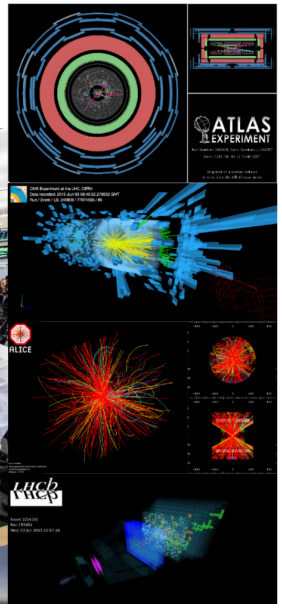
Preventivi 2016: CMS

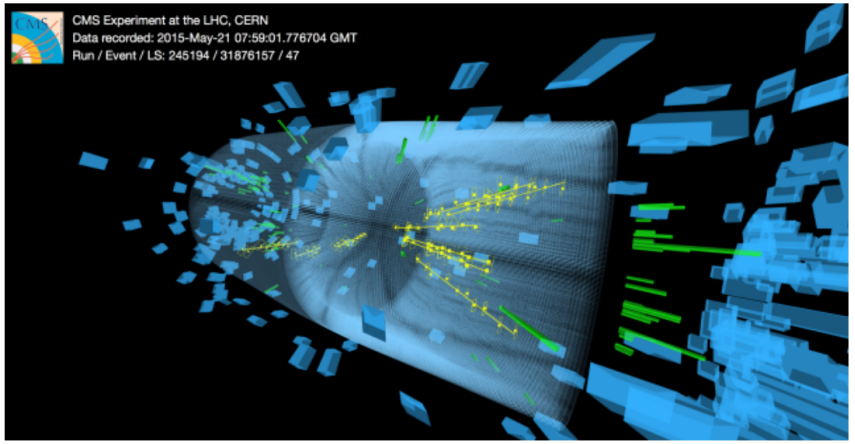
G. Bagliesi
03/7/2015

LHC experiments are back in business at a new record energy **13 TeV**
3rd June 2015



- Inizio Run2
  - CMS e Tracker in run2
- Fisica
  - attivita' a Pisa
- Upgrade tracker (fase I e II)
  - Inner pixel
- Tier2: stato e richieste
- Responsabilita' 2016
- Anagrafica 2016
- Sommario richieste

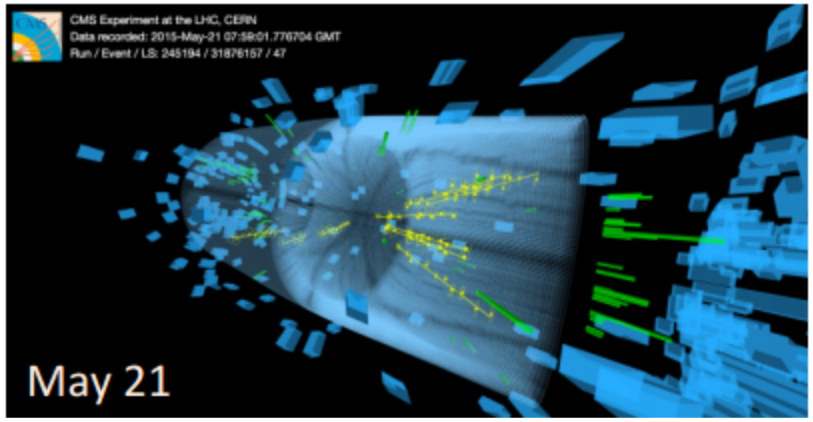
Run II: primo evento in CMS
21/5/2015



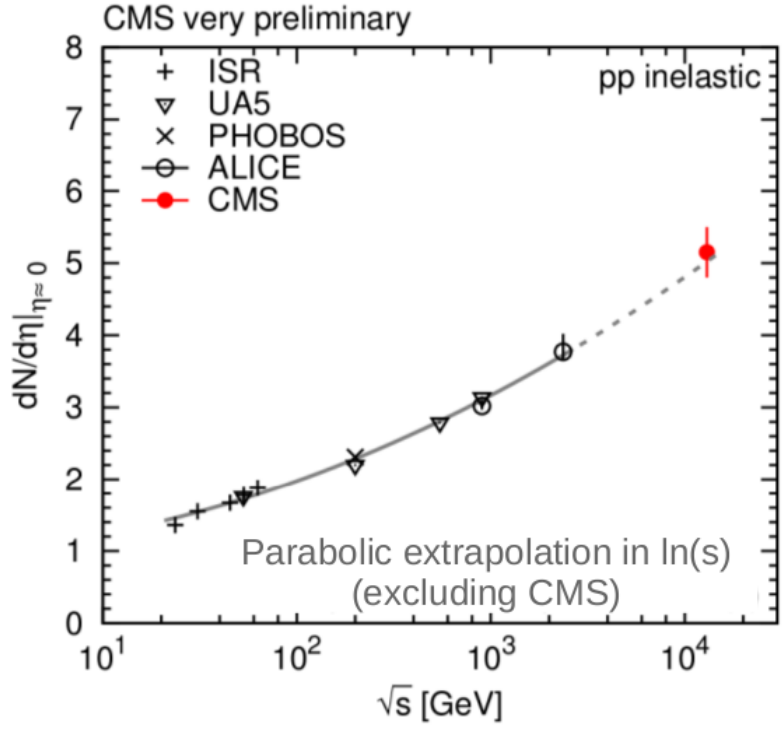
Wednesday evening, May 20, with 0T and Tracker+Pixel **off**
Thursday, May 21, with 0T and **Tracker on** but Pixel off

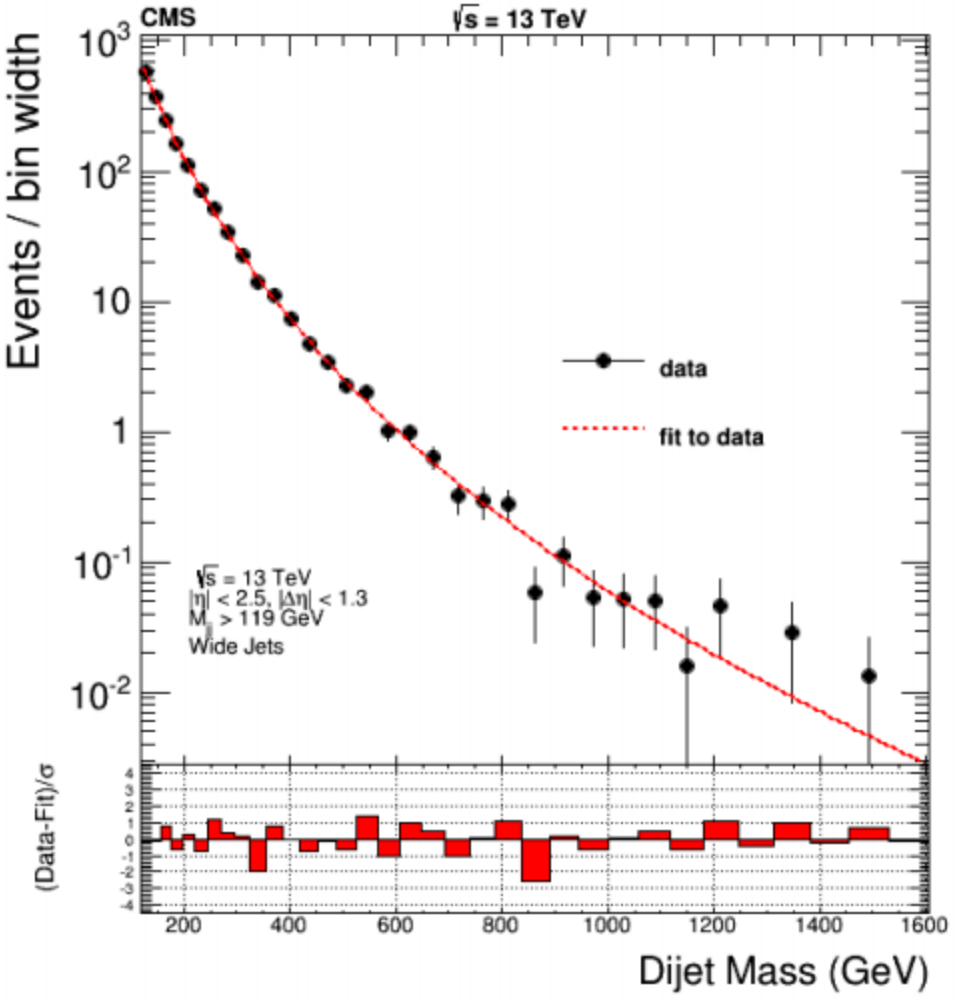
Inizio RUN II: CMS e tracker in run2

Start of Run-2



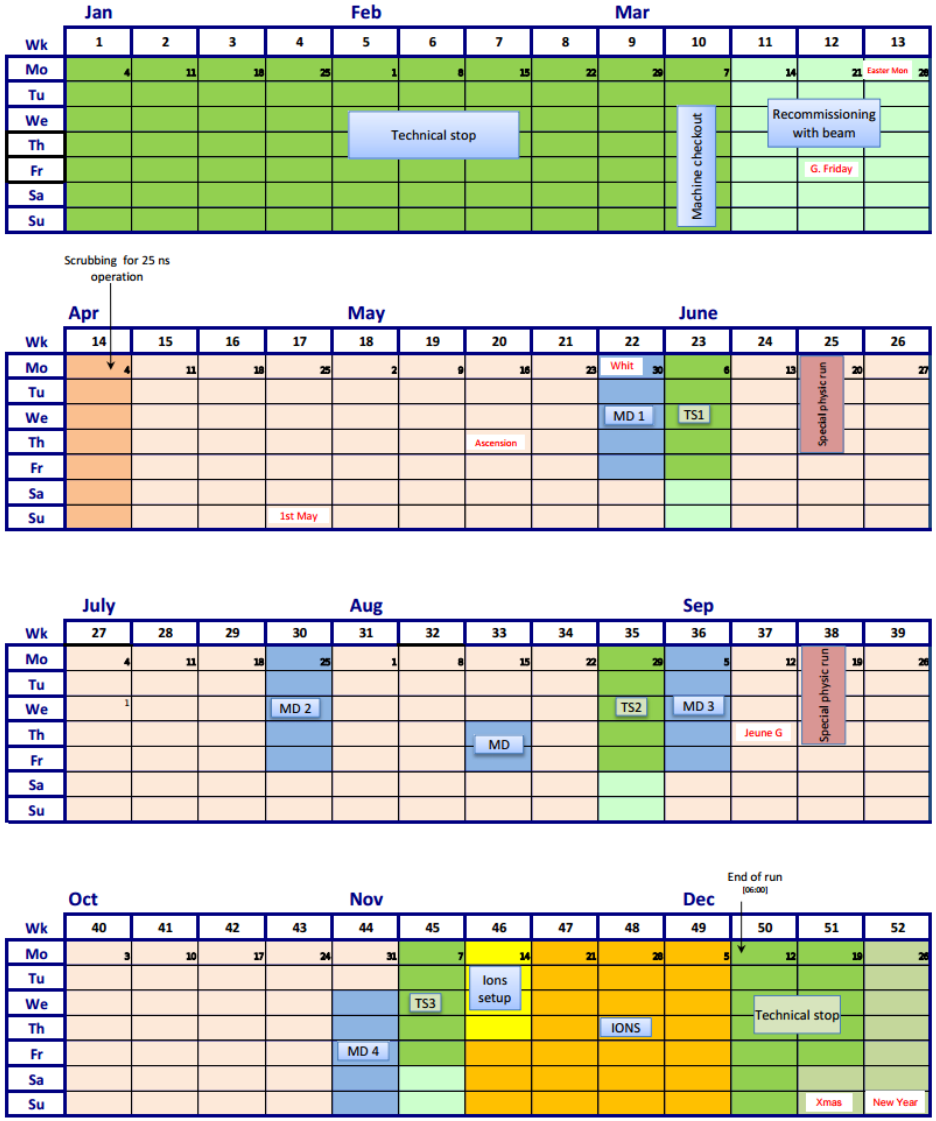
Anche con campo magnetico B=0T (dettagli in slides 11,12) abbiamo ottenuto dei risultati !

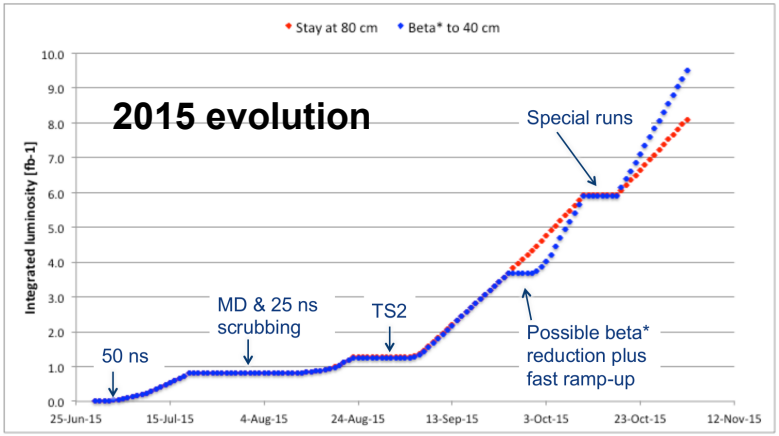


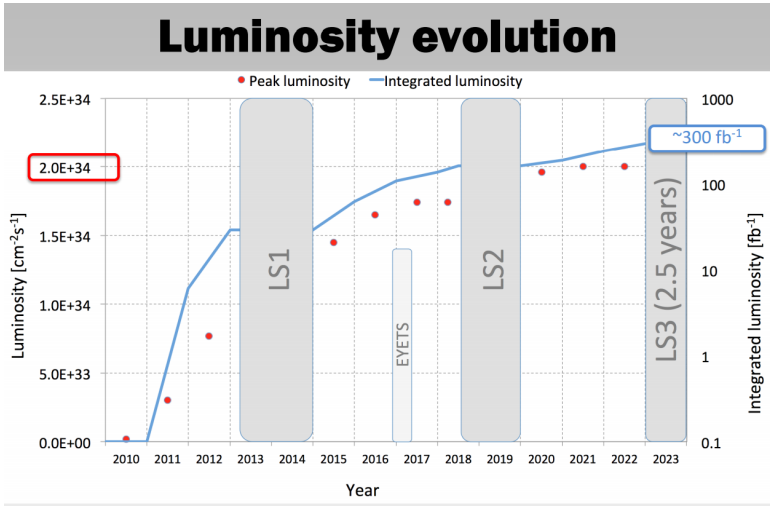


LHC 2015, 2016 and beyond

DRAFT schedule 2016

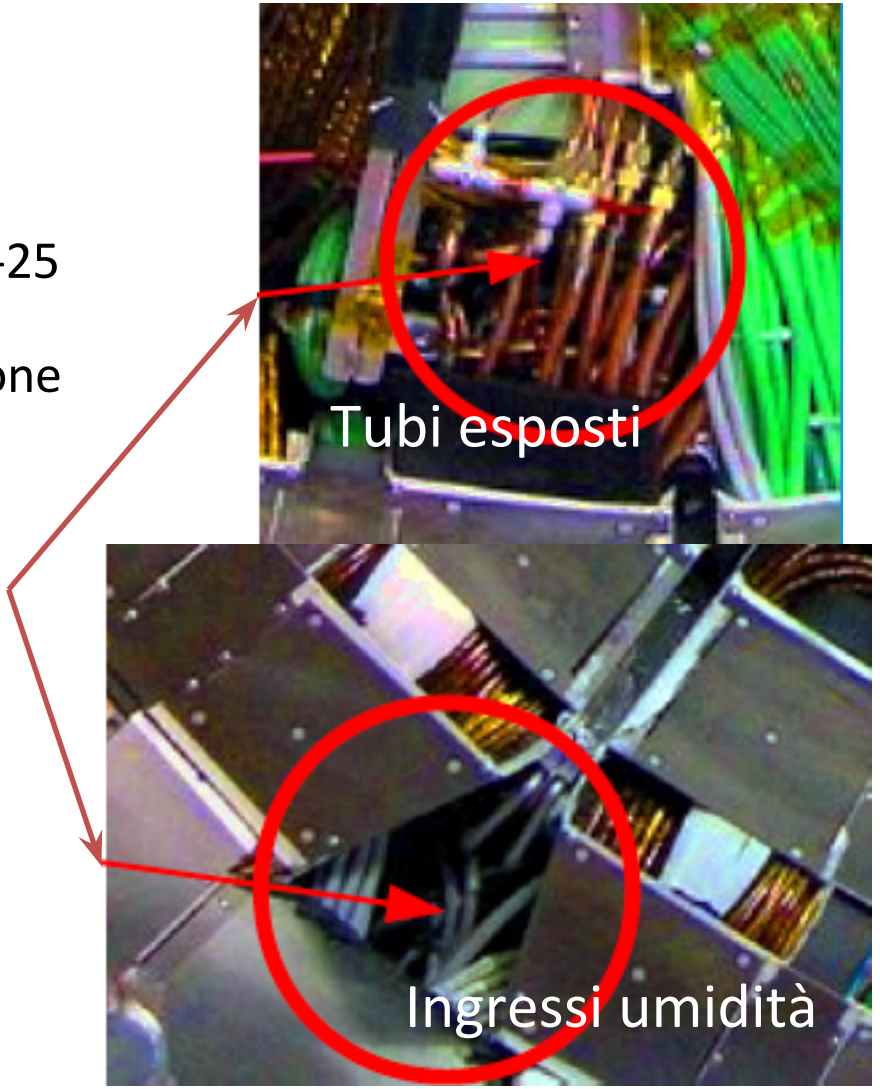






LS1: raffreddamento tracker

- Temperatura sensori <5°C per essere operativi fino a LS3 (strip) e LS2 (pixel)
  - ➔ temperatura raffreddamento -10/-15°C
    - Run 1: +4°C strip, 0°C pixel
- Revisione impianto di raffreddamento: -25 °C
- Il vero problema: umidità e condensazione
  - ➔ Volume interno del tracciatore: nessun problema
  - ➔ Interfaccia e cammini servizi: da curare
- Soluzione
  - ➔ Barriere per l'umidità
  - ➔ Elementi riscaldanti
  - ➔ Potenziamento e ottimizzazione distribuzione di aria secca
  - ➔ Sistema di monitoraggio capillare e ridondante



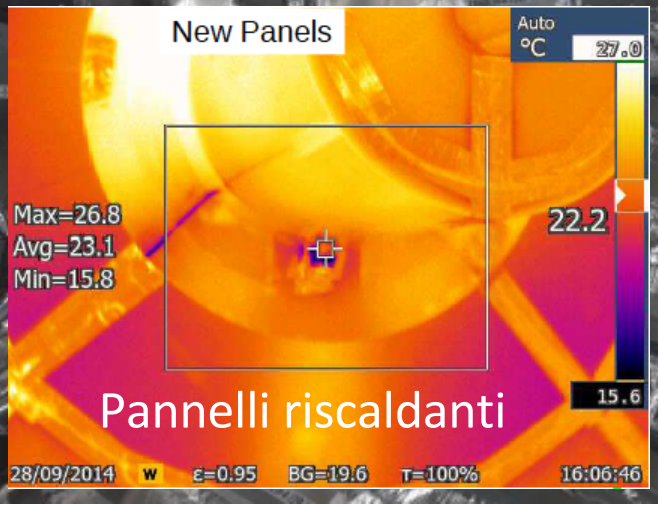
Alla fine…

… ed è solo una parte dell'opera

"Sniffer" per umidità

Isolamento fasci tubi su magnete e "yoke"

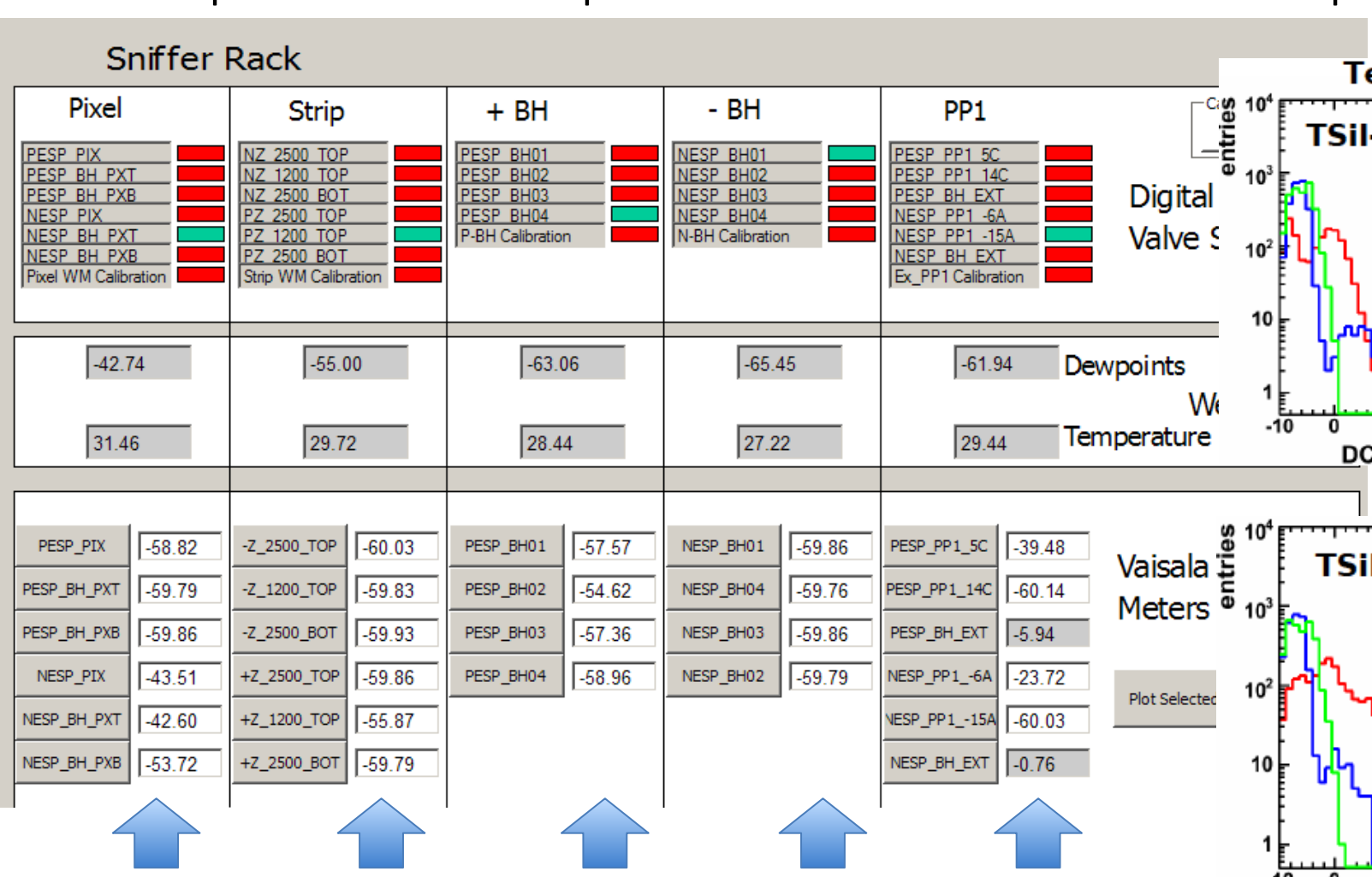
Aria secca: x7 Run 1

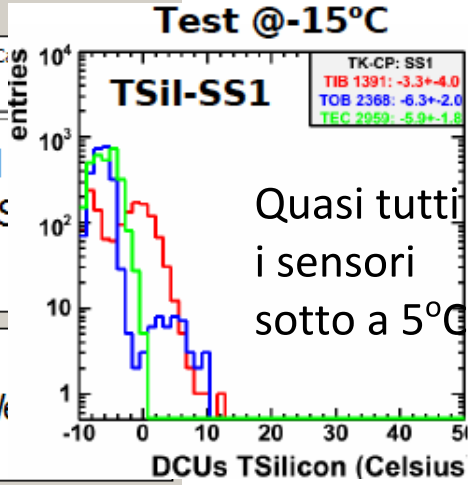


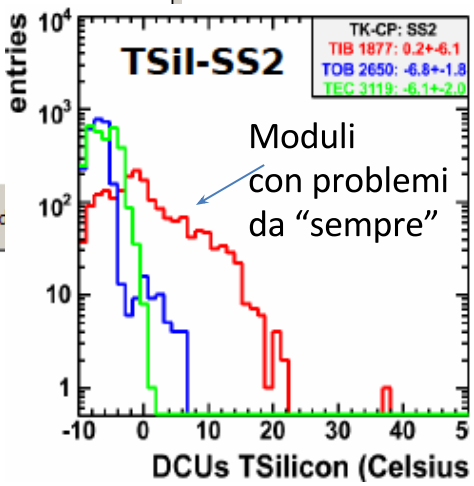
Pannelli riscaldanti

Risultato

Temperature sensori: risposta ideale ad abbassamento della temperatura







Misure umidità: punto di rugiada <-40°C

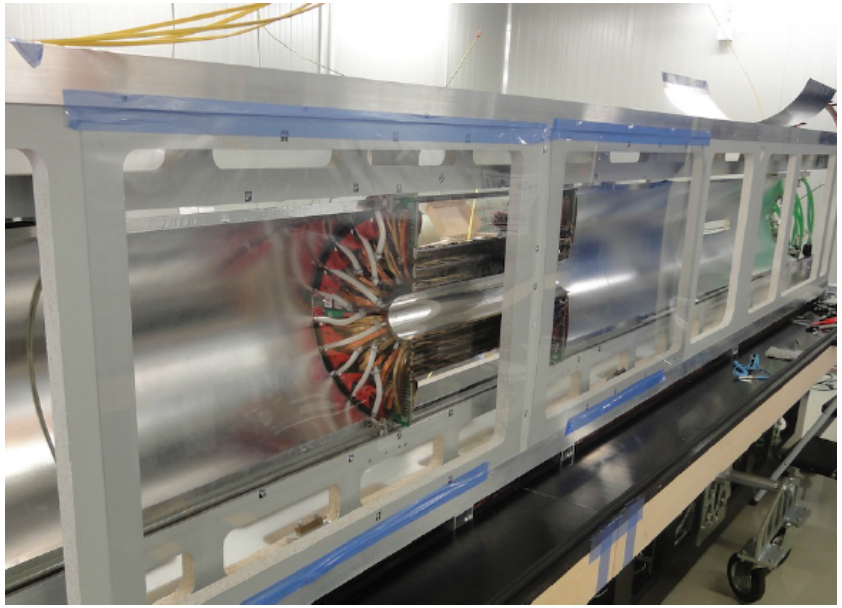
LS1:Manutenzione pixel detector

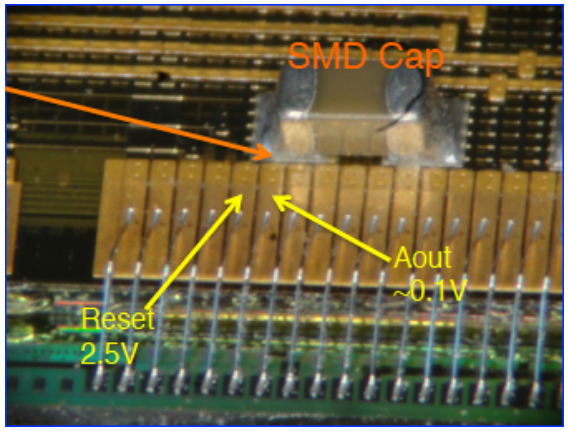
- Sostituzione beam pipe: Ø da 59.6 a 45.0 mm

➔Estrazione pixel detector per manutenzione e test

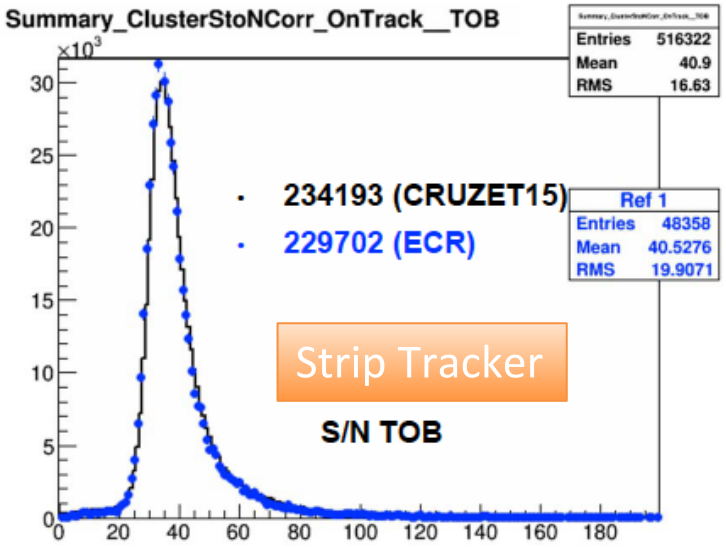
  - Pre-calibrazione a freddo
  - Riparazione canali non funzionanti
    - Brutta sorpresa con umidità e criticità di un elemento

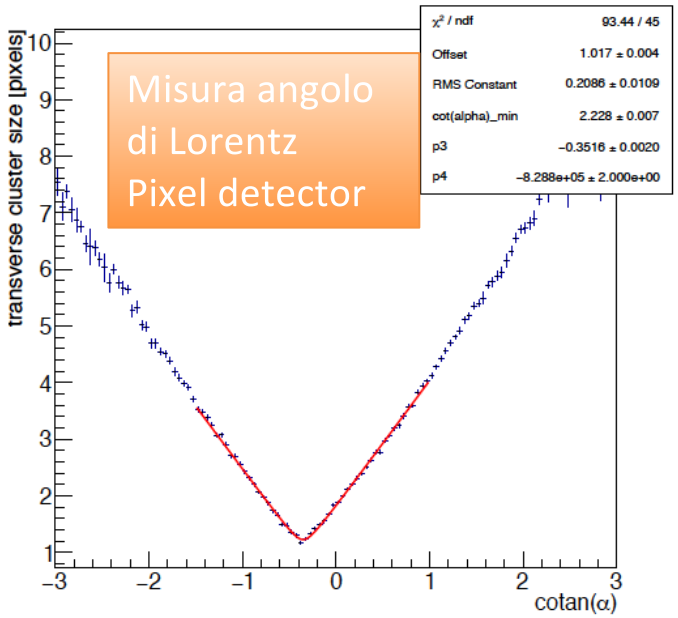
      ➔ corto circuito su una linea di reset
    - Sostituzione/riparazione di 40+19 moduli: ritardo nella installazione brillantemente recuperato
  - ➔ 99.2% canali funzionanti
    - 96.3% in Run 1
    - In questo momento problema intermittente (campo magnetico ON/OFF) in 1/32 del barrel

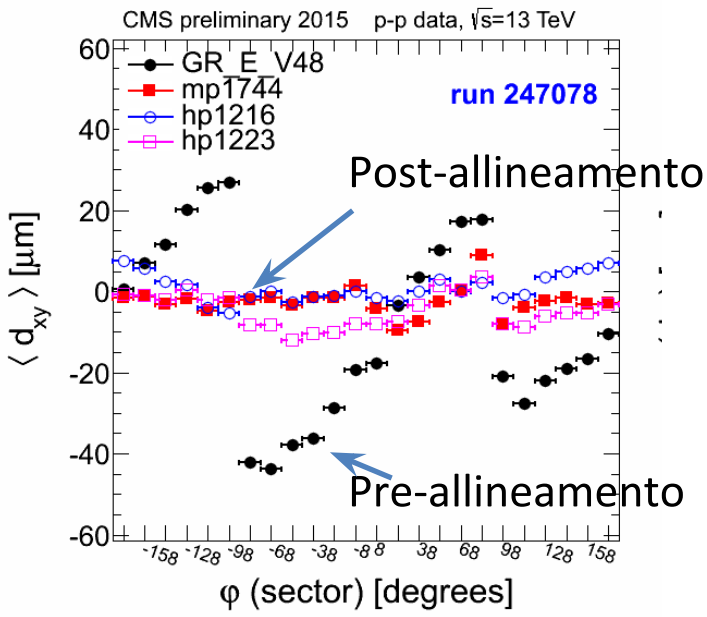




Tracker: Calibrazioni con Cosmici e Collisioni



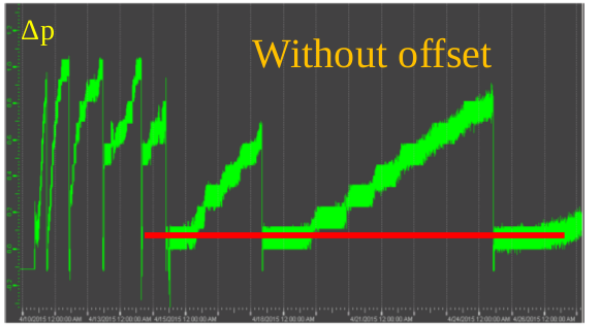




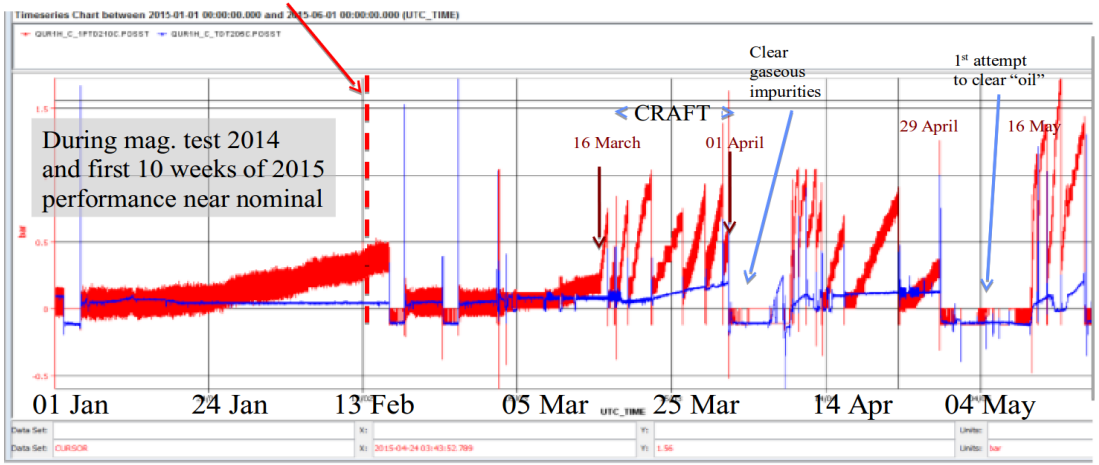
- Calibrazioni e prima iterazione allineamento completati con cosmici e prime collisioni

La saga del magnete e della cold box I

- Cryo cold box instabilities since March
  - Suspected oil contamination from compressor plant
- Three increasingly invasive campaigns of cleaning and replacement since Apr 1st



24-2-15 corrected faulty coalescing filters installed in Nov 2014

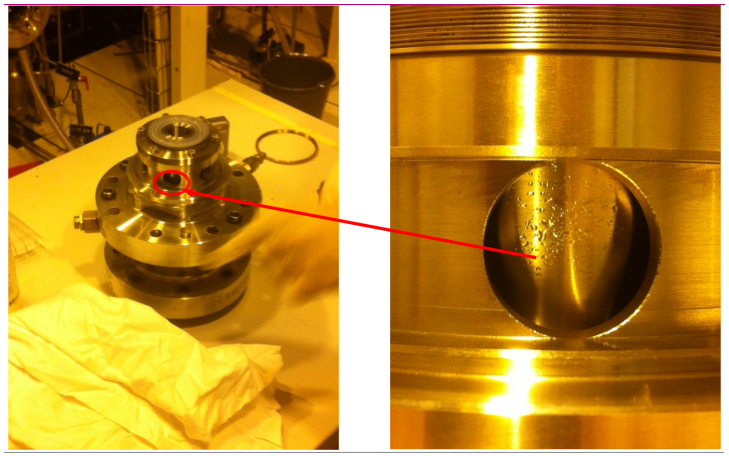


Red: Δp Turbine 1 inlet filter

Blue: ΔT first Heat-exchanger

- Pressure drop across filter over several regeneration cycles
  - Offset indicates non-volatile pollutant

La saga del magnete e della cold box II



Turbina 1: gocce d'olio (contaminante)
Origine non ancora del tutto chiarita

Conclusioni dopo gli ultimi interventi (fine giugno)

Magnet is OK and risk to it is slight providing we are careful.
- Breox contamination seems to have been overcome (at least for now)
- Longer term precautions being prepared to avoid a repeat.

Behaviour of cold box alone consistent with normal recovery from invasive interventions
- The vacuum vessel was closed last Weds
- No unusual pollutants found during initial re-commisisoning
- Going ahead with re-start interrupted by cryo valve damage.

Functionality of damaged cryo valve has been substituted using existing components
- -connecting thermal shield & magnet as reach their respective temperatures.

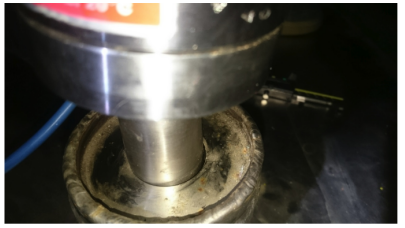
Aim: Magnet cold this week.
- Tests of new He transfer process are obligatory (avoid risking fast discharge)
  - ….then take ~12 hours to ramp to 3.8T

Altro problema scoperto:
danneggiamento di una valvola (forse urtata da una gru) su un dewar montato sul magnete.
Si sta indagando su eventuale correlazione fra i due problemi. La valvola e' stata al momento bypassata

Riaccensione completa magnete pianificata a inizio settimana prossima

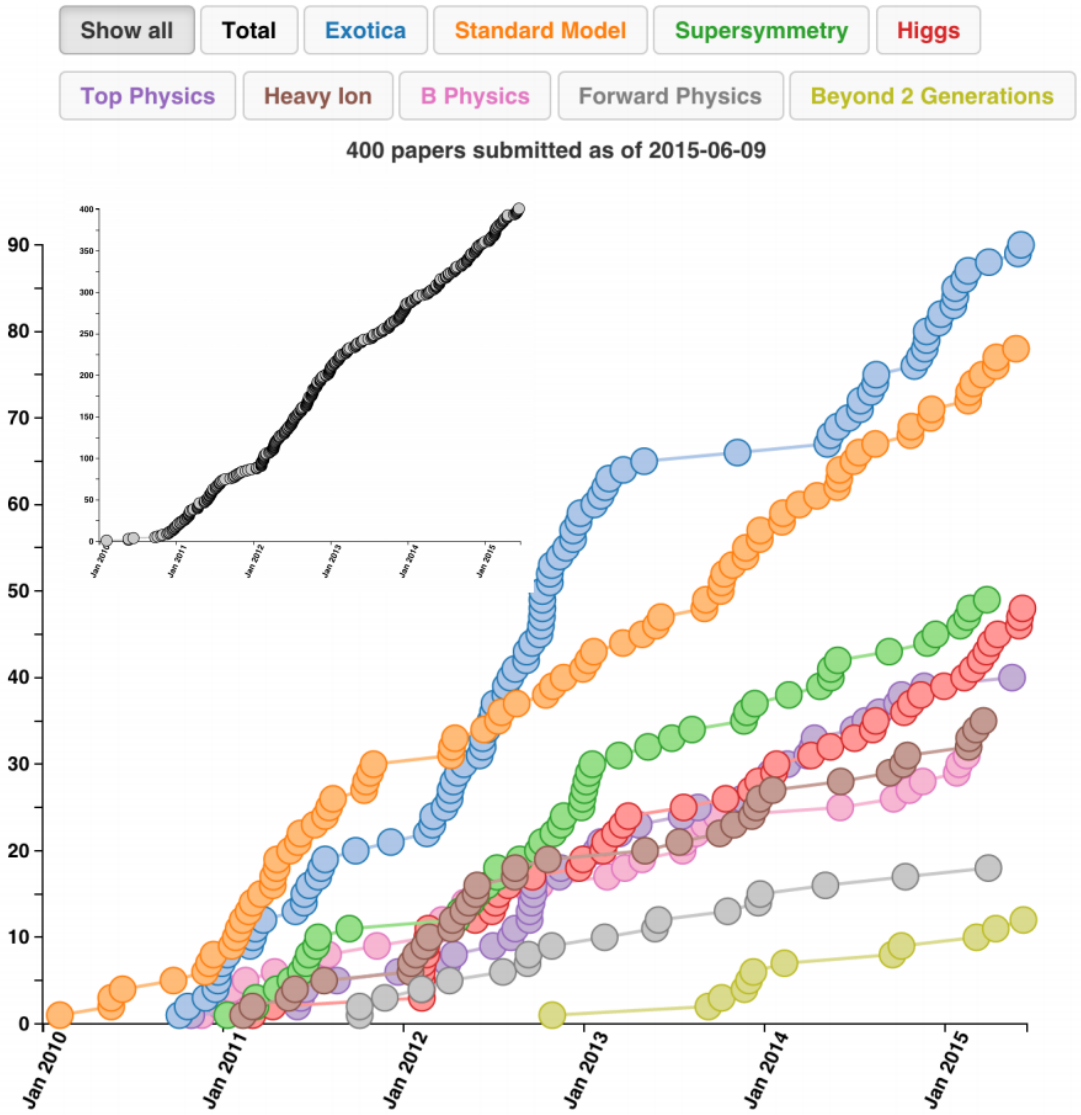
Severe mechanical damage, consistent with large forces applied near base then opposite force applied to pneumatic driver.

The actual valve is deep inside the vac vessel.



Fisica: attivita' a Pisa

Superati recentemente i 400 articoli di CMS!



Pub rate steady, ~2.5/week

400 papers submitted:

+23 CRAFT based

+32 ready for CWR or later

+17 PubDraft

In review process (128):

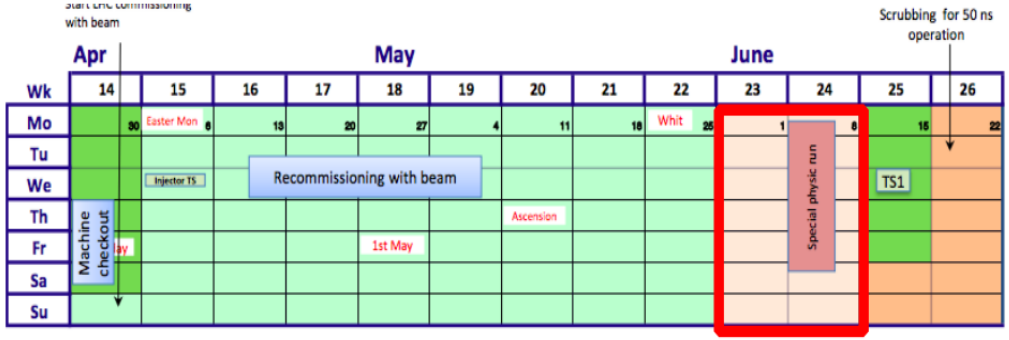
84 GoingToPreApp or higher

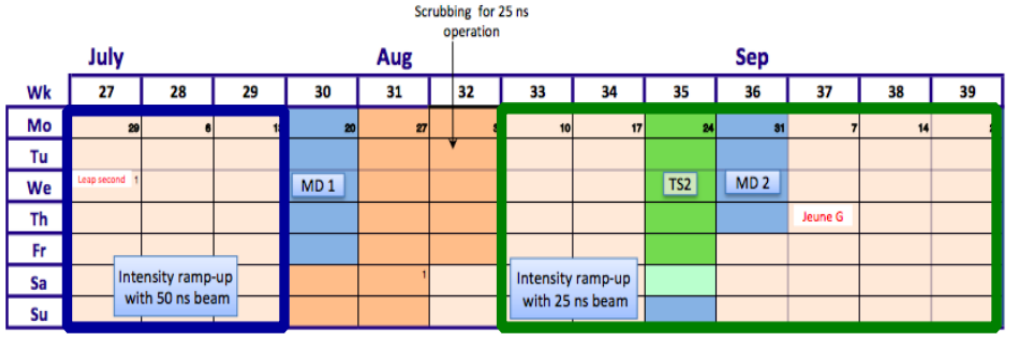
44 in PAG review (= in state "AWG")

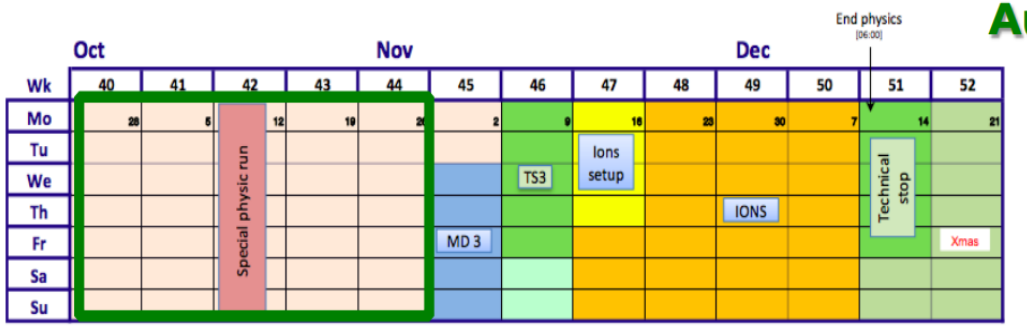
Steady progress, we are now well over the hump!

Bulk of remaining Run 1 measurements targeting publication by summer (to avoid overlap with Run 2)

2015: LHC planning and CMS goals







June 1: LHCf + VdM

- Very low luminosity
- POG performance studies begin (mostly LUM, TRK, MUO)
- **First luminosity measurements**
- **dN/dh (FSQ-15-001)**

  Task force in CMS Centre

July 1: 50ns run (~1 fb^{-1})

- Luminosity up to 0.5 x 10^{34} Hz/cm^2
- POG studies (JME, EGM, TAU, BTV)
- **Physics analyses:**

  dijet resonance search (EXO-15-001)
  ttbar cross section (TOP-15-003)
  single top (TOP-15-004)
  W/Z inclusive cross section
  inclusive b and quarkonia

Aug-Oct: 25ns run (<~10 fb^{-1})

- Luminosity up to 1.4 x 10^{34} Hz/cm^2
- POG studies at 25ns, OOTPU
- **Physics Analyses:**

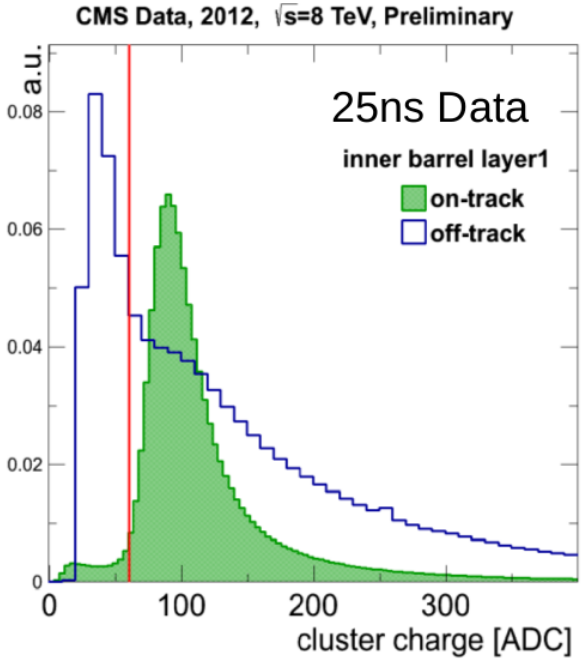
  More SM: SMP, TOP, BPH, FSQ
  More EXO searches
  First SUSY searches
  First B2G searches
  First look at Higgs

Reconstruction improvements for Run II

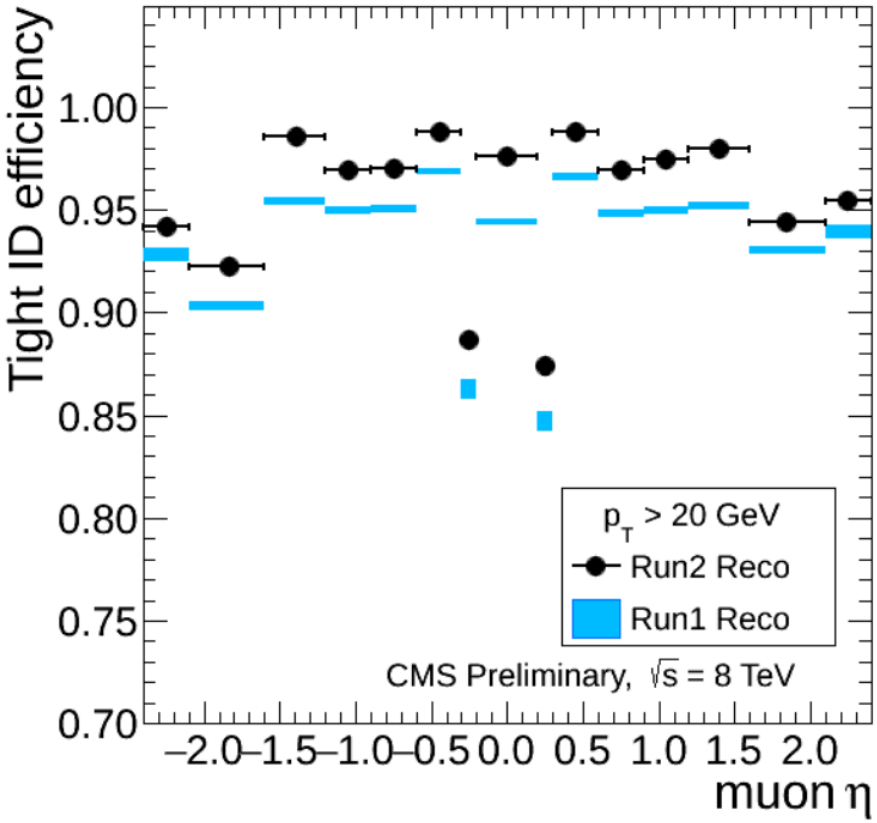
- Significant effort on algorithm improvements with emphasis on PU mitigation
  - Improvement on track reconstruction
  - Out of time PU mitigation in the calorimeters
    - Pulse fit in ECAL/HCAL to extract the in-time energy per cell
  - Revisiting of Particle Flow event reconstruction
    - A lot of ideas from the upgrade studies
- Improvements evaluated on 8 TeV data by re-reconstructing them with new algorithms

Tracking/Muons

- Improved track reconstruction
  - 2x faster at the same PU, lower fake rate
  - Improved track quality
  - Use of cluster charge to reduce OOT hits



- New muon specific tracking
  - Recovering lost tracks (outside-in) and non associated hits (inside-out)



Higgs to bb

LHC EXPERIMENTS

CMS identifies Higgs bosons decaying to bottom quarks

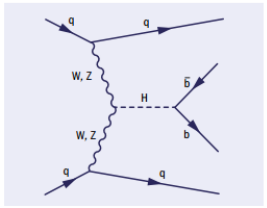
The mass of the Higgs boson discovered at CERN is close to 125 GeV. If it really is the Standard Model Higgs boson (H), it should decay predominantly into a bottom quark–antiquark pair ($b\bar{b}$), with a probability of about 58%. Therefore, the observation and study of the $H \to b\bar{b}$ decay, which involves the direct coupling of H to fermions and in particular to down-type quarks like d-, s- and b-quarks, is essential in determining the nature of the discovered boson. The inclusive observation of the decay $H \to b\bar{b}$ is currently not achievable at the LHC: in proton–proton collisions, $b\bar{b}$ pairs are produced abundantly via the strong force as described via QCD, providing a completely irreducible background.

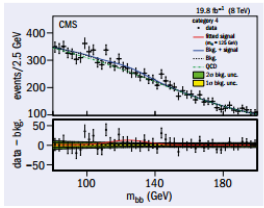
An intriguing and challenging way to search for $H \to b\bar{b}$ is through the mechanism of vector-boson fusion (VBF). In this case, the signal features a four-jet final state: two b-quark ($b\bar{b}$) jets originating from the Higgs-boson decay, and two light quark (qq) jets, predominantly in the forward and backward directions with respect to the beamline – a distinctive signature of VBF in proton collisions. An additional peculiar feature of VBF is that no QCD colour is exchanged in the processes. This leads to the expectation of a "rapidity gap" – that is, reduced hadronic activity between the two tagging qq jets, apart from Higgs boson decay products.

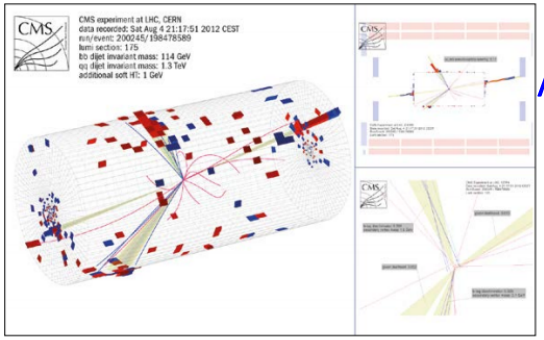
CMS has searched for these VBF-produced Higgs bosons decaying to b quarks in the 2012 8-TeV proton–proton collision data. This is the only fully hadronic final state that is employed to search for a Standard Model Higgs boson at the LHC. A crucial dedicated data-triggering strategy was put in place, both within standard "prompt" data streams and, in parallel, within "parked" data streams that were reconstructed later, during the LHC shutdown. Candidate events are required to have four jets with transverse momenta above optimized thresholds. Separation in terms of pseudorapidity (angle) and b-quark tagging criteria are employed to assign two jets to the $b\bar{b}$ system and the other two jets to the qq VBF-tagging jet system.

Selected events are passed to a multi-variate boosted decision tree (BDT) trained to separate signal events from the large background of multi-jet events produced by QCD. The events are categorized according to the output values of the BDT, making no use of the kinematic information of the two b-jet candidates. Subsequently, the invariant-mass distribution of two bjets is analysed in each category, to search for a signal "bump" on top of the smooth background shape. The figure shows the results of the fit in the best signal category. They reveal an observed (expected) significance of the signal of 2.2 (0.8)σ, for a Higgs-boson mass of 125 GeV. A parallel measurement of $Z \to b\bar{b}$ decays in the selected data samples, using the same signal-extraction technique, has been performed to validate the analysis strategy.

The results of this search have been combined with results of other CMS searches for the decay of the Higgs boson to bottom quarks, produced in association with a vector boson, or with a top-quark pair. For $m_H = 125$ GeV, the combination yields a fitted $H \to b\bar{b}$ signal strength $\mu = 1.03 + 0.44$, relative to the expectations of the Standard Model, with a significance of 2.6σ. This is a convincing hint from the LHC for the coupling of the discovered boson to bottom quarks.







Top left: Feynman diagram showing the production of a Higgs boson through vector-boson fusion, and decaying to bottom quarks. Top right: Fit of the invariant mass of the two b-jet candidates for a Higgs-boson signal with a mass of 125 GeV, with events selected in the best signal category. Above: A CMS proton–proton collision event at $\sqrt{s} = 8$ TeV, featuring a central di-jet system with invariant mass 114 GeV and a forward–backward di-jet system with invariant mass 1.3 TeV. The main display shows a 3D view of the event, the top right display is an rz view, and the bottom right display is a zoomed rφ view, where b-decay secondary vertices are visible within the two central jets.

Further reading

CMS Collaboration CMS-HIG-14-004, CERN-PH-EP-2015-121.

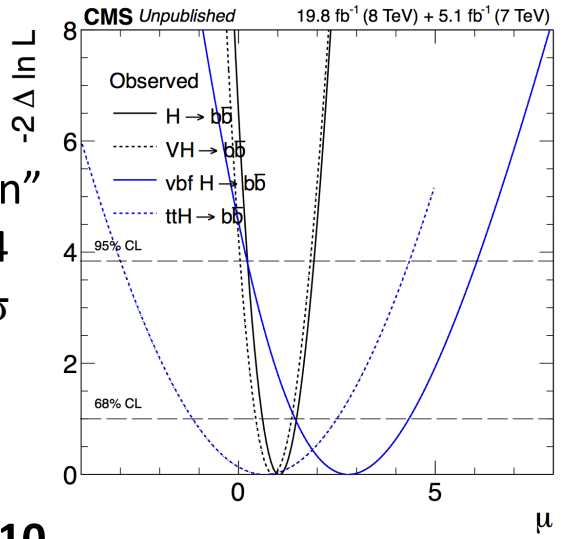
6

CERN COURIER

CMS Pisa molto presente e attivo nei canali H → BB

- **VH → bb ll/lν/νν**: Azzurri, Boccali, Botta, Donato, Rizzi, (Vernieri)
- **VBF H→ bb** : Azzurri, Donato, Rauco, Spagnolo (Vernieri)
- **X→HH→bbbb**: Donato, Rizzi (Vernieri)

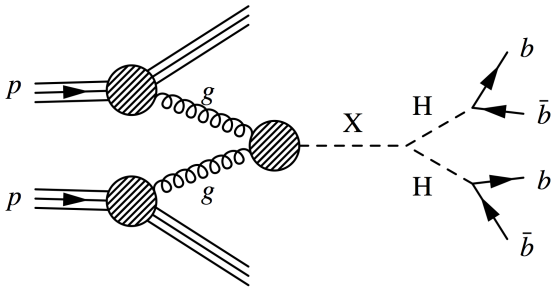
CMS Hbb Run1
"grand combination"
$\mu = \sigma/\sigma_{SM} = 1.0 \pm 0.4$
significatività 2.6σ



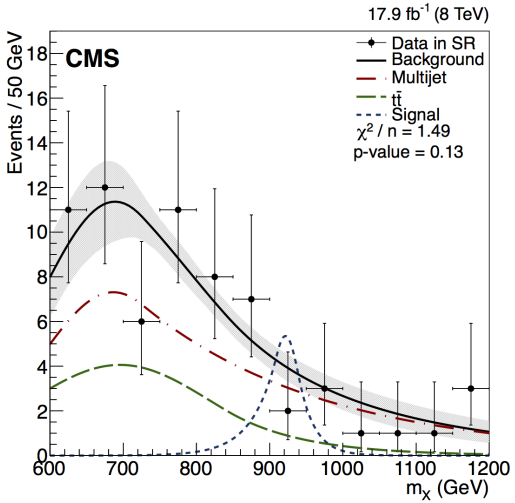
arXiv:1506.01010

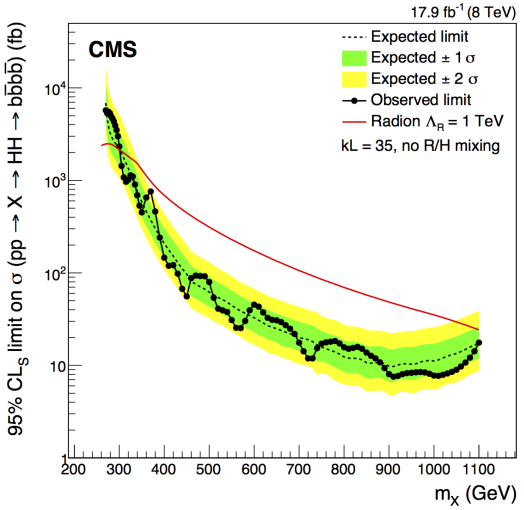
Submitted to Phys. Rev. D.

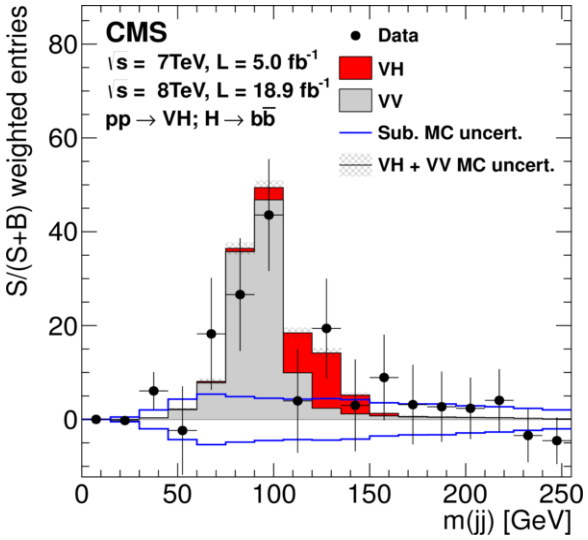
Higgs to bb



arXiv:1503.04114
Submitted to Physics Letters B





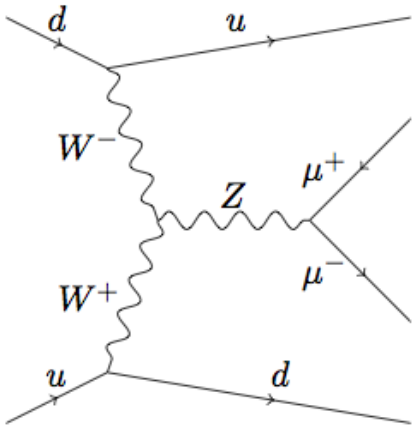


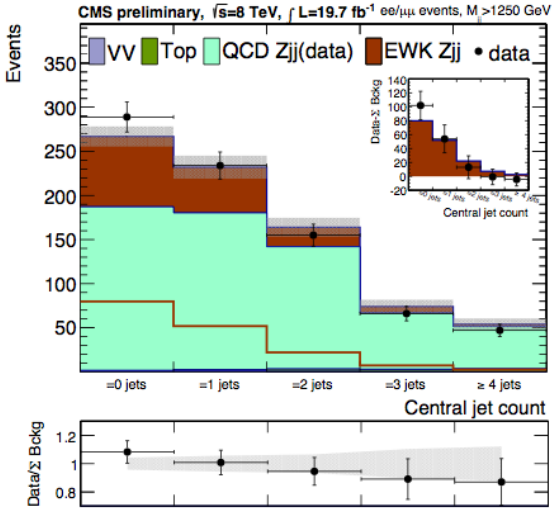
→ CMS Higgs mass and couplings combination
Eur. Phys. J. C 75 (2015) 212

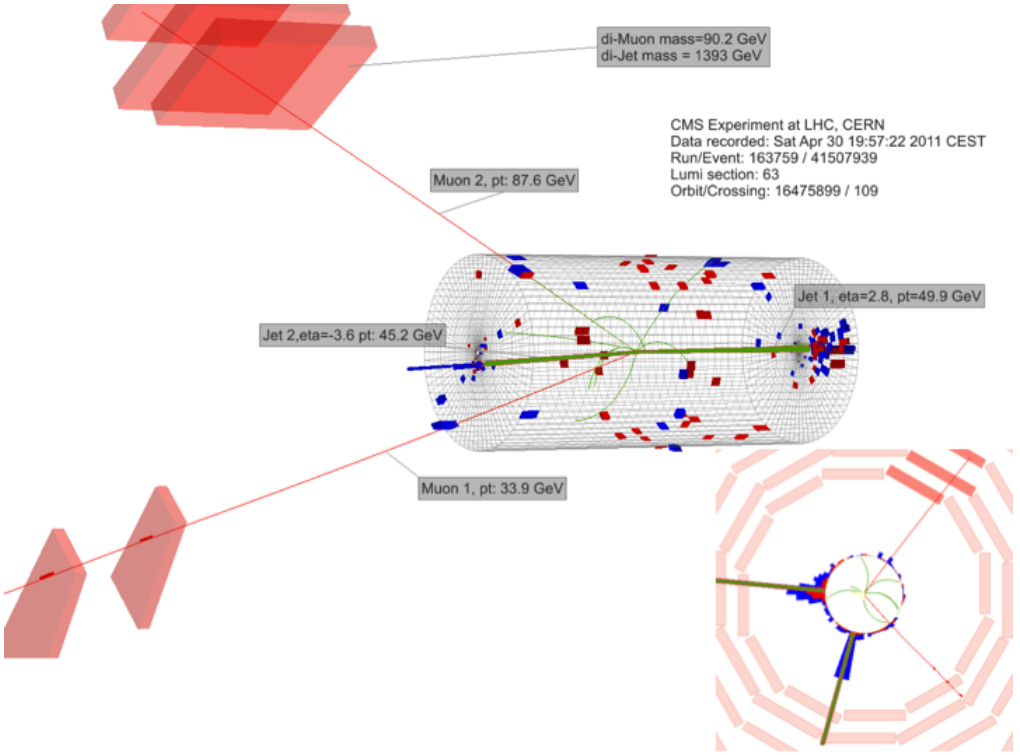
Fondamentale l'utilizzo del Tier2 Pisa per storage e processing

“VBF Z”

Pisa : Azzurri (Caiulo)







Eur. Phys. J. C 75 (2015) 66

σ_{EW}(lljj)=174± 15(stat) ± 40(syst) fb

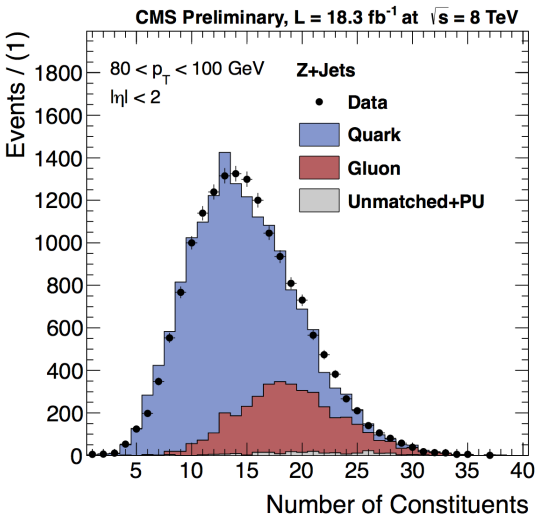
fondamentale conferma delle *cancellazioni di gauge* EW

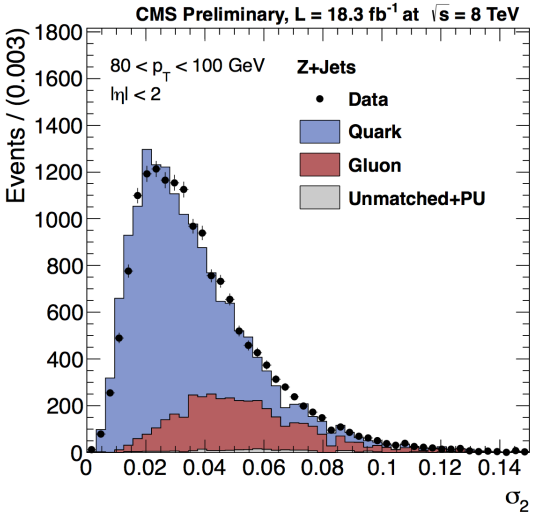
conferma della presenza del *rapidity gap* QCD previsto in VBF

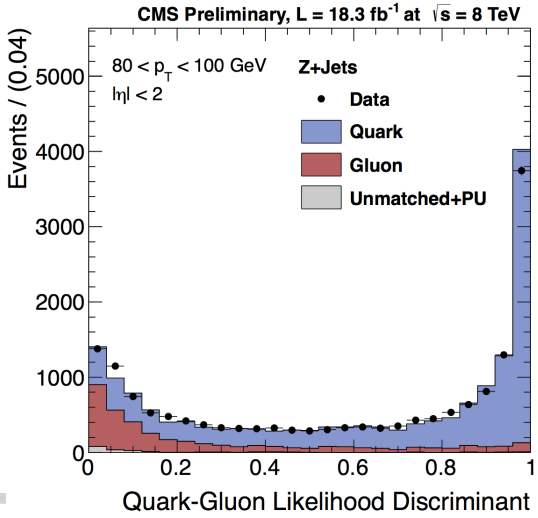
xsection più piccola misurata ad LHC con significatività >5σ

Quark/gluon jet separation

Pisa : Azzurri (Marini)







CMS PAS JME-13-002

DRAFT

CMS Physics Analysis Summary

The content of this note is intended for CMS internal use and distribution only

2013/06/25
Head Id: 191499
Archive Id: 192303MP
Archive Date: 2013/06/20
Archive Tag: trunk

Performance of quark/gluon discrimination in 8 TeV pp data

The CMS Collaboration

Abstract

We present a new discriminator to distingish jets originating from quarks and gluons, that extends the separation capabilities to jets in the forwad region, up to $|\eta| = 5$, and increases the overall performances, in particular for jets of low trasverse momentum, down to $p_T = 20$ GeV. The discriminator is based on observables sensitive to fundamental difference in the fragmentation properties of gluons and quarks. Depending on the need, one can choose between a likelihood discriminator or an artificial neural network to distinguish quark initiated jets from gluon jets. The performance of the tool is evaluated using di-jet and Z+jet data collected in 2012.

This box is only visible in draft mode. Please make sure the values below make sense.

PDFAuthor: CMS Collaboration
PDFTitle: Performance of quark/gluon discrimination in 8 TeV pp data
PDFSubject: CMS
PDFKeywords: CMS, physics, JETMET, jet, quark, gluon, QG, discriminator, tagger

Please also verify that the abstract does not use any user defined symbols

$X \rightarrow HH \rightarrow bb\tau\tau$

Stesso canale di quello in 4b, ma con un $H \rightarrow \tau\tau$

- Riduzione fondo QCD grazie ai tau
- Know-how a Pisa sia su b che su tau
- Paper su dati 2012 in fase di pubblicazione (HIG-14-034)
- Preparazione per analisi al RUN2
- Studi a lunga scadenza **(LHC phase 2)** su self-coupling dell'Higgs

Contributo fondamentale di persone di Pisa/Siena:

Maria Teresa Grippo (PhD)
Konstantin Androsov (PhD)
Agnese Ciocci
Giuseppe Bagliesi (paper editor)

Canali HH studiati

$e\tau_h$: $X \rightarrow HH \rightarrow b_{jet} b_{jet} \tau_e \tau_h$

$\mu\tau_h$: $X \rightarrow HH \rightarrow b_{jet} b_{jet} \tau_\mu \tau_h$

$\tau_h\tau_h$: $X \rightarrow HH \rightarrow b_{jet} b_{jet} \tau_h \tau_h$

DRAFT
CMS Paper

The content of this note is intended for CMS internal use and distribution only

2015/06/12
Head Id: 292209
Archive Id: 292209P
Archive Date: 2015/06/12
Archive Tag: trunk

Search for a heavy scalar boson decaying to a pair of 125 GeV Higgs bosons (hh) or for a heavy pseudoscalar boson decaying to Zh, in the final state with h→ ττ

The CMS Collaboration

Abstract

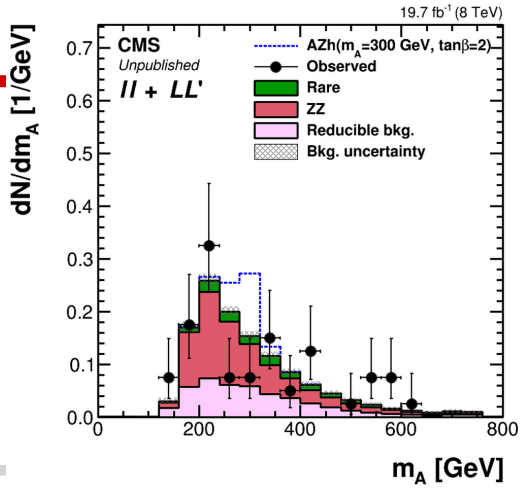
A search for a heavy scalar boson (H) decaying into a pair of lighter (standard-model-like) 125 GeV Higgs bosons (h) or a heavy pseudoscalar boson (A) decaying into a Z boson and an h boson is presented. This search is performed on a dataset corresponding to an integrated luminosity of 19.7 fb^{-1} of pp collision data collected by CMS in 2012. A final state consisting of two τs and two b jets is used to search for the H → hh decay. A final state consisting of two τs and two additional leptons, compatible with being the decay products of a Z boson, is used to search for the decay A → Zh. The results are subsequently interpreted in the contexts of both the minimal supersymmetric extension to the standard model and two-Higgs-doublet models. No excess is found above the standard model expectation and upper limits at 95% confidence level are set on the production cross section in the mass range 220< m_A <350 GeV and 260< m_H <350 GeV.

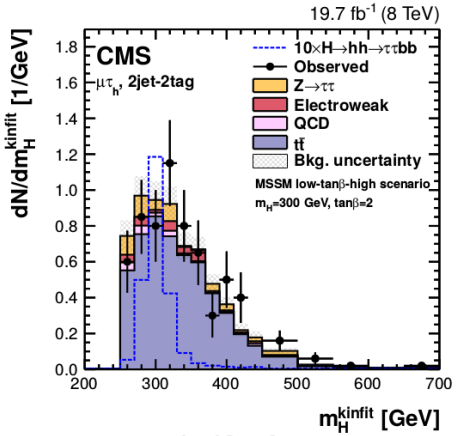
This box is only visible in draft mode. Please make sure the values below make sense.

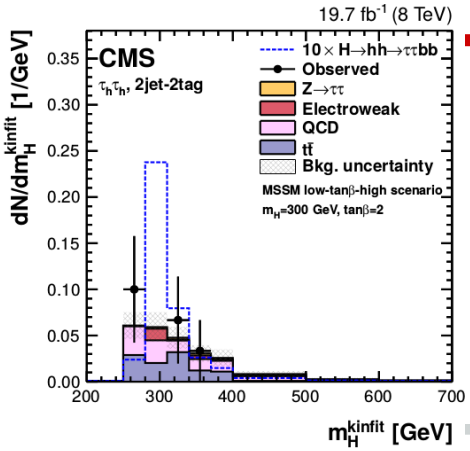
PDFAuthor: G. Bagliesi, D. Colling
PDFTitle: MSSM H-hh/A-Zh in tau channels
PDFSubject: CMS
PDFKeywords: CMS, physics, software, MSSM, tau, higgs

Please also verify that the abstract does not use any user defined symbols

Paper congiunto H->hh + A->Zh







Fisica del B

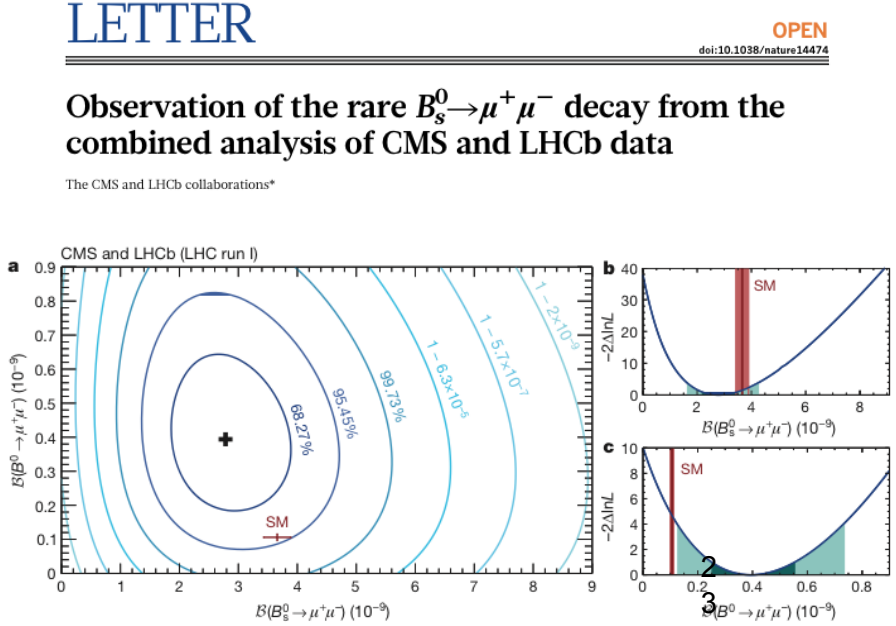
CMS convener F. Palla

Trigger convener: L. Martini

- $B_s/B^0 \rightarrow \mu\mu$
  - L. Martini (Premio Conversi 2014), P. Squillacioti e F. Palla, main analyzers
  - Analisi di controllo: F. Ligabue, F. Fiori, A. Mauri, G. Rolandi
  - Pubblicata combinazione Run 1 CMS e LHCb su Nature [first ever in CMS]
  - Stima sensitività con HL-LHC – contributo al TP e ECFA meetings
  - Analisi continua con i dati che verranno raccolti nel Run2

- Misura $\Delta\Gamma_s$ e ϕ_s con $Bs \rightarrow J/\psi\,\phi$
  - G. Fedi – autore principale
  - Analisi dati 2012 in CMS review

- Altre analisi in corso Run2
  - L. Martini: sezione d'urto J/ψ



Z' → μμ search at 13 TeV

CMS Draft Analysis Note

The content of this note is intended for CMS internal use and distribution only

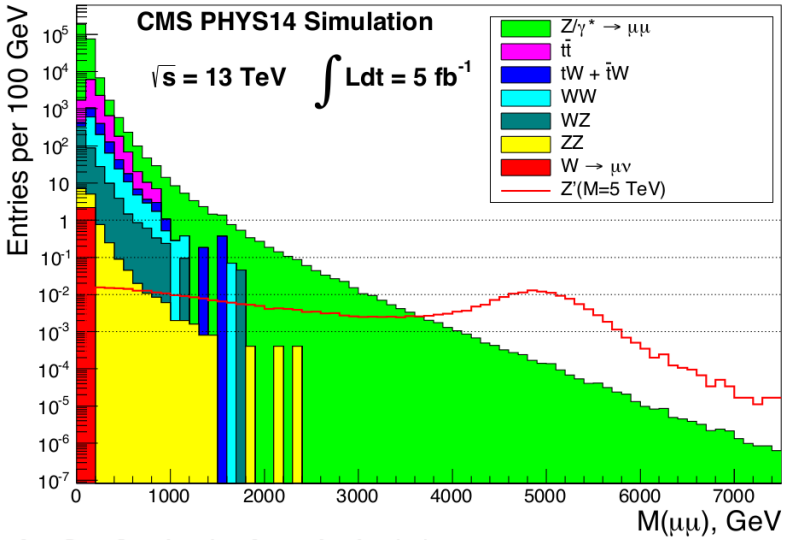
2015/05/25
Head Id: 290074
Archive Id: 286968:290074MP
Archive Date: 2015/05/25
Archive Tag: trunk

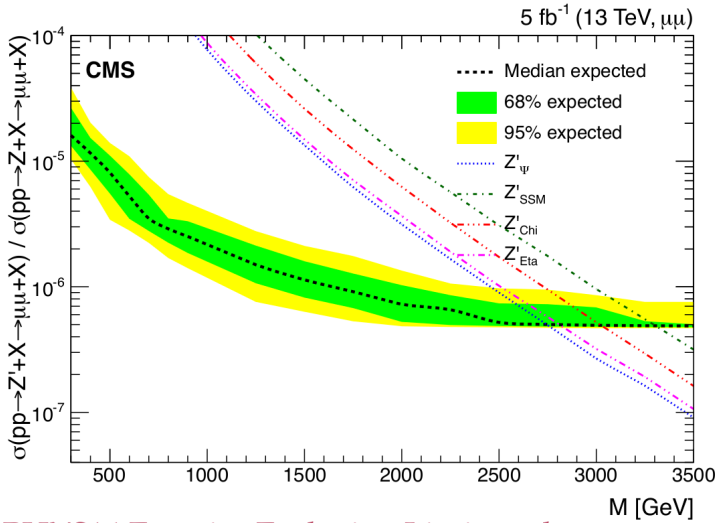
Search Strategy for High-Mass Resonances Decaying to Muon Pairs at $\sqrt{s} = 13$ TeV in Preparation of the Run2

G. Abbiendi[4], G. Bagliesi[6], L. Benato[5], D. Bourilkov[11], S.S. Chhibra[3], A. Colaleo[3], R. Cousins[10], G. Daskalakis[2], N. De Filippis[3], S. Elgammal[1], V.A. Giakoumopoulou[2], A. Lanyov[9], K.A Larson[12], K.P. Lee[8], S. Marcellini[4], A. Meneguzzo[5], K.W. Nam[8], N. Neumeister[12], A. Perrotta[4], F. Primavera[12], A. Qamesh[1], R. Radogna[3], F. Simonetto[5], P. Spagnolo[6], P. Traczyk[7], V. Valuev[10], and H.D. Yoo[8]

G. Bagliesi and P. Spagnolo (EDITOR)
within a strong italian contribution to this analysis (BA, BO, PD, PI, RM)

- Same strategy of Run1: search for an excess over the DY spectrum
- Limits are quoted in the Narrow Width Z' hypothesis and than translated in the different model depending limit
- No interference or pdf-tail problems, method quite solid
- N(obs) normalized to the Z peak
- Cuts are frozen before the data taking
- With the first fb^{-1} the exclusions of Run1 will be reached
- With 5 fb^{-1} new region of signal explored





PHYS14 Exercise Exclusion Limits only muons:
Z'_{SSM} from 2.7 TeV @Run1 to 3.3 @Run2 - 5fb^{-1}
Z'_{ψ} from 2.4 TeV @Run1 to 2.75 @Run2 - 5fb^{-1}

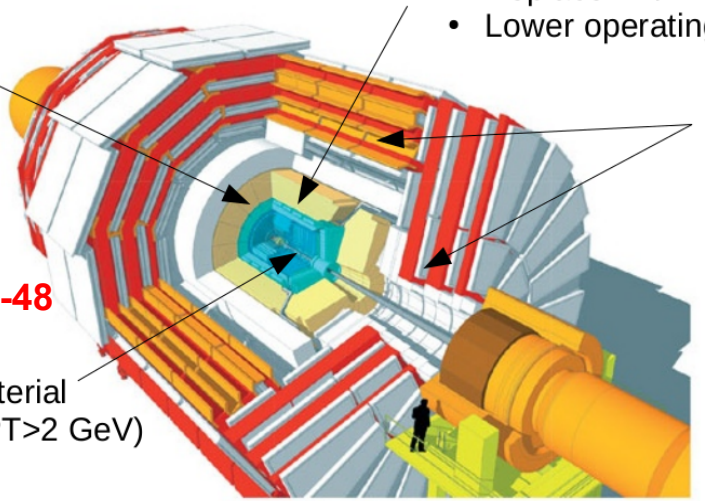
Upgrade tracker e trigger (fase I e II)

Upgrades overview

- Phase I upgrades progressing well
  - New Pixel Detector Vedi slides 27-33
  - L1 Trigger
  - HCAL HPD → SiPM
- Phase II technical proposal submitted

New Endcap Calorimeter
- Radiation Tolerant
- High Granularity
- 3D capability

Barrel Calorimeter
- Replace FE/BE electronics
- Lower operating temperature(8°)



Muon system
- Replace DT/CSC FE/BE electronics
- Complete RPC coverage In region 1.5<η<2.4
- Muon tagging with GEMs for 2.4<η<3.0

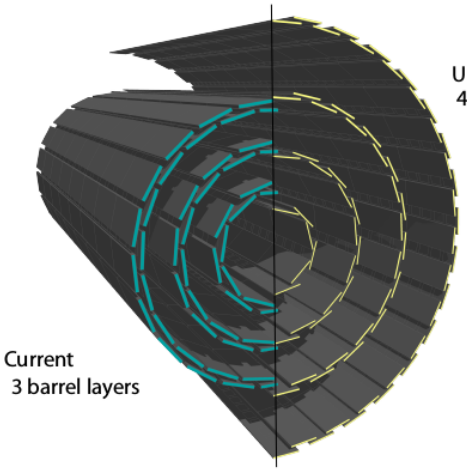
Inner Pixel vedi slides 37-48

New Tracker
- Radiation tolerant – less material
- 40 MHz selective readout (PT>2 GeV) for track trigger
- Extend to coverage of η~3.8

Trigger/HLT/DAQ
- L1 Track Trigger
- L1 Trigger: 12.5 μs latency, 750 kHz output
- HLT output of 7.5 kHz

(L1 Tk Trigger: Vedi talk successivo A. Annovi)

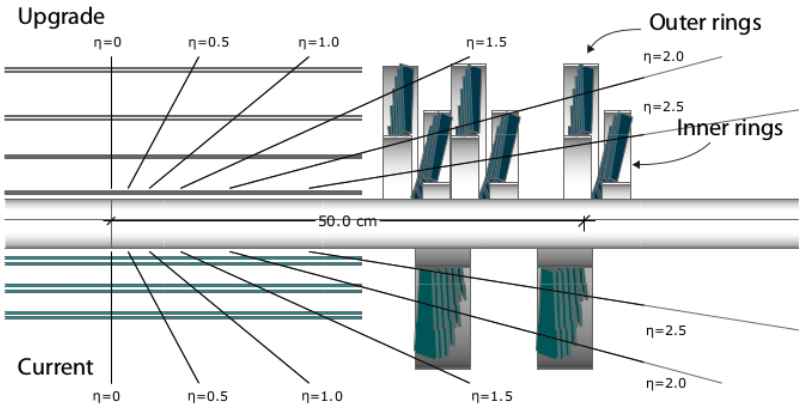
Introduction: CMS Pixel Phase I upgrade



Layer	radius	# faces	# modules	# ROCs	TBM	# Links
1	39 mm	16	96	1536	2 X (09)	4
2	68 mm	28	224	3548	(09)	2
3	109 mm	44	352	5632	(08)	1
4	160 mm	64	512	8192	(08)	1

Total: 1216 modules 19456 ROCs

~81M pixel (~1.7x old BPIX)



inner & outer ring for easier replacement

3 Disks r=45-161mm, 112 modules each, TBM08, 1 link

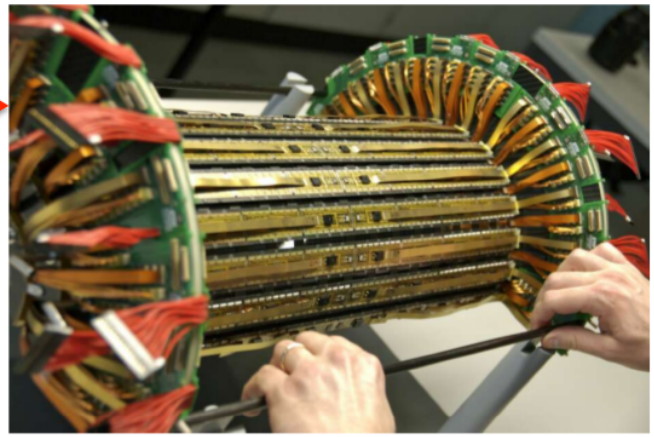
- → Outer ring rotated by 20° (turbine like)
- → Inner ring rotated by 20° and tilted by 12° with respect to IP

Total: 672 modules 10752 ROC's

~ 45M pixel (~2.5 x old FPIX)

Pixel Phase I: production in Italy & activity in Pisa

- INFN Commitment: **build 1/2 –L3 BPIX**
  - ***Production***
    - Plan to build 260 Pixel Modules
    - Production schedule ≤ 9 months
    - ½-Layer 3 ready ≤ Q_1 2016

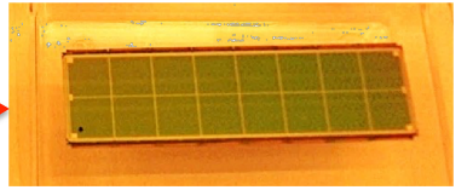


BPIX-L3

- Production center distributed in 5 Laboratories:
  - Bari, Catania, Padova, Perugia, Pisa
    Industrial partners/contacts
  - **IZM** (Berlin), local Manufacturers

Activities in Pisa

- **Pixel sensors QA**: measurement on wafer (100%) and after dicing (Pixel sensor producer CiS - De)
- **Bump Bonding process qualification**: Voltage-current probing, Identification of Bump failures: test on Bare modules (100%)
- **SiN base rails assembly**: fixing module in BPIX layer (100%)
- **Data Base:** Full BPIX data, design, first-level data analysis and maintenance.

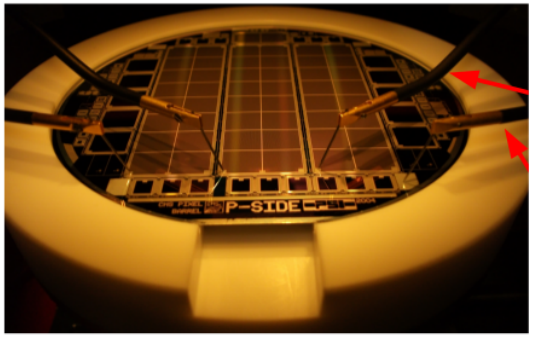


BPIX Bare Module

CMS Pixel Phase I: activities in Pisa

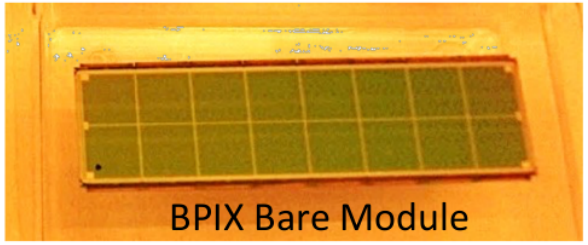
- Pixel sensors:
  - **Received and QA 100 % of the production**
    - **Production efficiency : 85 %**

Batch ID	wafer #	sensor #	CiS QA=0	Pisa QA=0	Pisa QA=1	3 good tiles wafer #	2 good tiles wafer #	1 good tile wafer #
S331152	20	60	8	8	52	12	8	
S331153	21	63	6	6	57	15	6	
S332106	21	63	9	14	49	9	10	2
S332107	21	63	10	11	52	11	9	1
S332108	23	69	10	10	59	13	10	
Total	106	318			269			

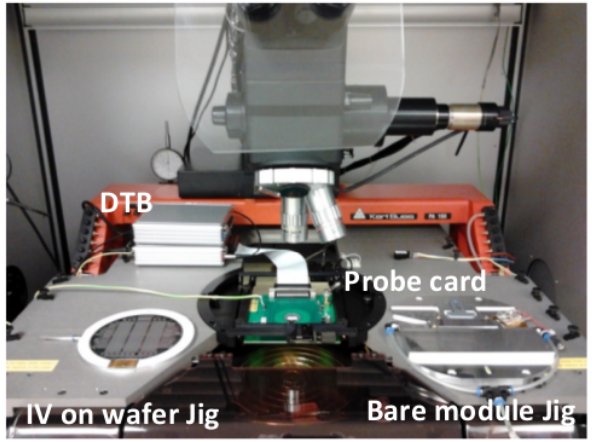


- Bare modules:
  - Bump Bonding project: process developed with IZM

- Test on bare module


BPIX Bare Module

Connected to DTB and DAQ via 35 tips probe card



Bare Module test in Pisa (& X-ray cross-check)

- Bare Module Test performed in Pisa with improved test setup and two different DAQ packages (pXar (BB) & PSI46testDesy (BB2)) in order to have more reliable results
  - Typical measurement performance for last 5 digital modules
    - ***A few bump failures out of 66560 bumps/module***

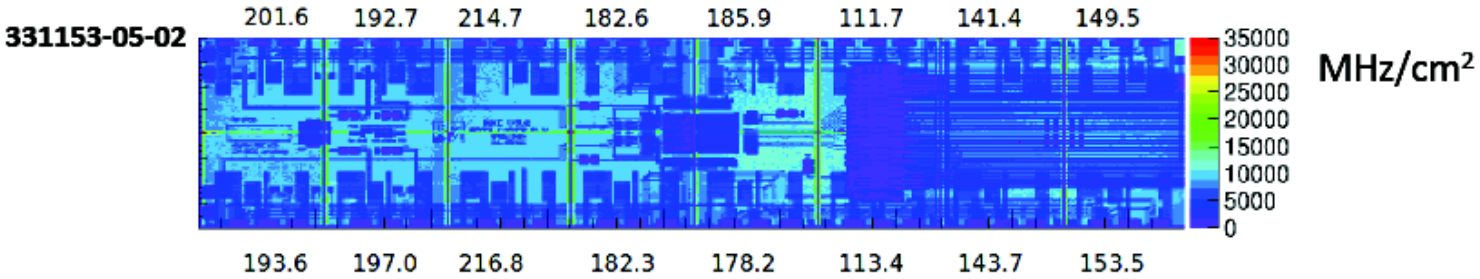
Summary of Bare Module test results

331153-05-2

	7	6	5	4	3	2	1	0
PA	0	0	0	0	0	0	0	0
BB	0	0	0	0	0	0	0	0
BB2	0	0	1	0	0	0	0	0

	8	9	10	11	12	13	14	15
PA	2	0	0	0	0	0	1	0
BB	0	0	0	0	0	0	1	0
BB2	1	0	0	0	0	0	1	1

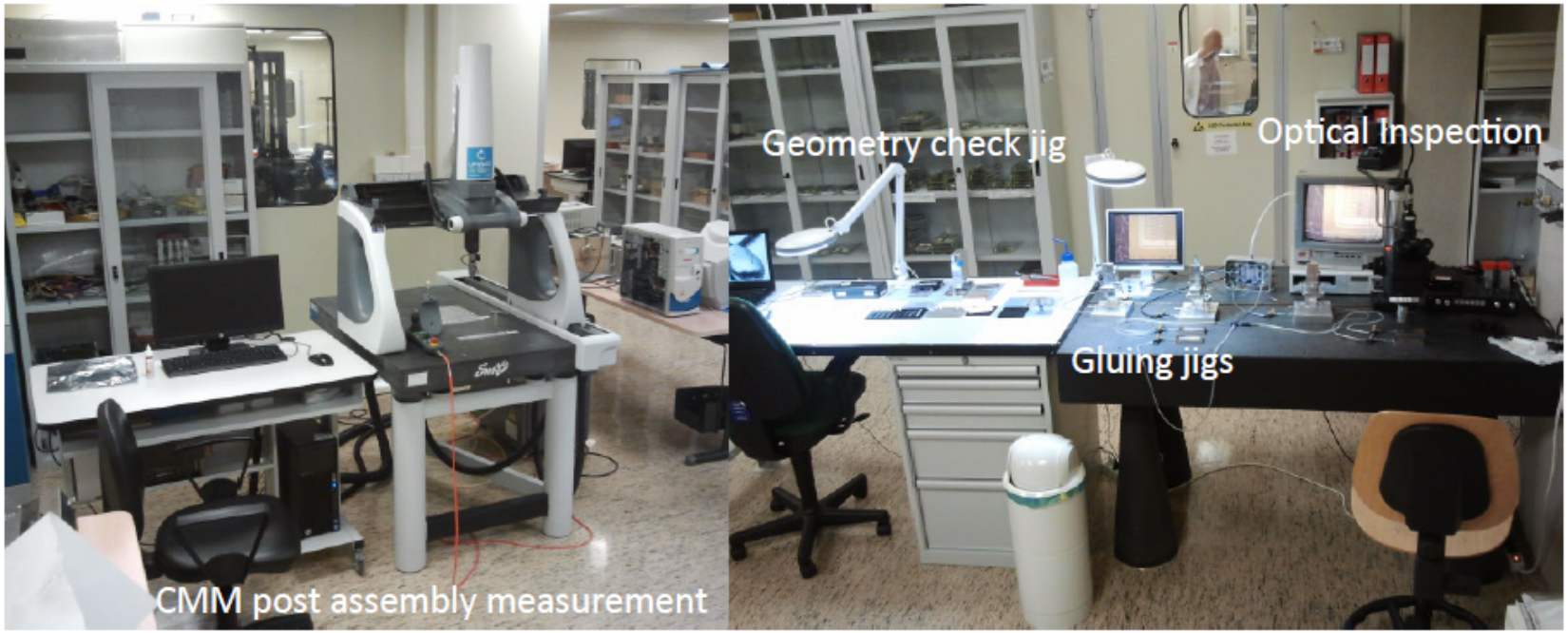
Cross check by X-ray Hit-map : 7 masked pixels out of 66560.



- None of the ROCs tested showed pattern of failing bumps experienced in 2014
- Very low level of failures observed: First 5 pre-production Bare modules all class A

Base strip assembly

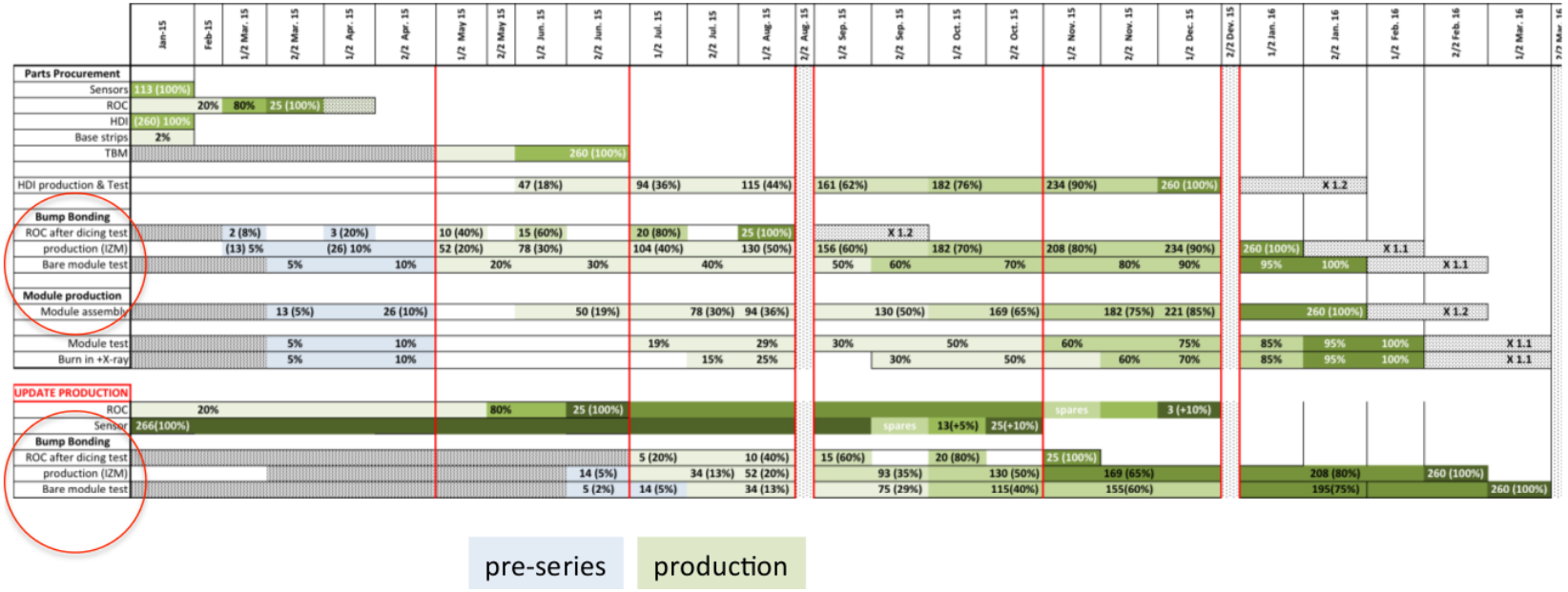
- New laboratory setup



- Modules assembled with 10-20 micron precision

1/2 L3 BIPIX-INFN Project schedule

- Production schedule fitting the CMS BPIX upgrade Phase I project
  - Production Kick-off July/15 (2 months delay compared to original plan), completed by ½ March 2016
    - Following a reasonable pre-series step
    - With a production rate of ~15%/month, taking into account 2 weeks stop in August and December
    - Bump bonding process could be extended to ½ March 2016 in case of extra production of 10%



Pixel Phase I

Activities 2015-16, Budget and manpower

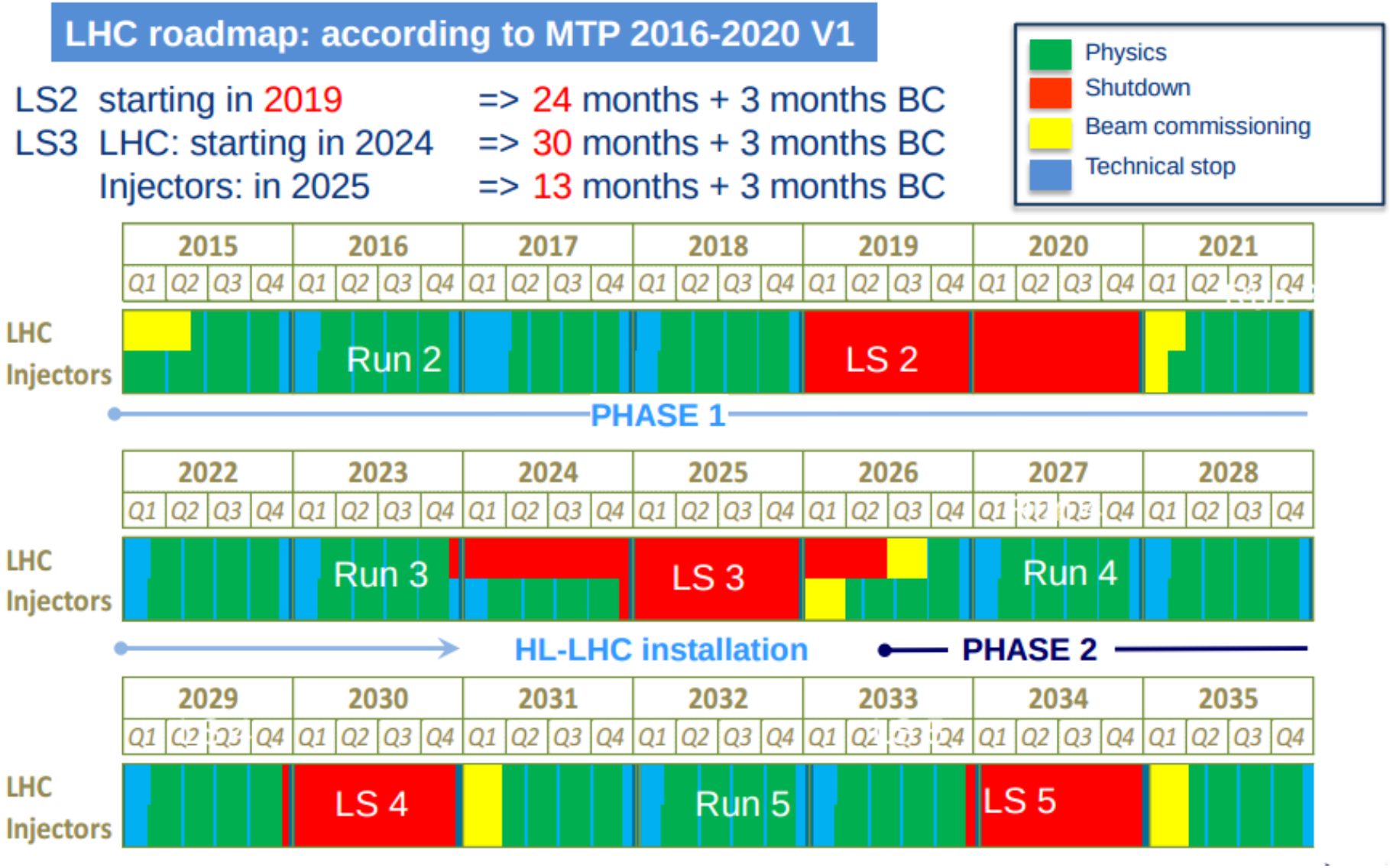
- Main activities in 2015/2016:
  - Pixel modules production and QA
  - Beam Test in Desy/PSI to confirm module performance
  - Detector integration (Activity hosted in ETH/PSI)
  - Detector commissioning (CERN - P5)

- Fund request in 2016:
  - Core activity: production
  - Activity in host laboratories

Item: Pixel Phase I	INFN-Pisa Upgrade Phase I Budget 2016	INFN Upgrade Phase I Budget 2016
costruzione apparati	5	
trasporti: modules delivery	2	
clean room maintenance	6	
Integration Pixel Phase I (M.E.)	3m.u 11.4	
total	**24.4**	**90**

Phase I	*Manpower Pixel Phase I*
Staff	
	T. Boccali
	F. Bosi
	M.A. Ciocci
	R. Dell'Orso
	A. Messineo
	A. Rizzi
PhD/Students	
	K. Androsov
	M.T. Grippo
	V. Botta
Technicians	
	M. Ceccanti
	P. Mammini
	A. Ragonesi

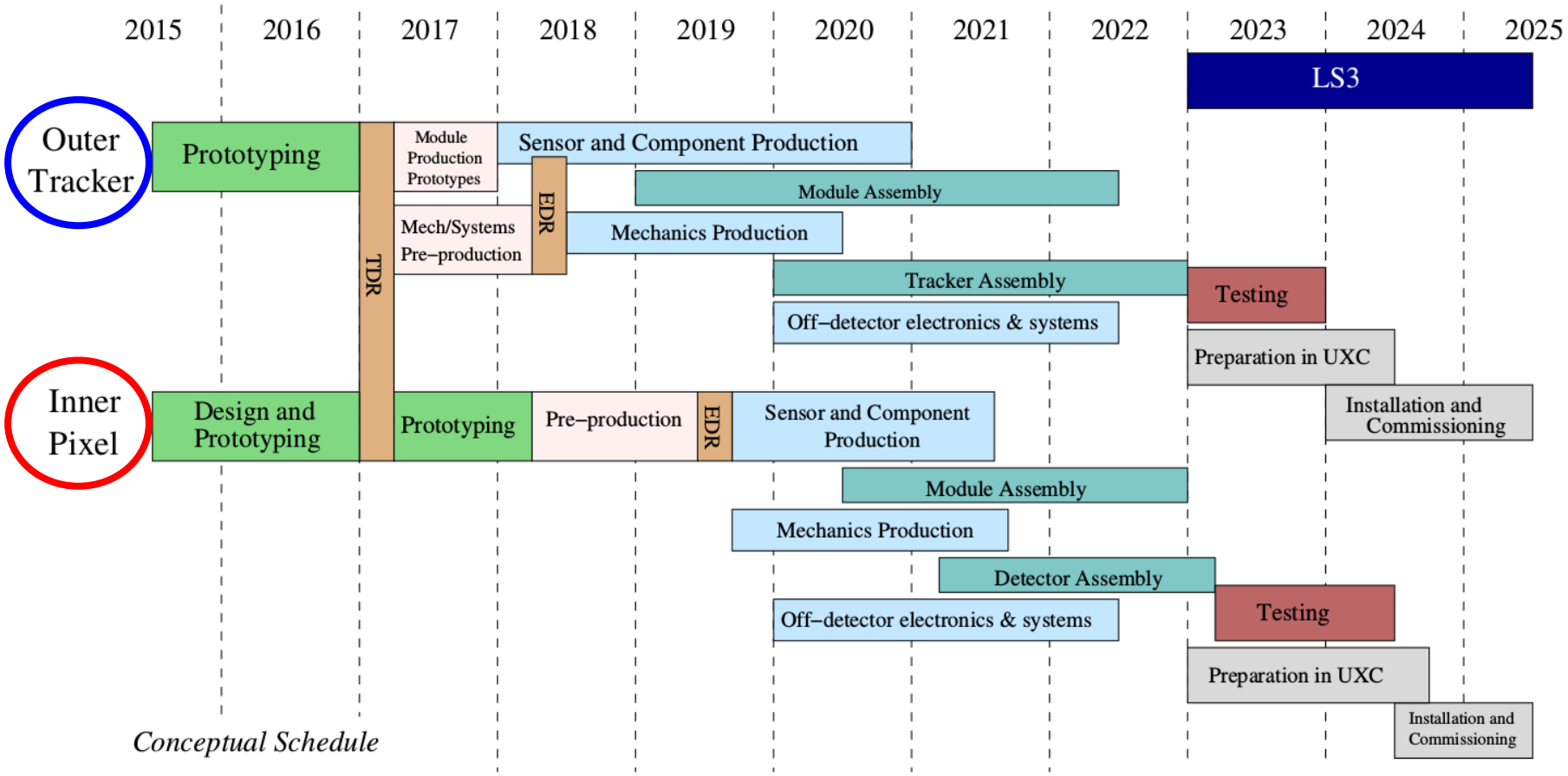
Nuova schedule LHC: LS2 in 2019



Schedule of phase II tracker upgrade From Technical Proposal

N.B: Coinvolgimento italiano in Outer Tracker upgrade in discussione

Prossime slides: attivita' attuale a Pisa e richieste 2016 per Inner Pixel



Tracker phase II important deadlines

- Construction of Pixel upgrade for Phase I on path with some (still manageable) delays.
  - INFN activities well on track (Bari, Catania, Padova, Perugia and Pisa)
- Technical Proposal for Phase 2 next to be delivered to LHCC
  - TP at https://cms-docdb.cern.ch/cgi-bin/DocDB/ShowDocument?docid=12143
  - Solid Tracker Chapter delivered
  - Solid Tracker cost assessment (123 MCHF update sent to CMS yesterday)
- Important discussions to define the CMS Upgrade Project, its scope and cost
  - Apr. CMS EE decision and Apr. RRB upgrade R&D cost and activities
  - June LHCC Technical Proposal
  - Sep. LHCC Scope Document
  - Oct. RRB first assessment construction cost and responsibilities
- Tracker internal discussion with contributing countries starting

N.B: Coinvolgimento italiano in Outer Tracker upgrade: dettagli e impegni in via di definizione

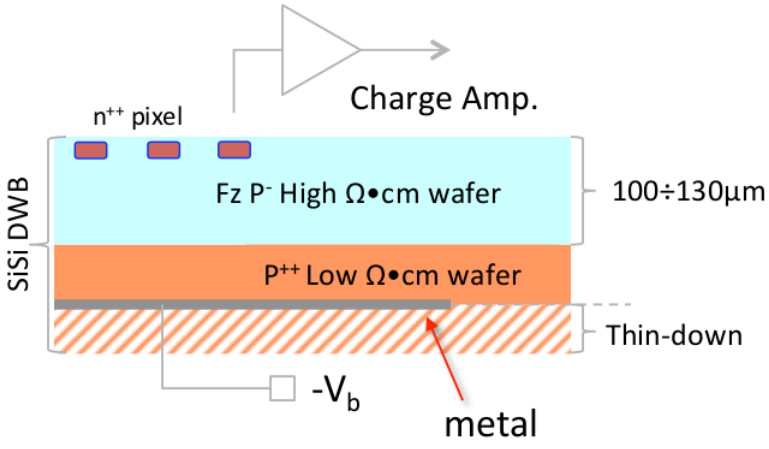
Pixel Phase II

- Small pitch and radiation tolerant Pixel devices
- Micro-channel cooling

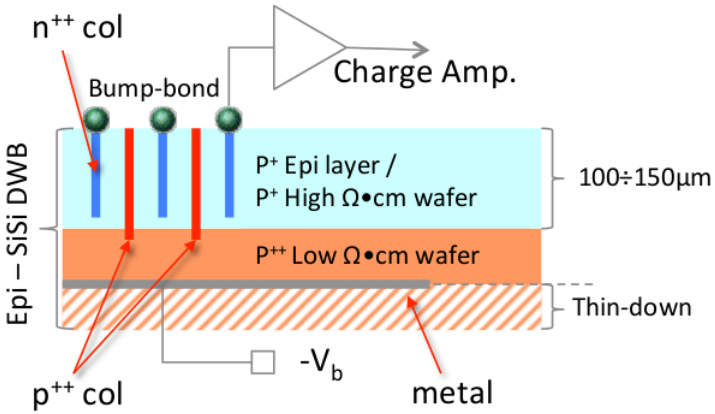
Pixel Sensors R&D

- Pixel R&D joint program ***ATLAS*** and ***CMS*** with ***FBK*** Trento under INFN agreement. Main project features:
  - Pixel sensors planar and 3D technologies
    - **Single sided n+-p on 6" wafers**
    - **New wafer material:**
      - **Direct Wafer Bond (DWB)**
      - **SOI**
    - **Small active thickness (~ 100-130 μm) on carrier wafer**

Planar pixel detector



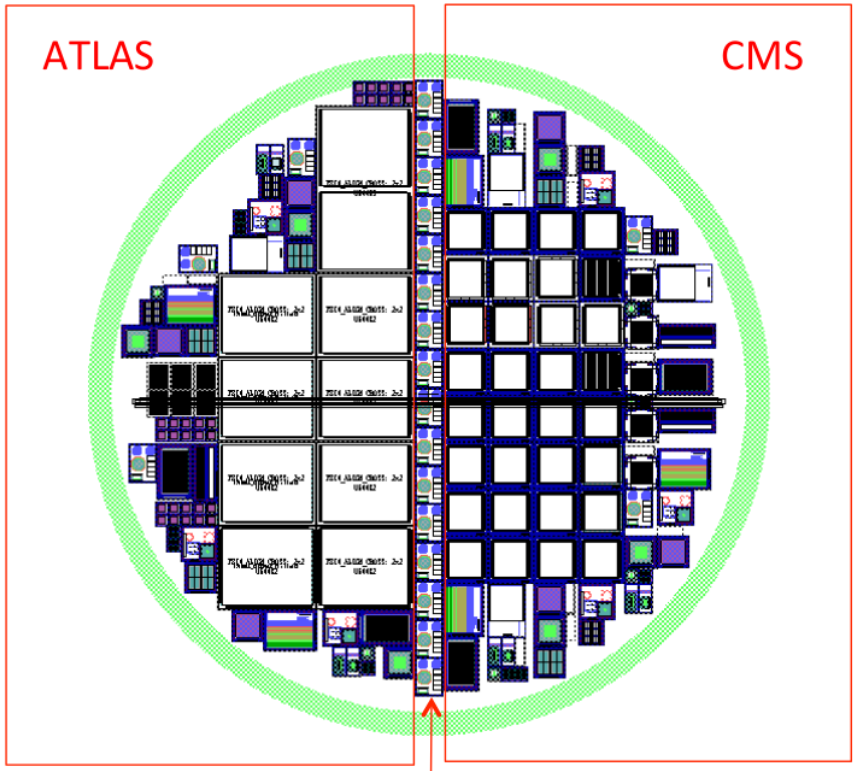
3D pixel columnar detector



Pixel Sensors R&D in Italy: a Three Year Plan

- Pisa involved in all items, from **design** to **production** and **qualification**:
  - Three pixel production batches funded:
    1. **(Planar) The planar pixel batch: main focus is to qualify 6" substrates, production line, process quality.**
    2. **(3D) The 3D pixel batch will be launched in 2015**
    3. **(AE) The Planar Pixel with Active Edge batch will follow closely, layouts should be prepared and discussed with FBK in 2015**
  - Research Program challenges:
    - **Thinning after processing**
    - **Single sided isolation treatment**
    - **Bump Bonding of single chip; explore different technologies and BB thermal budget**
    - **Devices and detector Irradiation campaign up to $2x10^{16}$ N_{eq}/cm^2**
    - **Beam Test**
  - Program presented this year in Elba conference.

Prototypes: planar pixel



Test structures for SiSi DWB substrate qualification

Wafers

6” Si-Si silicon wafers (ICEMOS), 100±2μm and 130±2μm sensor layer thickness with ρ>3000 Ωcm (+500±10μm support wafer)

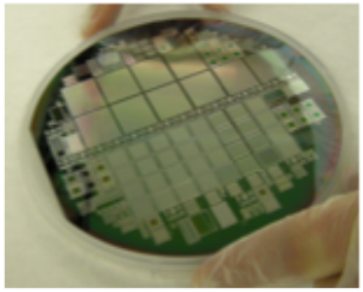
Process

- n-on-p planar process
- three different p-spray doses

Layout

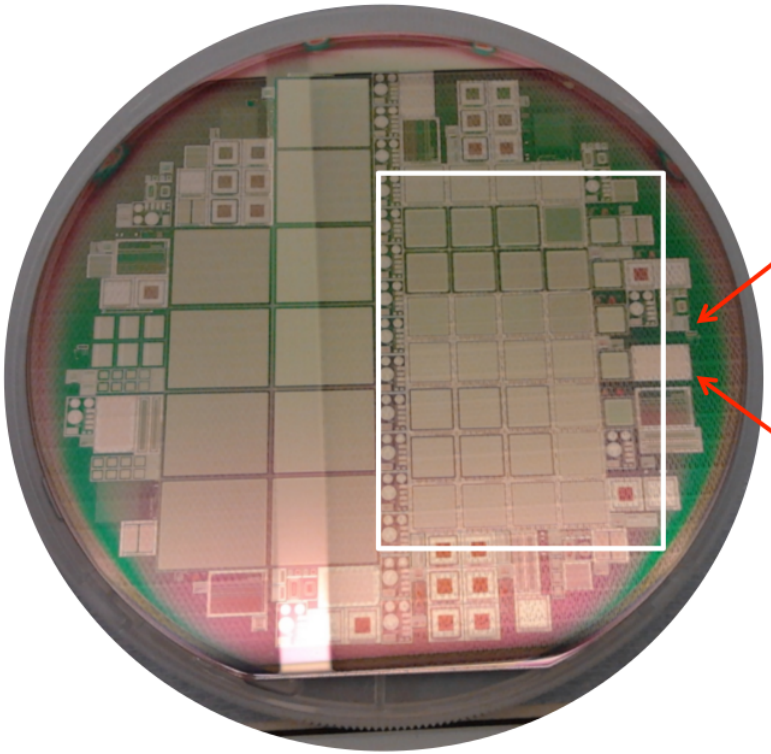
- 10 ATLAS pixels (FEI4)
- 30 CMS pixels (PSI46)
- Many test structures

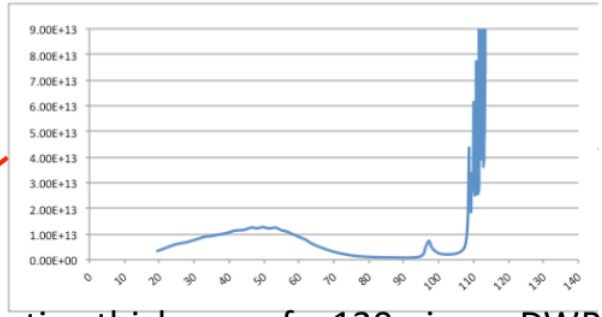
Batch completed at FBK in Dec. 2014



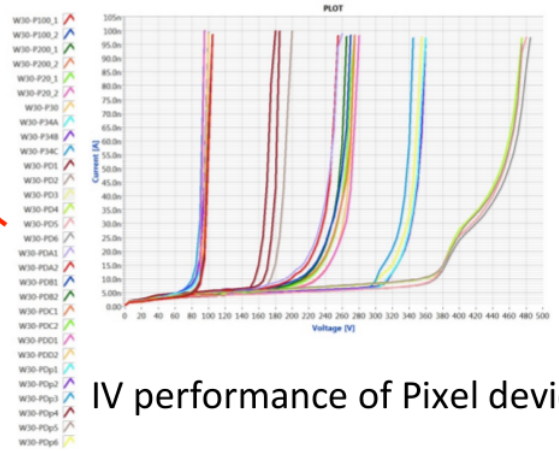
First Planar batch produced with FBK on 6-inch

- Picture of produced wafer, and preliminary measurement of the active thickness and IV performance
- 5 wafers qualified and under Bump Bonding process in IZM
  - Plan to produce 40 single chip detectors





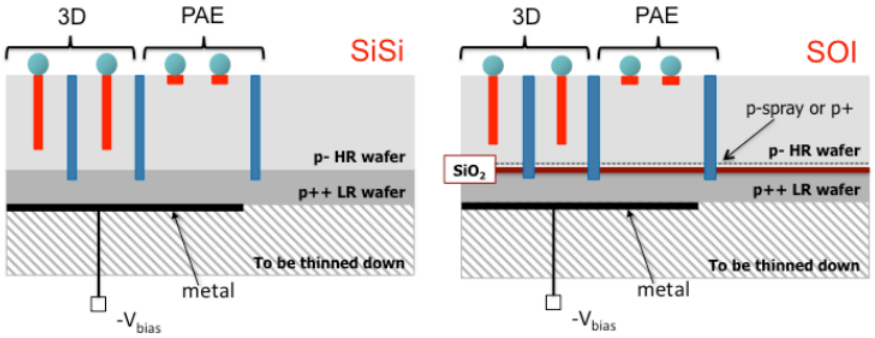
Active thickness of a 130micron DWB



IV performance of Pixel devices

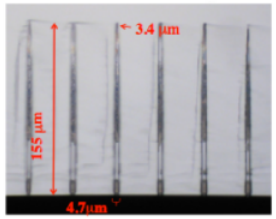
Short term plans: 3D and Pixel Active Edge

- Plan to produce two batches in 2015:
  - 3D columnar with column diameter 5 μm filled by poly-silicon
  - Pixel Active Edge (PAE)

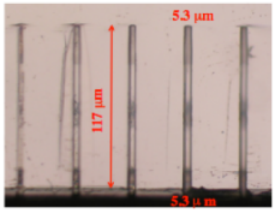


- Many challenges:
  - Small pitch (see next)
  - Filled column (poly silicon)
  - Bump deposition on top of column
  - Small pitch readout with available (phase I) readout electronics

Optimization of columns etching

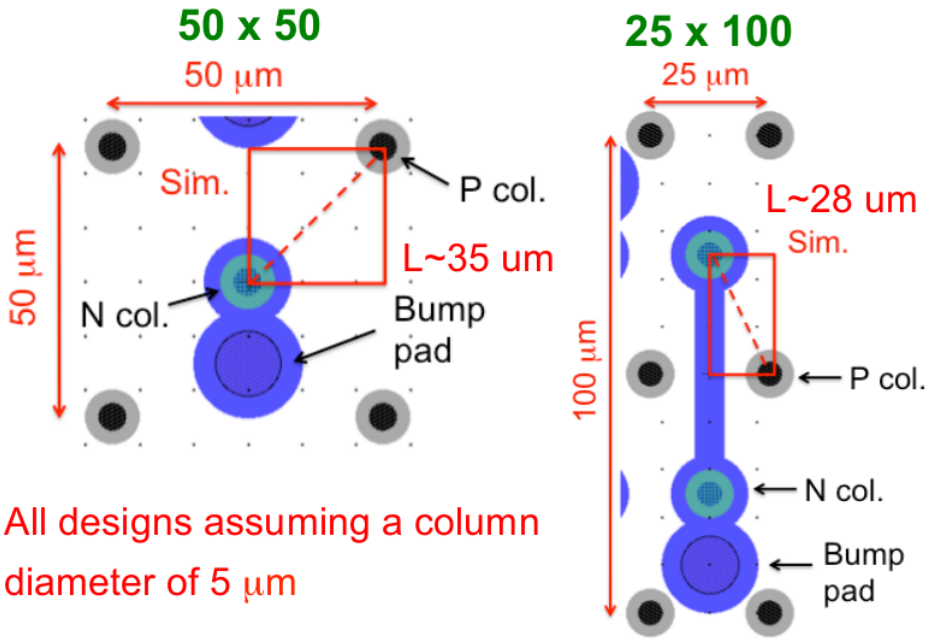


Ohmic columns optimized for depth

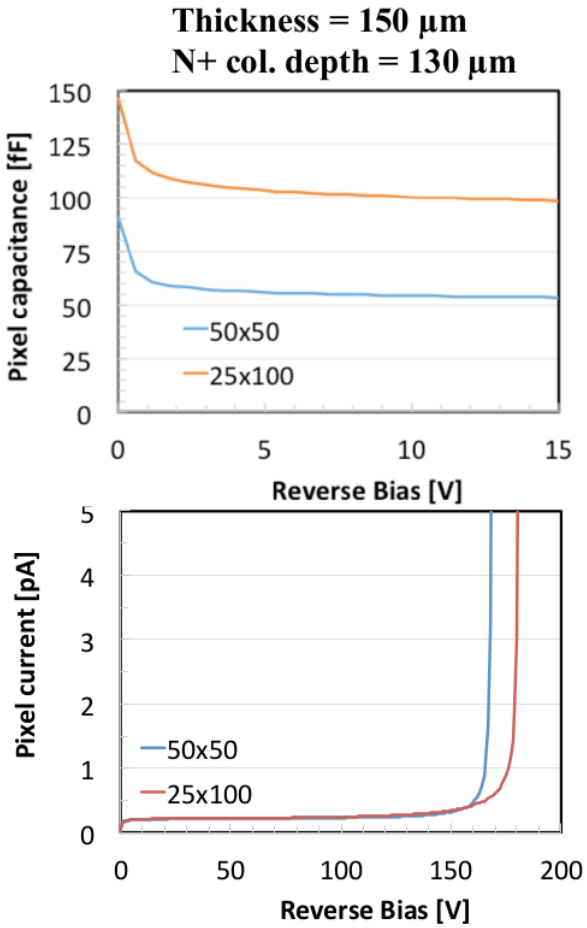


Junction columns optimized for uniform

3D devices with small pitch: example 3D



All designs assuming a column diameter of 5 µm



- 50x50 design safe, 25x100 is difficult … too little clearances (new ideas for bump pad to be tested)
- Capacitance compatible with RD53 specs
- Initial breakdown voltage high enough

Pixel Phase II

Activities 2015-16, Budget and manpower

- Pixel Phase II
  - Production and QA of 3D columnar and PAE planar pixel
  - Devices assembly: Bump Bonding
  - Irradiation (Liubljana, Los Alamos) and Beam test (FNAl, Desy) experiments
  - Bump Bonding engineering for small pitch pixels

2016 INFN R&D PIX-CMS budget	Total	238

2016 Pisa R&D PIX-CMS budget

Bump Bondig(BB) 3D e Active Edge		44
BB engineering run for small pitch		20
Beam Test (M.E.)	4.5 m.u.	17.1
	Total	81.1

Manpower Pixel Phase II

Phase II	Pixel R&D
Staff	
	T. Boccali
	M.A. Ciocci
	R. Dell'Orso
	A. Messineo
	A. Moggi/A.Basti
	P.G. Verdini
PhD/Students	
	K. Androsov
Technicians	
	M. Ceccanti
	P. Mammini
	A. Profeti

1.95 FTE

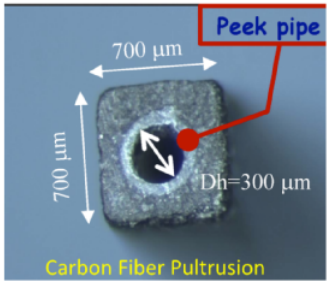
Micro-channel cooling

Micro-channel cooling R&D

- **Motivations:**
- Pixel modules for HL-LHC require high power dissipation
  - i.e. FE-I4 (65nm) 30 uW/bond => **(100k bonds/cm^2) : 0.75 W/cm^2**
  - sensors, (operating at -15-20 ^{o}C) will add 0.2W/cm^2
- Efficient detector operation at low T
- Cooling system with low material budget
  - Optimization of fluid choice: CO_2
  - Integration inside the module
- Optimization of technology compatible with ROC and Pixel processing

Activity planned in Pisa: Implementation of evaporative CO_2 cooling on Carbon Fibre Reinforced Plastics (CFRP) with low T working point (-20°C)

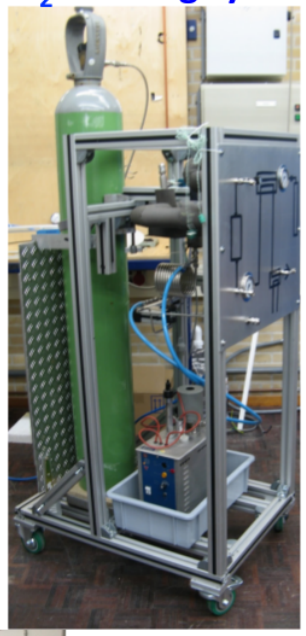
- Application to small hydraulic diameter (≤300 µm)
- Design of realistic cooling channel length (300-600 mm)
- Optimization of Cooling system material budget: goal 0.15% X_0.
- Optimization of material budget vs. temperature working point.



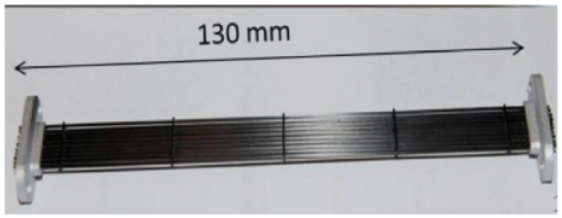
Microchannel cooling: plans 2015-2016

- **Steps to assess Phase transition cooling in micro-cooling channel**
  - CO_2 cooling unit (Nikeff) + safety system
  - Boro-silicate + CFRP channel length 50-60 cm
  - CAD design and simulations (TFD and TS)
  - Micro-channel assembly optimization:
    - **All parts already procured laboratory , activity now in the assembly phase**
  - Measurements/qualification in TFD laboratory including structural tests. System integration.
  - Focusing on Phase II Pixel detectors geometries
    - **Planar and 3D columnar pixel detectors**
    - **Custom development of interconnections, high pressure rated**

CO_2 Cooling system



200 Watt at -30 C



Low mass Cooling unit

INFN Pisa TFD facility

Micro Channel Cooling

Activities 2015-16, Budget and manpower

- Micro-channel cooling
  - Device prototyping
  - Miniaturized Interconnections high pressure rated
  - Demonstrator
- AIDA-2020
  - Pisa should/will be a member
  - We can start there embedded in Silicon micro-channel R&D
    - Responsibility al Device prototype convener (F.Bosi)

2016 INFN R&D PIX-CMS budget	Totale	238

2016 Pisa R&D PIX-CMS budget

Single microchannel cooling demonstrator		10
Sensor pipe welding and interconnection		10
Cooling consumables + running costs		2.5
	Total	22.5

Manpower Micro channel cooling

Phase II	
	u-channel cooling
Staff	
	F. Bosi
	R. Dell'Orso
	A. Messineo
	P.G. Verdini
Technicians	
	P. Mammini
	A. Profeti
	G. Petragnani/ G.Balestri

1.3 FTE

Tracker Pixel phase I e II

Manpower & Budget summary

		Phase I Pixel	Phase II Pixel	Phase II Micro-ch cooling
Staff	T. Boccali	X	X	
	F. Bosi	X		X
	M.A. Ciocci	X		
	R. Dell'Orso	X	X	X
	A. Messineo	X	X	X
	A.Moggi/A.Basti		X	
	A. Rizzi	X		
	P.G. Verdini		X	X
PhD/Students	K. Androsov	X	X	
	M.T. Grippo	X		
	V. Botta	X		
Technicians	M. Ceccanti	X	X	
	P. Mammini	X	X	X
	G. Petragnani/G. Balestri			X
	A. Profeti		X	
	A. Ragonesi	X		
			1.95 FTE	1.3 FTE

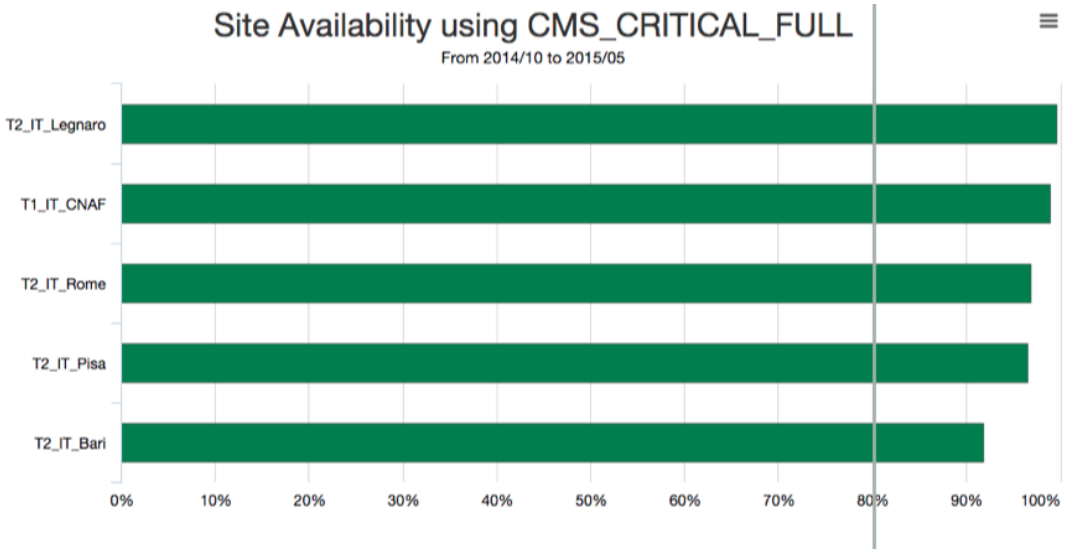
	INFN-Pisa Budget 2016
Pixel Upgrade Phase I	24.5
Phase II: R&D PIX-CMS	81.1
Phase II: R&D micro-channel cooling	22.5
Total	128.1

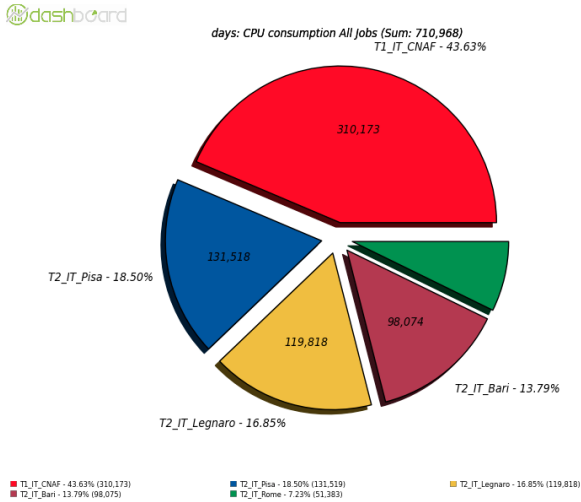
Incluse m.e. per test beam e integrazione

Tier2 Pisa: stato e richieste

Stato Tier2 Pisa

- Tutto bene, Tier2 stabile e tra I migliori di CMS
- Alcune metriche:
  - Availability (== frazione di tempo in cui e' tutto a posto) > 95% (deve essere > 80%)
  - Sito italiano + produttivo per CMS in Italia dopo il CNAF (== migliore dei T2)





Altre features Tier2 Pisa

- Unico sito italiano abilitato AAI
  - Tutti i partecipanti a CMS Italia hanno automaticamente account e risorse
- Fra i pochi siti T2 in CMS abilitato al reprocessing dei dati
  - Vuol dire performance al livello dei Tier1
  - Review T2 2014:

Raccomandazioni e osservazioni

Il centro di calcolo che include il Tier-2 è certamente uno dei migliori in Italia. Il fatto che la frazione di risorse dedicate a CMS sia (relativamente) una piccola parte rispetto al totale delle risorse installate lascia ben sperare per quanto riguarda la sostenibilità futura del Tier-2. Da evidenziare anche la buona collaborazione con l'industria. Non ci sono raccomandazioni particolari.

Richieste – raccomandazioni - delta

CERN–RRB–2015–015

	2014	Increase from 2013	2015	Increase from 2014	2016 (C-RSG Oct 14)	Increase from 2015
Tier-0 CPU (kHS06)	121	0%	256	111%	302	18%
Tier-0 Disk (TB)	7000	0%	3000	Reallocated to CAF	3250	0%
Tier-0 Tape (TB)	26000	0%	31000	31%	38000	23%
CAF CPU (kHS06)	0	0%	15	-	15	17%
CAF Disk (TB)	0	0%	12000	-	13100	9%
CAF Tape (TB)	0	0%	4000	-	6000	50%
T1 CPU (kHS06)	175	0%	300	71%	400	33%
T1 Disk (TB)	26000	0%	26000	4%	35000 (33000)	30%
T1 Tape (TB)	55000	11%	74000	34%	100000	35%
T2 CPU (kHS06)	390	14%	500	25%	700	40%
T2 Disk (TB)	27000	4%	29000	16%	40000 (38000)	37%

		2015 CMS	2015 CRSG	2016 CMS	2016 CRSG
CPU (kHS06)	T0	271	271	317	317
	T1	300	300	400	400
	T2	500	500	700	700
Disk (PB)	T0	15	15	16	16
	T1	27	26	35	33
	T2	31	29	40	38
Tape (PB)	T0	35	35	44	44
	T1	74	74	100	100

T1:
- CPU +30%
- Disk +25%
- Tape +35%

T2:
- CPU +40%
- DISK +30%

Una nota importante

- Il 2016 e' l'anno del grande aumento delle risorse di CMS ai T2.
- 2015 e 2017 sono molto piu' bassi (**flat o sub flat**)
  - Per il T1 l'anno del grande aumento e' gia' passato, era il 2015
- L'aumento e' necessario per garantire l'analisi sui (<)3+5 = 8 miliardi di eventi attesi a fine 2016 (fattore >2.7 rispetto a quelli a fine 2015)
- In particolare, come descritto nel documento RRB, il disco ai T2 sembra la risorsa + critica per CMS, dove c'e' meno margine (in realta' abbiamo chiesto meno di quello che pare necessario dalle simulazioni, e ottenuto ancora meno)
- L'aumento e' critico per le attivita' di CMS, e come si sa per il disco non esiste il concetto di uso opportunistico di risorse esterne …

Richieste Tier2

- L'Italia e' sempre storicamente stata il 13% di CMS, scesa al 12% negli ultimi documenti
  - Le richieste riflettono questo
  - Nonostante questo:

				TOT	disco TBN	disco Eur	CPU HS06	CPU Eur	Rete Eur	Server Eur
			Bari	308137.12	647.5025	142451	10.95	131400	15117.033	19169.5385
			Pisa	150229.12	347.5025	76451	4.75	57000	7437.033	9341.5385
Se vogliamo essere il		12% di CMS	Legnaro	264453.12	747.5025	164451	5.85	70200	13377.033	16425.5385
TOT	909670.49		Roma1	186851.12	397.5025	87451	6.55	78600	9177.033	11623.5385
			TOT	909670.49	2140.01	470802.20	28.10	337200.00	45108.13	56560.15

  - 150kEuro di base per Pisa
    - Che ha minori dismissioni da fare nel 2016

Pisa: responsabilita' 2016

Resp. Nazionale CMS

R. Tenchini (L1)

Fisica

P. Azzurri - Convener Higgs ->bb (L3)

Computing

G. Bagliesi - Resp. Tier2 CMS Globale (L3)

T. Boccali - Resp. Calcolo CMS Italia (L2)

T. Boccali - Comp. CMS Project Office (L2)

E. Mazzoni - Resp. Tier2 Pisa (L3)

Tracker

A. Giassi - TK DAQ coordinator (L3)

A. Messineo - Coord. TK INFN Pixel Upgrade (L3)

F. Palla - Coord. Track Trigger Ass. Mem. (L3)

A. Venturi - Tracker Project Manager (L1)

P.G. Verdini - TK safety coord. (L3)

CMS Pisa: Anagrafica 2016

FISICI	Età	Contratto	Qualifica	% Totale
Androsov Konstantin		Associato	Post-doc	100
Azzurri Paolo		Dipendente	Ricercatore	100
Bagliesi Giuseppe		Dipendente	Primo Ricercatore	100
Boccali Tommaso		Dipendente	Ricercatore	100
Borrello Laura		Associato	Insegnante	30
Castaldi Rino		Associato (anz.)	Dirigente di Ricerca	100
Ciocci Maria Agnese		Associato	Ricercatore	100
Dell'Orso Roberto		Dipendente	Primo Ricercatore	100
Donato Silvio		Associato	Borsista	100
Giassi Alessandro		Dipendente	Ricercatore	100
Grippo Maria Teresa		Associato	Dottorando	100
Ligabue Franco		Associato	Ricercatore	100
Lomtadze Teimuraz		Dipendente	Primo Ricercatore	70
Maestro Paolo		Associato	Ricercatore	30
Martini Luca		Associato	Assegnista	100
Messineo Alberto		Associato	Prof. Associato	100
Navarro Savoy Aurore		Associato (anz.)	Ricercatore straniero	100
Palla Fabrizio		Dipendente	Primo Ricercatore	100
Palmonari Francesco		Associato	Insegnante	30
Rizzi Andrea		Associato	Ricercatore	100
Rolandi Luigi		Associato	Prof. a Contratto	100
Spagnolo Paolo		Dipendente	Ricercatore	100
Tenchini Roberto		Dipendente	Dirigente di Ricerca	100
Tonelli Guido Emilio		Associato	Prof. Ordinario	100
Venturi Andrea		Dipendente	Ricercatore	100
Verdini Piero Giorgio		Dipendente	Primo Ricercatore	100
Totale 1: CMS Ricercatori				**21.6**

TECNOLOGI	Età	Contratto	Qualifica	
Arezzini Silvia		Dipendente	Primo Tecnologo	**30**
Basti Andrea		Associato	Tecnologo	**10**
Beccherle Roberto		Dipendente	Tecnologo	**30**
Ciampa Alberto		Dipendente	Primo Tecnologo	**30**
Magazzu' Guido		Dipendente	Primo Tecnologo	**70**
Mazzoni Enrico		Dipendente	Tecnologo	**50**
Moggi Andrea		Dipendente	Tecnologo	**20**
Morsani Fabio		Dipendente	Primo Tecnologo	**25**
Totale tecnologi				**2.65**

+F. Bosi !

Informazione passata ai referee tramite il rappr. naz.

FTE Fisici	20.7	PRIN inclusi (CMS)
FTE Tecnologi	1.8	
FTE Tecnici	0	
FTE Prog. Est	2.55	INFIERI
FTE CSN5	1.2	CHIPIX65
FTE Tot	26.25	

NON in anagrafica CMS (ma contati nel metabolismo)

FISICI (INFIERI)	Età	Contratto	Qualifica
Fedi Giacomo		Art. 23	Ricercatore
Poulios Stamatis		Art. 23	Ricercatore

Sommario richieste

Gran Totale
Richieste finanziarie 2016

MI, ME, consumi che si evincono dall'anagrafica non sono riportati

TIER2

Pisa	Dismissione Disco	TBN	150	220	33000	33000
	Dismissione CPU	kHS06	0	12000	0	0
	Nuovo Disco	TBN	197.5025	220	43450.55	43500
	Nuova CPU	kHS06	4.75	12000	57000	57000
	Overhead per Server				9341.5385	9500
	Overhead per Rete				7437.033	7500
	TOTALE				**150229.12**	**150500**

Costruzione Pixel fase I	**5 kE**	CMS Costr. App.
Pixel integration	**3 m.u**	CMS m.e.
Test Beam fase II	**4.5 m.u**	
Camionette CERN	**8 kE**	CMS consumi
Manut. Camere pulite	**6 kE**	
Trasporti	**2 kE**	
R&D Pixel fase II	**86 kE**	RD fase II

Backup

Schedula riaccensione magnete

Action	Time needed
Nominal Cryo ready	4-5 days
Ramp to 1.5T	2 hours
Slow discharge (+ post mortem)	3 hours
Re-liquefy 1200 l He	20-24 hours (estimated)
Verified cryo ready	
Ramp to 2T (1A/s)	2-3 hours
Ramp 2T – 3.8T	4-6 hours

Magnete dovrebbe essere ON a inizio settimana prossima > 6 giugno

Dettaglio anagrafica

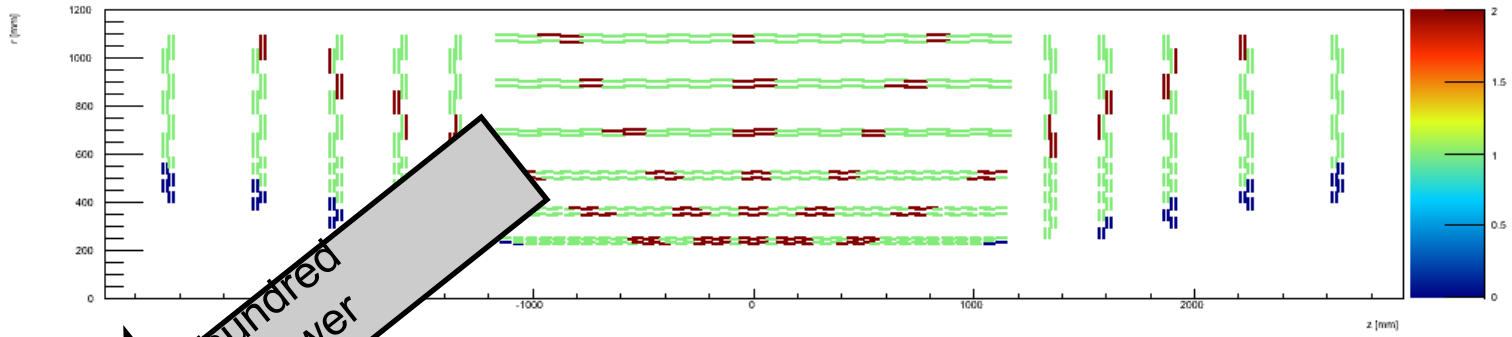
	B	C	D	E	F	G	H	I	J	K	L	M	N
1	**FISICI**	Età	**Contratto**	**Qualifica**	**% Totale**	**% senza INFIERI**	**% CMS pura**	di cui fase II sensori	di cui fase II CHIPX65	di cui fase II L1 TT	di cui PRIN H-Tean	altri GR 5 per CMS	INFIERI (a parte)
2	Androsov Konstantin		Associato	Post-doc	100	**95**	**70**	15	10				5
3	Azzurri Paolo		Dipendente	Ricercatore	100	**100**	**83**				17		
4	Bagliesi Giuseppe		Dipendente	Primo Ricercatore	100	**100**	**83**				17		
5	Boccali Tommaso		Dipendente	Ricercatore	100	**100**	**60**	20				20	
6	Borrello Laura		Associato	Insegnante	30	**30**	**30**						
7	Castaldi Rino		Associato (anz.)	Dirigente di Ricerca	100	**100**	**100**						
8	Ciocci Maria Agnese		Associato	Ricercatore	100	**90**	**53**	10	5		22		10
9	Dell'Orso Roberto		Dipendente	Primo Ricercatore	100	**95**	**38**	40			17		5
10	Donato Silvio		Associato	Borsista	100	**100**	**100**						
11	Giassi Alessandro		Dipendente	Ricercatore	100	**100**	**80**			20			
12	Grippo Maria Teresa		Associato	Dottorando	100	**95**	**70**	20	5				5
13	Ligabue Franco		Associato	Ricercatore	100	**90**	**90**						10
14	Lomtadze Teimuraz		Dipendente	Primo Ricercatore	70	**70**	**70**						
15	Maestro Paolo		Associato	Ricercatore	30	**30**	**30**						
16	Martini Luca		Associato	Assegnista	100	**100**	**20**			80			
17	Messineo Alberto		Associato	Prof. Associato	100	**95**	**55**	40					5
18	Navarro Savoy Aurore		Associato (anz.)	Ricercatore straniero	100	**100**	**100**						
19	Palla Fabrizio		Dipendente	Primo Ricercatore	100	**90**	**55**		15	10	10		10
20	Palmonari Francesco		Associato	Insegnante	30	**30**	**30**						
21	Rizzi Andrea		Associato	Ricercatore	100	**100**	**100**						
22	Rolandi Luigi		Associato	Prof. a Contratto	100	**100**	**100**						
23	Spagnolo Paolo		Dipendente	Ricercatore	100	**100**	**100**						
24	Tenchini Roberto		Dipendente	Dirigente di Ricerca	100	**100**	**100**						
25	Tonelli Guido Emilio		Associato	Prof. Ordinario	100	**100**	**89**				11		
26	Venturi Andrea		Dipendente	Ricercatore	100	**100**	**100**						
27	Verdini Piero Giorgio		Dipendente	Primo Ricercatore	100	**95**	**45**	50					5
28													
29	**Totale 1: CMS Ricercatori**				**21.6**	**21.05**	**16.51**	1.95	0.35	1.1	0.94	0.2	0.55
30													
31	**FISICI (PROGETTO EUR)**	Età	**Contratto**	**Qualifica**		**%**							
32	Fedi Giacomo		Art. 23	Ricercatore	100	**0**	**0**						100
33	Poulios Stamatis		Art. 23	Ricercatore	100	**0**	**0**						100
34						**21.05**							
35	**Totale 2: CMS fisici + INFIERI puri**				**23.6**		**16.51**	**1.95**	**0.35**	**1.1**	**0.94**	**0.2**	**2.55**
36													
37													
38	**TECNOLOGI**	Età	**Contratto**	**Qualifica**		**%**							
39	Arezzini Silvia		Dipendente	Primo Tecnologo	**30**	**30**	**15**					15	
40	Basti Andrea		Associato	Tecnologo	**10**	**10**	**10**						
41	Beccherle Roberto		Dipendente	Tecnologo	**30**	**30**	**0**		30				
42	Ciampa Alberto		Dipendente	Primo Tecnologo	**30**	**30**	**15**					15	
43	Magazzu' Guido		Dipendente	Primo Tecnologo	**70**	**70**	**0**		30	40			
44	Mazzoni Enrico		Dipendente	Tecnologo	**50**	**50**	**50**						
45	Moggi Andrea		Dipendente	Tecnologo	**20**	**20**	**0**	20					
46	Morsani Fabio		Dipendente	Primo Tecnologo	**25**	**25**	**0**		25				
47													
48	**Totale tecnologi**				**2.65**	**2.65**	**0.9**	0.2	0.85	0.4	0	0.3	0
49													
50													
51	**GRAN TOTALE**				**26.25**	**23.7**	**17.41**	**2.15**	**1.2**	**1.5**	**0.94**	**0.5**	**2.55**
52													

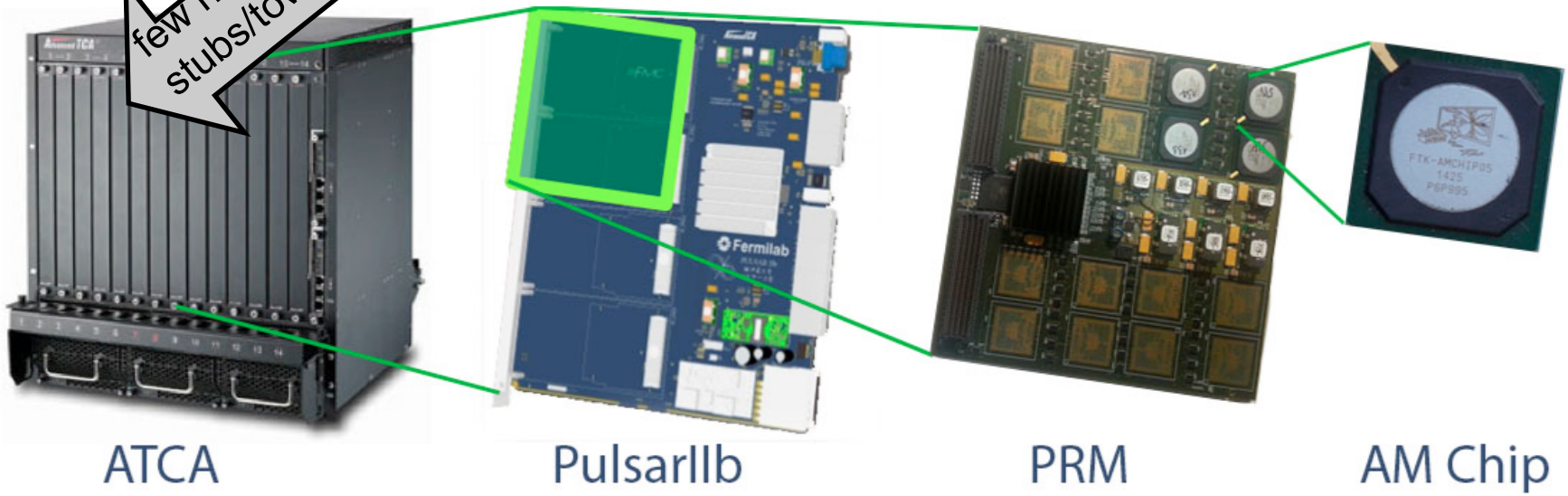
Richieste T2

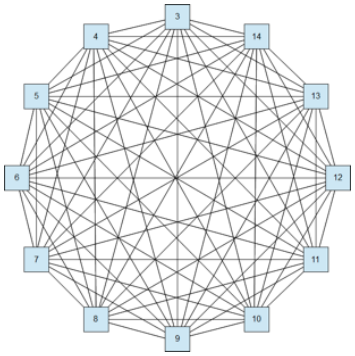
		Unita' Misura	Quantita'	Costo unitar	Costo totale	ROUND
Bari	Dismissione Disco	TBN	450	220	99000	99000
	Dismissione CPU	kHS06	6.2	12000	74400	74500
	Nuovo Disco	TBN	197.5025	220	43450.55	43500
	Nuova CPU	kHS06	4.75	12000	57000	57000
	Overhead per Server				19169.539	19000
	Overhead per Rete				15117.033	15000
	TOTALE				**308137.12**	**308000**
Legnaro	Dismissione Disco	TBN	550	220	121000	121000
	Dismissione CPU	kHS06	1.1	12000	13200	13000
	Nuovo Disco	TBN	197.5025	220	43450.55	43500
	Nuova CPU	kHS06	4.75	12000	57000	57000
	Overhead per Server				16425.539	16500
	Overhead per Rete				13377.033	13500
	TOTALE				**264453.12**	**264500**
Pisa	Dismissione Disco	TBN	150	220	33000	33000
	Dismissione CPU	kHS06	0	12000	0	0
	Nuovo Disco	TBN	197.5025	220	43450.55	43500
	Nuova CPU	kHS06	4.75	12000	57000	57000
	Overhead per Server				9341.5385	9500
	Overhead per Rete				7437.033	7500
	TOTALE				**150229.12**	**150500**
Roma1	Dismissione Disco	TBN	200	220	44000	44000
	Dismissione CPU	kHS06	1.8	12000	21600	21500
	Nuovo Disco	TBN	197.5025	220	43450.55	43500
	Nuova CPU	kHS06	4.75	12000	57000	57000
	Overhead per Server				11623.539	11500
	Overhead per Rete				9177.033	9000
	TOTALE				**186851.12**	**186500**
	TOTALE dei TOTALI				**909670.49**	**909500**

(rosa = inserire nei preventivi)

Fase II upgrade: L1 Track trigger







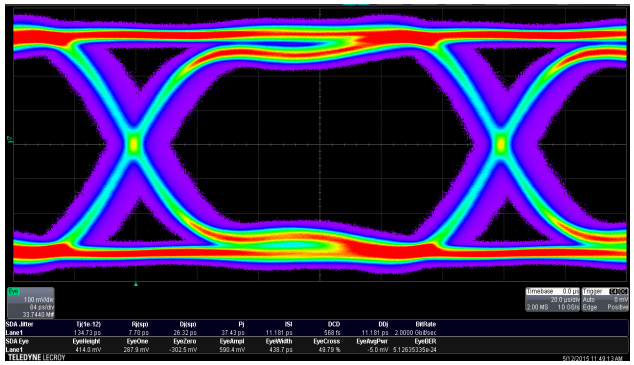
- Send data to Pattern Recognition Mezzanine in each ATCA blade
  - Data distributed to Pulsar boards in time multiplexed mode in round robin
  - Perform pattern recognition using several AM chips (120k Patterns/AM chip)
  - Track fit with FPGA inside the Mezzanine (~1 ns/fit)

L1 Tracking Trigger

- Sviluppo di un "dimostratore" con tecnologie allo stato dell'arte per il TDR del Tracker (2017)
  - Data sharing, misure di latenza (<5 μs) e architetture di time-multiplexing
  - ATCA standards (fino a 40 Gbps) + AM chip sviluppati per FTK
  - Giustificazione delle scelte di disegno per il TDR del Tracker.
- Sviluppo di un nuovo chip di AM, in sinergia con ATLAS
  - Aumento della densità dei pattern e della velocità di clock in tecnologia 28 nm
  - R&D per il TDR del Track-Trigger a seguire (~2020?)
- Piano di spesa discusso e approvato in CSN1
  - Include chip 28 nm in sinergia con IMPART (FIRB CSN5) + Bicocca (nuovo) dal 2015
  - Sviluppo mezzanine, acquisto Pulsar boards e crates ATCA
- Sedi INFN: Fi (SW), Pd (SW), Pg (HW+SW), Pi (HW+SW), Ts (SW)
  - Bicocca (New Entry!) sul chip 28nm

L1 track trigger: risultati 2015

- **Testati ~100 chips AM05 a Pisa (G. Fedi)**
  - **in collaborazione con FTK**
- **Test e caratterizzazione della mezzanina di test prodotta a Perugia (G. Fedi, G. Magazzu)**



Test links @2 Gbps (verso i chip) e @8 Gbps (verso Pulsar)
Nessun errore in 8 ore: BER<10^{-14}

- **Sviluppo Firmware di test (G. Magazzu)**
- **Sviluppo Track fit e Data Organizer**
  - **C++ (L. Martini) + Perugia**
  - **FW (G. Gentsos – IAPP / FTK)**
- **Studio configurazione banche (L. Martini)**

Prossimi passi

- **2015**
  - Ricezione e test seconda mezzanina AM05
    - 16 chip – in produzione a Perugia
  - Test integrazione mezzanina nella Pulsar a FNAL
    - In estate
  - Acquisto crates ATCA e integrazione Pulsar a Pisa e Perugia
- **2016**
  - Sviluppo nuova mezzanina AM06
    - Richieste su Pg
  - Sviluppo nuovo chip 28 nm
    - Richieste su Bicocca
  - Test-stand dimostratore al CERN
    - Missioni

Richieste 2015: reminder

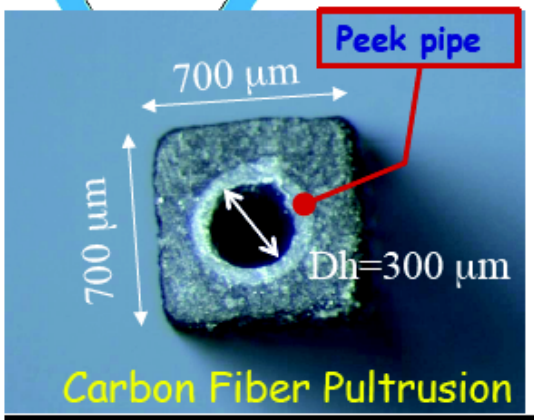
RICHIESTE FINANZIARIE

- **Non elenco le richieste che si evincono dall'anagrafica e responsabilita' (MI, ME, Met)**
- **3 mesi uomo personale tecnico ripartenza tracker al CERN**
- Calcolo

	k€
CPU	40
Disco	30
Rete	4
Server	5

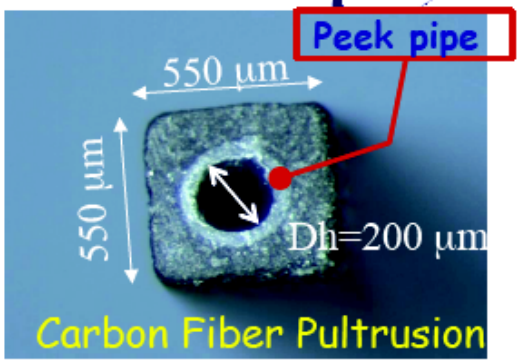
- **Costruzione Pixel fase I => 14 kEuro**
- **R & D Pixel fase II => 90 kEuro**
- **R & D Track Trigger fase II => 24 kEuro**
- **Camionette CERN 8 kEuro**
- **Manutenzione Camere pulite 6 kEuro**

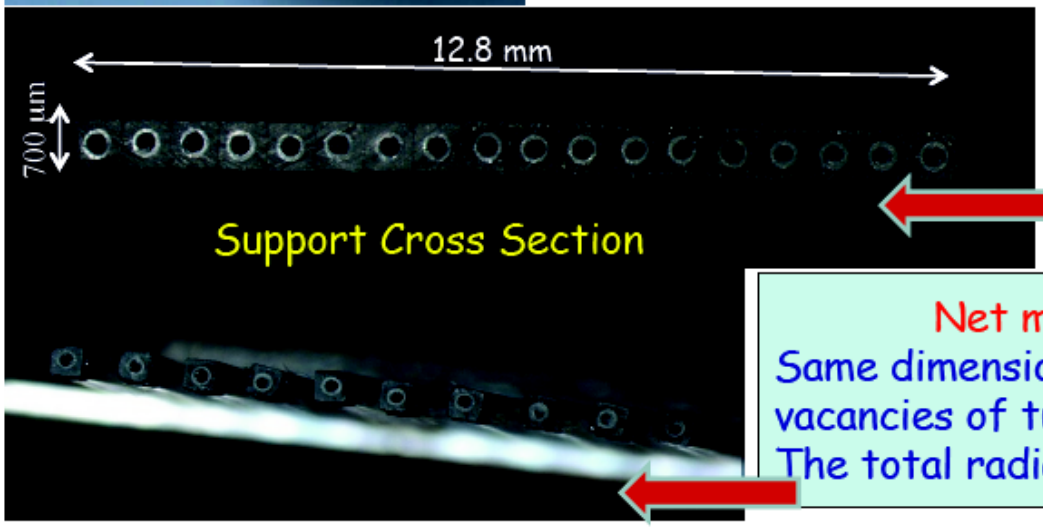
Module supports summary



The single base microchannel unit

A square CF micro-tube with an internal peek tube 50 μm thick used to avoid moisture on carbon fiber





Full micro-channel module

The total radiation length (*) of this support is 0.28 %X_0

Net micro-channel module

Same dimensions of full micro-channel but vacancies of tubes in the structure.

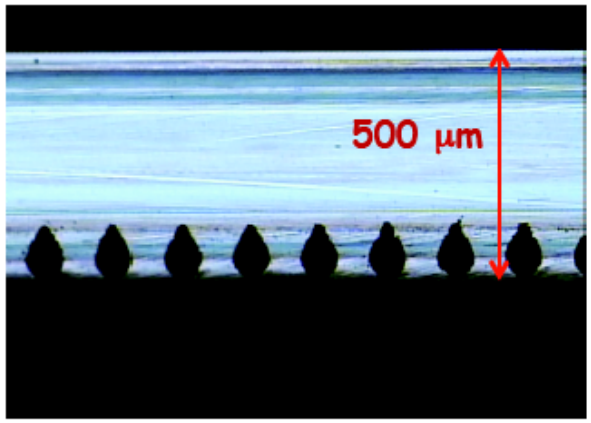
The total radiation length (*) is 0.15 %X_0

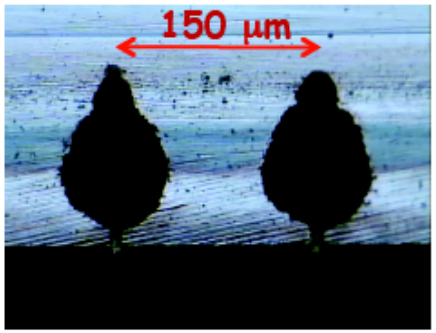
02/07/15

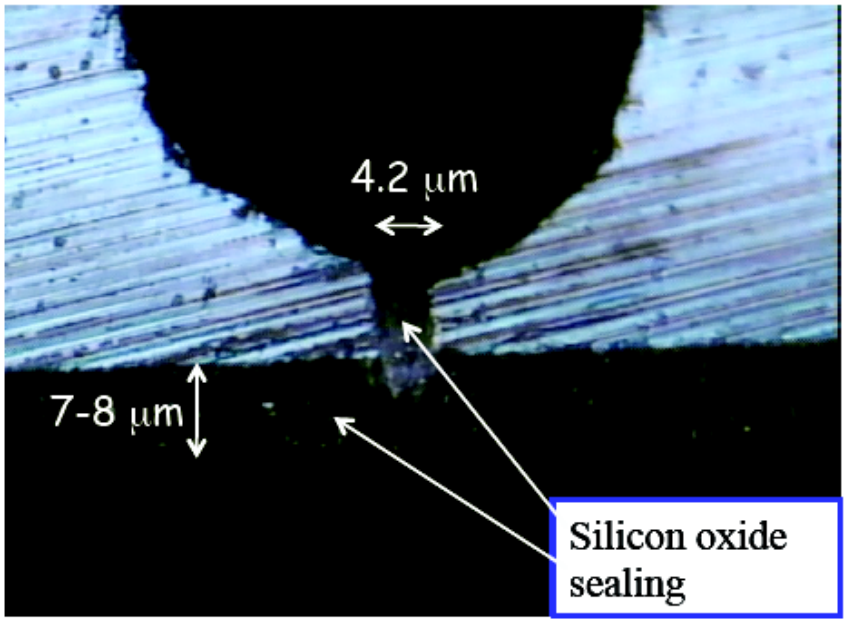
(*): Material of the support structure: (All C.F. material + peek tube + Water)

Microchannel integration on silicon prototype

From a 4" wafer are obtained N.5 silicon modules of 12.8 width mm x 60 mm length x 500 μm thick with N.61 microchannel to perform cooling tests







In the picture, the dimensions of the module prototypes in our hand .

Thermo-Fluid-Dynamic Lab

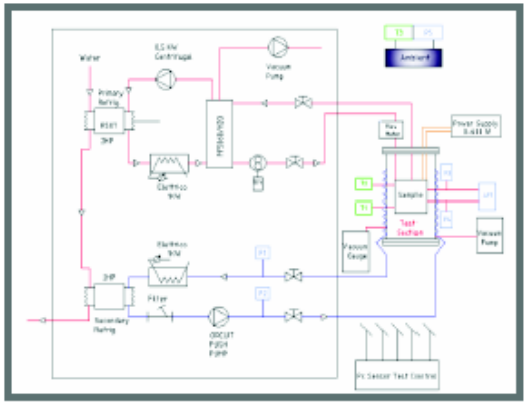
The lab is used for cooling tests and thermal characterization of low mass support structure based on micro-channel technology

- Test bench and chiller for forced convection of liquid monophase

The instrumentation allows to measure/ store the values of temp/pressure/flow in the thermal exchange.

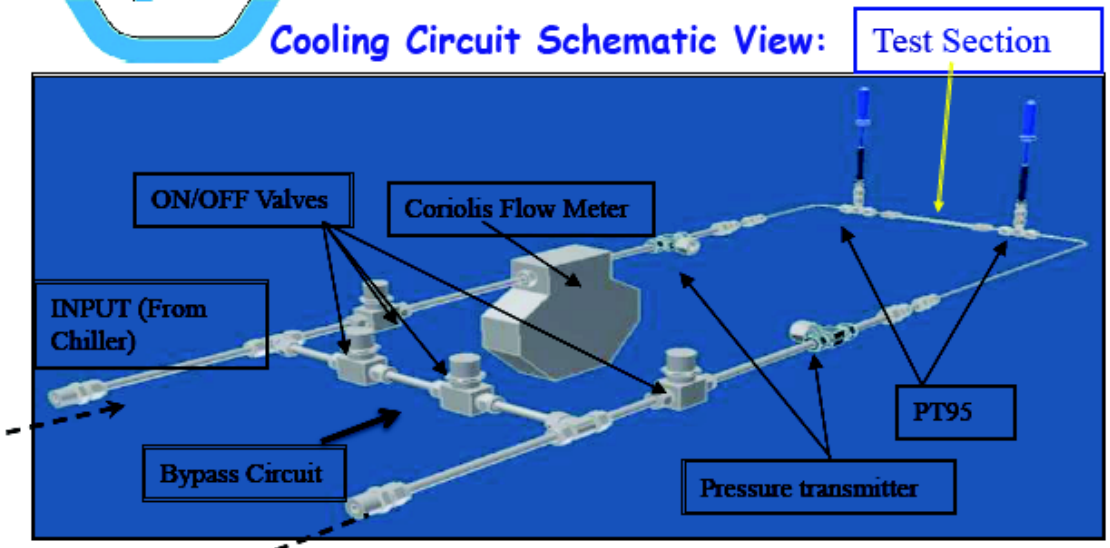
- DAQ HW system (N.24 probe for temperatures, pressure and flow).
- Chiller dimensioned for a cooling power > 1/2 kW primary and secondary cooling circuit

Scheme of the Test-bench hydraulic circuit

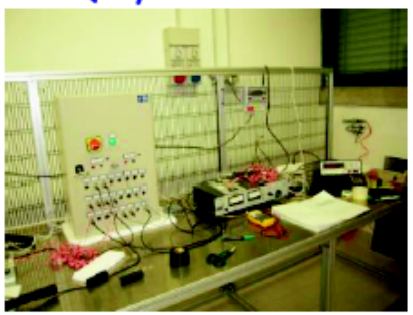


Test set-up at TFD lab

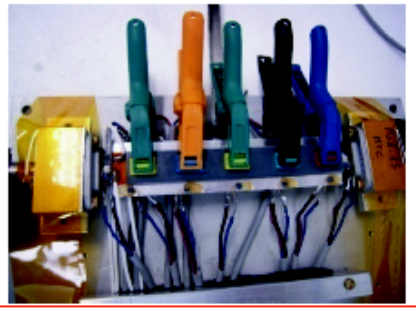
Cooling Circuit Schematic View:

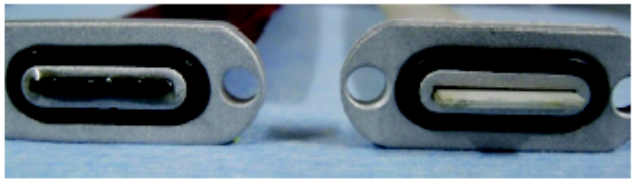


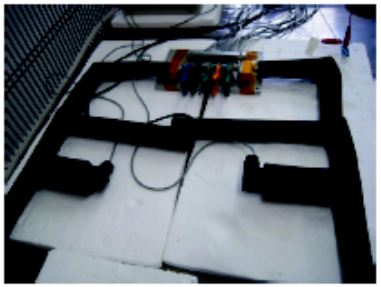
DAQ System:

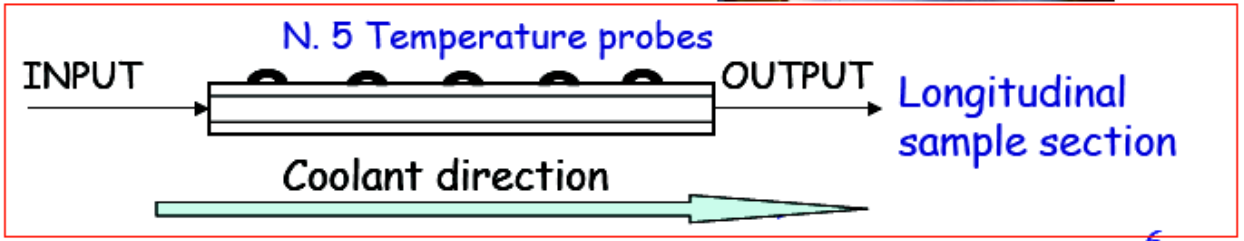


Test Section:

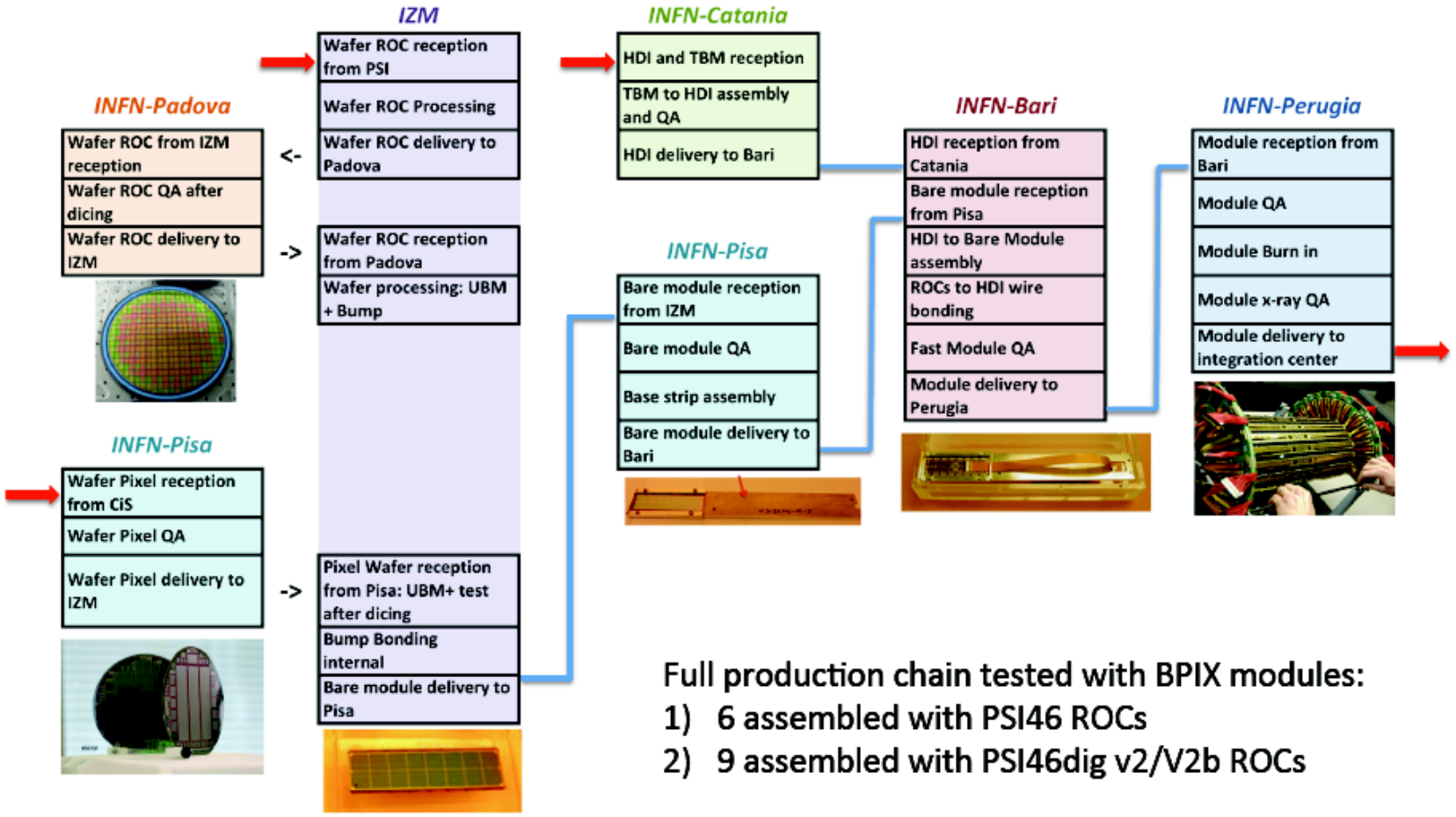








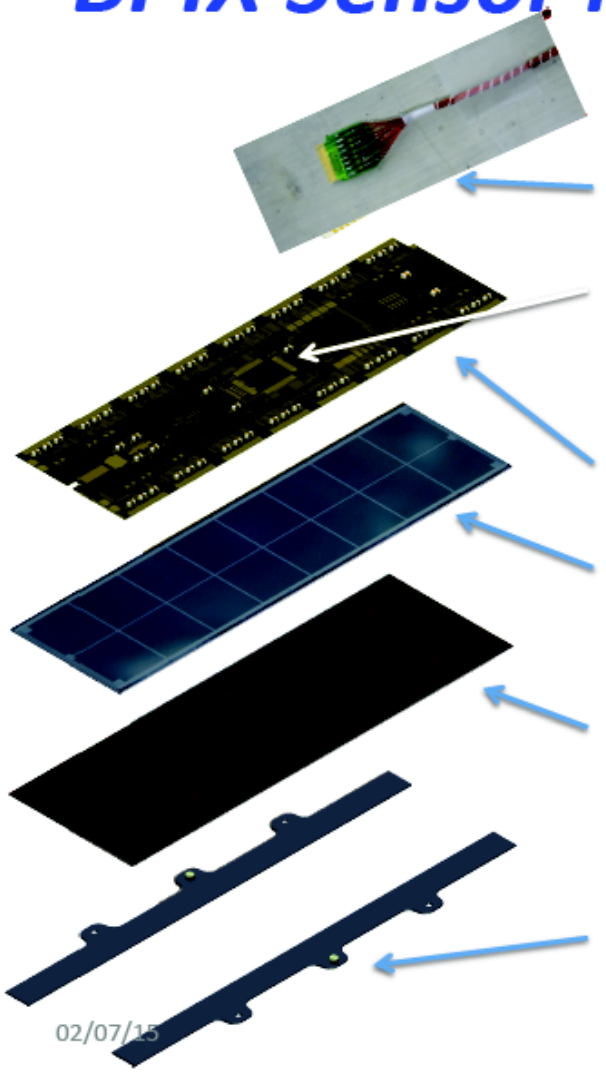
1/2 L3 BIPIX-INFN project workflow



Full production chain tested with BPIX modules:

1) 6 assembled with PSI46 ROCs
2) 9 assembled with PSI46dig v2/V2b ROCs

BPIX Sensor module for Layers 2-4



Cable & Connector
Twisted pairs ~ 1 mt long in order to move material far from IP.

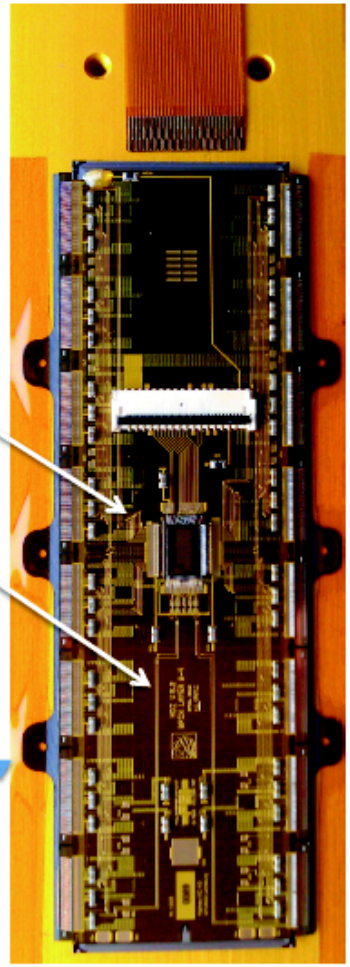
TBM
New chip to allow 360 MHz data transfer

HDI new design

Silicon Sensor
2008 n+/n design

16 ROCs Digital PSI46Dig
(5000ch/cm^2)
Charge digitized 8 bit, 40 MHz DCS
R.O. 160 Mbit/s
Extended Buffering

SiN Base strips
200 μm thick

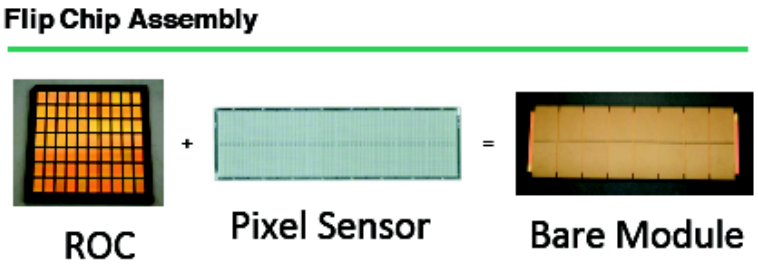


Pixel Phase I: production

- **Production Centers**
  - **BPIX**
    - 5 production centers:
      - Switzerland **(L1+L2)** , CERN/TW/FIN, **(1/2-L3)** Italy **(1/2-L3)**, Germany (KIT/RWTH + Desy) **(L4)**.
      - with 2-5 labs per production center + external vendors
    - Bump bonding and sensor options decided in each center
    - Full (analog/digital) modules made wih IZM, ADVACAM, PSI-Dectris, KIT-RTI
  - **FPIX**
    - Module production and qualification centers: Purdue and Nebraska Universities + Fermilab
    - Pre production of Digital prototypes for Pilot Run.

½-L3-BPIX Bare Module Production

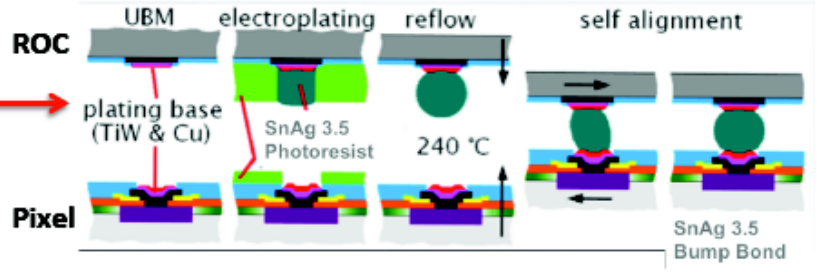
- ***Interconnection between Pixel Sensor and ROC chip:***
  - *5000 connection/cm²*
- ***A few technologies available***
  - *Interconnection metal/alloy*
  - *Thermal budget*
  - *Mechanical robustness*
- ***Service provided by industrial partner***



Production of BPIX Prototypes

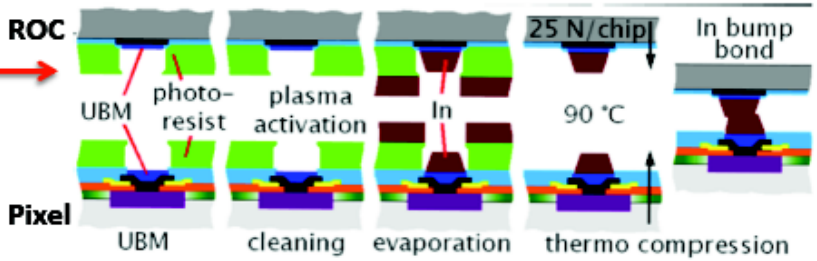
Analog ROC (Pixel 2008):

- ***IZM*** **(SnAg Bump Bonding process)**
  - **2 Bump Bonded half modules** (mechanical test)
  - **15 Bump Bonded full modules**



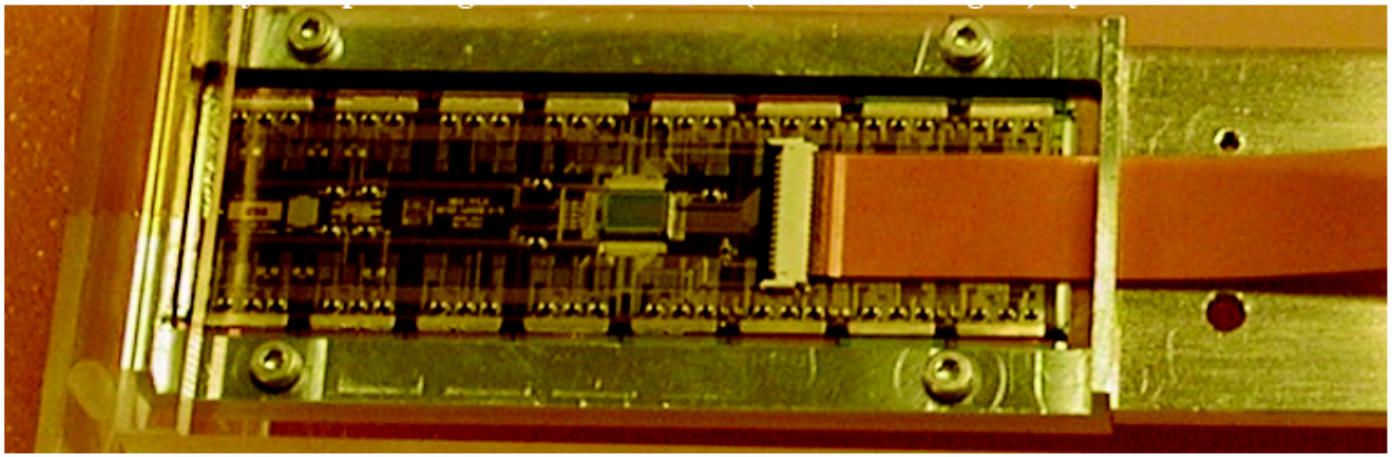
- ***Selex*** **(In Bump Bonding process)**
  - **Karlsruhe-IT & INFN joint project**
    - **6 Bump Bonded full modules (INFN)**
    - **Bump deposition on Sensors and ROCs (KIT)**

(modules delivery by December)



BPIX Layer 3: 1st Digital Module

- First digital module fully assembled (M313206-20-02)



Data base

- Dbase has a structure based on mysql and pyton.
- of Inventory and Test tables and handles also object Transfer
  - Links to synthetic info (data analysis results) as well as full data payload (full measurement)
  - Inventory trace position and object status
    - **Finalization of tables 2014**