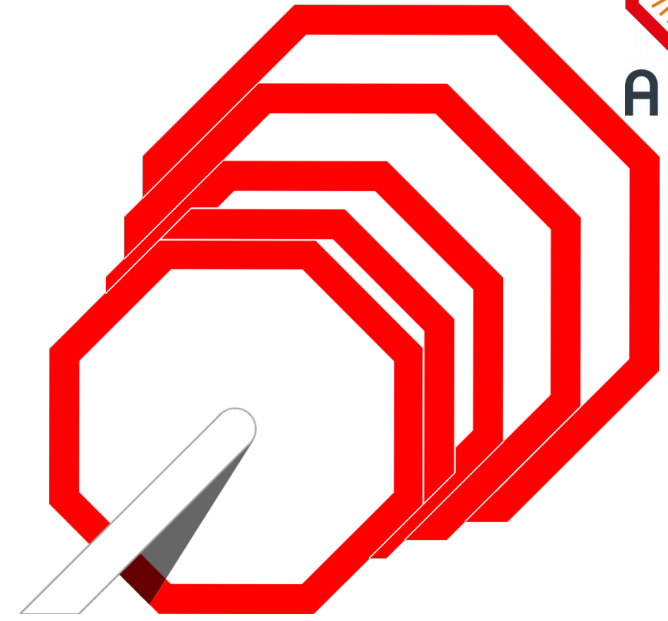




ALICE



**MFT**

# **Latest news on from CERN**

**Diana Krupova**

Czech Technical University

UPC Decin

26/09/2019

Workshop supported by grant SVK30/19/F4

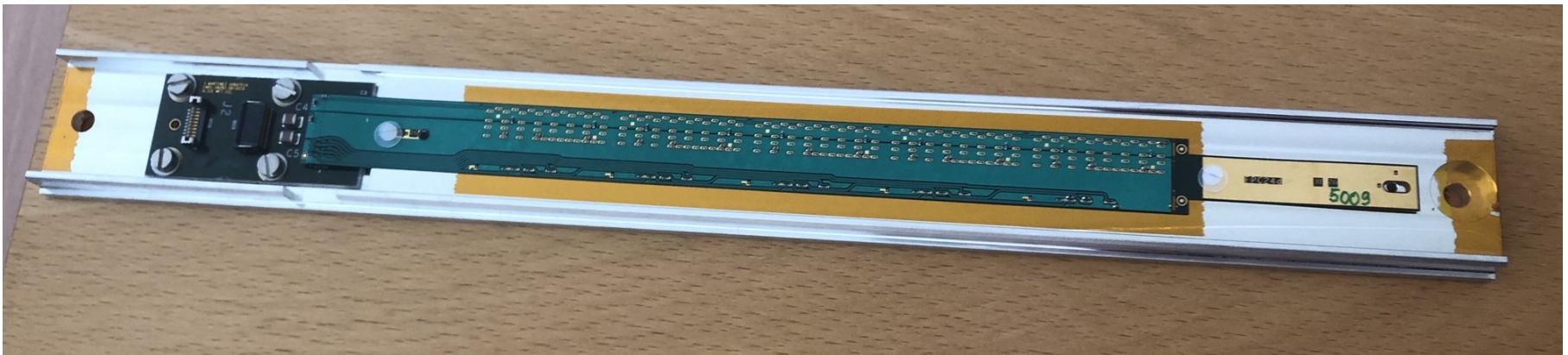
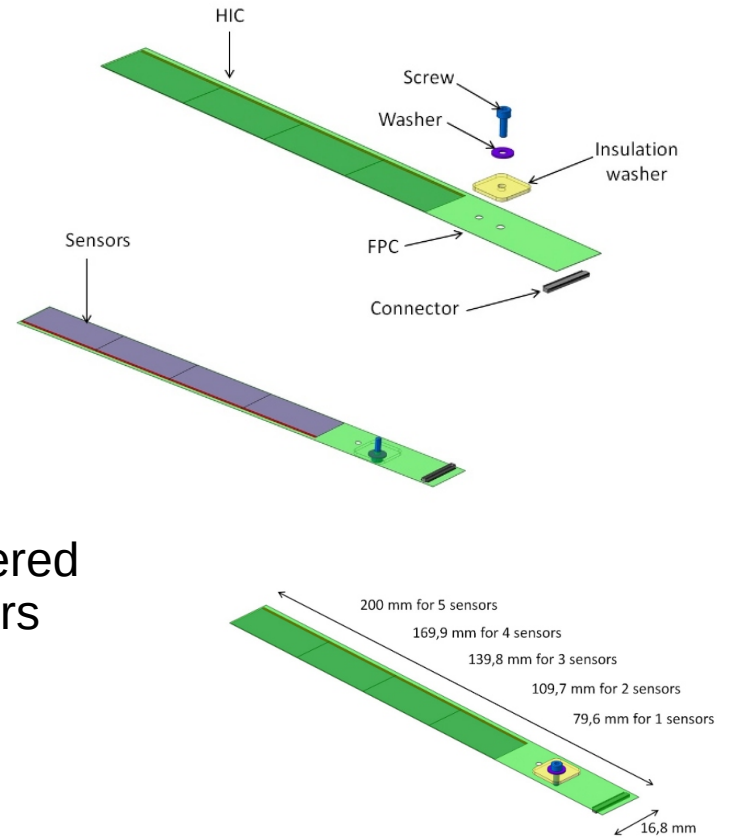


# Outline

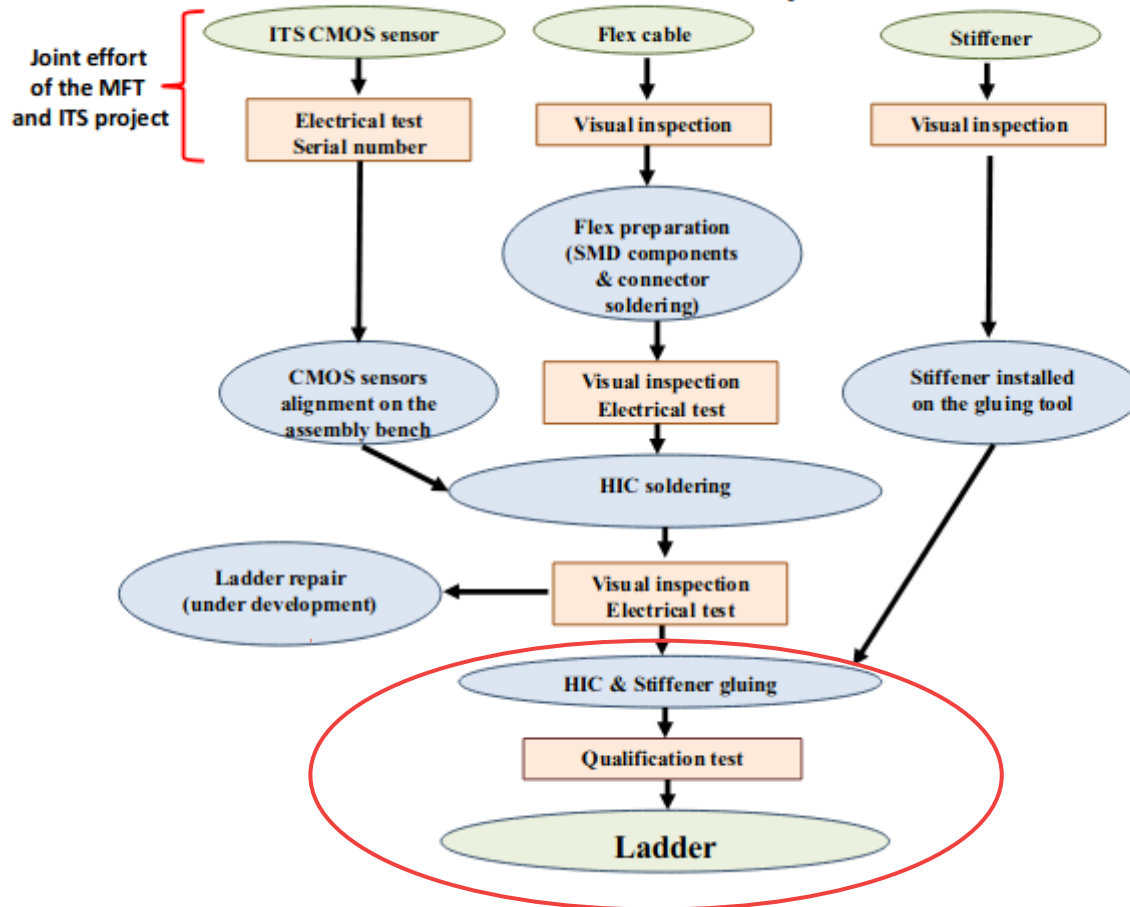
- Ladders
- Ladder design
- Ladder assembly
- Ladder qualification

# Ladder design

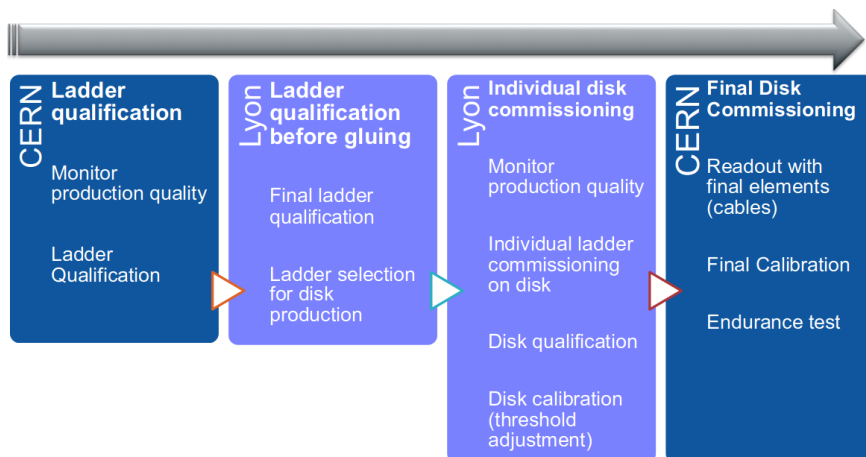
- the stiffener
- the silicon pixel sensors
- the Flexible Printed Circuit (FPC)
- 
- HIC (Hybrid Integrated Circuit) – sensors laser-soldered to the FPC with a gap of 100  $\mu\text{m}$  between sensors
- FPC precisely positioned during assembly



# MFT ladder assembly scenario



## Commissioning:

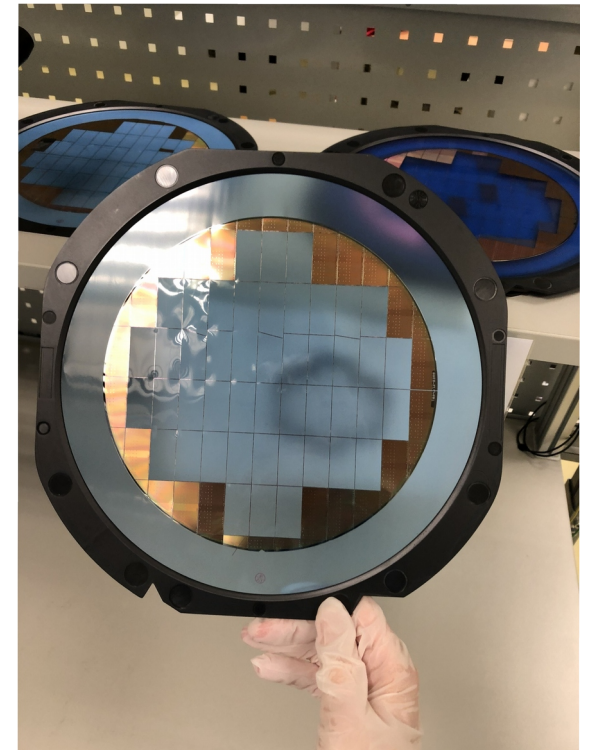
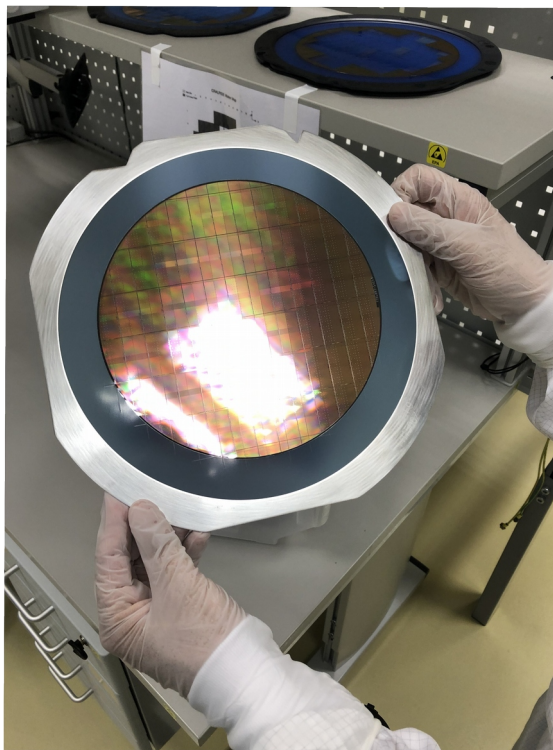
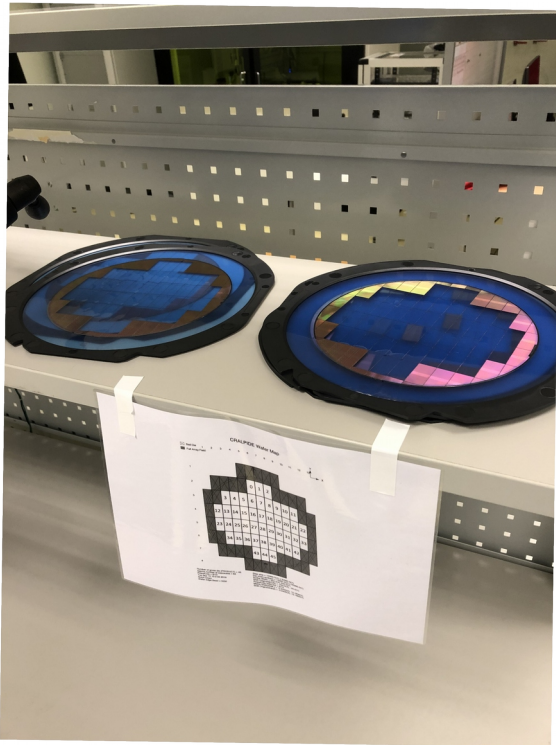


# Ladder assembly

- FPC placed on top of sensors
- Placing soldering grid on top, soldering of each connection
- HIC removed from vacuum table
- Stiffener is placed in the gluing tool – glue is applied
- HIC placed on top of stiffener
- Quality tests of ladders

# Ladder assembly ~wafers

- wafer production, thinning, dicing and qualification – procedure defined by ITS
- 100 wafer allocated for MFT (3 half-MFT + spares + prod. yield)



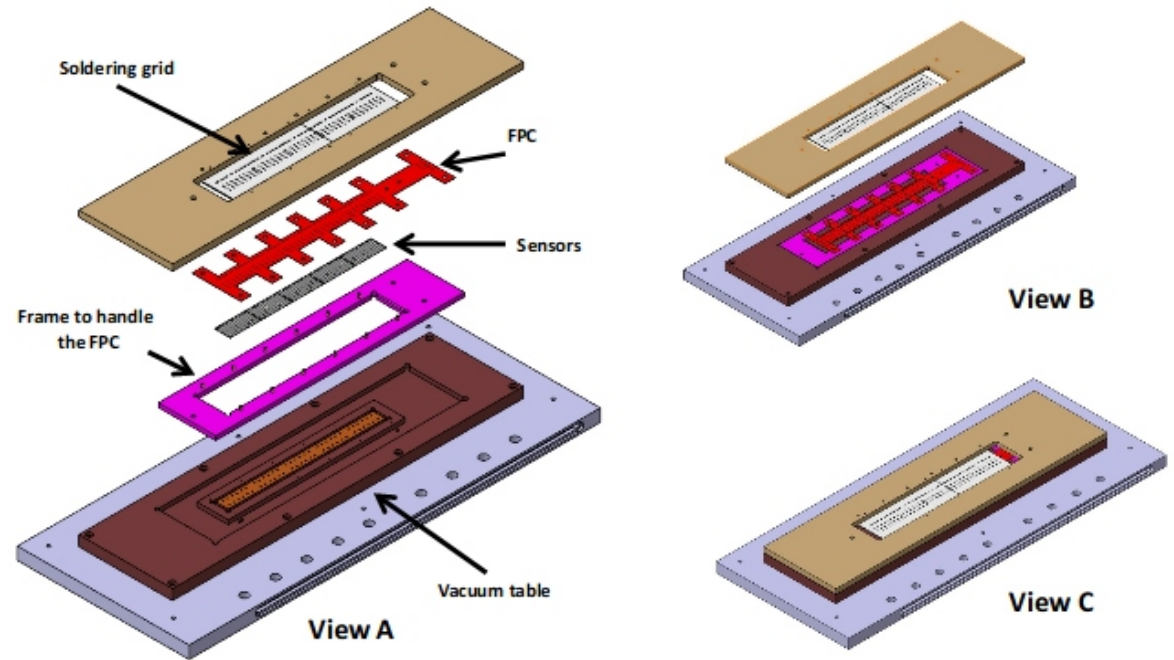
# Chip cleaning



# Positioning FPC

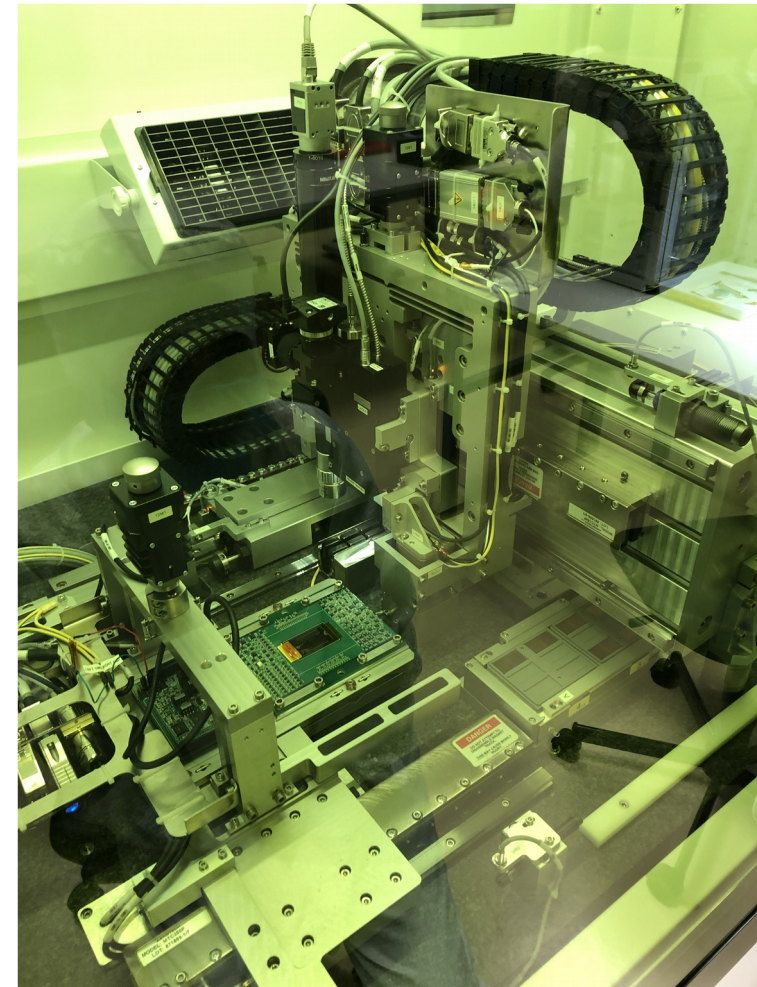
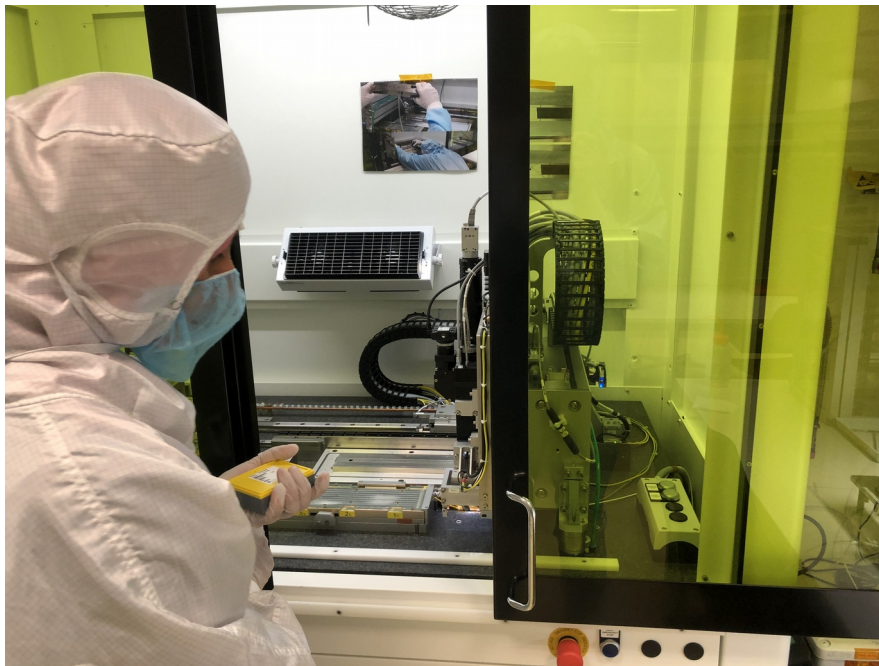


# Ladder assembly

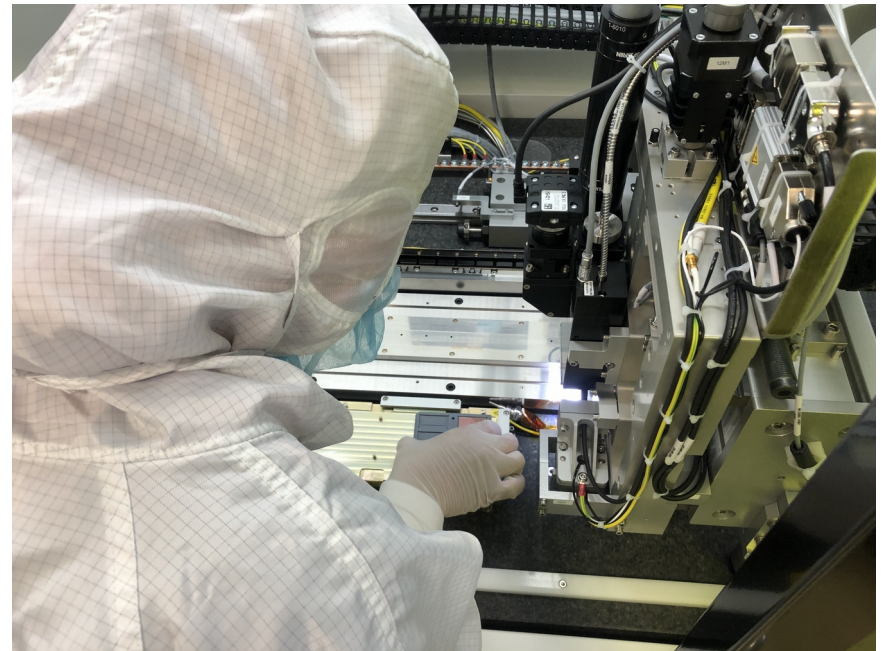
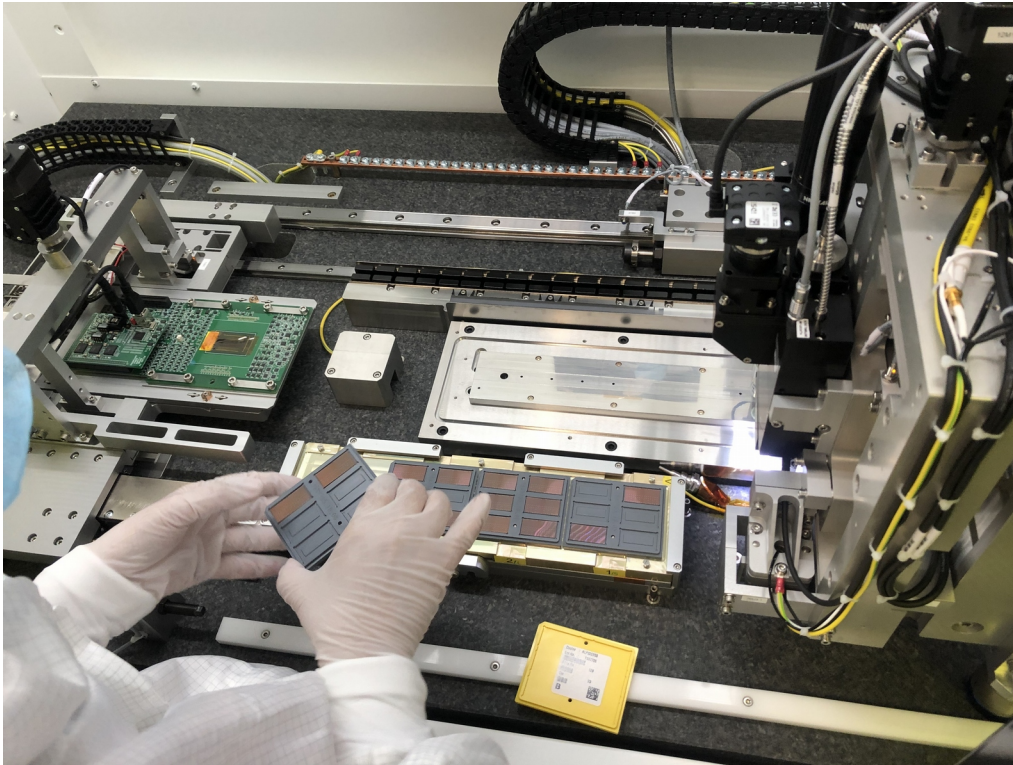


# Ladder assembly ~ALICIA

- automatic assembly system ALICIA
- ALICIA picks up each fragile chip from a supply tray and places it on the frame and solder all interconnects
- high-accuracy image system ( $< 0.1 \mu\text{m}$ ) to measure markers
- final assembly accuracy of  $< 5 \mu\text{m}$  over full array of chips

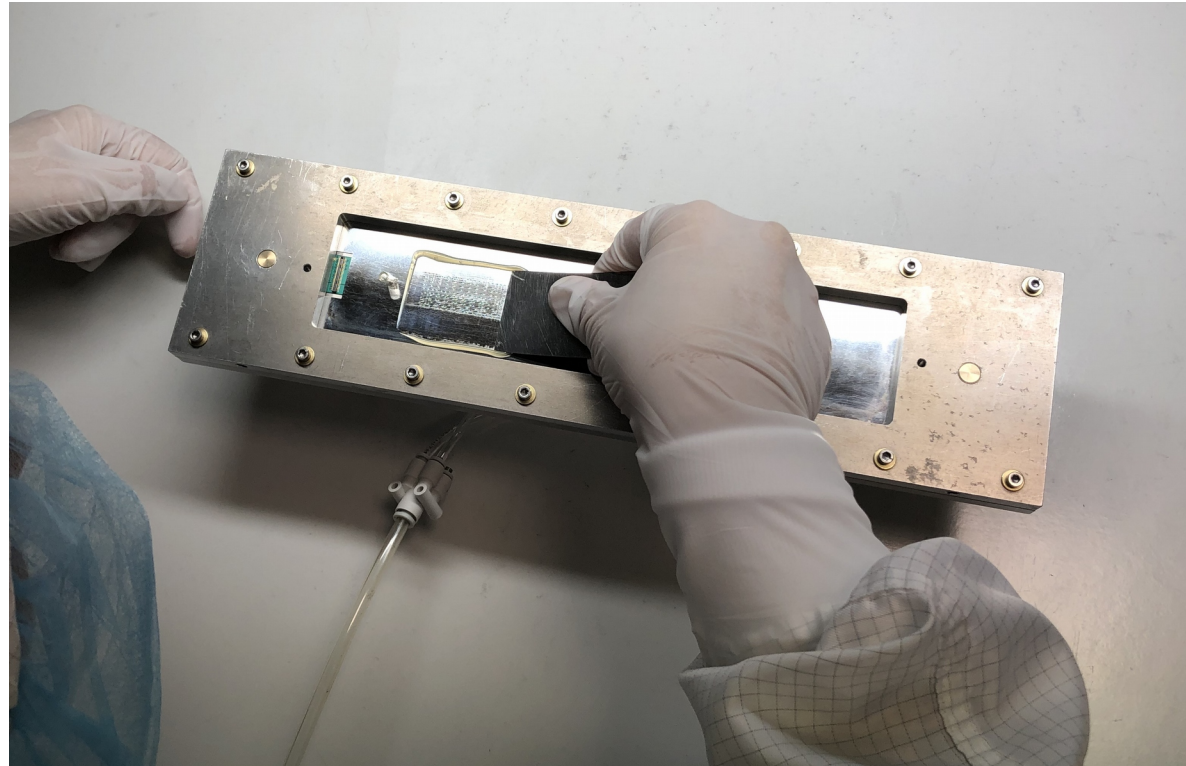


# Ladder assembly ~ALICIA chips positiniong



# Ladder assembly ~gluing

- glue preparation + FPC-chip gluing

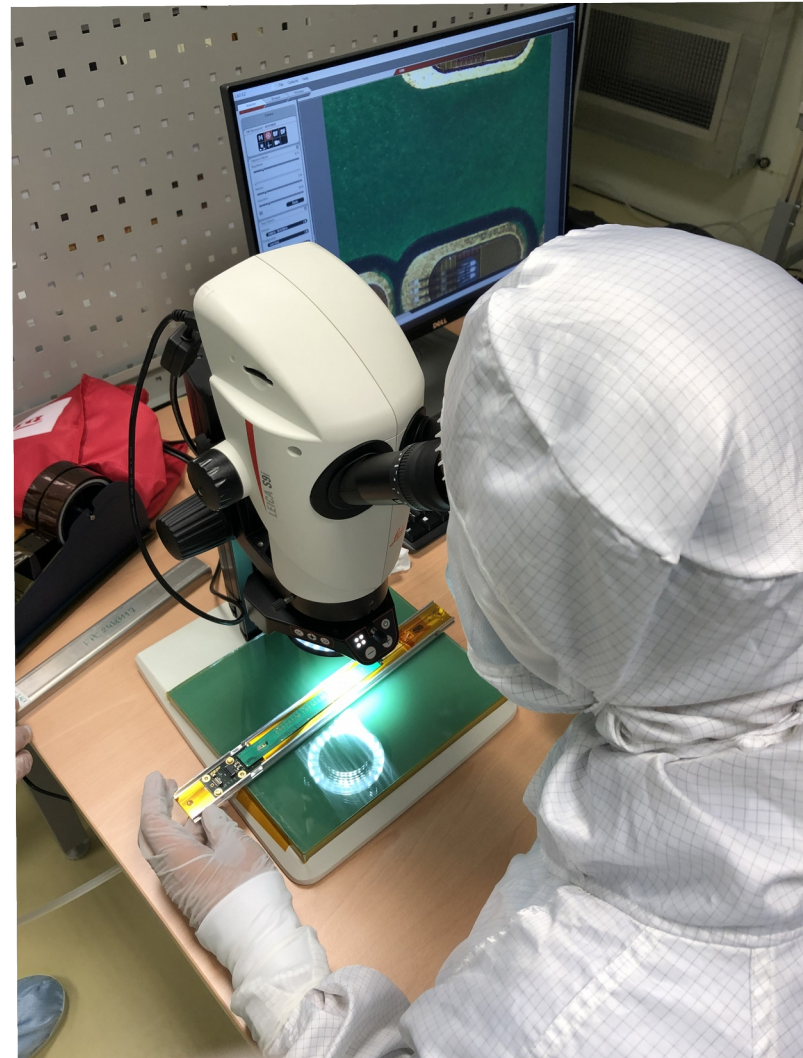
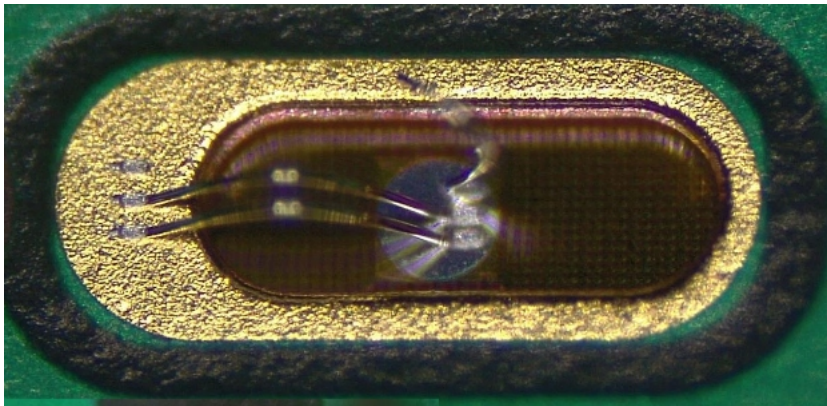


# Bonding

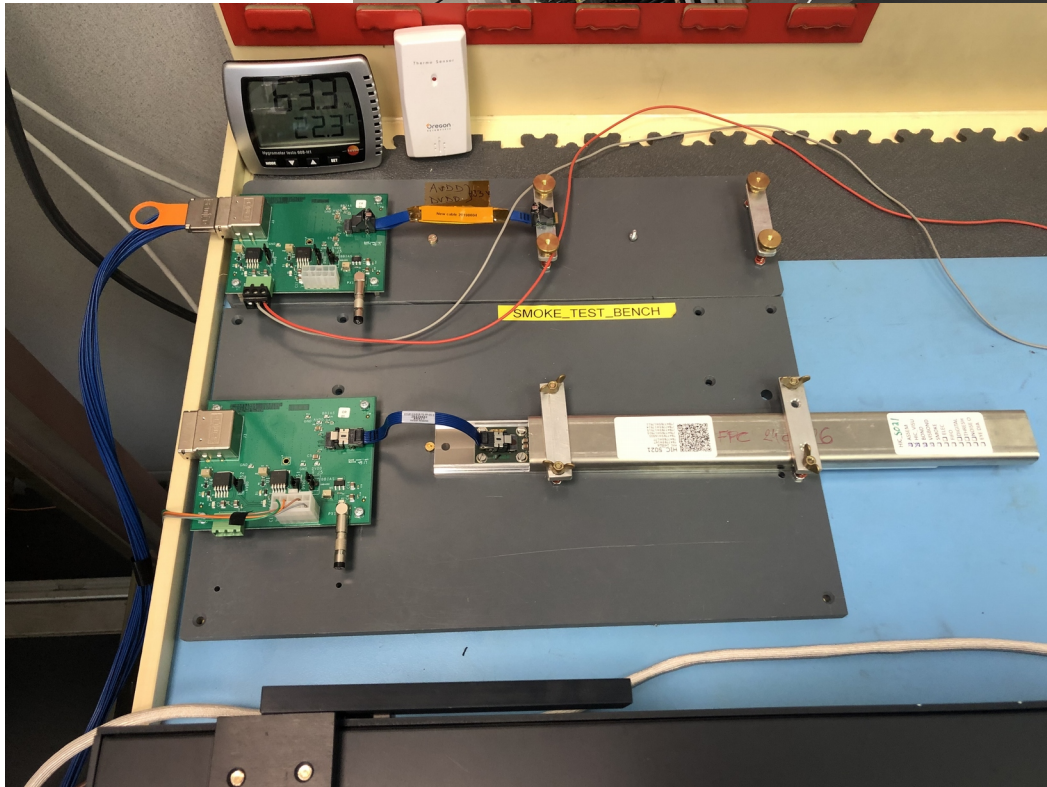
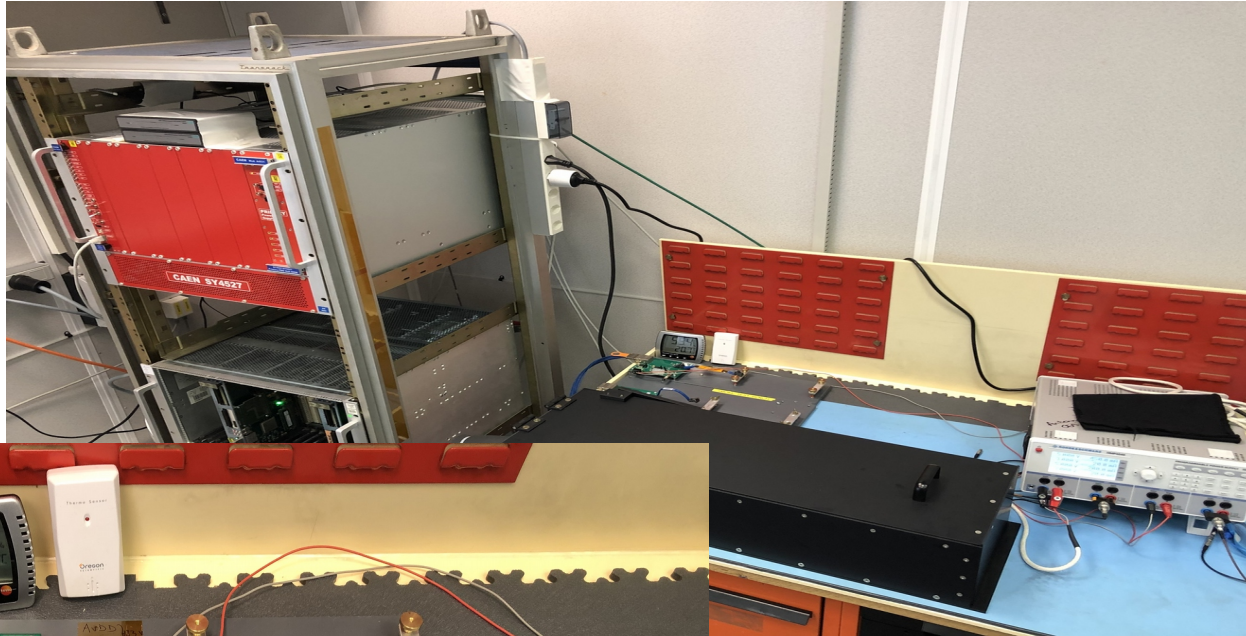
Pull tests (tests for wire bond strength and quality): average weight 11g



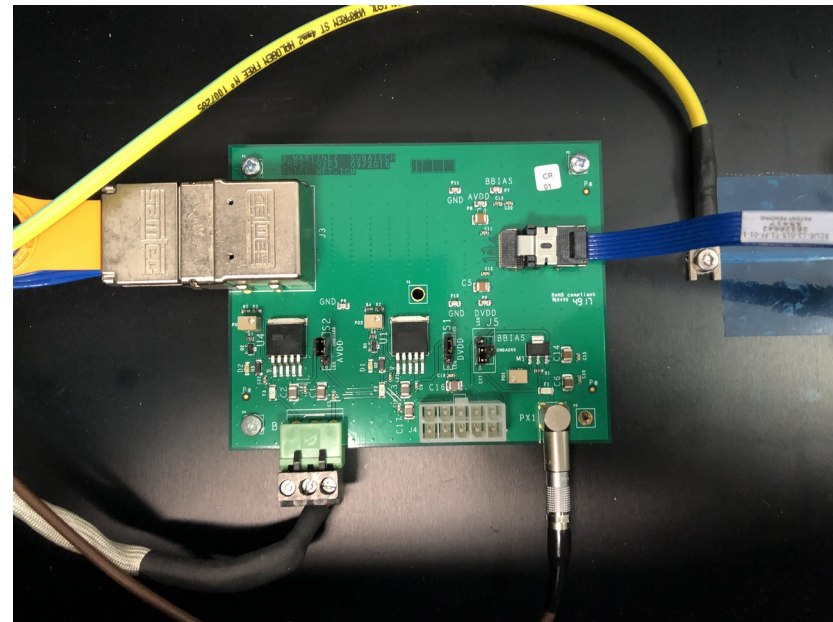
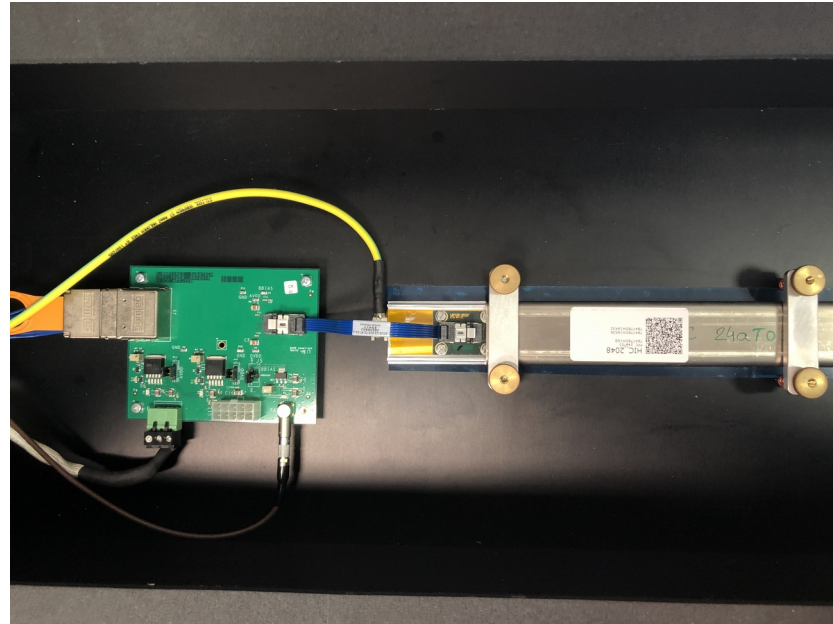
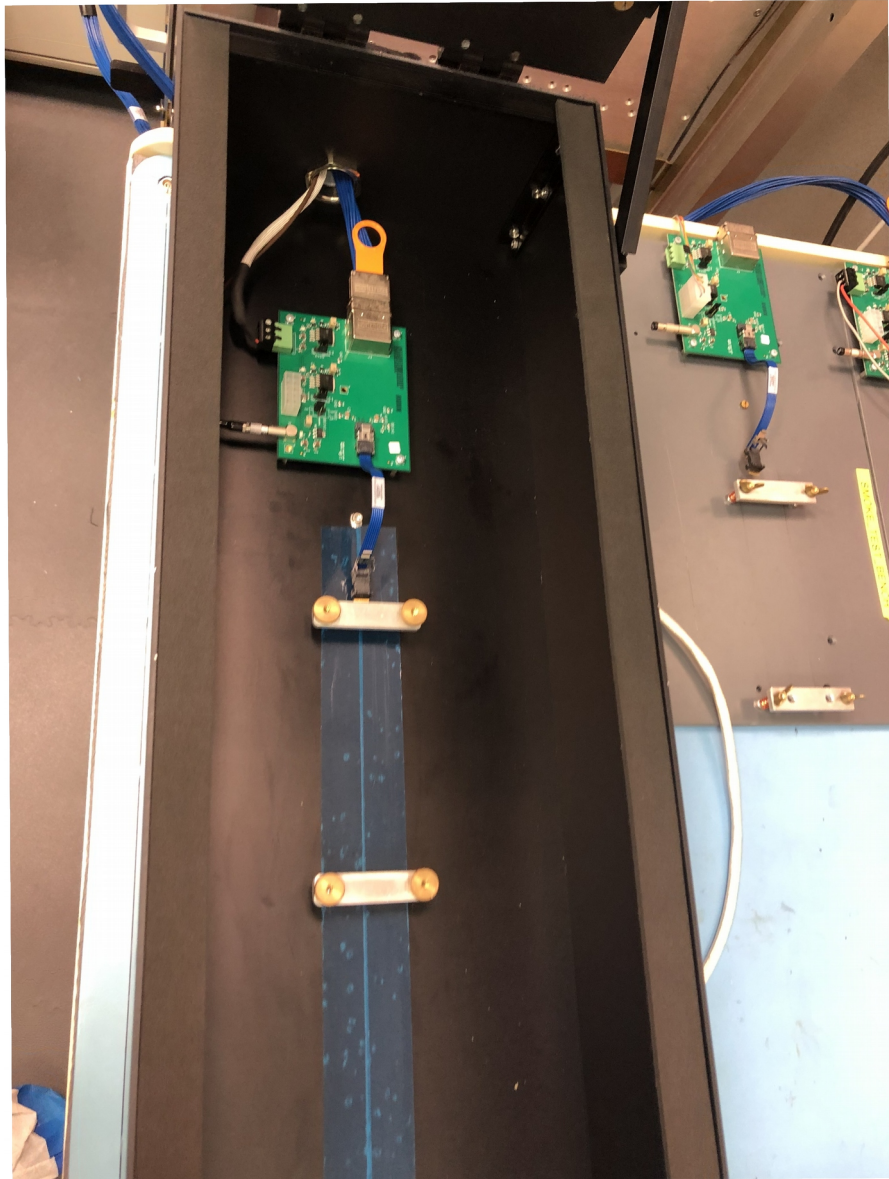
MFT – Ladder Production – ALICE mini-week – September 24th 2019



# Ladder qualification



# Ladder qualification



# Ladder qualification

- Smoke test
- FIFO scan (slow control)
- Digital scan (digital circuitry test)
- Threshold adjustment (analog circuitry test + threshold equalization)
- Noise occupancy
- Eye diagram (output signal strength and stability test)

gold + silver yield: 88%

Number of 8b10b errors	0
Number of corrupt events	0
Number of oversized events	0
Number of timeouts	0

**Functional Tests Status**  
check tests which have been done

☒ FIFO test

☒ Digital test without back-bias

☒ Threshold test without back-bias

☒ Noise occupancy without back-bias

☒ Digital test with back-bias

☒ Threshold test with back\_bias

☒ Noise occupancy with Back-bias

☒ Eye Diagram

☒ Files added in the Cernbox ladder\_Func Folder

**Final status LADDER\_FUNC :**

☐ Undefined

☒ Conformal

☐ Require intervention

☐ Non conformal

# Ladder qualification

- Smoke test
- FIFO scan (slow control)
- Digital scan (digital circuitry test)
- Threshold adjustment (analog circuitry test + threshold equalization)
- Noise occupancy
- Eye diagram (output signal strength and stability test)



# Ladder qualification

- Smoke test
- FIFO scan (slow control)
- Digital scan (digital circuitry test)
- Threshold adjustment (analog circuitry test + threshold equalization)
- Noise occupancy
- Eye diagram (output signal strength and stability test)

The screenshot displays the 'Alpide Testing' software interface. On the left, under the 'Actions' tab, there is a table titled 'MFT HIC Qualification' and 'MFT HIC'. The table lists seven test steps, each with a status of 'Done' and a completion time. The fourth and fifth steps are highlighted in cyan. To the right of the table, there is a section titled 'MFT Upgrade HIC qualification' which includes a sub-section 'MFT HIC' containing five buttons labeled 'Chip4', 'Chip5', 'Chip6', 'Chip7', and 'Chip8'.

	scan	status
1	Fifo Scan	Done (in 33 sec)
2	Digital Scan BB 0	Done (in 12 sec)
3	Threshold Scan 3.0 V	Done (in 36 sec)
4	Tune VCASN Scan 3.0 V	Done (in 56 sec)
5	Tune ITHR Scan 3.0 V	Done (in 44 sec)
6	Threshold Scan 3.0 V	Done (in 4 min)
7	Noise Occupancy 3.0 V	Done (in 30 sec)

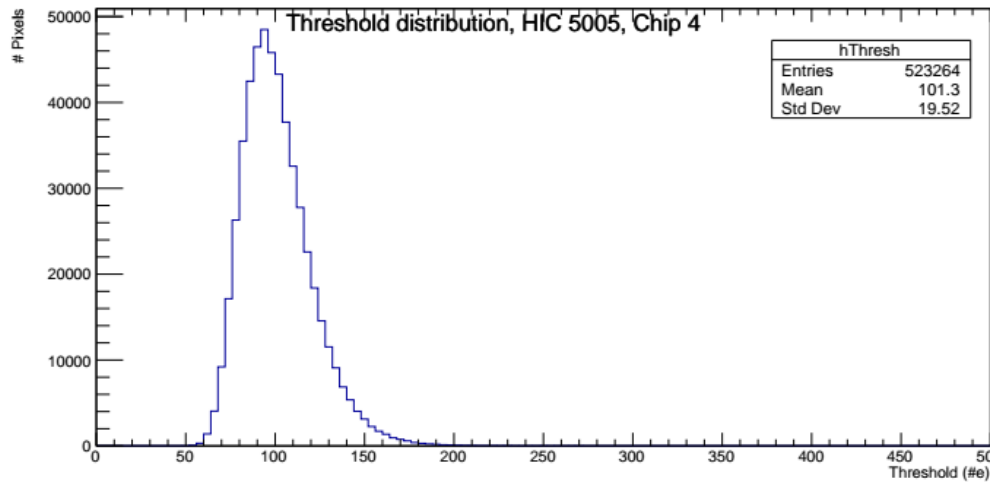
MFT Upgrade HIC qualification

MFT HIC

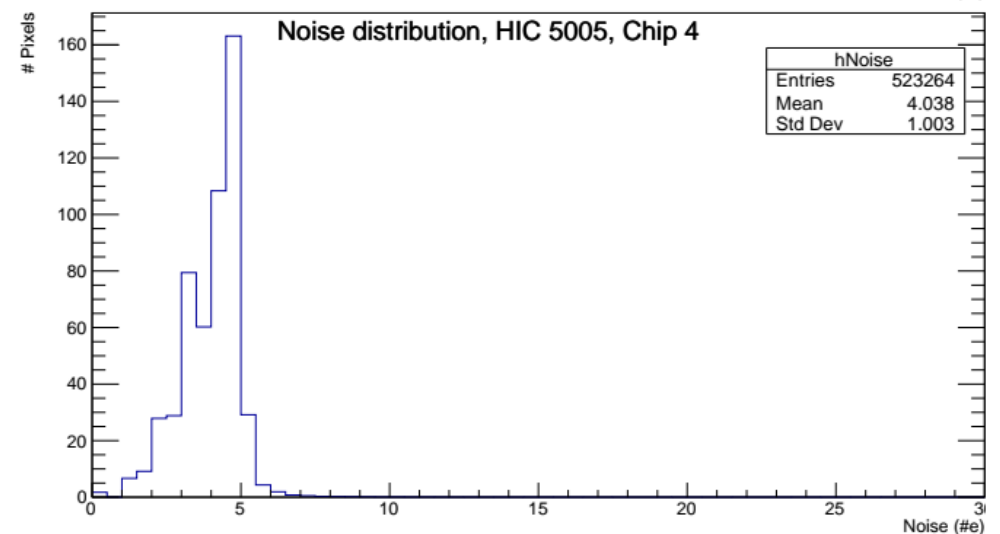
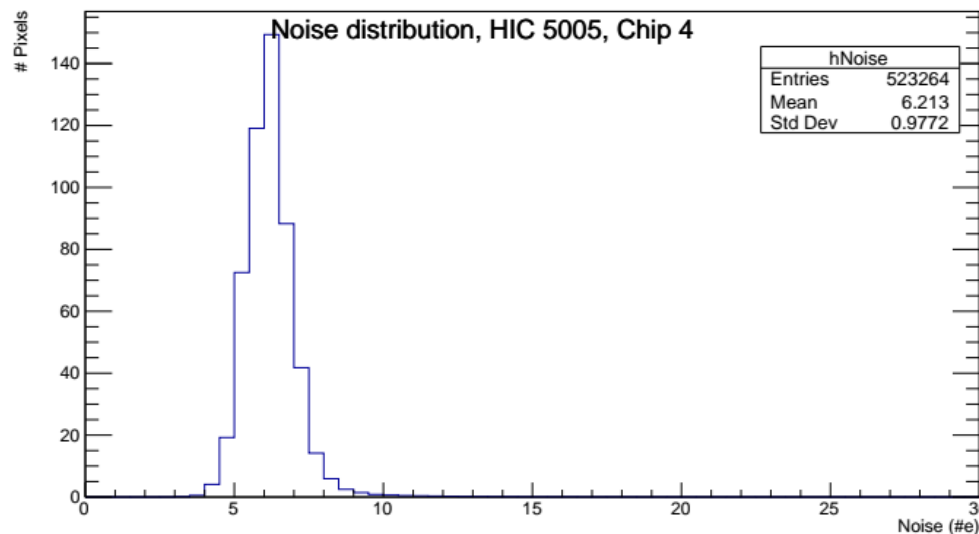
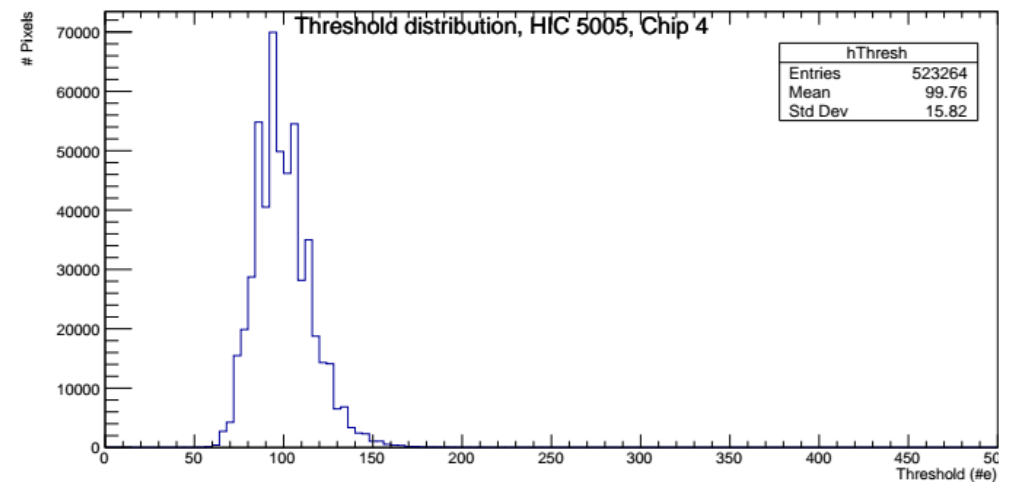
Chip4 Chip5 Chip6 Chip7 Chip8

# Threshold distributions

Without back-bias

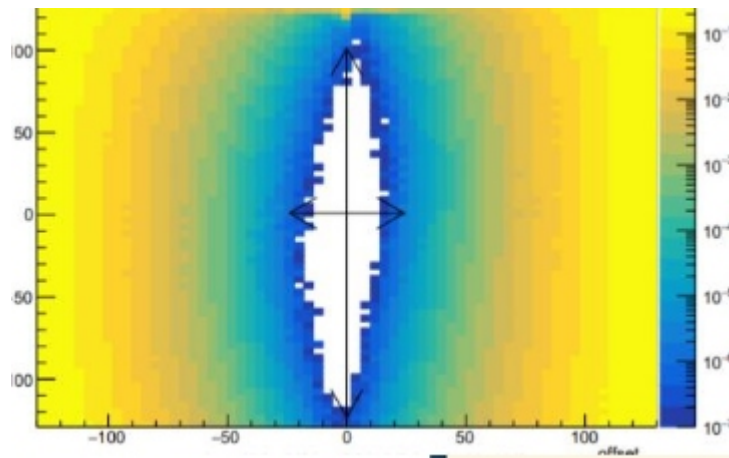


With back-bias



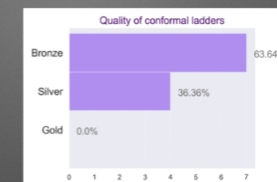
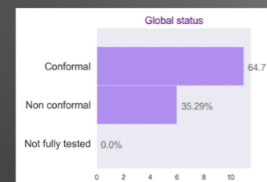
# Ladder qualification

- Smoke test
- FIFO scan (slow control)
- Digital scan (digital circuitry test)
- Threshold adjustment (analog circuitry test + threshold equalization)
- Noise occupancy
- Eye diagram (output signal strength and stability test)

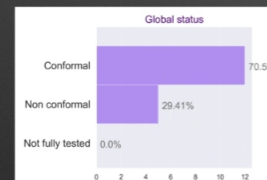


## Better yield of 5-chip ladders

Charge pump = 8 (default value)



Charge pump = 10



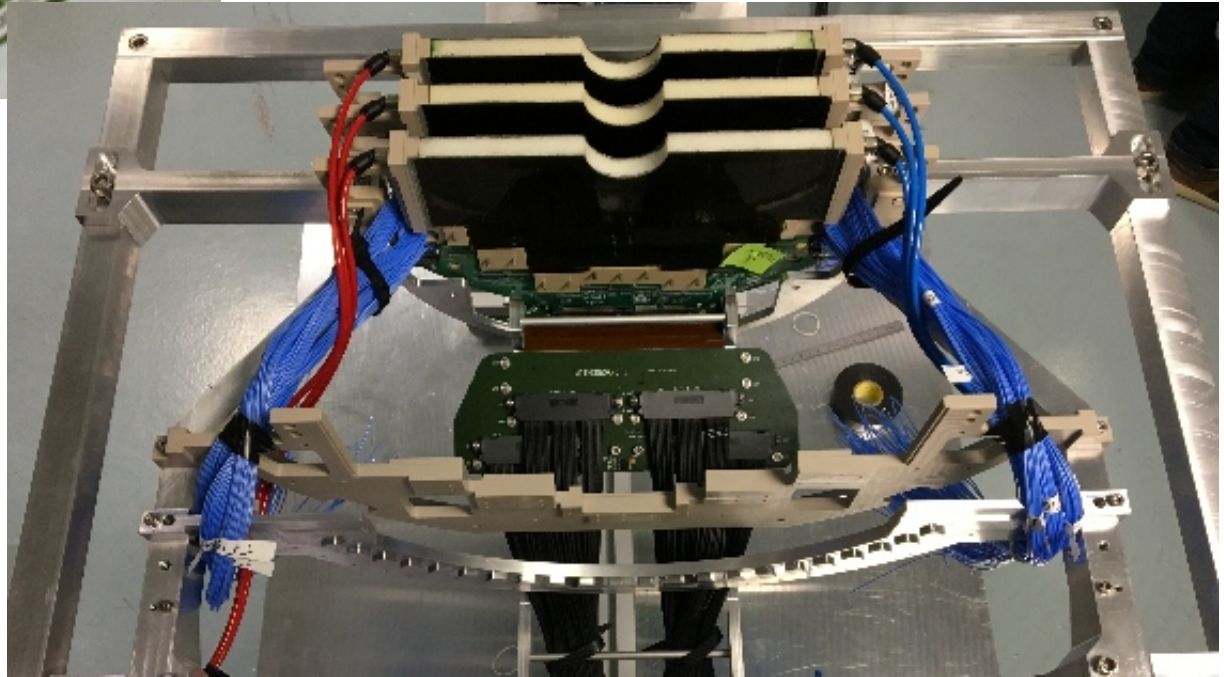
# Qualification results

Sl No.	Ladder	FIFO	Digital	Threshold	Noise	Eye-diagram	Comments	Date of test
1	4094	Gold/ Gold	Silver/ Silver	Silver/ Silver	Gold/ Gold	Bronze	Conformal	10-09-2019
2	5009 (Retested)	Gold/ Gold	Silver/ Silver	Silver/ Silver	Gold/ Gold	Silver	Conformal	10-09-2019
3	5021	Gold/ Gold	Silver/ Silver	Silver/ Silver	Gold/ Gold	Silver	Conformal	11-09-2019
4	4093	Gold/ Gold	Silver/ Silver	Silver/ Silver	Gold/ Blue	Silver	Non-Conformal	11-09-2019
5	2048	Gold/ Gold	Silver/ Silver	Silver/ Silver	Gold/ Gold	Silver	Conformal	11-09-2019
6	3103 (Retested)	Gold/ Gold	Silver/ Silver	Silver/ Silver	Silver/ Gold	Silver	Conformal	11-09-2019
7	4009 (retested)	Gold/ Gold	Silver/ Silver	Silver/ Silver	Silver/ Gold	Bronze	Conformal	12-09-2019
8	3163	Gold/ Gold	Silver/ Silver	Silver/ Silver	Gold/ Gold	Silver	Conformal	12-09-2019
9	3164	Gold/ Gold	Silver/ Silver	Silver/ Silver	Gold/ Gold	Silver	Conformal	12-09-2019
10	3165	Gold/ Gold	Silver/ Gold	Silver/ Gold	Gold/ Gold	Silver	Conformal	12-09-2019
11	2049	Gold/ Gold	Silver/ Silver	Silver/ Silver	Gold/ Gold	Silver	Conformal	12-09-2019
12	3084 (retested)	Gold/ Gold	Red/ Red	Red/ Red	Gold/ Gold	Silver	Non-conformal	12-09-2019
13	2050	Gold/ Gold	Silver/ Silver	Silver/ Silver	Gold/ Gold	Silver	Conformal	13-09-2019
14	3158	Gold/ Gold	Silver/ Gold	Silver/ Gold	Gold/ Gold	Gold	Conformal	13-09-2019
15	4010 (retested)	Gold/ Gold	Silver/ Silver	Silver/ Silver	Silver/ Gold	Bronze	Conformal	13-09-2019
16	3161	Gold/ Gold	Gold/ Gold	Gold/ Gold	Gold/ Gold	Silver	Conformal	13-09-2019

# Qualification results

Sl No.	Ladder	FIFO	Digital	Threshold	Noise	Eye-diagram	Comments	Date of test
1	4032 (retested)	Gold/ Gold	Silver/ Gold	Silver/ Silver	Silver/ Gold	Bronze	Conformal	16-09-2019
2	4036 (retested)	Gold/ Gold	Silver/ Silver	Silver/ Silver	Silver/ Gold	Bronze	Conformal	16-09-2019
3	4045 (retested)	Gold/ Gold	Silver/ Silver	Silver/ Silver	Silver/ Gold	Bronze	Conformal	16-09-2019
4	3166	Gold/ Gold	Silver/ Silver	Silver/ Silver	Gold/ Gold	Gold	Conformal	17-09-2019
5	3167	Gold/ Gold	Gold/ Gold	Gold/ Gold	Gold/ Gold	Silver	Conformal	17-09-2019
6	3168	Gold/ Gold	Silver/ Silver	Silver/ Silver	Gold/ Gold	Silver	Conformal	17-09-2019
7	3169	Gold/ Gold	Silver/ Gold	Silver/ Gold	Gold/ Gold	Silver	Conformal	17-09-2019
8	5005 (retested)	Gold/ Gold	Silver/ Silver	Silver/ Silver	Silver/ Gold	Silver	Conformal	17-09-2019
9	3171	Gold/ Gold	Silver/ Silver	Silver/ Silver	Gold/ Gold	Silver	Conformal	18-09-2019
10	3172	Gold/ Gold	Silver/ Silver	Silver/ Silver	Gold/ Gold	Silver	Conformal	18-09-2019
11	3173	Gold/ Gold	Silver/ Silver	Silver/ Red	Gold/	Silver	Non-conformal	19-09-2019
12	3174	Gold/ Gold	Gold/ Gold	Gold/ Gold	Gold/ Gold	Gold	Conformal	19-09-2019
13	3176	Gold/ Gold	Silver/ Silver	Silver/ Silver	Gold/ Gold	Silver	Conformal	19-09-2019
14	3175	Gold/ Gold	Silver/ Silver	Silver/ Silver	Gold/ Gold	Silver	Conformal	19-09-2019
15	3170	Gold/ Gold	Silver/ Silver	Silver/ Silver	Gold/ Gold	Silver	Conformal	19-09-2019
16	3177	Gold/Gold	Gold/Gold	Gold/Gold	Gold/Gold	Silver	Conformal	24-09-2019

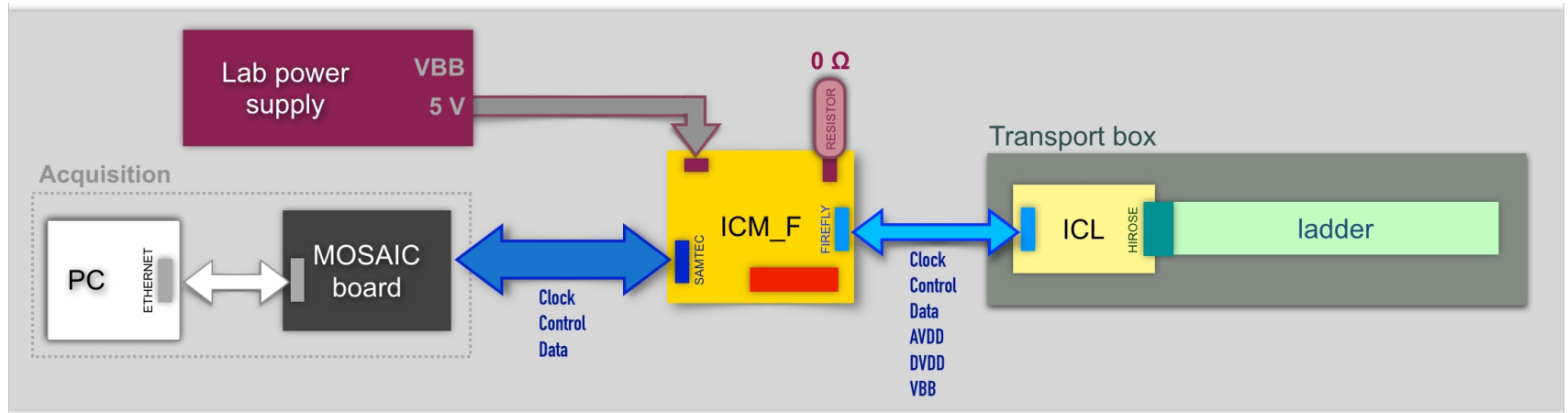
**Ladder assembly →  
half-disk assembly →  
cone assembly**



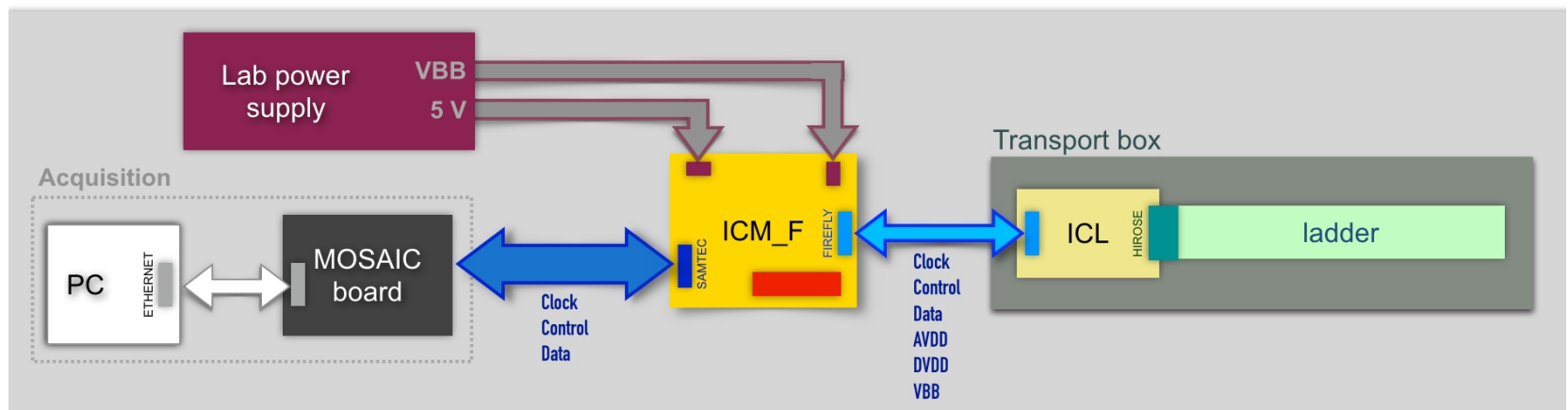


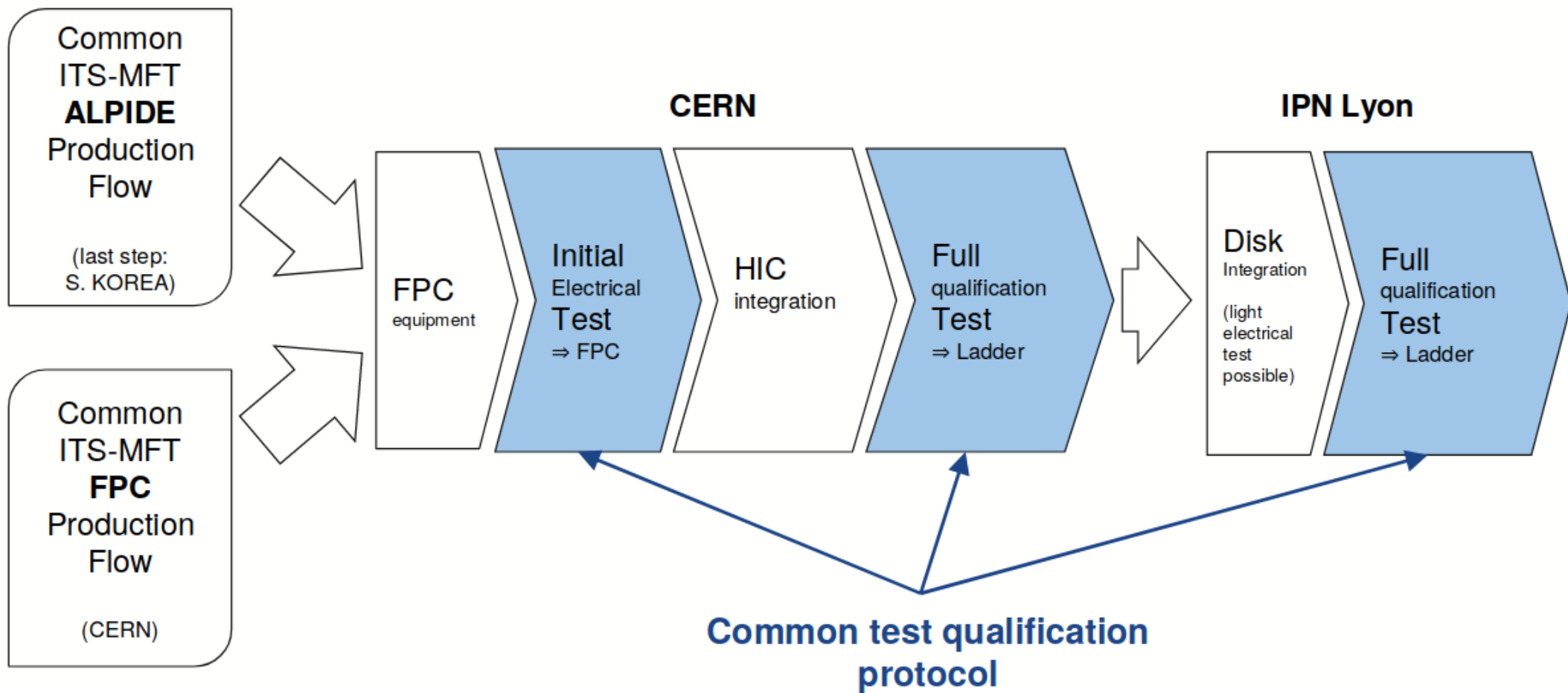
# Additional slides

- Functional tests without back-bias



- Functional tests with back-bias





o

## Procedure overview :

### *Without DAQ*

#### **Electrical Test**

Output:  
Power supplies currents

#### **Communication** (ChipID, Register, FIFO)

Output : go / nogo

### *Functional tests*

#### **Digital scan**

Outputs :  
Dead/noisy pixels

#### **Threshold scan**

Outputs :  
Threshold & noise

### *Optimization tests :*

Thresholds equalization

#### **Analogue scan**

Outputs :  
Parameters / ASIC  
Threshold & noise

### *Endurance tests :*

100 kHz trigger  
48 hours

#### **Continuous readout**

Outputs : go / nogo

#### **Fake hit rate**

Outputs :  
Dead/noisy pixels  
Fake Hit Rate