SVD
Activities in Pisa

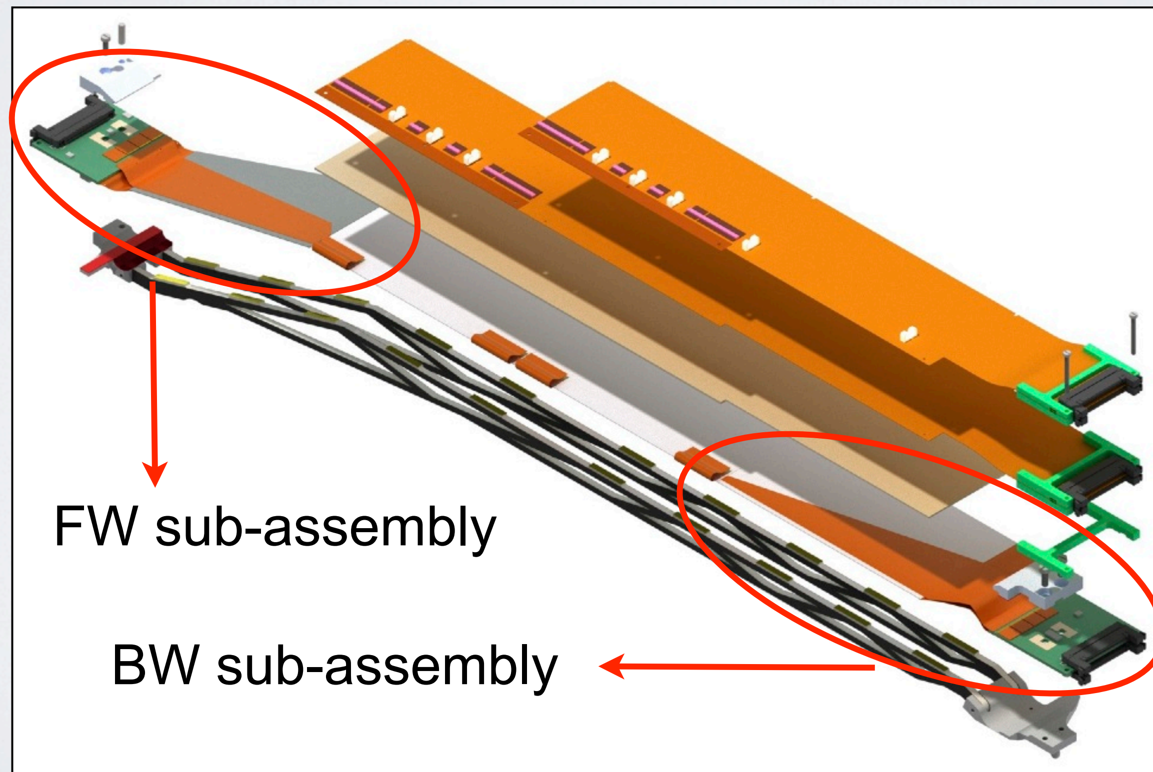
Antonio Paladino - 17/12/2014
Napoli - Belle II Italia collaboration meeting

OUTLINE

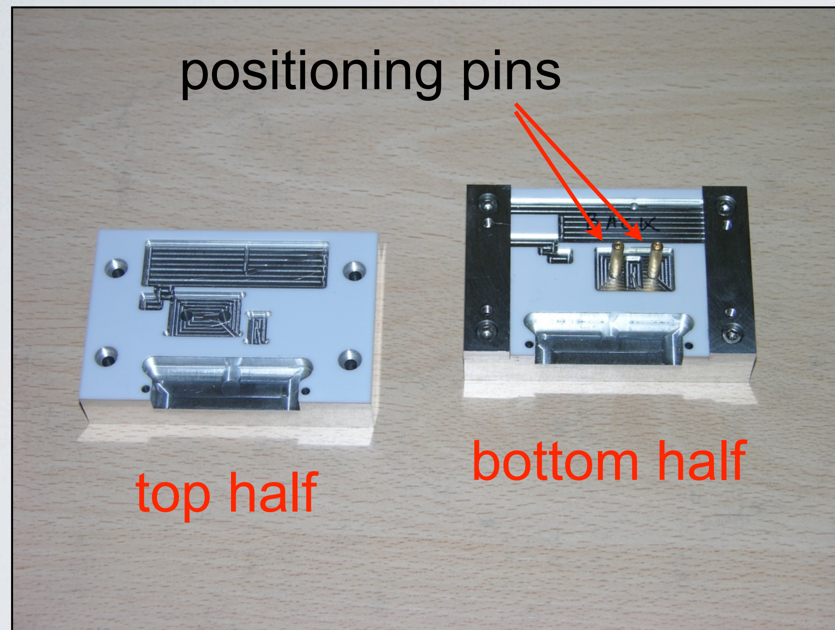
- ➡ Activities in Pisa
  - Hybrid sandwich gluing
  - Sub-assemblies gluing
  - Wire bonding
  - Visual checks and mechanical measurements
  - Electrical tests and laser scan
- ➡ Test beam at CERN
- ➡ Future activities

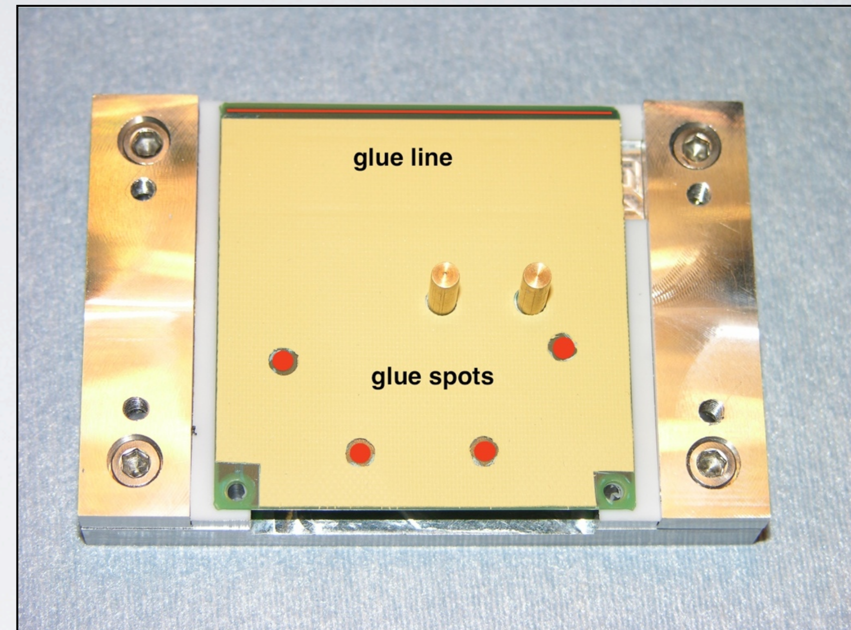
Our tasks

- Gluing of double sided hybrid board (hybrid sandwich) starting from two single sided ones.
- Building Forward and Backward region sub-assemblies, which consist of a DSSD, two pitch adapters and a hybrid sandwich.
- Performing electrical tests on hybrid sandwiches and sub-assemblies to qualify their electrical performance.
- Performing a laser scan on complete sub-assemblies to qualify detector performance.



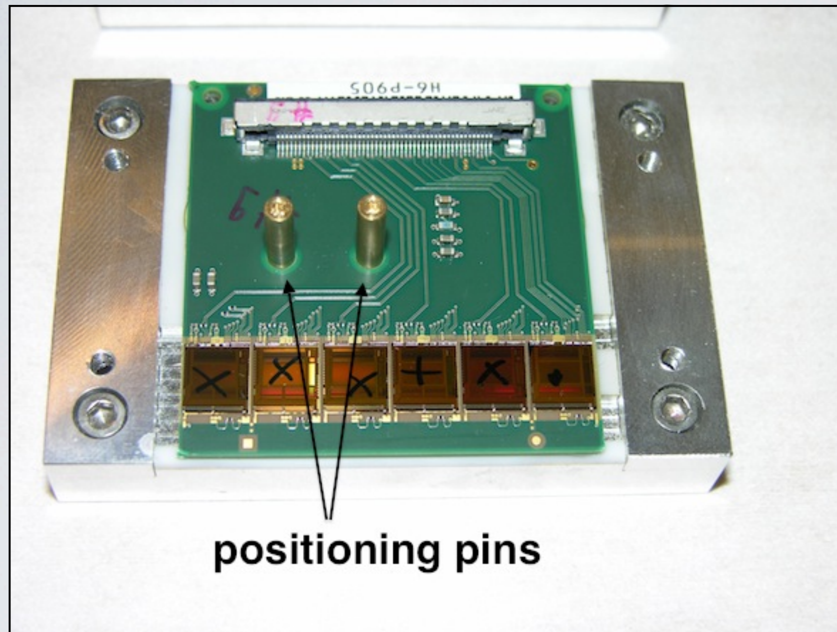
Hybrid sandwich gluing

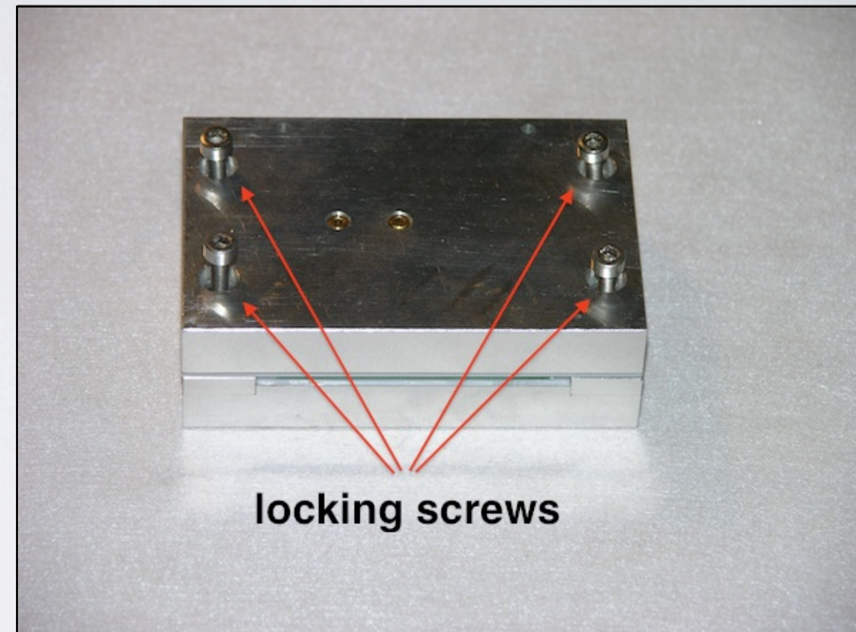


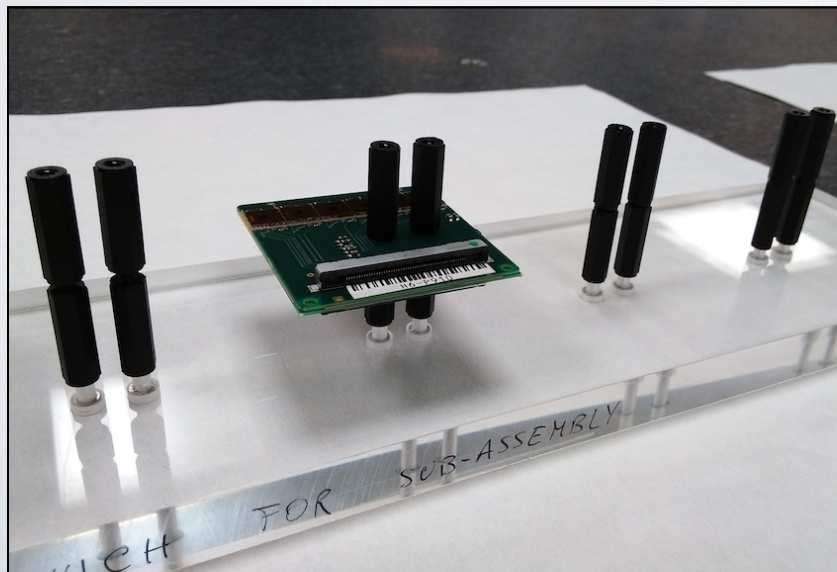


- Single sided hybrid boards arrive from Vienna.
- Electrical tests and mechanical measurements are performed (see following slides).
- P-side and N-side hybrids are glued together to build the hybrid sandwich.
- Gluing jigs for both FW and BW hybrid sandwiches were designed and built to perform the gluing. We now have 3 + 3 gluing jigs.

Hybrid sandwich gluing

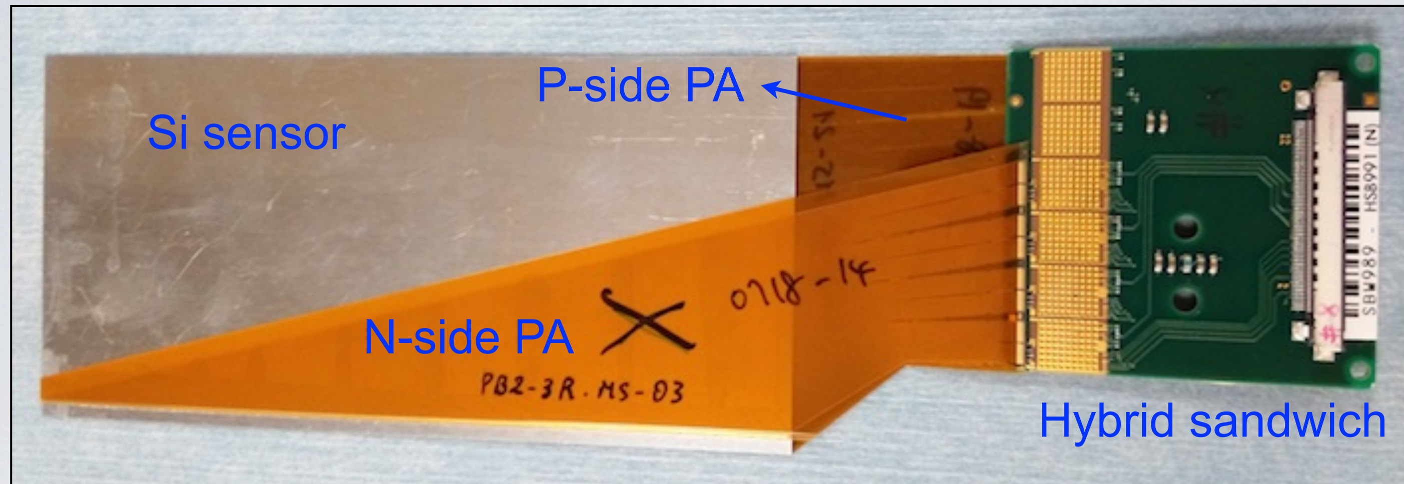




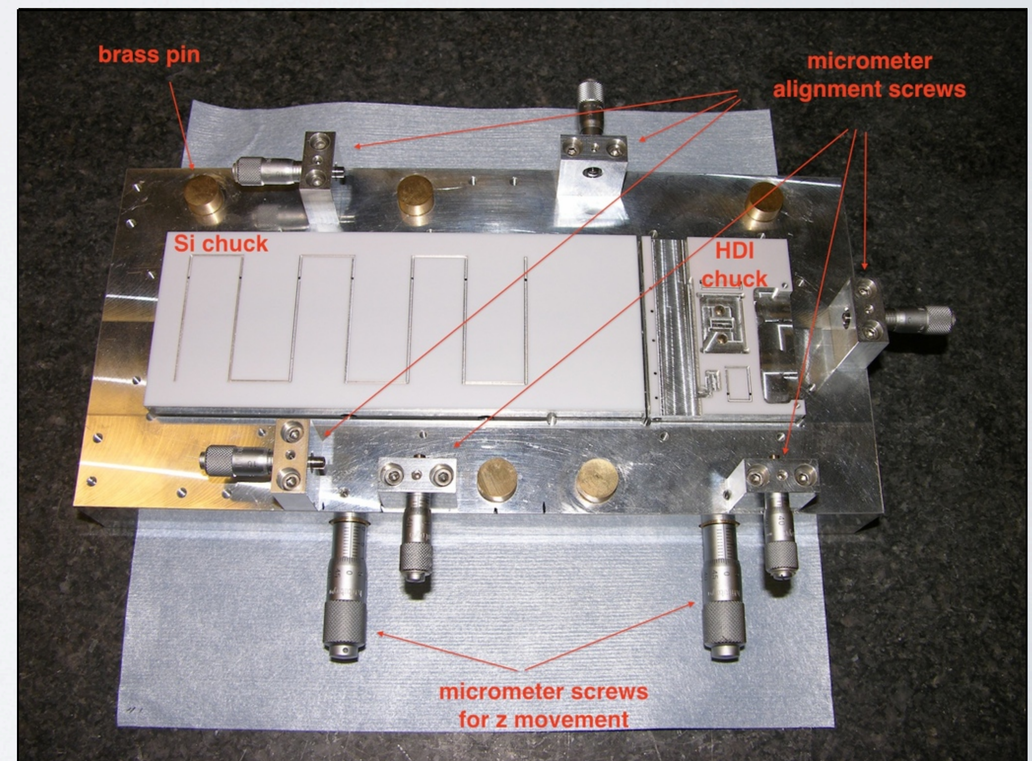


Hybrid sandwiches (HS) are electrically tested and then stored on appropriate supports that prevent wire bonding damages, ready for sub-assembly gluing.

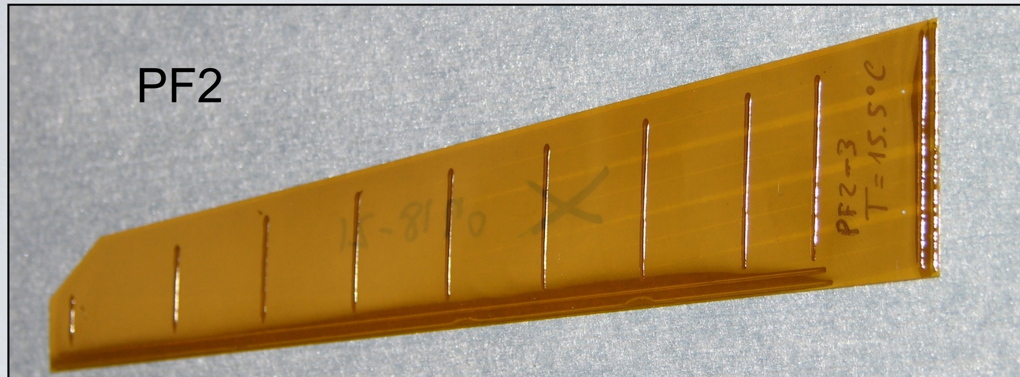
Sub-assembly gluing (I)



P-side is glued first. Then an upside-down is performed to do the N-side gluing. Four different gluing jigs were designed and built to deal with the four different gluing configurations.
Sensor and HS are positioned on two different chucks, that allow z-coordinate movement. A removable chuck is used to position the PA over sensor and HS.
Special tools are used to transfer and move the items.

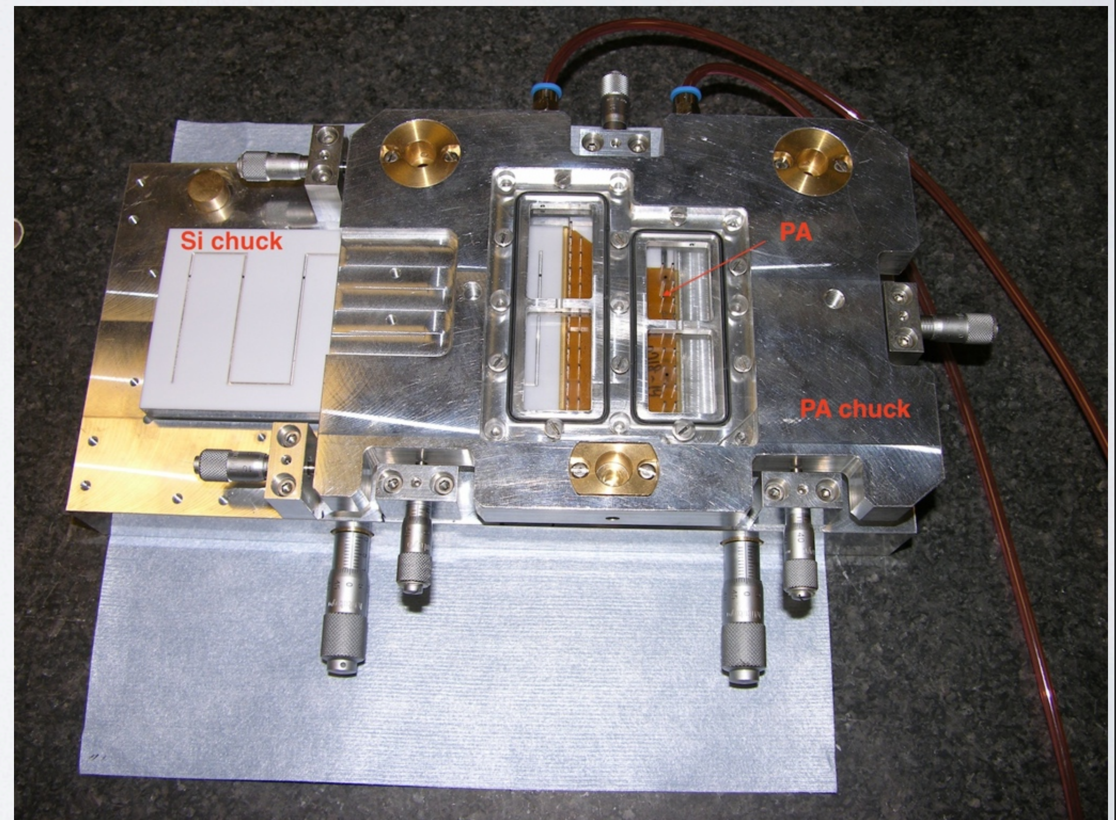


Sub-assembly gluing (II)

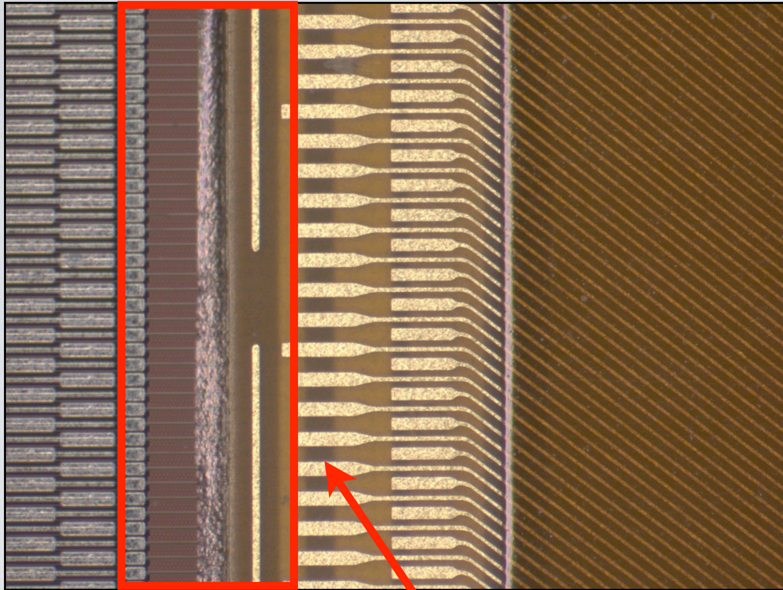


The three parts are positioned and aligned. Priority is given to the alignment between PA and APV chips, in order to be able to perform a good wire bonding.

The PA chuck is then moved under the glue dispensing robot. The Glue is dispensed on the PA, using Labview programs to control the robot. Then the PA chuck goes again over the gluing jig, the alignment is checked and then the sensor and the hybrid sandwich are moved up until there is contact between PA and sensor or HS.

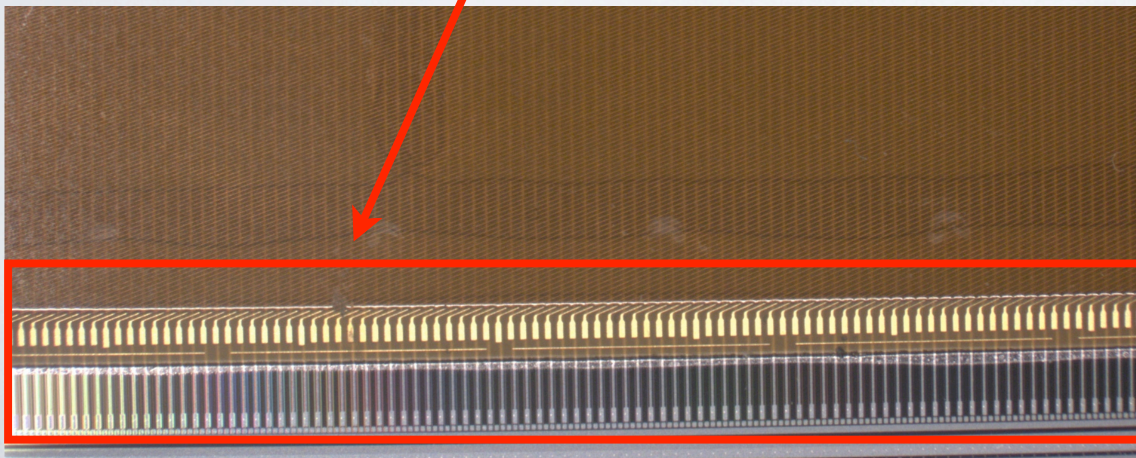


Sub-assembly gluing (III)



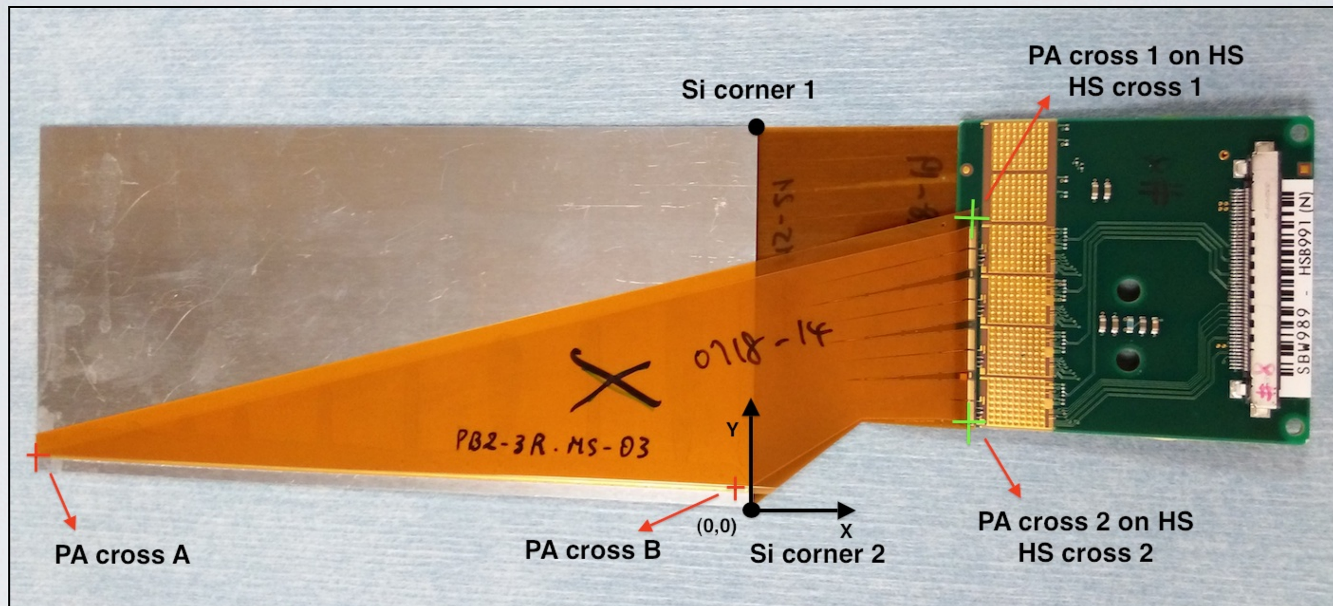
Uniform glue overflow from the edge of the PA

Glue overflow on hybrid side



Glue overflow is observed to find the final height of sensor and hybrid sandwich. We have to be sure that all the PA pads have glue underneath them, because glue is also a support for the wire bonding.

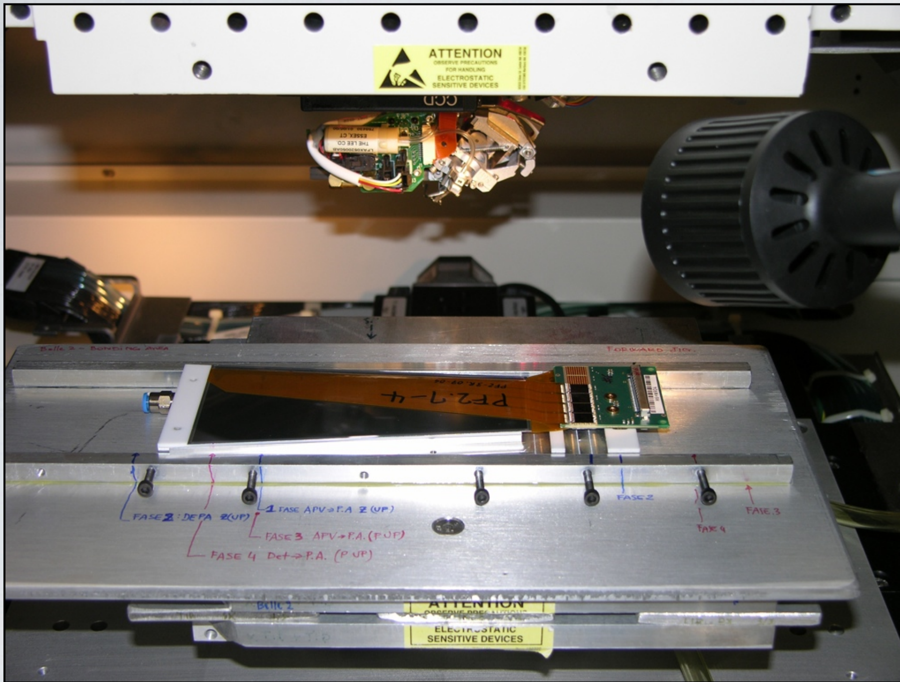
Survey on glued sub-assemblies



BW N-side									
		NOMINAL			GLUING			SURVEY	
Points	x (mm)	y (mm)		x (mm)	y (mm)	z (um)	x (mm)	y (mm)	z (um)
Si corner 1	0.000	-59.600							
Si corner 2	0.000	0.000							
Si corner 3-A	-124.880	0.000							
HS cross on corner 1	32.992	45.215		32.890	45.145		32.875	45.160	
				0.102	0.070		0.117	0.055	
HS corner 1	30.316	60.000							
HS cross on corner 2	32.992	14.615		32.915	14.552		32.900	14.567	
				0.077	0.063		0.092	0.048	
HS corner 2	30.316	14.000							
PA cross A on Si	-124.507	2.660		-124.427	2.817		-124.445	2.785	-3750
				-0.080	-0.157		-0.062	-0.125	
PA corner A on Si	-124.880	2.210							
PA cross B on Si	-0.373	2.660		-0.430	2.814		-0.435	2.817	-3730
				0.057	-0.154		0.062	-0.157	

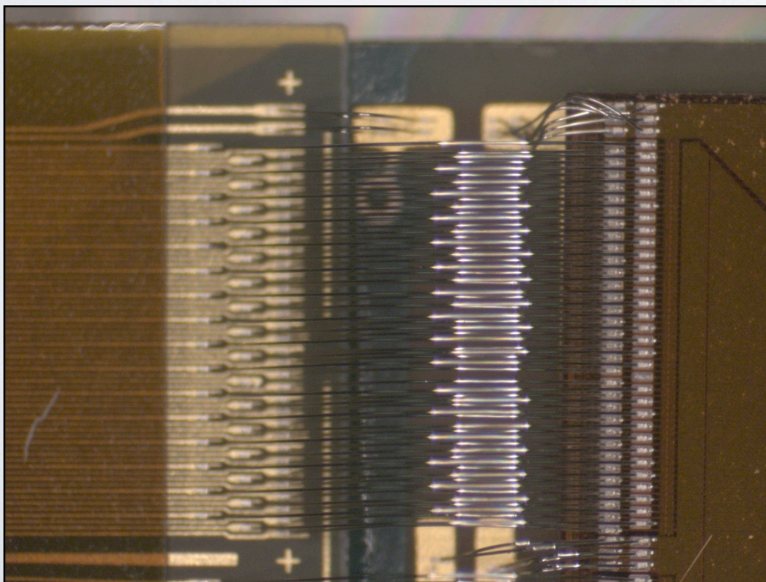
Measurements are taken during and after the gluing, then are uploaded in the DB.

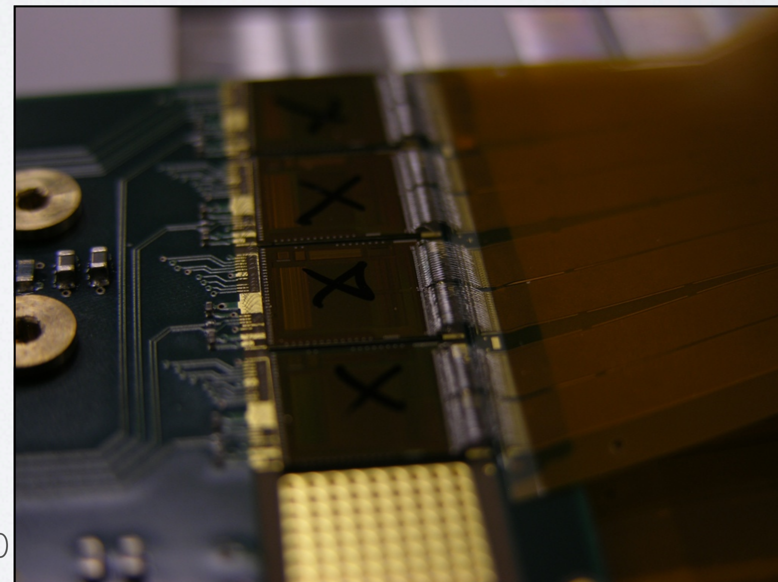
Wire bonding



After the gluing the sub-assembly is positioned N-side up. This is also the first side on which the wire bonding is done. Then an upside-down is performed using two MP chucks, to position the sub-assembly P-side UP and to do the second side of the wire bonding.

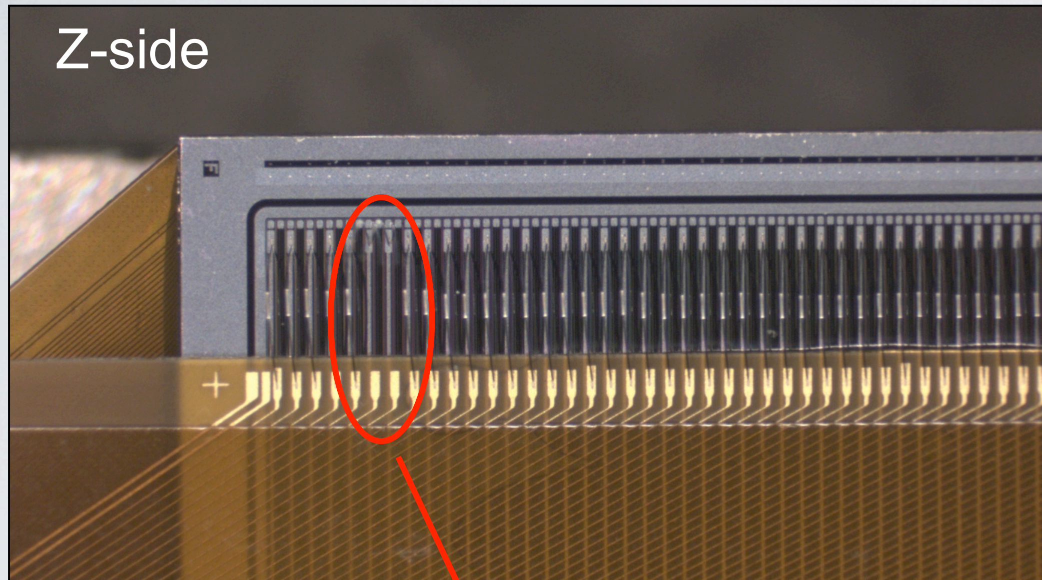
PA <--> APV25 wire bonding

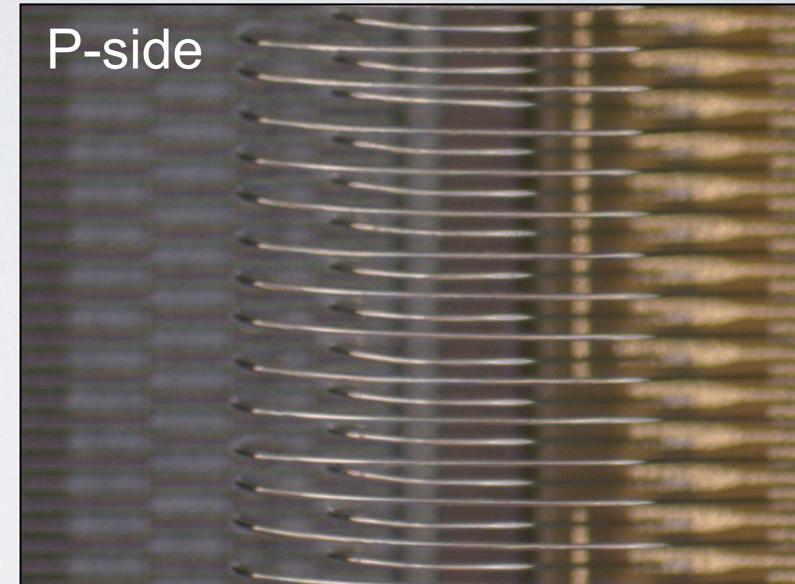




Wire bonding

PA <--> Sensor wire bonding





Two missing bonds

Low loop

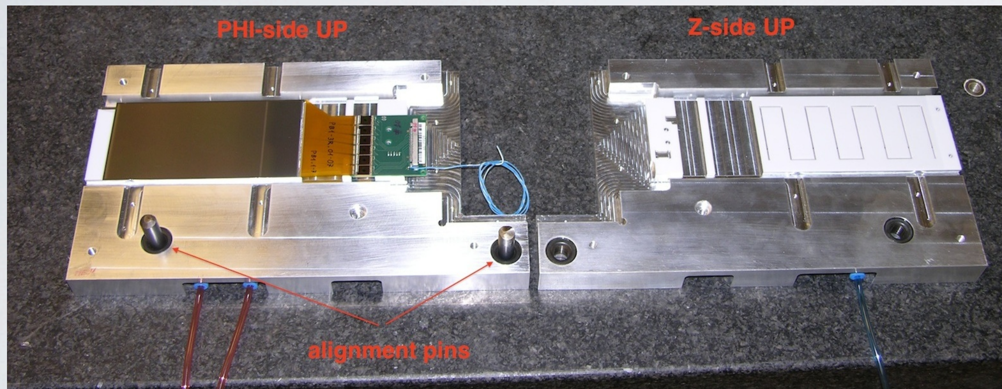
High loop

Every side of the wire bonding consist of two parts:
2) PA <--> Hybrid board - APV25 chips
1) PA <--> Sensor wire bonding

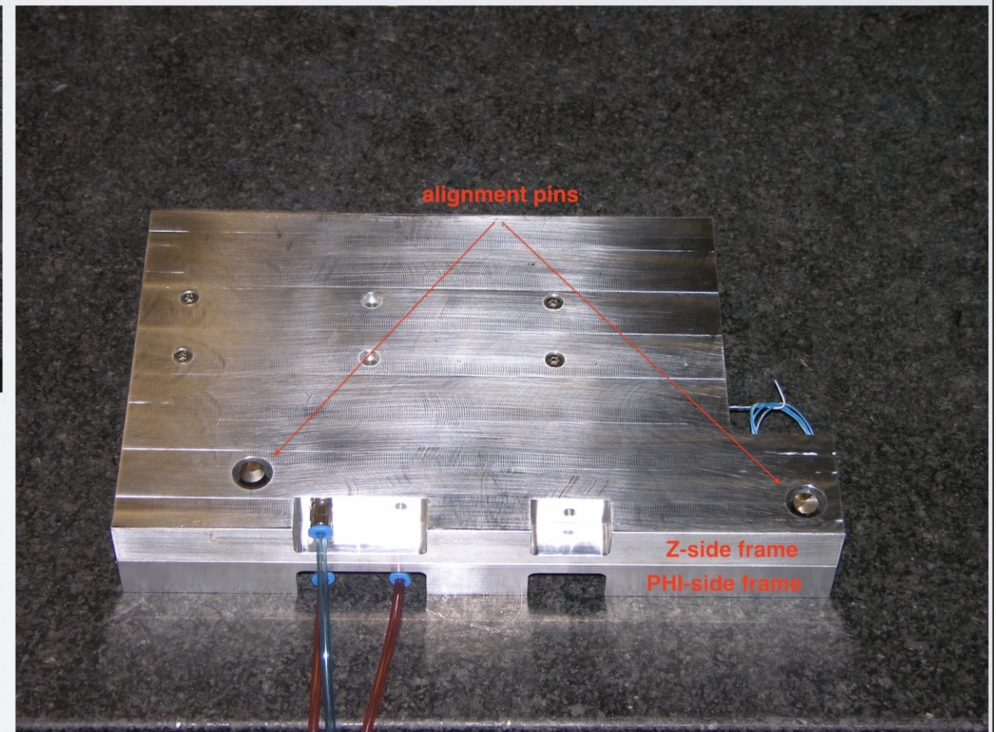
Some defects of the sensor and/or of the APV channels can lead to unplugging some wire bondings.

Sub-Assembly upside down

A procedure has been setup to turn the sub-assembly without damaging the sensor or the wire bondings. For instance, if the sub assembly is on the MP_P frame, the MP_N frame is positioned over the MP_P frame, guided by the two alignment pins. When the two frames are in contact, the whole "sandwich" is turned upside down.

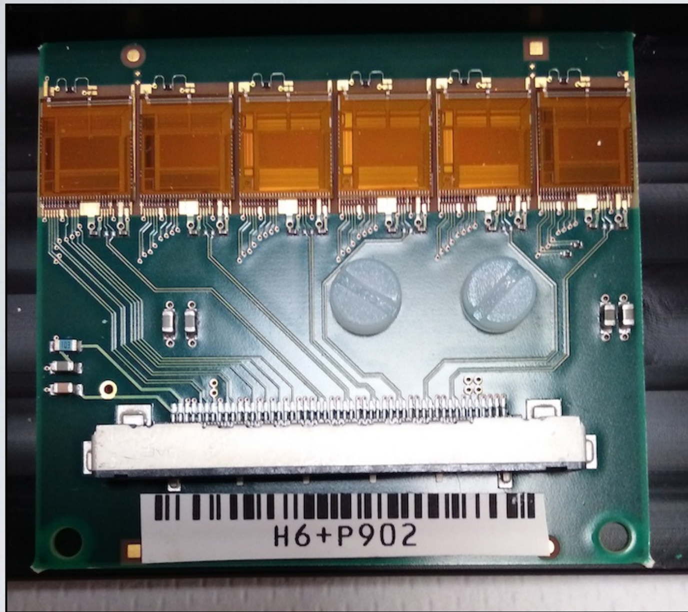


The vacuum of the MP_P chuck is turned off **before** turning on the vacuum on the MP_N chuck, so that the Si sensor could gently "fall" onto the MP_N chuck.



The MP_P frame can now be removed carefully and the sub-Assembly is positioned N-side up.

Preliminary checks on arrived hybrids



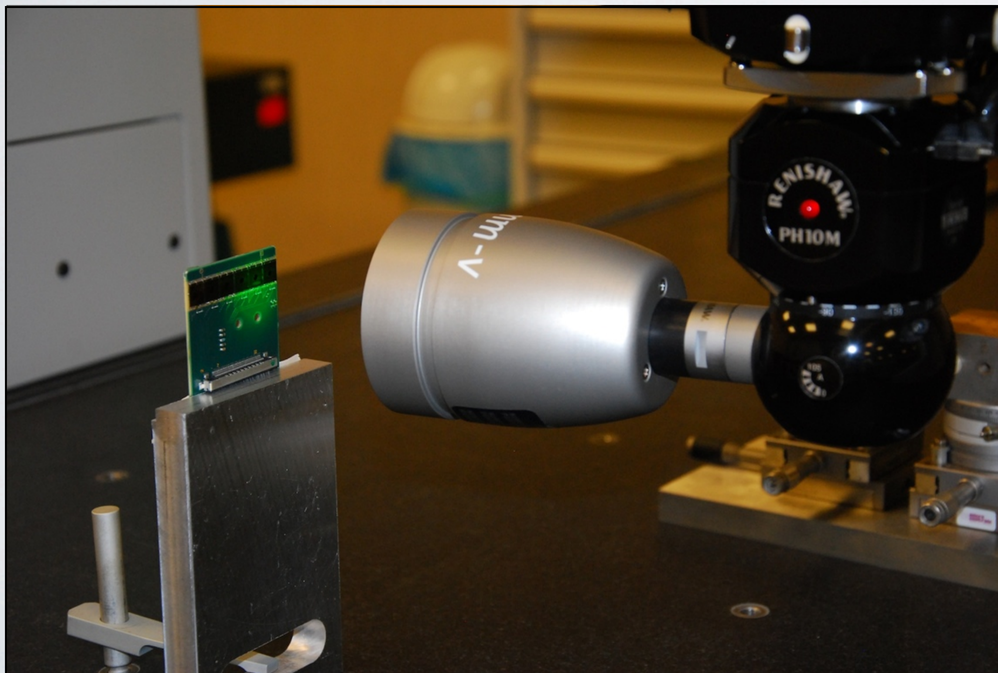
Single side hybrids arrive in a transport box. When received, some visual checks are done:

- APV25 chips gluing;
- bondings on front and back side of APV chips;
- APV surface (dust, scratches, pen signs);
- strip for bias redundancy (N-side only);
- discrete components presence/welding.

After the first visual check, a mechanical measurement is performed to get the positions of APV25 chips wrt the hybrid board: APV chips are glued on the hybrid board, but a shift and/or a rotation wrt to its nominal positions are possible, and this could lead to difficulties in the wire bonding. To avoid such difficult conditions, a measurement is done preliminarily and the hybrids with badly glued APV chips will not be used for class A hybrid sandwiches.

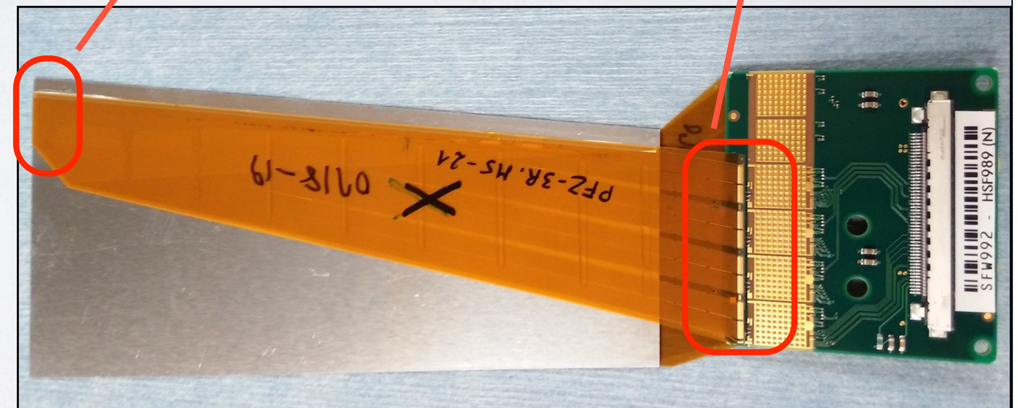
Measurements on hybrid sandwiches

When the hybrid sandwich is glued, a measurement with an optical tool is performed to see if there is a mutual shift and/or rotation between the two halves of the HS. This measurement is done to avoid that the shift/rotation lead to a position of the N-side pitch adapter out of tolerances set for the coordinates.



Region where the effect of the shift/ rotation of HS is bigger

Alignment between PA and APV chips



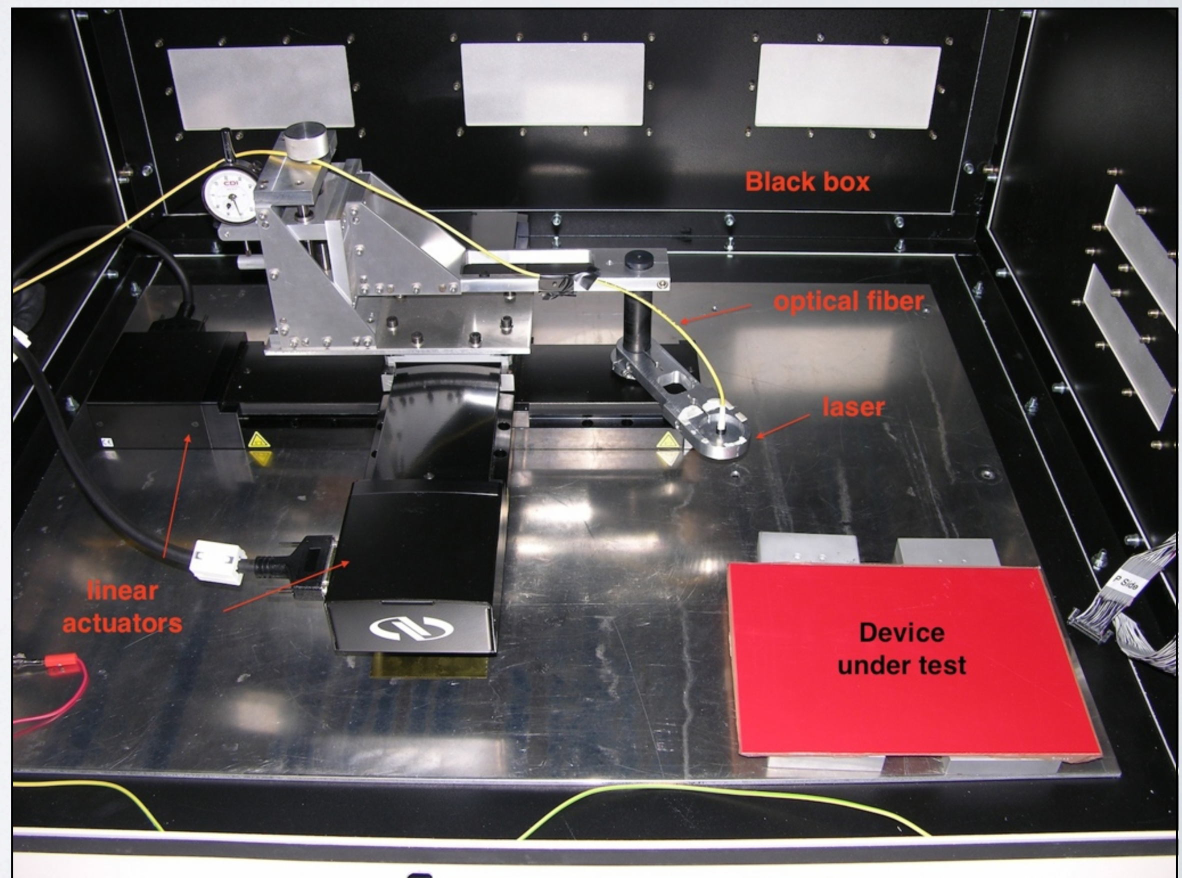
Electrical tests - equipment

- APVDAQ system (by HEPHY);
- 3 APVDAQ VME boards + 3 repeater boards;
- VME crate and controller (CAEN 2718);
- 2 low voltage power supplies -5V, 0V, +5V (2 CAEN A522 + SY527);
- Keithley 2400 SMU for high voltage bias.

In additionf for the laser scan:

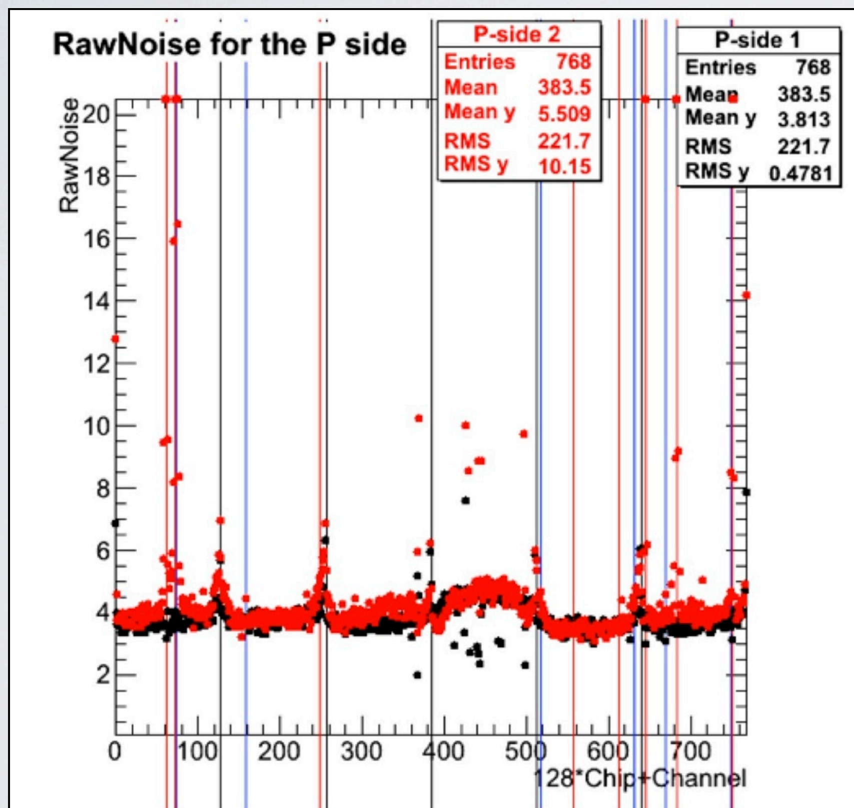
- IR laser LD-1060;
- Newport controller;
- Newport linear actuators.

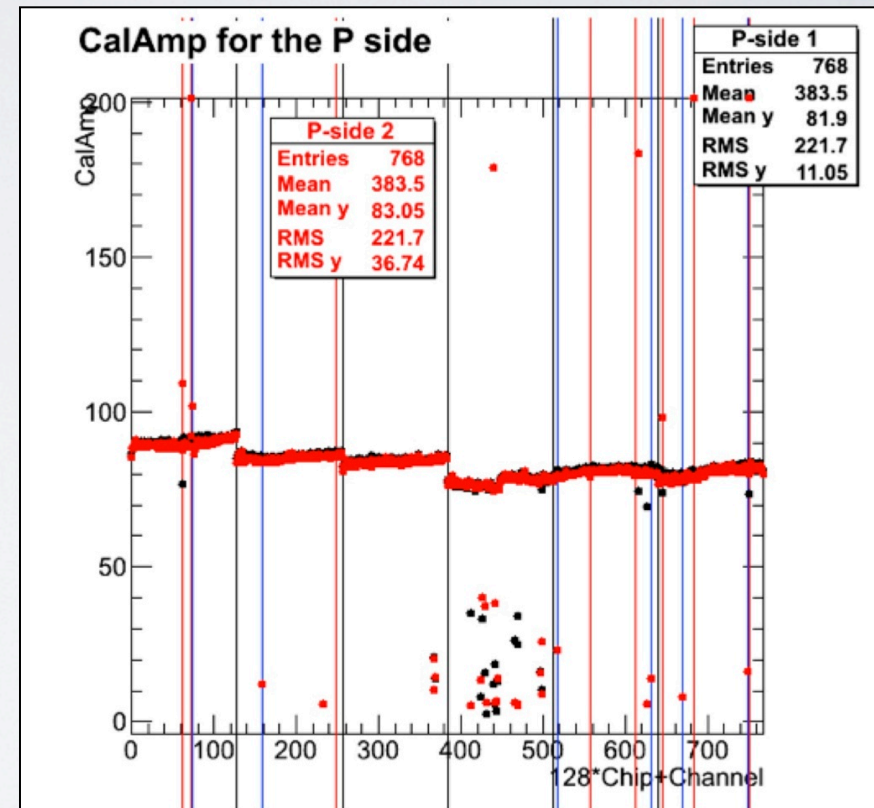
In the laser scan, a charge is sent through the sensor and its response is recorded. The laser is mounted on a support moved by the two linear actuators. Moving the laser spot in a diagonal direction, there's the possibility to test all the sensor channels on both sides.



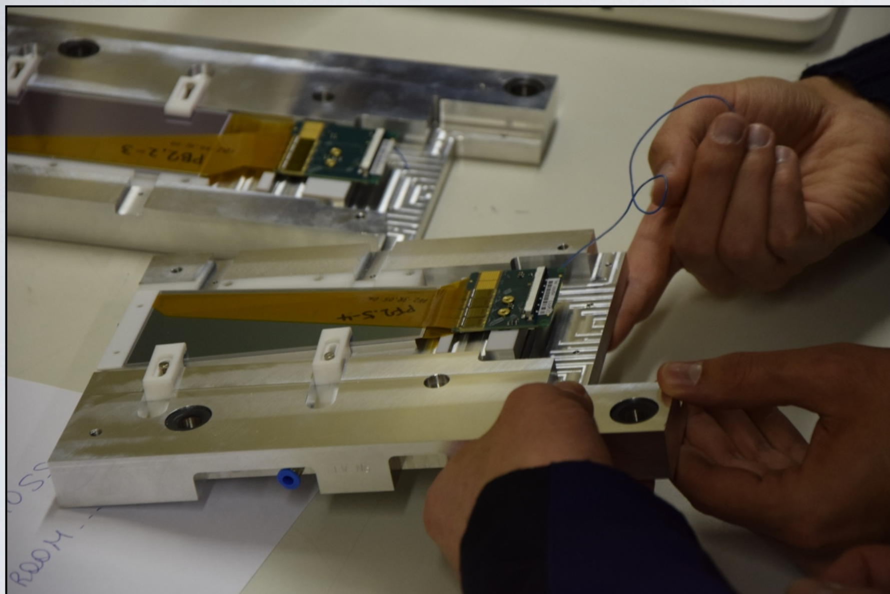
Electrical tests

Electrical tests are performed on single sided hybrid boards, on hybrid sandwich and on complete sub-assembly completely wire bonded. Every test consists of: ADC delay scan, pedestal scan, noise scan, gain calibration (one point on the gain curve). Here are the noise and the calibrations results for the FW module.



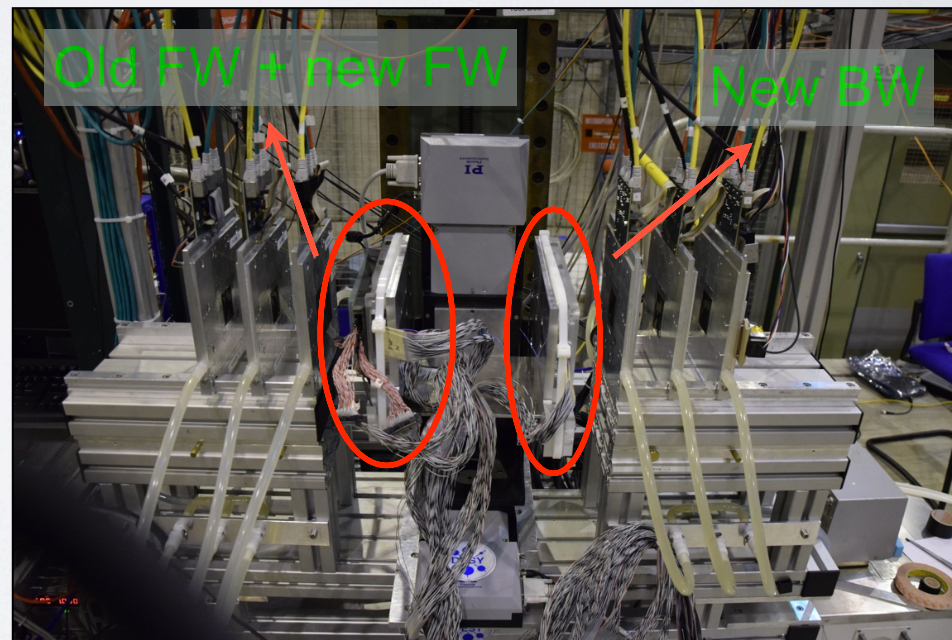


Beam test at SPS, CERN - Geneve



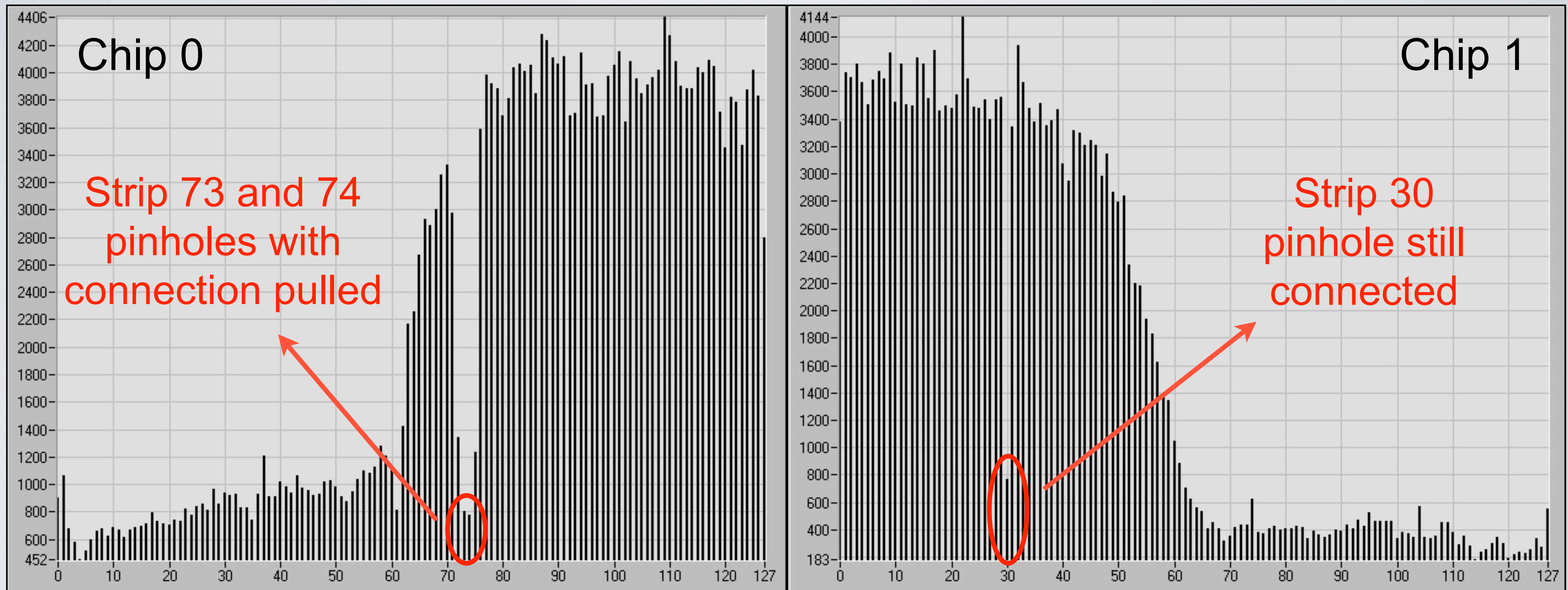
One week available for the beam test.
Beam of pions at 120 Gev/c.
Unfortunately useful data with our sub-assemblies were taken only in the last day. FW sub-assembly with some known defects (pinholes, shorts). The sub-assemblies were stored in their MP frame. The whole frame was put on a movable support, which allowed the positioning of the sensor wrt to the beam spot.

The beam spot was positioned where defects were present, to understand their behavior.
The DUT layout was unconventional, with an old FW module (built in Vienna) glued on the MP chuck of the new one, and the BW module after them. This was an emergency accommodation due to DAQ problems of the original system.



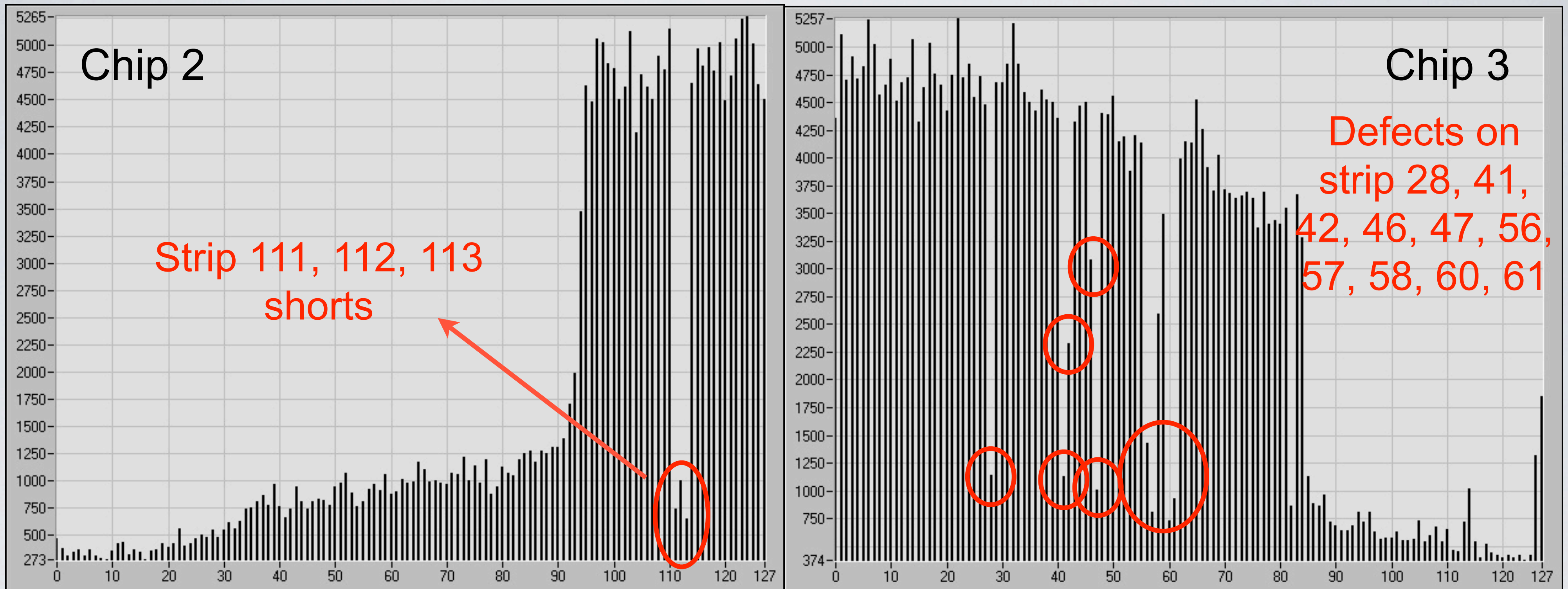
Beam test at CERN - on-line results

Data analysis will be done starting from January. Now we have just some screenshots taken live from the DAQ.



In the FW sub-assembly, some strips of the P-side have pinholes. Some of them were still connected to the APV chips through the PA, others were disconnected pulling away the wire bonding. A comparison is possible between the behavior of the two configurations.

Beam test at CERN - on-line results



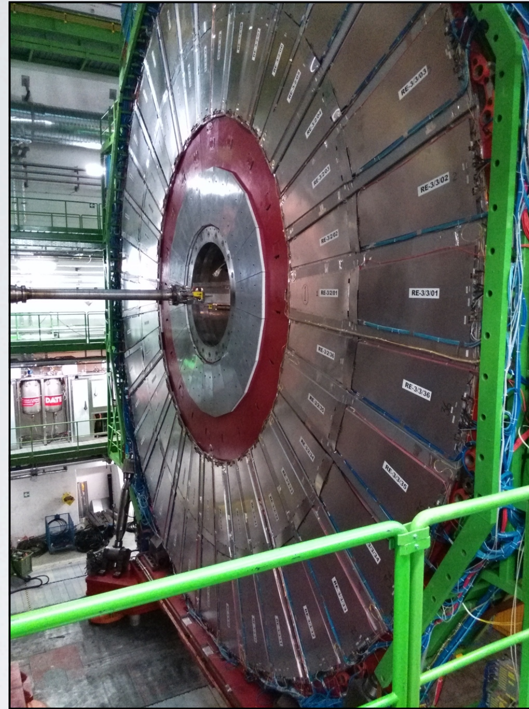
In the same FW sub-assembly, the chip 2 has three contiguous strips in short. In the chip 3 lots of defects arose in Pisa, maybe due to some little scratches of (initially) unknown nature. These defects were observed for the first time in Pisa and they were seen also in the beam test. No new defects in both FW and BW sub-assemblies were shown during the beam test.

Beam test at CERN - HEPHY first analysis

After the beam test, HEPHY people made a measurement in their clean room, applying an extra voltage to see if it's possible to cure P-side pinholes. Results confirmed what we have also seen in Pisa before the beam test, with a lower extra voltage. It seems reasonable to leave the channels with pinholes connected and apply the extra voltage, instead of unplug them. With unplugged channels, neighbor strips are affected by larger noise.

			Vsep=0V		Vsep=+5V		Vsep=-5V	
APV	**Strip**	**Defect**	**Noise**	**IntCal**	**Noise**	**IntCal**	**Noise**	**IntCal**
0	61	Pinhole, pulled	Huge	Narrow	Huge	Between narrow & normal	Huge	Narrow
0	73	Pinhole, pulled	Huge	Narrow	Huge		Huge	Narrow
0	74	Pinhole, pulled	Huge	Narrow	Huge		Huge	Narrow
1	30	Pinhole	Low	Wide	Low (2)	Low	Huge	Slightly negative
1	104	Pinhole	Low	Wide	Low (2)	Low	Huge	
1	121	Pinhole (1)	Normal	Normal	Normal	Normal	Huge	
2	111	Short	Low	Low	Low	Low	Low	Low
2	112	Short	High	Low	High	Low	High	Low
2	113	Short	High	Low	High	Low	High	Low

Beam test - things you **must** do in Geneve



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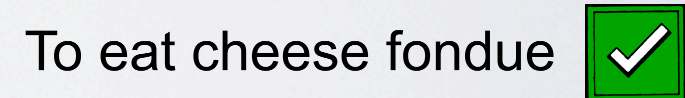

To eat cheese fondue

To get lost in a corn field

Future activities

- Finalize all procedures for preliminary tests.
- Production of other class B sub-assemblies to finalize, tune and verify all the procedures for both BW and FW modules.
- Finalize test stand setup.
- Start mass production in late jan/ early feb 2015 (if all parts are available).
- Test beam data analysis for FW and BW sub-assemblies.

THANKS FOR YOUR ATTENTION