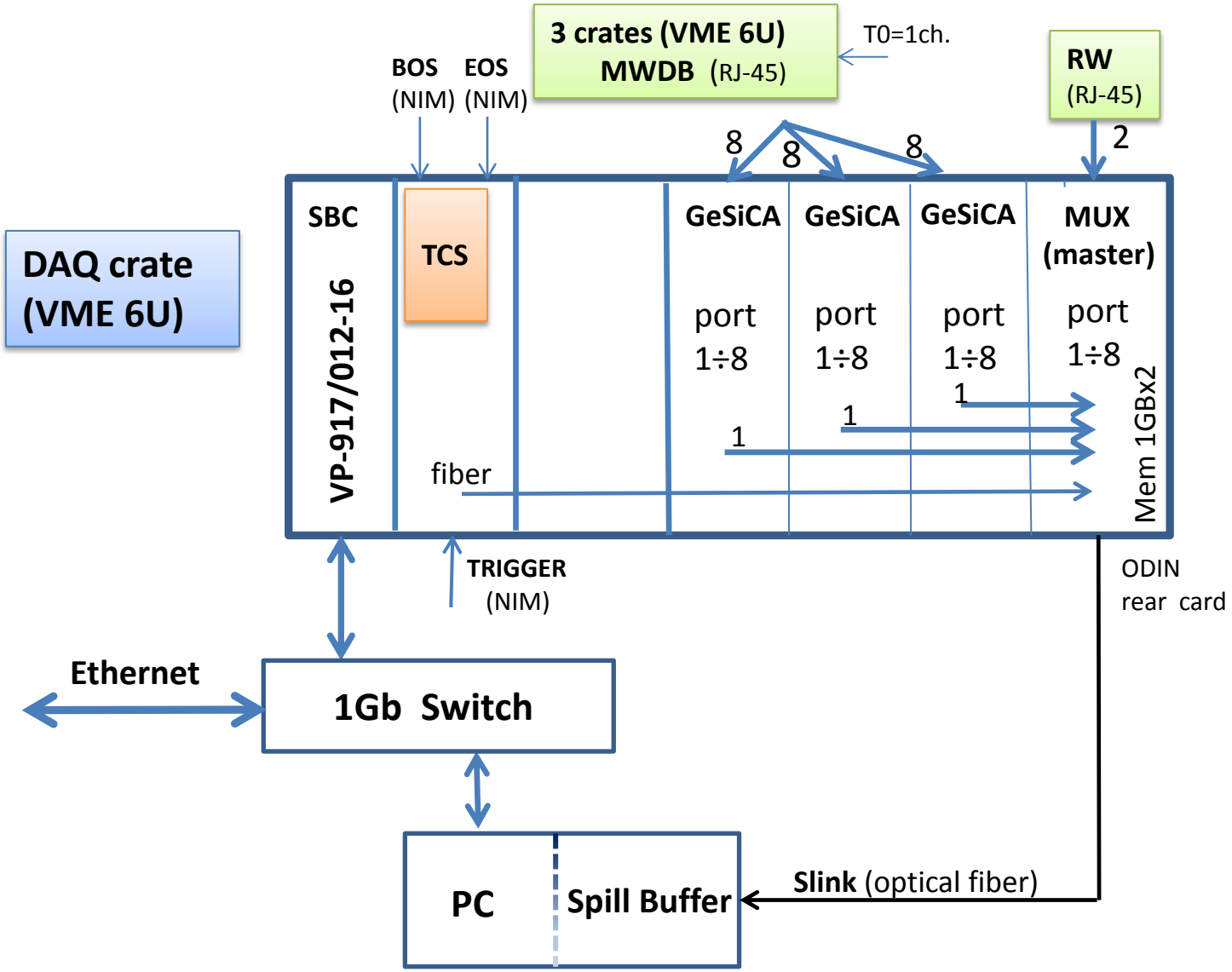
Test stand for digital R/O cards MWDB at CERN

21 cards (4032 ch) were tested/debugged/repaired



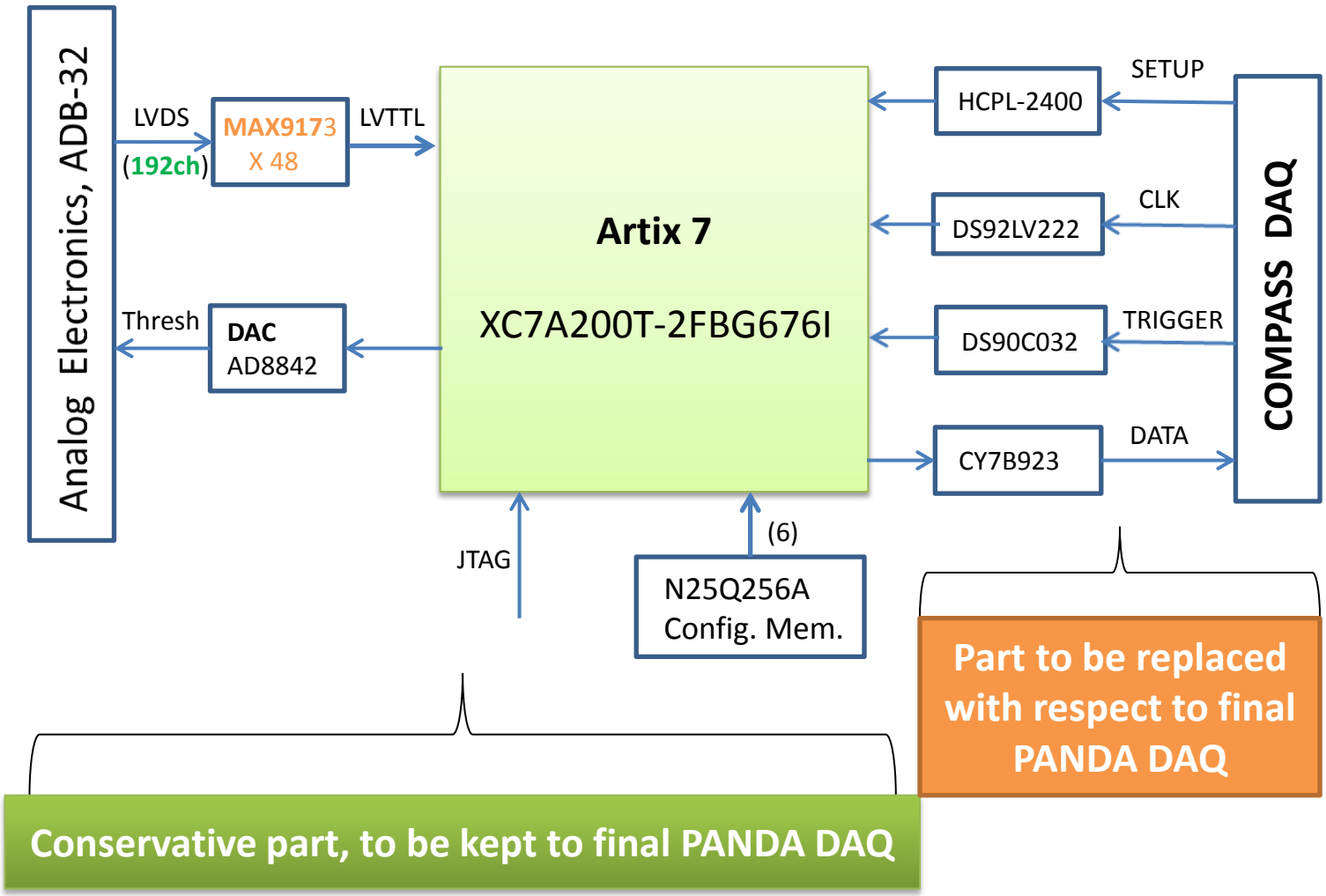
Stand-alone DAQ Block-diagram

(version 5, developed and completed in cooperation with COMPASS DAQ experts)



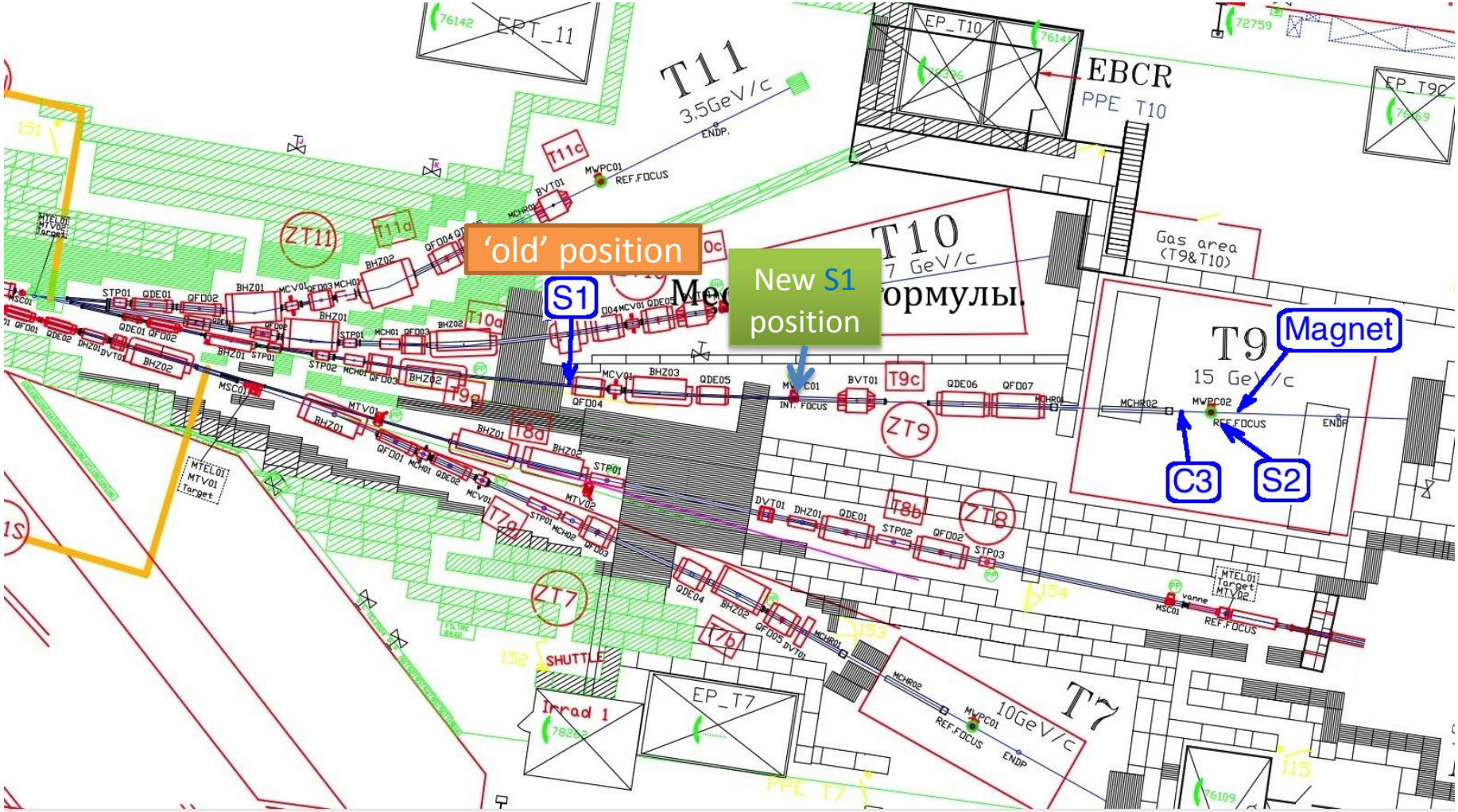
Simplified Schematic of Xilinx FPGA Prototype R/O Module (192ch)

(to be tested with Range System Prototype at CERN; if results will be positive, the Artix 7 chip may be regarded as basis for the final PANDA/Muon/DAQ)



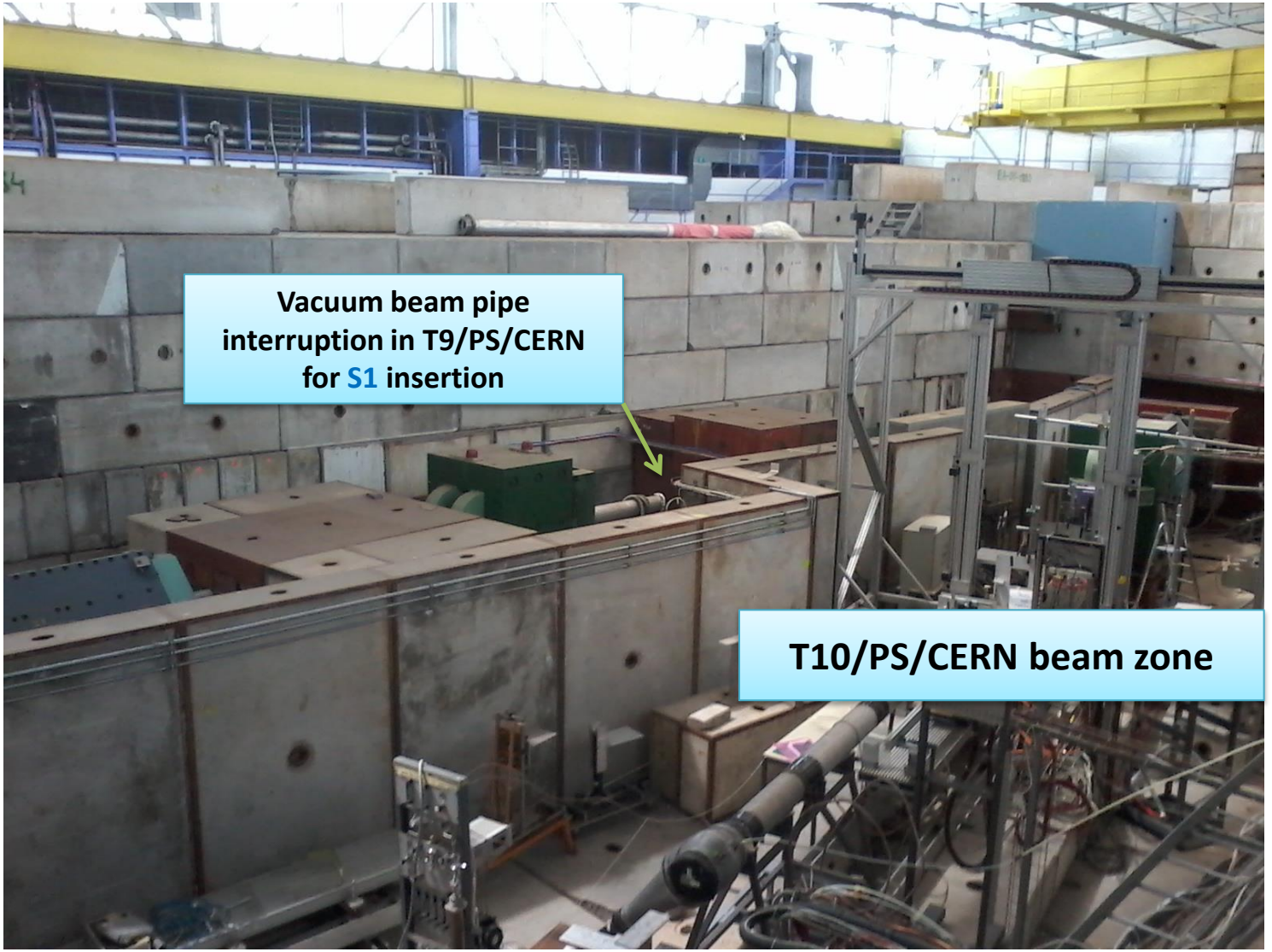
Assumed upgrades to T9 beam line for π/μ separation < 1-2 GeV/c:

S1,S2 time-of-flight scintillator counters based at ~ 16-24 m to each other,
pressurized (up to 60 bar) Cherenkov counter C3,
magnetic analysis of incoming muon momenta with ~ +/- 1% accuracy



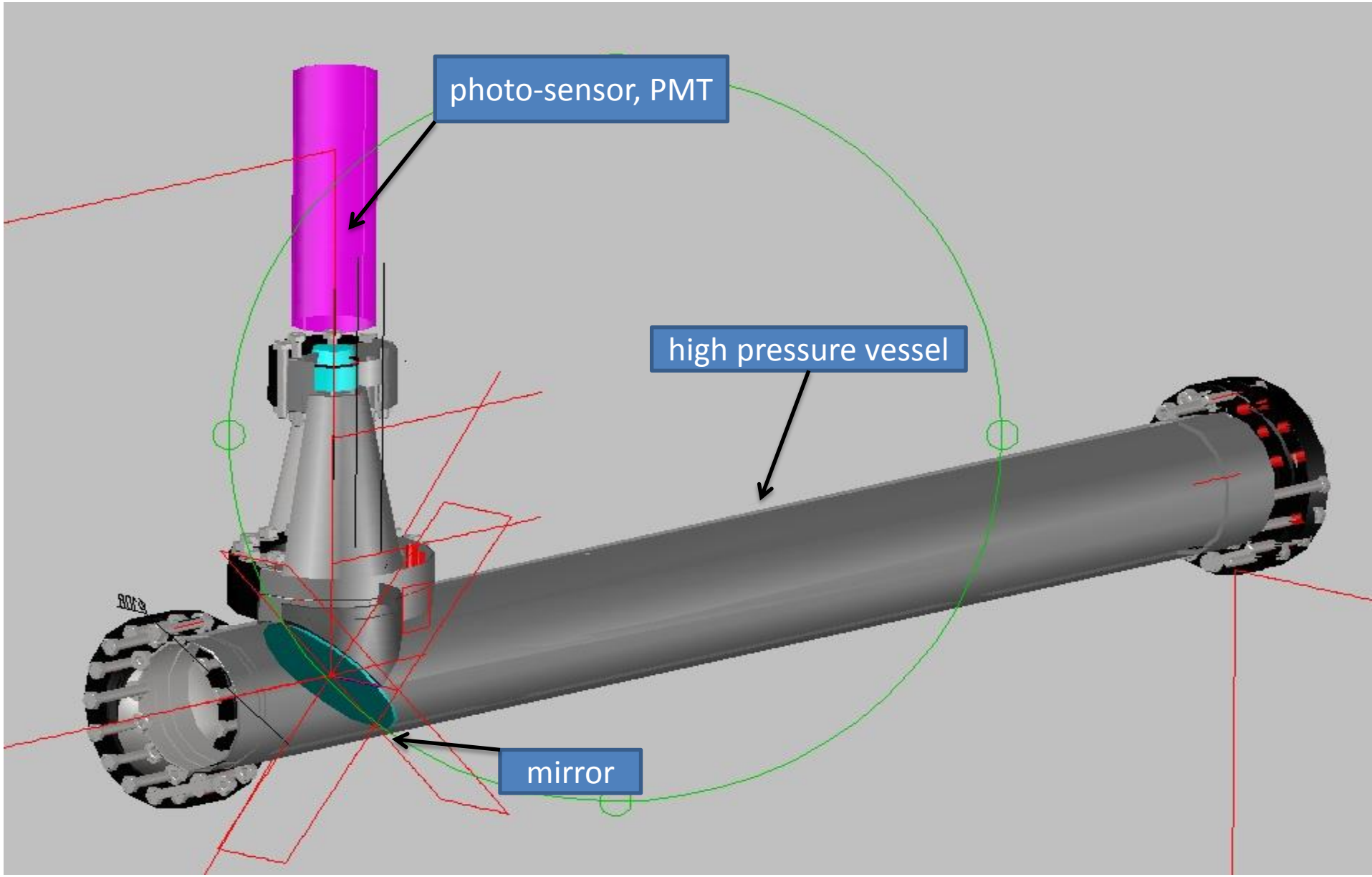
T9/PS/CERN beam line

after reconstruction of 2013-14

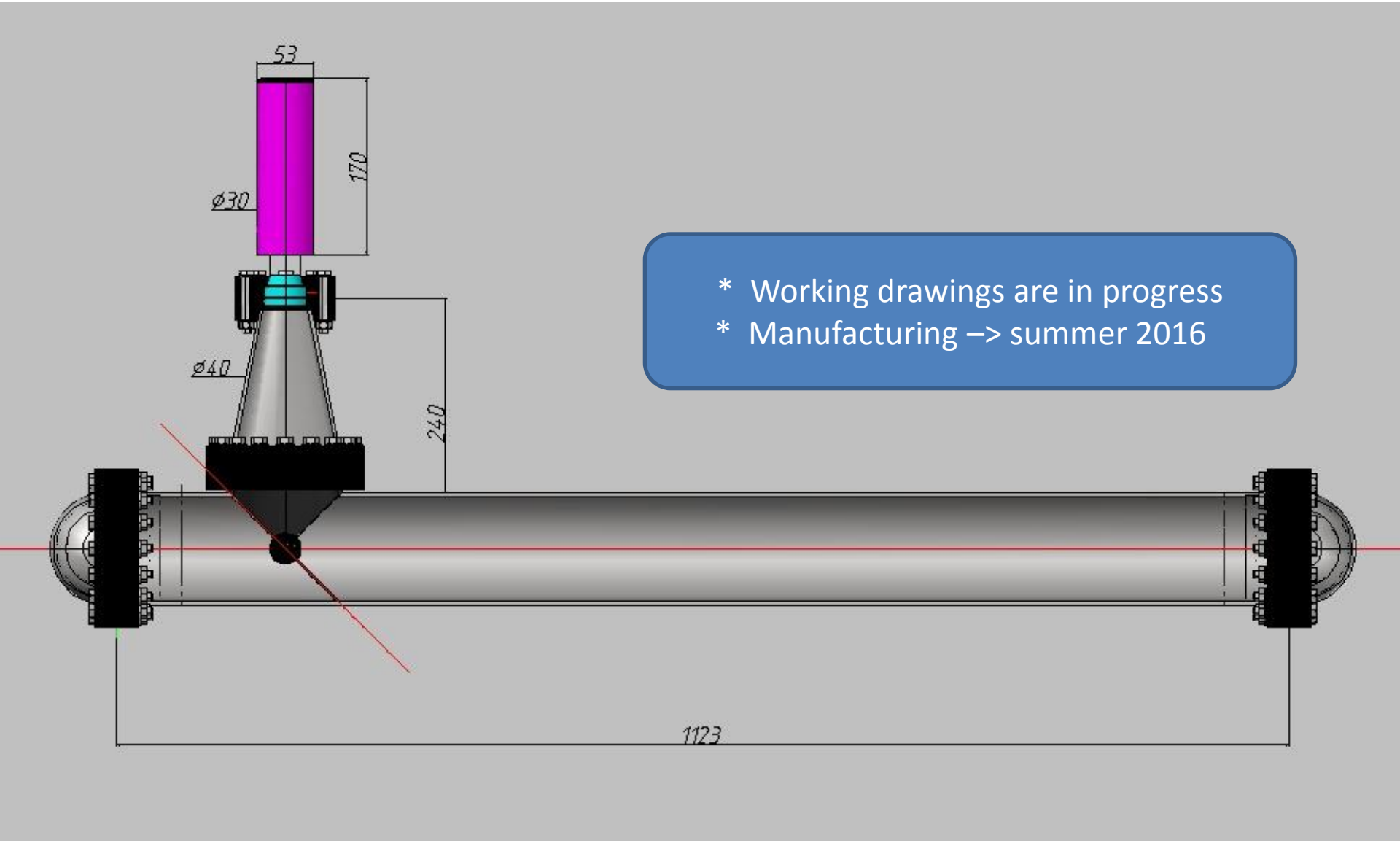


ToF Hamamatsu PMTs and power supply unit at CERN

Čerenkov counter (up to 60 bar), schematic view



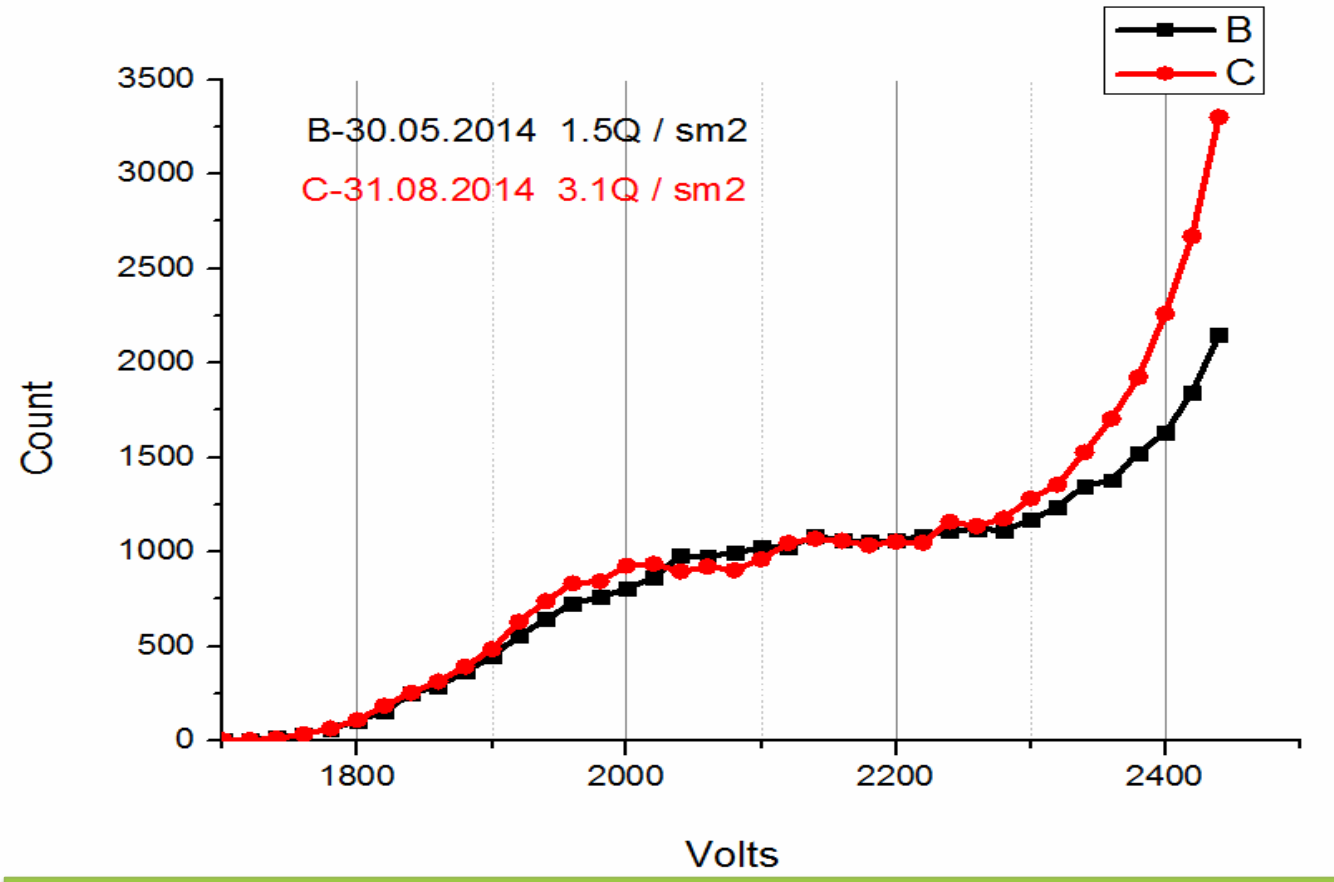
Čerenkov counter (up to 60 atm), main dimensions



* Working drawings are in progress
* Manufacturing –> summer 2016

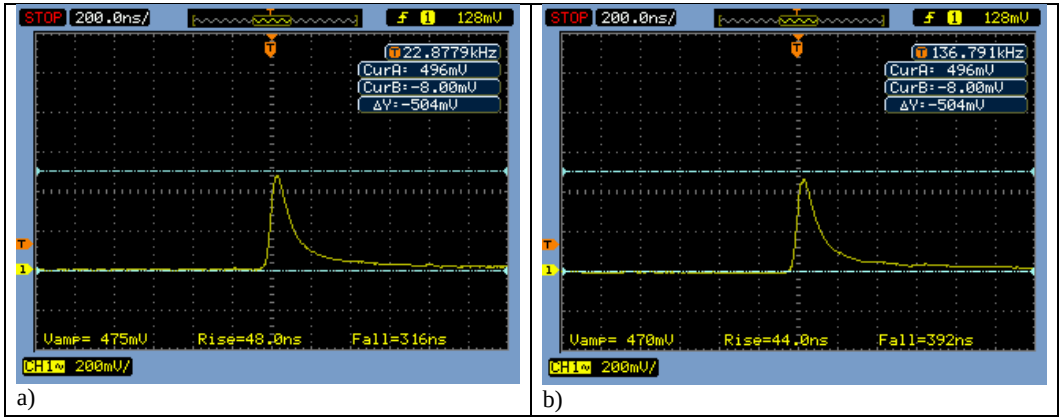
Dubna test stand: MDT counting characteristics after irradiation by 1.5 and 3.1 Coulomb / cm2

NO AGEING !



Collected charge is increased by factor 3 compared to 'threshold value' in 1 C/cm presented for ECE referees last year

High rate performance (wires & strips) studied at Dubna test stand



a) b)

Fig.9 Average strip signals for (a) 70 kHz and (b) 250 kHz strip r/o channel loads

To check the stability of MDT operation at very high irradiation intensities we also made a measurement of counting rate curves for different loads up to 900 kHz. Normalized (to the plateau) counting rate curves are presented in Fig. 10. No counting rate curve plateau (2150 – 2300 V; spread of plateau beginnings is within 20 V) constriction was observed up to the 900 kHz load.

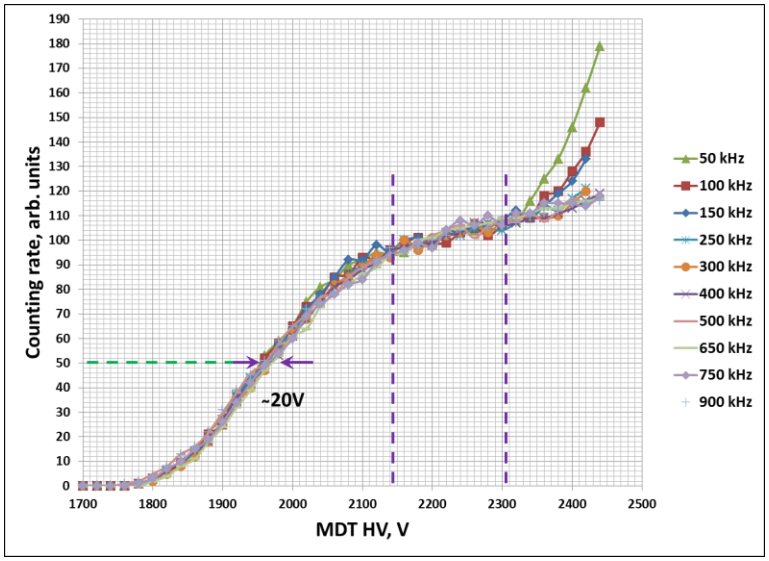


Fig.10 Normalized MDT counting rate curves for different wire channel loads (X-ray intensities)

Thus, the data presented above demonstrate absence of the rate effects dangerous for the MDT operation, both for nominal luminosity and its instant fluctuations.

Contacts with industry

* **MDTs components:**
  - ALU profile -> **Agrisovgaz** (www.agrisovgaz.ru), **reliable partner**, Kaluga Region, Russia
  - End plugs (active & passive) -> **Mars**, **reliable partner,** Erevan, Armenia (changed drawing are sent to them and accepted)
  - Plastic envelope (Noryl) -> in search for partner, two companies study the technology to extrude Noryl plastic (**Mars**, Erevan and **EPPI limited**, Moscow
* **Front End Electronics:**
  - ASIC chips -> **Integral**, **reliable partner**, Minsk, Belorussia
  - Assembly of cards -> **Marathon**, **reliable partner**, Moscow, Russia
* **Mechanical structures:** pending clarity with magnet (cost)

PANDA project was extended for 5 years with first priority after presentation to JINR PAC, January 2015

PANDA experiment at FAIR

(JINR participation)

PANDA project,
extension for 2015-2019

G.D.Alexeev

for JINR PANDA team

VBLHEP – DLNP – LIT - BLTP

МЕЖДУНАРОДНАЯ МЕЖПРАВИТЕЛЬСТВЕННАЯ ОРГАНИЗАЦИЯ
INTERNATIONAL INTERGOVERNMENTAL ORGANIZATION

ОБЪЕДИНЕННЫЙ ИНСТИТУТ ЯДЕРНЫХ ИССЛЕДОВАНИЙ
JOINT INSTITUTE FOR NUCLEAR RESEARCH

Дубна, Московская область, Россия 141980 Dubna Moscow Region Russia 141980
Fax: (7-495) 632-78-80 **Tel.:** (7-49621) 6-50-59 **AT:** 205493 WOLNA RU **E-mail:** post@jinr.ru
http://www.jinr.ru

To Research Director of FAIR
Prof. Dr. Günther Rosner

19. 05. 2014 010-27/171

Dear Prof. Rosner,

The Joint Institute for Nuclear Research (JINR, Dubna) is interested to implement its long term experience for the construction detectors of the Facility for Antiproton and Ion Research (FAIR).

Our Institute is ready to provide the Muon System of PANDA detector in framework of Collaboration Contract between our Institute and FAIR GmbH (for the cost-book price including an inflation correction coefficient). This proposal comprises the following PSP Number of the cost-book: 1.4.1.13.

The cost-book value for this item amounts to 2,318,000.00 €.

Kind regards,

Academician V. A. Matveev
Director

Prof. Boris Sharkov
FAIR
Planckstr. 1
D-64291 Darmstadt
Germany

Intended contributions to PANDA work packages

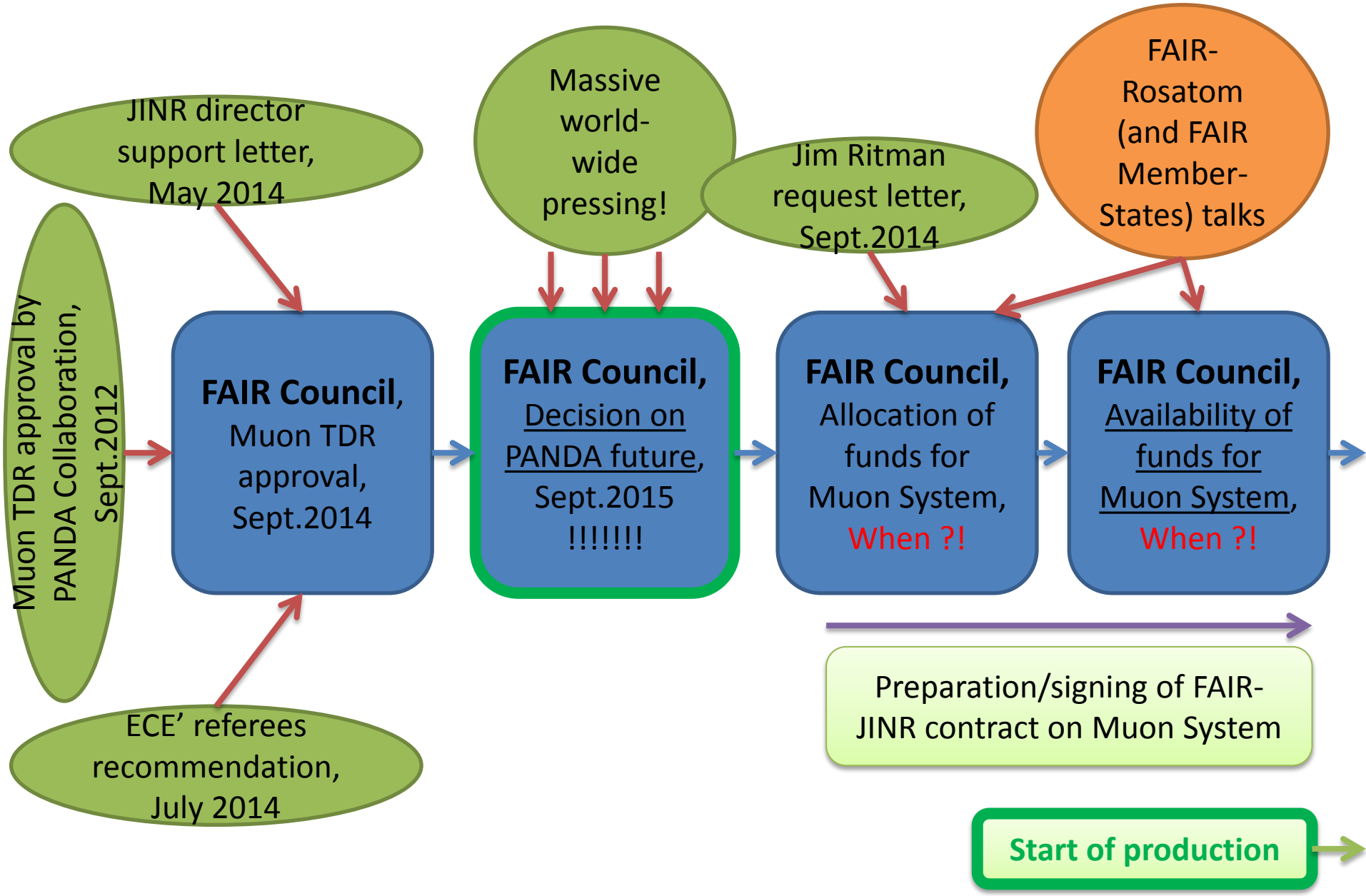
Dear Boris,

with this letter PANDA requests the official allocation of FAIR shareholder funds for the construction of the following component of PANDA:
PSP 1.4.1.13 – Design, production and delivery of the Muon Detector system
which is described in the Technical Design Report for the PANDA Muon System, approved by the FAIR management September 22, 2014. In accordance with the cost estimate laid out in the Experiment Cost Book (ECB). The following contributions from shareholder countries to this work package are planned (all cost in Euro from 2005):
Russia, JINR, Dubna 2.318.000,00 EUR
Additional costs covering any increase with respect to the ECB in-kind value (as mentioned above) are matched by external funding.
All items defined in the work package have to be in accordance with the technical specifications and quality requirements determined by the PANDA Collaboration and FAIR GmbH.
No later than 3 months after a positive Council decision, all technical specifications for the proposed contribution as approved by the Collaboration, the potential contracting party and a draft of Annex 2 of the contract containing all details as in the model contract provided will be submitted to FAIR.

Sincerely yours,

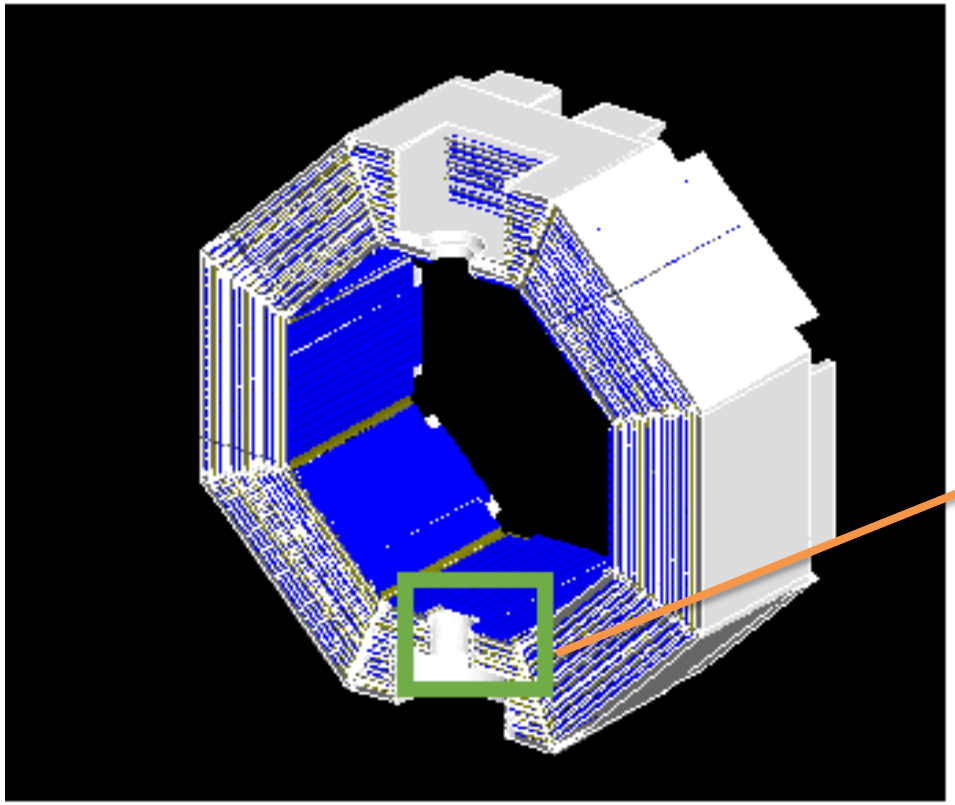
Jim Ritman

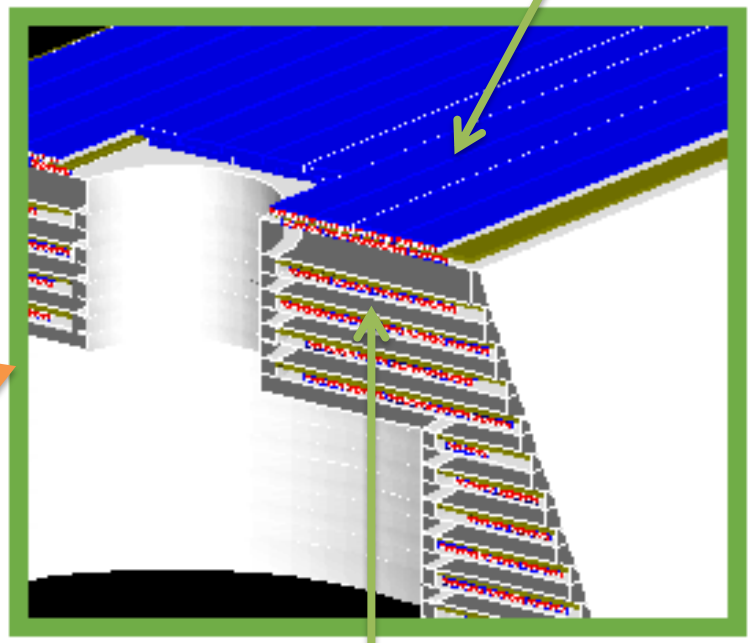
Processing of PANDA Muon Project at FAIR



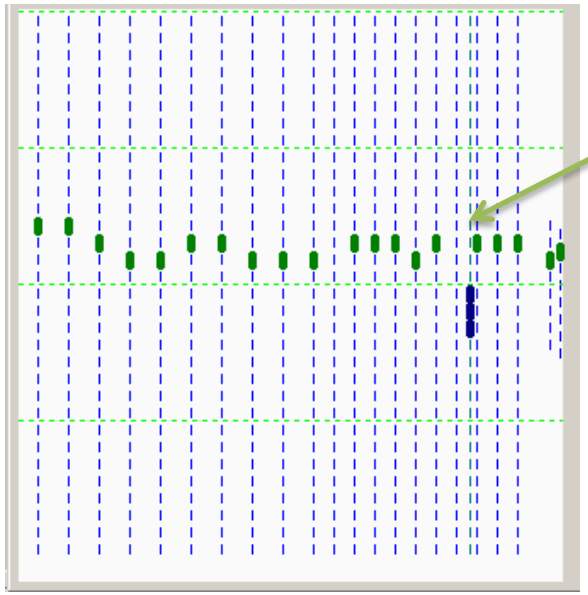
Backup slides

Cross section of Barrel in target region



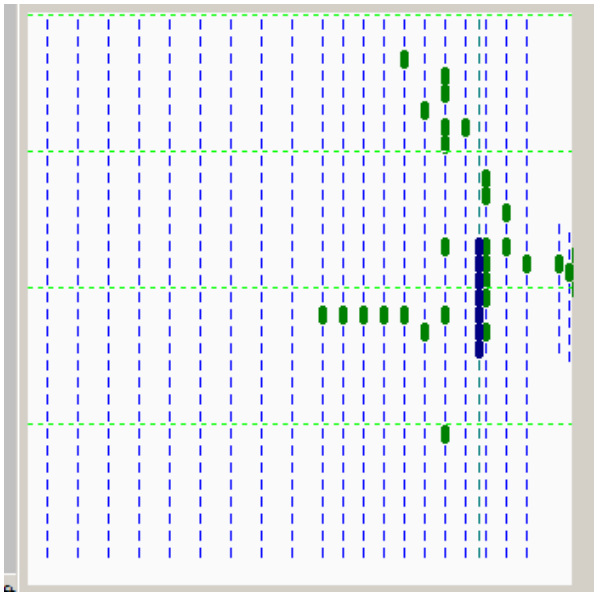


BEAM: e,μ,π,p (3 GeV/c, trigger: S_1 (Ø 11,5 cm) & S_2 (Ø 3,5 cm)),
Range System Prototype data of T9/PS/CERN run 2012



wire hits (in green)

μ



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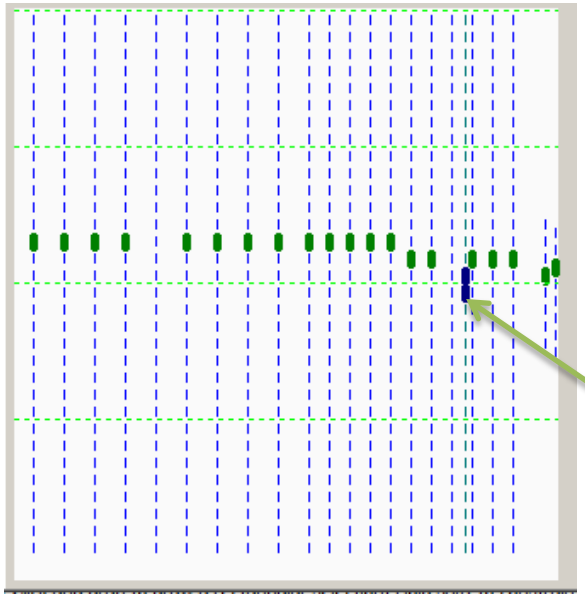
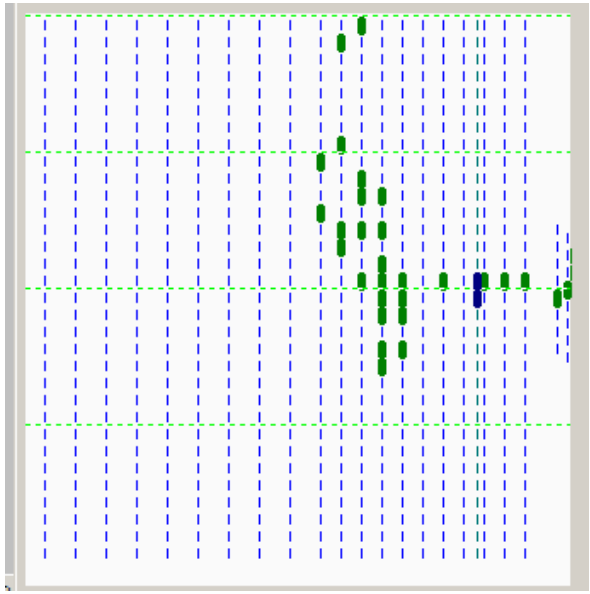


μ

strip hits (in blue)



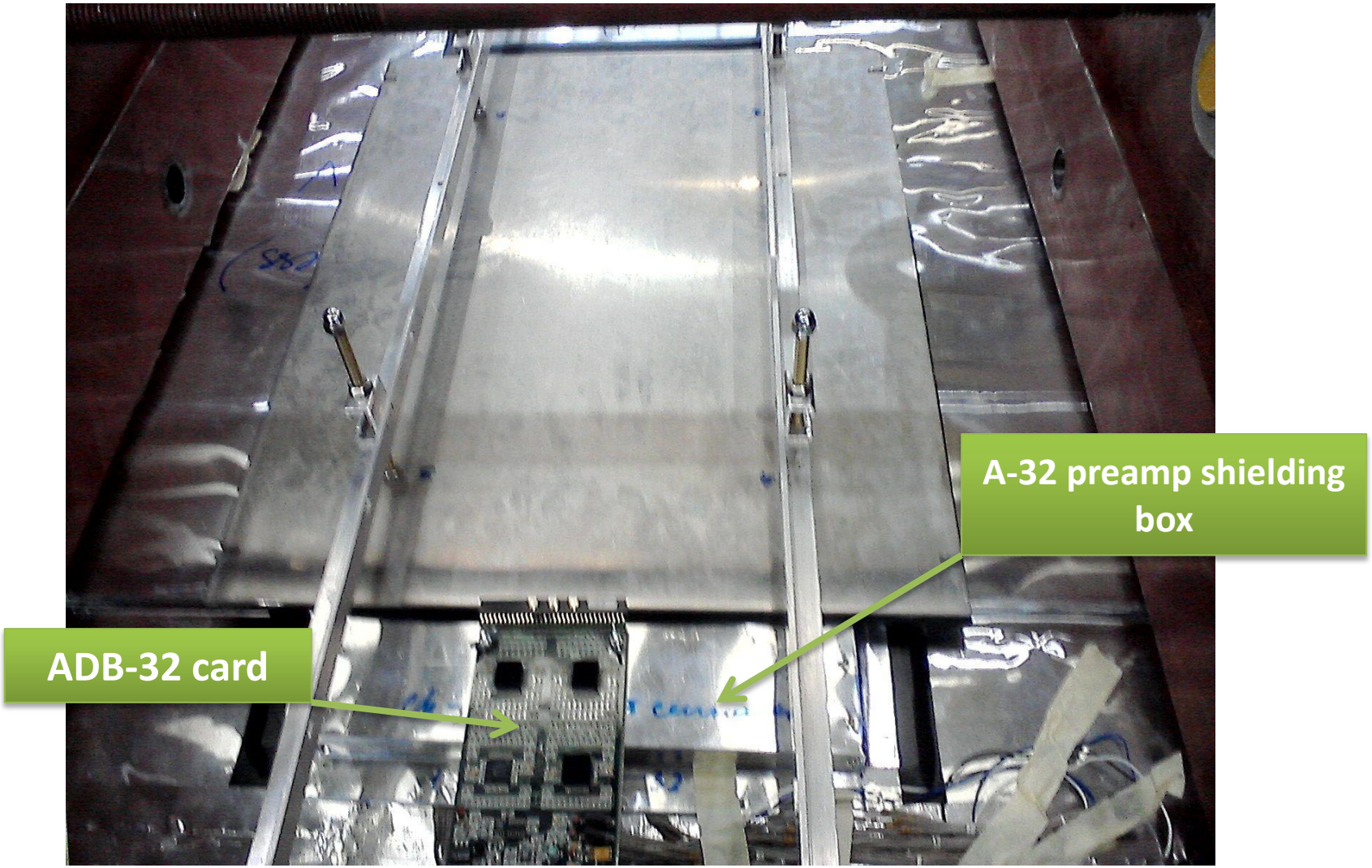
h

Table of conditions for written events; T9/PS/CERN run 2012

P[Gev/c]	Trigger	Composition	N of events	file # , Comments
Spectrum	S3*S4	cosmic	635	f39, S3 & S4 on RSP top
Spectrum	S3*S4	cosmic	8375	f41,S3 on top & S4 on bottom
0.5	S1*S2	- (e,μ,π)	6575	f85, strips on
0.5	S1*S2	+ (e,μ,π,p)	27374	f83, strips on
1	S1*S2	+ (e,μ,π,p)	3087	f65
1	S1*S2*vetoC1	+ (μ,π,p)	90 000	f68
2	S1*S2	+ (e,μ,π,p)	3161	f80, strips on
2	S1*S2+Pb	+ (μ,π,p)	1087	f81, 2.5 cm Pb brick in beam, strips on
3	S1*S2	+ (e,μ,π,p)	11766	f77
3	S1*S2*C2	+ (e,μ)	3283	f78
3	S1*S2*C2+Pb	+ (μ)	299	f79, 2.5 cm Pb brick in beam, strips on
5	S1*S2	+ (e,μ,π,p)	9702	f56
5	S1*S2*C1*C2	+ (e)	2181	f57
5	S1*S2*C1*C2	+ (e,μ)	1217	f58
5	S1*S2*C1*C2	+ (e,μ)	200 000	f59
5	S1*S2	+ (e,μ,π,p)	6407	f69, strips on
5	S1*S2*C2	+ (e,μ)	3201	f70, strips on
5	S1*S2*C2	+ (e,μ)	13266	f71, strips on
7	S1*S2	+ (e,μ,π,p)	11940	f75, strips on
7	S1*S2*C2	+ (e,μ)	3492	f76, strips on
10	S1*S2	+ (e,μ,π,p)	9899	f72, strips on
10	S1*S2*C2	+ (e,μ)	1213	f73, strips on
10	S3*S4	+ (e,μ,π,p)	7405	f74, beam + halo, strips on

Moving of RSP by crane for putting in vertical position and further assembly with detecting planes and tests with cosmic at CERN

Fixation of ‘chess board’ zero bi-layer to RSP external surface

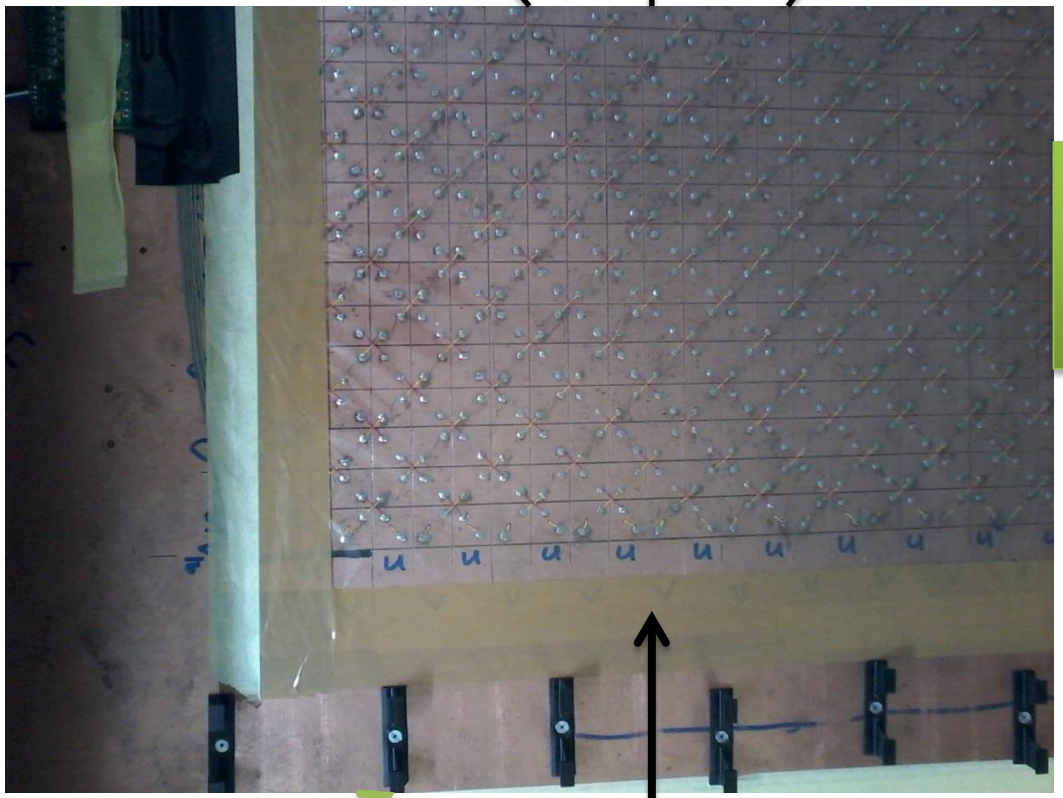


‘Chess board’ zero bi-layer (fragment)

wire direction

U-strip, -45 deg.

V-strip, + 45 deg.

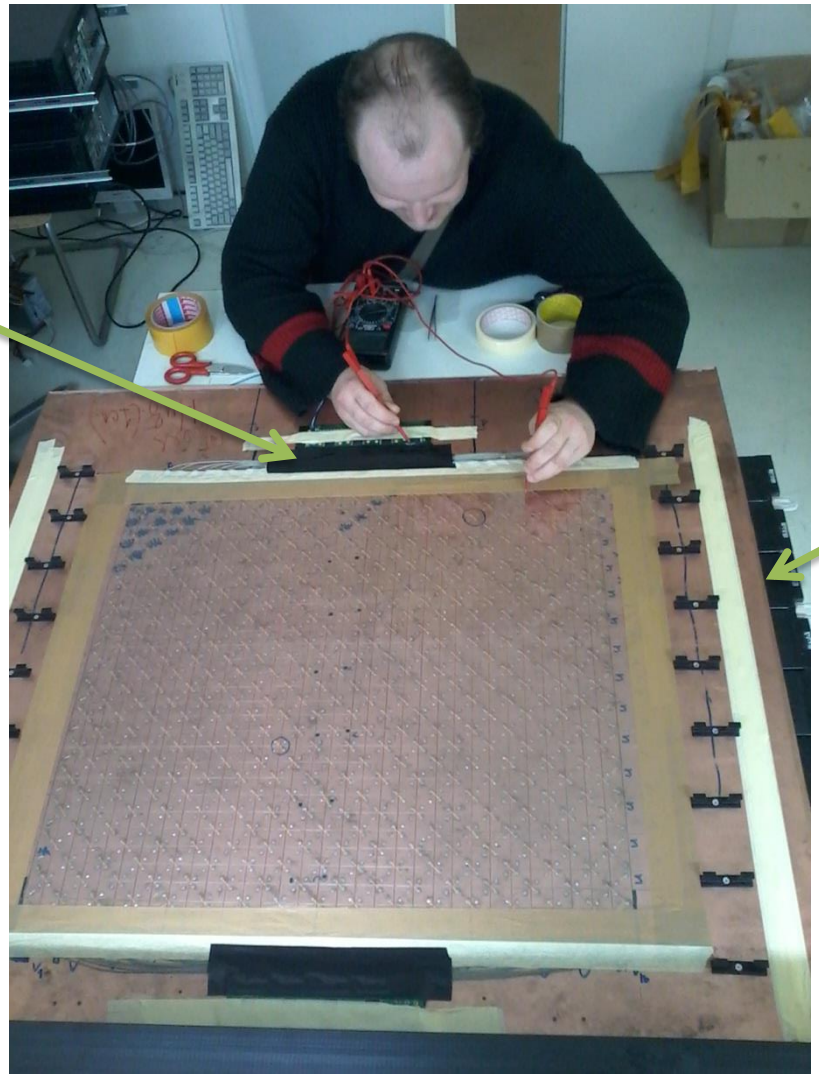


Strips are formed from 2 cm x 2cm squares by soldering

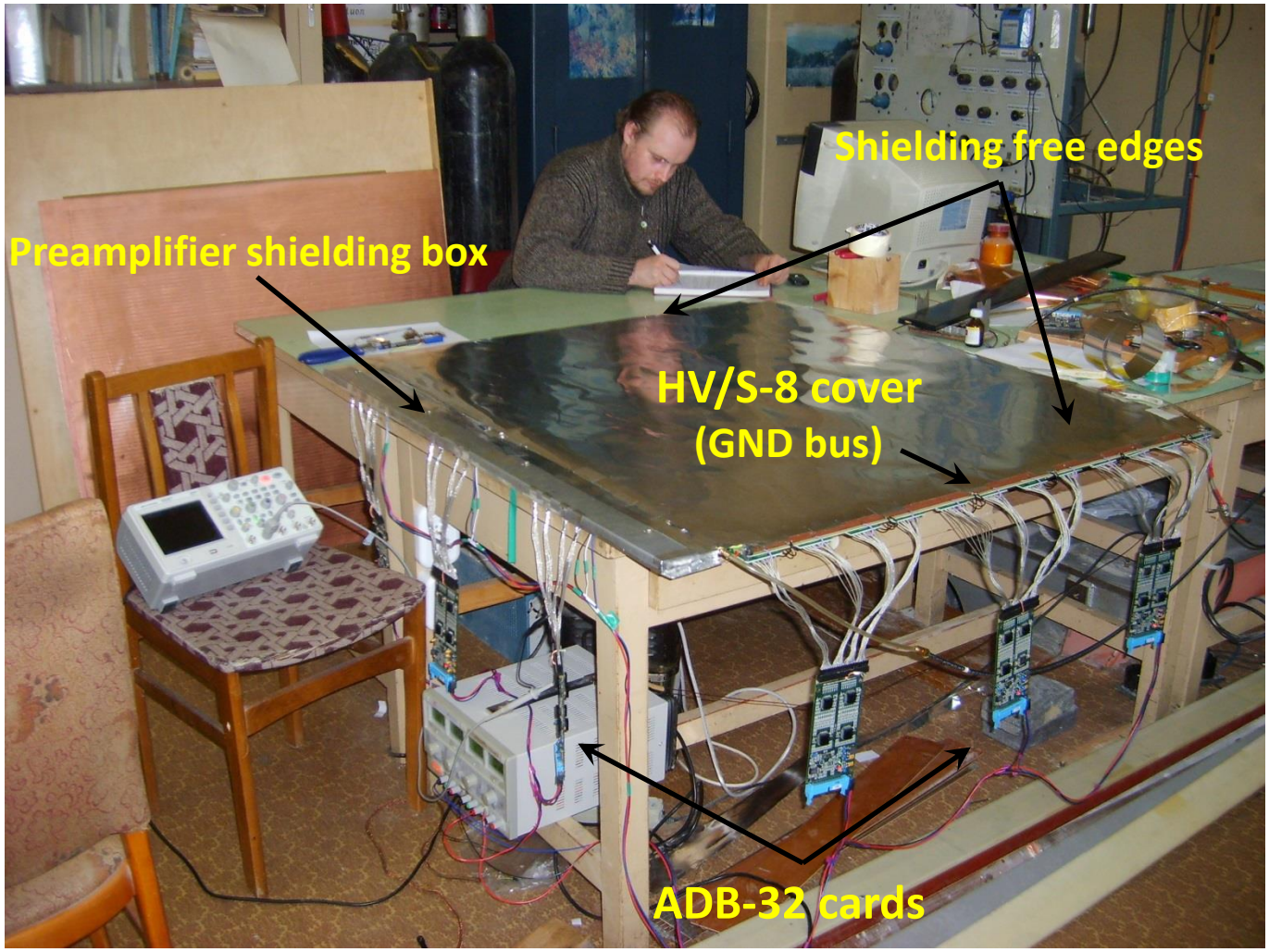
Brackets to fix MDTs to strip board

MDT tube

Test of ‘chess board’ zero bi-layer preamplifier A-32



Final variant of detector plane shielding developed at Dubna test stand – was implemented in Range System Prototype at CERN



All results of shielding tests were applied to this final detector plane version

Preamplifier shielding box consists of several Al plates which provide:

- shielding of A-32 cards (from detector and each other),
- shielding of input strip-to-preamp-wires
- preamplifier GND connections

Fully equipped detector plane was tested for a month – no performance changes were observed