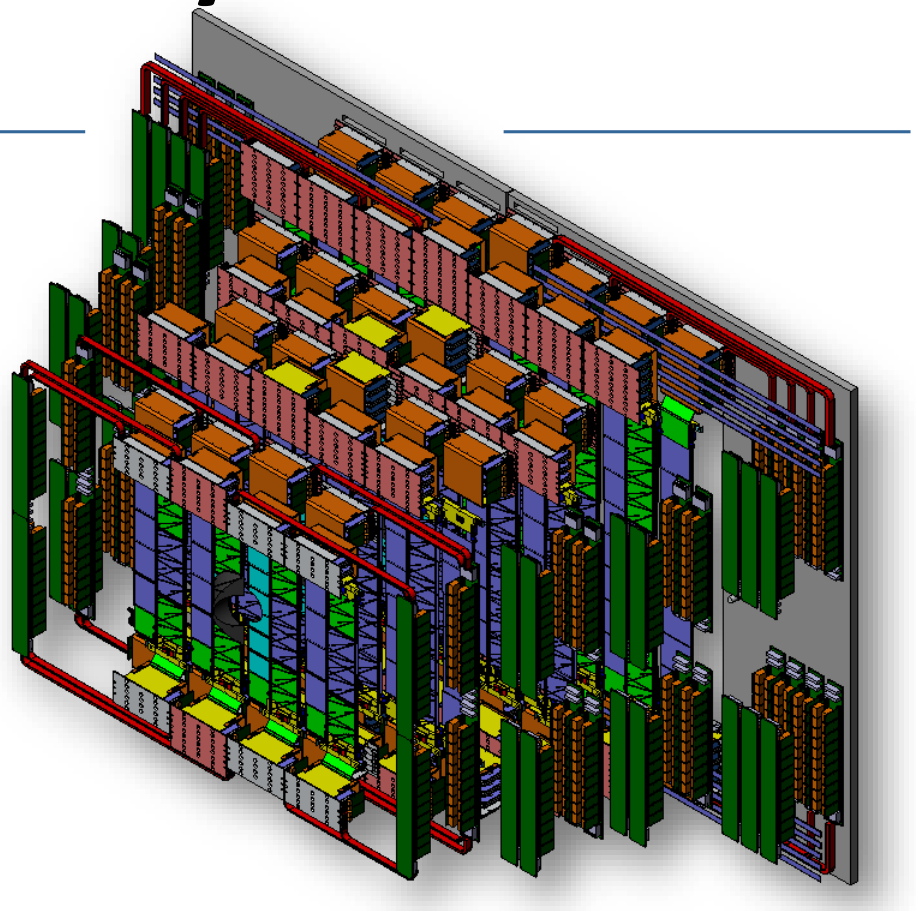
Status of the BM@N STS module assembly

Nikita Sukhov, for CBM-BM@N STS group

“RFBR grants for NICA”,

20-23 October 2020,

VB LHEP, JINR, Dubna



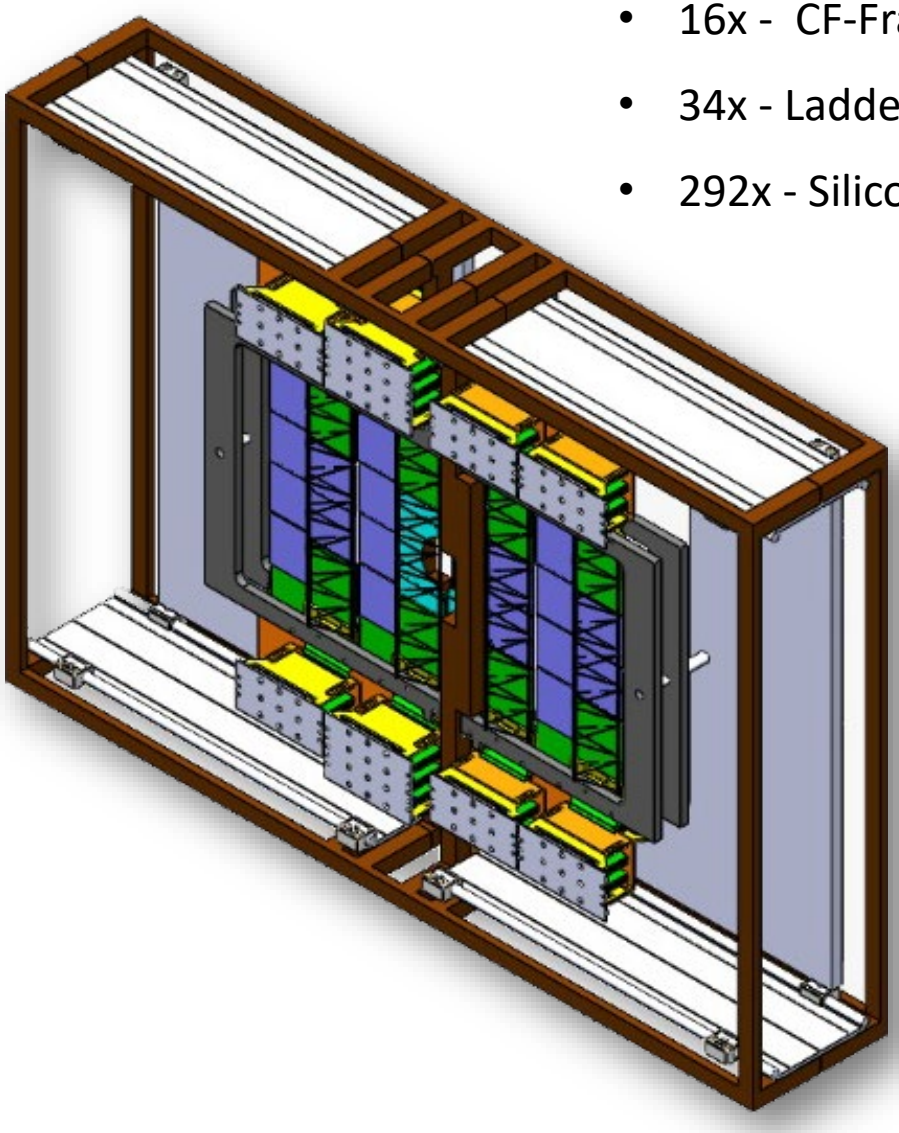
Grants RFBR 18-02-40047 и 18-02-40113

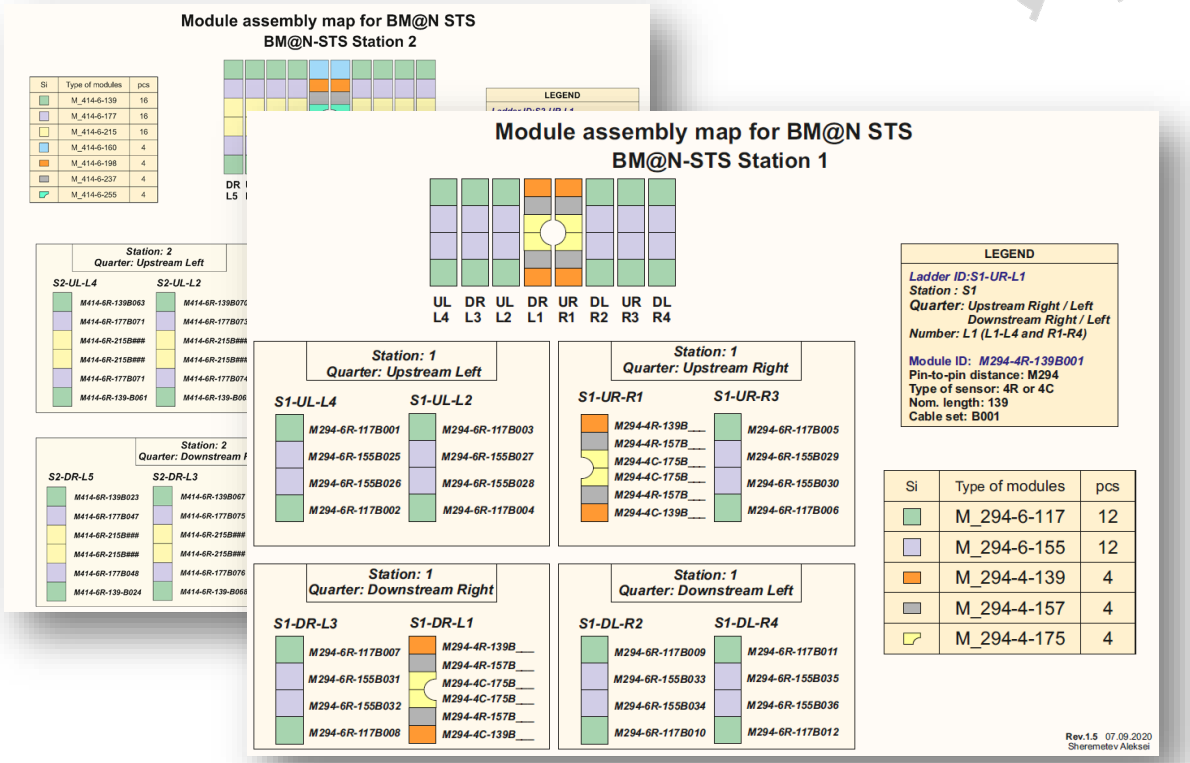
Outline

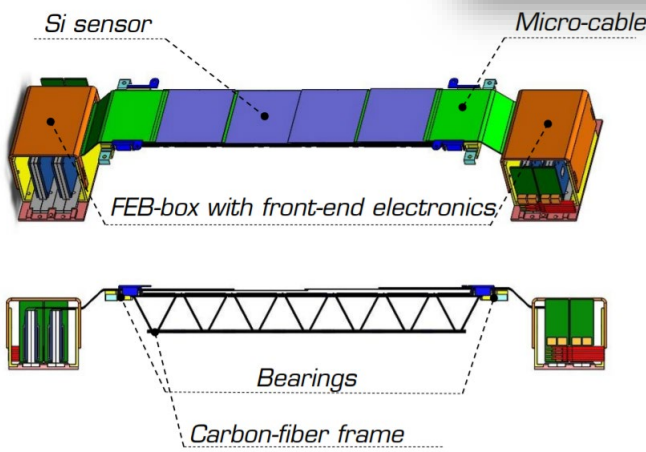
- Structure of BM@N STS Stations
- Electronic logbook for the module assembly
- Technological processes of assembling modules for the BM@N STS
  - Preparation parts of module for assembly
  - Assembly of the ASIC with flexible Al – microcables
  - QA of assembly process
  - The cut procedure of flexible Al – microcables
  - Evolution of the module's channels in the assembly process
- Pull test of assembly process
- Test of STS module
- Conclusions

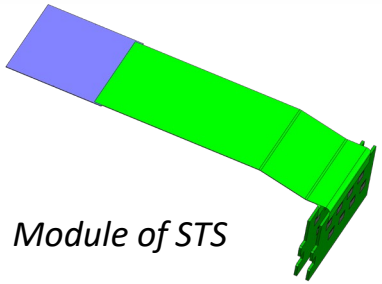
BM@N STS Stations

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









Module of STS

Electronic logbook for the module assembly

BMN STS

Module Data | LDO Assembly | Pull test | Module Assembly | Electrical test

Pre-production Data, Page 1 of 1 — Logged in as "Aleksei Sheremetiev" — ELOG

New | Find | Select | Import | Config | Logout | Last day | Help

Full | Summary | Threaded — -- Ladder ID -- | -- All entries -- | -- Status -- | 9 Entries

ID	Date	Author	Ladder ID	Module ID	Status	Sensor ID	Sensor ID visually checked	Cable set batch	Cable set batch visually checked	ASIC batch	ASIC batch visually checked	LDO batch	LDO batch visually checked	FEB p-side	FEB p-side visually checked	FEB n-side	FEB n-side visually checked	P-Box	N-Box	E-Box	Site	
1	Thu Jun 18 10:19:20 2020	Aleksei Sheremetiev	Dummy	M294-2R-212-D003	Assembly done	CBM62HDS0030	Yes	D003	Yes	G001	Yes	G001	Yes	FEB8-LNRP-2-A_8_V2	Yes	STS_FE8-2_LP_RN_B28	Yes				Cleanroom DC2/3	52x
2	Wed Jul 29 13:54:07 2020	Aleksei Sheremetiev	Dummy	M294-2R-212-D004	Assembly done	CBM62HDS0031	Yes	D004	Yes	G002	Yes	G002	Yes	FEB8-LNRP-2-A_13_V2	Yes	STS_FE8-2_LP_RN_B26	Yes				Cleanroom DC2/3	71x
3	Thu Jul 30 14:33:25 2020	Aleksei Sheremetiev	Dummy	M294-2R-212-D005	Assembly done	CBM62HDS0032	Yes	D005	Yes	G003	Yes		Yes	FEB8_LNRP_2_A7	Yes	STS_FEB_2_LP_RN_B27	Yes				Cleanroom DC2/3	
4	Tue Aug 11 14:37:28 2020	Aleksei Sheremetiev	Dummy	M294-2R-212-D006	Not ready	CBM62HDS0033	Yes	D006	Yes	G004	Yes		Yes		Yes		No	BP004	BN004	BE004	Cleanroom DC2/3	
5	Tue Aug 18 15:17:58 2020	Aleksei Sheremetiev	Draft	Draft	Not ready	Draft	No	Draft	No	Draft	No	Draft	No	Draft	No	Draft	No				Cleanroom DC2/3	
Draft	**Thu Oct 15 11:58:55 2020**	**Aleksei Sheremetiev**	**S1-UL-L4**	**M-294-2R-117B001**	**In the process**	**CBM62HDS0034**	**Yes**	**B001**	**Yes**	**G001**	**Yes**	**G001**	**Yes**	**N/A**	**No**	**N/A**	**No**	**BP001**	**BN001**	**BE001**	**Cleanroom DC2/3**	
8	Thu Oct 15 13:36:21 2020	Aleksei Sheremetiev	S1-UL-L4	M294-2R-117-B002	Not ready	CBM62HDS0037	Yes	B002	No	G006	Yes	G006	Yes	Draft	No	Draft	No	BP002	BN002	BE002	Cleanroom DC2/3	
9	Thu Oct 15 13:37:56 2020	Aleksei Sheremetiev	S1-UL-L4	M294-2R-155-B025	Not ready	CBM62HDS0038	Yes	B025	No	G007	Yes	G007	No	Draft	No	Draft	No	BP006	BN006	BE006	Cleanroom DC2/3	
10	Thu Oct 15 13:38:10 2020	Aleksei Sheremetiev	S1-UL-L4	M294-2R-155-B026	Not ready	CBM62HDS0041	Yes	B026	No	G009	Yes	G009	No	Draft	No	Draft	No	BP007	BN007	BE007	Cleanroom DC2/3	

Several logbooks are defined on this host.
Please select the one to connect to:

Logbook	Entries	Last submission
BMN STS		
Module Data Pre-production Data	9	Thu Oct 15 13:38:10 2020 by Aleksei Sheremetiev
LDO Assembly Pre-production Data	4	Thu Jul 30 11:08:15 2020 by Aleksei Sheremetiev
Pull test Pre-production Data	4	Tue Jul 21 16:58:26 2020 by Aleksei Sheremetiev
Module Assembly Assembly Data	2	Wed Aug 5 13:05:13 2020 by Aleksei Sheremetiev
Electrical test Assembly Data	2	Wed Jul 29 15:57:04 2020 by Aleksei Sheremetiev

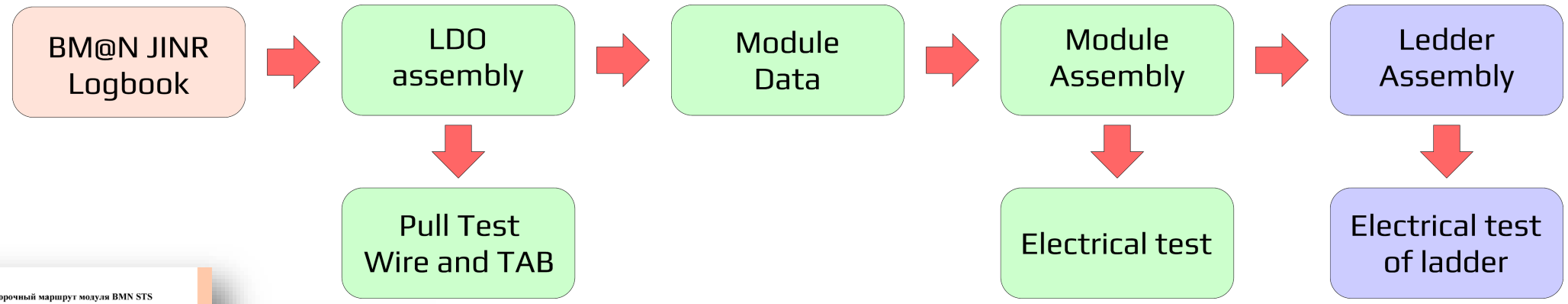
The ELOG development jointly with

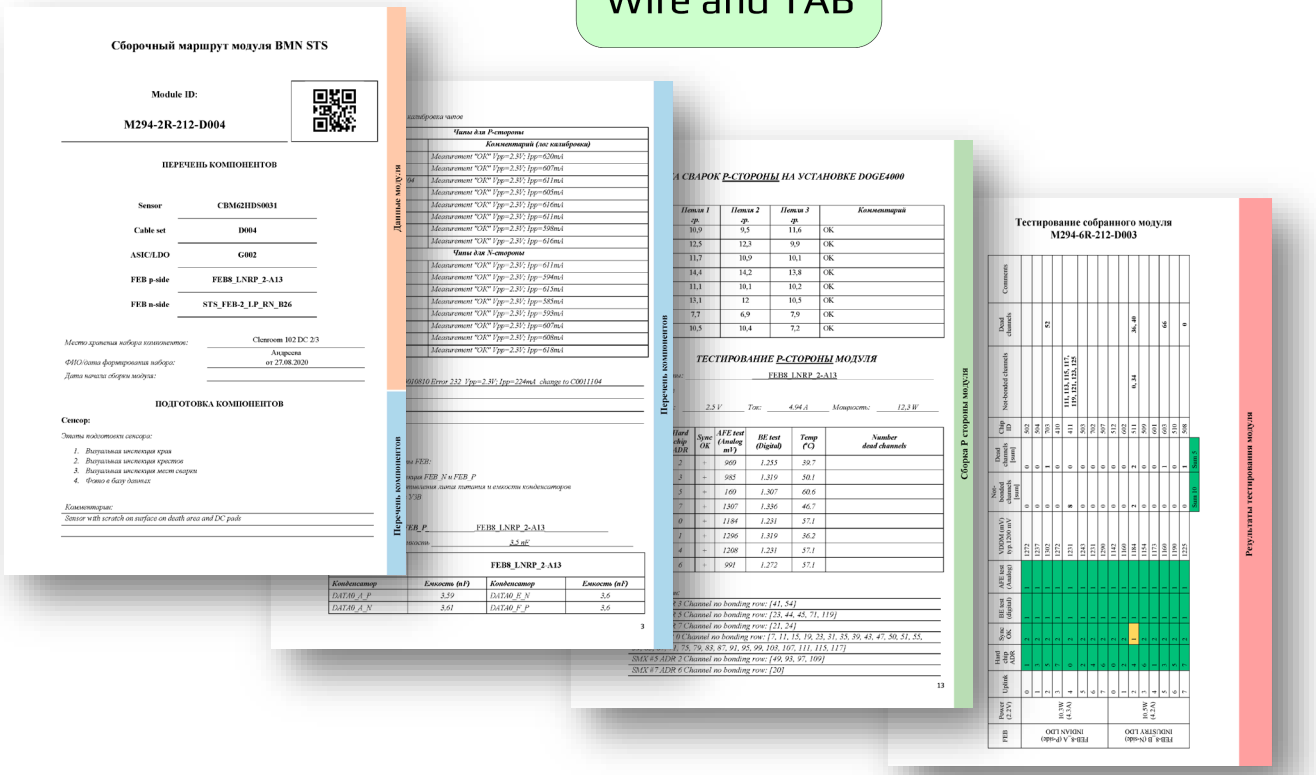
Laboratory of Information Technologies (JINR)

A.Kondratyev, A. Bondyakov

BM@N JINR Elog link
https://159.93.221.79/elog/

Electronic logbook for the module assembly





Сборочный маршрут модуля BMN STS

Module ID:

M294-2R-212-D004

ПЕРЕЧЕНЬ КОМПОНЕНТОВ

Sensor	CBM62HDS0031
Cable set	D004
ASIC/LDO	G002
FEB p-side	FEB8_LNRP_2-A13
FEB n-side	STS_FEB-2_LP_RN_B26

Место хранения набора компонентов: Cleanroom 102/DC 2/3

ФИО/дата формирования набора: Андреева от 27.08.2020

Дата начала сборки модуля:

ПОДГОТОВКА КОМПОНЕНТОВ

Сенсор:

Этапы подготовки сенсора:

1. Визуальная инспекция краев
2. Визуальная инспекция кристов
3. Визуальная инспекция мест сварки
4. Фото в базу данных

Комментарии:

Sensor with scratch on surface on death area and DC pads

Данные модуля

Перечень компонентов

Чипы для P-стороны

	Комментарий (нос калибровка)
	Measurement "OK" Upp=2.3V; Ipp=620mA
	Measurement "OK" Upp=2.3V; Ipp=607mA
	Measurement "OK" Upp=2.3V; Ipp=611mA
	Measurement "OK" Upp=2.3V; Ipp=605mA
	Measurement "OK" Upp=2.3V; Ipp=616mA
	Measurement "OK" Upp=2.3V; Ipp=611mA
	Measurement "OK" Upp=2.3V; Ipp=598mA
	Measurement "OK" Upp=2.3V; Ipp=616mA

Чипы для N-стороны

	Measurement "OK" Upp=2.3V; Ipp=611mA
	Measurement "OK" Upp=2.3V; Ipp=594mA
	Measurement "OK" Upp=2.3V; Ipp=613mA
	Measurement "OK" Upp=2.3V; Ipp=585mA
	Measurement "OK" Upp=2.3V; Ipp=598mA
	Measurement "OK" Upp=2.3V; Ipp=607mA
	Measurement "OK" Upp=2.3V; Ipp=608mA
	Measurement "OK" Upp=2.3V; Ipp=618mA

FEB8_LNRP_2-A13

Конденсатор	Емкость (nF)	Конденсатор	Емкость (nF)
DAT40_A_P	3,59	DAT40_F_N	3,6
DAT40_A_N	3,61	DAT40_F_P	3,6

3

Перечень компонентов

А СВАРОК P-СТОРОНЫ НА УСТАНОВКЕ DOGE4000

Петля 1 гр.	Петля 2 гр.	Петля 3 гр.	Комментарий
10,9	9,5	11,6	OK
12,5	12,3	9,9	OK
11,7	10,9	10,1	OK
14,4	14,2	13,8	OK
11,1	10,1	10,2	OK
13,1	12	10,5	OK
7,7	6,9	7,9	OK
10,5	10,4	7,2	OK

ТЕСТИРОВАНИЕ P-СТОРОНЫ МОДУЛЯ

FEB8_LNRP_2-A13

2,5 V Ток: 4,94 A Мощность: 12,3 W

Hard chip ADR	Sync OK	AFE test (Analog mV)	IIE test (Digital)	Temp (°C)	Number dead channels
2	+	969	1,255	39.7	
3	+	985	1,319	50.1	
5	+	1169	1,307	60.6	
7	+	1307	1,336	46.7	
0	+	1184	1,231	57.1	
1	+	1206	1,319	56.2	
4	+	1208	1,231	57.1	
6	+	991	1,272	57.1	

Channel no bonding row: [41, 54]
Channel no bonding row: [23, 44, 45, 71, 119]
Channel no bonding row: [21, 24]
Channel no bonding row: [7, 11, 15, 19, 23, 31, 35, 39, 43, 47, 50, 51, 55, 75, 79, 83, 87, 91, 95, 99, 103, 107, 111, 115, 117]
SMX 45 ADR 2 Channel no bonding row: [49, 93, 97, 109]
SMX 47 ADR 6 Channel no bonding row: [20]

13

Сборка P стороны модуля

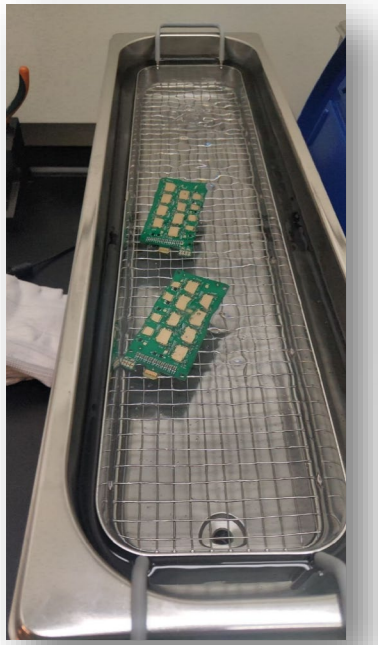
Тестирование собранного модуля M294-6R-212-D003

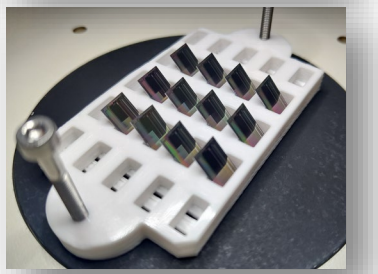
FEB	Power (2.2V)	Uplink	Hard chip ADR	Sync OK	IIE test (digital)	AFE test (Analog)	VDD0A (mV) typ 1200 mV	Num bonded channels (sum)	Dead channels (sum)	Chip ID	Num bonded channels	Dead channels	Comments
FEB-A_A (P-side) INDIAN LDO	3,3 V	0	2	+	1	1	1272	0	0	562			
		1	3	+	1	1	1257	0	0	504			
		2	5	+	1	1	1302	0	1	576			
		3	7	+	1	1	1272	0	0	410			52
		4	0	+	1	1	1231	8	0	411	HA, HB, HC, HD, HE, HF, HG, HH		
		5	2	+	1	1	1243	0	0	503			
		6	4	+	1	1	1231	0	0	703			
		7	6	+	1	1	1230	0	0	515			
FEB-A_B (N-side) END/STRY LDO	3,3 V	0	1	+	1	1	1142	0	0	532			
		1	2	+	1	1	1160	0	0	602			
		2	4	+	1	1	1184	2	2	511	0, 34		
		3	6	+	1	1	1154	0	0	559			36, 40
		4	1	+	1	1	1173	0	0	604			
		5	3	+	1	1	1160	0	0	693			66
		6	5	+	1	1	1196	1	1	530			
		7	7	+	1	1	1295	0	0	548			0

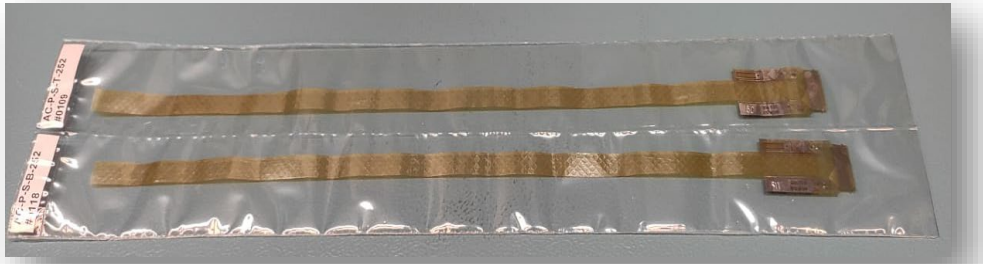
Результаты тестирования модуля

BM@N JINR data of one assembly module:
https://disk.jinr.ru/index.php/s/7dZyMjr9pbwnD6F

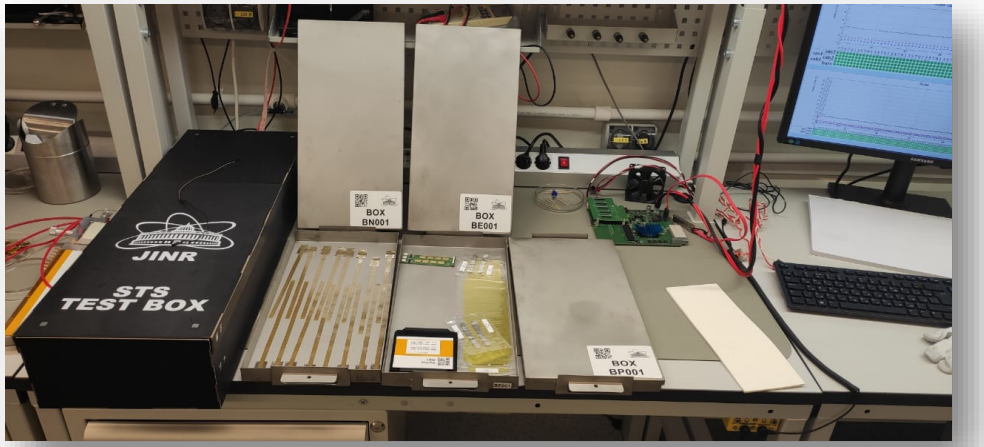
Preparation parts of module for assembly

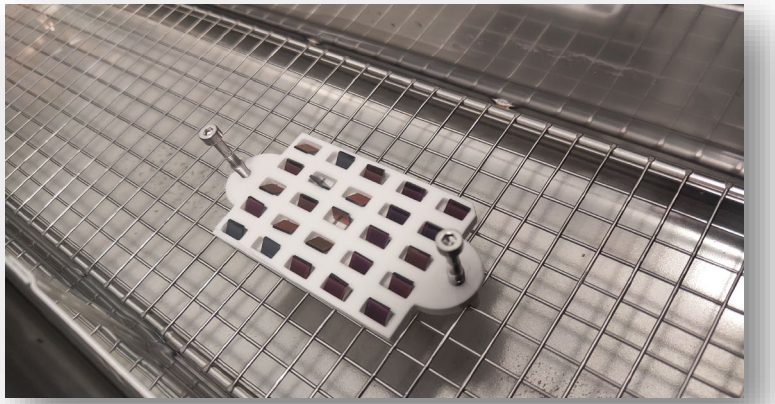




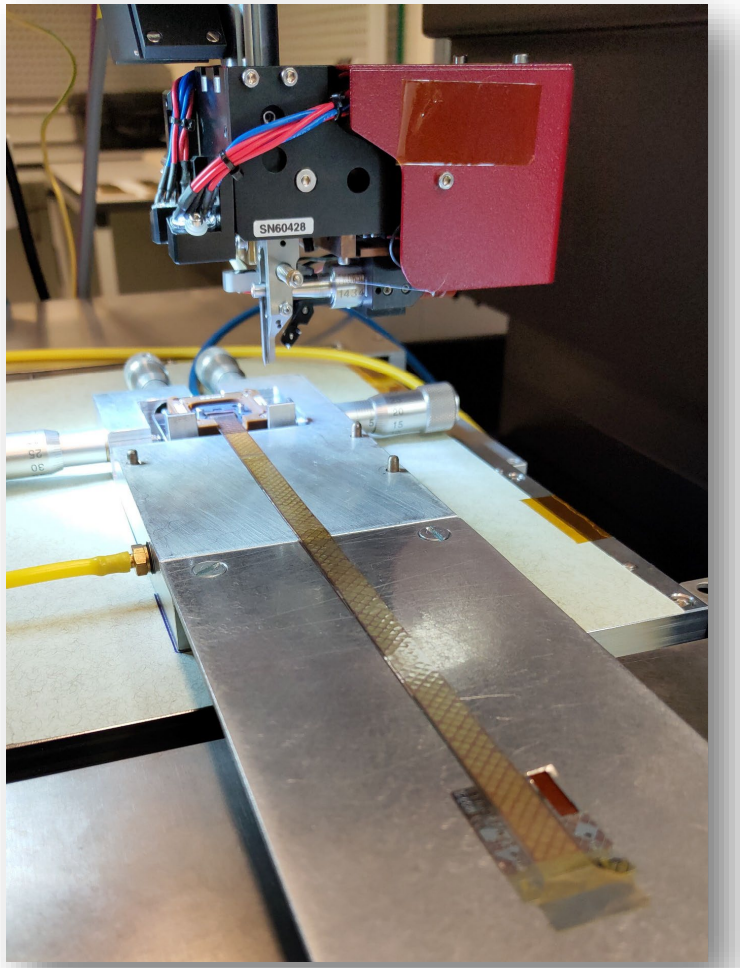


ESD

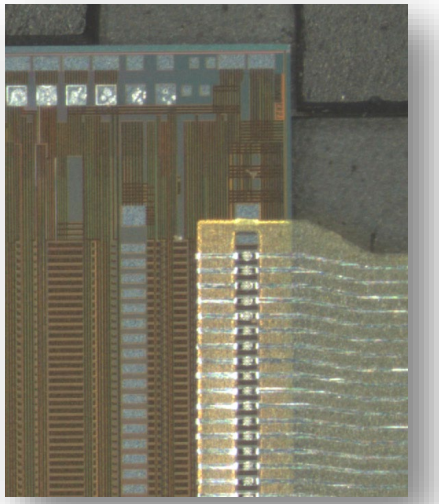




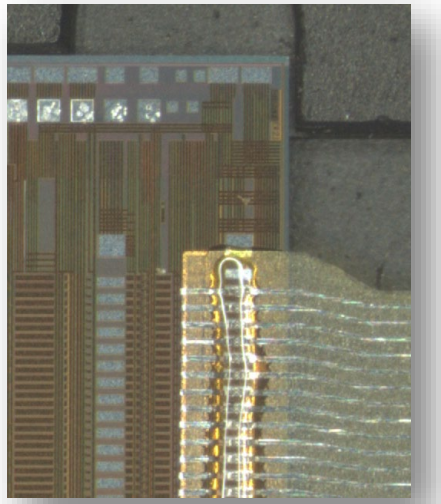
Assembly of the ASIC with flexible Al - microcables



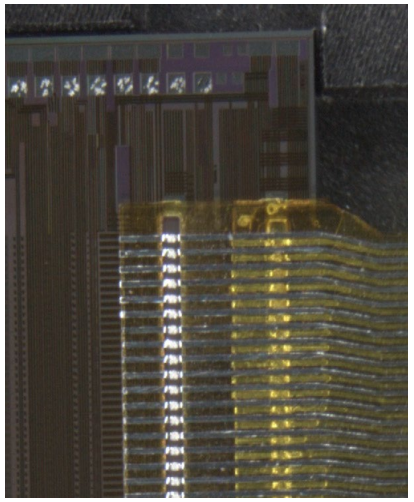
Ultrasonic assembly process
on TAB-bonding machine



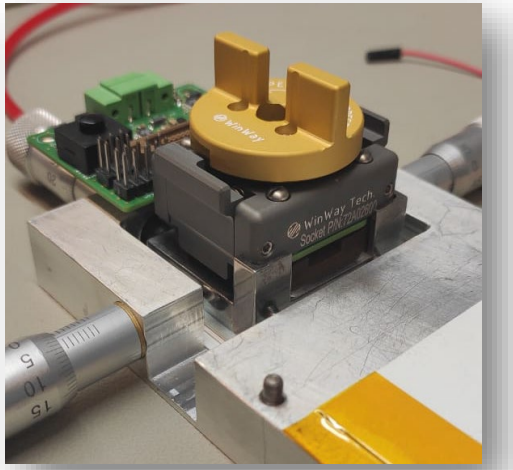
TAB - Bonding result
of 1-st row of contacts



Encapsulation of 1-st row
of contacts

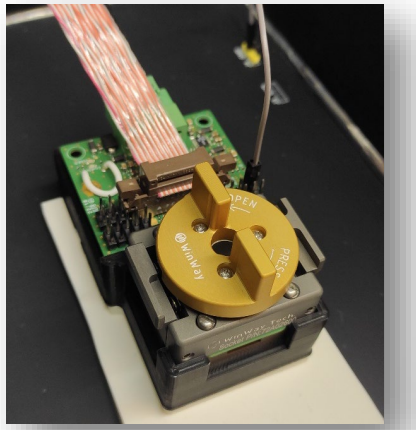


TAB - Bonding result
of 2nd row of contacts

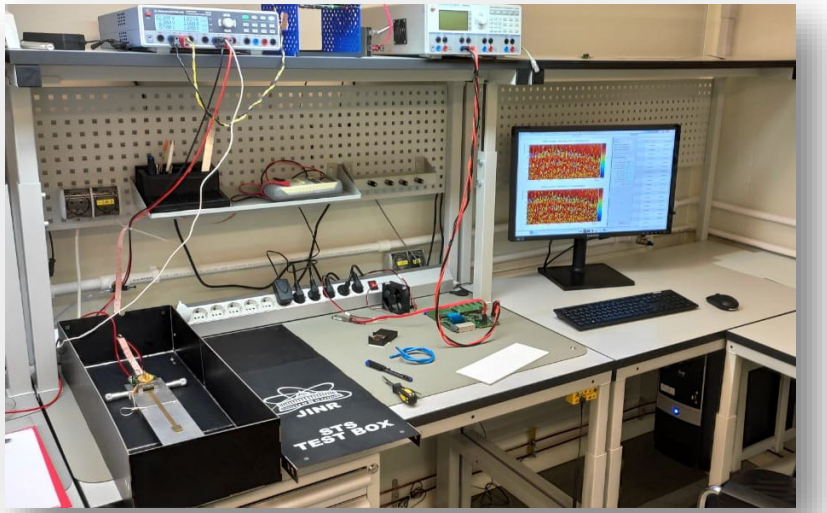


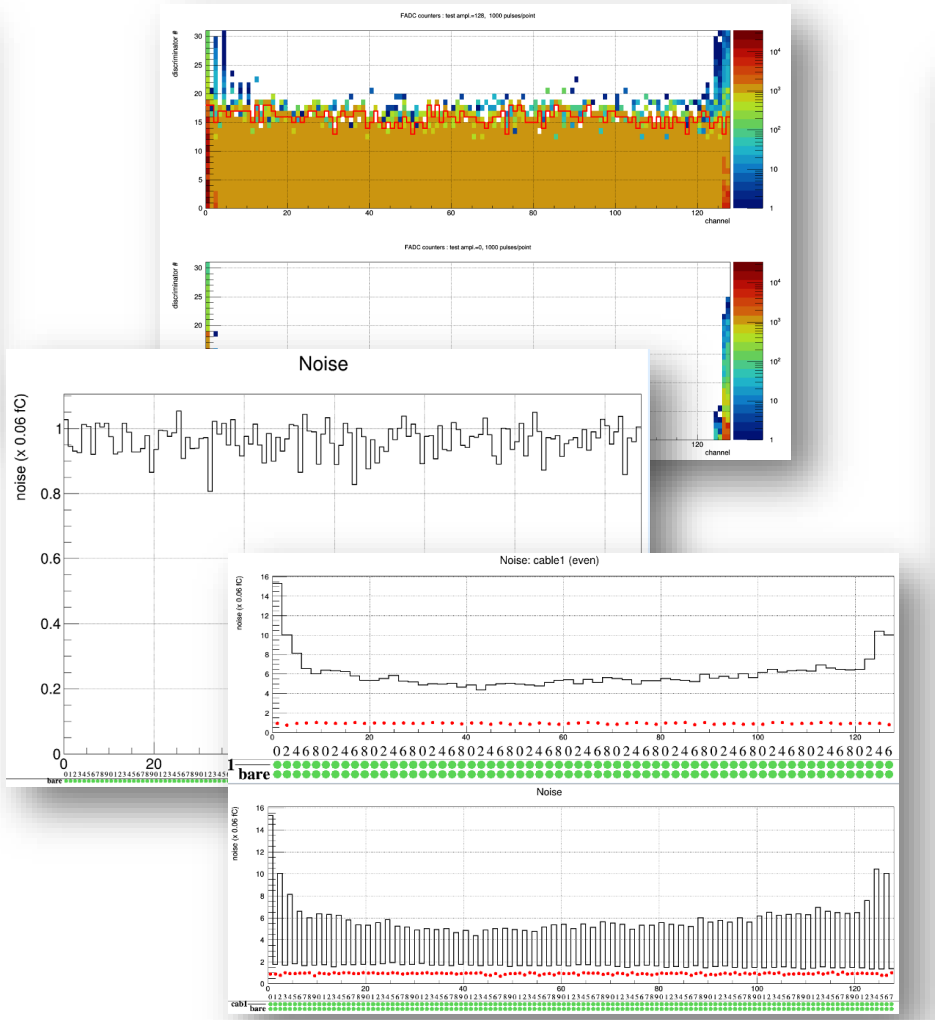
QA of assembly process

AFCK board v.1.1 and FMC board

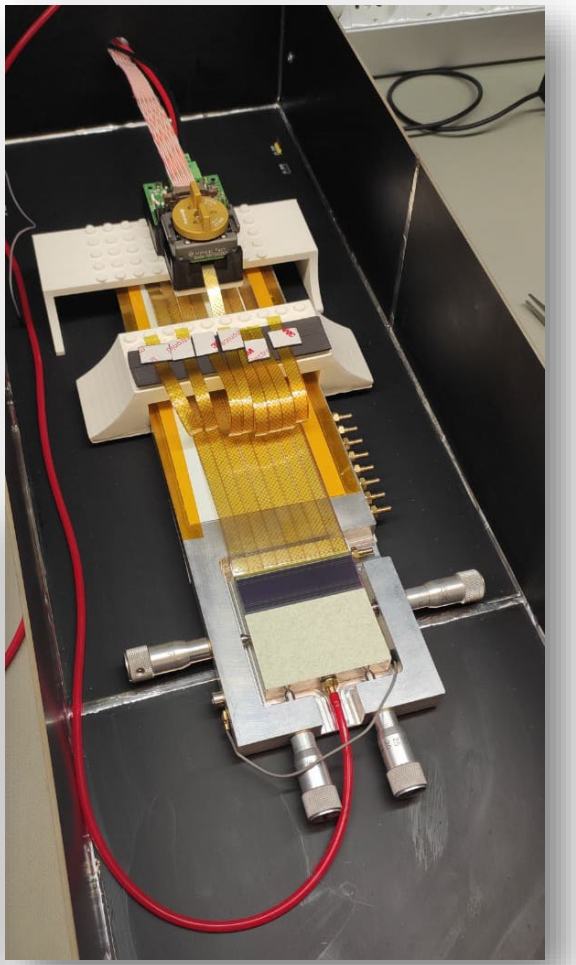


Winway socket PogoPin device (GSI)





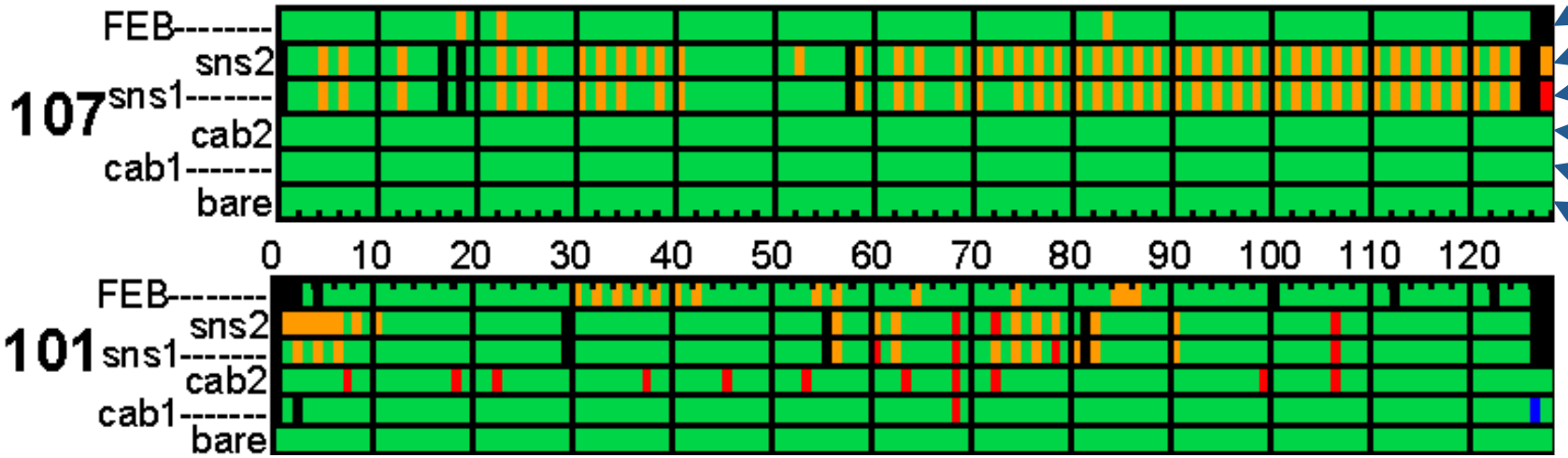
GUI of Test Program by A. Kolozhvari (JINR)



Bonding QA tests of 1st row on sensor

Evolution of the module's channels in the assembly process

Result of first assembled chips for module M294-2R-212-D001

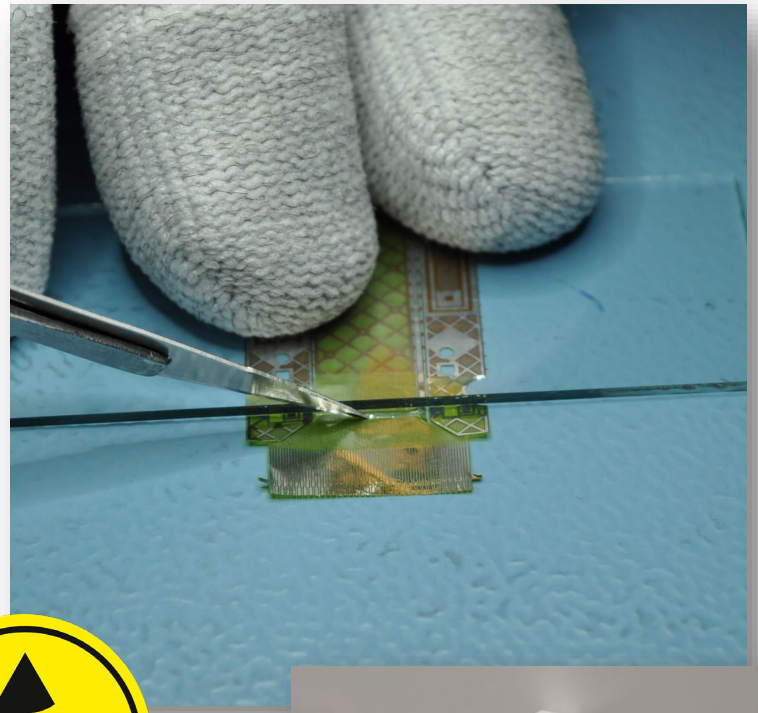


- Test on FEB
- Bonding 2nd row on Si- sensor
- Bonding 1st row on Si- sensor
- Bonding 2nd row on ASIC
- Bonding 1st row on ASIC
- ASIC without cable

Green - the bonding is OK;
Red - the bonding between a cable and an ASIC is absent;
Orange - the bonding between a cable and a sensor is absent;
Black - the channel is "dead";
Blue - the noise level in the channel is not measured because it is too high;
White - information on this channel is not available.

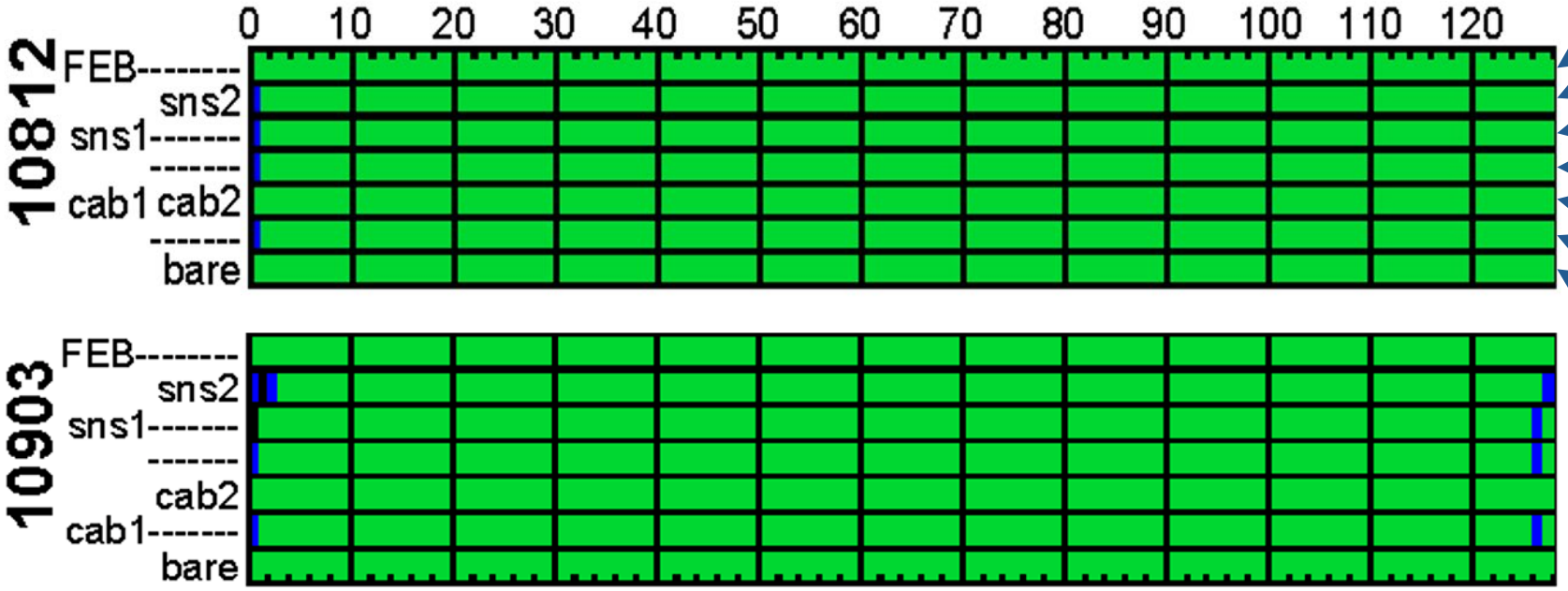
The cut procedure of flexible Al - microcables

DESCO 222687 Europe ESD survey kit



Evolution of the module's channels in the assembly process

Last of assembled chips for module
M294-2R-212-D005

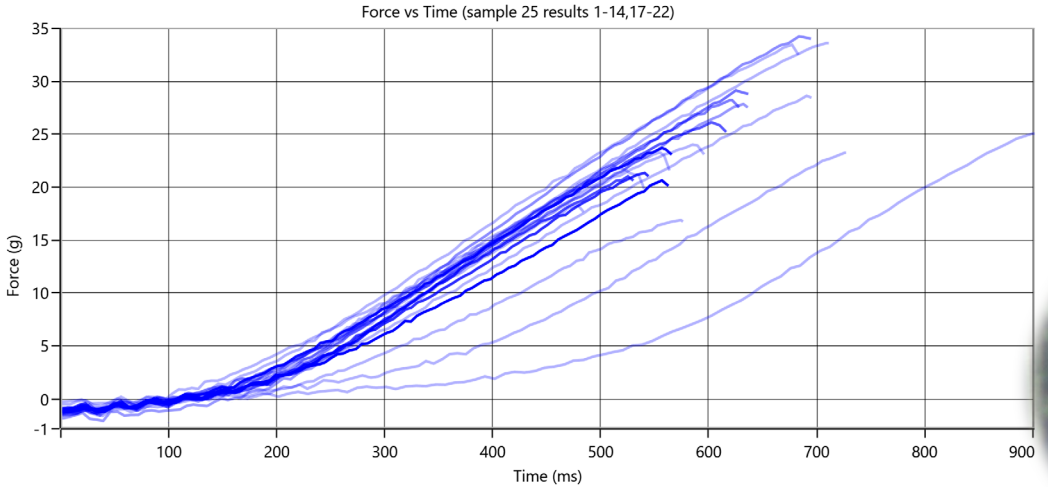


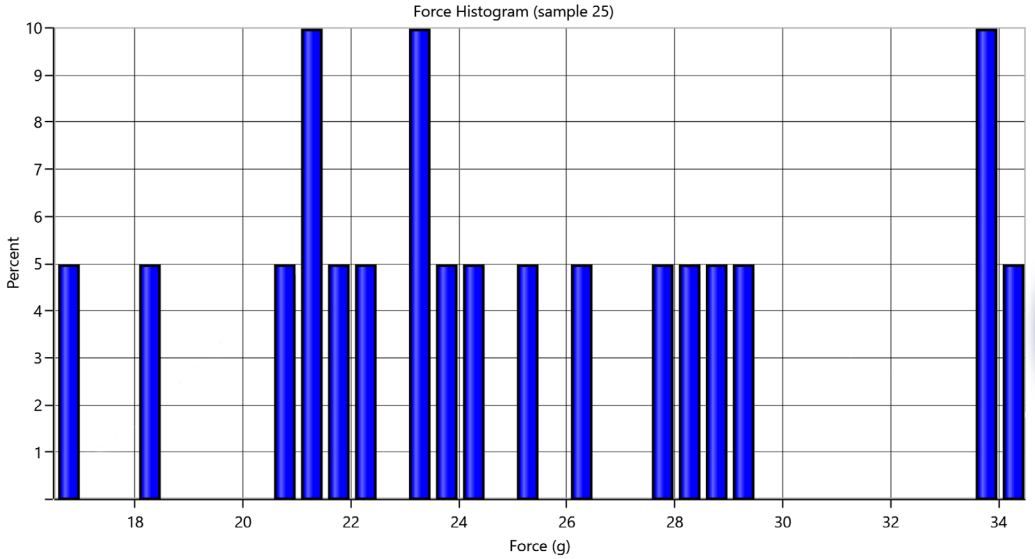
- Test on FEB
- Bonding 2nd row on Si- sensor
- Bonding 1st row on Si- sensor
- Cut process
- Bonding 2nd row on ASIC
- Bonding 1st row on ASIC
- ASIC without cable

Green - the bonding is OK;
Red - the bonding between a cable and an ASIC is absent;
Orange - the bonding between a cable and a sensor is absent;
Black - the channel is "dead";
Blue - the channel is overloaded (high noise);
White - information on this channel is not available.

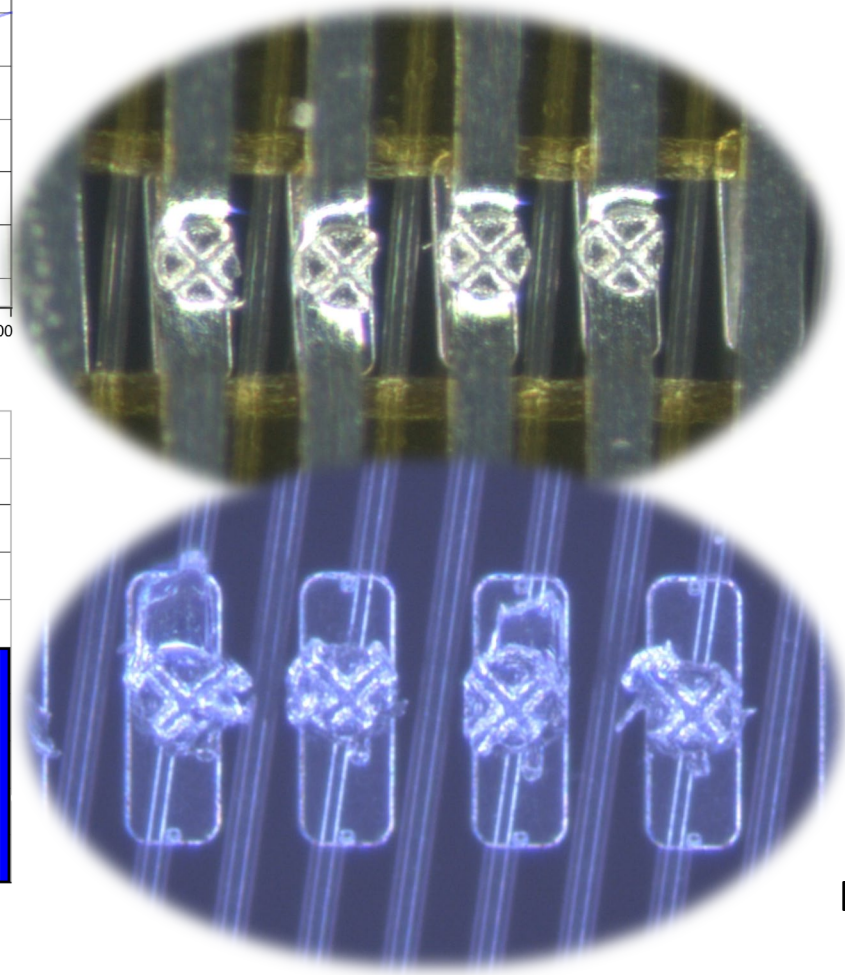
Pull test of assembly process

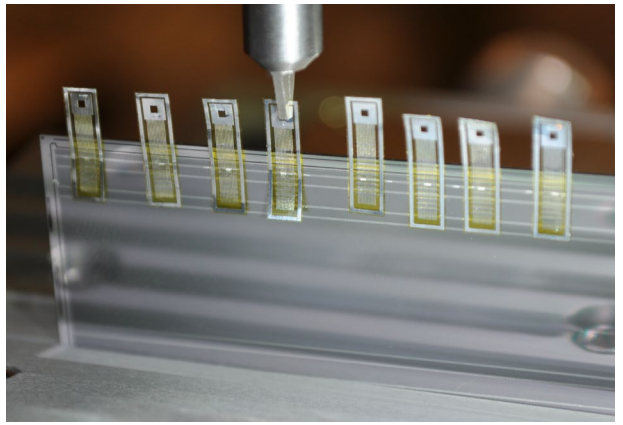
Pull test result of TAB bonding for one module



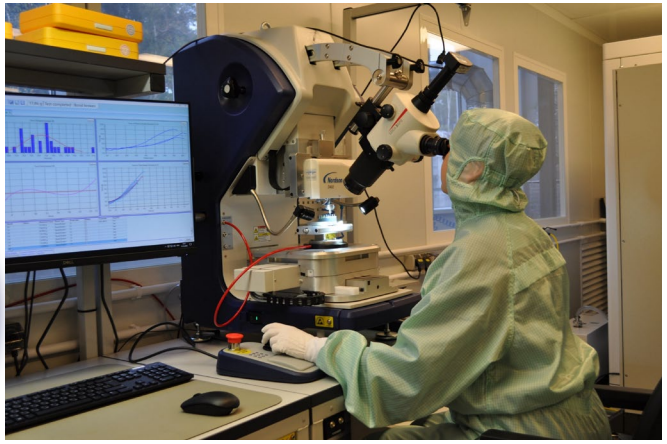


- Test cables per module: **20 pcs;**
- TAB-bonding point per test: **4 pcs;**
- Minimum force: **16,9 gram;**
- Maximum force: **34,3 gram;**



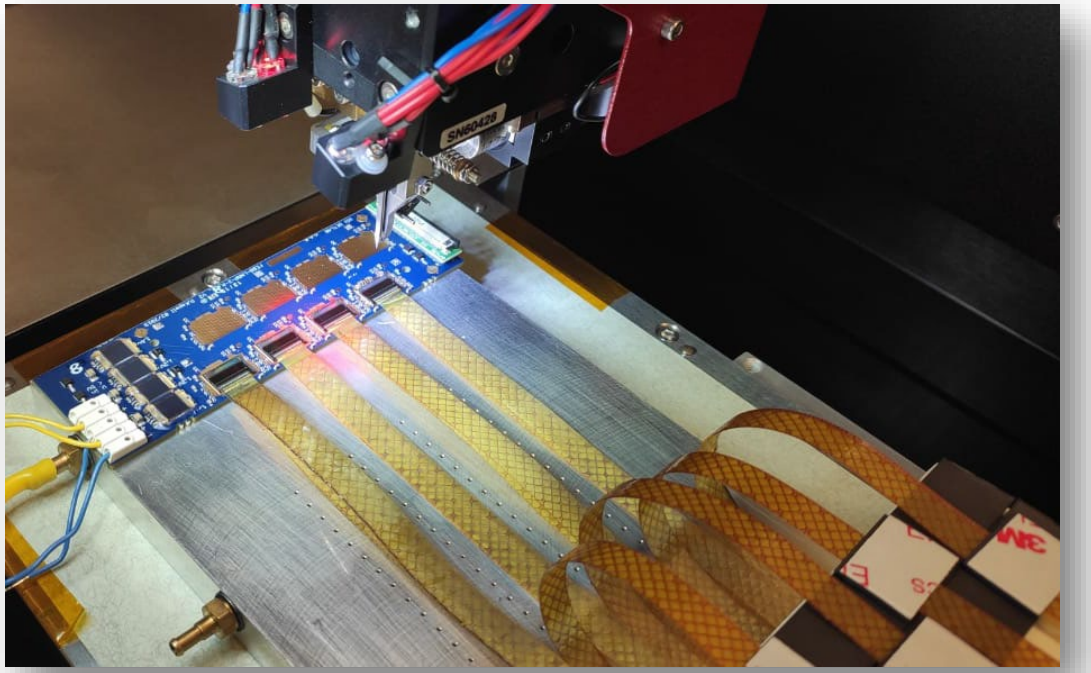


Result of TAB bonding

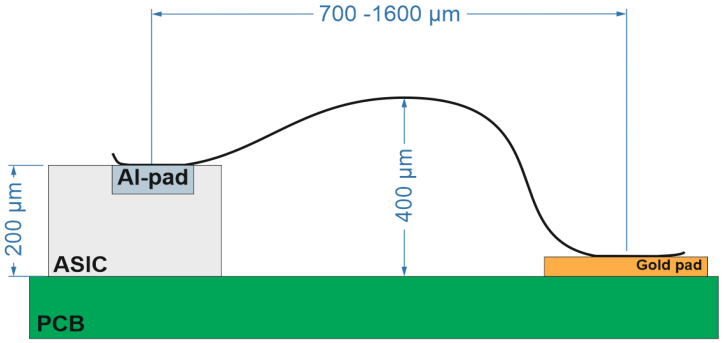


Dage 4000+ pull test machine

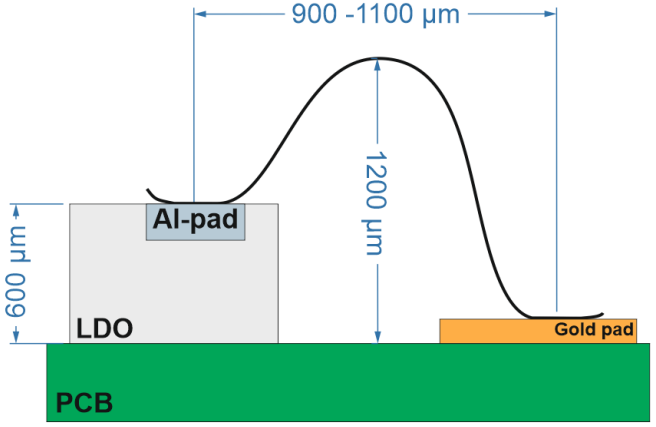
Wire bonding process ASIC and LDO to PCB



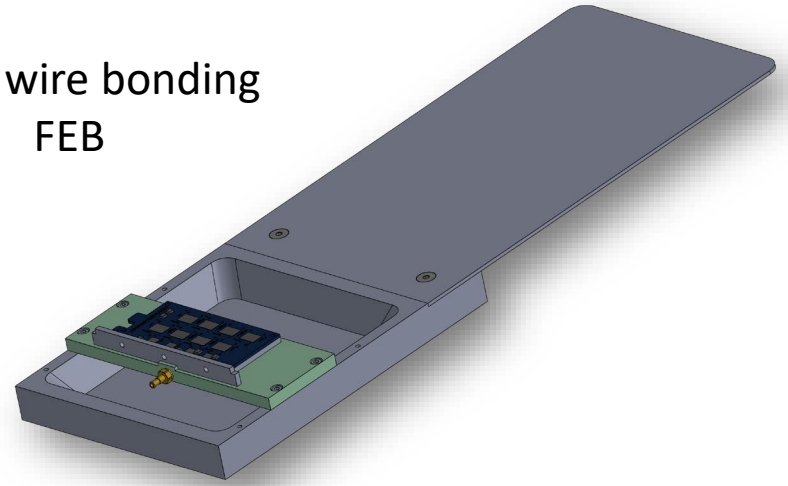
Wire track on ASIC-PCB



Wire track on LDO-PCB



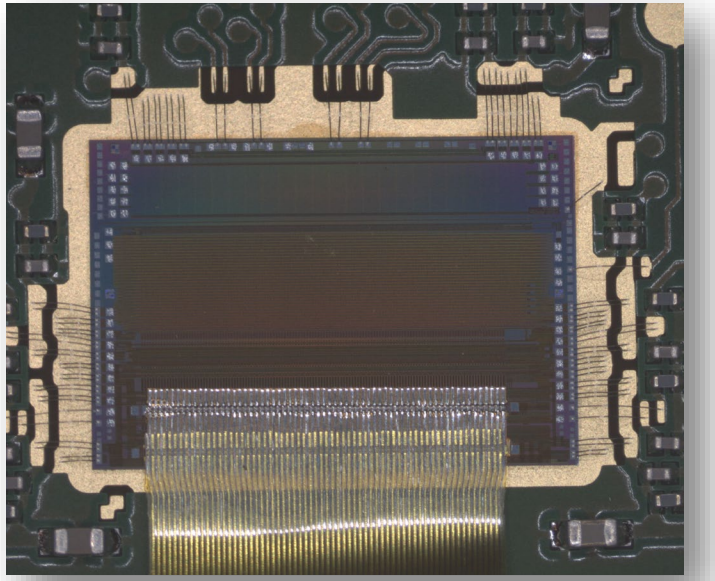
Jig for wire bonding FEB



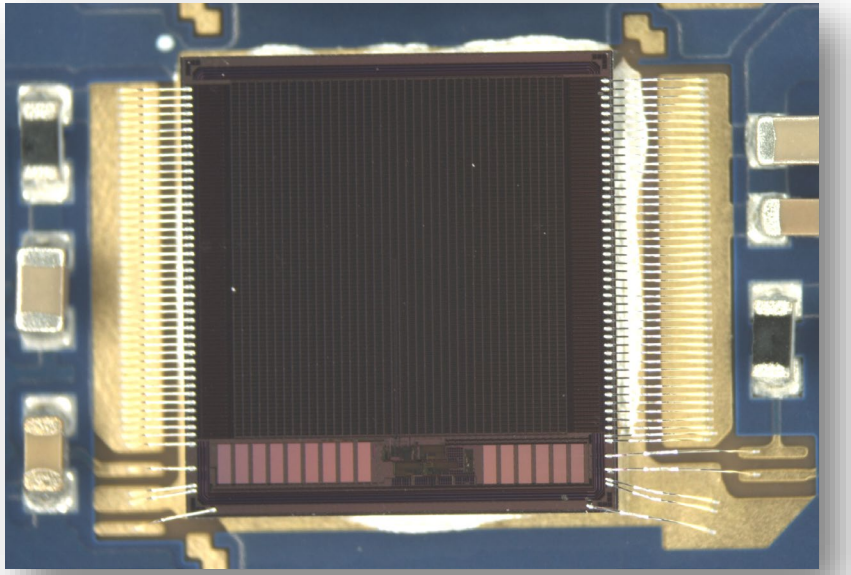
- Two types of wire bonding process;
- 25 µm Aluminum wire;
- Special ultrasonic needle with small pitch;

Wire bonding process ASIC and LDO to PCB

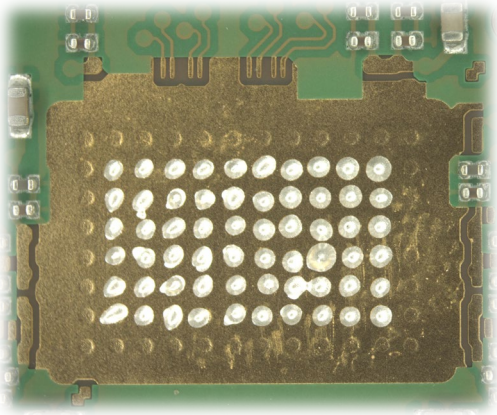
Wire bonding process of ASIC



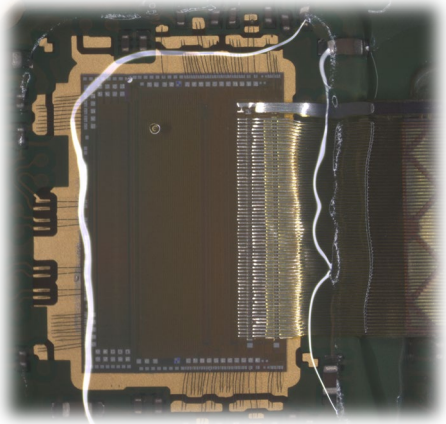
Wire bonding process of LDO



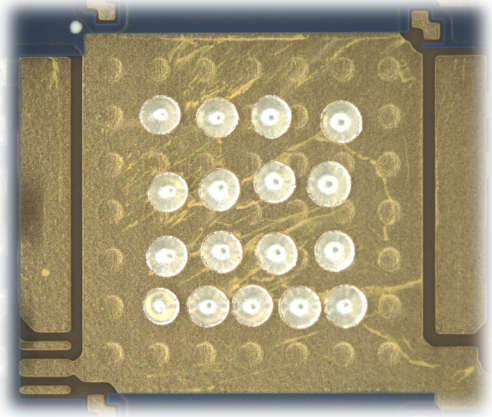
Thermal adhesives



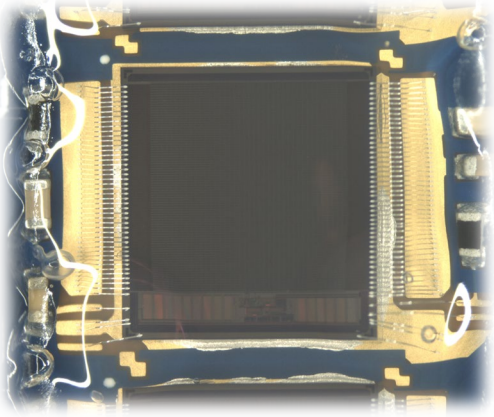
Encapsulate glue



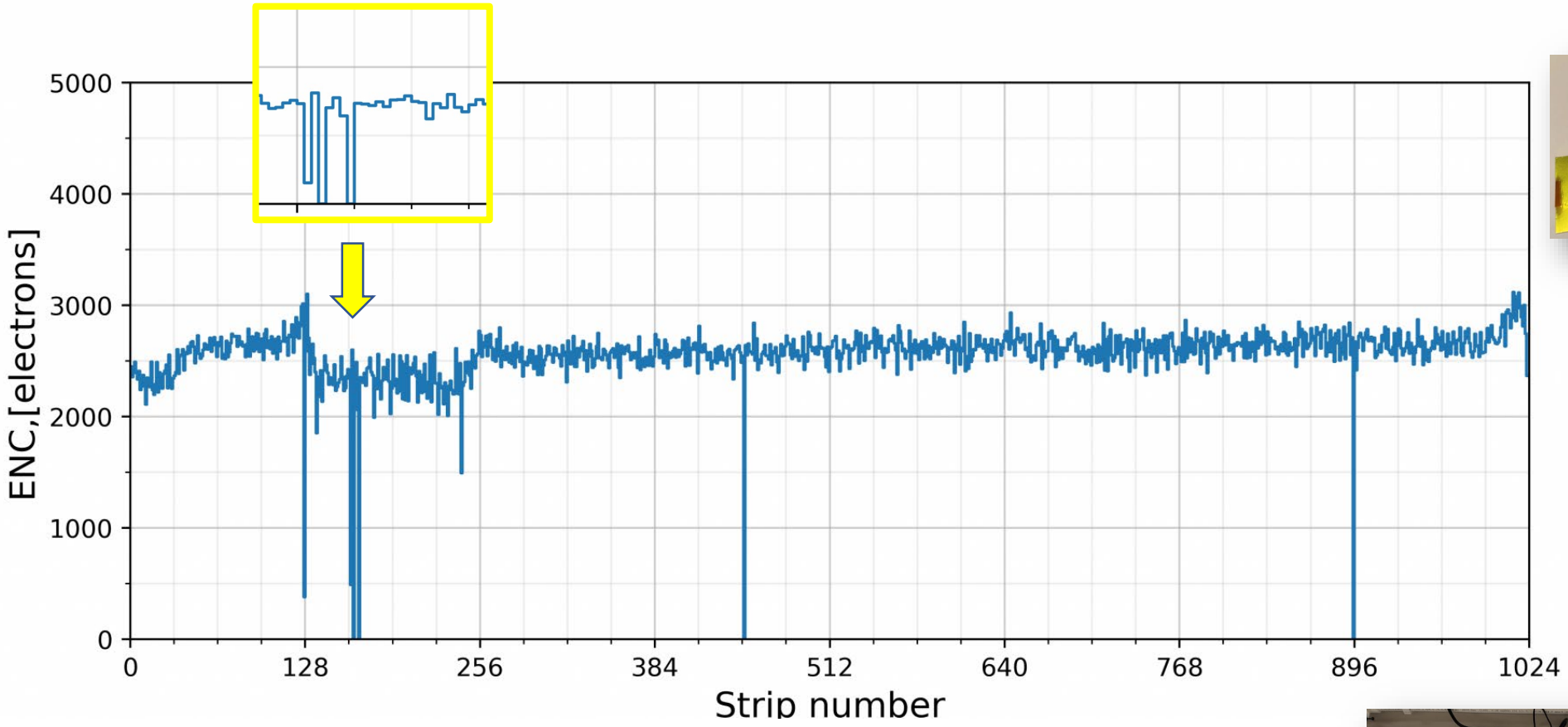
Thermal adhesives



Encapsulate glue



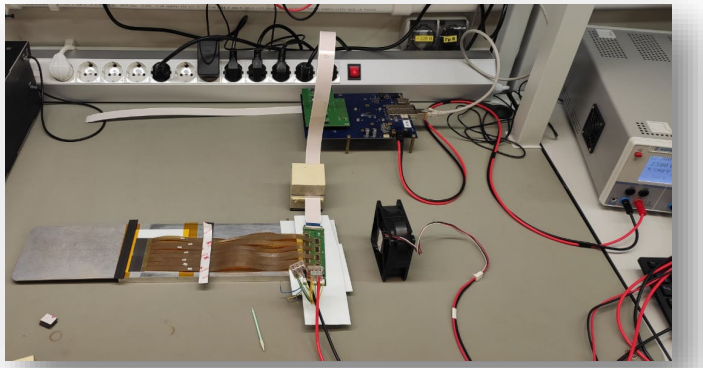
Electrical test of half-module



Measurement without HV and Test box

Dead channels= [164, 168, 450, 896]

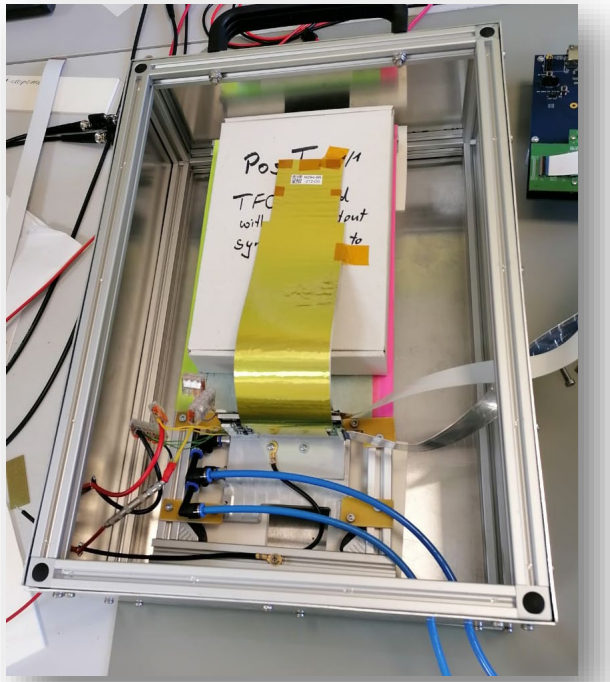
Not bonding channels = [128, 162, 235]



Not working channels on N-side of sensor: 7 Ch. [0.7%]

Test by: D. Dementev, M. Shitenkow,

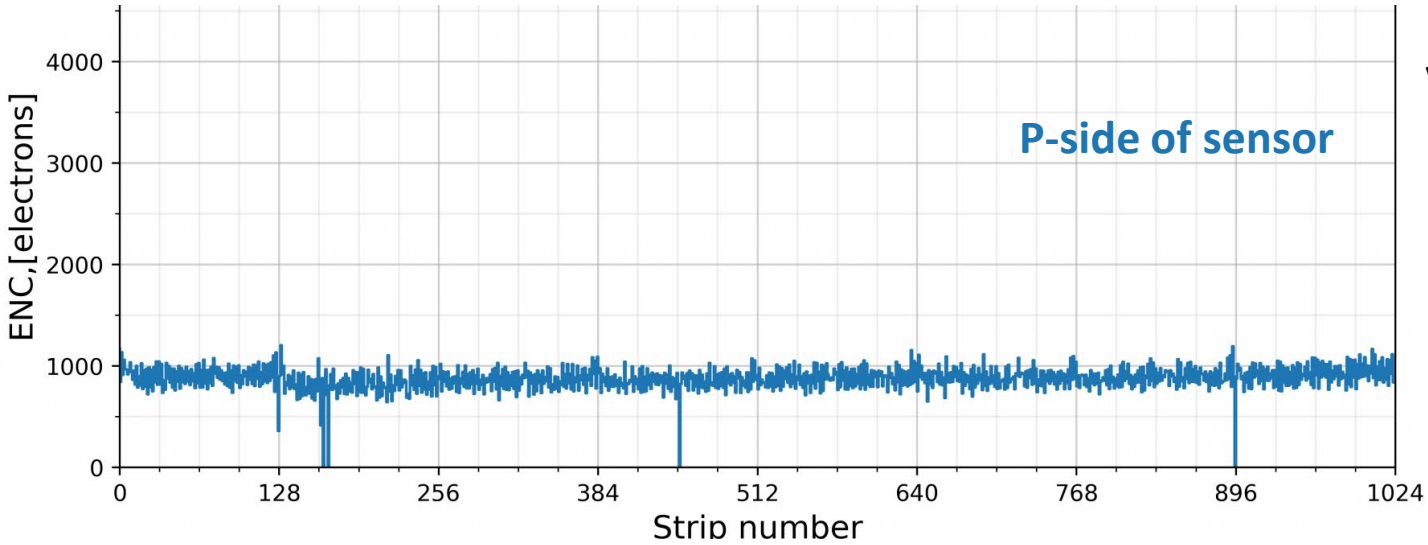
Test of STS module



Result of dead channels
at assembled modules

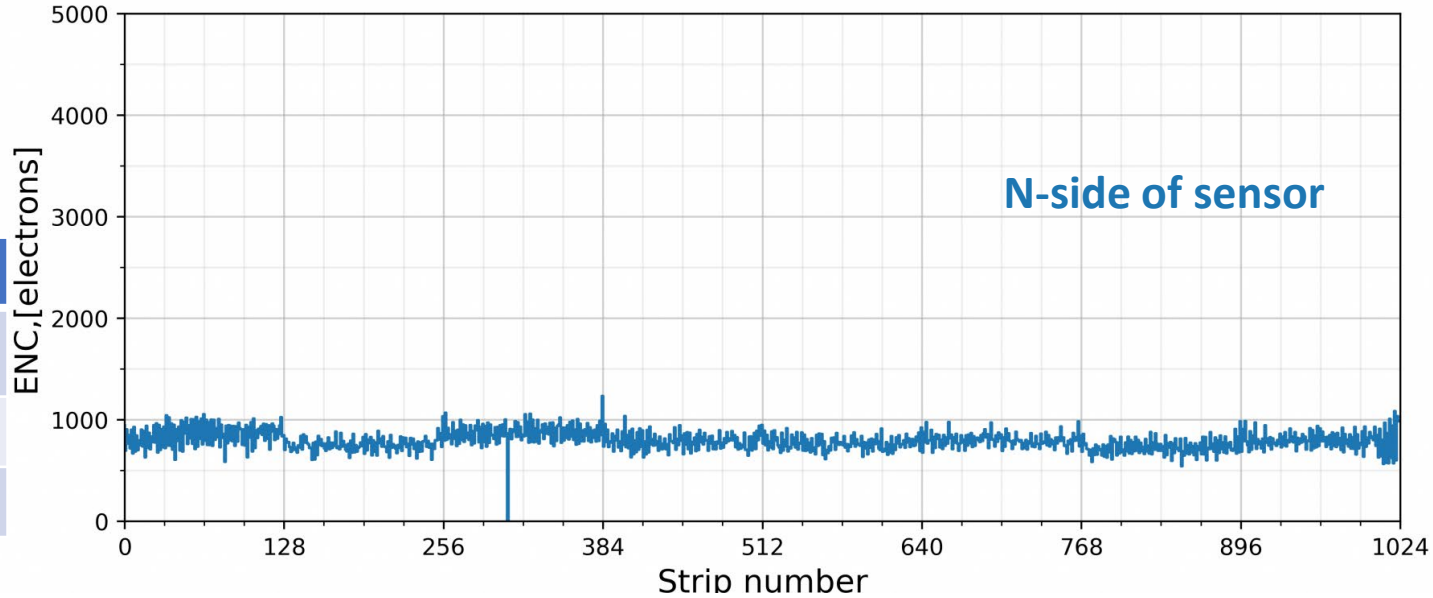
Module	N-side	P-side
M294-6R-212-D001	40 (4%)	23 (2,3%)
M294-2R-212-D003	5 (0.5%)	10 (1%)
M294-2R-212-D004	7 (0.7%)	11 (1.1%)

Test by: D. Dementev, M. Shitenkow.



V_{bias} = 100V;
I_L = 300 nA;

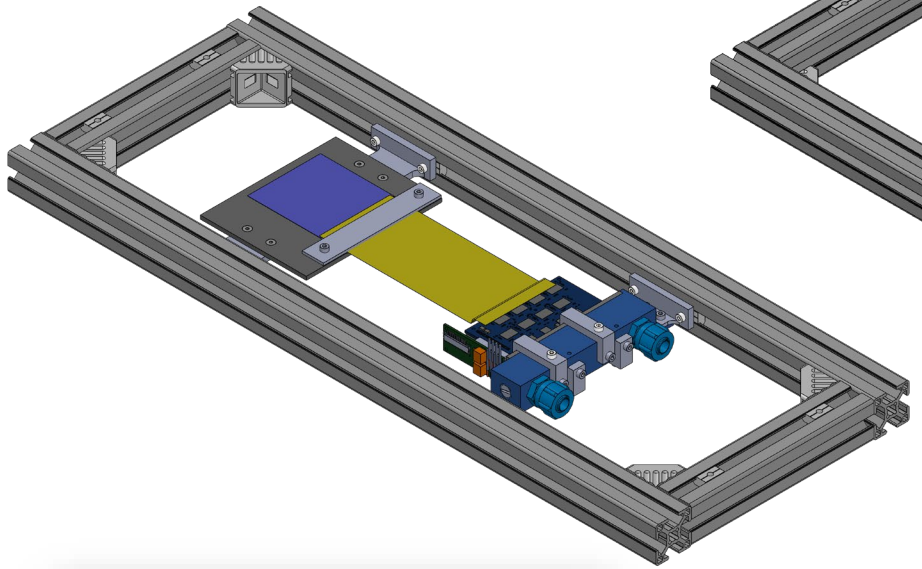
Mean: 880 e^-



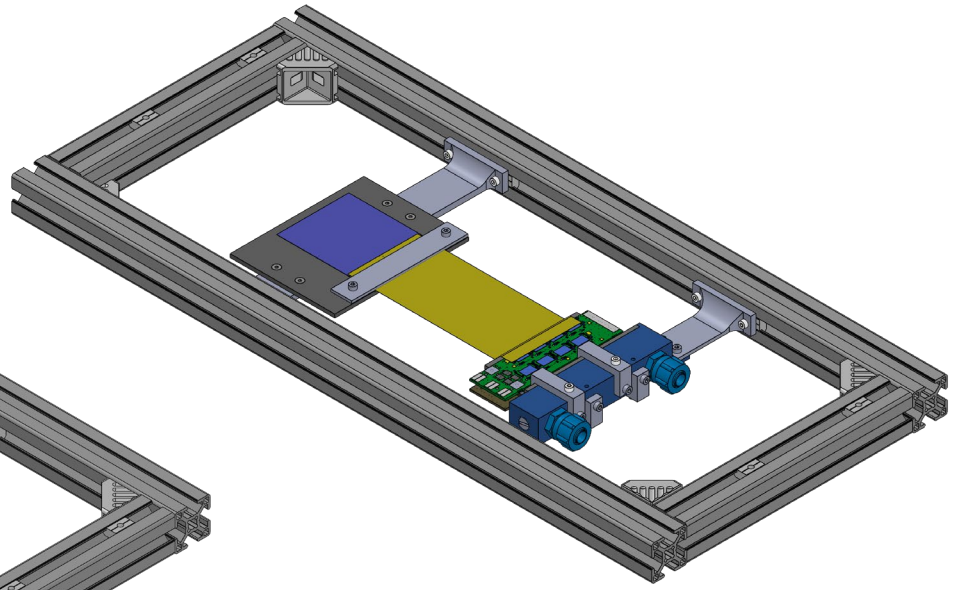
Mean: 795 e^-

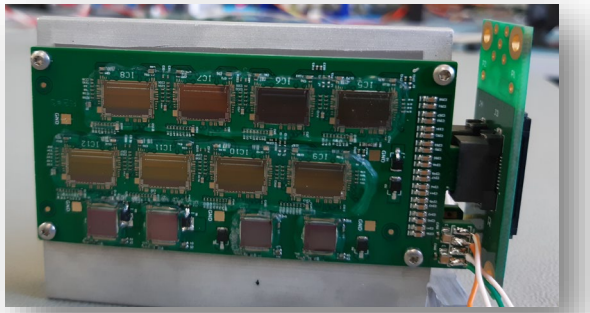
Concept of jig for testing and storage

Test tool
for BM@N module

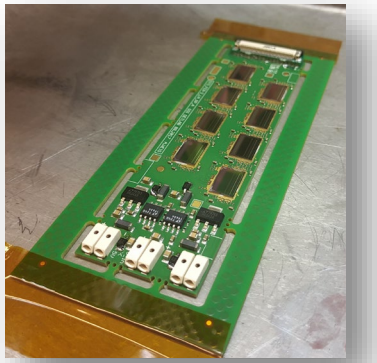


Test tool for CBM module

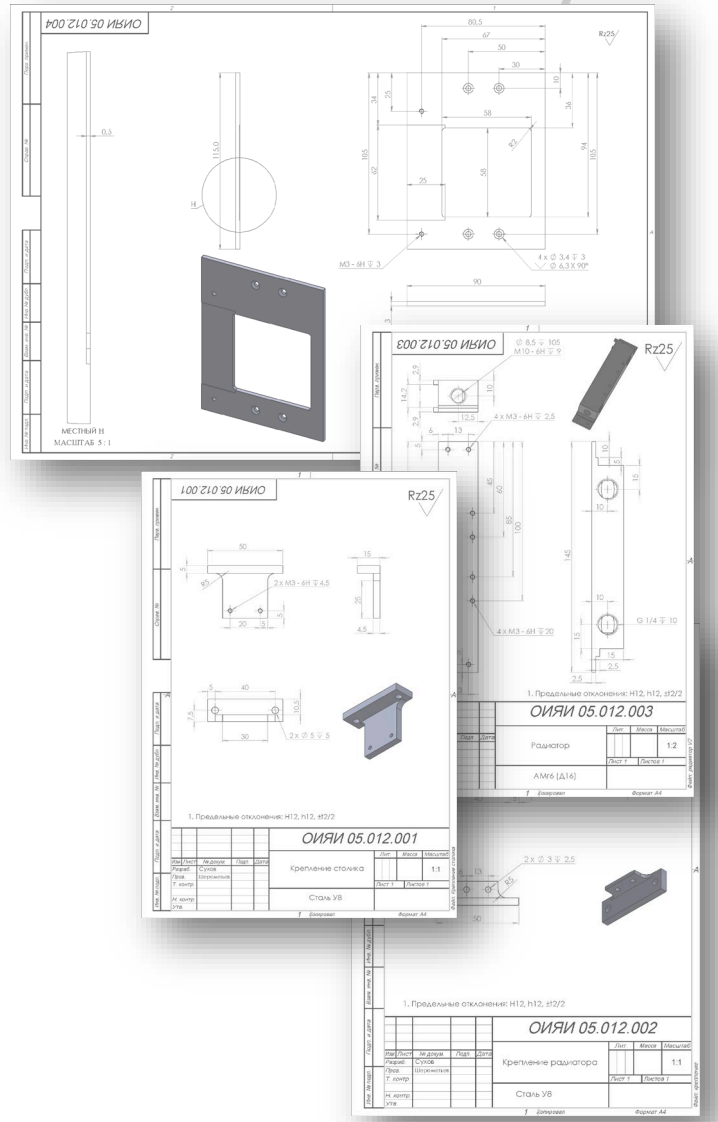




BM@N design of FEB



CBM design of FEB



Conclusions

- Assembly workflow has been developed and tested
- Workplaces and test benches for key technological operations has been prepared
- Set of bonding tools for assembly was designed and manufactured
- QA procedures for all components and steps of the assembly has been developed
- Technological documentation and Electronic logbook customize design has been development to store data during assembly modules
- Five modules have been assembled at JINR lab, still more components for assembly of 20 modules are required to estimate production yields for mass production

Thank you for attention!