# SILICON TRACKING SYSTEM FOR THE BM@N

Yuri Murin for the CBM-BM@N STS team

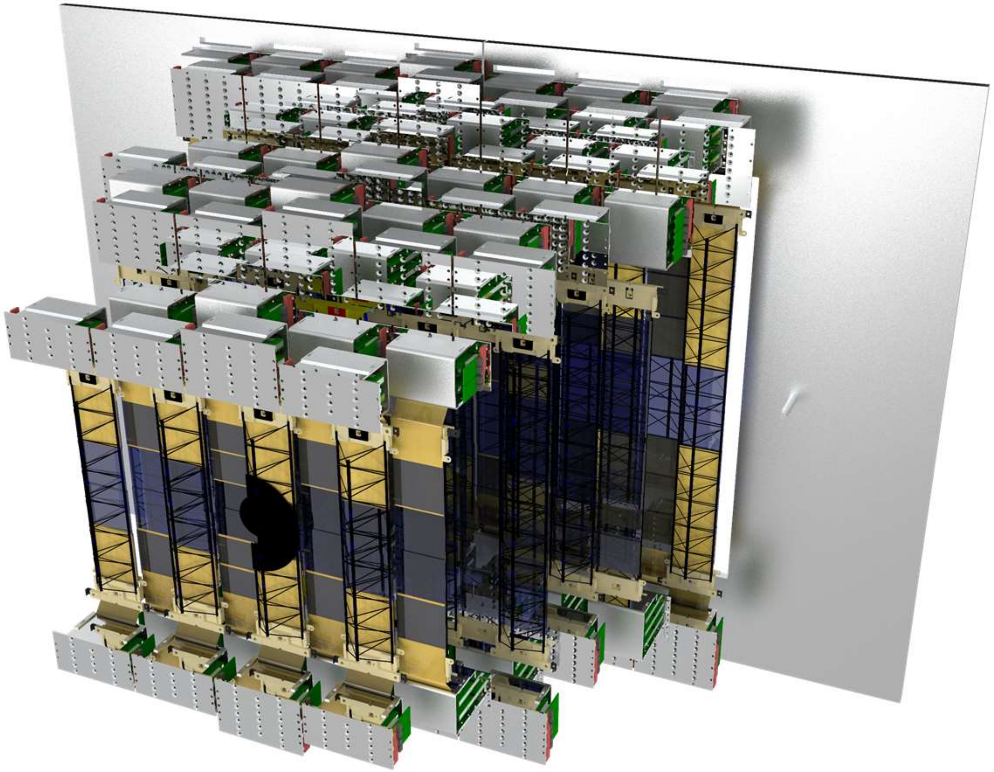
*"7th BM@N Collaboration meeting",*
*19-20 April 2021,*
*VB LHEP, JINR, Dubna*

RUSSIAN FOUNDATION FOR BASIC RESEARCH
RFBR
№ 18-02-40047
№ 18-02-40113

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

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 871072

# Outline



- ❑ Historical Background
- ❑ Major Achievements
- ❑ Current Status
- ❑ Planning and timeline of delivery
- ❑ Existing risks and ways of mitigating
- ❑ Concluding remarks

# Historical Background

2006-2008
ITSC grant – CBM-ITS Consortium
(CBM grant support)

2008-2014 (GSI and JINR support – first clean room equipped for GSI money and start of R@D on basic components)

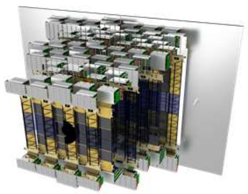
2014- current time (Continuation of R@D," death" of the consortium on R@D, preparations for serial assembly of modules, split of activities related to CBM and BM@N;
JINR and BMBF support, RFBR and EC grants)

Optional:
2022 – STS v.2.0
2023– STS v.4.0
2023-24 – ITS-OB

BM@N
Forward Si

Close to completion

BM@N-STS



Production to start this year

MPD-ITS

In initial stage

## Milestones of the Project

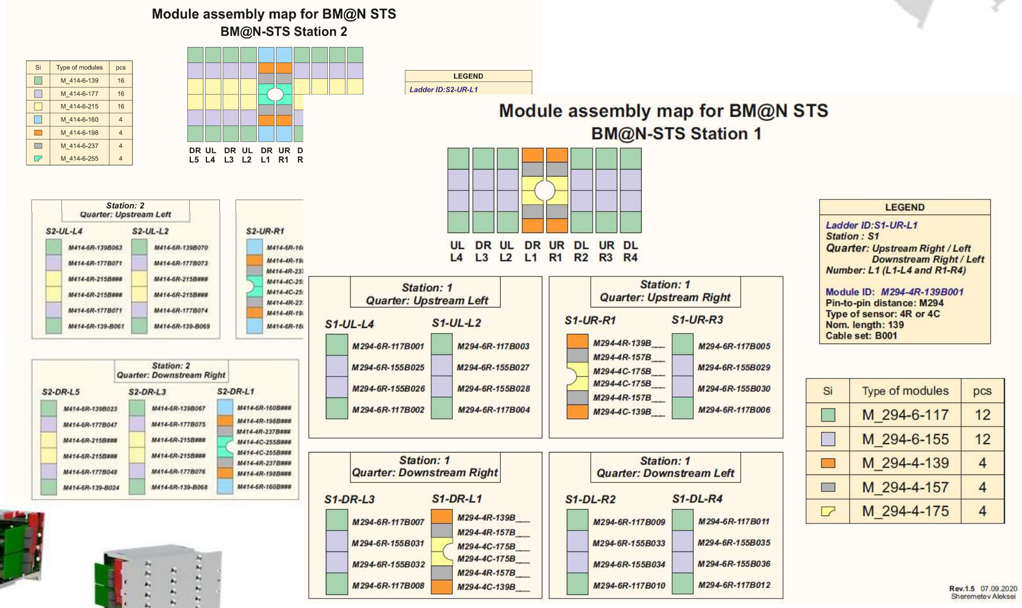
- ❑ Start at 2006 followed by sustainable growth with support of CBM
- ❑ 2008: Organization of the CBM-MPD STS Consortium for joint R@D on components
- ❑ 2014: Recognition by JINR management after getting direct financial contribution of GSI in LHEP infrastructure and building the first clean room at LHEP
- ❑ 2014: Organization of the STS Department at LHEP
- ❑ 2018: Protocol on MAPS ITS technology know-how transfer with CERN as the basis for the MPD-ITS project

2019: "Split" with the CBM STS and start a work on the BM@N version of FEBs, modules, ladders, etc. and their connectivity

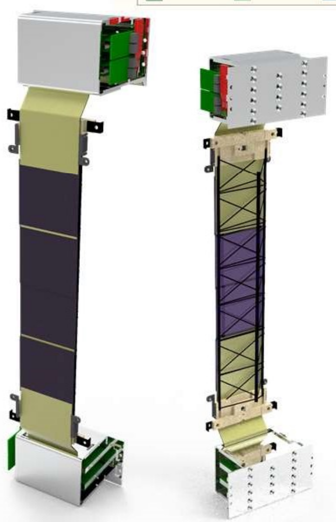
2021: Getting financial support from EC through CREMLINplus grant agreement for hiring new personal and activation of the in-kind contribution of BMBF to NICA @21,5 M EUR, getting close to production readiness

# BM@N STS Stations

- **4x** - Stations;
- **16x** - CF-Frames
- **34x** - Ladders;
- **292x** - Silicon strip modules.

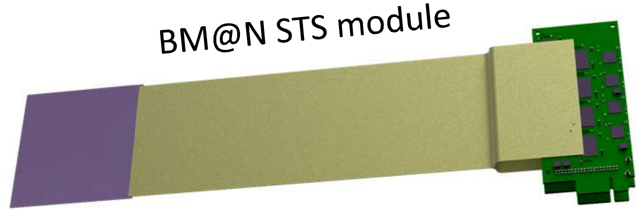



BM@N STS Station



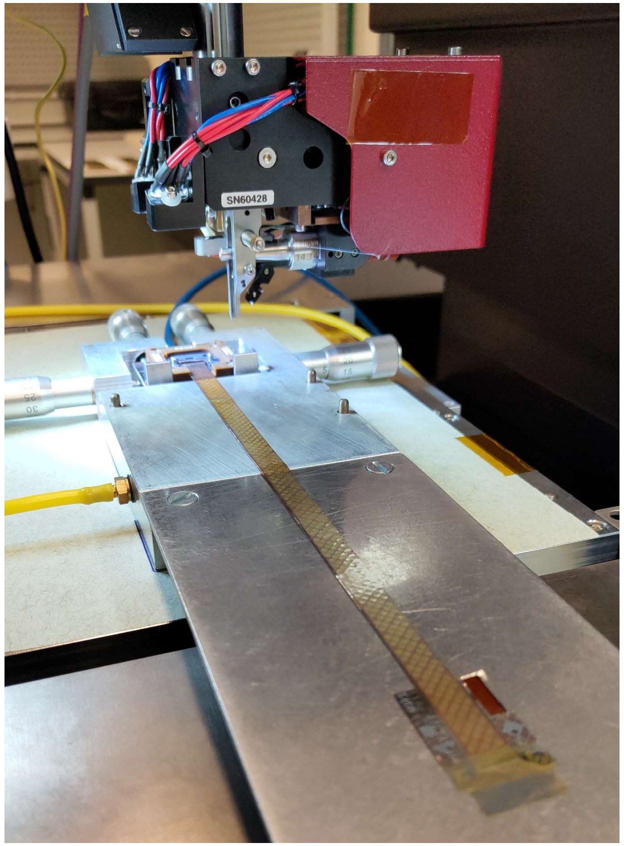
BM@N STS Ladder

BM@N STS module

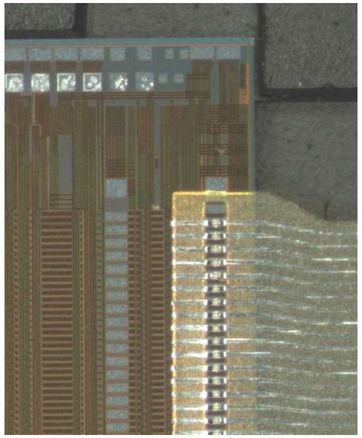


# Assembly of  modules                                   1/2

A.Shereremtiev, N. Sukhov, T.Andreeva, T.Semchukova, M.Shitenkow

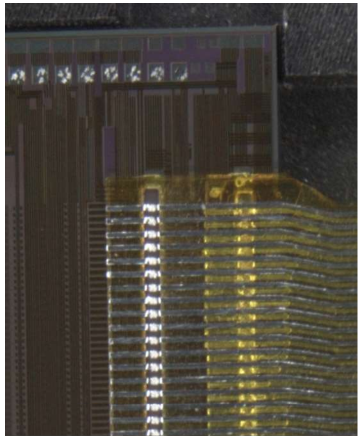


Ultrasonic assembly process
on TAB-bonding machine

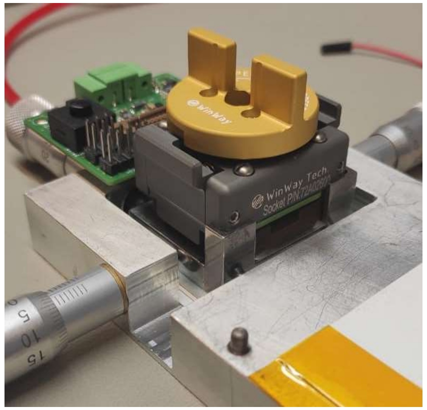


TAB - Bonding result
of 1-st row of contacts

Encapsulation of 1-st row
of contacts

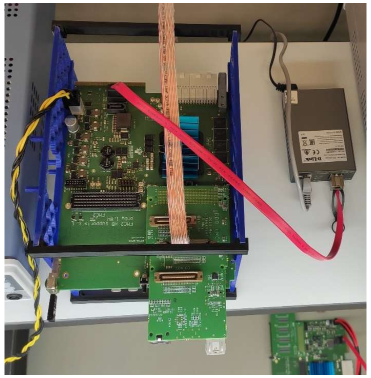


TAB - Bonding result
of 2nd row of contacts

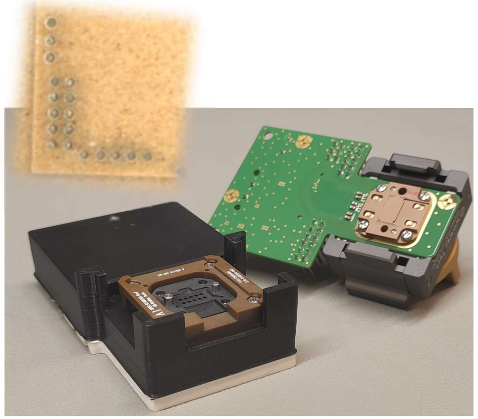


# Assembly of modules 2/2

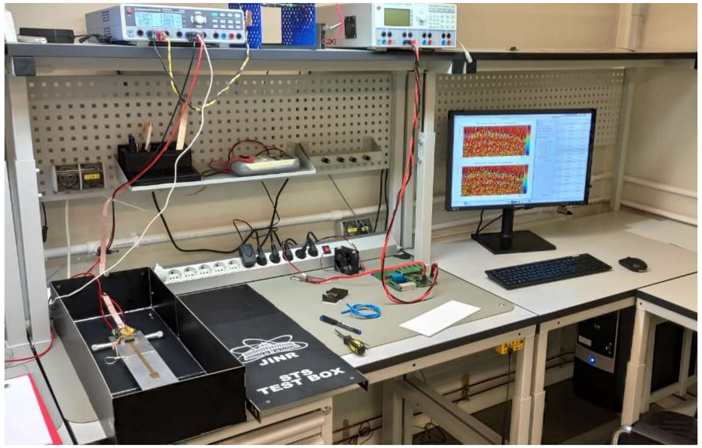
A.Shereremtiev, N. Sukhov, T.Andreeva, T.Semchukova, M.Shitenkow

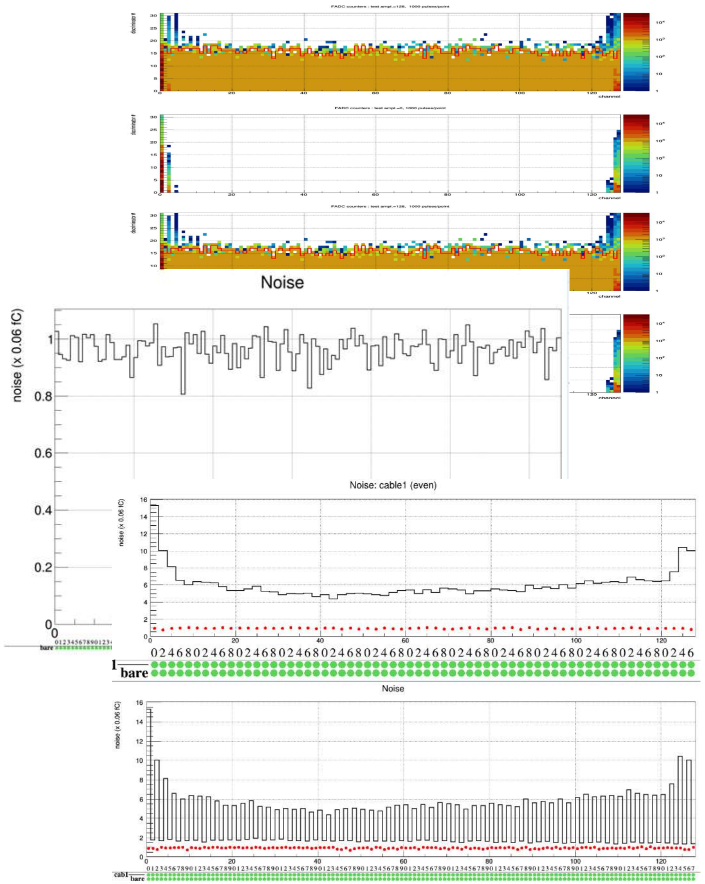


AFCK board v.1.1 and FMC board

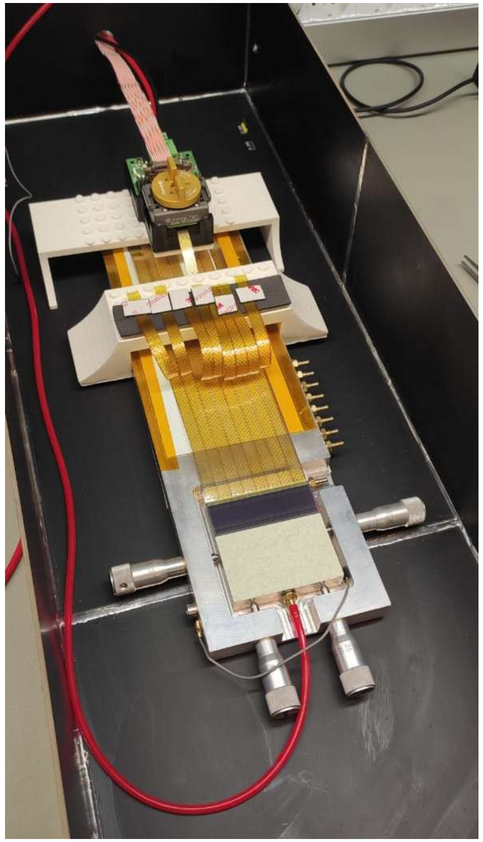


Winway socket PogoPin device (GSI)



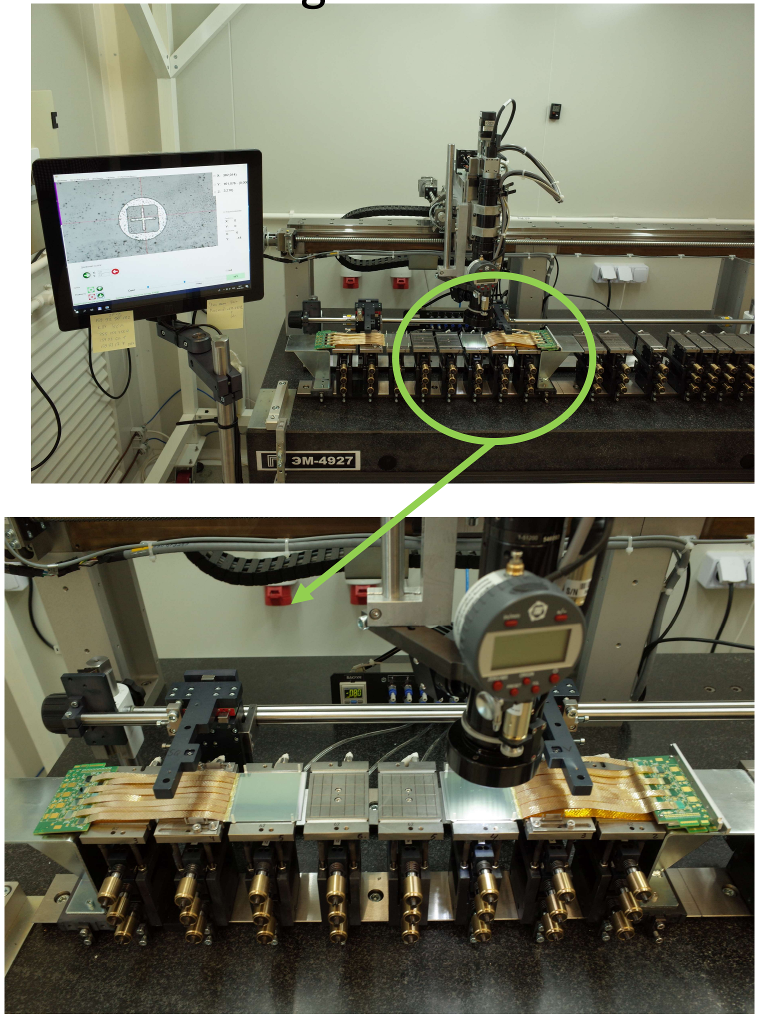

GUI of Test Program by **A. Kolozhvari** (JINR)



Bonding QA tests of 1st row on sensor

# Ladder Assembly Device

## custom-designed and manufactured  by PLANAR ltd, Minsk




**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.

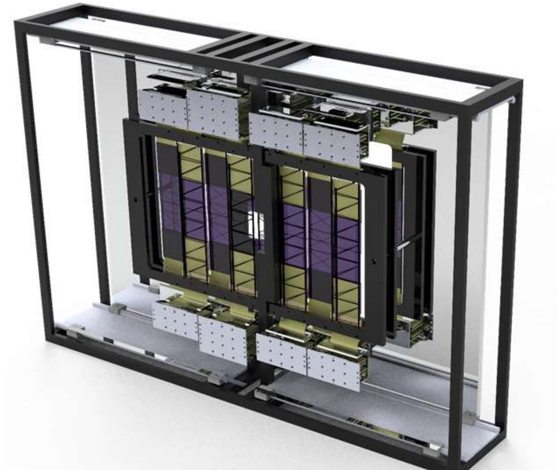
**LAD should provide the following accuracy of the sensor positioning:**

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

**Ladder assembly team:**
**V. Elsha**, N.Sukhov, M.Korolev (MSU)

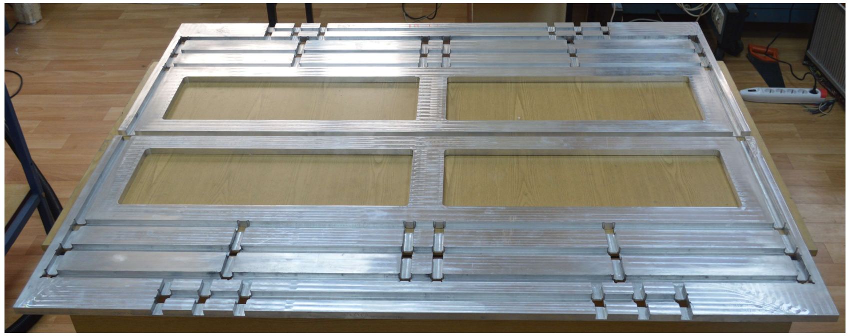
# STS Mainframe to favour repearability

Schematic view of the Mainframe

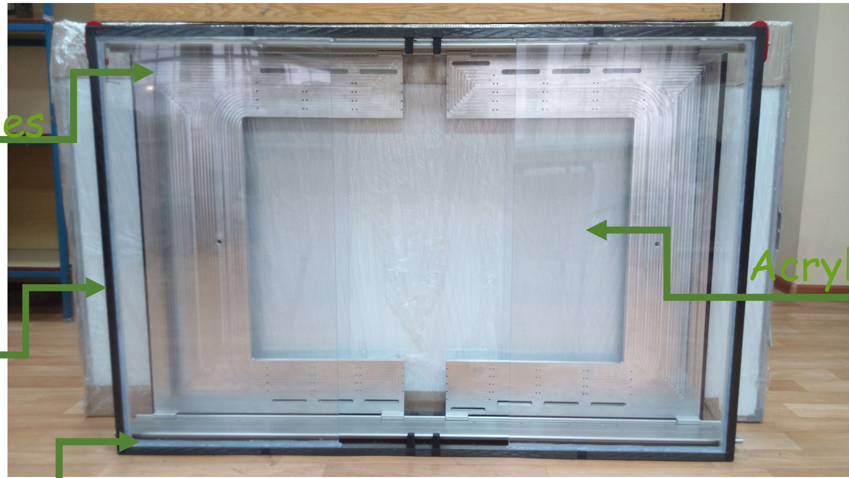


Station in the Mainframe

*Tentative design and feasibility demonstrations of key properties are carried out by MSU group , M.Merkin with approach different from the CBM STS*

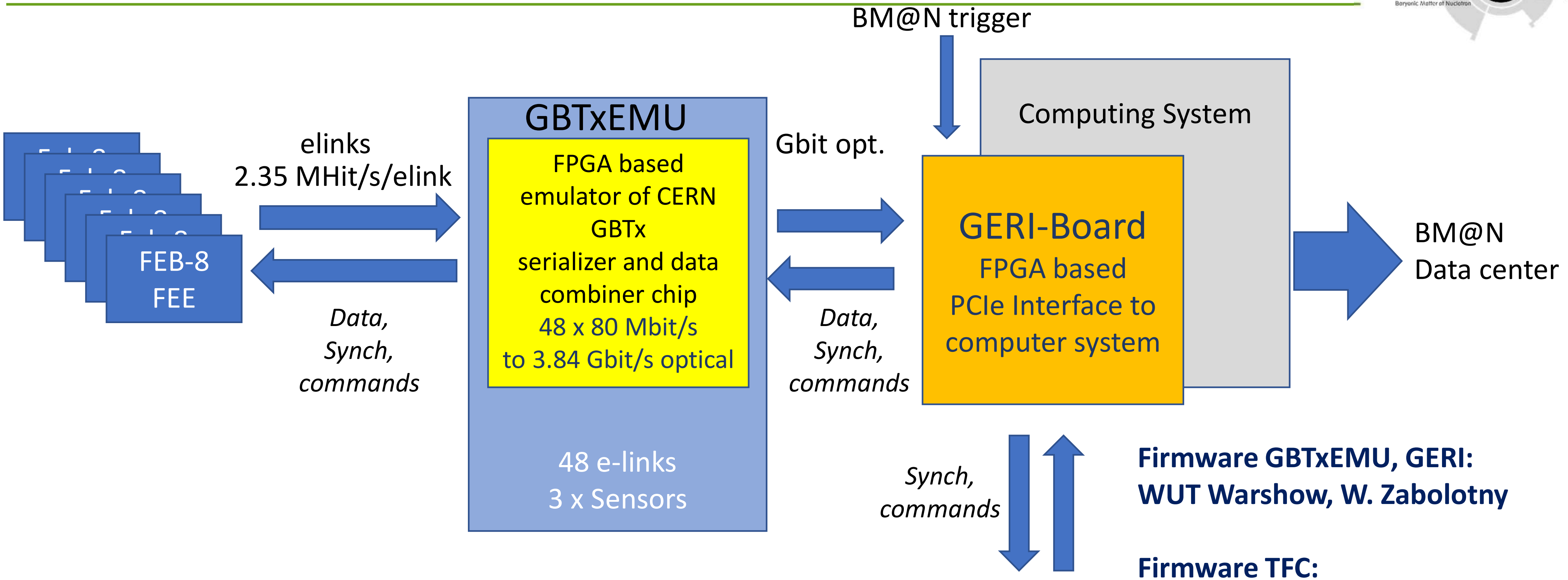


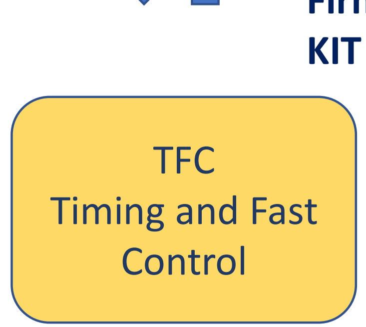
**Master-Jig for the assembly of CF Mainframe**




**Mainframe prototype with 2*Al. C-frames**

# Readout electronics as a major stopper



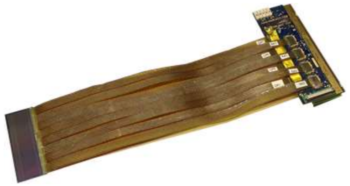

**Firmware GBTxEMU, GERI:**
**WUT Warshow, W. Zabolotny**

**Firmware TFC:**
**KIT Karlsruhe, Vladimir Sidorenko**

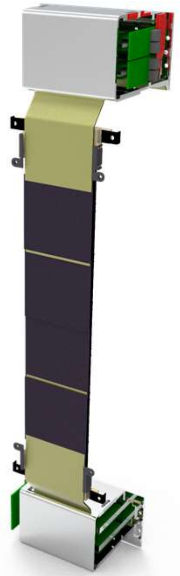
**Initially designed by CBM for 10 MHz HI collision frequency is being adapted for use in Russia at 50kHZ**

**<u>JINR team:</u>**
**D.Dementev**, M.Shitenkov, Raul Arteche is  joining in!

# Basic elements: Estimation of Readiness for Production

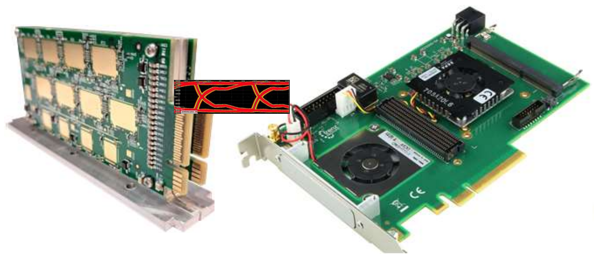


292 x Modules
90%
i. 3-d generation of jigs and fixtures
ii. Expansion of clean area



34 x Ladders
70%
i. Demonstration of productivity
ii. Optimization of jigs

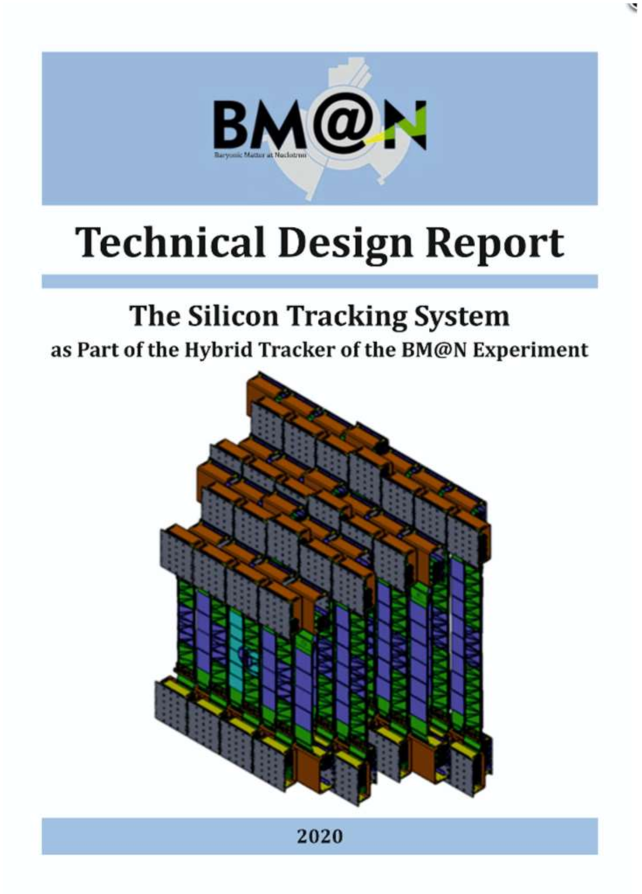
STS mainframe with in-build liquid and gas cooling systems
25%
i.Demonstration of positioning accuracy and stability of the system with cooling system builtined



Electronics for fast data readout to the nodes of the on-line farm
25%
i. Finalization of firm ware development
ii. Demonstration of functionality at laser testbench, with cosmic rays, and during in-beam tests

Service equipment: freon and dry air cooling plants
0%
i. Procurement of equipment
ii. Demonstration of functionality
Iii. DCS with WinCC OA SCADA

# To Do List for 2021-2022




**Reached or almost reached:**

- *The TDR on STS (completed)*
- *Finalization of R@D on modules and supermodels (the ladder) (to be completed within a quarter)*
- *Technology for module assembly including step-by- step QA control ( to be completed within a quarter with final generations of fixture sets)*

**Still in reach:**

- *Finalization of the readout chain development and demonstration its feasibility to the requirements of BM@N DAQ system*
- *Mainframe mechanics (coolling sinks and gas nodes to be inbuilt, stability of with full cable connectivity demonstrated )*
- *Power supply and cooling system basic equipment acquired and installed*
- *DCS with WinCC OA SCADA implemented both for power supply and cooling plants*

http://www1.jinr.ru/Books/The%20Silicon%20Tracking%20v System_sajt.pdf

# Planning and time delivery

*Laser (ourselves) and cosmic rays( together with BM@N-GEM)*

- ❑ **Bench tests**

*Telescope of 3 modules plus reference detectors for demonstration of integration to the triggered small system*

- ❑ **Run #1 with light ions**

*Two-three ladders for noise and cross talk optimization*

- ❑ **Run # 2 with light ions**

*Quarter of a station test with final cooling systems implemented*

- ❑ **Run #3 with light ions**

*Two plane system for final adjustments*

- ❑ **Run # 4 with heavy ions *)**

***) optional**

# Risks and ways for their mitigating

*Improvement of delivery coordination and efficiency of procurement procedures*

- ❑ *Module components flow from GSI budgeted by GSI delayed*

*Improvement of coordination with technical groups of BM@N*

- ❑ **Sudden technical problems with integration with BM@N**

*Hiring of personal with CREMLINplus financial support*

- ❑ **Lack of software engineers**

# Conclusions and thanks

- **2**x - Stations;
- **18**x - Ladders;
- **100**x - Silicon strip modules.

❑ **2022**

- **4**x - Stations;
- **34**x - Ladders;
- **292**x - Silicon strip modules.

❑ **2023-2024**