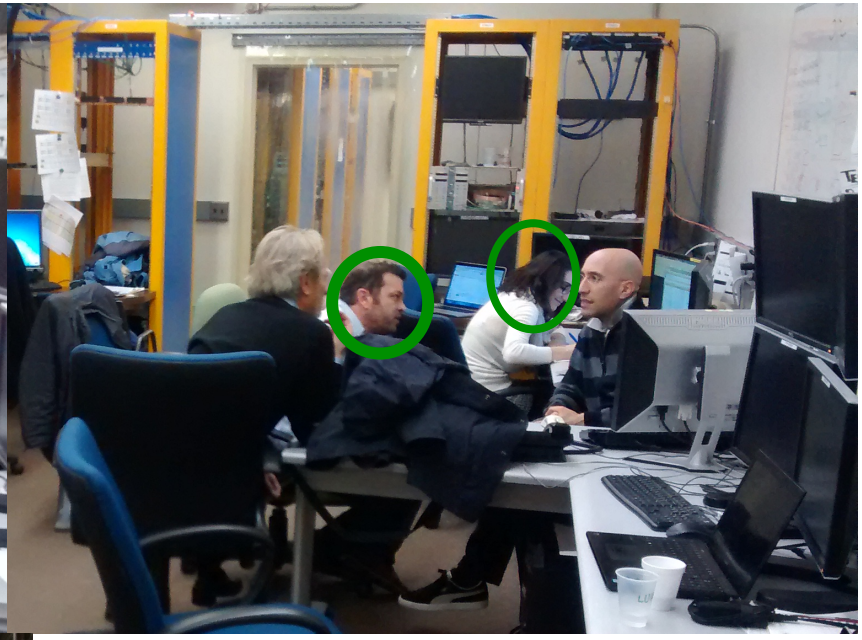
M. Meschini

Test Beam at FNAL
10-22 December 2015



Formazioni

Ospiti:
Dinardo
Meschini (dietro l'obiettivo)
Moroni
Sguazzoni

Locali:
Bolla
Uplegger
Vernieri
Rivera (missing in picture)

Tutti italiani tranne 1: indovinate quale?

Sensori Bump Bonded @Selex tutti con PSI ANALOGICO

Planari

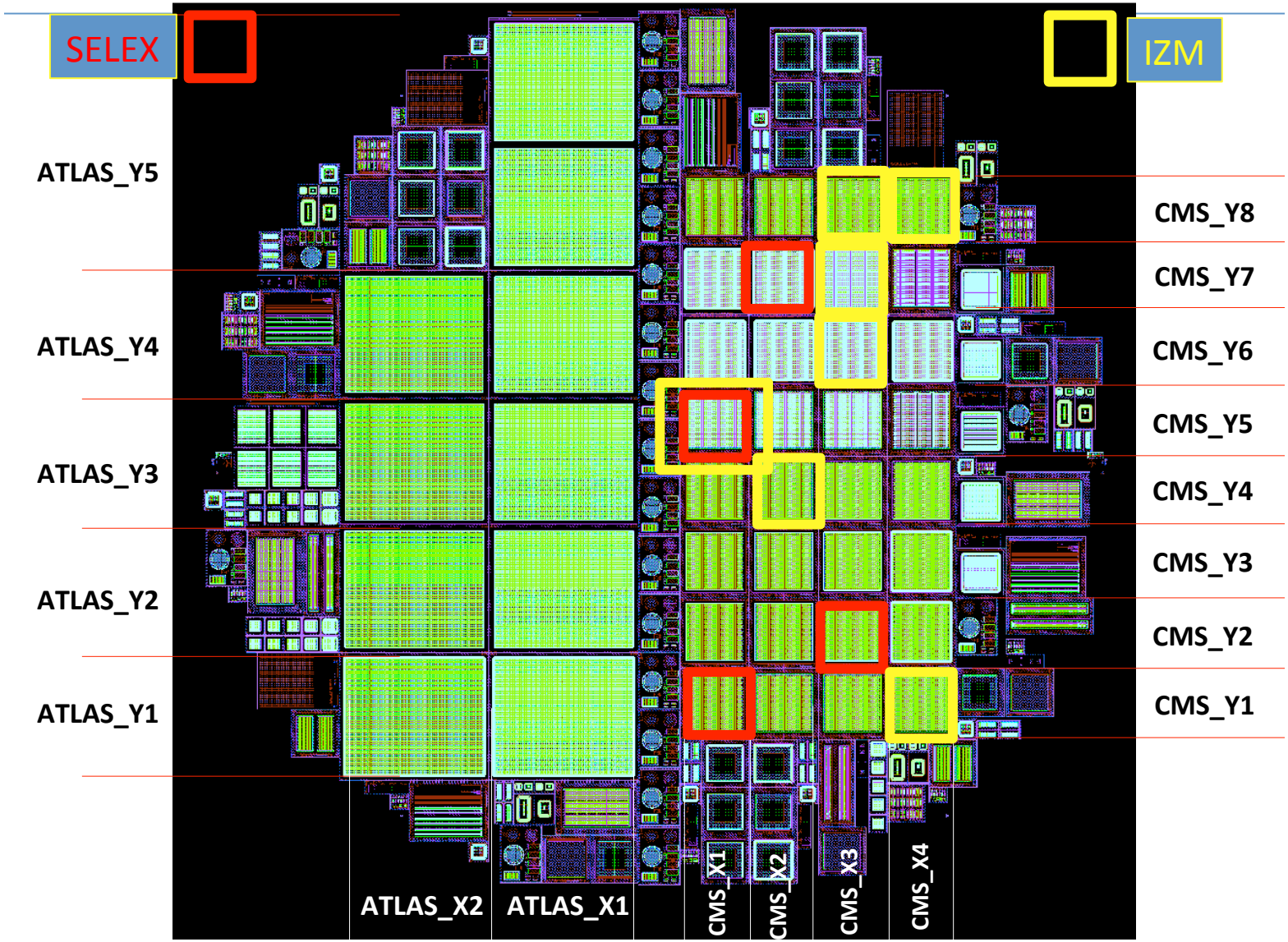
- P20_2, pstop, 10GR ps, COORDINATE x=2 y=7
- PD34A, pstop, 1GR no ps, COORDINATE x=1 y=5
- PD1, no pstop, 1GR no ps, COORDINATE x=1 y=1
- PDC1, no pstop, 5GR ps, COORDINATE x=3 y=2

3D

Scelti per il TB

- C2ES2
- C3E5

Pixel Devices identification



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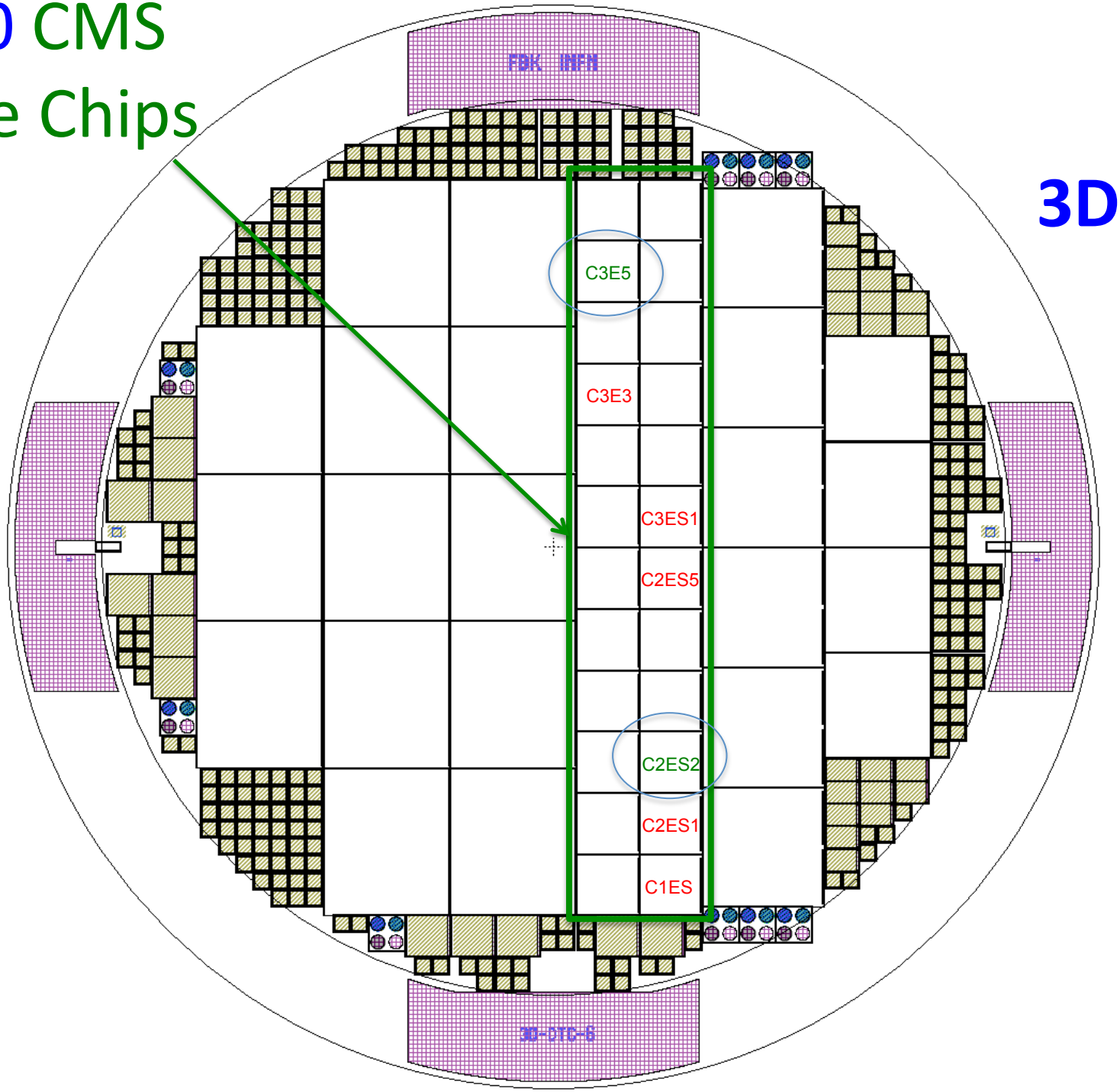
A. Messineo and M. Meschini, CMS R&D meeting with IZM

W10 CMS
Single Chips

3D



Sensori Bump Bonded @IZM

Final total wafer thickness 285µm

100µm thick device

Wafer ID	30		TIPO
CMS Devices	X	Y	
95V	x1	y5	P34A
95V	x3	y7	P30
180V	x3	y8	PDp5
390V	x4	y1	PD4

MM
15/10/15

130µm thick device

Wafer ID	80		TIPO
CMS Devices	X	Y	
	x1	y5	P34A
	x2	y4	PD6
	x3	y6	P200_1
	x4	y8	PDp6

V_bd

Bump bonded con PSI46dig-respin utilizzando ROC della produzione Pixel Fase-1 con qualche pixel non funzionante

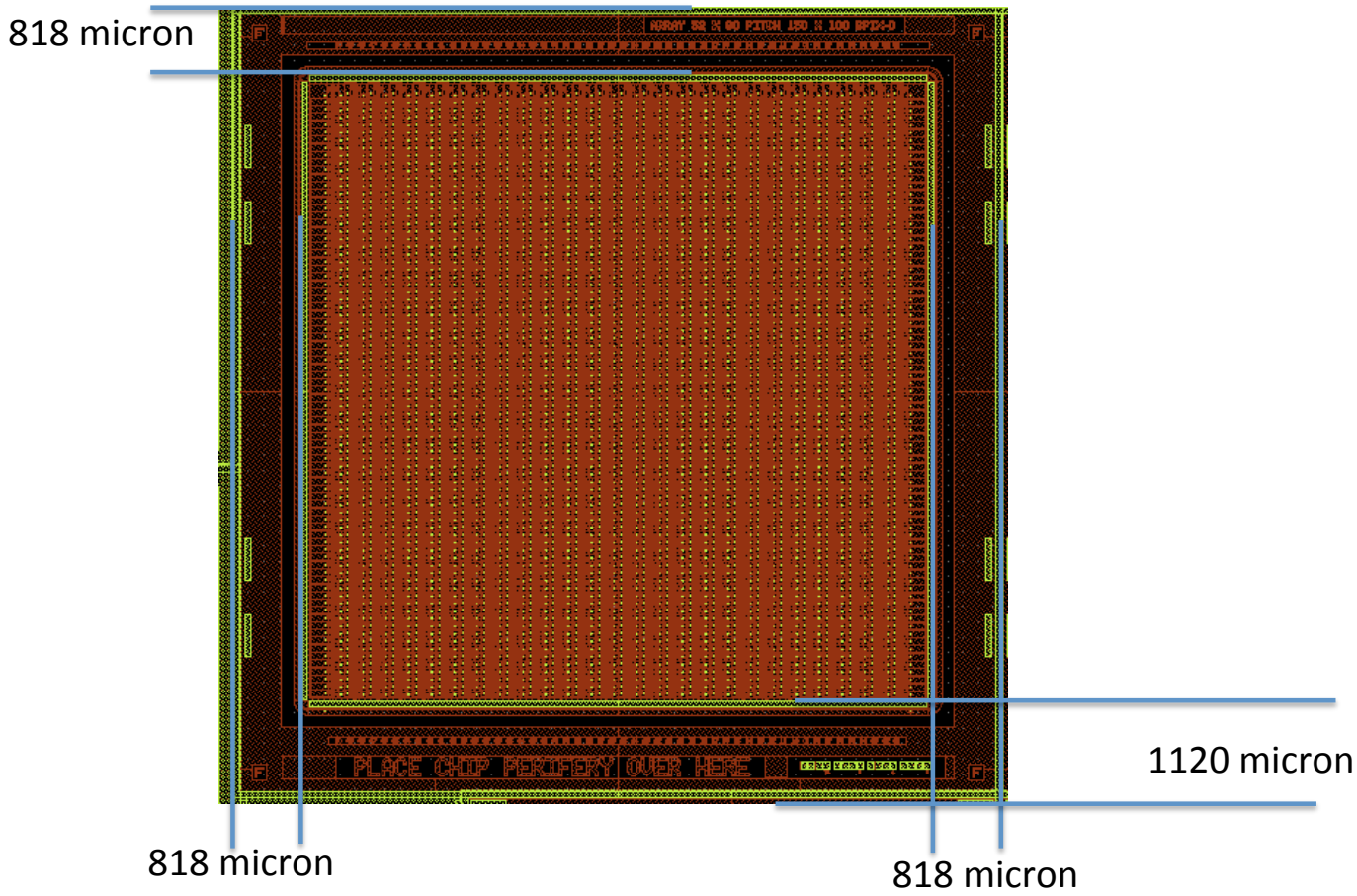
I sensori processati a IZM hanno la "cornice" di BCB per prevenire le scariche HV-GND

- Other Devices Bump bonded at IZM (no results available yet)
  - 2 ATLAS doublets
  - 6 ATLAS FEI4

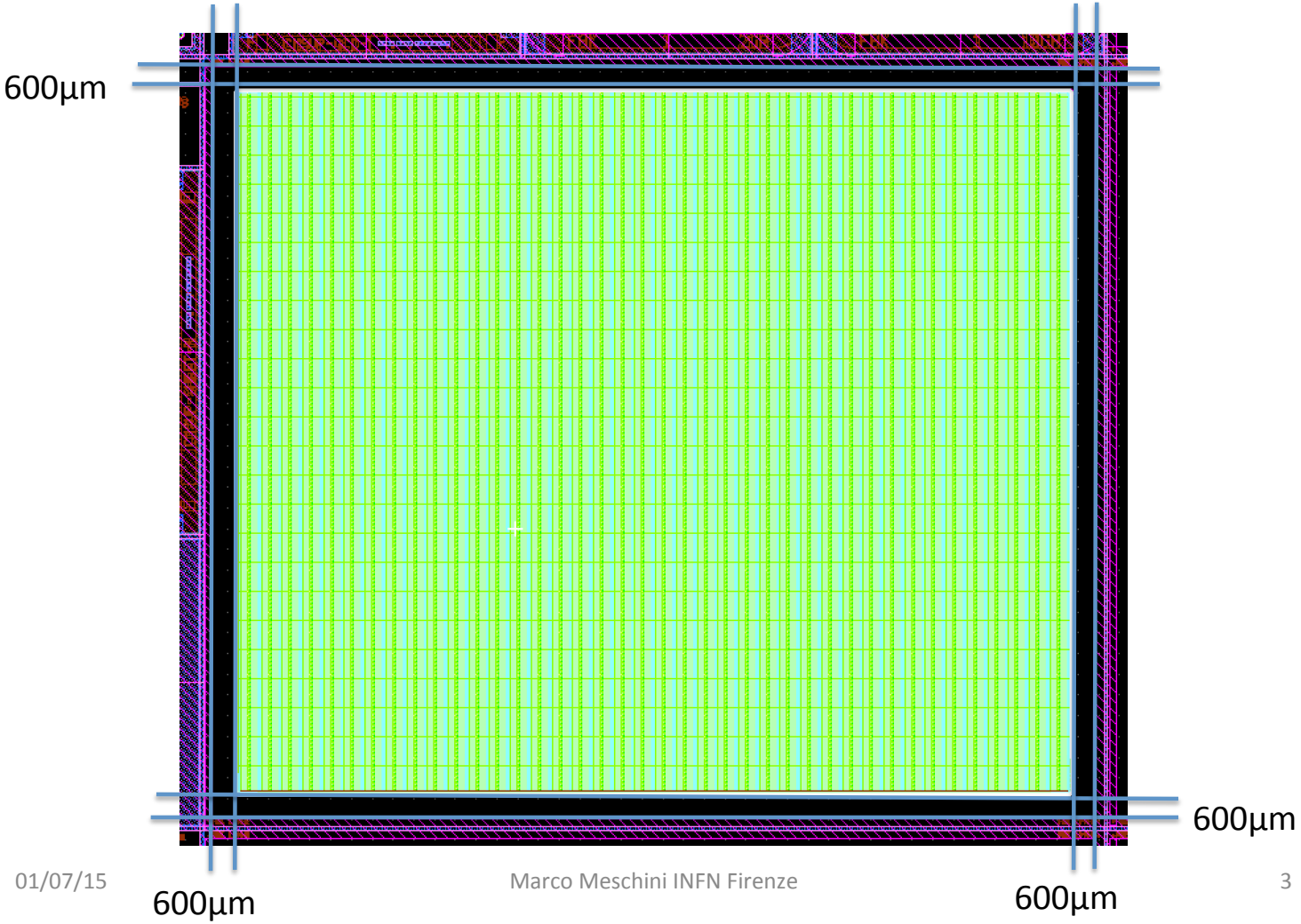
BCB PIXEL CMS

	Y1	Y2	Y3	Y4	Y5	Y7	Y8
CMS_X1	PD1	PDA	PDA2	PD5	P34A	PD1	PDp1
CMS_X2	PD2	PDB	PDB2	PD6	P34B	PD2	PDp2
CMS_X3	PD3	PDC	PDC2		P34C	PD3	PDp3
CMS_X4	PD4	PDD	PDD2				PDp4

	Y6	Y7
CMS_X4	FP30	FP50

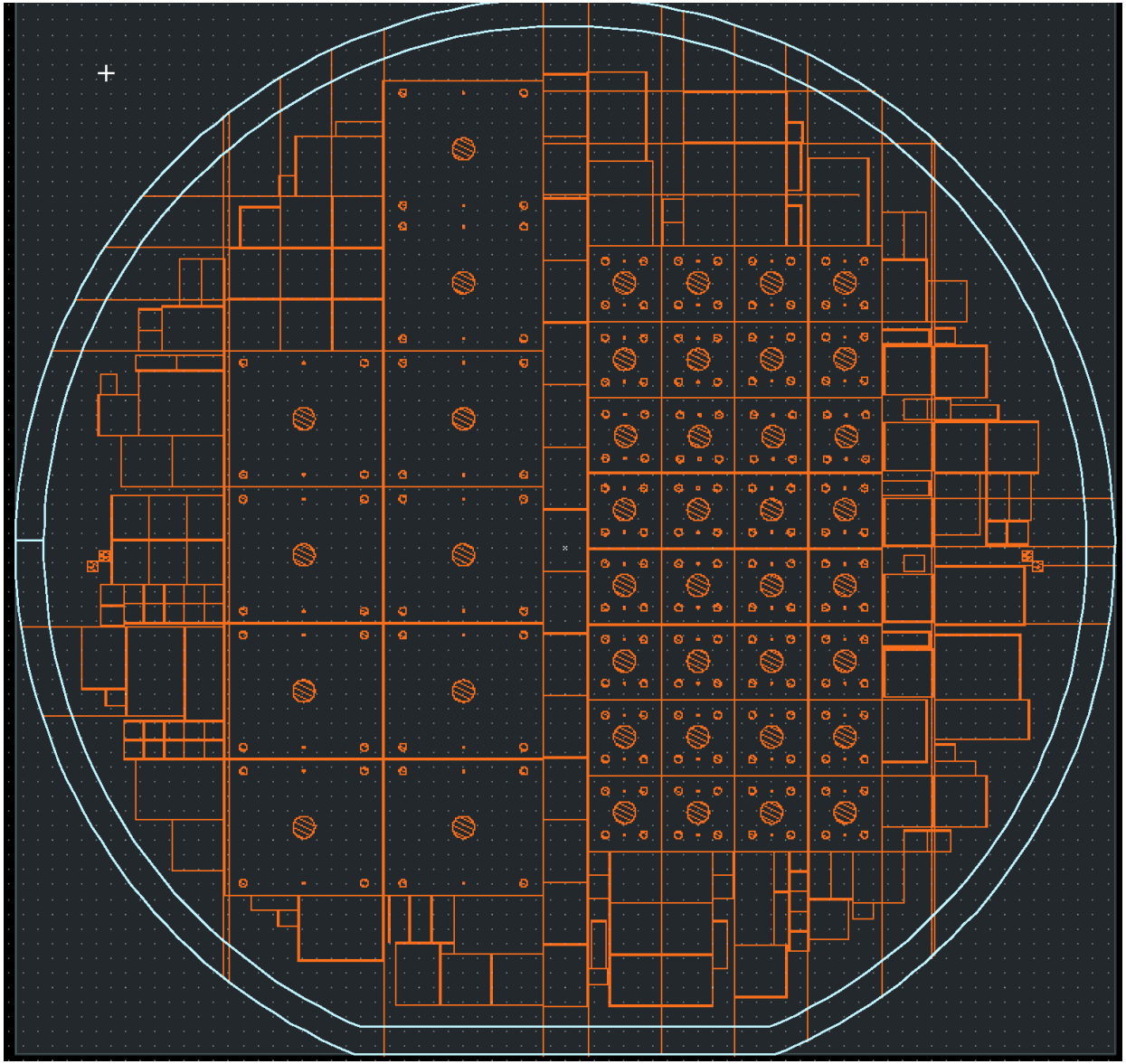


FE-I4 SINGLE ATLAS X1-X2; Y1-Y4



Metal Back at IZM

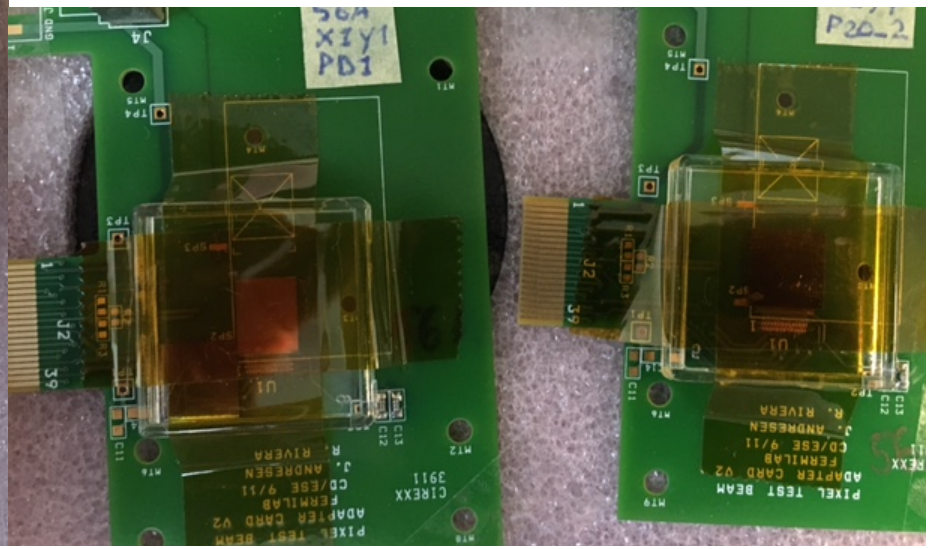
- Metal mask agreed with IZM
- Orange lines and shaded area are without metal



Sensori SELEX

- I sensori sono stati wire bonded e provati a Torino (grazie ad Ada, Fabio, Bonding Lab)
- Qualita' del BB molto critica
- I risultati dei test lasciavano poche speranze

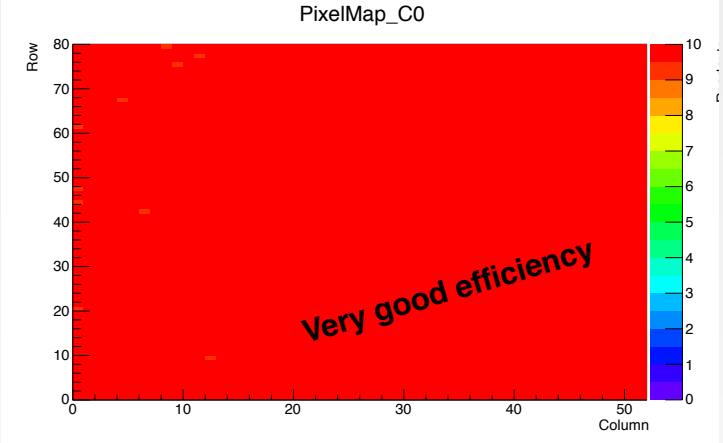
- Arrivati a FNAL quasi tutti i sensori si erano staccati dal ROC!

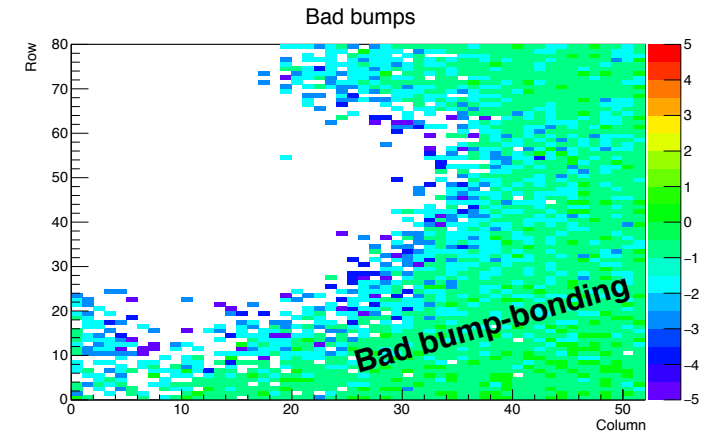


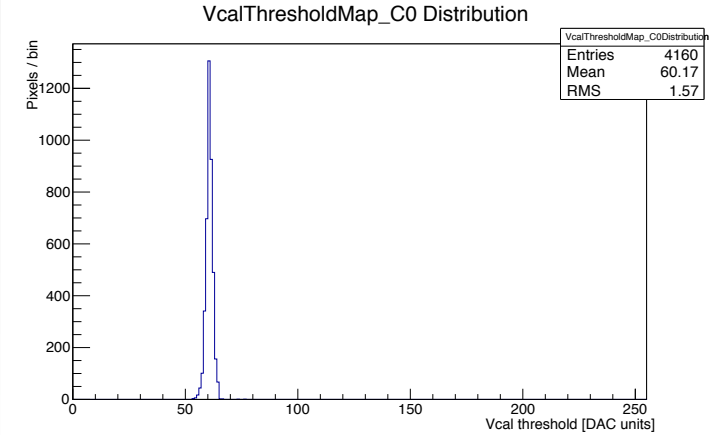
Fabio Ravera (TO): risultati dei test dopo wirebond

x2y7_P20_2

Il migliore…







Testing conditions:
Vbias = -60 V
Ibias ~ 160 nA
Iana ~ 25.3 mA
Idig ~ 25.8 mA
Trimming @ 60 Vcal

Comments:
The ROC is working well and the trimming was successful, but the bump-bonding is very bad. Maybe there are enough pixels…

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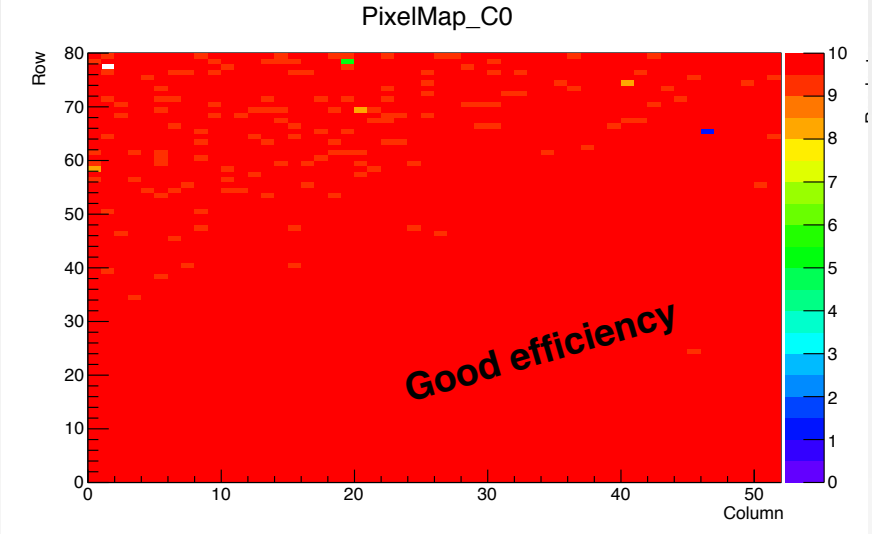
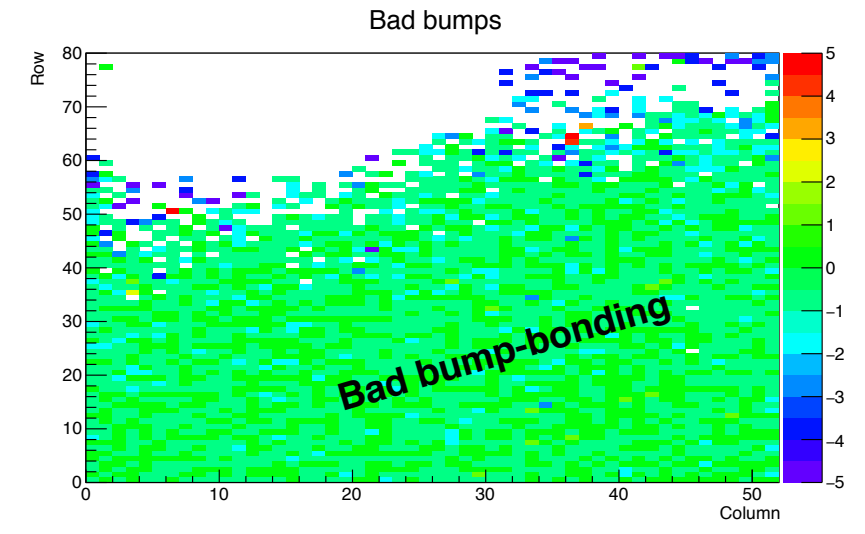
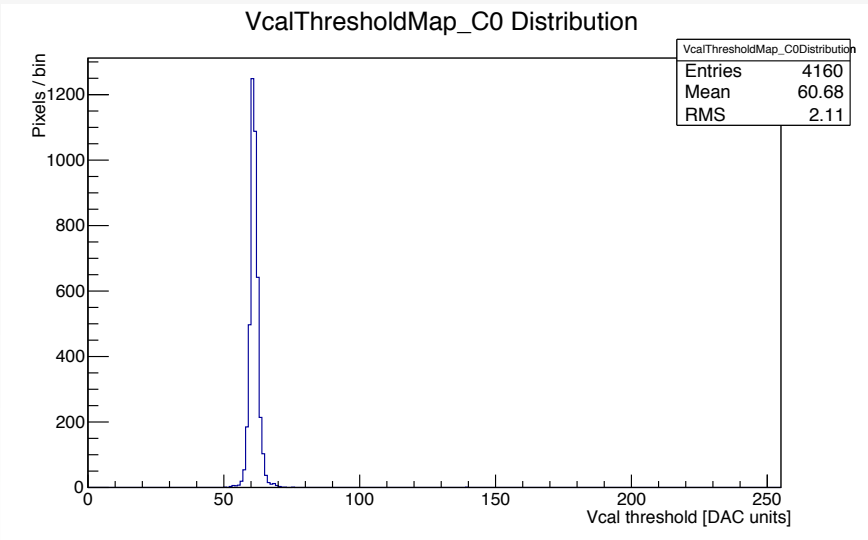
x1y1_PD1





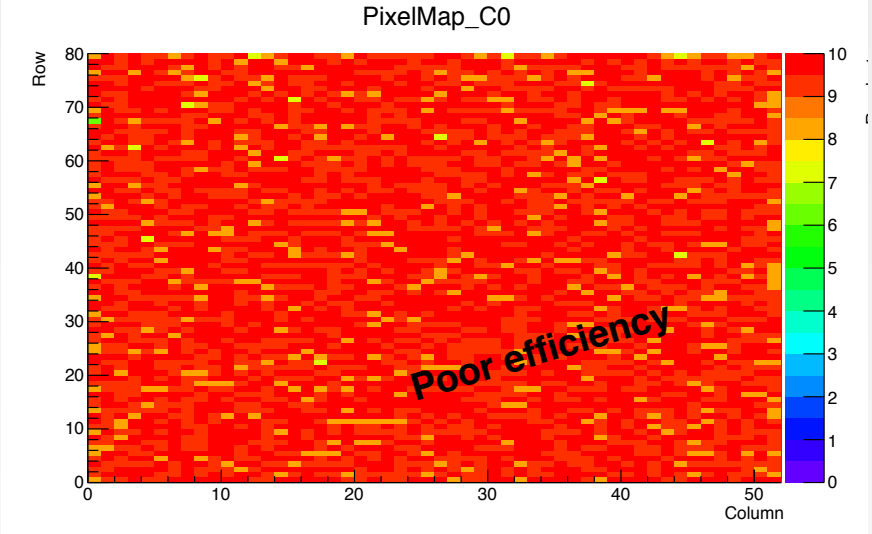


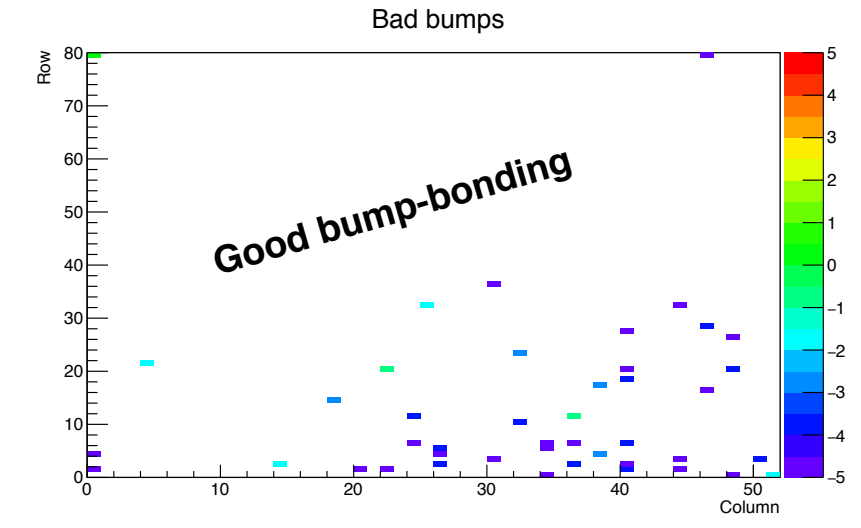
Testing conditions:
Vbias = -60 V
Ibias ~ 100 nA
Iana ~ 25.6 mA
Idig ~ 26.7 mA
Trimming @ 60 Vcal

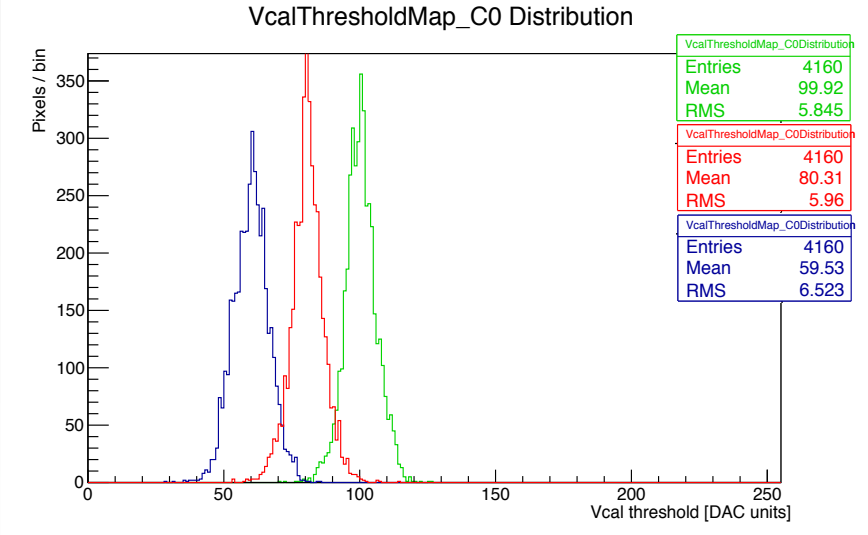
Comments:
The ROC is working pretty well and the trimming was successful, but the bump-bonding is very bad (good bumps in the white region)

C3E5

3D sensor, now at FNAL







Testing conditions:
Vbias = -20 V
Ibias ~ 1000 uA
Iana ~ 37.5 mA
Idig ~ 29.1 mA
Trimming @ 60-80-100 Vcal

Comments:
The ROC is not working well and the trimming failed. The bump-bonding seems ok.
I increased the analog current to improve the efficiency of the pixel map

Further considerations

Fabio Ravera

- Since I don't trust the bump-bonding test I tried to test the bonding keeping the sensor with no bias or not in the dark while doing a pixel map. Since in these conditions the sensor becomes very noisy I expect to see a bad behaviour only for the pixels properly connected. The maps obtained are very similar to the ones from the bump-bonding test, so I consider solid the conclusions on the bb.
- The only sensor which seems to be connected properly is the 3D 2E sensor even if the bb test is very bad. I had not an available source in the lab so I could not crosscheck
- The 3Ds are a bit more difficult to test. As I already observed with the digital ROC, they are quite sensitive to noise coming from external sources. I shielded the detectors with a copper box and used a ferrite ring on the ATB power cable to improve the testing conditions, but anyway the 3E could not be properly trimmed.

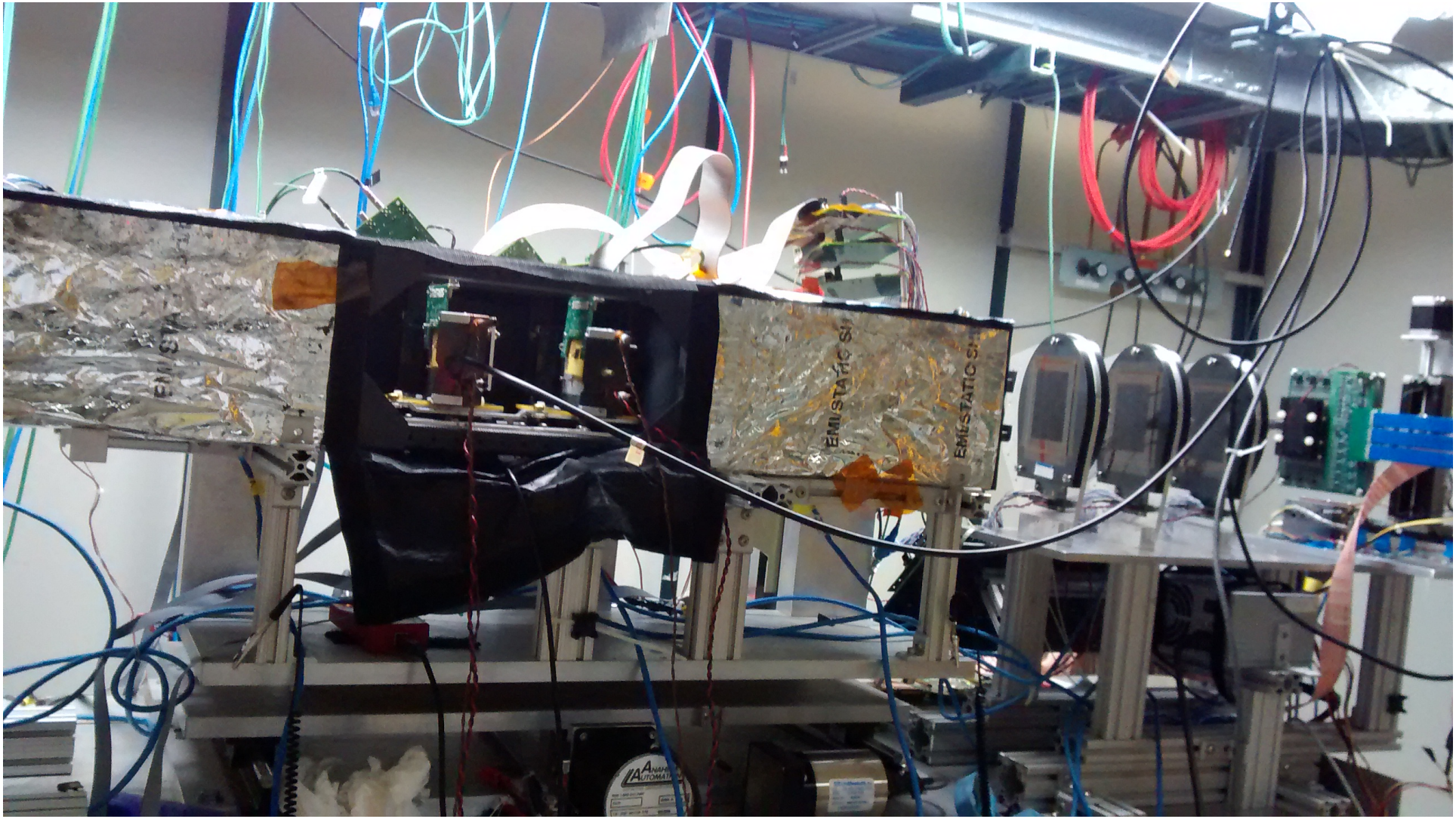
Sensori planari FBK-IZM: un grande successo!

- 8 modules wire-bonded and tested @FNAL
- Test e calibrazioni fatte da C. Vernieri.
- Durante i test 1 modulo non ha risposto, apparentemente ROC non funzionante, ora a Pisa per controlli DAQ e studi HV spark
- 7 Moduli sul fascio in ~1 settimana, 2 moduli in contemporanea, senza raffreddamento, zona telescopio "termalizzata" con condizionatori

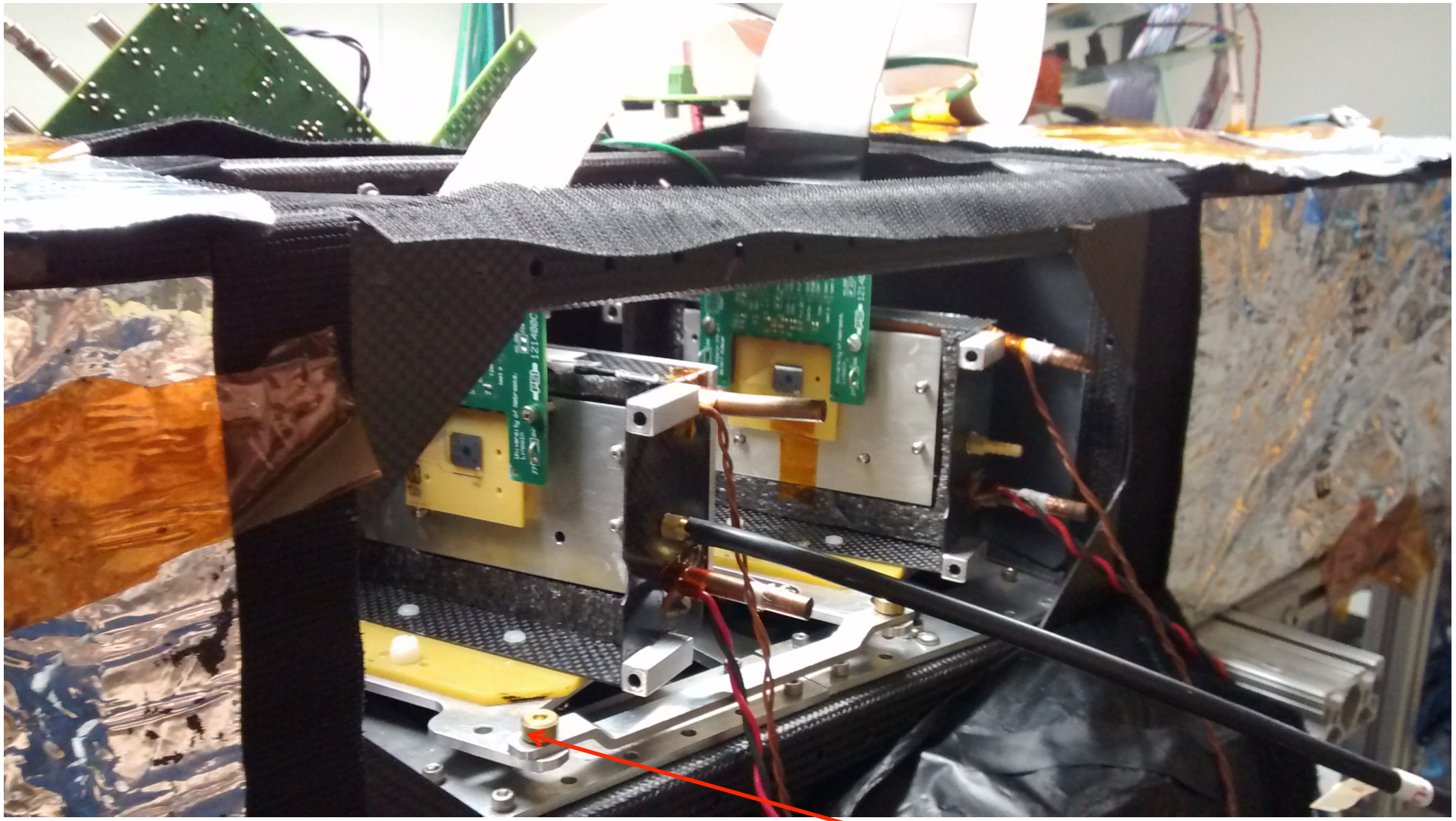
- Vdepletion dalle misure FBK, Firenze, Pisa ~18-20V
- HV bias durante la presa dati 40V
- Scan HV (su alcuni moduli) fino a 90V (piu' alcuni run a 5, 10, 20V su un solo modulo)
- Scan angolare 0˚, 10˚, 20˚

- I moduli FBK-IZM si sono comportati in modo eccellente ed i colleghi di FNAL si sono molto congratulati!

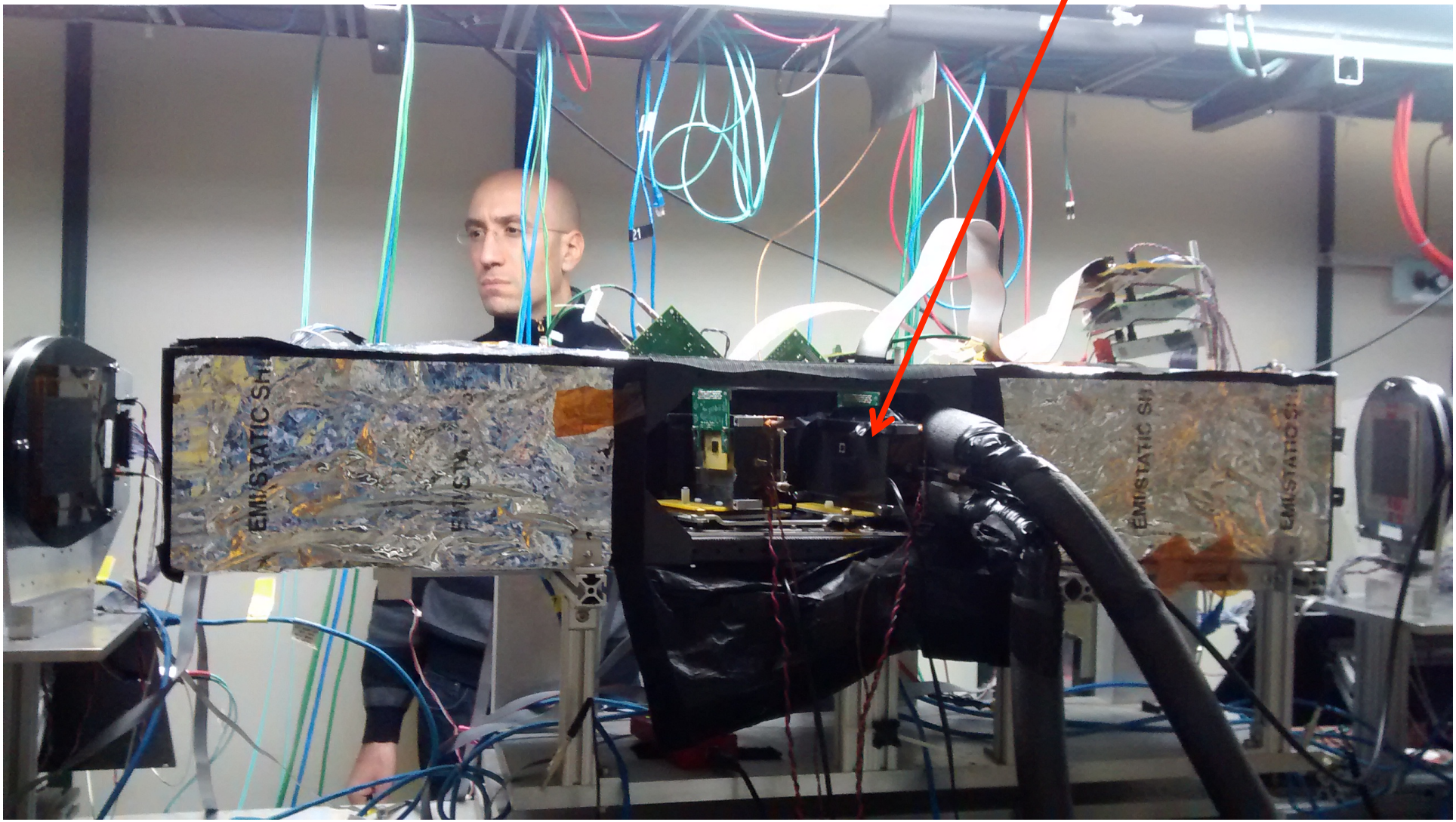
FNAL TB Telescope



CMS DUTs and Pivoting Support for Angular Scan



Gli ultimi giorni del TB abbiamo preso dati in contemporanea con un rivelatore irraggiato, tenuto a -20C, senza problemi

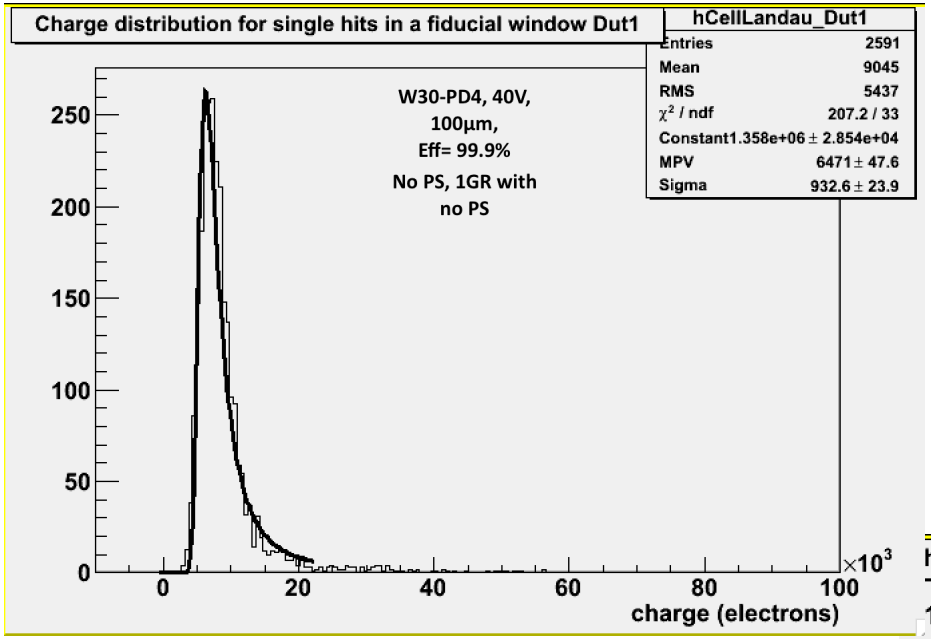


Analisi Preliminare

- Risultati **molto preliminari**, dai file presi al test beam e analizzati quasi online
- L'analisi e' in corso principalmente a MI-B; in fase di apprendimento anche a FI
- Landau fitted Charge Most Probable Value: molto incoraggiante anche per i sensori da 100µm
- Efficienze vicine al 100%
- Per ora non abbiamo visto differenze macroscopiche di prestazioni tra le varie strutture: con/senza P-stop, uno/molti Guard ring, con/senza P-stop tra i guard ring
- I_bias durante il TB ~ 20-40nA

- Risultati piu' accurati verranno presentati da Mauro Dinardo al CERN durante la prossima CMS Tracker Week il 27/1/2016
- Vorremmo anche studiare l'efficienza delle varie strutture in maggior dettaglio per poter avere altre informazioni prima di far partire il batch planar Active Edge

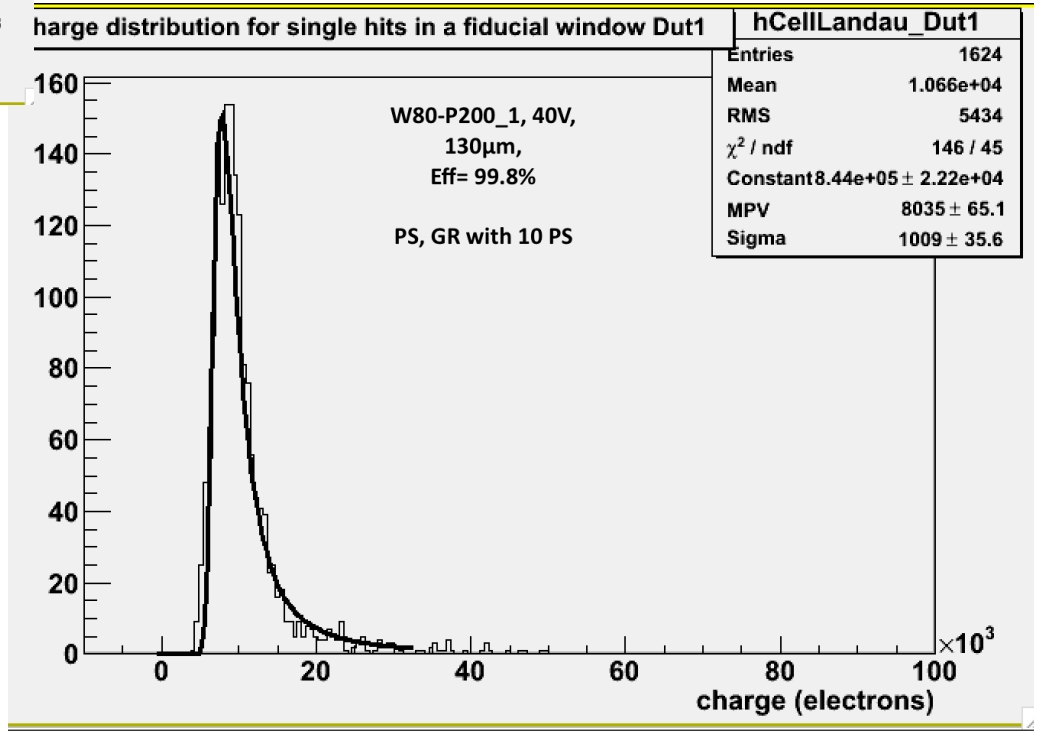
Spettri di Carica



MPV 100µ → 6400e⁻
MPV 130µ → 8000e⁻

Carica media 100µ → 9000e⁻
Carica media 130µ → 10600e⁻

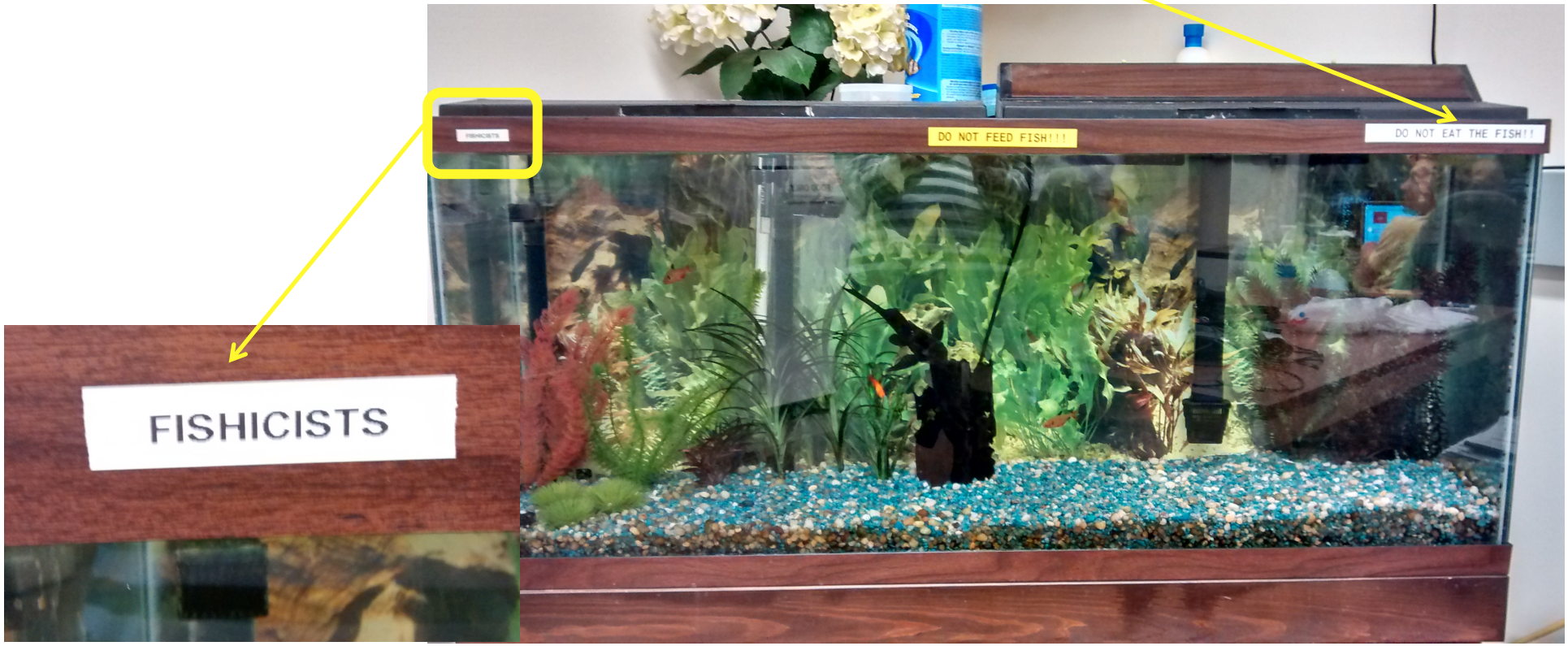
Efficienze >99.8% sul volume fiduciale, ottenuto escludendo tutti i pixel non funzionanti e richiedendo 8 pixel attivi intorno al pixel attraversato dalla traccia



Conclusioni

- Un test beam ben riuscito, grazie anche alla collaborazione con i colleghi FNAL-CMS che ringraziamo pubblicamente (e che in caso di pubblicazioni andranno tra gli autori)
- I sensori planari FBK sono eccellenti
- La cosa piu' bella del TB era questo acquario con la scritta:

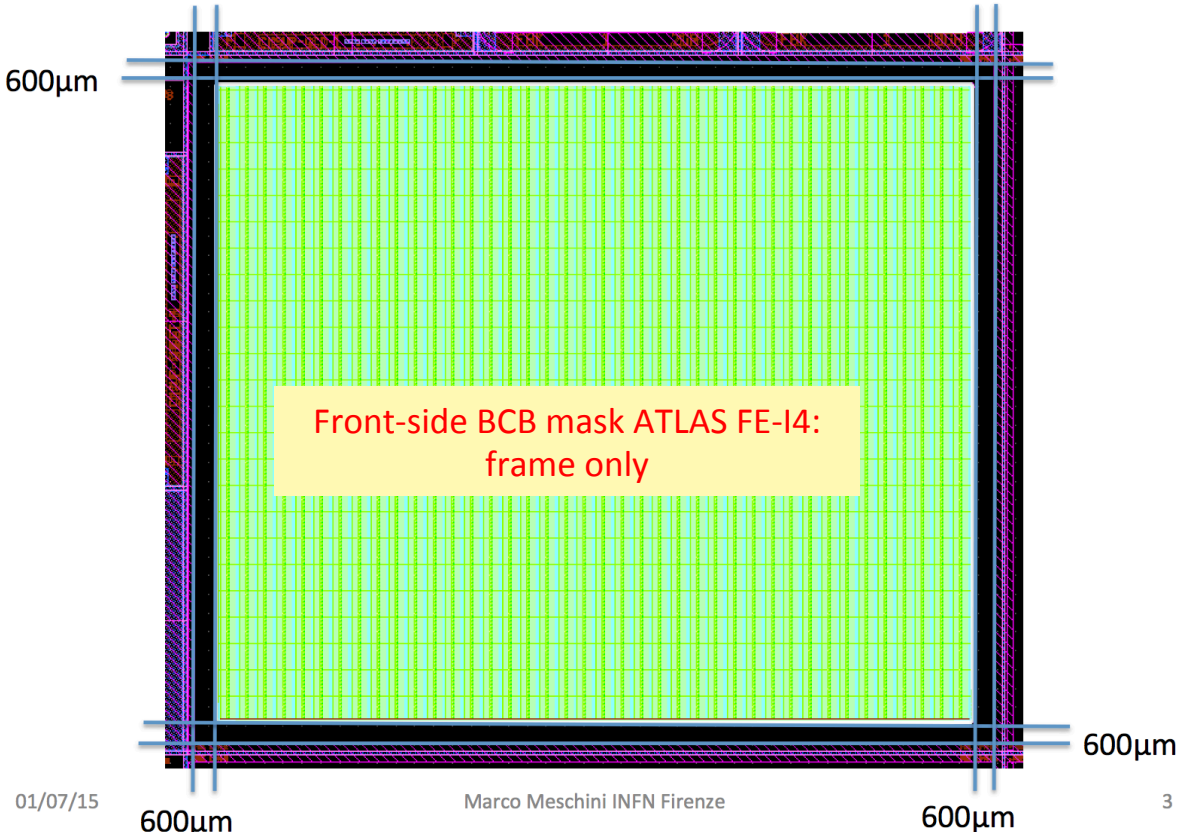
"DO NOT EAT THE FISH!!"

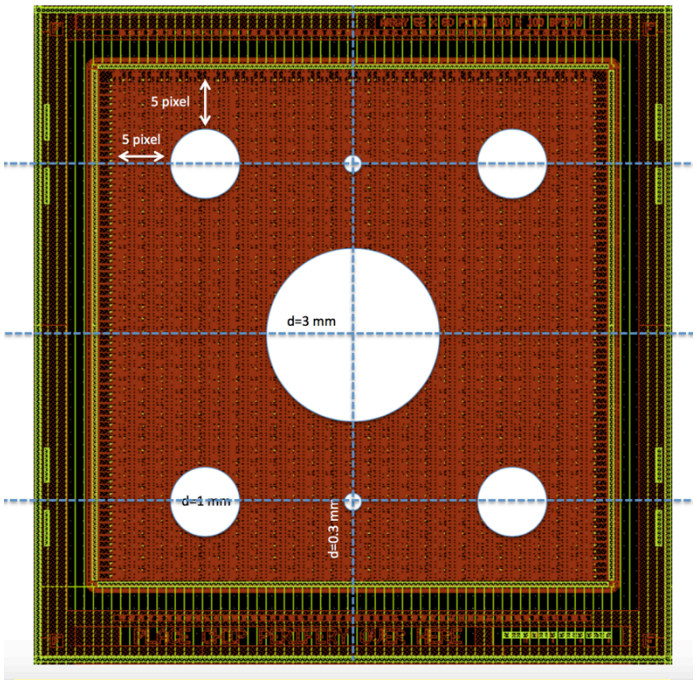


BACKUP

Back and Front-side Wafer Processing at IZM

Design of Sensor BCB and backside metal masks (INFN design)





Backside metal mask of CMS sensors with holes for Laser to illuminate pixels from the backside

First trial: BCB on sensor (CMS+ATLAS) periphery only
ATLAS 600µm width, CMS 800-1100µm width