# *IBL Report*

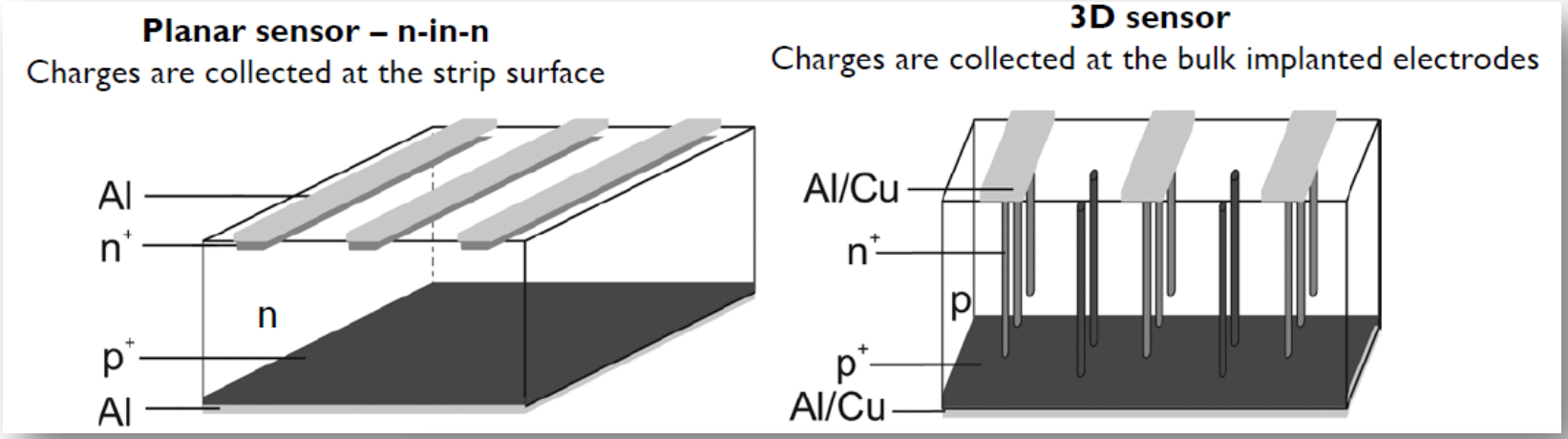
C. Gemme - INFN Genova

ATLAS Italia – 17/5/2012, Milano

Inputs da M.Citterio, S.Coelli, G.Darbo, A.Gabrielli, C.Meroni, P.Morettini

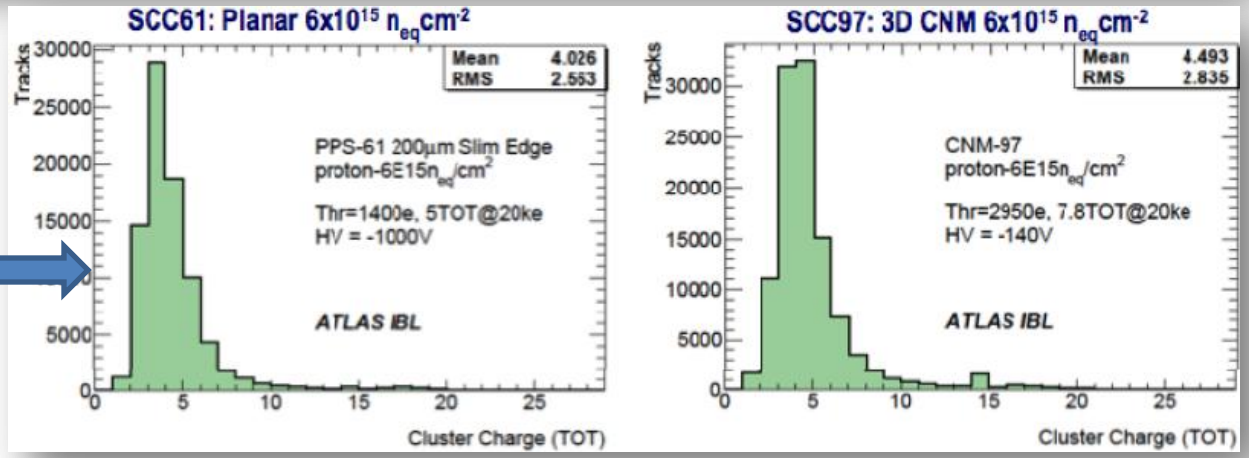
- ✓ IBL: Stato del progetto
  - Moduli: sensori, elettronica, ibridizzazione, module flex
  - Stave, flex, integrazione
  - Servizi: PP2 e ROD
- ✓ Richieste finanziarie

# Sensors




Test Beam results show that the sensors match IBL requirements.

Charge collection:



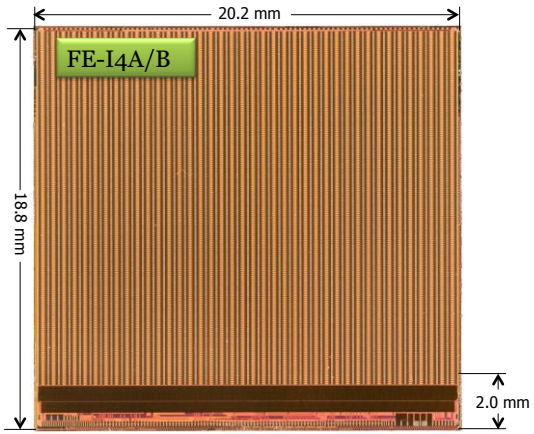

✓ Production Status – assuming 75% planar and 25% 3D

- Planar sensors from CiS: 424 good double chip (DC) tiles (89.1 % yield) - IBL needs 168
- 3D sensors from CNM and FBK: 306 good tiles as today (62% yield) – IBL needs 112

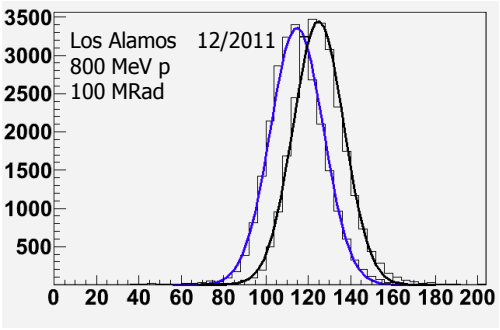
Ge/Ud

# Electronics

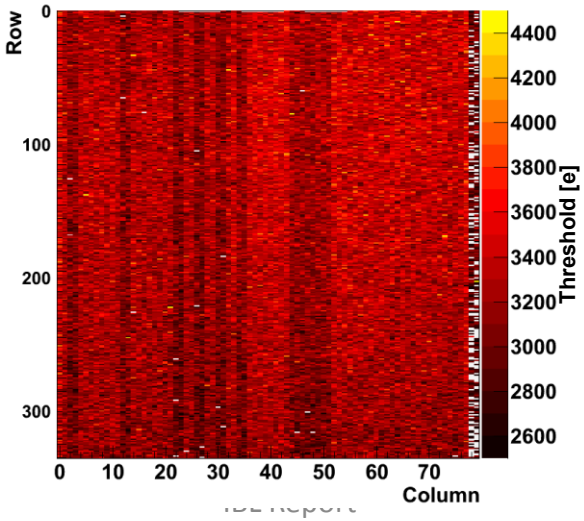
- ✓ First version FEI4a for validation and IBL prototypes (32 FE-I4A wafers received in 2010/11)
- ✓ FEI4b features: minor fixes + r/o functionalities + uniform pixel matrix + Power functionality
- ✓ First FEI4b delivery in Dec. 2011
- ✓ FEI4b now in production (30 wafers) and wafer probing is almost completed (yield ~60%)



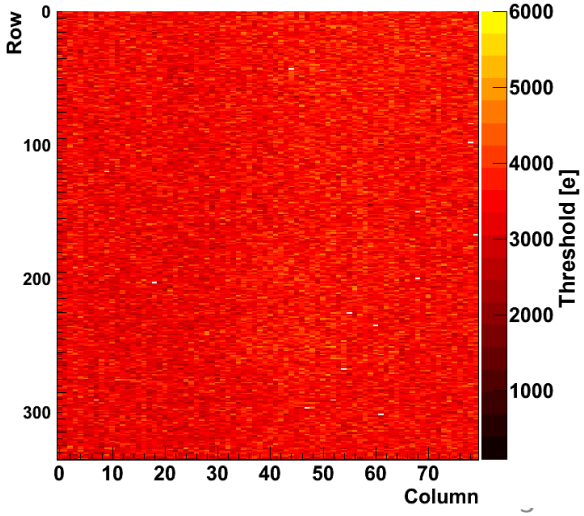

**FEI4b noise before and after irradiation:**
**114e → 124e (both tuned)**




**Threshold FEI4a**




**Threshold FEI4b**

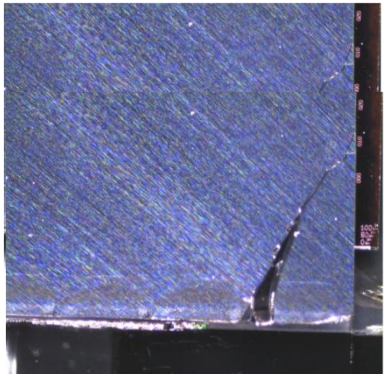


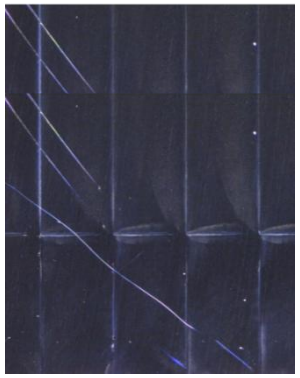
# Bump-Bonding – Thin Modules

- ✓ 125 modules built at IZM using FEI4a; assembled (glue hybrid and wirebond) and qualified in two assembly sites (Genova/Bonn)
- ✓ Thin module prototypes (100 and 150 um thick electronics):
  - Thin module process steps: ① FE-I4 wafers thinned – ② glued on glass support wafer – ③ bump deposition – ④ dicing wafer & substrate – ⑤ flip-chip & reflow – ⑥ substrate wafer removal by power laser.
  - Some cracks during the process of laser release of the substrate.
    - mainly in 100μm thin modules
    - Decided to go to 150μm thick chips for IBL module production (safety)
  - Module flex design is being finalized for the final submission (Genova).
  - ***Module PRR 6-7 June2012***

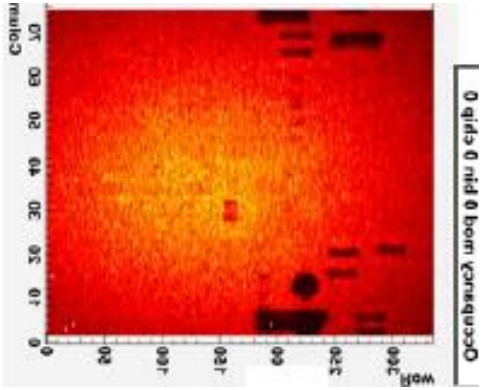
Ge/Mi

Ge





Cracks developed in the FE-I4 back side

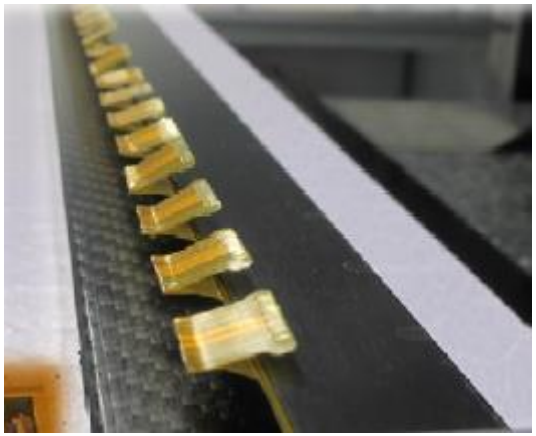


Am source scan
SMDs visible

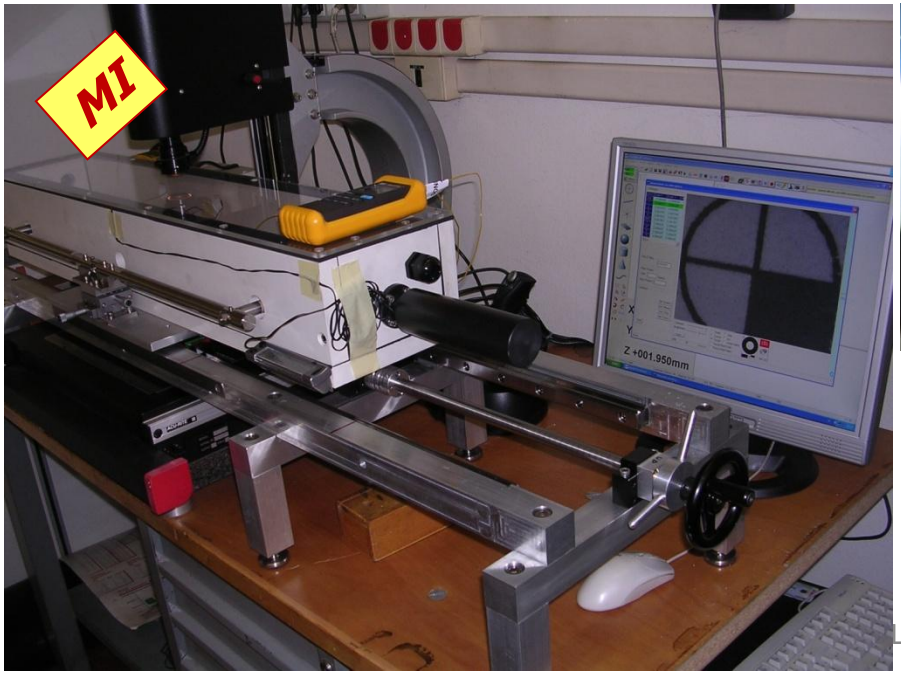
# Staves

- ✓ Staves are Made of carbon foam with a K13C omega, a faceplate and a Ti pipe of 1.5 mm ID and 0.1 mm wall thickness for cooling.
- ✓ Stave Production has started and 6 staves have already been delivered for module loading.
  - Planned to produce 33 staves → load 24 (14 needed for IBL).

MI



EXPERIMENTAL MEASUREMENT OF THE STAVE DEFORMATION INDUCED BY THE COOLING

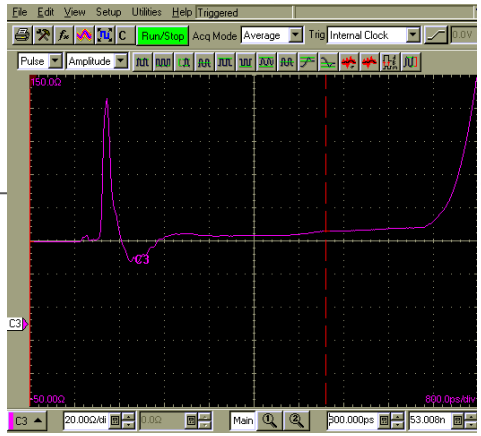




TEST OF INFRARED TRANSPARENT MATERIALS FOR THERMAL IMAGE TAKEN USING A I.R. CAMERA (FLIR)

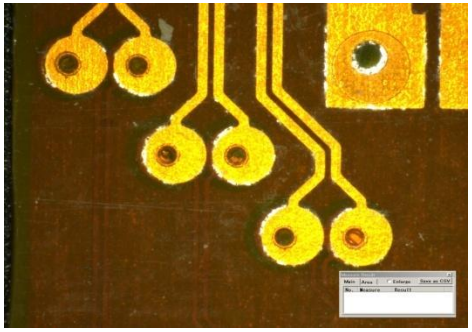
TEST BOX INSTALLED IN THE LASA METROLOGY LAB. COOLED USING NITROGEN. OPTICAL MEASUREMENT OF THE STAVE DISPLACEMENT IN SEVERAL POINTS CONSTRAINS ATTACHED TO INVAR REFERENCE BAR TEMPERATURE THERMORESISTANCE PT100 SENSORS

# Flex



GE

- Mix of 4 Cu-layers and 2 Al-layers for the LV lines. Total thickness ~450 um. Special fabrication for the Al-Cu vias.
- ✓ Folded Wings to provide connectivity to the FEs.
- ✓ 6 prototype sets delivered in March. Test in Ge, Slac, Mi.
  - Test in Genova to validate layout. Critical the Al/Cu vias and maintain low resistivity on the LV lines. 20% higher than expected →vias to be improved.
  - Full production, minor modifications on the Al-Cu vias, will ***restart in few days***.



| Layer Name | Type | Material | Thickness (um) |
|---|---|---|---|
| Coverlay | Dielectric | KAPTON | 12.5 |
| | | GLUE | 12.5 |
| TOP (HV) | Conductor | Copper | 19 |
| | Dielectric | Pyralux 25 µm | 25 |
| *LVDS2* | Conductor | Copper | 18 |
| GLUE | Dielectric | GLUE | 25 |
| GLUE | Dielectric | GLUE | 25 |
| GND1 | Conductor | Copper | 5 |
| | Dielectric | Pyralux 75 µm | 75 |
| LVDS1 | Conductor | Copper | 19 |
| GLUE | Dielectric | GLUE | 25 |
| | Dielectric | Kapton 25 µm | 25 |
| GLUE | Dielectric | GLUE | 25 |
| Aluminium | Plane | Aluminium | 50 |
| GLUE | | | |
| | Dielectric | Kapton 12.5 µm | from 40 to 60 |
| GLUE | | | |
| Aluminium | Plane | Aluminium | 50 |
| Coverlay | Dielectric | GLUE | 12.5 |
| | | KAPTON | 12.5 |

1 2 Al

First prototype of stave with flex is being assembled in these days. Real stave, services, FEI4a modules.

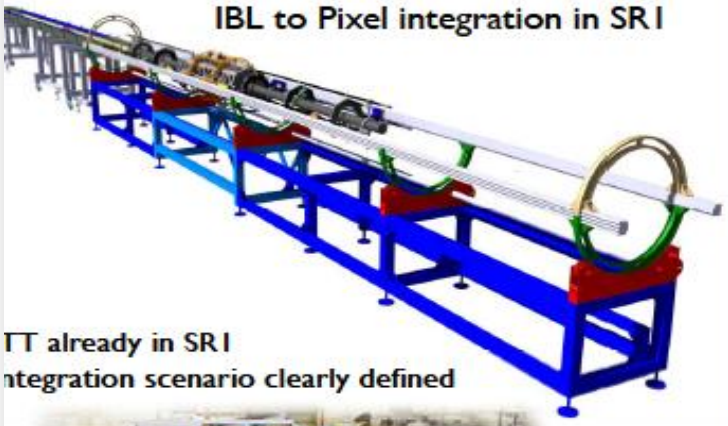
***Assembled stave PRR In July.***

# Installation

***Two viable options are investigated:***

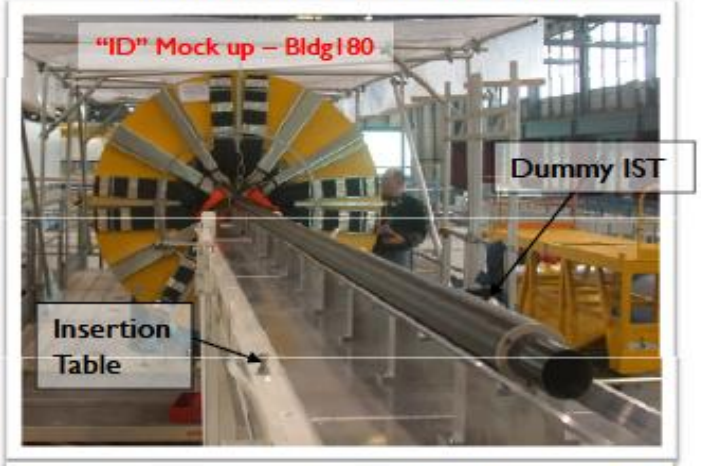
- IBL to Pixel integration in the surface building associated to nSQP installation
- IBL to ATLAS integration in the pit

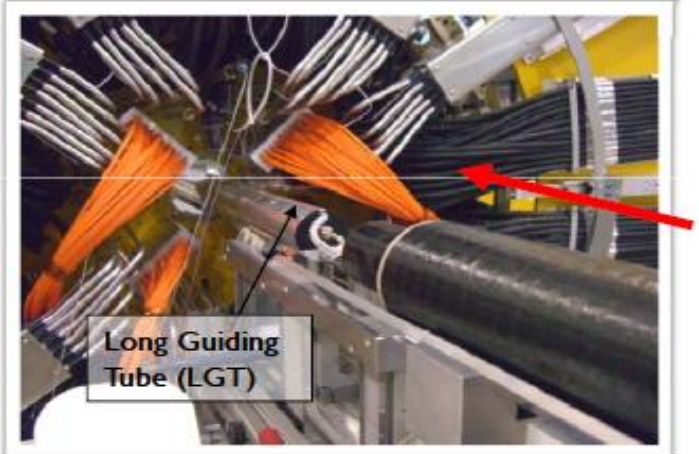
IBL to Pixel integration in SR1



TT already in SR1
ntegration scenario clearly defined

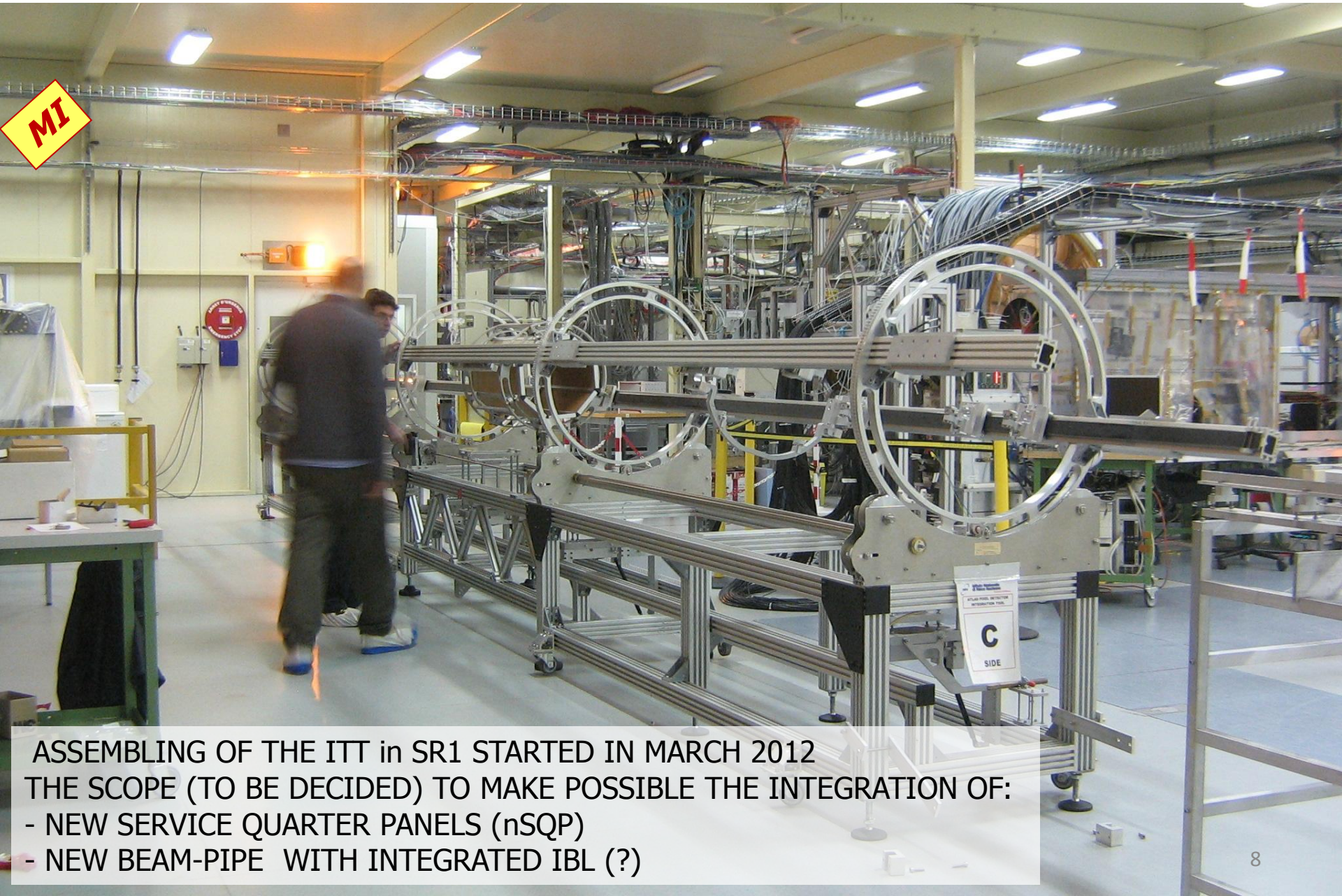

IBL to ATLAS integration in the pit




***Decision if to extract the Pixel package to change the services panels (nSQP) will be taken on 12-13 June review!***

# *ATLAS PIXEL DETECTOR INTEGRATION AND TESTING TOOL (ITT) MARCH 2012 SET-UP INTO CERN CLEAN ROOM SR-1*




ASSEMBLING OF THE ITT in SR1 STARTED IN MARCH 2012
THE SCOPE (TO BE DECIDED) TO MAKE POSSIBLE THE INTEGRATION OF:
- NEW SERVICE QUARTER PANELS (nSQP)
- NEW BEAM-PIPE WITH INTEGRATED IBL (?)

# PP2

Milano

- ✓ The PP2 crate overall "concept" is kept from the Pixel Detector. The IBL PP2 crate is logically divided in two parts:
  - The voltage regulation (VDD and VVDC)
  - The patch panel for HV (NEW wrt to Pixel) and DCS
- ✓ Most of the electrical boards of which the crate is made are re-designed towards an IBL optimization
  - INPUT Board
  - Output ("BUS") Board
  - Regulator cards (motherboard and daughterboard)

  → Prototyping Fall 2012, production late 2012/Early 2013
- ✓ The PP2 Control Board (FPGA and ELMB based) stay the same. The ST voltage regulators are used for the IBL regulator boards..
- ✓ In discussion possible splitting of LV power supply to multiplicity 1 instead of 7.

# ROD

Bo/Ge

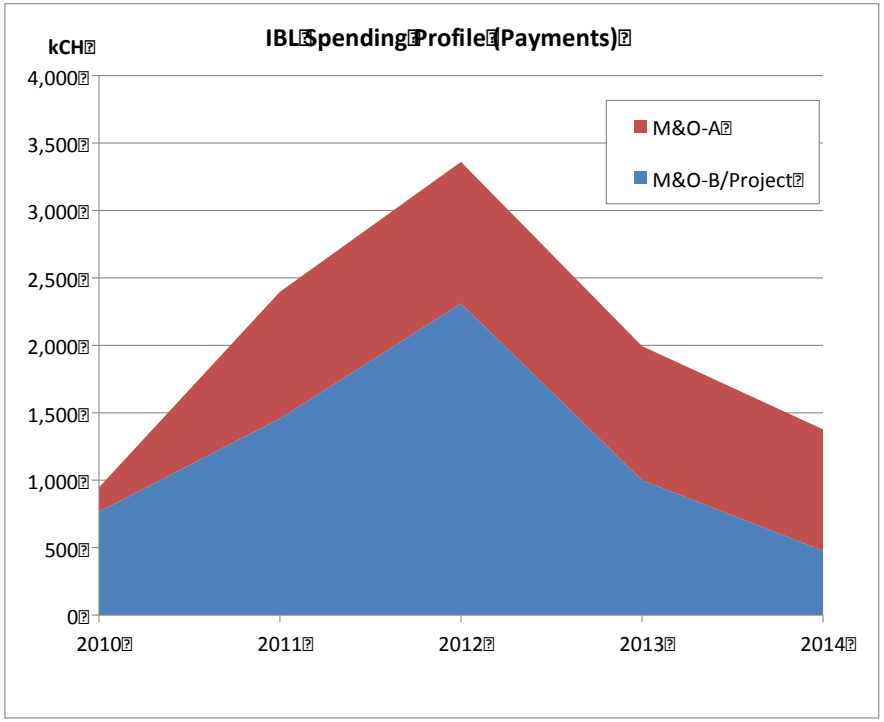
- ✓ Prototypes:
  - ROD minor problems on the first batch are now fixed on the second batch of 5 boards (Bo),
  - Current batch of 5 boards have been designed and extensively tested (Bo): till now these tests are OK,
  - To allow a parallel ROD firmware development , 3 boards have been temporarily shipped to Wuppertal, Mannheim and Goettingen,
  - Setting up a complete data acquisition system: on-detector electronics, optolink , formatting, histo → ready by end of June in SR1 at Cern with boards from Germany.
  - Next production foreseen by Summer.
- ✓ Studying ROD compatibility

With other systems. To be investigated:

- - Diamond Beam Monitor
- - ATLAS Forward Physics
- - Other ATLAS pixel/SCT layers

# MoU – Spending Profile (annex 5)

- ✓ Definite MoU
  - spending profile considers speed-up IBL schedule
  - 2012 value matches CERN-RRB-2012-028 Table 2 (24 April 2012)
  - Note: spending profile does not matches




**IBL Payment Profile**

| | 2010 | 2011 | 2012 | 2013 | 2014 | Total |
|---|---|---|---|---|---|---|
| **M&O-A** | 180 | 940 | 1 050 | 995 | 900 | 4 065 |
| **M&O-B/Project** | 767 | 1 457 | 2 310 | 1 000 | 478 | 6 012 |
| **Total including DBM** | 947 | 2 397 | 3 360 | 1 995 | 1 378 | 10 077 |

# *Finanziamenti 2012-13*

- ✓ Mancano le coperture delle pledges (debiti CERN) e il resto dei MOF-A
  - MOF-A mancanti: 126 kCHF (354 totale -228 ass. 2011)
  - Pledges: 230 kCHF (55+15 FEI4B + 60 Bump bonding +100 sensori)
- ✓ Alcuni extra costi:
  - PP2 (ass. 30) e Stave Flex (ass. 40), stima dei costi on-going. Stave (già finanziato). Verifica se possono essere coperti da risparmi su altre voci.
  - Per i referee della CSN1 il progetto (a parte quanto sopra) è (quasi) completamente finanziato.
  - Su ROD, PP2, HV/LV PS ci aspettiamo contributo da istituti DBM (da quantificare).

| Anno | | sez | cap | finanza | | | | tipologia (MoU) | descrizione |
|---|---|---|---|---|---|---|---|---|---|
| | | | | ric | ric-sj | ass | ass-sj | | |
| 2012 | Sep-11 | BO | con | 5 | | 5 | | A1.6 | schede demo e componenti |
| 2012 | Sep-11 | BO | inv | 4 | | 4 | | A1.6 | 2 PC linux |
| 2012 | Sep-11 | BO | app | 150 | | 150 | | A1.6 | produzione 20 schede ROD |
| 2012 | Sep-11 | GE | app | 55 | | | | A1.2 | Produzione FEI4-B (12%) - ANTICPO DAL CERN |
| 2012 | Sep-11 | GE | app | | 15 | | | A1.2 | Produzione FEI4-B (12%) batch aggiuntivo - ANTICPO DAL CERN |
| 2012 | Sep-11 | GE | app | 95 | | 95 | | A1.7 (MOF-A) | HV power supply - riconosciuto come MOF-A |
| 2012 | Sep-11 | GE | app | 40 | | 40 | | A1.8 (MOF-A) | Infrastruttura DAQ per System Test - riconosciuto come MOF-A |
| 2012 | Sep-11 | GE | app | 25 | | 25 | | A1.5 | Produzione moduli |
| 2012 | Sep-11 | GE | app | 40 | | 40 | | A1.5 | Produzione FLEX |
| 2012 | Sep-11 | MI | con | 5 | | 5 | | A1.6 | USB pix per lettura multimoduli |
| 2012 | Sep-11 | MI | app | 30 | | 30 | | A1.6 | crate PP2 e preproduzione 10 schede |
| 2012 | Sep-11 | MI | app | 55 | | 55 | | A1.7 (MOF-A) | LV Power Supply - riconosciuto come MOF-A |
| 2012 | Sep-11 | MI | con | 30 | | 30 | | A1.4 | extra costi stave production |
| 2012 | Sep-11 | MI | con | 90 | | 30 | | A1.3 | bump bonding - 60 kEu ANTICIPO DAL CERN |
| 2012 | Sep-11 | UD | con | 100 | | | | A1.1 | produzone sensori - ANTICPO DAL CERN |
| 2012 | Sep-11 | TN | con | 4 | | 4 | | A1.1 | probe card |
| **2112** | | **SUM** | | **728** | **15** | **513** | **0** | | |

# *Richieste ME 2013*

- ✓ Pixel
  - Consolidation of the services
  - Integration of 4° layer in the software
  - Much more work if Pixel is bring on surface. But no direct involvement for the Italian groups.

FTE: ~12 mesi

- ✓ IBL
  - follow up delle delivery dai laboratory, moduli e flex.
  - integrazione del detector in Geneva (moduli su stave) e poi Cern (stave attorno alla beam pipe, connessione ai servizi elettrici e raffreddamento)
  - electrical, mechanical test in superficie
  - stretta collaborazione BO-GE per lo sviluppo SW-HW per l'integrazione nuovi ROD nel sistema di DAQ
  - Preparazione nel pozzo all'inserimento + installazione nuovi servizi (PP2)

FTE: ~18-24 mesi

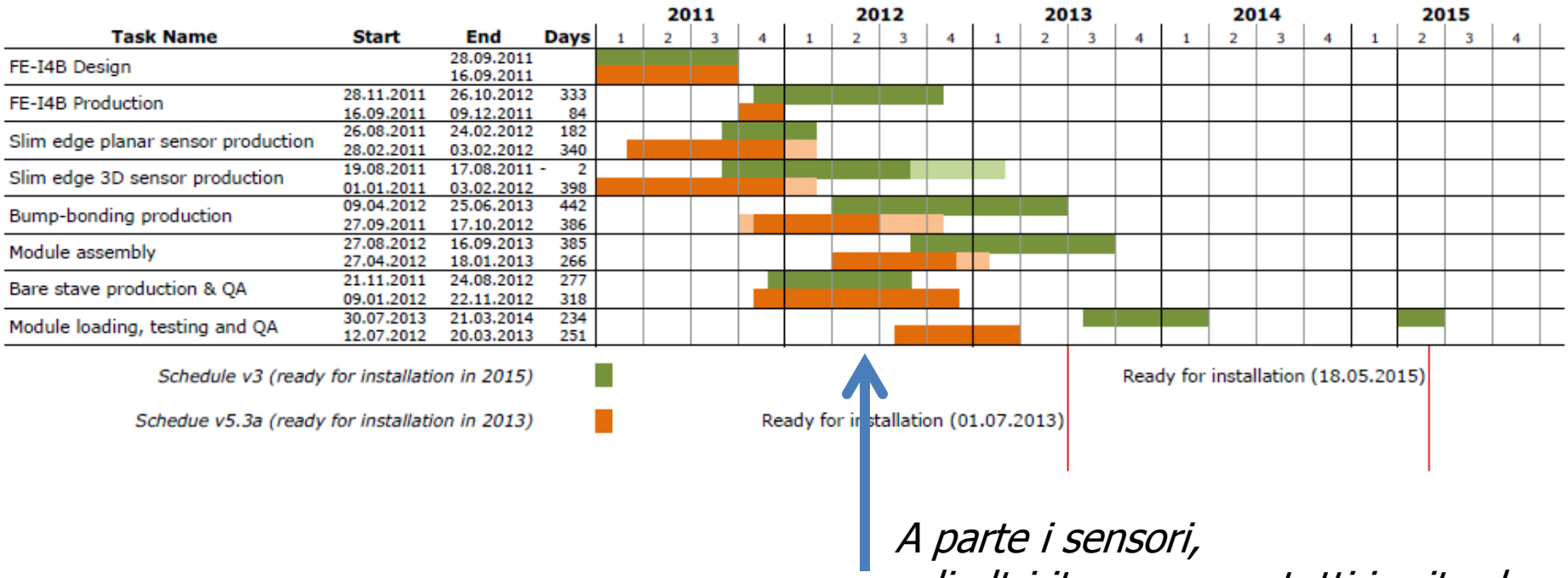
# AoB

- ✓ Addendum to *ATLAS IBL TDR of September 2010* just out:
  - https://edms.cern.ch/document/1217596/1.6
  - Covering the accelerated schedule, sensors mixed scenario, the module flex, Stave integration, the beam diamond telescope.
  - ATLAS Approval and send to LHCC in June
- ✓ First Paper out for comments on CDS: Prototype ATLAS IBL Modules using the FE-I4A Front-End Readout Chip
  - http://cdsweb.cern.ch/record/1447066

# Spares

# Schedule

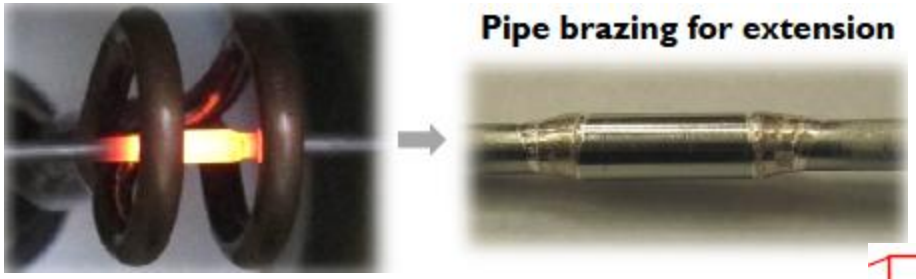
- ✓ New schedule is being updated in these days. Pixel package extraction for services replacement could have an impact on it.

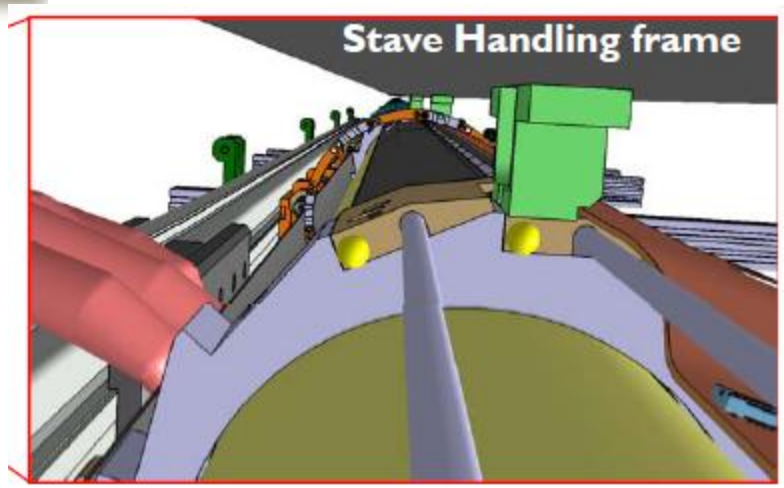



*A parte i sensori,*
*gli altri item sono ~ tutti in ritardo*

# Stave Integration

- ✓ Modules loaded in Geneva, wirebonded to the flex wings and fully qualified.
- ✓ Once staves are ready integration of the cooling pipes is done at Cern and arrangement of the staves around the beampipe is done.

# MoU & RRB Tables

- ✓ Payment table (CERN-RRB-2012-028)
  - Recognized 475 kCHF till 2011
  - For 2012 expected 407 kCHF (of which 220kCHF from open commitments)

| Project (FA) | Contributions: plan 2012 | | | | |
|---|---|---|---|---|---|
| | 2010-11 kCHF | 2012-tot kCHF | 2010-12 kCHF | MoU ref. kCHF | % |
| Canada | 40 | 52 | 92 | 100 | 91.5 |
| Czech Republic | 27 | 0 | 28 | 27 | 101.7 |
| France IN2P3 | 316 | 140 | 456 | 576 | 79.2 |
| Germany BMBF | 467 | 450 | 917 | 1 225 | 74.9 |
| Germany DESY | - | 50 | 50 | 72 | 69.1 |
| Germany MPI | 11 | - | 11 | - | |
| **Italy** | **475** | **407** | **882** | **1 047** | **84.3** |
| Japan | - | 71 | 71 | 92 | 76.9 |
| Netherlands | 172 | 23 | 195 | 211 | 92.5 |
| Norway | 12 | 57 | 69 | 73 | 95.3 |
| Slovenia | 65 | 30 | 95 | 88 | 108.5 |
| Spain | - | 108 | 108 | 132 | 81.6 |
| Switzerland | 210 | 260 | 470 | 830 | 56.6 |
| Taipei | - | - | - | 41 | - |
| United Kingdom | 14 | 93 | 106 | 106 | 100.0 |
| US DOE & NSF | 303 | 320 | 622 | 846 | 73.6 |
| CERN | 111 | 249 | 360 | 546 | 66.0 |
| ***Total*** | ***2 223*** | ***2 310*** | ***4 533*** | ***6 012*** | ***75.4*** |