Summary
of the detector meeting

Anna Maksymchuk on behalf of the BM@N collaboration
15/10/10

BM@N SLOW CONTROL SYSTEM
PRESENT STATUS AND PROSPECTS

P. Chumakov, D. Egorov, R. Nagdasev, V. Shutov

MAIN TASKS

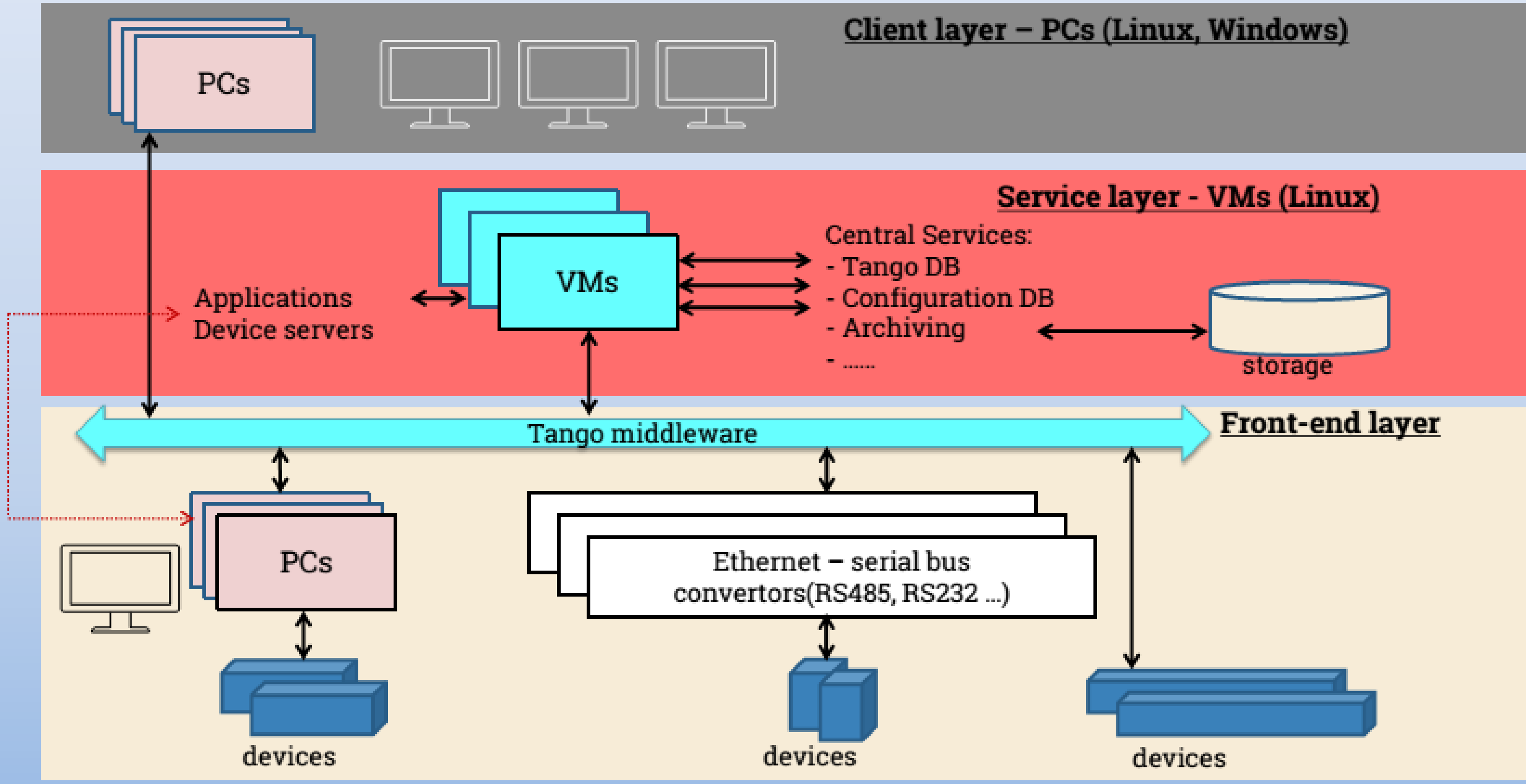
- Monitoring of the diverse experimental hardware

(High Voltage, Low Voltage, Gas systems, Temperature,

Humidity, Pressure sensors, etc.)

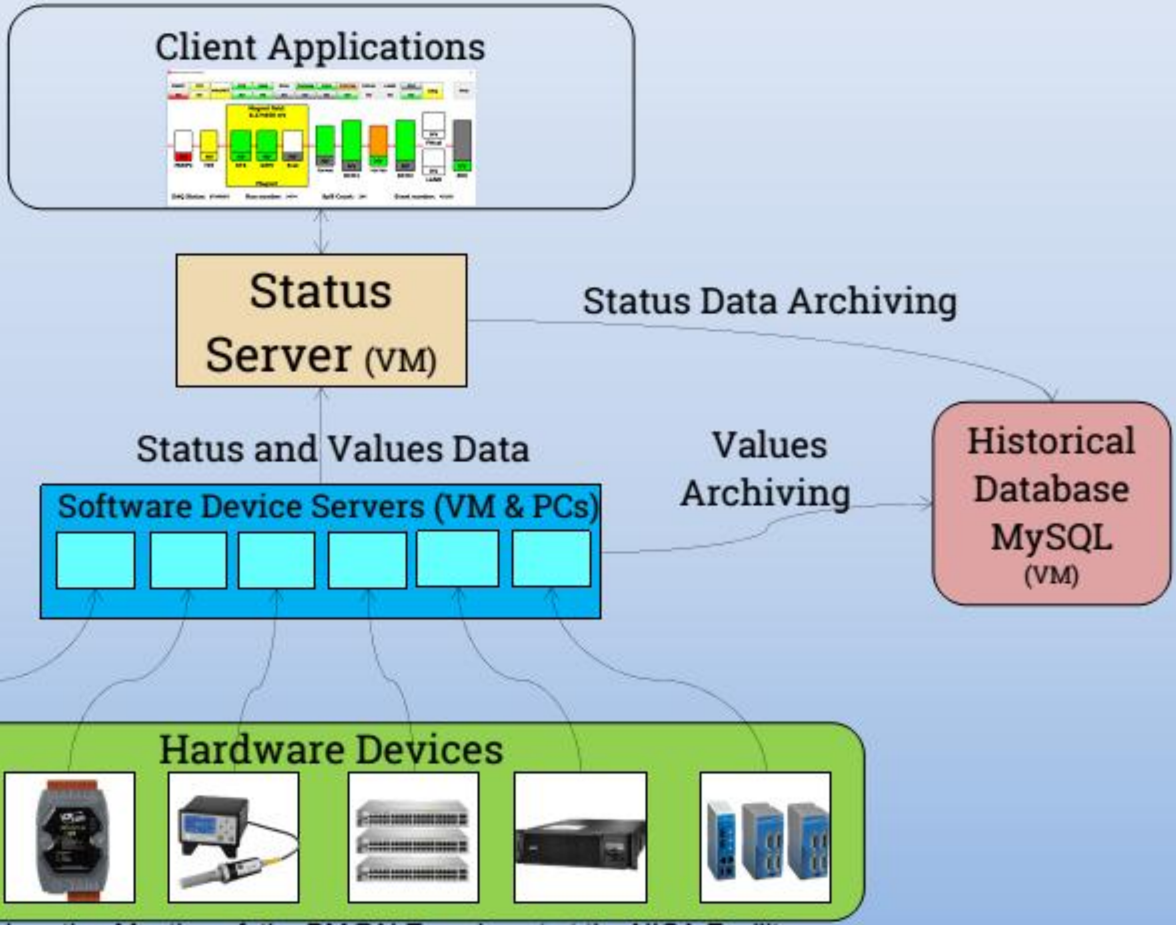
- Alarm system
- Archiving data from devices
- Centralized control of the equipment

TANGO-BASED SCS SCHEME



BM@N STATUS MONITORING SYSTEM

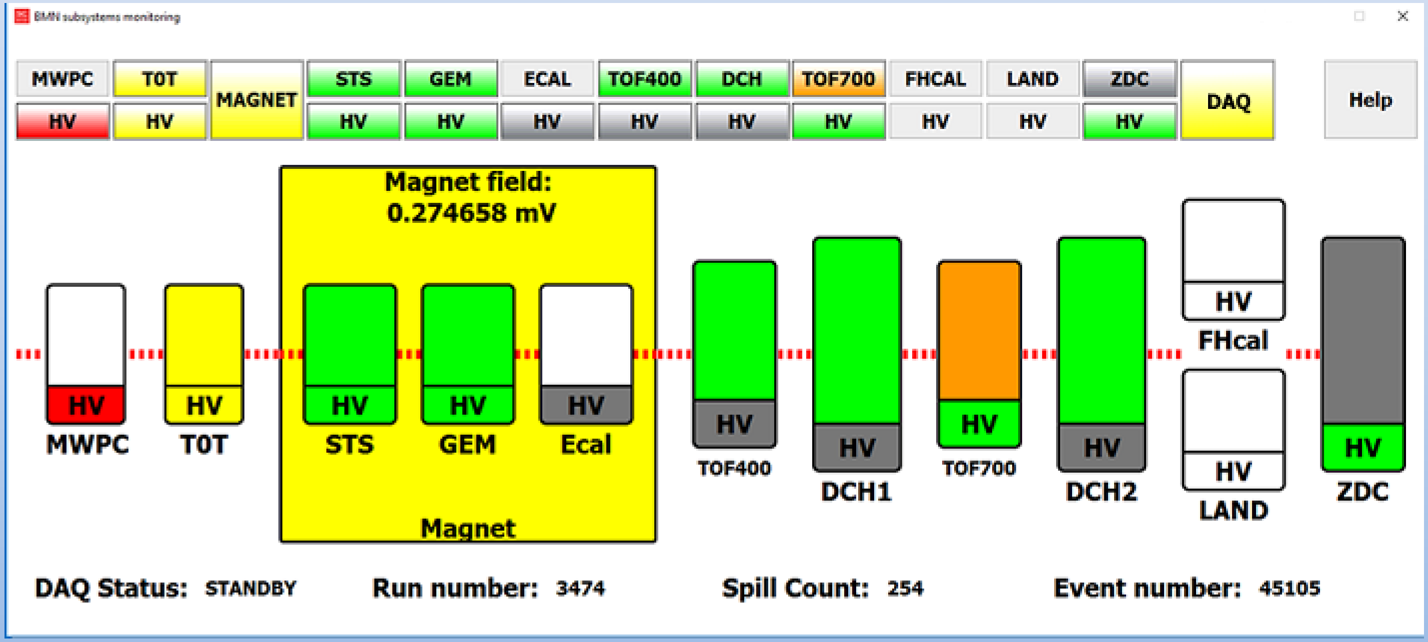
- Client - Server Model
- Event Based
- Online Monitoring
- Alarms
- Customizable
- Scalable



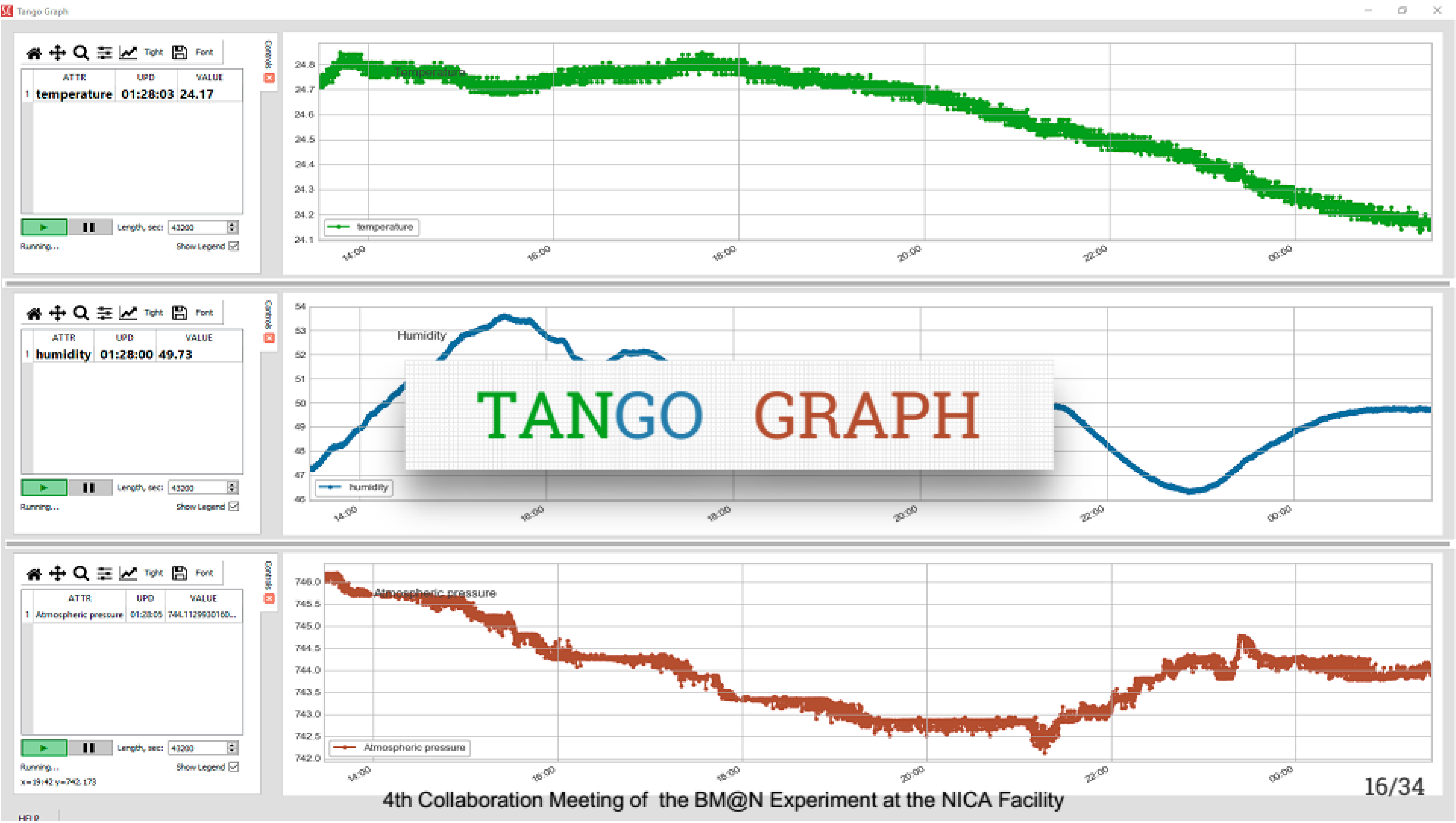
BM@N STATUS MONITORING SYSTEM

The Device Server and GUI application were developed to monitor the statuses of experiment subsystems.

Event-based system subscribes to “State” and “Status” attributes and sort information according to the device type and detector. Client is based on Python3 + PyQt4.



Data acquisition is ready (not started)


Tango Graph
TANGO GRAPH
ATTR
UPD
VALUE
temperature
01:28:03
24.17
humidity
01:28:00
49.73
Atmospheric pressure
01:28:05
Length, sec:
43200
Running...
Show Legend
Temperature
Humidity
Atmospheric pressure
temperature
humidity
14:00
16:00
18:00
20:00
22:00
00:00

CONCLUSION

- Created main components of Slow Control for BM@N including databases, archiving system, alarms system, etc.
- Developed software specific for BM@N experiment (status monitoring system, applications for data access and visualization, device configuration system);
- Developed software for various hardware used in BM@N subdetectors Slow Control;
- Essential part of Slow Control system was tested during several BM@N runs at Nuclotron.

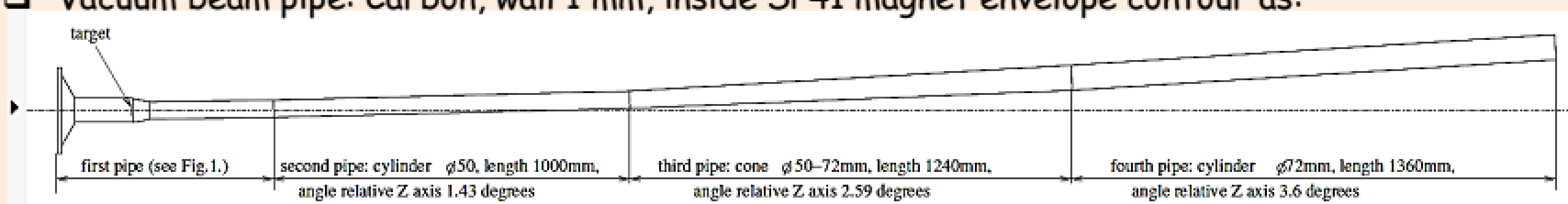
Calculations of biological protection for Au-Au collisions

E.I. Litvinenko, C.M. Piyadin, M.V. Kapishin

BM@N: heavy ion energy 1 - 4.5 GeV/n, beams: p to Au, Intensity ~few 10^6 /s (Au)

Task definition

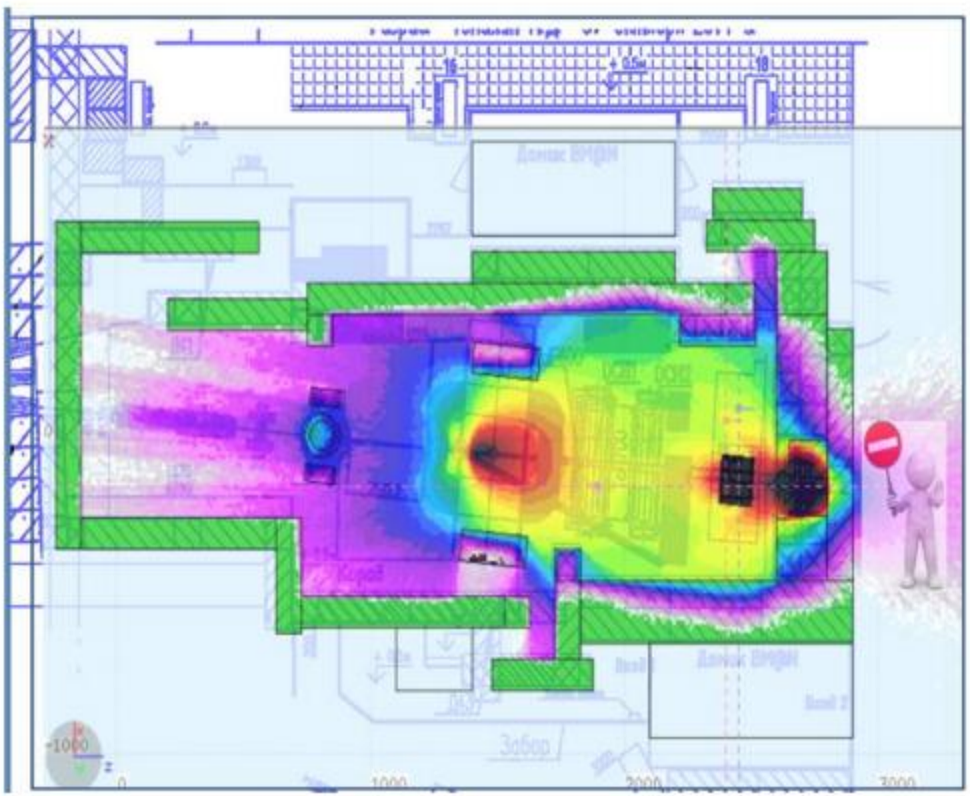
- To perform equivalent dose rate calculations in the experimental area of the BM@N using particle physics MonteCarlo simulation package FLUKA
- To calculate the equivalent dose rate in μSv/h in the areas where personnel are located during the experiment (COUNTING and HOUSING rooms), as well as in the areas of short-term presence of personnel (GAS) and personnel passage (PASSAGE) at different beam intensities.
- Beam: Au 4.5 AGeV, Gaussian, $\sigma_x = \sigma_y$ = 3.5 mm (on the target), intensity $2{\cdot}10^6$ ions/sec (also $1{\cdot}10^6$ and $5{\cdot}10^5$)
- Target: Au, cylider, radius 15 mm, length 1.06 mm
- Beamstop: Steel-15, cube 1.6x2.45x1.1 m^3 , behind near half of meter layer of concrete
- Vacuum beam pipe: Carbon, wall 1 mm, inside SP41 magnet envelope contour as:



- Magnets: analyzing SP41 and bending SP57
- ZDC: layers from Pb (16 mm) and scintillator (4mm) with the inclusion of 20 mm steel plates for screed, hole 15x15 cm in the center.
- Staff houses with thin steel walls
- Main protection - concrete walls of various thicknesses, 5 m high, in the configuration implemented in the experimental zone, with concrete roof, 1.2 m high

Conclusions

- The doze level inside the areas where personnel are located during the experiment (COUNTING and HOUSING), as well as in the areas of short-term presence of personnel (GAS), does not exceed allowed radiation level (6 μSv/h) for intensities up to $2{\cdot}10^6$ ions/sec
- For the passage area (PASSAGE) the final decisions have to be discussed



中国航天

CASC

Beijing Microelectronics Technology Institute

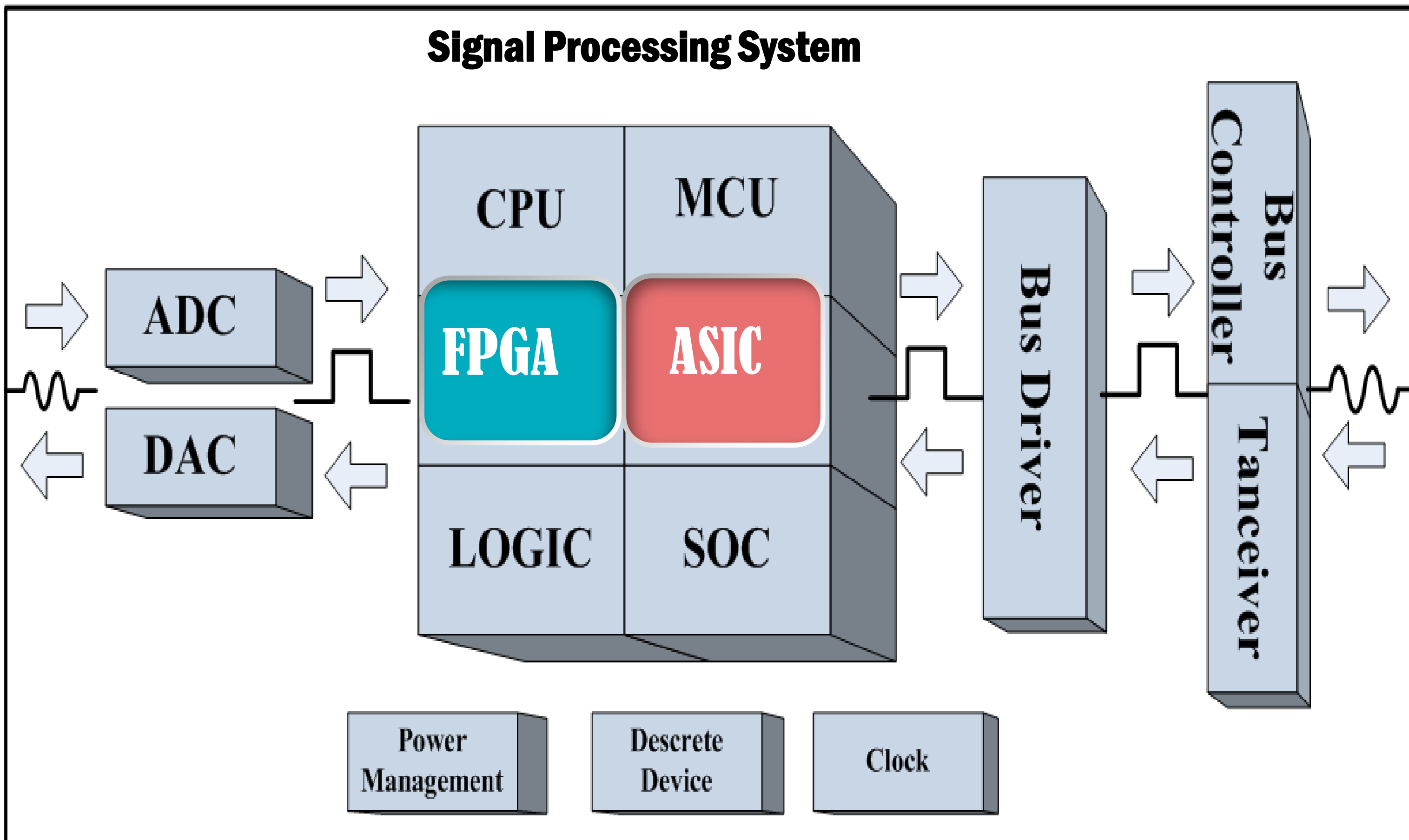
Пекинский институт микроэлектронной техники

2019.9

Product Family

➢Basically, over 300 types of ICs from BMTI contributed to the product family of China space qualified microelectronic components and served over 30 national space projects.

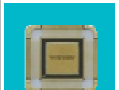
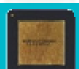
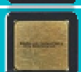
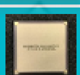
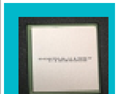
➢Logic processing unit is the core of signal processing system. BMTI offers high-reliability radiation hardened logic processing solutions, such as FPGA solution and ASIC solution.



FPGA Devices of BMTI

Beijing Microelectronics Technology Institute

➢BQVR, BQR2V and BQR5V series are **mature products**, and widely used in China, which have **already exported to Russian and France market**.

	Device	System Gates	Maximum Frequency	User I/O	Package	Compatible Device	IP Cores	Radiation Hardness
	BQVR300RH	300K	180MHz	162	CQFP228	XQVR300	DLL	TID ≥ 100Krad(Si) SEL ≥75 MeV·cm²/mg SEU≥15 MeV·cm²/mg
	BQR2V1000	1M	300MHz	328	CBGA575	XQR2V1000	DCM, BRAM, Multiplier Blocks	TID ≥ 100Krad(Si) SEL ≥75 MeV·cm²/mg
	BQR2V3000	3M	300MHz	516	CCGA717	XQR2V3000		
	BQR2V6000	6M	300MHz	824	CCGA1144	XQR2V6000		
	BQR5VSX95T	9.5M	450MHz	640	CCGA1136	XQR5VSX95T	CMT, BRAM, DSP, MAC, PCIe, Rocket IO	TID ≥ 100Krad(Si) SEL ≥75 MeV·cm²/mg
	BQR5VLX155T	15.5M	450MHz	680	CCGA1136	XQR5VLX155T		

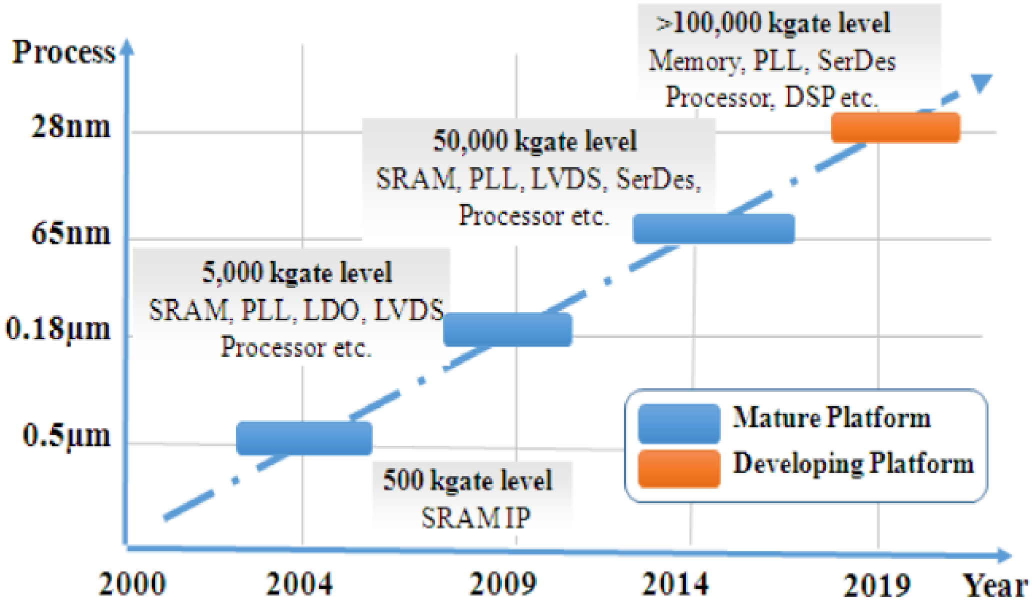
- means product has been exported.

BMTI's Radiation-Hardened ASIC Solution

BMTI has produced nearly 100 RH ASICs, most of which have been delivered to our domestic customers and applied in China's space projects.

Main customers: CAST, CALT, CASIC, CAS, …

- BMTI has developed 0.5μm, 0.18μm and 65nm ASIC design platforms, supporting RH ASIC with a scale up to 50 Million gates
- The next-generation (28nm) platform is under development and to be released in 2019



Roadmap of BMTI's RH ASIC

Summary and Expectation

BMTI has complete and mature radiation hardened FPGA and ASIC solutions

- ✓ **Thoroughly verified and widely applied in China space project**
- ✓ **World leading level in technology**

In the context of the "One Belt, One Road", we are pleased to provide China solution in ICs to our friends, especially Russia. BMTI has cooperated with Russian company RCM by providing radiation hardened 65nm IP technology and has successfully finished this project in 2019.

Other than logic processing solution, BMTI has various radiation hardened solutions, such as RF and high-speed solution, high-speed ADC and DAC solution, etc.

Email: gjhz@mxtronics.com; Tel:(8610)68758115; Fax:(8610)68757706

Development of multipurpose high speed bidirectional optical interface for BM@N experiment based on radiation hardened BMTI FPGA

Alexander Chepurnov

SINP MSU

4th Collaboration Meeting of the BM@N Experiment at the NICA Facility, 14-15 October, 2019

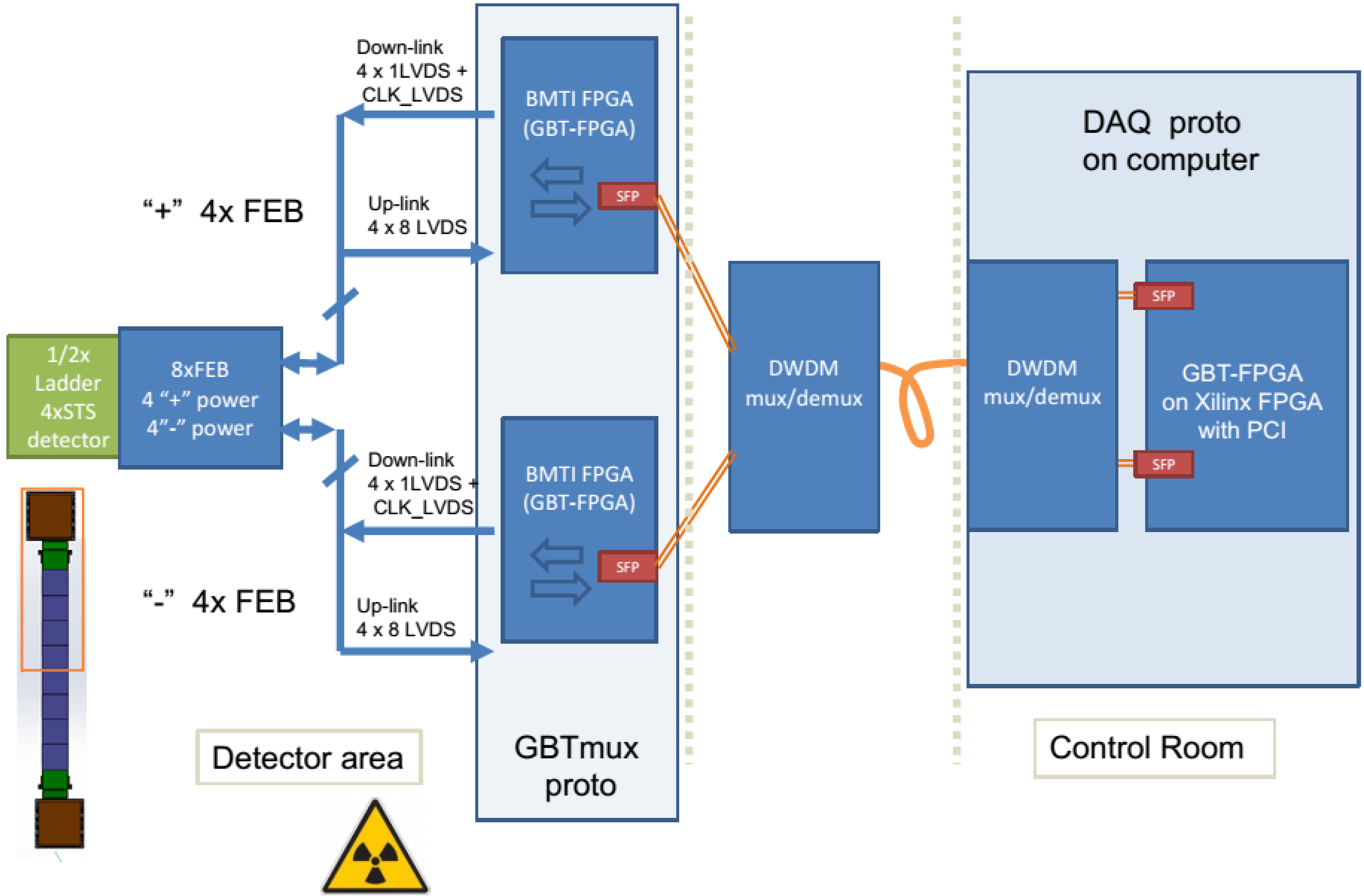
Radiation hardened FPGA from BMTI

BQ5V series FPGA Members

Device	System Gates	CLB			DSP48E Slices	Block RAM Blocks (Kb)	CMTs	EndpointBlocks for PCI Express	Ethernet MACs	Max GTPs	Max I/O Pads	Package
		Array Row x Col.	Slices	Maximum Distributed RAM Kbits								
BQ5V SX35T	3.5M	80 x 34	5440	520	192	3024	2	1	4	8	360	BGA665
BQ5V SX50T	5M	120 x 34	8160	780	288	4752	6	1	4	12	360	BGA665
BQ5V SX95T	9.5M	160 x 46	14,720	1,520	640	8,784	6	1	4	16	640	CCGA1136
BQ5V SX240T	24M	240 x 78	37440	4200	1056	18576	6	1	4	24	960	BGA1738
BQ5V LX155T	15.5M	160 x 76	24320	1640	128	7632	6	1	4	16	680	CCGA1738

- For "R" radiation hardness version:
- TID (total ionizing dose) >= 150K Rad (Si), Latch-up immune to LET >= 90MeV cm2/mg
- Certified to CAST

DAQ prototype for STS BM@N



From FPGA to ASIC with BMTI

Successful development of GBT-compatible DAQ hardware based on BMTI FPGA based can be extended in the direction of rad-hard GBTX BMTI ASIC development

VMM3a for GEM readout status

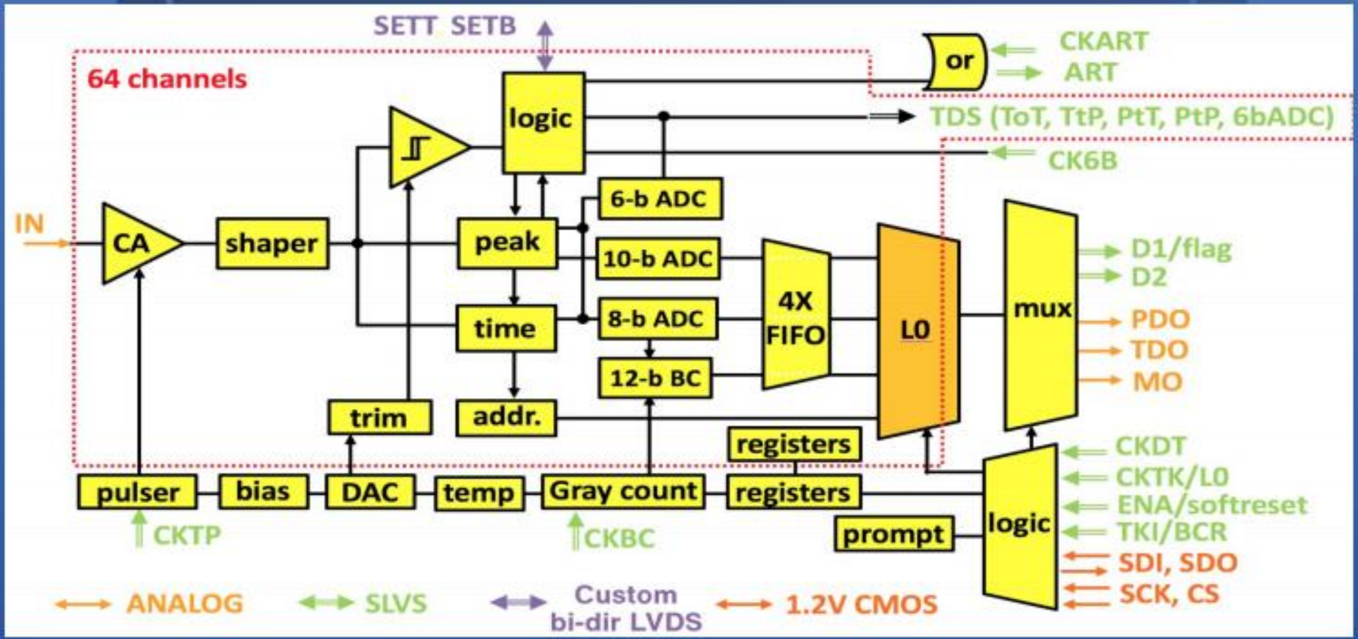
Vitalii Burtsev on behalf of BM@N collaboration

4th Collaboration Meeting

of the BM@N Experiment at the NICA Facility

14 October 2019

VMM Architecture and highlights

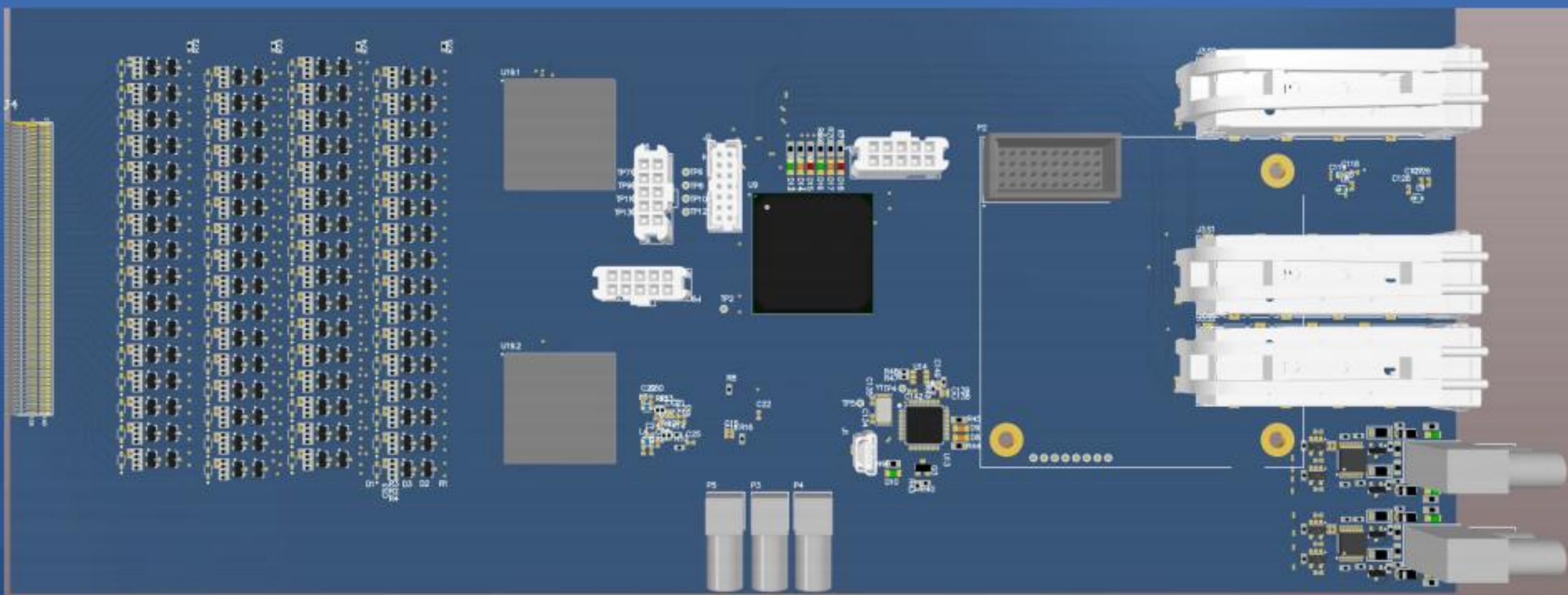


- Peaktime (200, 100, 50, 25 ns)
- Gain (0.5, 1, 3, 4.5, 6, 9, 12, 16 mV/fC)
- Neighbor logic
- Both input charge polarity
- TAC slope adjustment (60, 100, 350, 650 ns)
- Low power 10mW/ch
- 64 input ch/ASIC

Viking and VMM3a chip comparsion

	VMM3a	VA162	VA163
Input channels	64	32	32
Input charge	-2 to 2 pC	-1.5 pC to +1.5 pC	-750fC to +750 fC
Shaping time	25 to 200 ns	2 to 2.5 us	500 us
Noise	500e ENC at 25pF	2000e ENC at 50 pF	1797e ENC at 120pF
Gain	0.5 to 16 mv/fC	0.5 uA/fC	0.88 uA/fC
Total power max	640mW	66mW	77mW

Kintex7 based 128ch GEM evaluation board



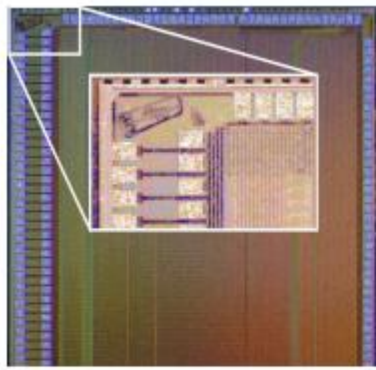
TIGER: A front-end ASIC for timing and energy measurements with radiation detectors

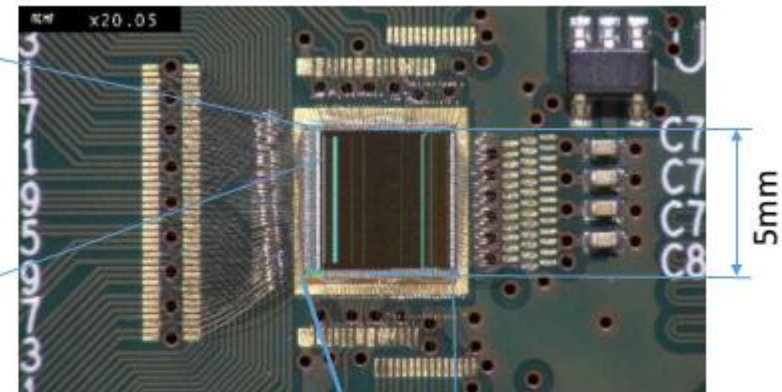
M. Alexeev & Colleagues

UNIVERSITÀ
DEGLI STUDI
DI TORINO

INFN
Istituto Nazionale di Fisica Nucleare

Torino Integrated Gem Electronics Readout (TIGER)





TIGER Design:

- INFN-Torino
- LIP-Lisboa
- PETSYS-Lisboa
- IHEP Beijing

Test responsible:

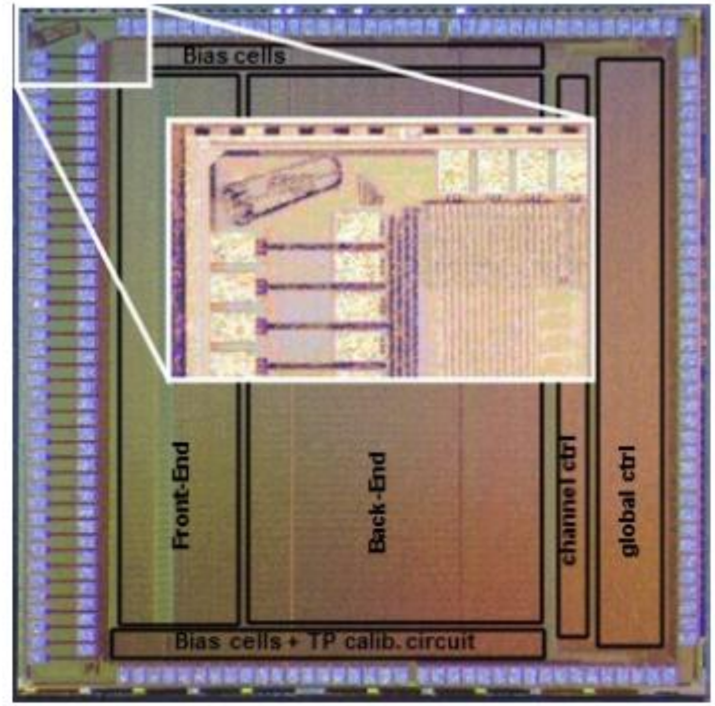
- INFN-Torino

Ref.: A. Rivetti et al. "TIGER: A front-end ASIC for timing and energy measurements with radiation detectors
Nuclear Inst. and Methods in Physics Research, A 924 (2019), pp. 181–186.

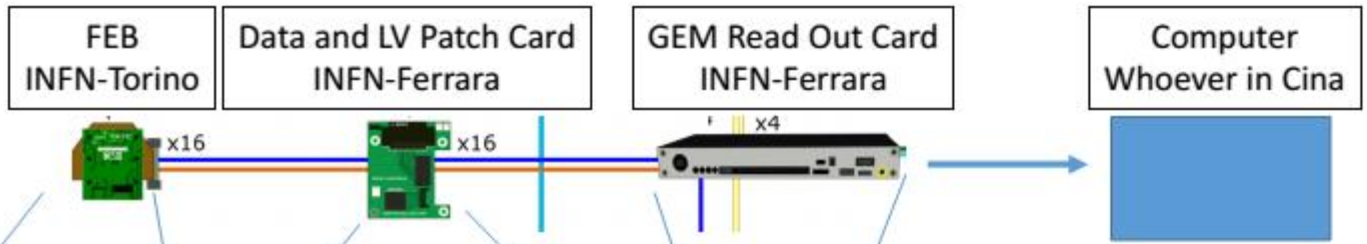
Main features

Chip features:

- 64 channels
- Power consumption < 12 mW /channel
- Sustained event rate 100 kHz
- Input dynamic range up to 50 fC
- Time resolution < 5 ns
- ENC < 2000 e rms with 100 pF input capacitance
- Analog read out providing charge and time measurement
- Digital logic protected from single event upset (SEU)
- Tunable internal test pulse generator
- 110 nm technology



Laboratory setup



- Minimal laboratory equipment in triggerless mode
- Adding a trigger logic the trigger matching can be added to the system

Summary

- The TIGER ASIC has passed the initial tests and is now being deployed
- We have a set of FEs and a DAQ environment that are in principle pretty portable for external test
- Coupling test to different detectors is in evaluation
- Some support upon agreement may be provided to external users interested in a evaluation test

The TIGER ASIC has been developed within the BESIIICGEM Project, funded by European Commission within the call H2020 MSCARISE2014

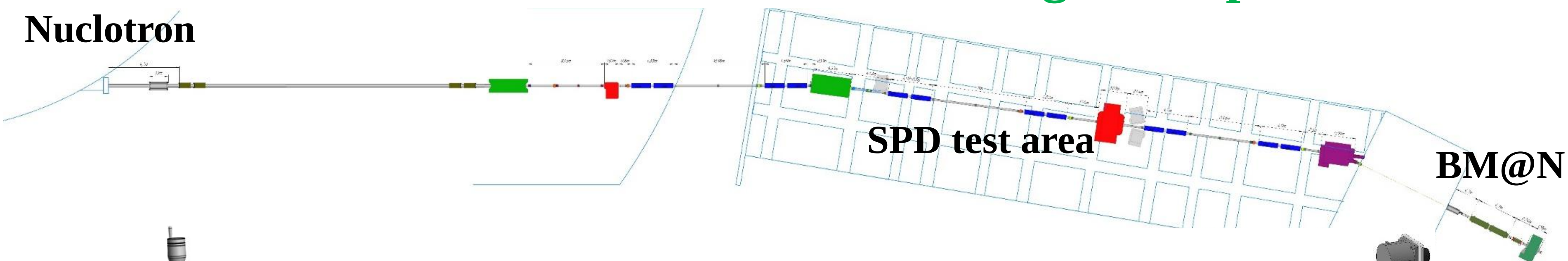
Status of the beam channel from Nuclotron to BM@N setup

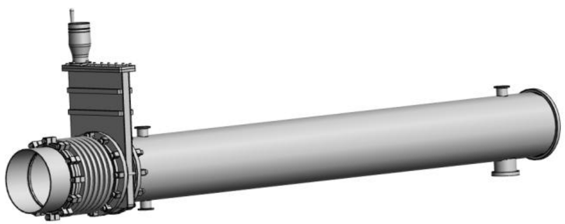
A. Kubankin at all.

October 2019

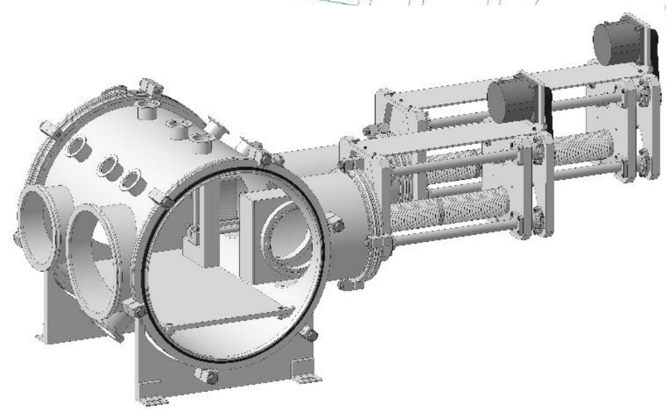
Current status of LONG ion pipe development

3D model has been developed
Technical documentation is being developed

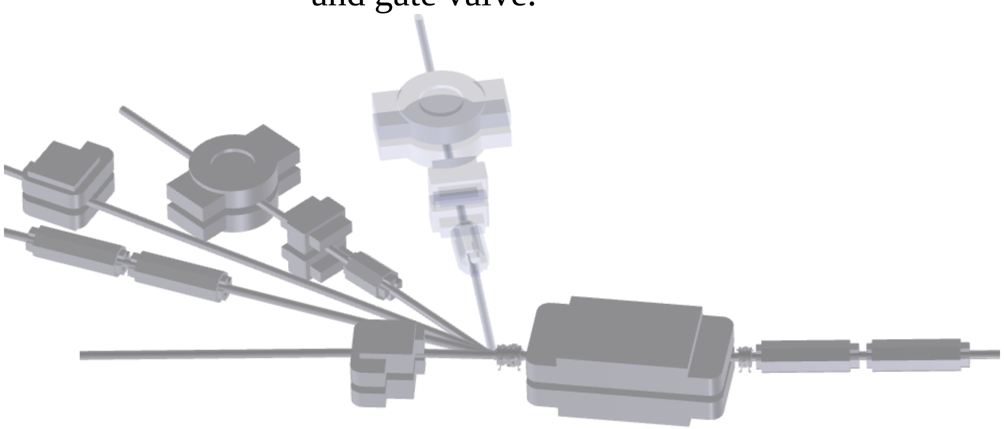




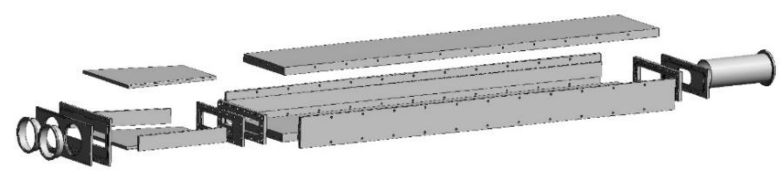
The basic part of the ion guide - a vacuum pipe with ISO-K, KF flanges assembled with a bellow and gate valve.



Multitask vacuum boxes for modern beam diagnostic tools and experimental research.



User area F4 «MARUSYA» will allow measuring angular distribution of products formed under ions interaction with a medium.

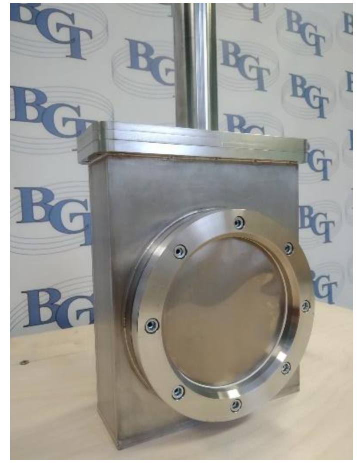


The vacuum box of a magnet.

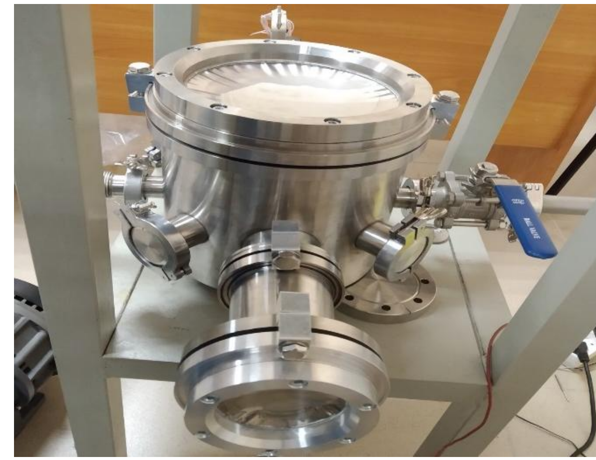
Current status of LONG ion guide development

Prototypes of the guide parts are being manufactured

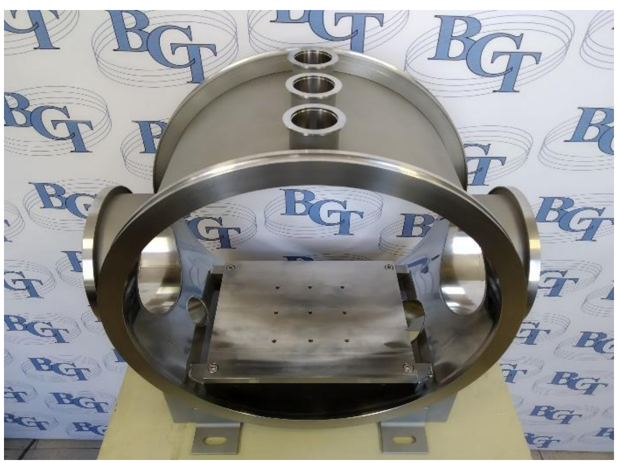
Motorized stages for detectors and targets



Vacuum box with thin titanium window for ion beam gas detectors



Setup for thin windows testing



Vacuum chamber for diagnostics

Vacuum parts of the ion guide

Vacuum chamber for beam diagnostic tools and targets

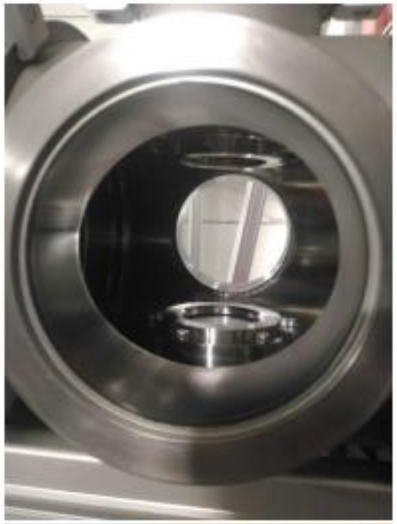
Schedule

- Development of the technical documentation for the LONG ion guide – December of 2019
- Manufacturing of the LONG ion guide parts – September 2020
- Assembling and testing of the LONG ion guide – November 2020

BEAM PIPE UPSTREAM AND DOWNSTREAM THE TARGET

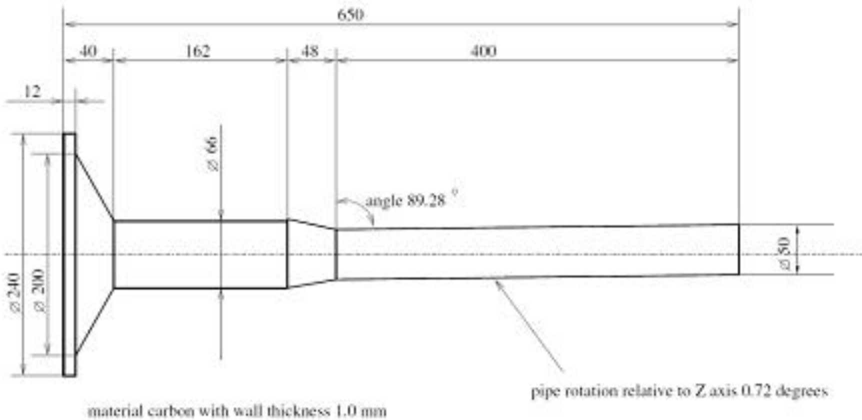
Piyadin S.M.
on behalf of BM@N Collaboration

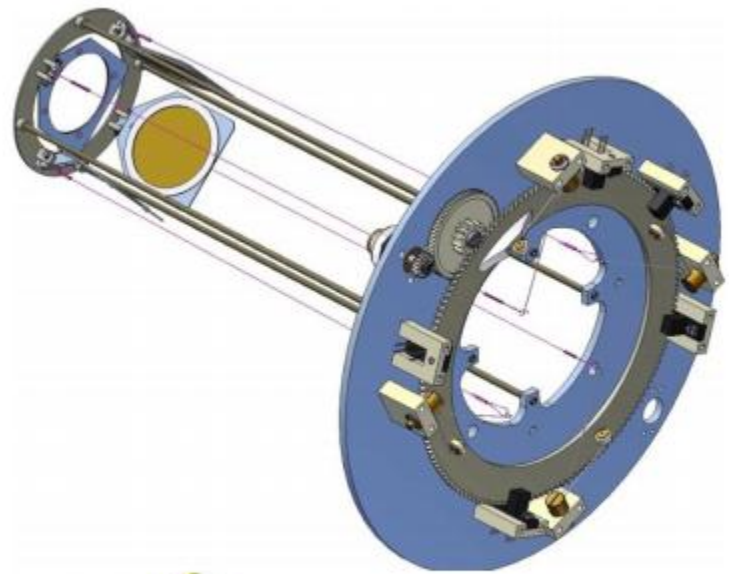
Beam pipe upstream the target

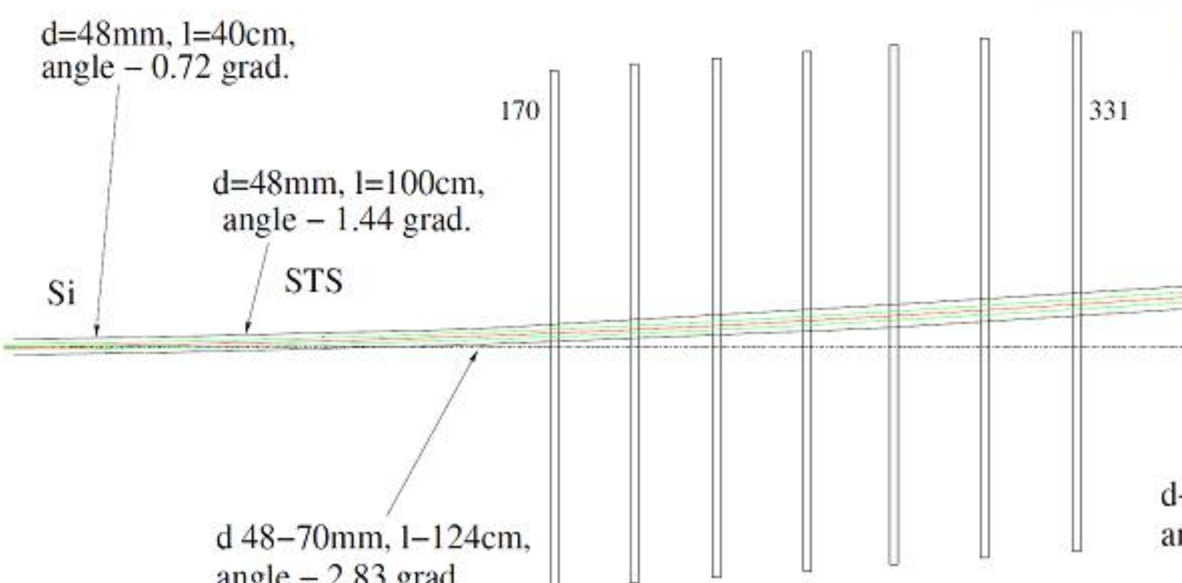


Beam pipe upstream the target with vacuum box for trigger and Si detectors. This configuration of beam pipe was manufactured and tested by **LLC Vacuum systems and technologies**

Target station and beam pipe configuration for tracker system







d–70mm, l–136cm,
angle – 3.6 grad.

Conclusions

1. Position of beam detectors were determined.
2. All vacuum boxes for beam detectors were developed.
3. Vacuum beam pipe configuration before the target was finished.
4. Beam pipe before the target and all vacuum boxes for beam detectors were produced.
5. Installation of all elements of beam pipe was started.
6. Construction of the target station was developed.
7. Configuration of beam pipe inside the analyzing magnet was simulated basing on different positions of central tracker detectors.
8. Production of first prototype of carbon beam pipe was started.
9. Development of beam pipe configuration behind the analyzing magnet was started.

Plans:

06.2020 - Production of the target station with control system.

09.2020 - Production of carbon beam pipe inside the analyzing magnet.

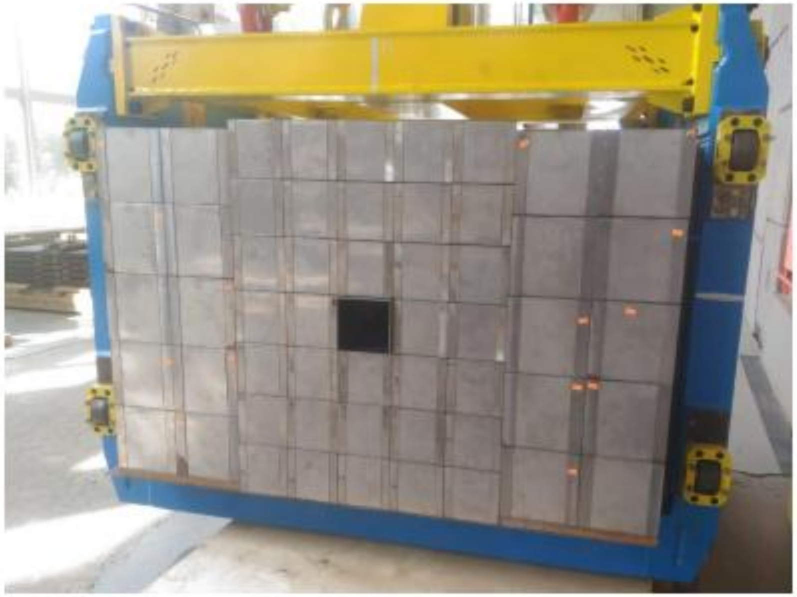
11.2020 - Development and production of aluminum beam pipe behind the analyzing magnet.

Integration of new FHCAL and Forward Hodoscope

A. Ivashkin
INR, Moscow

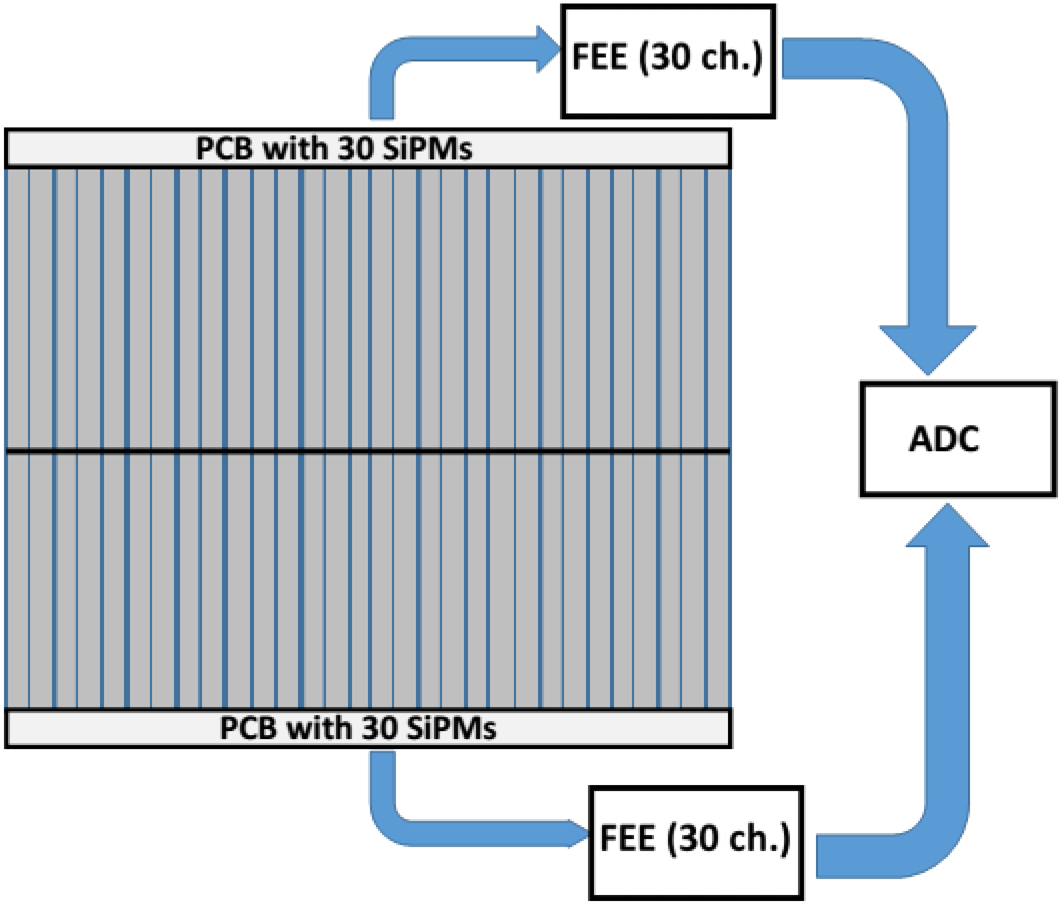
4th BM@N Collaboration meeting, October 14-15, 2019

Front view of FHCal

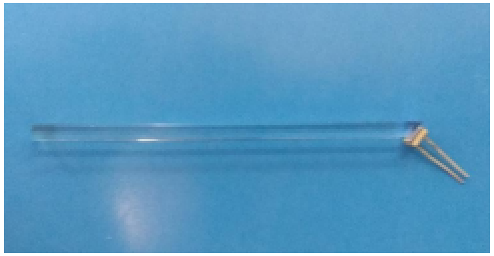


FHCal is already in BM@N experimental area!

Forward Hodoscope in FHCal beam hole – in development



30x2=60 quartz strips;
5x80x4 mm^3;
It covers beam hole 15x15 cm^2.



quartz strips 5x80x3 mm.
Light readout by Hamamatsu MPPC.

One ADC board is needed.

Slow control and DAQ would be the same as for FHCal.

Summary and open issues.

- **Next year FHCal and Forward Hodoscope must be integrated to BM@N setup.**
- **Data Acquisition is the most sensitive issue.**
- **9 ADC boards and power supplies are needed.**
- **Cooling system.**
- **Integration to general DAQ.**
- **Trigger? Centrality – FHCal? Minimum bias - Forward Hodoscope?**
- **<u>Collaboration with other detector groups is strongly appreciated!</u>**

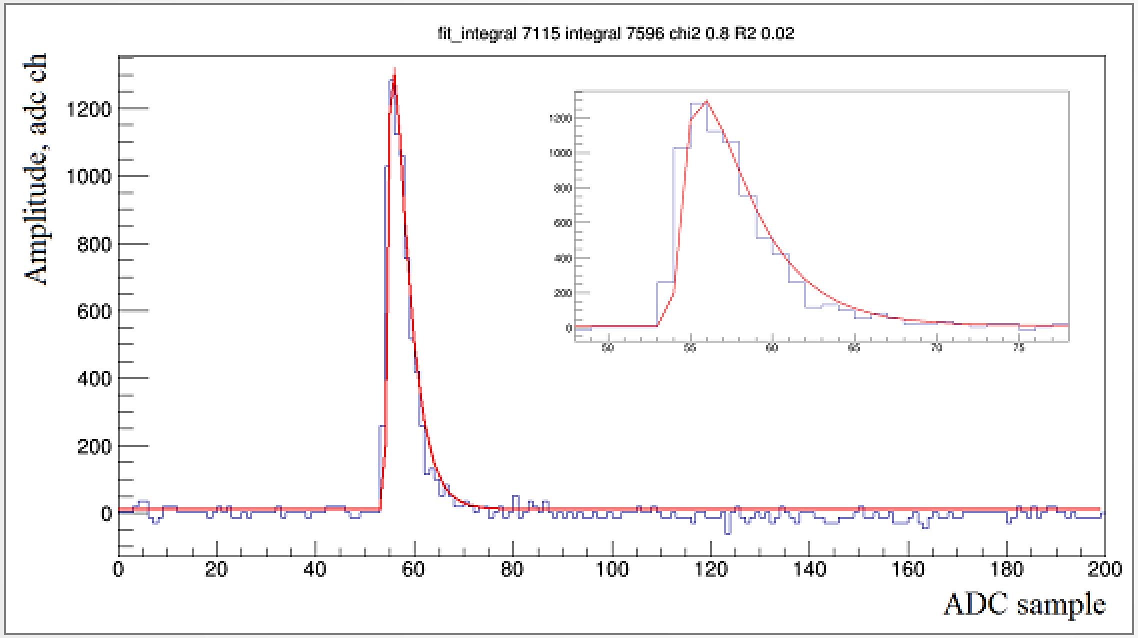
Method of FHCAL calibration with cosmic muons

Nikolay Karpushkin, INR RAS

4th BM@N Collaboration Meeting
14 October 2019

Why do we need waveform fitting

No muon beam at BM@N ➔ Calibration by cosmic muons ➔ Large amount of noise in data

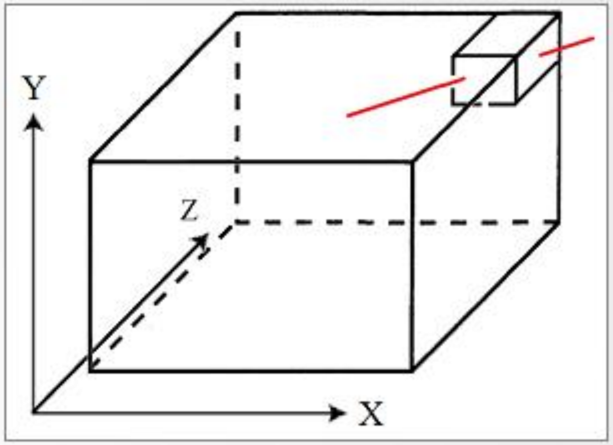


Advantages of the fitting procedure:

- ❖ Working with small signals near the noise level
- ❖ More correct determination of amplitude and charge
- ❖ Identification of pick-up noise and signal pile-ups
- ❖ True signal recovery

New muon calibration approach

Cosmic muons deposit different amounts of energy in the calorimeter sections depending on the position and direction of the particle track. This should be taken into account when conducting a muon calibration.

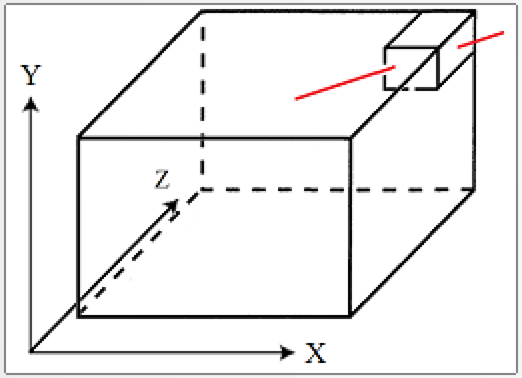


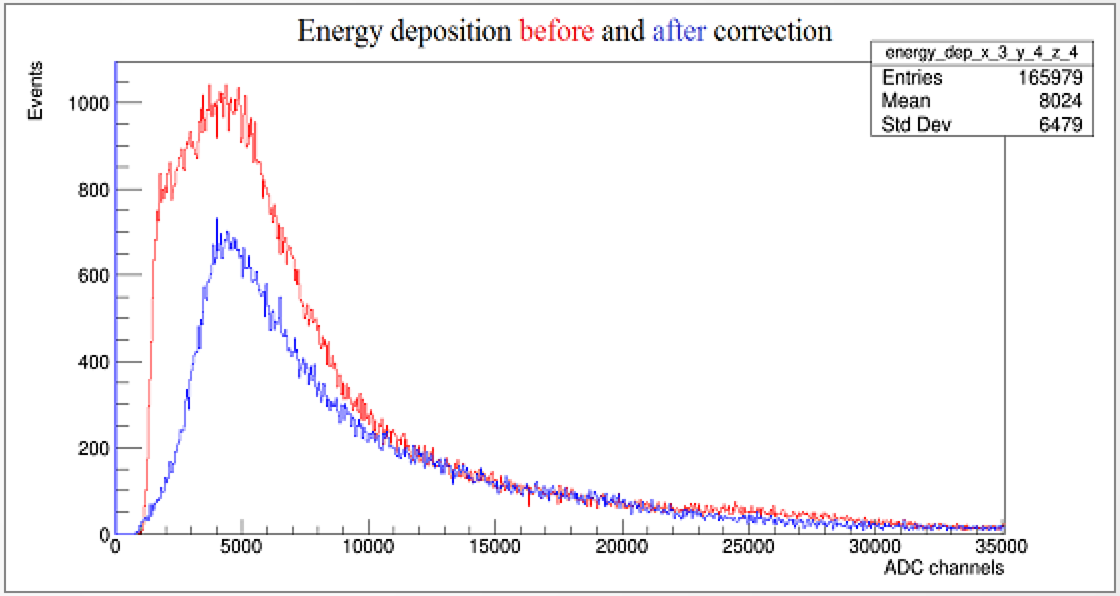
Calibration approach:

- ❖ Reconstruct muon tracks using signals selected with fit QA
- ❖ Determine the thickness of the scintillator passed by track in each cell
- ❖ Make corrections when calculating energy deposition

Adjusted charge calculation

Calculation of the thickness of scintillator material traversed by the particle track by enumerating 6 faces of each triggered section.





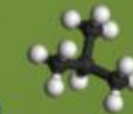
The adjusted charge is considered as if the particle has passed straight through the section, traversing 6×4 mm of the scintillator. In the case when the track did not pass through the section, it is impossible to correct the charge, the adjusted energy deposition is considered to be zero.

STATUS OF THE GEM TRACKING SYSTEM

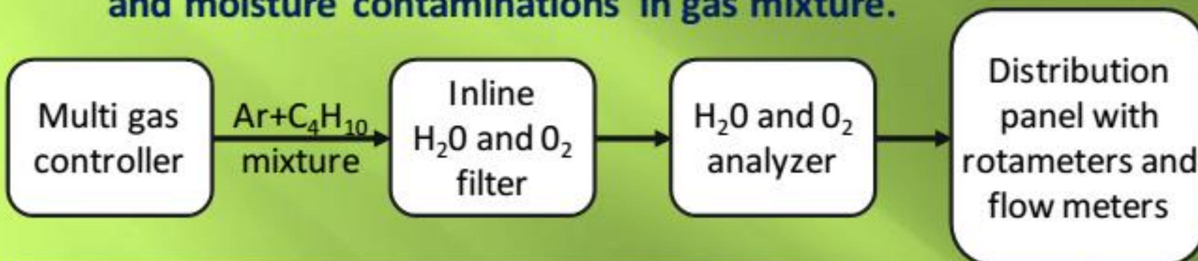
Elena Kulish on behalf of BM@N Collaboration

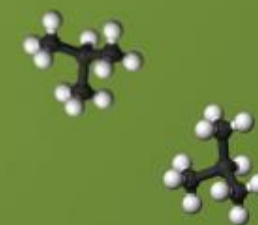
Bracing system for FEE

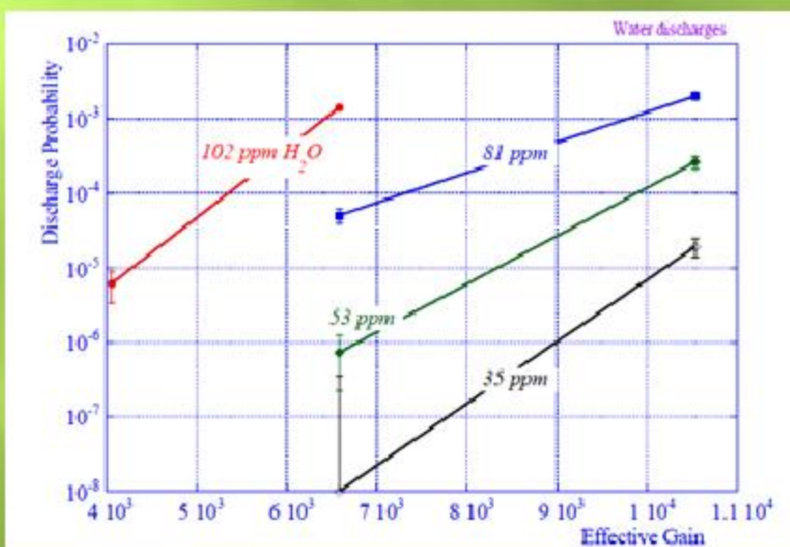
Gas system

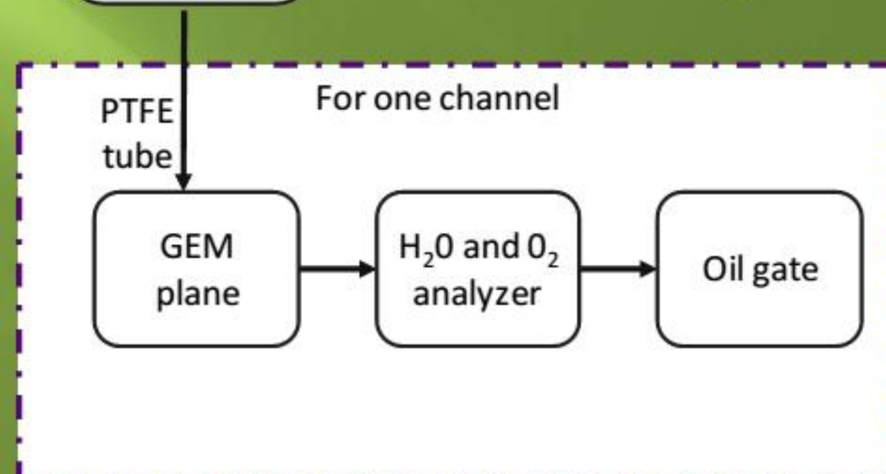


Now we have: 1 channel with Argon (80%) + Isobutane (20%) gas mixture, flow = 3 l/h through all series-connected GEM-detectors.
What we want: 7 independent channels to each GEM-plane; reduce and control oxygen and moisture contaminations in gas mixture.









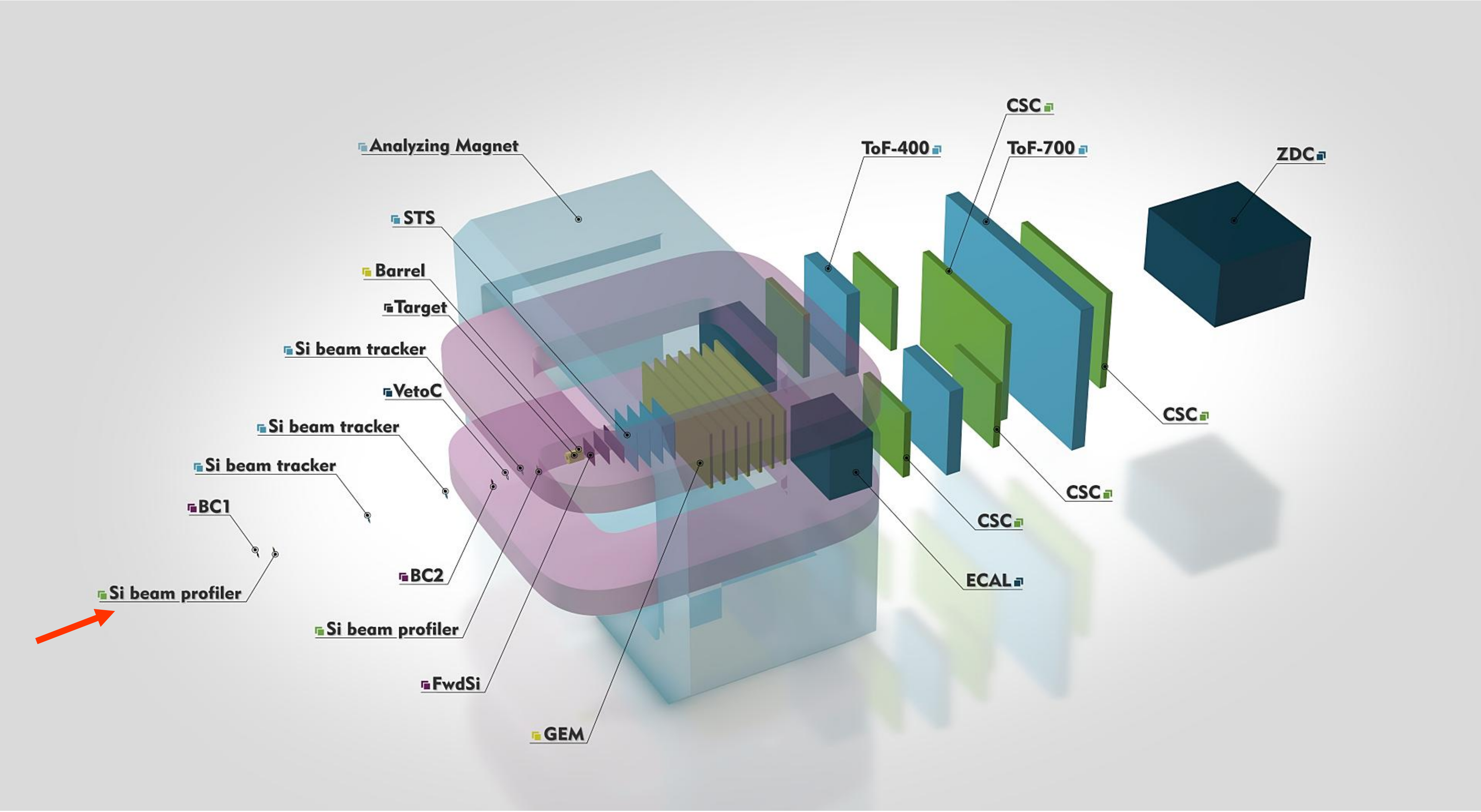
Discharge probability on alphas as a function of moisture level in the gas. COMPASS

Control O2 by GE sensing oxy.IQ
Control H2O by GE sensing IQ.probe + GE sensing dew.IQ

CSC for BM@N experiment. Status report 14.10.2019

Balandin, R.Kattabekov, Yu.Kiryushin, E.Kulish, N,Kuzmin
A.Makankin, A.Maksimchuk, S.Vasiliev , A.Vishnevskiy

The main aim for CSCs is prolongation of track from GEM to space behind magnet and definition of more precise coordinate of grossing point with TOF.



CSC 1x1 m^2

Status:

1-st CSC is ready

2-nd CSc 90% readyness

3 and 4-th 10% readyness

Production schedule

2019, The end of December – completion of assembling

2020, January to April – cosmic test.

CSC 1,5x2,3 m^2

Status:

Drawings of CSC are ready.

Preparation of codes for printed boards production - in progress (expected completion – end of 2019)

Drawings of additional technical equipment are ready for order in industry

Production schedule:

Preparation of technological equipment - 2020, February

Production of PB in industry - 2020, April

Start of assembling - 2020 October

Test and installation into set-up - 2021, January – February.