CREMLIN PLUS
Connecting Russian and European Measures for Large-scale Research Infrastructures

BM@N
Baryonic Matter at Nuclotron

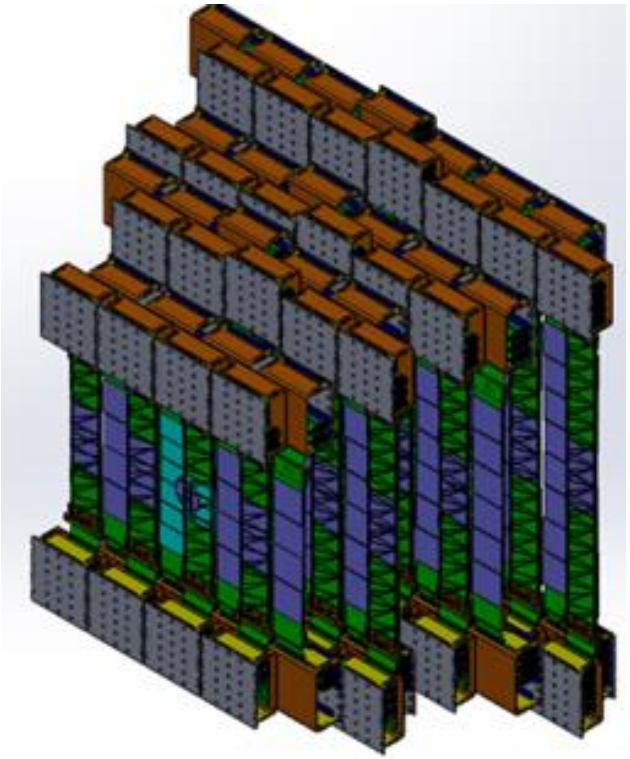
Current status of BM@N STS*

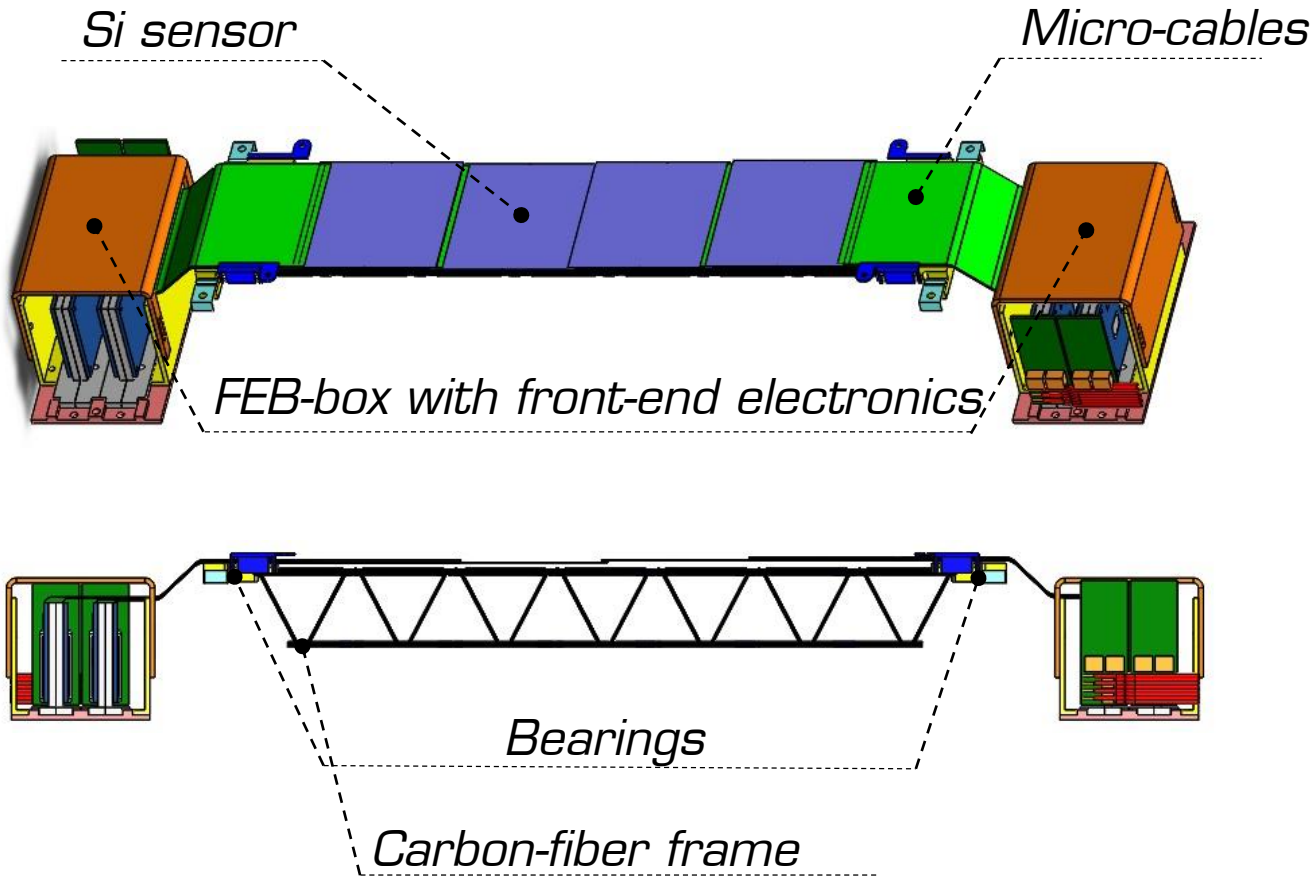
Dmitrii Dementev for JINR STS group

Detector board meeting 06/10/2020

*Work supported by RFBR 18-02-40047 grant

BM@N STS Ladder



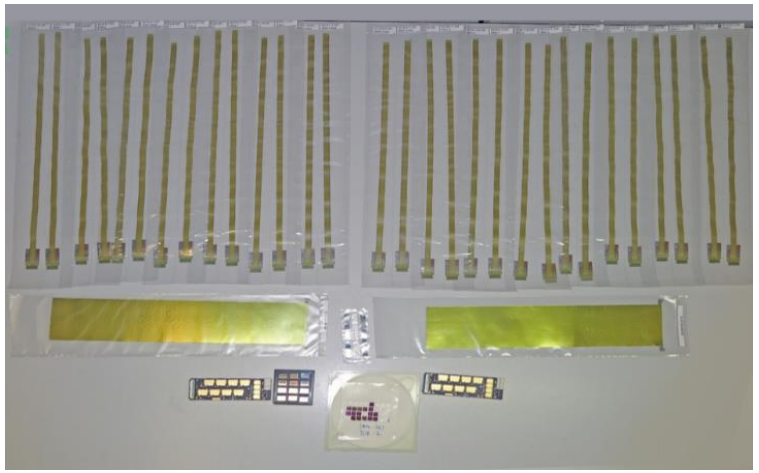


4 BM@N STS Stations;

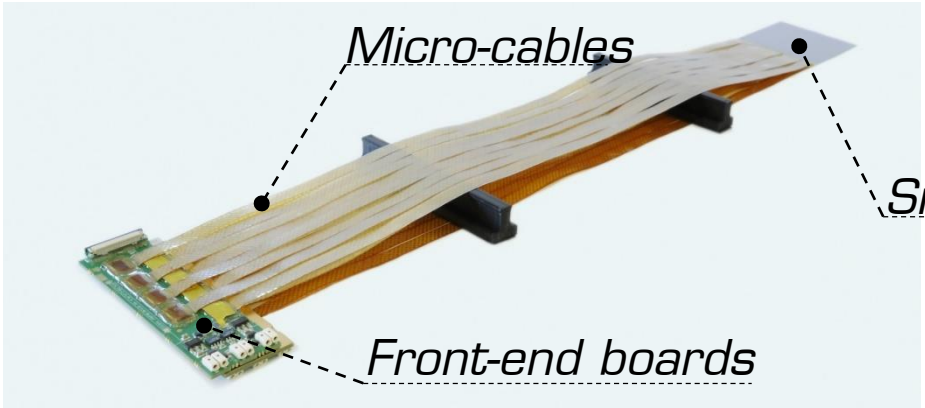
34 ladders;

292 modules;

STS Module



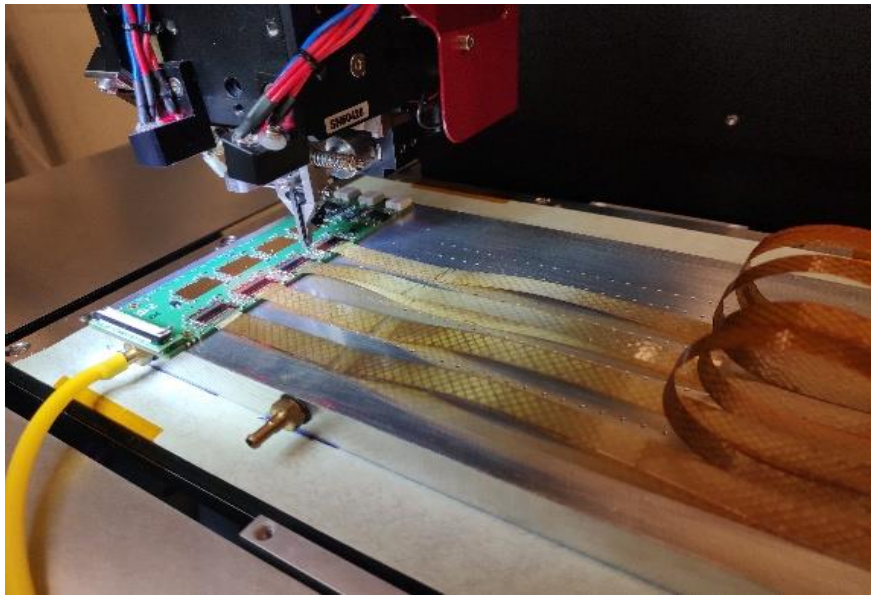
Module components



Assembled module (GSI)

Assembled module covered with shieldings (JINR)

Module assembly at JINR



Module assembly

Current status:

- Set of jigs was developed and produced;
- Assembly workflow developed and tested on the mockups and first operational modules;
- QA tests during and after assembly were developed and implemented in Elog;
- Yields still to be estimated

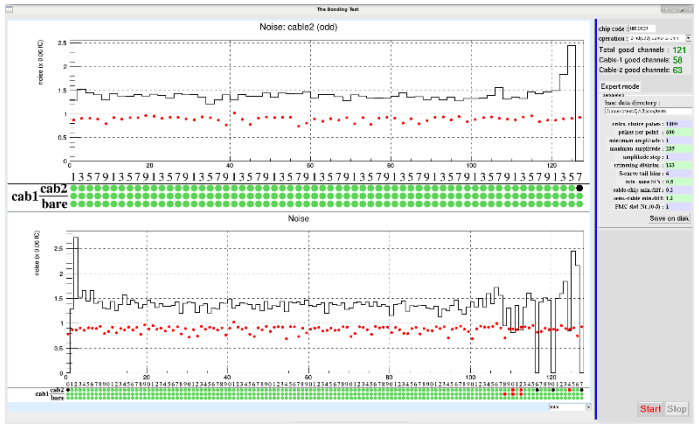
Module assembly team:

A.Sheremetev, N. Sukhov, T. Andreeva, T. Semchukova

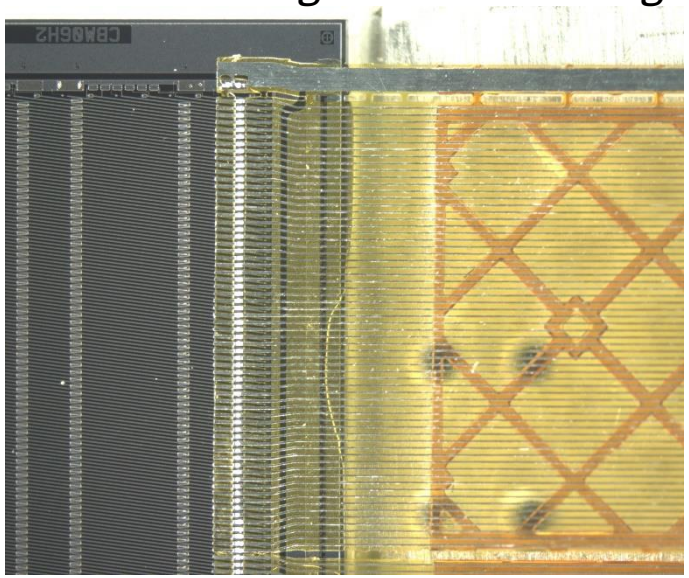
Delays caused by pandemic control measures in RF:

2.5 month pause in the assembly cite;
Assembly of a new module started this week

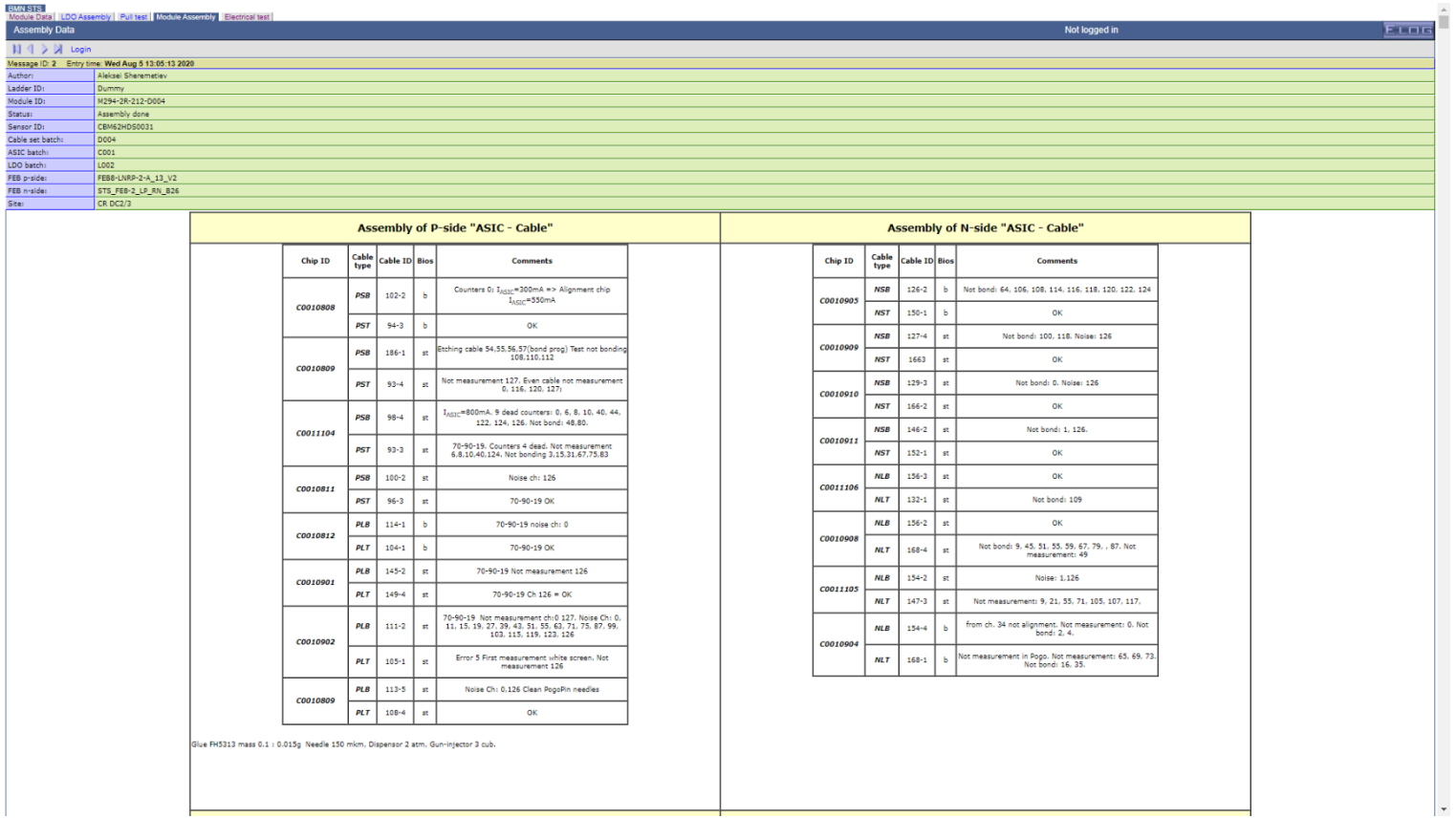
Electronic logbook for the module assembly



Results of bonding tests with Pogo-pin



Optical inspection of the Tab-bonds



Assembly Data — Not logged in

Author:	Alekse Sheremetiev
Ladder ID:	Dummy
Module ID:	M294-2R-212-D004
Status:	Assembly done
Sensor ID:	CBM62HDS0031
Cable set batch:	D004
ASIC batch:	C001
LDO batch:	L002
FEB p-side:	FEB8-LNRP-2-A_13_V2
FEB n-side:	STS_FEB-2_LP_RN_B26
Site:	CR DC2/3

Assembly of P-side "ASIC - Cable"

Chip ID	Cable type	Cable ID	Bios	Comments
C0010808	PSB	102-2	b	Counters 0; I_{ASIC}=300mA => Alignment chip I_{ASIC}=550mA
	PST	94-3	b	OK
C0010809	PSB	186-1	st	Etching cable 54,55,56,57(bond prog) Test not bonding 108,110,112
	PST	93-4	st	Not measurement 127. Even cable not measurement 0, 116, 120, 127)
C0011104	PSB	98-4	st	I_{ASIC}=800mA. 9 dead counters: 0, 6, 8, 10, 40, 44, 122, 124, 126. Not bond: 48,80.
	PST	93-3	st	70-90-19. Counters 4 dead. Not measurement 6,8,10,40,124. Not bonding 3,15,31,67,75,83
C0010811	PSB	100-2	st	Noise ch: 126
	PST	96-3	st	70-90-19 OK
C0010812	PLB	114-1	b	70-90-19 noise ch: 0
	PLT	104-1	b	70-90-19 OK
C0010901	PLB	145-2	st	70-90-19 Not measurement 126
	PLT	149-4	st	70-90-19 Ch 126 = OK
C0010902	PLB	111-2	st	70-90-19 Not measurement ch:0 127. Noise Ch: 0, 11, 15, 19, 27, 39, 43, 51, 55, 63, 71, 75, 87, 99, 103, 115, 119, 123, 126
	PLT	105-1	st	Error 5 First measurement white screen. Not measurement 126
C0010809	PLB	113-5	st	Noise Ch: 0.126 Clean PogoPin needles
	PLT	108-4	st	OK

Glue FH5313 mass 0.1 : 0.015g Needle 150 mkm, Dispensor 2 atm, Gun-injector 3 cub.

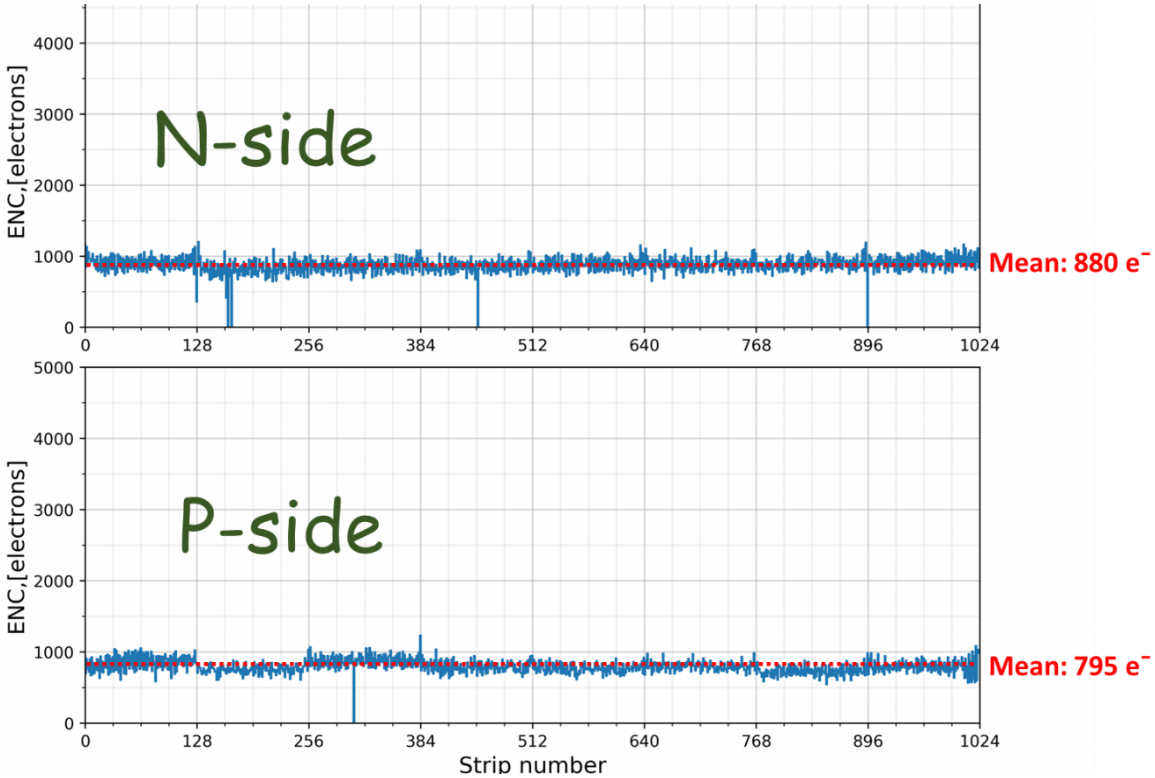
Assembly of N-side "ASIC - Cable"

Chip ID	Cable type	Cable ID	Bios	Comments
C0010905	NSB	126-2	b	Not bond: 64, 106, 108, 114, 116, 118, 120, 122, 124
	NST	150-1	b	OK
C0010909	NSB	127-4	st	Not bond: 100, 118. Noise: 126
	NST	1663	st	OK
C0010910	NSB	129-3	st	Not bond: 0. Noise: 126
	NST	166-2	st	OK
C0010911	NSB	146-2	st	Not bond: 1, 126.
	NST	152-1	st	OK
C0011106	NLB	156-3	st	OK
	NLT	132-1	st	Not bond: 109
C0010908	NLB	156-2	st	OK
	NLT	168-4	st	Not bond: 9, 45, 51, 55, 59, 67, 79, , 87. Not measurement: 49
C0011105	NLB	154-2	st	Noise: 1,126
	NLT	147-3	st	Not measurements: 9, 21, 55, 71, 105, 107, 117,
C0010904	NLB	154-4	b	from ch. 34 not alignment. Not measurement: 0. Not bond: 2, 4.
	NLT	168-1	b	Not measurement in Pogo. Not measurement: 65, 69, 73. Not bond: 16, 35.

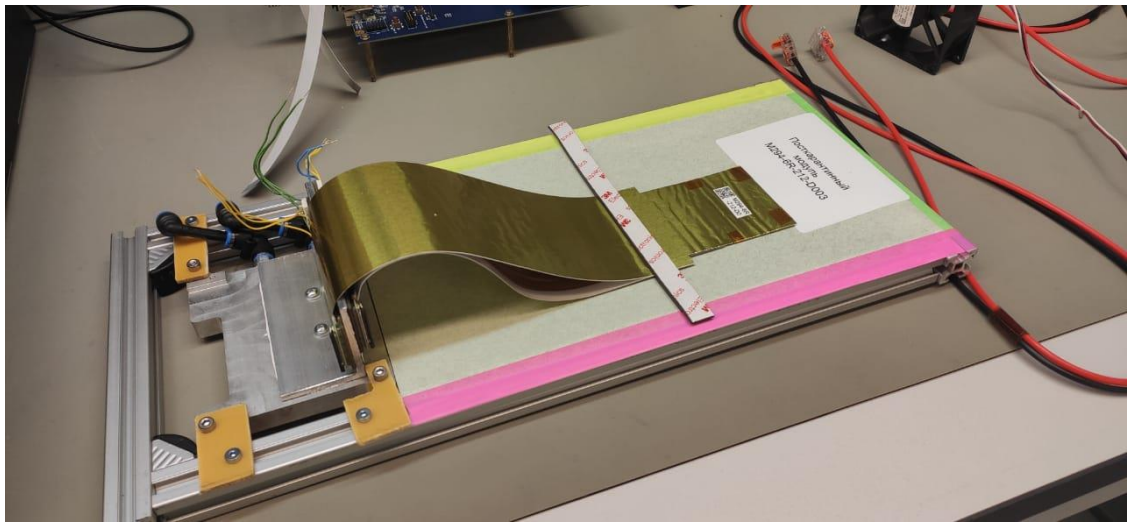
Elog interface

V. Korenkov, A. Kondratyev, A. Batuk (LIT)

Characterization of assembled modules



Noise/channel distribution for ModuleD004

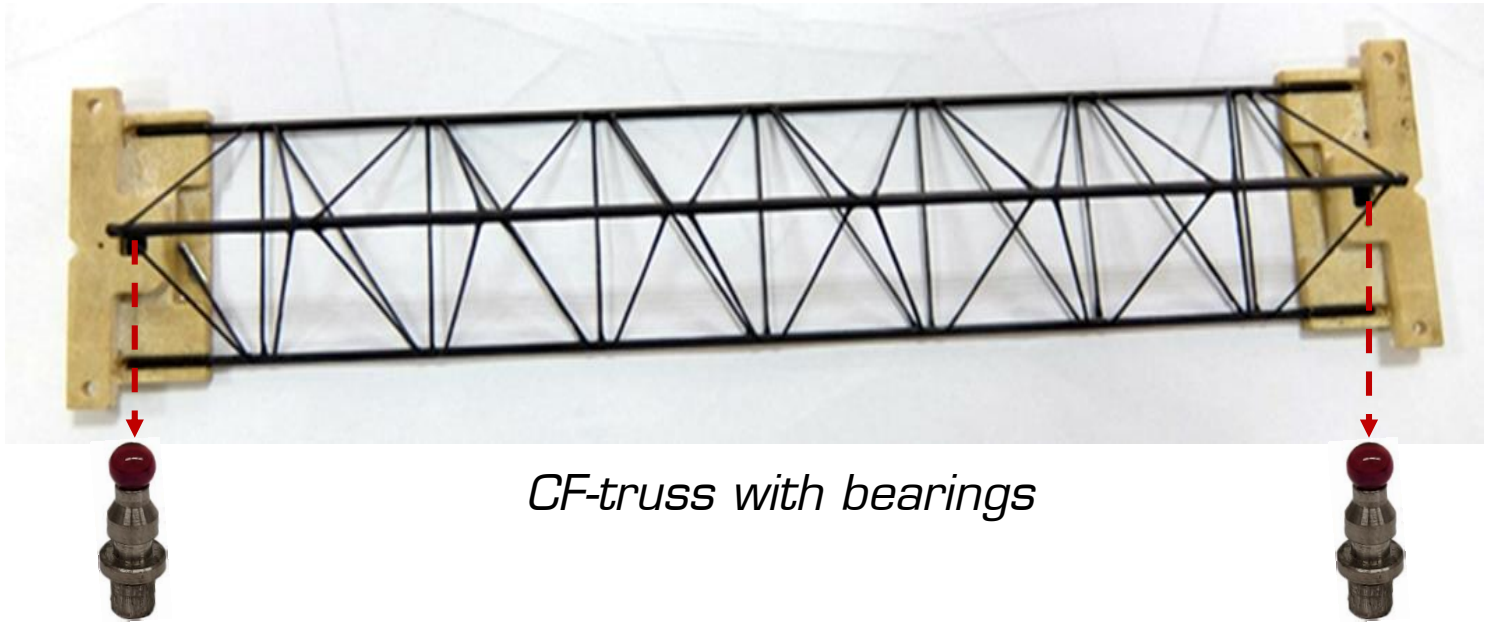


Module D003

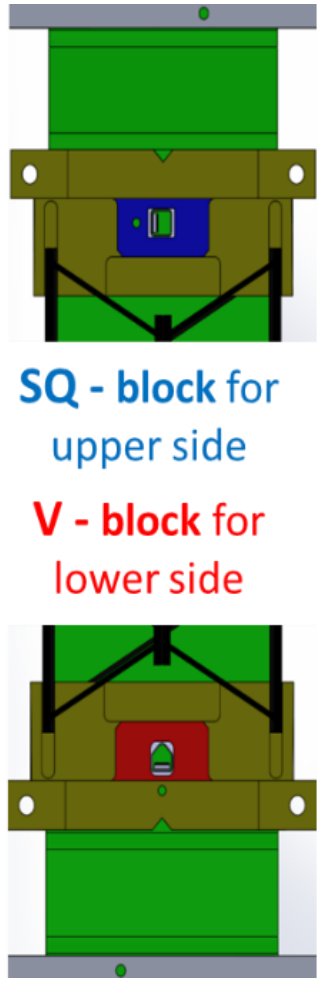
% of not-operable channels per side :

Module	N-side	P-side
M294-2R-212-D004	7 (0.7%)	11 (1.1%)
M294-6r-212-D003	5 (0.5%)	10 (1%)
M294-6r-212-D001	40 (4%)	23 (2,3%)

CF frame and bearings



CF-truss with bearings



- All CF trusses are already produced at CERN and delivered to JINR;
- Jigs for gluing of ruby-ball bearings were developed and produced for all ladder lengths;

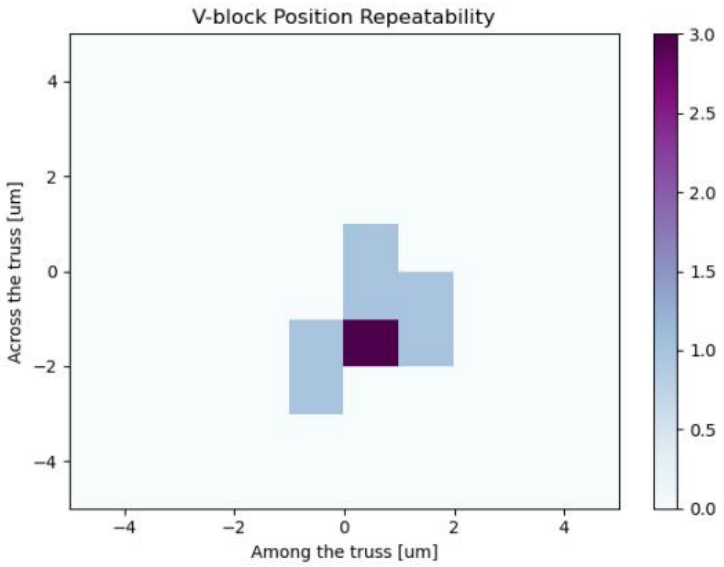
Stuff involved:

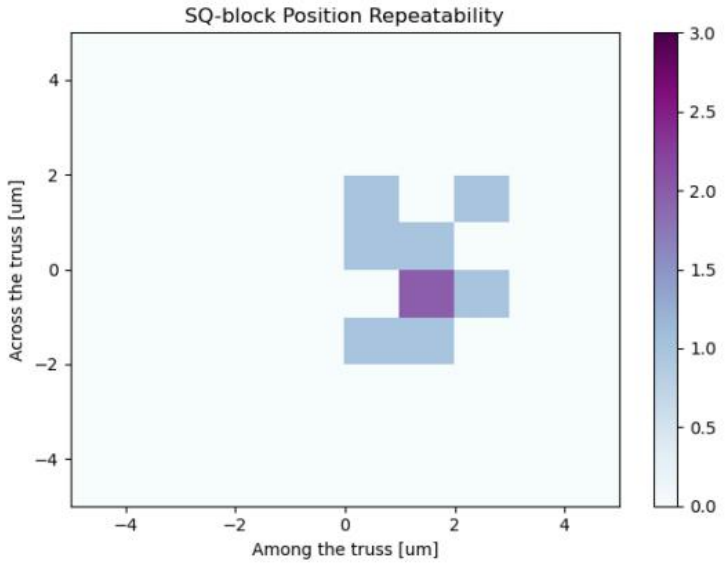
A.Voronin, I.Gorelikov, S. Igolkin as a consultant

Bearings for the precise positioning of the ladder on ruby-balls pins

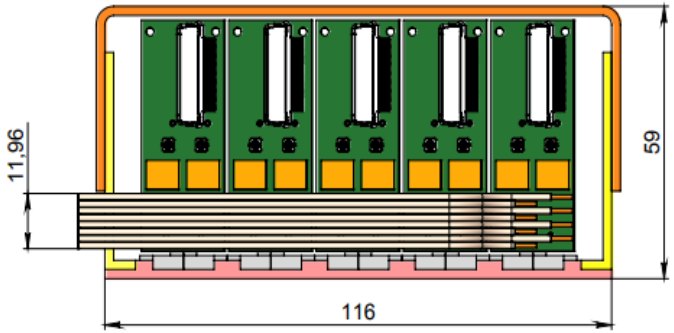
Developed by Van den Brink A.

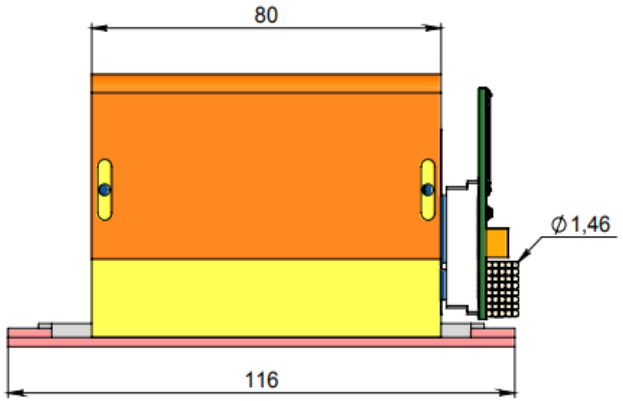
CF-truss position repeatability test

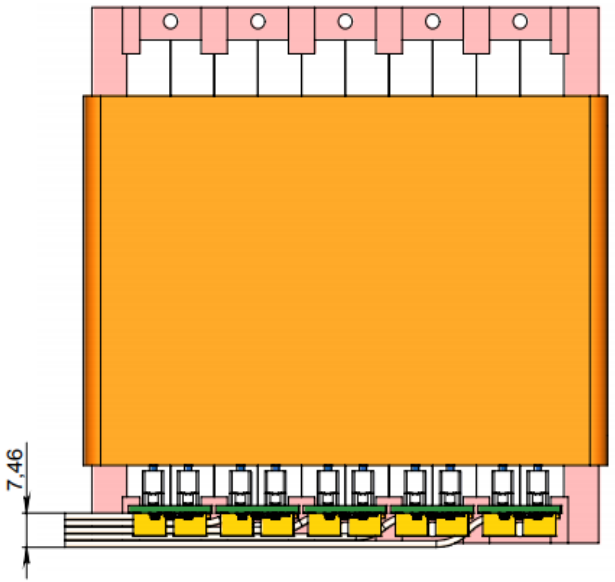


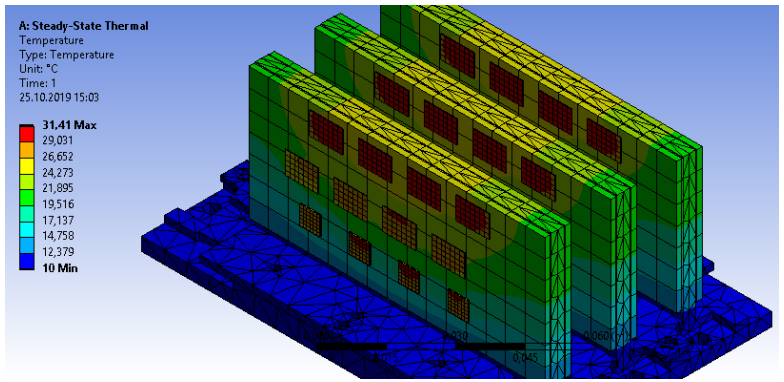


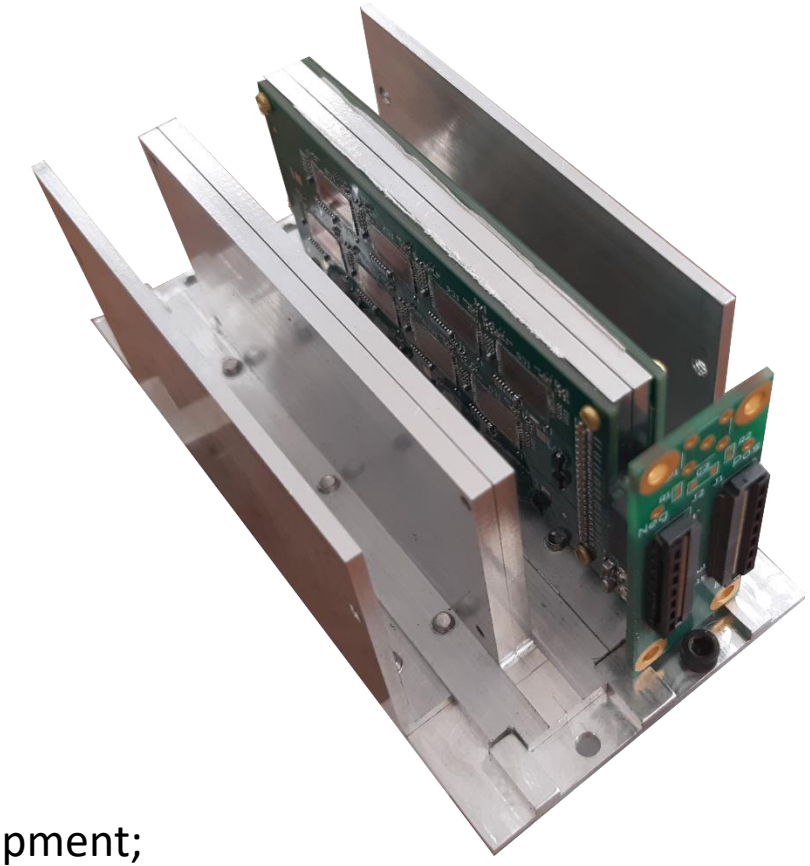
FEB-box









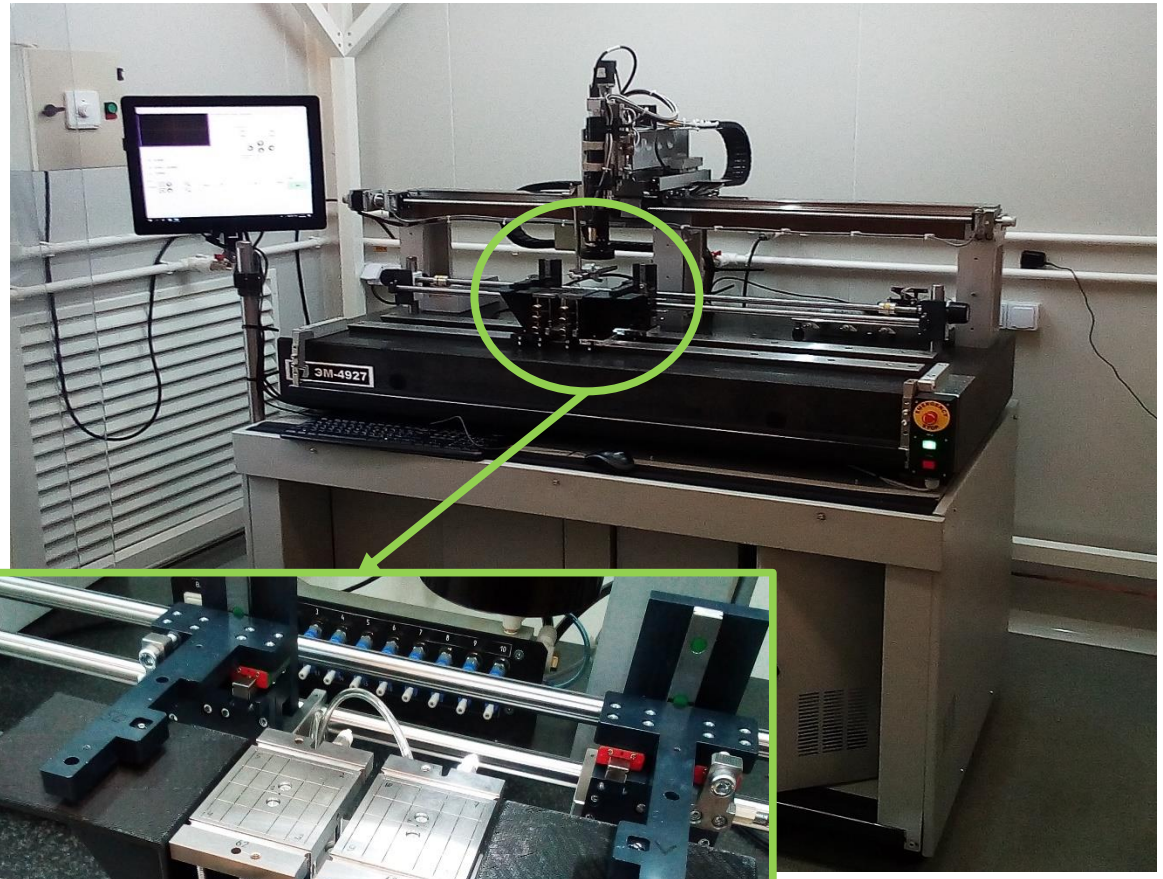


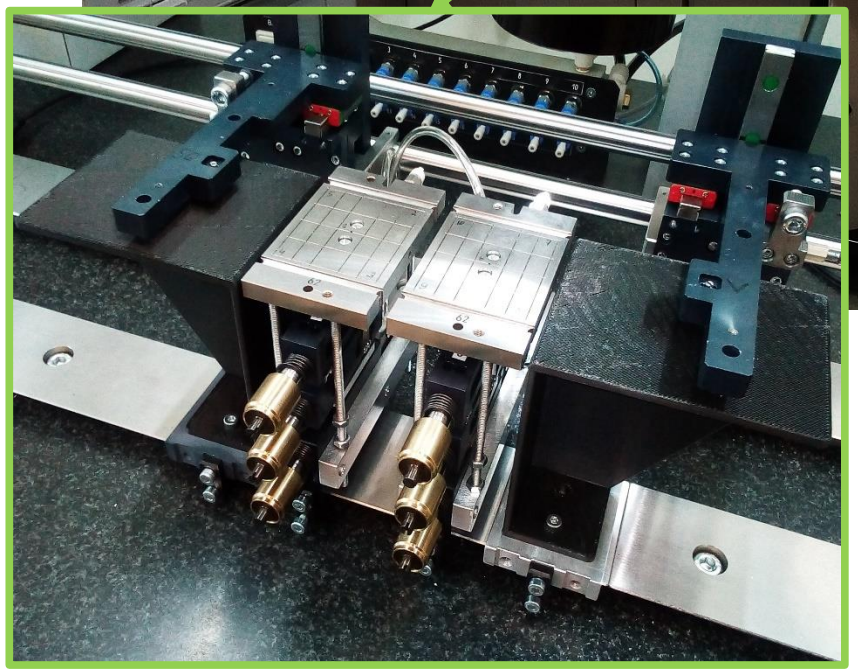
Workforce:

A.Baranov (SINP MSU) - design development;

T.Lygdenova (LHEP) – thermal tests.

JINR Ladder Assembly Device





LAD consists of:

- optical system, which is used for the monitoring of the sensor position in a horizontal plane and has an accuracy of 2µm.
- different sets of sensor positioning tables with micro-screws
- lift unit for the vertical displacement of the ladder sensor supporting CF truss.
- Device is installed on the heavy diabase table to avoid vibrations of the LAD during operation.

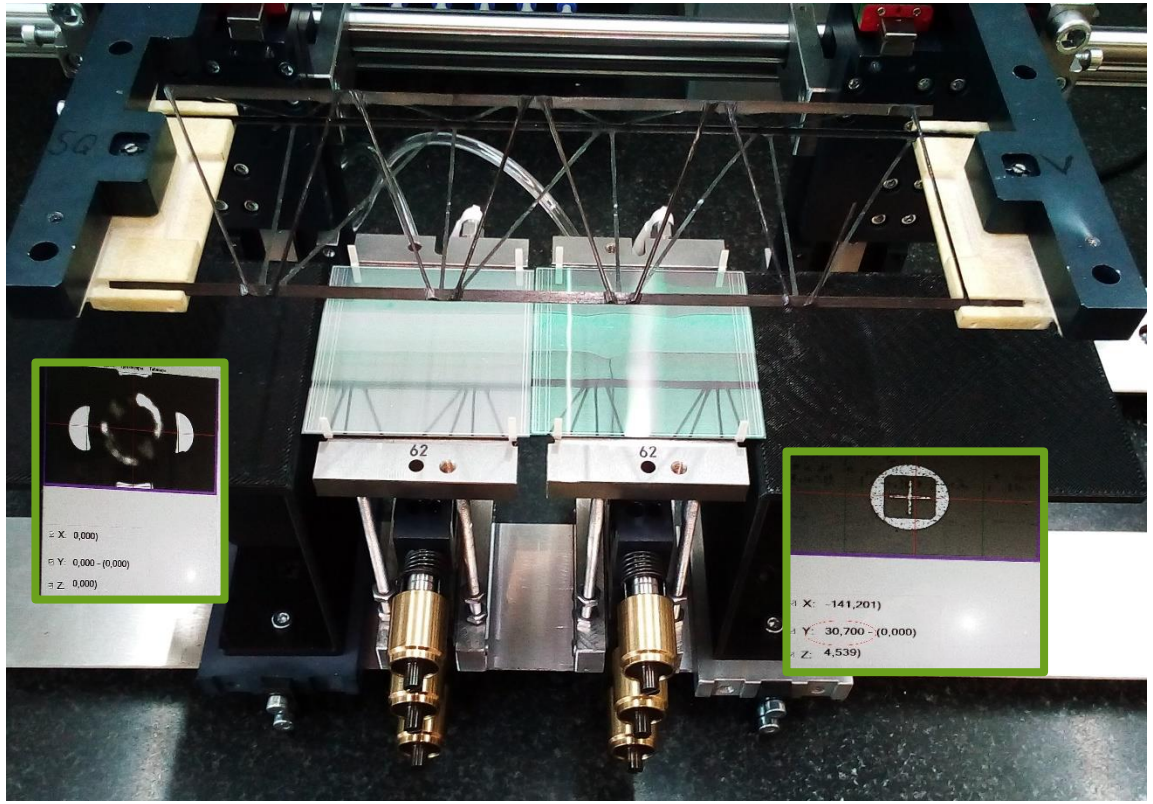
LAD should provide the following accuracy of the sensor positioning:

X coordinate: ±15 µm on 1200 mm along the truss;
Y, Z coordinates: ± 50 µm across the truss;

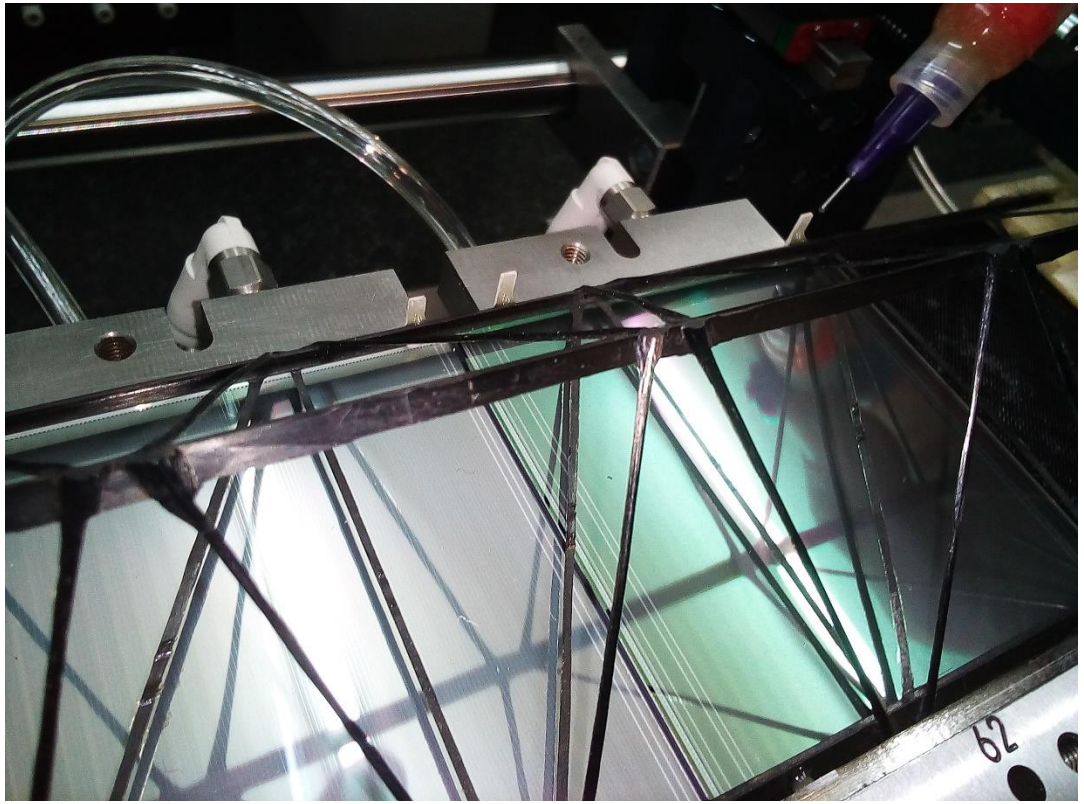
Ladder assembly team:

V. Elsha, A.Baranov

First assembled mockup of the ladder

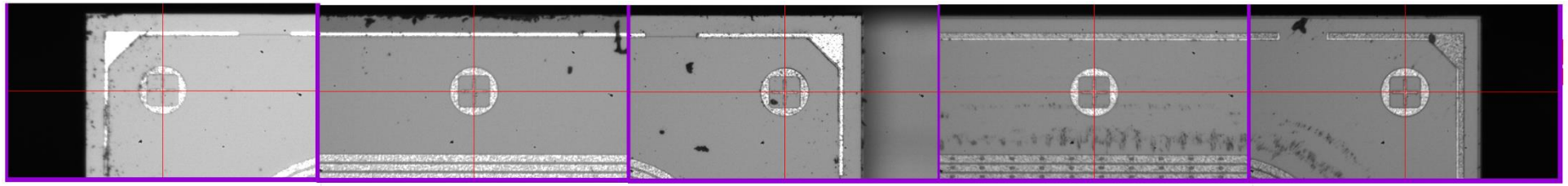


Lifting down the CF frame on pre-aligned sensors

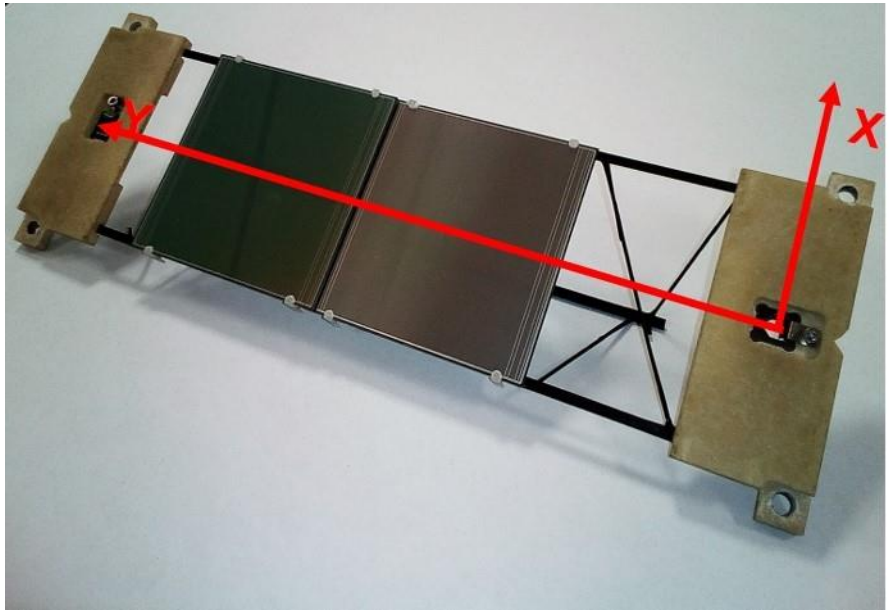


Gluing of sensors to CF truss

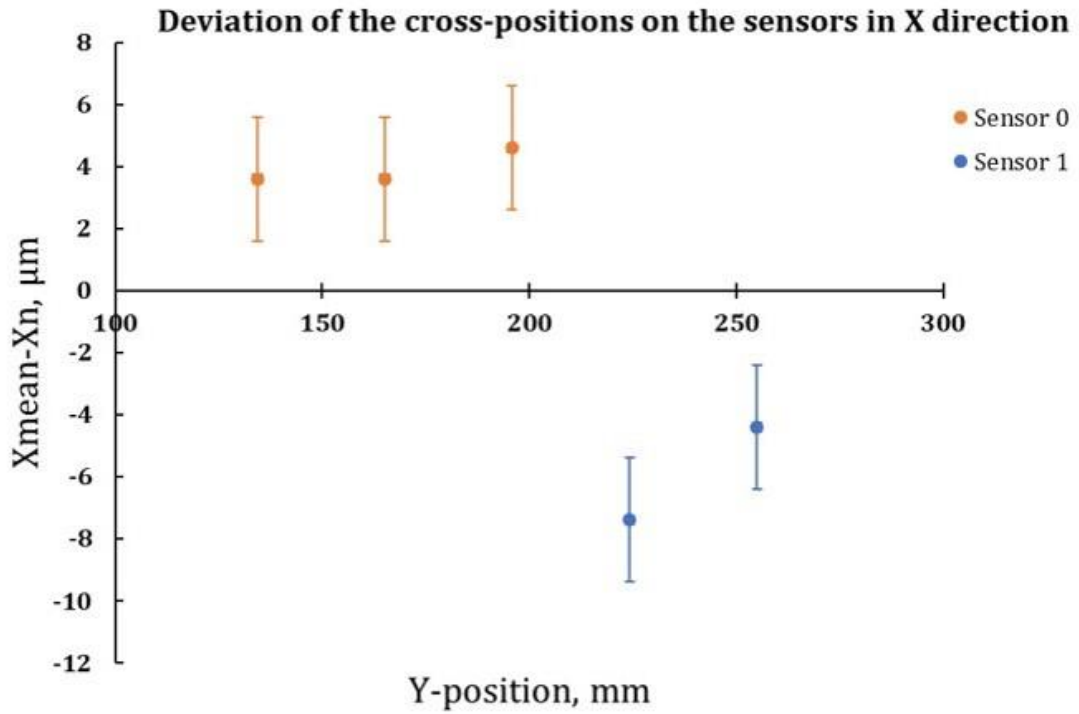
First assembled mockup of the ladder



Fiducial marks on sensors



Mockup of the ladder



Measured deviations of X coordinates of the fiducial marks on the sensors from the mean value.

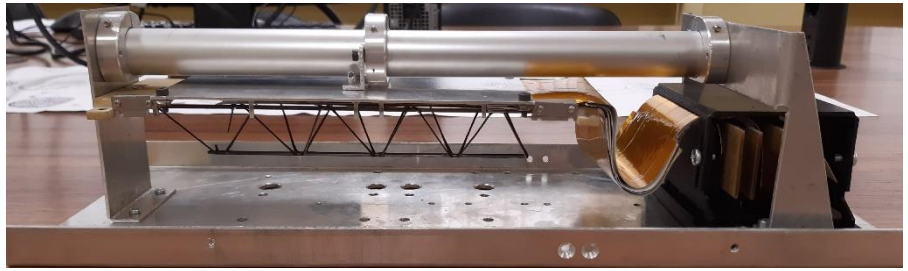
Open tasks

Task	Taskforce
Upgrade of jigs for LAD:	V. Elsha, Planar Ltd
Software developments for LAD:	M. Korolev (SINP MSU), Planar Ltd
Cable-clamp development:	V. Elsha
Development of the ladder-carrying jig:	V. Elsha
Development of the ladder test box	V. Baranov, M. Merkin (SINP MSU)

Delays caused by pandemic control measures in RF:

2.5 month pause in the assembly cite;

Assembly of the mockup of 1st BM@N STS station ladder mockup started this week



Mockup of the ladder-carrying tool

Metrology of assembled ladders

Coordinate-Measuring Machine

Features:

- Measuring area (XYZ): 905 x 2005 x 605 mm
- Equipped with a contact and optical sensor;
- Accuracy ~ 1.8 um;

Current status:

- Delivered to JINR;
- Installation is postponed till 2021 due to absence of available space

Personnel:

- One vacant CREMLINPlus position for the metrology

CMIS

It is composed of the following base modules:

- » Resources Module
  - » Members
  - » Institutes
- » Project Module
  - » Project Definition and Planning
  - » Project Management and Resources
  - » Construction Data
  - » Activities
  - » Finances
  - » Reports
- » Administration
- » Help

People involved:

C.C. Sanchez, E. Tsapulina (LHEP), V. Korenkov, S.Romanov, A.Dolbilov, A.Kondratyev, A. Batuk (LIT)

The Construction Management Information System (CMIS) adopted by the STS department for the NICA projects at JINR, is an Oracle-based all-around project management database system, that allows the organization and follow-up of every aspect of the project.

It will be hosted at LIT JINR and is the same one that is being used by the ALICE collaboration at CERN for the production of the ITS2 and MFT detectors.

Towards first detector ladder

Milestones:

- Mockup of the ladder of 1st BM@N STS station – Oct 2020
- 4 Modules + spare operational and tested for the assembly of 1 STS ladder – Nov 2020
- Operational ladder for the 1st BM@N STS station assembled and tested – Dec 2020

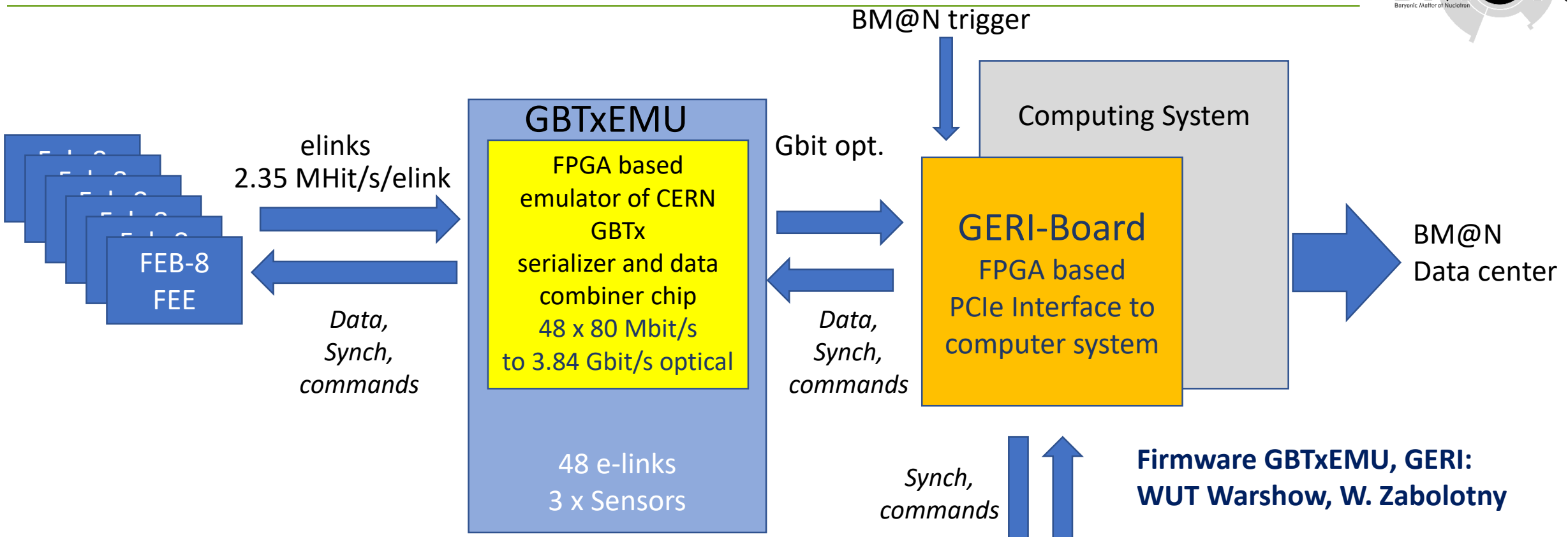
People involved:

- Module assembly: 2 engineers + 2 technicians;
- Ladder assembly: 1 engineer;
- Jigs and S/W developments for LAD: 2 engineers from SINP MSU + Planar Ltd.
- Tests of assembled ladder: 2 PhD students;
- CMIS developments: 1 Postdoc + 1 Engineer.

Personnel hired for CREMLINPlus Task 2.1:

- Ekaterina Tsapulina – engineer
- Tuyana Lygdenova - engineer
- Ilya Gorelikov – technician
- Margarita Perez - technician

Readout chain of BM@N STS



Firmware GBTxEMU, GERI:
WUT Warshow, W. Zabolotny

Firmware TFC:
KIT Karlsruhe, Vladimir Sidorenko

Hardware developments: GSI Detector Lab, JINR, MSU

TFC
Timing and Fast
Control

General requirements

BM@N STS data acquisition chain is based on the readout concept of CBM and is adopted to BM@N requirements.

BM@N experiment:

- 4.5 AGeV Au beam;
- Maximum IR: 5 MHz;
- Trigger rate: 50 kHz;

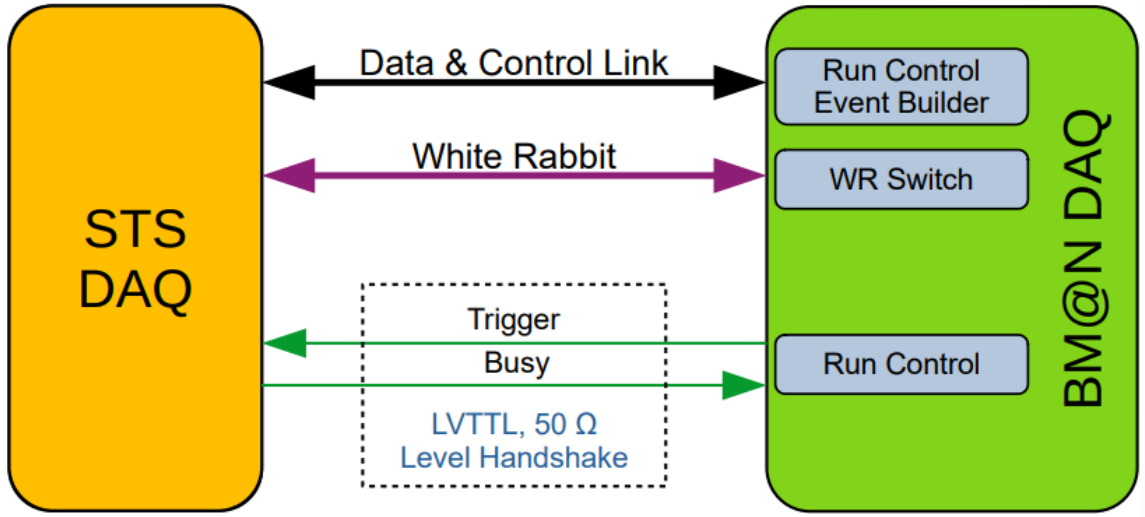
Requirements to the Front-end electronics:

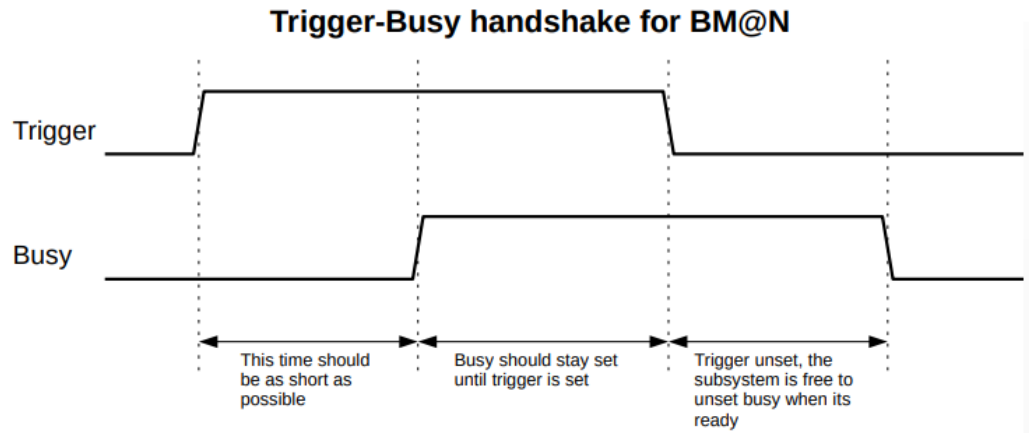
- Maximum strip occupancy is $\sim 5 \cdot 10^{-4}$ per event ⇨ 0.32 Mhit/s – per one STSXYTER ASIC;
- Bandwidth of each STSXYTER ASIC could be decreased down to 2.5 Mhits/s in comparisson to 50 Mhits/s in CBM;
- Total number of channels ~ 600k;
- Signal integrity of the data transmitted via 10 m copper cables between on-detector electronics and GBTxEmu boards

Requirements to the processing chain:

- Emulation of GBTx functionality on FPGA;
- Trigger-based readout with a trigger latency of 5 us;
- Synchronization of STS timing system with the one used in BM@N within 1 ns accuracy;
- Data packaging into MPDRawData format.

Integration of STS readout into BM@N DAQ





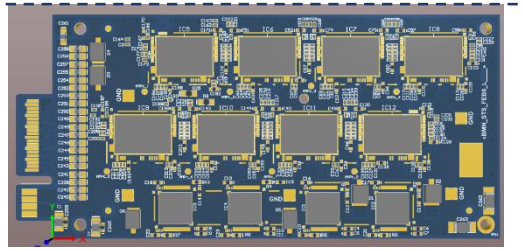
Slide by A. Baskakov from 5th BM@N CM

STS integration requirements:

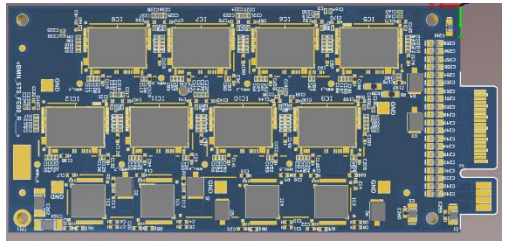
- Data & Control link from BM@N Run Control and Event Builder software
- White Rabbit Link
- Two 50 Ω coaxial connectors for trigger distribution and busy collection;
- Data packed in MPDRawData format
- Time synch between BM@N DAQ and STS DAQ within ~1 ns

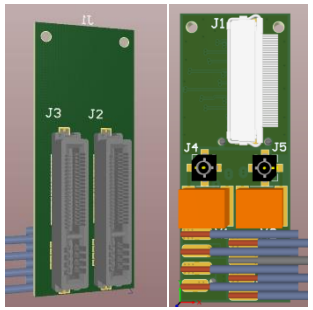
STS needs 40 MHz reference clock;
BM@N WRS could provide 10 MHz (or 125 MHz) clock + PPS

Readout chain



BM@N FEBs

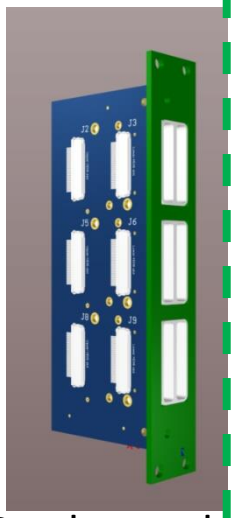




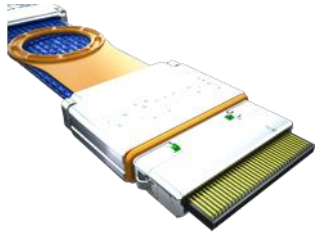
FEB-panel

FEB box

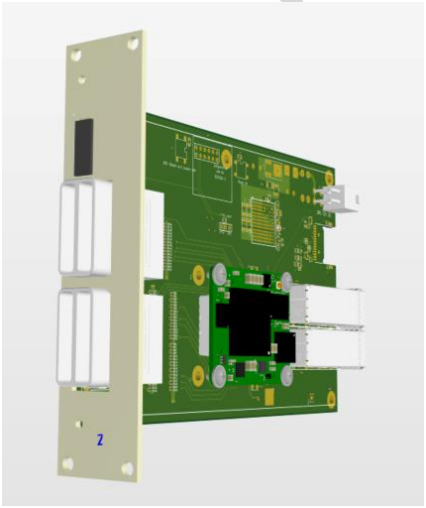
Microcoax cable
~0.7 m long



Patch panel
STS box



Twinax cable
~10 m long



GBTxEmu in crate

Tasks:

- PCB design developments (FEBs, FEB-panel?):
  - Front-end boards;
  - FEB-panels and patch panels;
  - New design of GBTxEmu board;
- Development of FEB connectivity scheme;
- Optimization of the noise performance;
- S/W Developments:
  - Configuration routines;
  - Data analysis.
- Integration aspects: BM@N DAQ group

Taskforce:

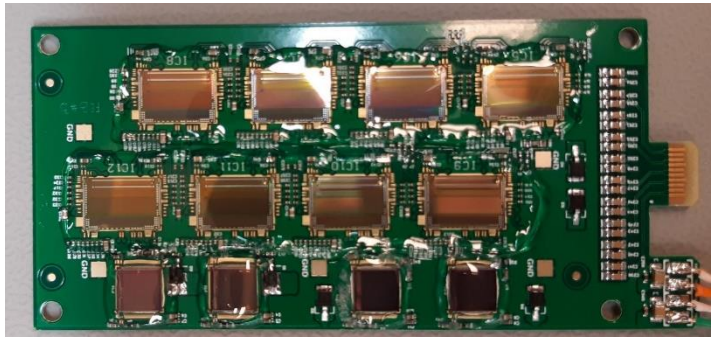
JINR: D.Dementev, M. Shitenkow, N.Sukhov, V. Leontyev
SINP MSU: A. G.Voronin, I. Kudryashov,
Maraphon Ltd.

CREMLINPlus open positions:

S/W engineer;
H/W engineer;

BM@N FEB developments

Comparison of two FEB geometries



1x Downlink – 40 Mb/s
1x Clock - 40 MHz

8x Uplinks – 80 Mb/s

~ 10 m electrical connection to GBTxEMU

Features:

- Size: 87*40 mm^2;
- Thickness with components: 3 mm;
- Edge-type connector with two pin groups: [HV, LV] & [DATA]
- 1 Uplink per one ASIC

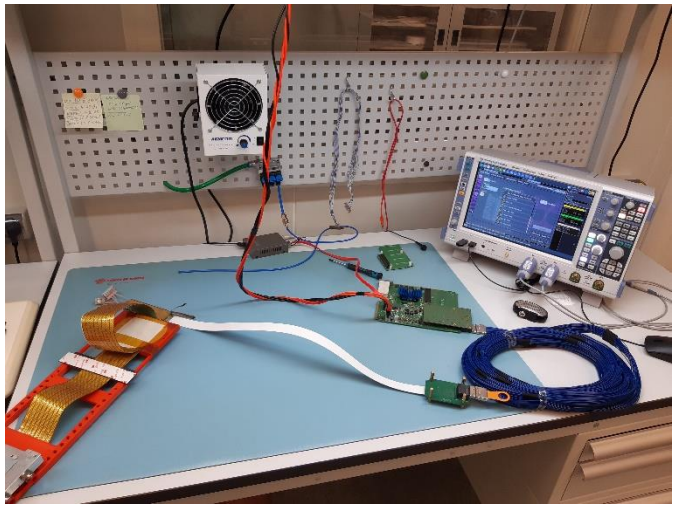
Advantages:

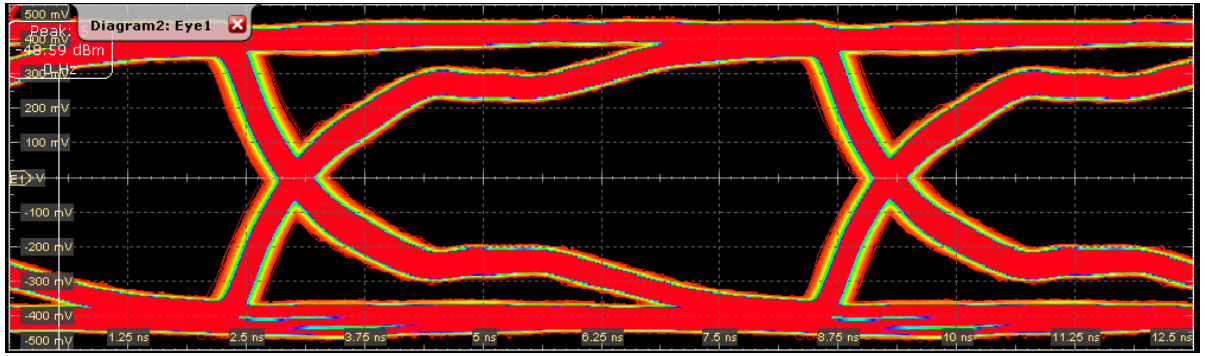
- Increased space for the cabling between FEB-boxes;
- 90 bending of cables is not needed ;
- Easy connectivity with a FEB-panel;
- Low thickness of the board allows to increase thickness of the cooling fin for one FEB up to 3 mm.

Current status:

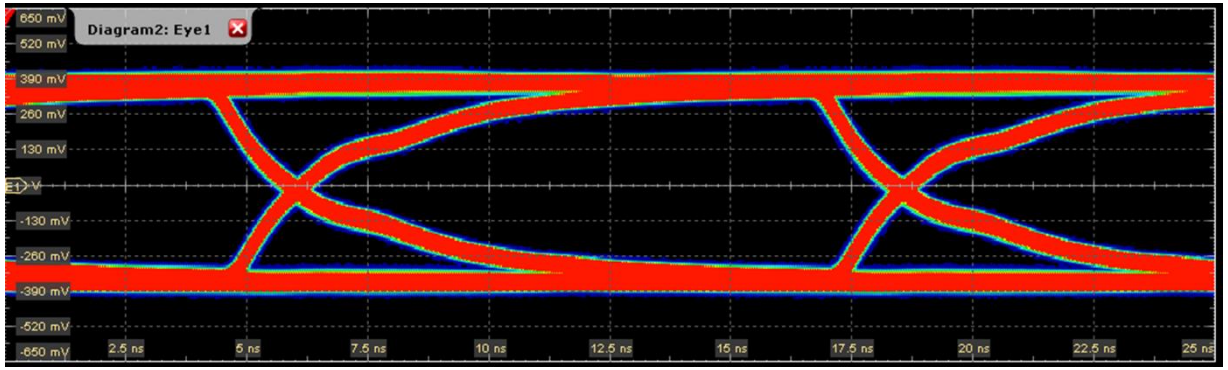
- First prototypes are developed and tested;
- New design is now ready;
- New FEB boards will be available in October

FEB connectivity

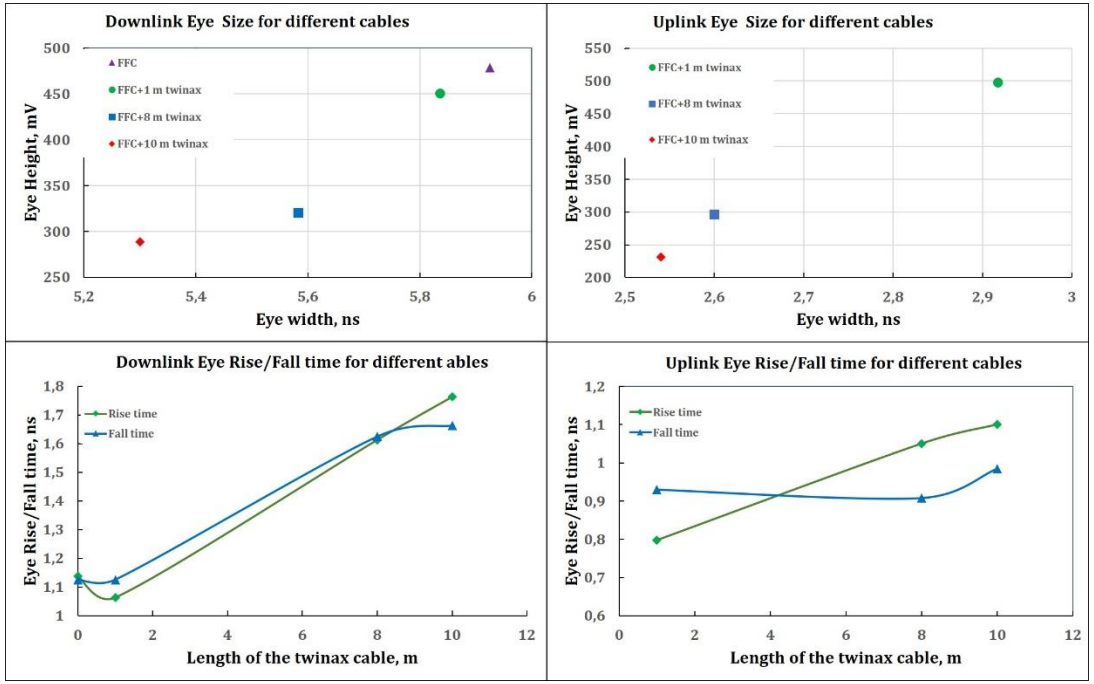




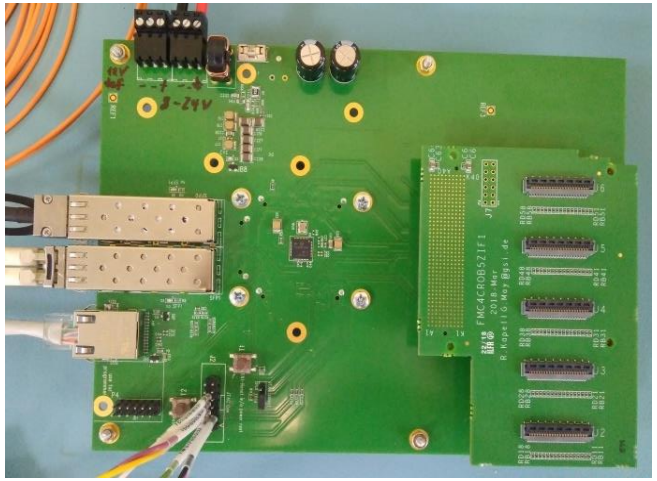
Eye diagram of the Up-link signal at 160 MHz Clck



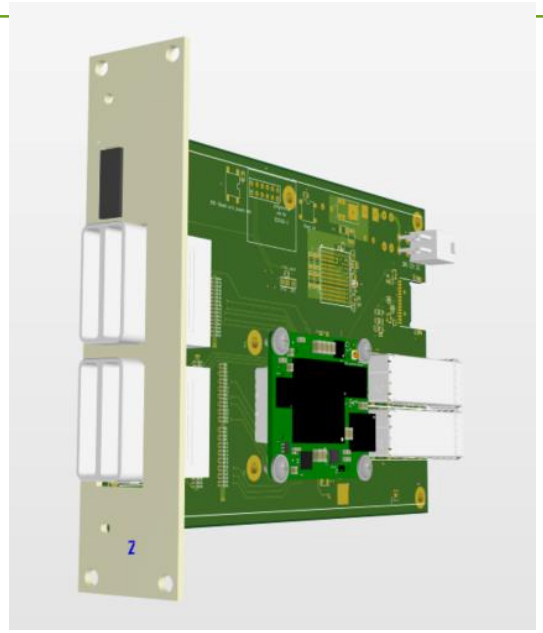
Eye diagram of the Dwn-link signal at 80 MHz Clck



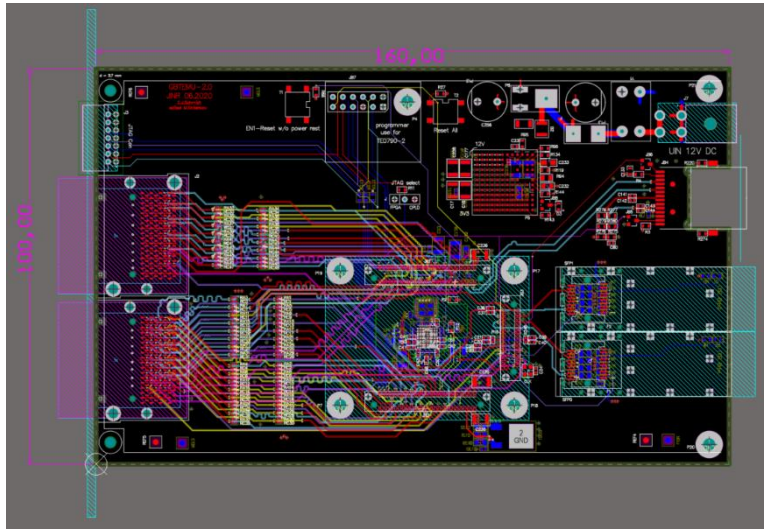
GBTxEmu board



GBTxEmu board developed at GSI



GBTxEmu board being developed at JINR



Features:

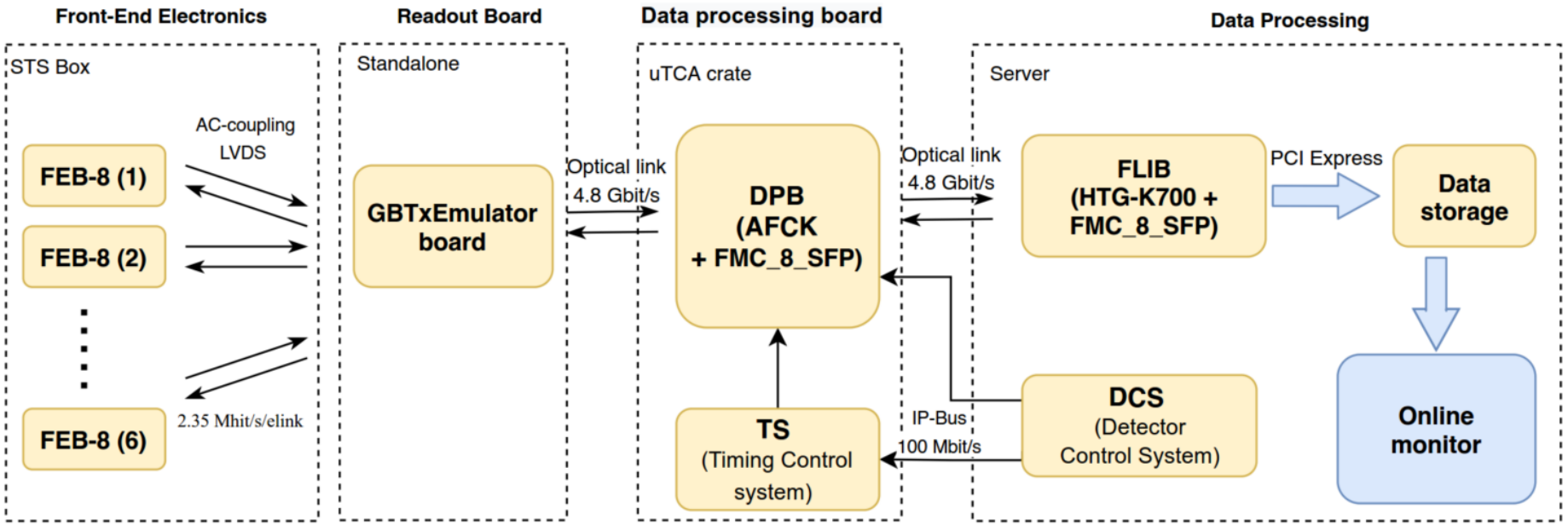
- 12 layers PCB design;
- 3U crate format;
- HDI6 connectors instead of mezzanine card;
- Minimal number of s/w modifications are needed according to the prev. h/w platform

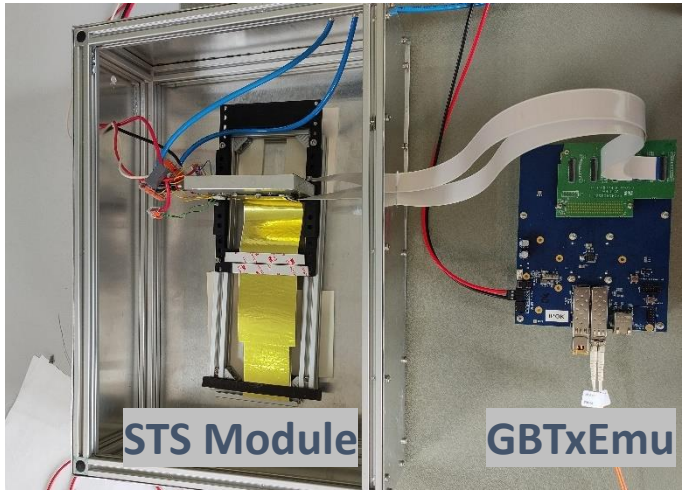
Status:

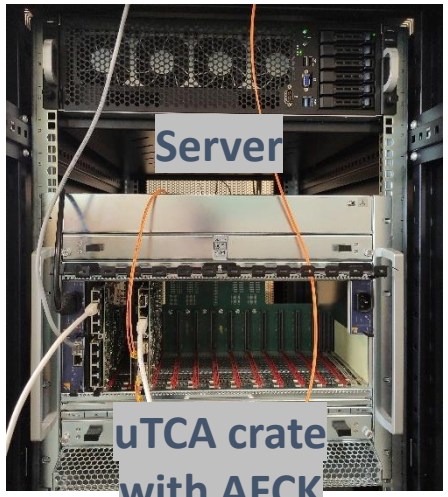
- Preliminary PCB Design is ready;
- First boards on the table – November 2020

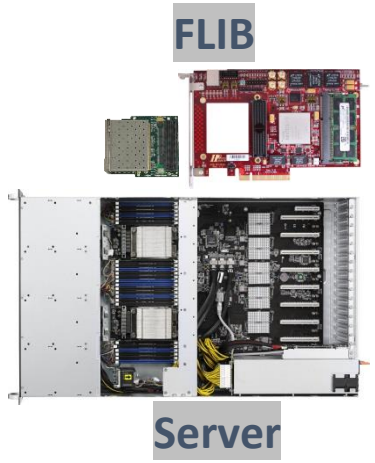
By M. Shitenkow

Current version of the readout chain for one module









Slide by M. Shitenkow

Timelines

- 2022 – pilot v. of STS based on two stations with 42 modules
- 2023 – readout chain for 292 modules

Delays of the project caused by pandemic control measures in Russia – ½ year

- Tests and optimization of the FEB-GBTx connectivity: Q4/20;
- BM@N FEB8 – start of serial production: Q1/21;
- GBTxEmu for the pilot v.: Q2/21

Thank you for your attention!

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