

12th ALICE ITS upgrade, MFT, and O2 Asian workshop
INHA University
November 19-20, 2018



OB HIC QA at CERN

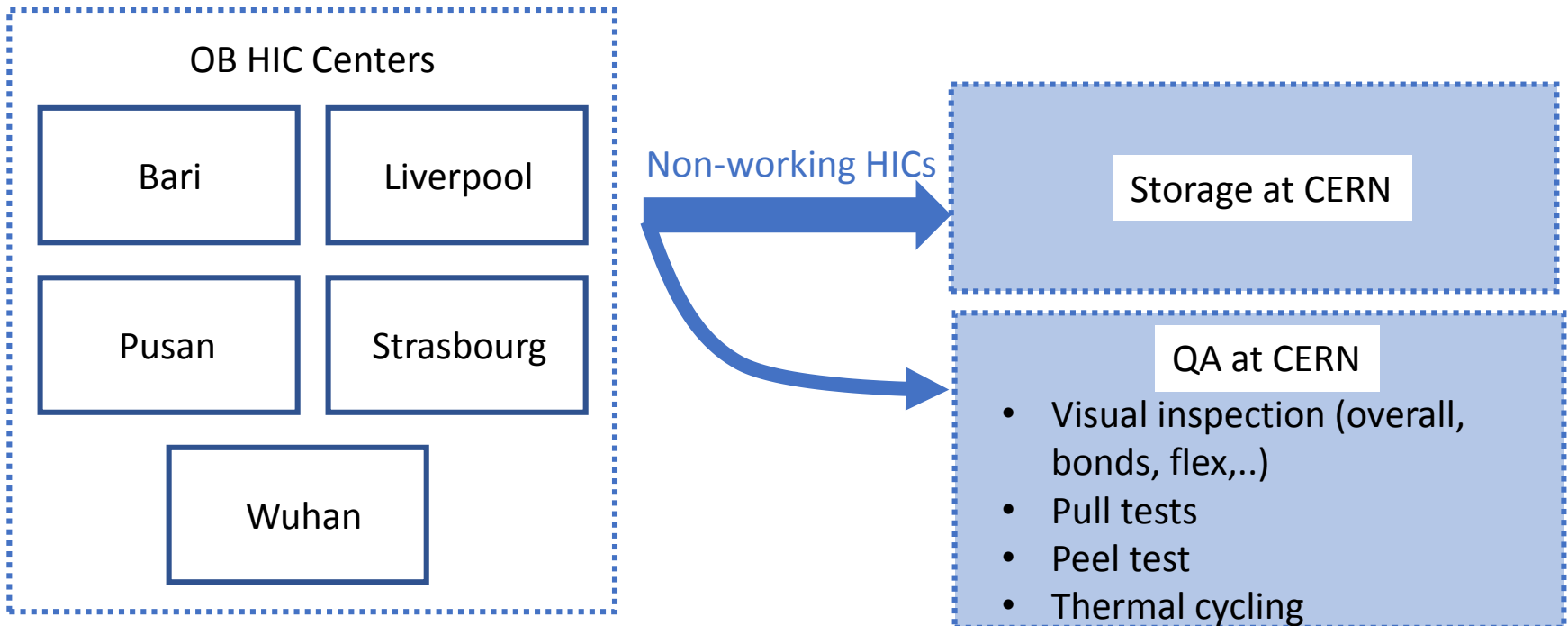
Petra Riedler, CERN

OB HIC QA at CERN



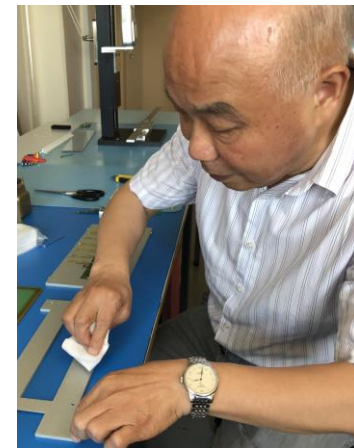
QA tests on a sub-set of OB-HICs from each center

Started in 2018 to provide feed-back in addition to QA done in the centers and have a monitor for production homogeneity across the centers from one location.



OB HIC tests at CERN

- **Many people involved**
 - **Florentina, Ian, Daicui, Andres, Vladimir, Petra**
- Progress reports are given weekly at the TC and HIC meetings as well as in plenary meetings
- All tests and pictures of each HIC are stored in a dedicated folder on cernbox
- Data transferred into construction database



Procedure

1. **Reception:** inspect for any damages on the package, sealing of the wrapping or transport plate, contamination
2. **Inspection:** with a digital microscope of the FPC, bonding connections, glue spots, possible contaminations,...
3. **Bondlab inspection:** visual inspection with a high performance optical microscope (Leica), wire bonding pull tests
4. **Peel test:** glue adhesion strength between FPC and chips, followed by high magnification microscope inspection
5. **Cycling test:** thermal cycling of the HIC, including pull tests before, during and after cycling, followed by peel tests

The procedure has been tuned and improved continuously, adding more detailed inspections, additional information on individual tests, videos, etc.

Example: QA tests on HICs from Bari



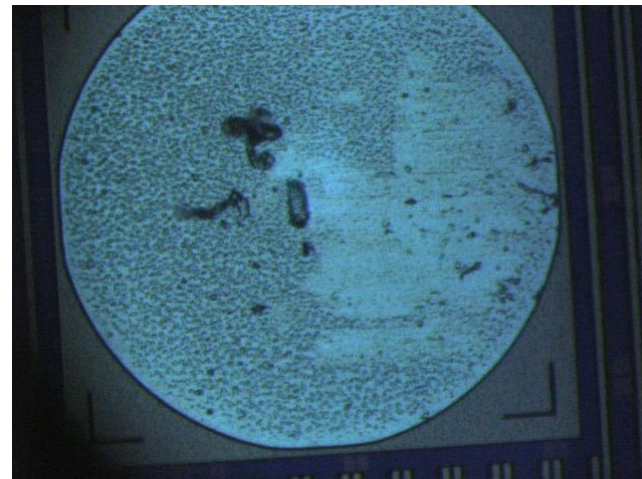
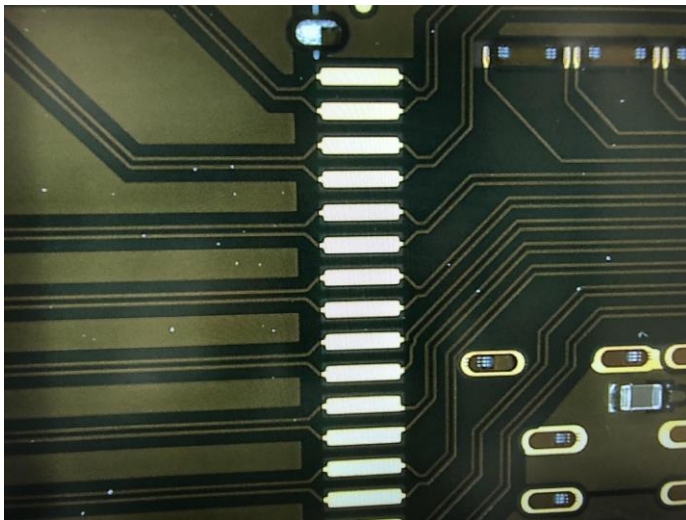
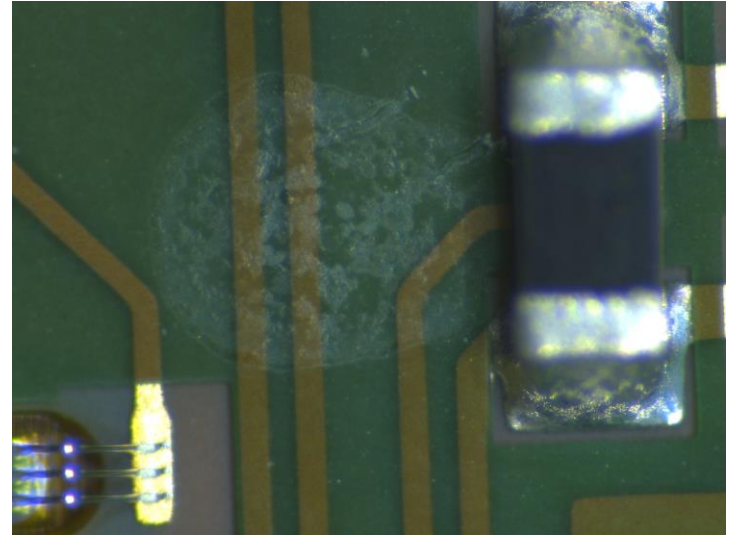
	HIC	Center		QC Tests		Glued/bonded
1	370	Bari	Non-working HIC	Pull test, peel test	Non-final bonding parameters	Jan 9/10 2018
2	592	Bari	Non-working HIC	Pull test, peel test	Final bonding	Apr 4/5 2018
3	692	Bari	Working HIC	Pull test, cycling, peel test	Final bonding	Apr 27/May 3 2018
4	636	Bari	Non-working HIC	Pull test, peel test	Final bonding	Jun 4/5 2018
5	758	Bari	Non-working HIC	Pull test, peel test	Final bonding	May 10/11 2018
6	942	Bari	Non-working HIC	Pull test, peel test	Final bonding, improved gluing	Jun 27/Jul 13 2018
7	1224	Bari	Non-working HIC	Pull test, peel test	Final bonding, improved gluing	Sep 12/14 2018
8	1243	Bari	Non-working HIC	Pull test, peel test	Final bonding, improved gluing	Oct 4/5 2018
9	1701	Bari	dummy HIC	Pull test, peel test	Final bonding, improved gluing	Oct 29 2018
10	1703	Bari	dummy HIC	Pull test, peel test	Final bonding, improved gluing	Oct 29 2018
11	314	Bari	Non-working HIC	inspected	Frascati gluing test, storage	

Since spring 40 HICs have undergone QA testing

Examples – visual inspection

Issues flagged:

- Contamination of the carrier plate
- Contamination/patterns on FPCs
- Chip pad contamination
- Particle contamination in general

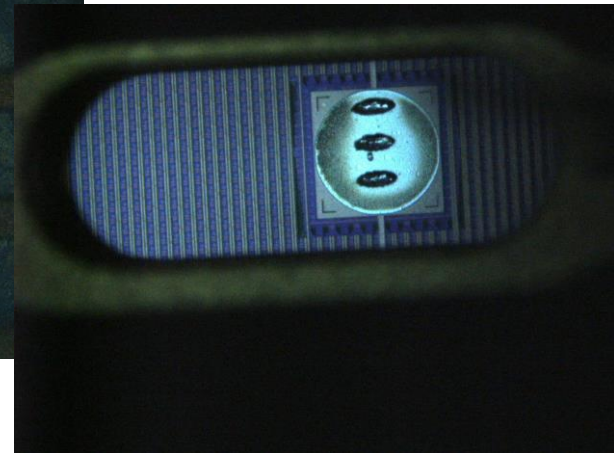
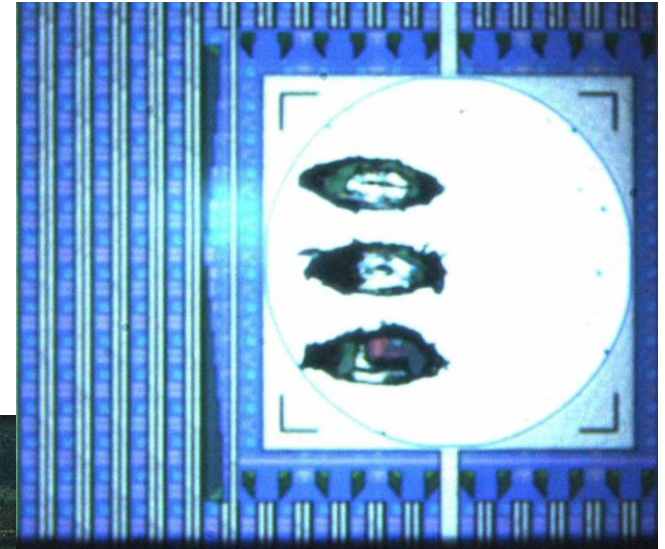


Examples – bond inspection

Pull test and visual inspection carried out by the CERN bondlab

Issues flagged include:

- Too low pull test values
- Contaminations on chip pad or FPC
- Deformed or irregular bond feet
- Cratering
- Bond foot lift



Pull tests

(update in plenary 13/11/18)



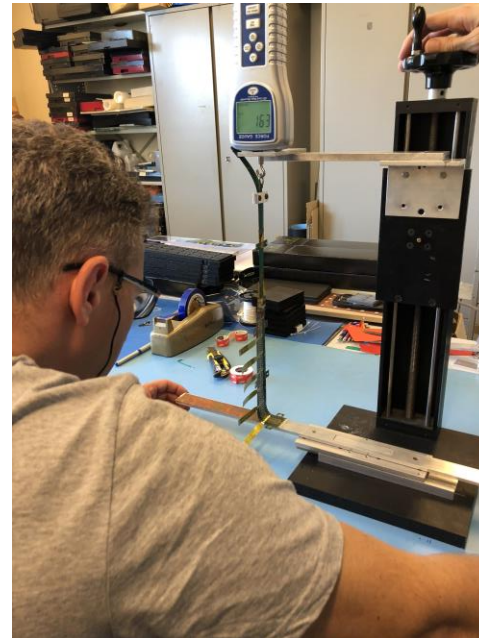
	Min [g]	Max [g]	Mean [g]	Stdv [g]	inspection
Bari 942	10.6	14.6	12.8	0.8	ok
Bari 636	9.5	16.1	13.4	1	ok
IPHC 1127	8.2	11.9	10	0.8	ok
Lvpl 398	8.3	11.8	10	0.7	ok
Lvpl 776*			9.6	1.3	ok
Lvpl 1110*			9.7	1.1	ok
CCNU1215	5.3	11.2	8.5	0.9	Worsening of first bond heel fracture; possible tool degradation
CCNU 932*	4.7	10.1	7	1.1	Worsening of first bond heel fracture; possible tool degradation
Bari 1243	11.5	14.5	13	0.7	ok
Bari 1701	10.6	14.9	12.3	0.8	ok
Bari 1703	11	14.3	12.4	0.5	ok
CCNU 1215	5.3	11.2	8.5	0.9	Worsening of first bond heel fracture; possible tool degradation

New results reported in weekly HIC meeting and to sites at end of tests

*cycling

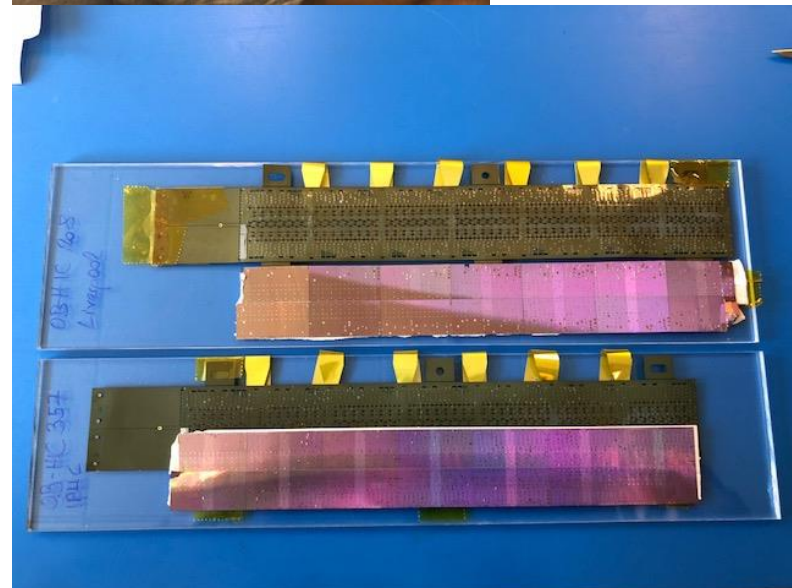
Peel test

In order to do a peel test (measure adhesion strength between chips and FPC, all wire bonds are removed.



The HIC is mounted on a translation stage and the FPC is peeled off from the chips.

The adhesion strength is measured with a force gauge.



Peel tests

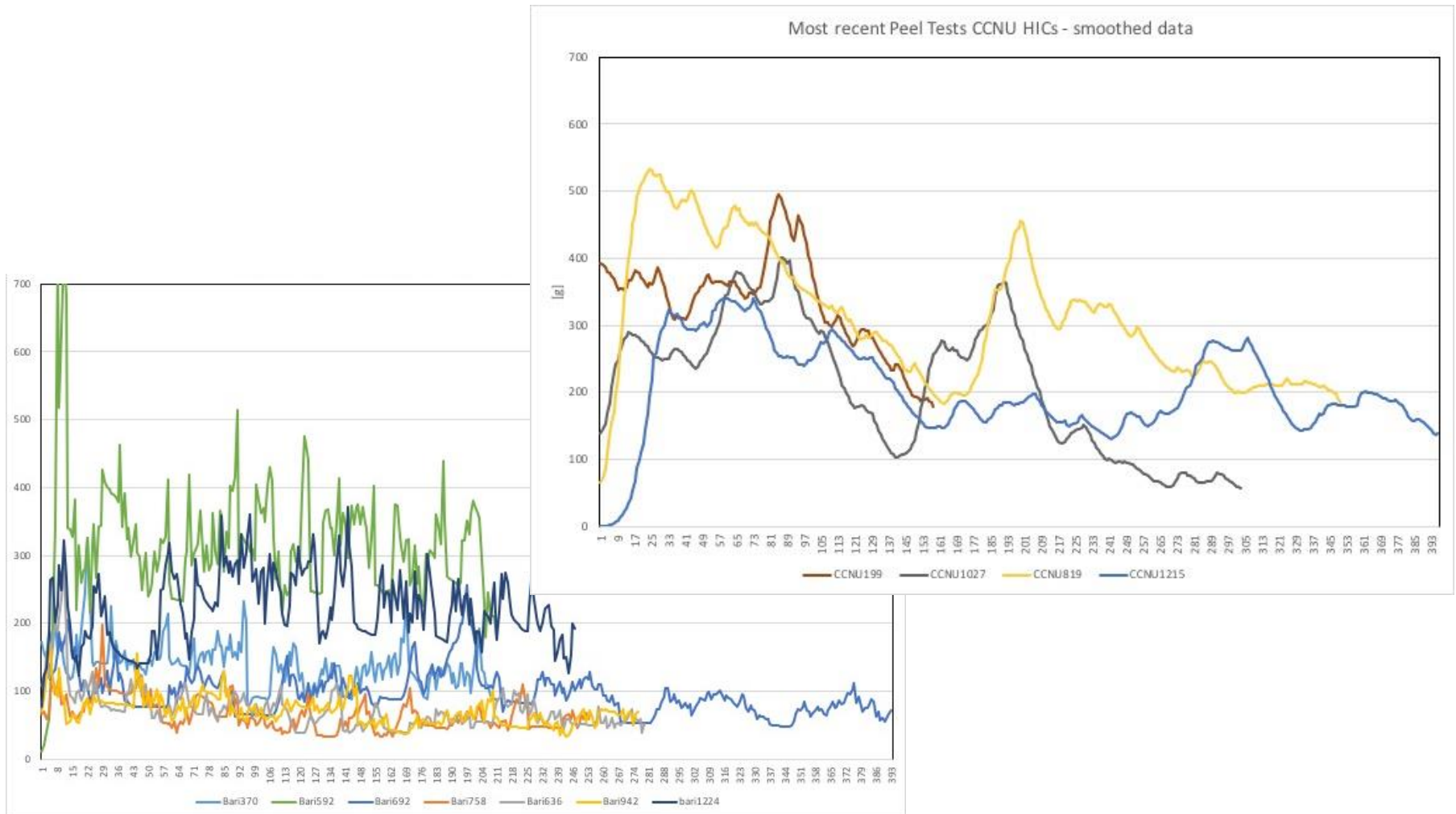
HIC		average	stdv
370	bari	136.81	34.39
592	bari	315.20	91.75
220	pusan	134.28	86.58
90	liverpool	194.62	55.94
208	liverpool	412.54	70.72
260	liverpool	593.75	217.04
357	iphc	270.14	54.99
199	ccnu	320.64	111.85
1027	ccnu	207.01	103.95
168	ccnu	481.93	131.79
684	iphc	201.89	64.94
172	ccnu	315.37	123.45
758	bari	66.04	23.48
182	ccnu	290.55	134.30
692	bari	97.86	31.70
819	ccnu	314.82	123.70
91	ccnu	336.12	129.13
167	ccnu	342.63	117.11
1110	lvpl	394.91	117.21
636	bari	73.01	30.97
942	bari	70.59	21.11
1127	iphc	192.76	48.27
1224	bari	222.74	52.31
1243	bari	140.00	
1701	bari	333.97	73.75
1703	bari	160.00	
1215	ccnu	212.41	76.48

Most HICs are peel tested after bond inspection and pull test, 3 have been peel tested after thermal cycling.

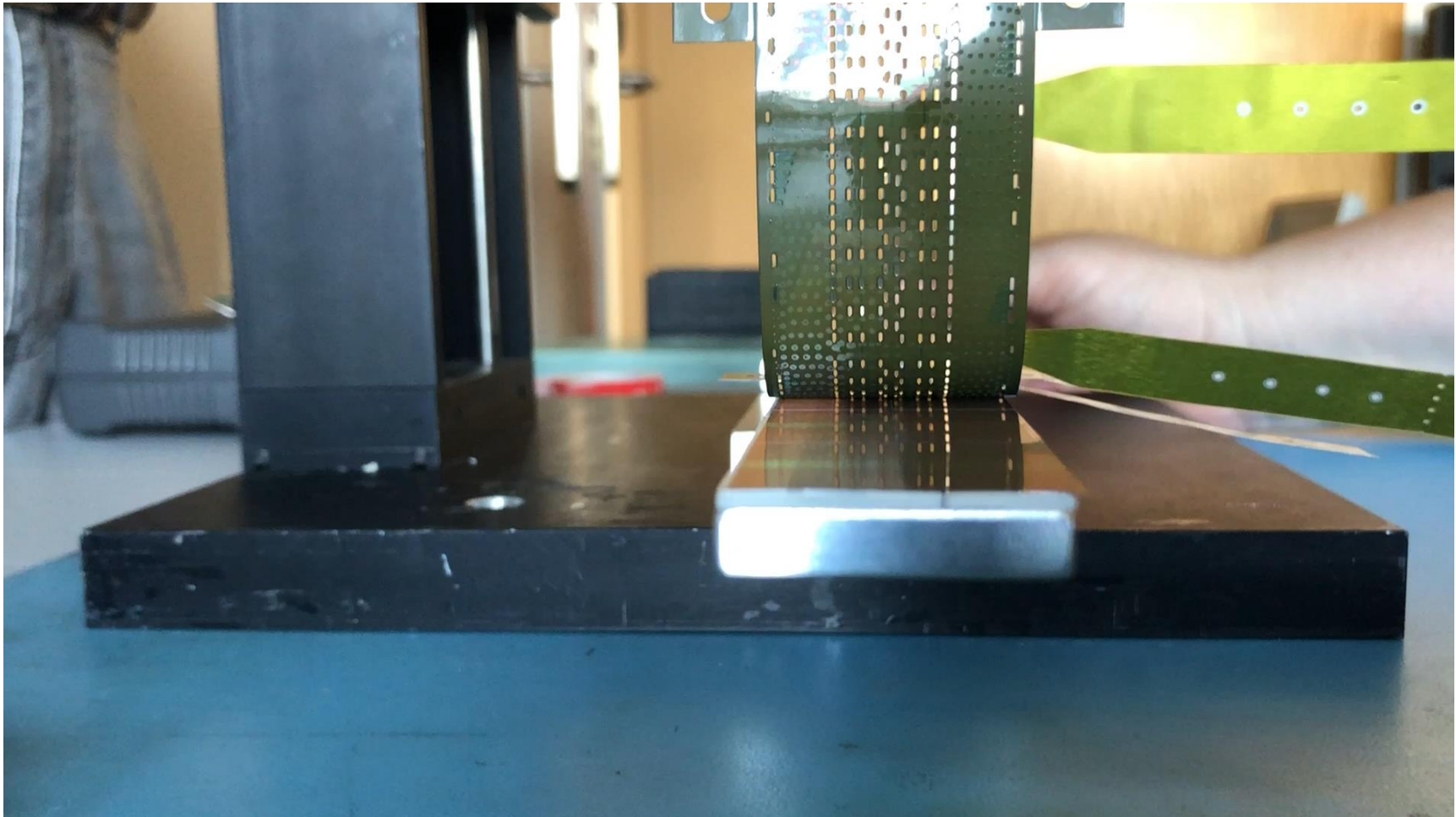
Average peel force and standard deviation are important indications for good/bad adhesion, but also **other aspects need to be monitored closely:**

- Form of the curve
- Glue filaments during the peel test
- Inspection of FPC and chips after peel test

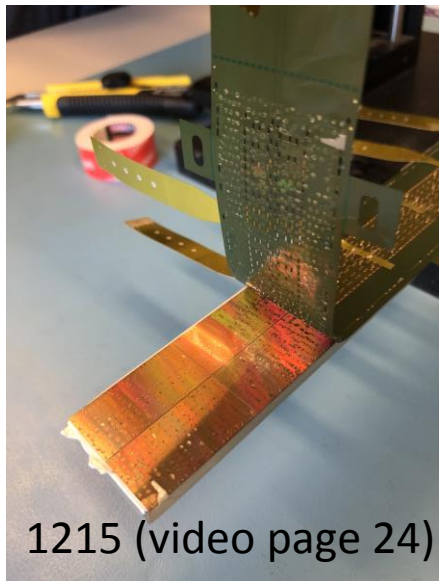
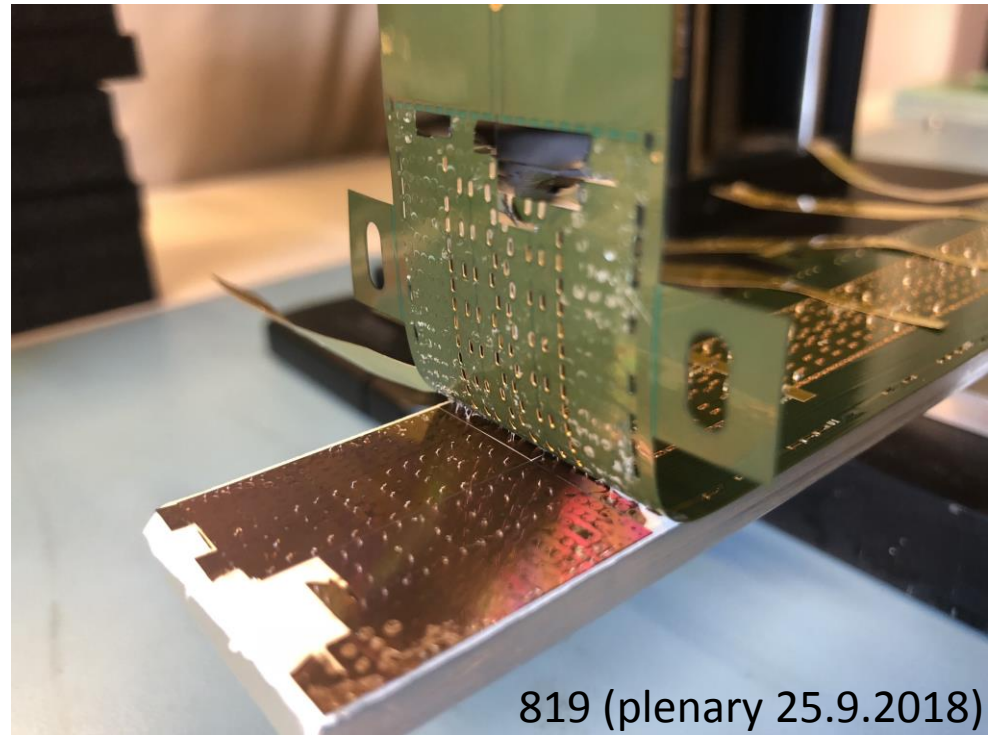
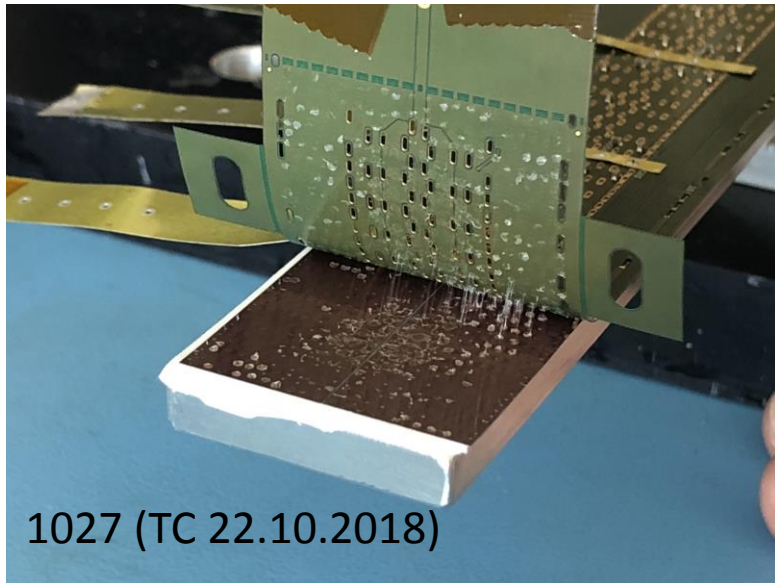
Peel test curves examples



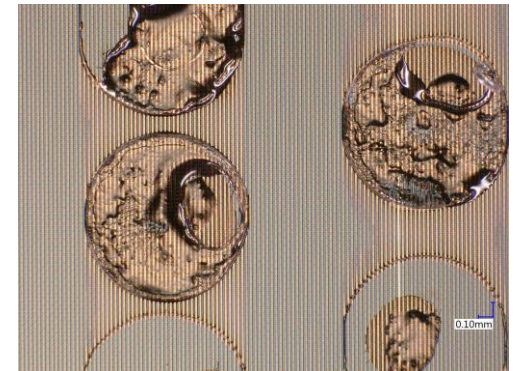
Bari 758



Peel test – most recent CCNU HICs



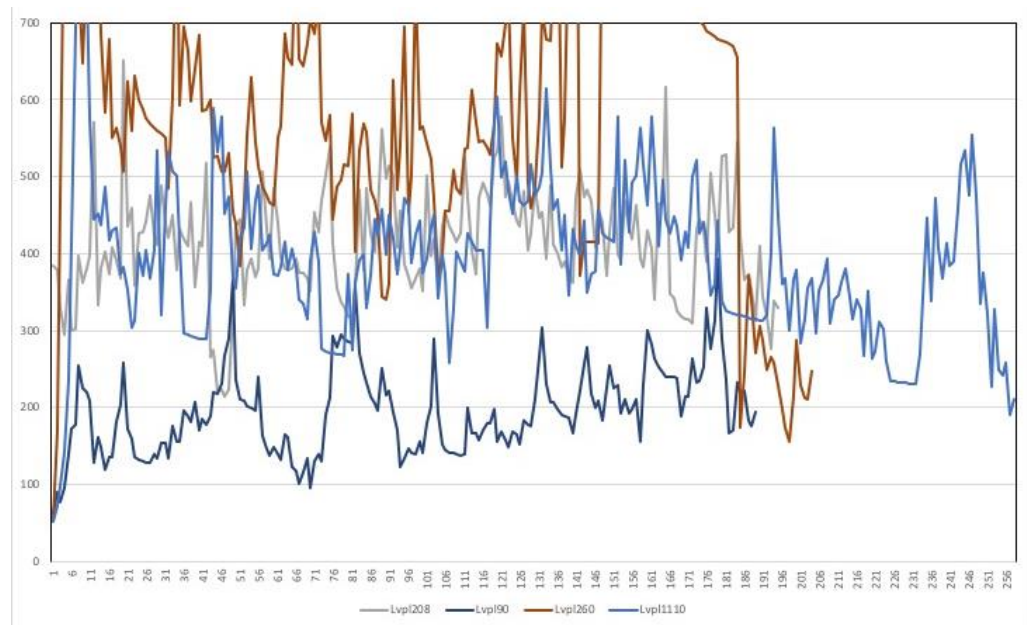
- Filaments observed since summer when we started to take pictures during the peel process
- Further details became visible with access to a high magnification microscope



Peel tests – Liverpool HICs

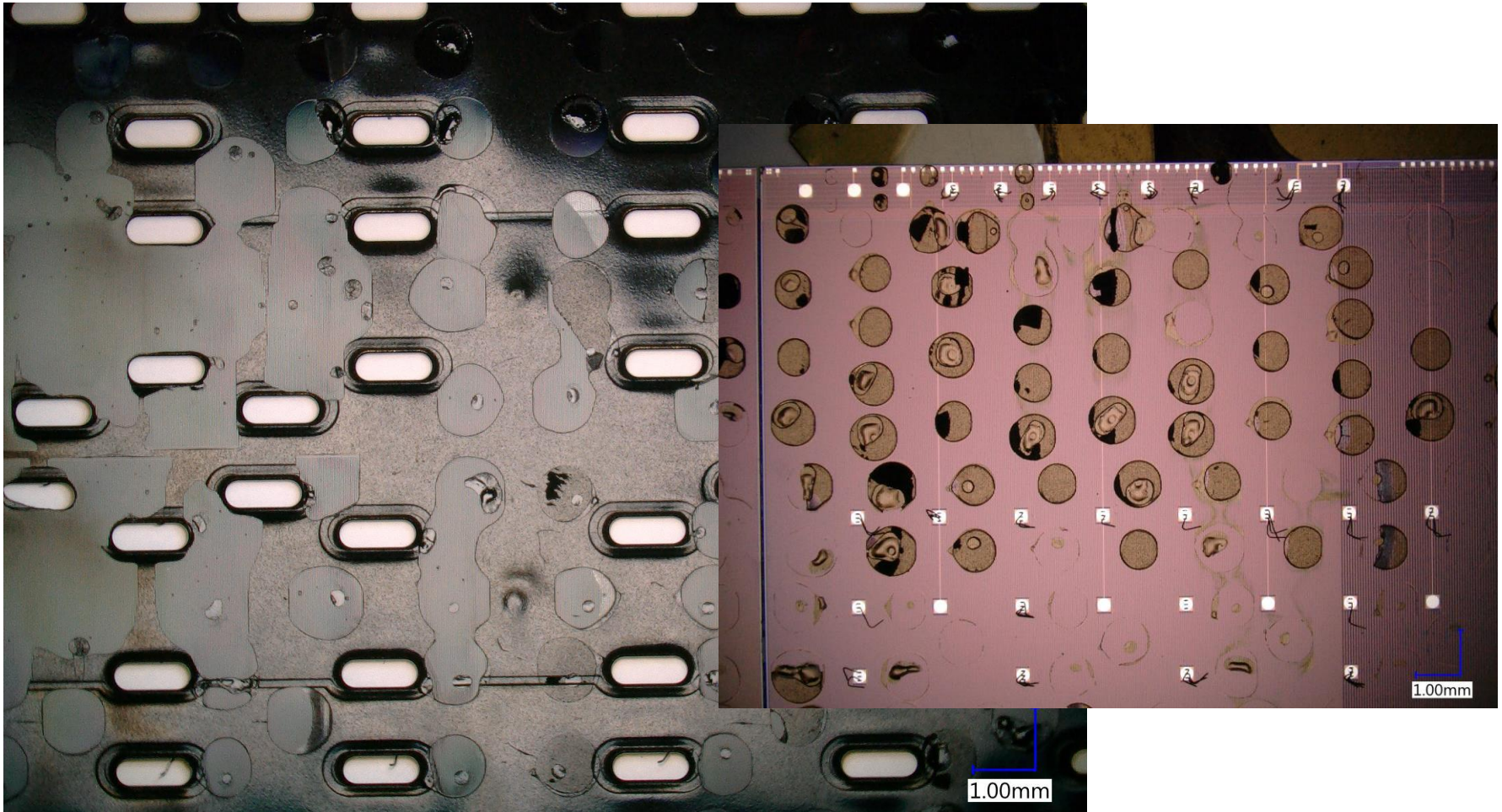
HIC	center	Average [g]	Stdv [g]	Gluing/bonding
90	Liverpool	194.62	55.94	Jan 11/15 2018
208	Liverpool	412.54	70.72	Dec 11/15 2017
260	Liverpool	593.75	217.04	Jan 16/24 2018
1110	Liverpool	394.91	117.21	Jul 20/30 2018

2 HICs (398, 776) in cycling



Liverpool 1110

Inspection after peel-test is important!



Thermal Cycling Tests – 1st test



3 HICs: CCNU167, CCNU 819, Bari 692 completed in July/August

Note: Bari 692 has already done 90 cycles before this test!

Pull test results at T0, T=30 and 68cycles; T=158 cycles (Bari692 only)

Mean	OB_HIC_167	OB_HIC_819	OB_HIC_692
T0	12.9g	11.2g	No results
T1=30cycles	12.7g	11.4g	11.5g
T2=68cycles	12.5g	10.9g	11.3g
T2'=158 cycles			11.5g
StDev	OB_HIC_167	OB_HIC_819	OB_HIC_692
T0	0.8g	0.9g	No results
T1=30cycles	0.9g	0.9g	1g
T2=68cycles	0.9g	0.9g	1g
T2'=158 cycles			1.1g
Failure Mode	OB_HIC_167	OB_HIC_819	OB_HIC_692
T0	no FPC lifts	no FPC lifts	No results
T1=30cycles	no FPC lifts	no FPC lifts	no FPC lifts
T2=68cycles	no FPC lifts	no FPC lifts	no FPC lifts
T2'=158 cycles			no FPC lifts

68 cycles completed so far

Conditions : **tmin chamber : 10C, tmax chamber : 50C**, ramp rate : 5C/mn, dwell time : 10mn

→ Pull test results before, during and after cycling are comparable

Thermal Cycling Tests – 2nd test



3 HICs: Liverpool 398, Liverpool 776, CCNU 932, completed Friday 16/11/18

Pull test results at T₀, T=30 cycles and T=68 cycles

Mean	OB_HIC_398	OB_HIC_776	OB_HIC_932
T ₀	10g	9.6g	7g
T ₁ =15cycles	10.3g	9.1g	6.9g
T ₂ =30cycles	10.1g	10g	7g
T ₃ =68cycles	10.2	9g	7.3g
StDev	OB_HIC_398	OB_HIC_776	OB_HIC_932
T ₀	0.7g	1.3g	1.1g
T ₁ =15cycles	0.7g	0.6	0.6g
T ₂ =30cycles	0.9g	0.7g	0.6g
T ₃ =68cycles	0.8g	0.6g	0.8g
Failure Mode	OB_HIC_398	OB_HIC_776	OB_HIC_932
T ₀	no FPC lifts	no FPC lifts	no FPC lifts
T ₁ =15cycles	no FPC lifts	no FPC lifts	no FPC lifts
T ₂ =30cycles	no FPC lifts	no FPC lifts	no FPC lifts
T ₃ =68cycles	no FPC lifts	no FPC lifts	no FPC lifts

68 cycles completed so far

Conditions : **t_{min} chamber : 10C, t_{max} chamber : 50C**, ramp rate : 5C/mn, dwell time : 10mn

→ Pull test results before, during and after cycling are comparable

Next: HICs are now being prepared for peel test

Summary

- OB HIC QA at CERN as complementary information for QA done in the centers.
- HICs from all assembly centers received and inspected, focus on HICs produced with final procedure.
- Procedure more refined now, adding further information and using new equipment for inspection.