# Belle-II
# Stato e sblocchi 2014

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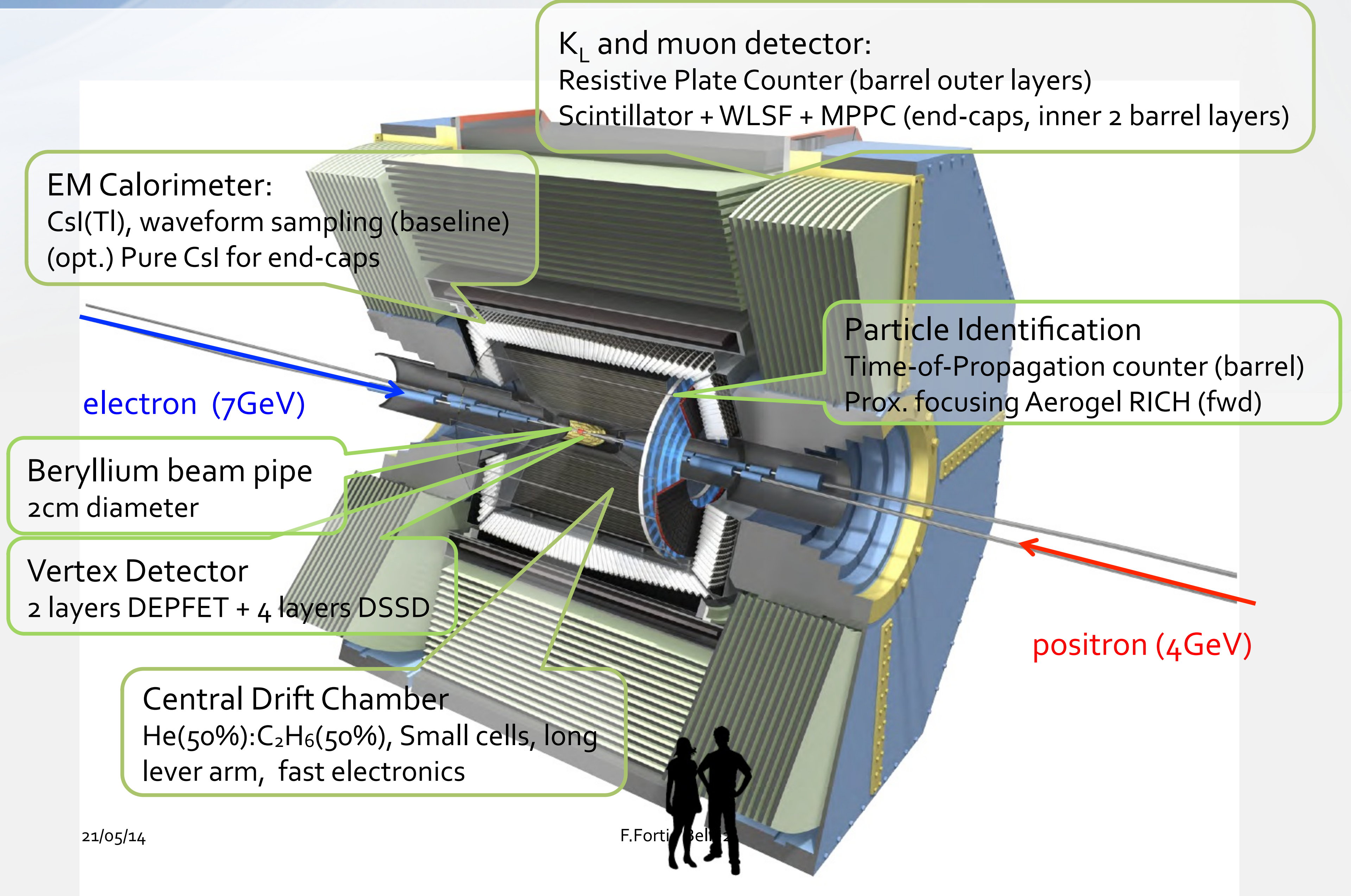
INFN e Università di Pisa
Commissione Scientifica Nazionale 1
La Biodola, 21 maggio 2014

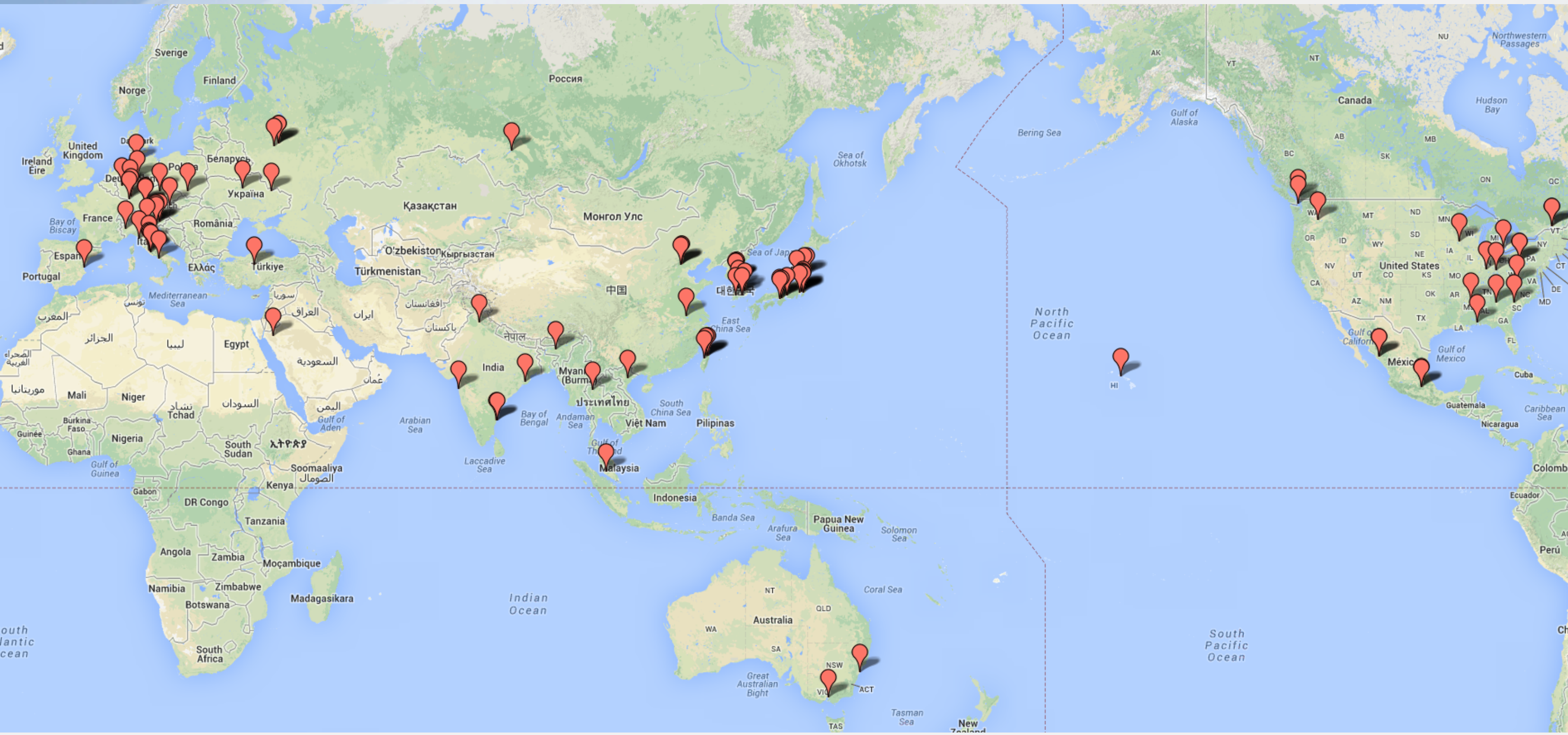
# Outline

- Stato di Belle-II / SuperKEKB
- Collaborazione italiana e attività 2014
- Piano del calcolo
- Richieste sblocchi 2014
- Conclusioni

# Belle II Detector



# Belle II Collaboration




20 countries/regions, 70 institutions, 459 collaborators
+1 country, 6 institutions in March 2013
+2 countries, 18 institutions in July 2013
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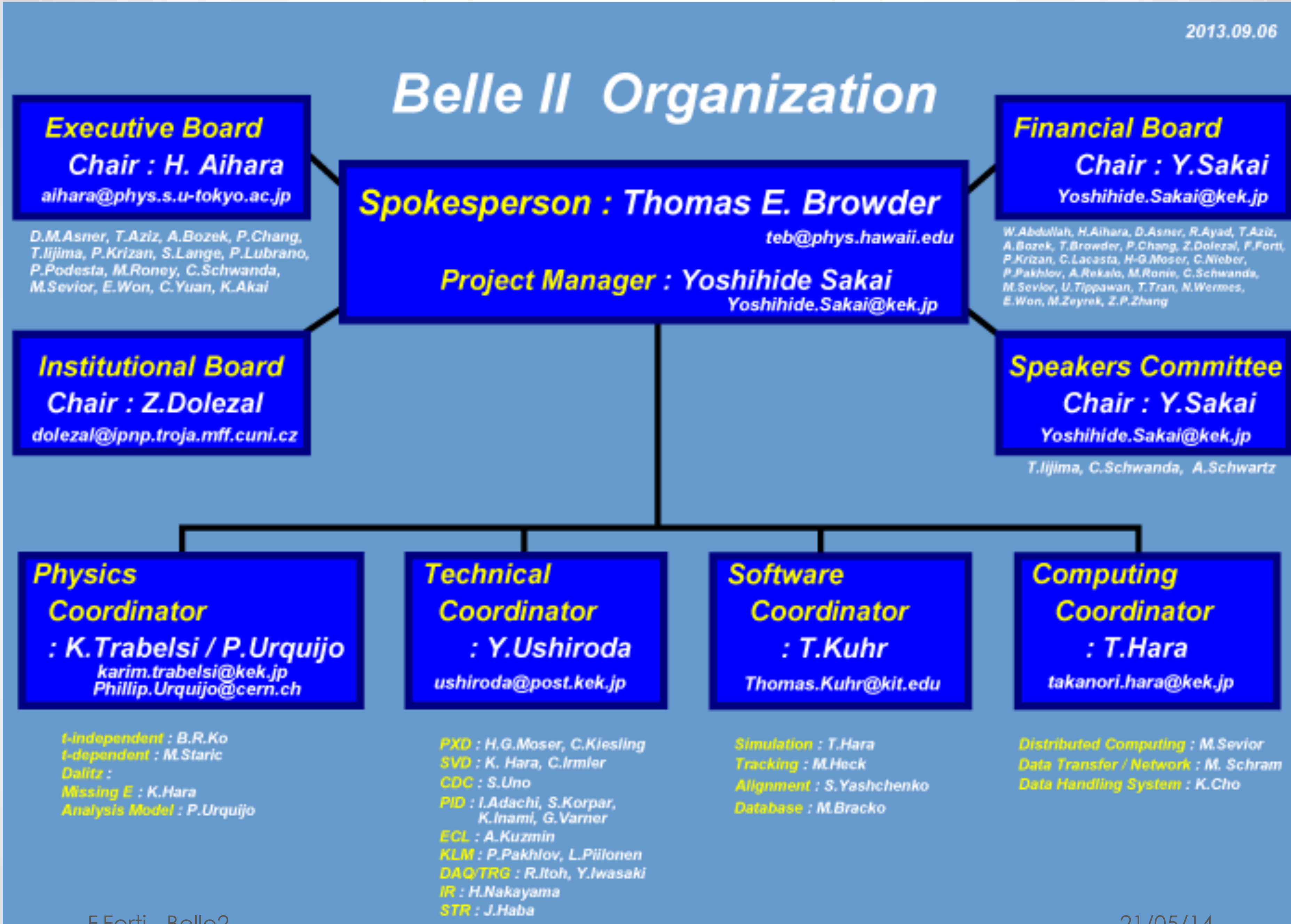
23 countries/regions, 94 institutions, >518 collaborators


2013.09.06
Belle II Organization
Executive Board
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D.M.Asner, T.Aziz, A.Bozek, P.Chang, T.Iijima, P.Krizan, S.Lange, P.Lubrano, P.Podesta, M.Roney, C.Schwanda, M.Sevior, E.Won, C.Yuan, K.Akai
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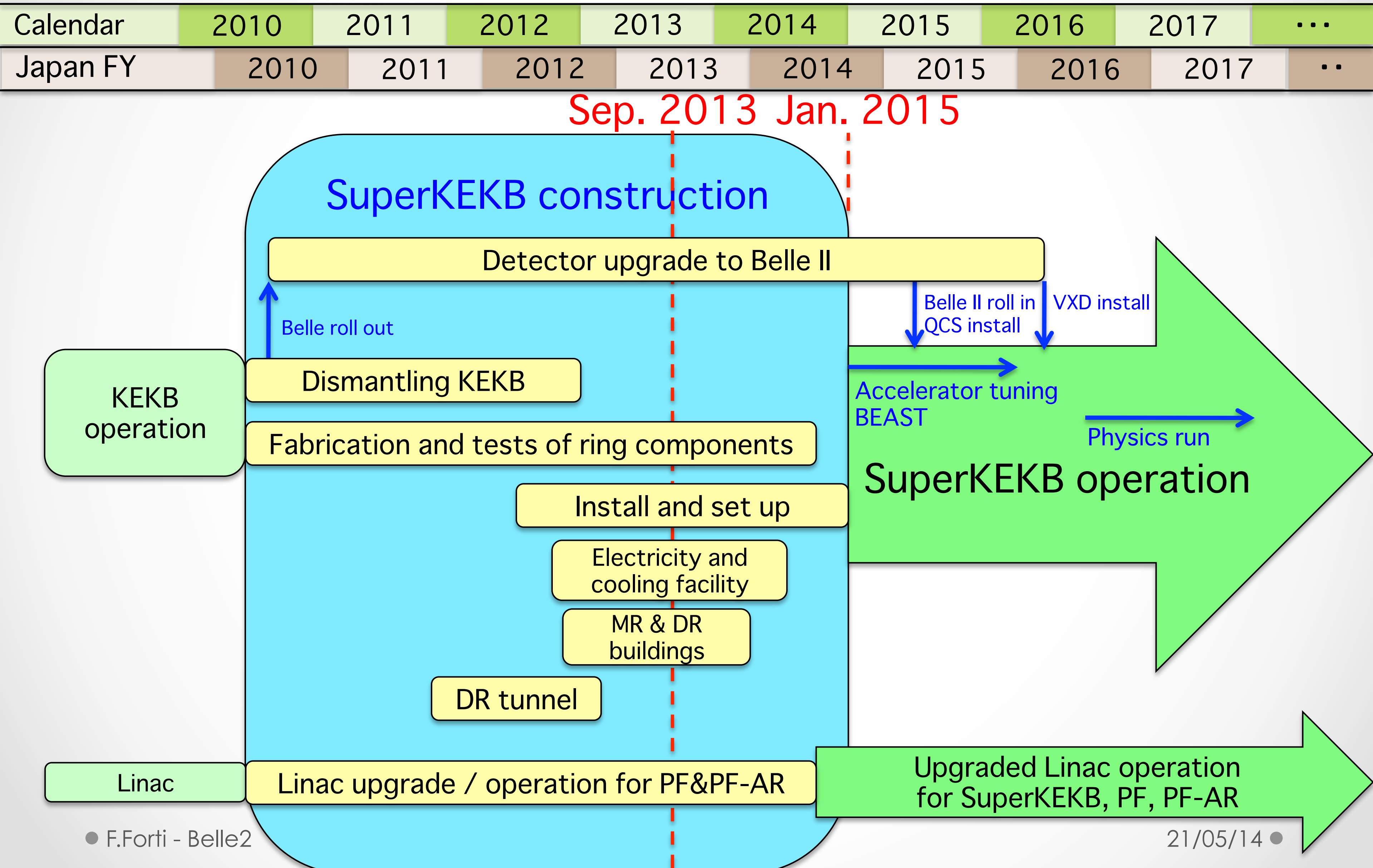
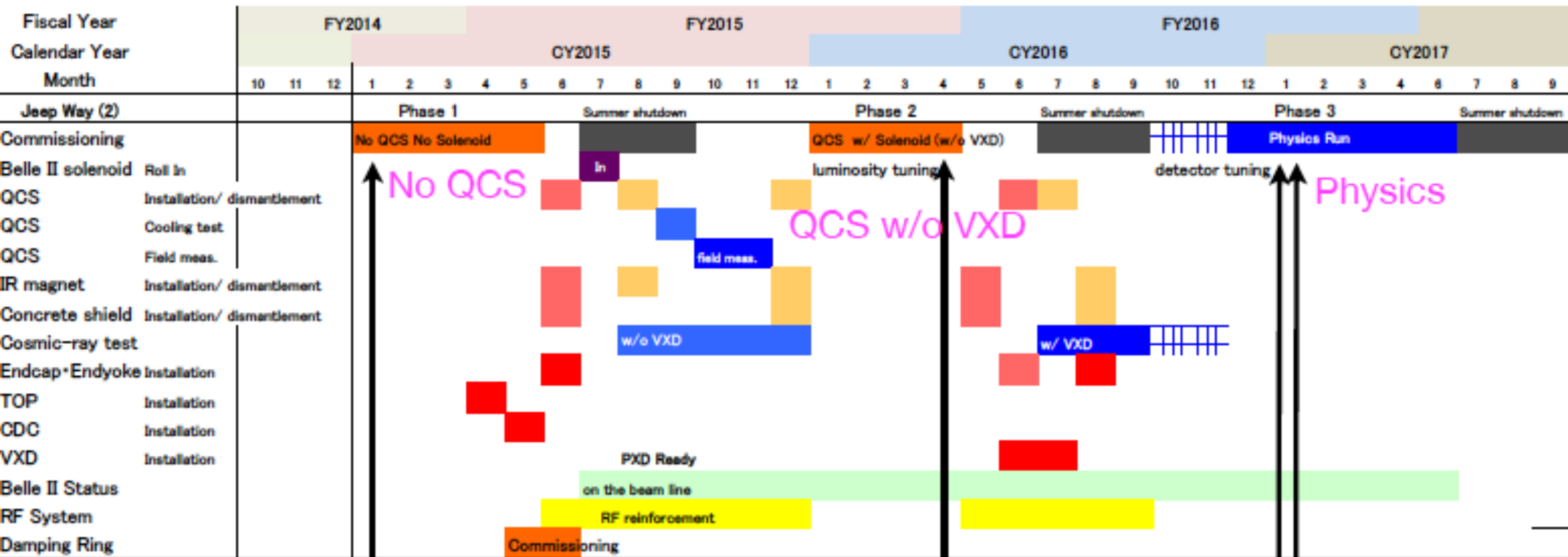
Dalitz :
Missing E : K.Hara
Analysis Model : P.Urquijo
PXD : H.G.Moser, C.Kiesling
SVD : K. Hara, C.Irmler
CDC : S.Uno
PID : I.Adachi, S.Korpar, K.Inami, G.Varner
ECL : A.Kuzmin
KLM : P.Pakhlov, L.Piilonen
DAQ/TRG : R.Itoh, Y.Iwasaki
IR : H.Nakayama
STR : J.Haba
Simulation : T.Hara
Tracking : M.Heck
Alignment : S.Yashchenko
Database : M.Bracko
Distributed Computing : M.Sevior
Data Transfer / Network : M. Schram
Data Handling System : K.Cho

# SuperKEKB/Belle II schedule



# Commissioning Schedule: Baseline




***Phase-1***

Target: > 500 mA

**Positron injection w/o Damping Ring.**

**Vacuum scrubbing**
**Optics tuning**
Detector background

***Phase-2***

Target: $10^{34}$ $cm^{-2}s^{-1}$

**Detuned: 10 x nominal β***
**Squeezing β* gradually**

**Optics tuning**
**Detector background**
Increase currents

# Partecipazione Italiana

- Gruppi italiani perfettamente inseriti nella collaborazione.
- Ruoli di coordinamento
  - Gruppi di fisica
  - Reconstruction
- SVD, TOP, ECL
  - Assunzione di responsabilita' specifiche

## Physics Groups

| | |
|---|---|
| Semileptonic and Missing Energy Decay WG | Anze Zupanc, Guglielmo De Nardo |
| Electroweak Penguin WG | Akimasa Ishikawa, XXX |
| Time Dependent CP Violation WG | Takeo Higuchi, XXX |
| Hadronic B Decay WG | Jim Libby, Pablo Goldenzweig |
| Y(nS) WG | Roman Mizuk, XXX |
| Charm and Charmonium WG | Roy Briere, Giulia Casarosa |
| Tau and Low Multiplicity WG | Kiyoshi Hayasaka, XXX |

## Reconstruction Contacts

| | |
|---|---|
| Tracking | Eugenio Paoloni |
| ECL | Kenkichi Miyabayashi |
| Electron ID | Guglielmo De Nardo |
| Muon ID | Leo Piilonen |
| K/pi/p ID | Marko Staric |
| K long ID | Timofey Uglov |
| V0 (K_S, Photon conversions) | Kazutaka Sumisawa |

# Status SuperKEKB e Belle-II

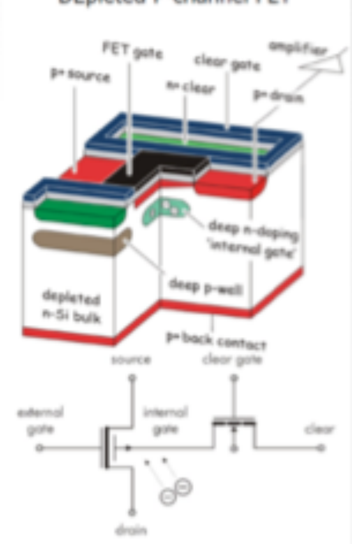
- Costruzione sta andando avanti come previsto
  - Installazione magneti SuperKEKB on schedule
  - Test beam congiunto PXD-SVD
  - Filatura della camera completata
  - PID passato CD2-3
  - Refurbishing ECL avanzato
- Possibili problemi
  - Simulazioni background updatate sembrano mostrare situazioni problematiche
    - In corso una valutazione dell'impatto della riduzione di B
  - Operation budget per accendere la macchina nel 2015 problematico
    - forte azione di KEK, **ma senza successo (notizia di ieri)**
  - Vari sistemi sul critical path:
    - Produzione sensori DEPFET PXD
    - Assemblaggio SVD
    - Produzione e assemblaggio TOP
    - Software

Impatto grosso, tra 4 e 12 mesi sull'inizio della presa dati, in fase di valutazione ed ottimizzazione:

# Vertex Detector

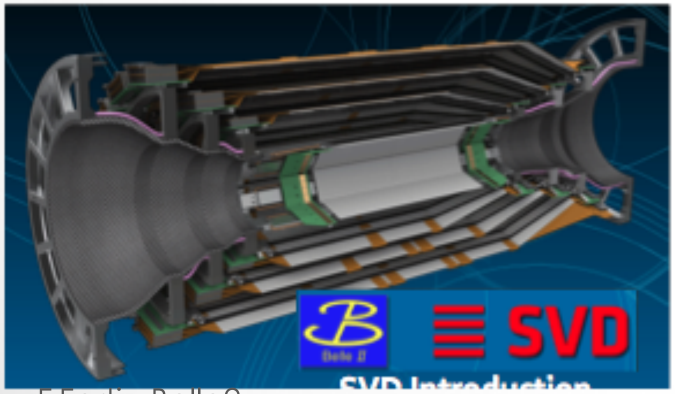
- **Pixel Detector (PXD)** – 8M pixels
  - 2 DEPFET layers at r = 14, 22 mm
  - Excellent and unambiguous spatial resolution (~15 μm)
  - Coarse time resolution (20 μs)

Mechanical mockup of pixel detector

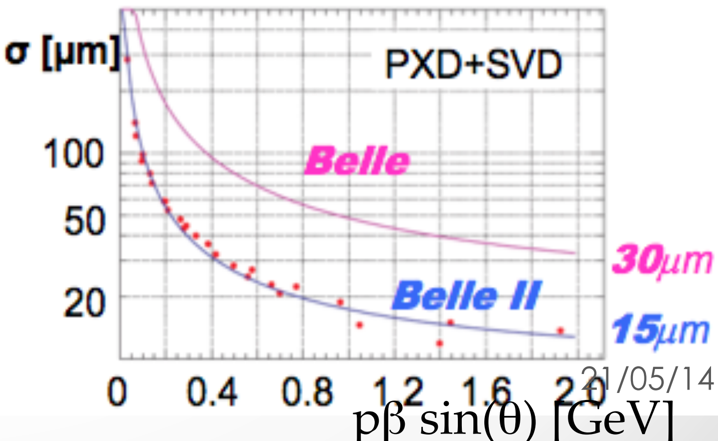


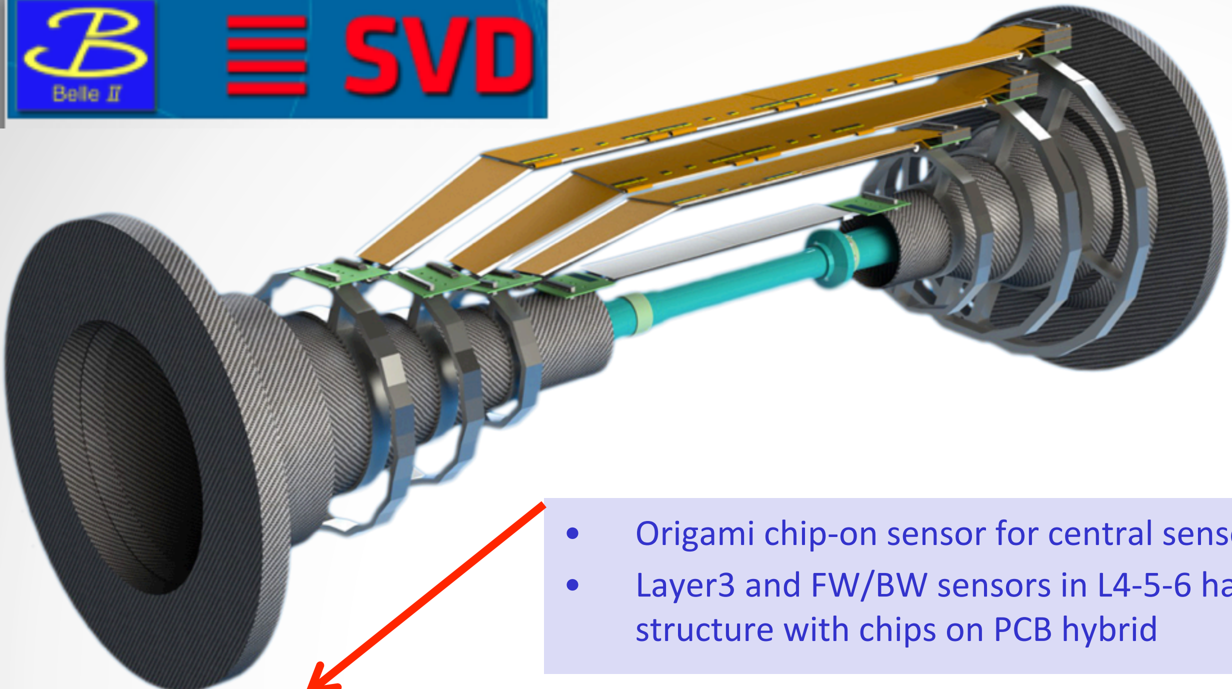

- **Silicon Vertex Detector (SVD)** – 220k strips
  - 4 DSSD layers at r = 38, 80, 104, 135 mm
  - Good spatial resolution (~12/25 μm) but ambiguities due to ghosting
  - Excellent time resolution (~3 ns)

Combining both parts yields a very powerful device!




Significant improvement in z-vertex resolution



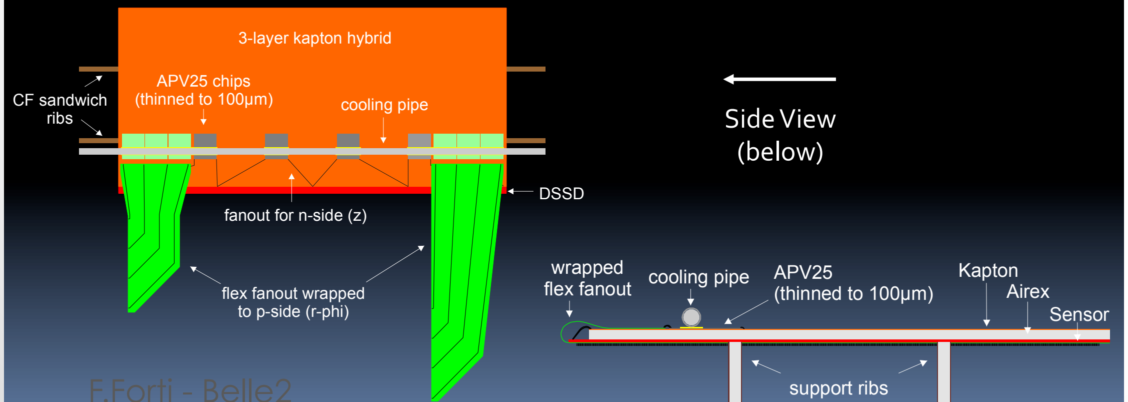


- 4 layers with silicon strips (DSSD) with APV25 read out
- Individual sensors connected to APV25 chips, to reduce capacitive load

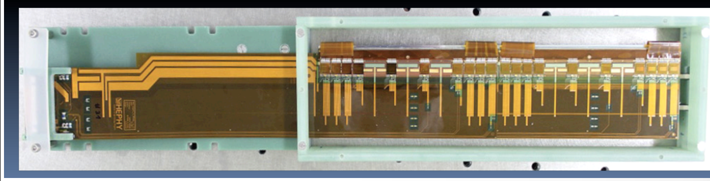
- Origami chip-on sensor for central sensors in L4-5-6
- Layer3 and FW/BW sensors in L4-5-6 have more conventional structure with chips on PCB hybrid

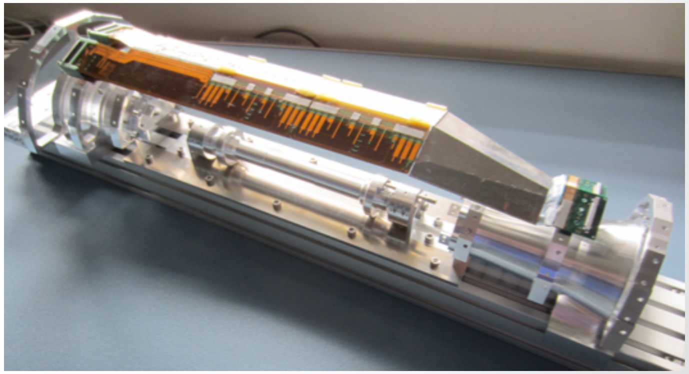
## Origami Chip-on-Sensor Concept

- Low-mass double-sided readout
- Flex fanout pieces wrapped to opposite side
- All chips aligned on one side → single cooling pipe (D = 1.6 mm)

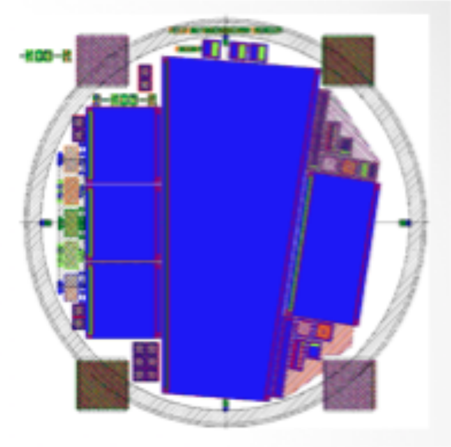



- Double Origami module



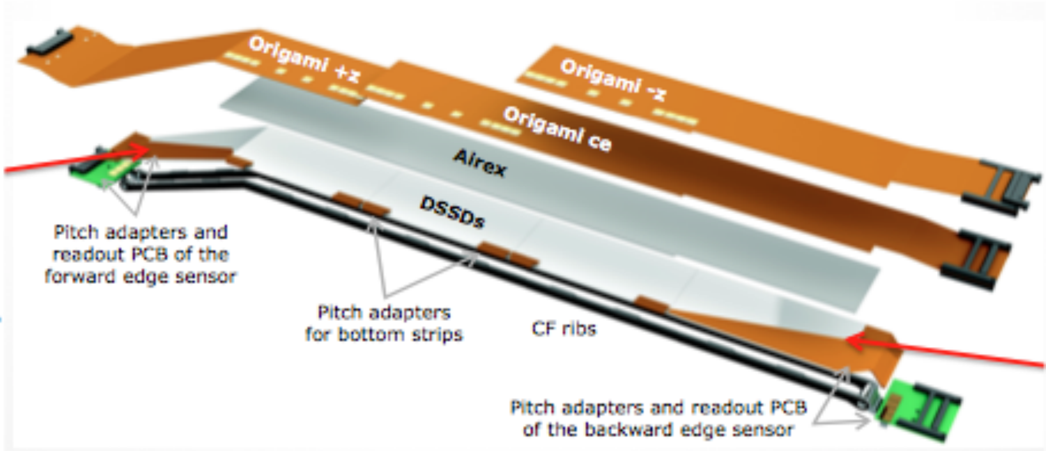


# Vertex Detector (PXD+SVD)



## Trieste:

- Contribution to silicon detector testing (Micron)
- Environmental & Radiation Monitoring
  - Take advantage of development funded in SuperB for diamond detectors with fast remote readout




## Pisa:

- Contribution to assembly of strip detector modules:
  - On critical path
  - Assemble FW and BW sensors of Layer 4-5-6 & ship to other assembly sites (Vienna, IPMU-Tokyo, TATA at IPMU lab)

Replacement of the old Power-Supply

- SVD software development:
  - Si only tracking & PXD data reduction with ROI (region of interest) selection
  - Alignment

# Test on Micron and HPK DSSD

Bottleneck for the production was testing at Micron

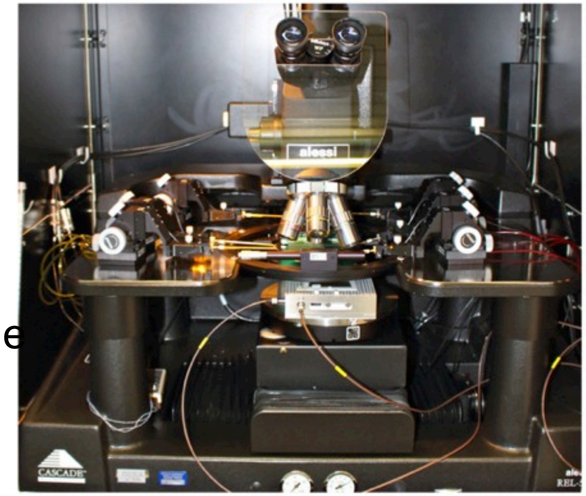
- **Trieste**/Vienna decided to take over these tests
- 3 pre-series and 15 (final prod.) tested
- 10 are under test now

Test from HPK not very clear/accurate (eg they didn't test n-side, list of defective strips)

- Trieste performed a detailed tests on 2 sensors, showing some problems (low inter-strip resistance, ect)
- HPK acknowledged our results

**Overall quality good in both cases**

Sensor testing set-up

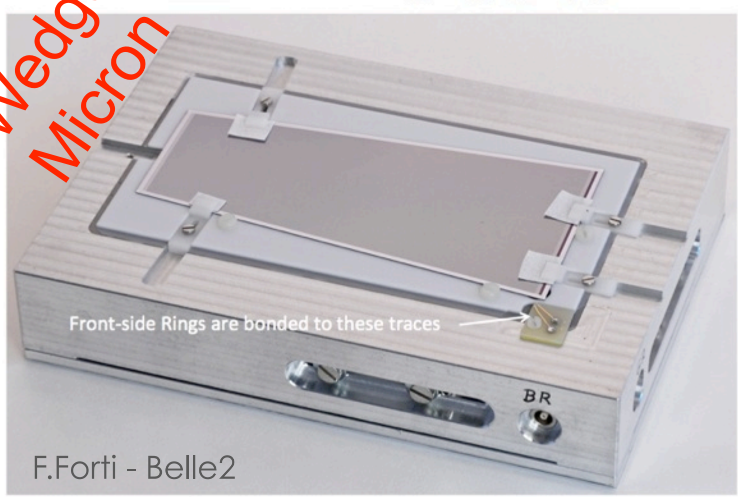



- Front and Back-side Rings are connected through cables
- Strips are contacted by a 40-needle Probe Card

5th Belle II PXD/SVD Workshop 23-01-2014 -- L. Bosisio - Test of Micron Trapezoidal Sensors

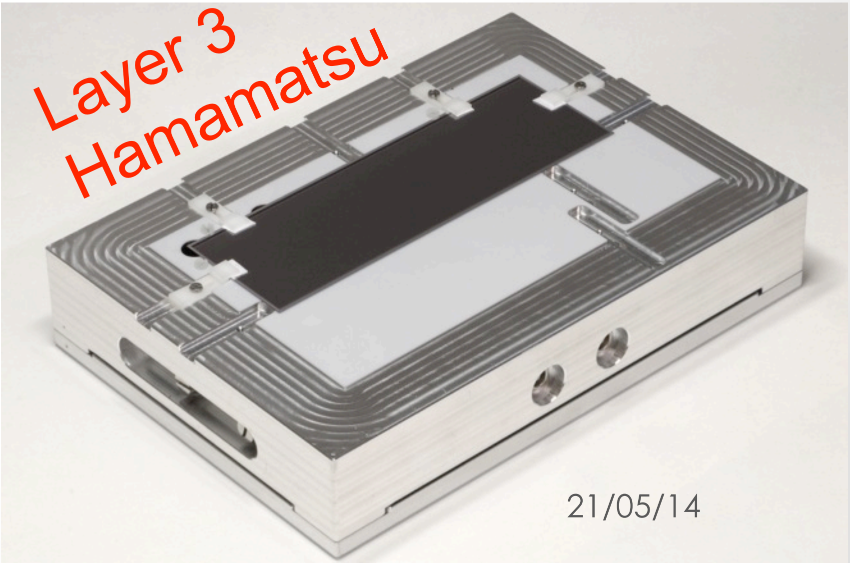
Sensor testing Jig (top)

Wedge Micron




5th Belle II PXD/SVD Workshop 23-01-2014 -- L. Bosisio - Test of Micron Trapezoidal Sensors 3

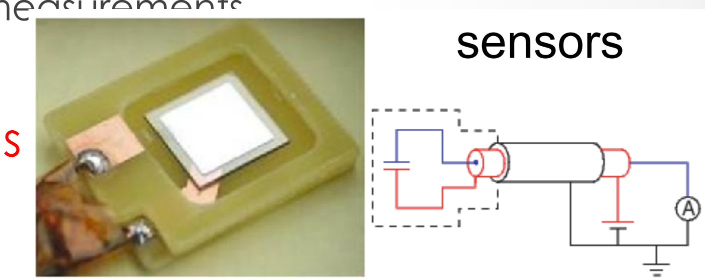
Layer 3 Hamamatsu



# Radiation Monitoring and Beam Abort

- A document with Requirements prepared
  - Measurement of instantaneous dose rates & integrated doses
    - sensitivity O(1 mrad/s), sampling rate O(100 KHz), etc
  - Beam Abort for excessive beam losses affecting PXD, SVD
    - "Fast" (10 $\mu$s), "slow" (ms - s) Beam Abort triggers with programmable thresholds
- Conceptual design based on experience from BaBar, Belle, CDF…
  - **Rad-hard Diamond sensors**, measurement of currents
    - Noise should be limited to a few pA, in current measurements
  - up to 4 + 4 sensors PXD-beam pipe
  - up to 8 + 8 sensors on SVD L3 support rings

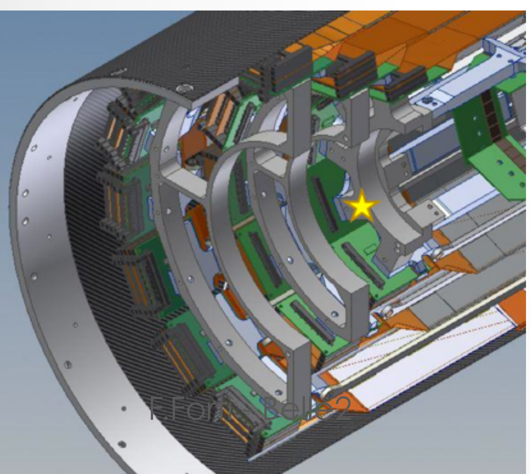
Shielded diamond sensors

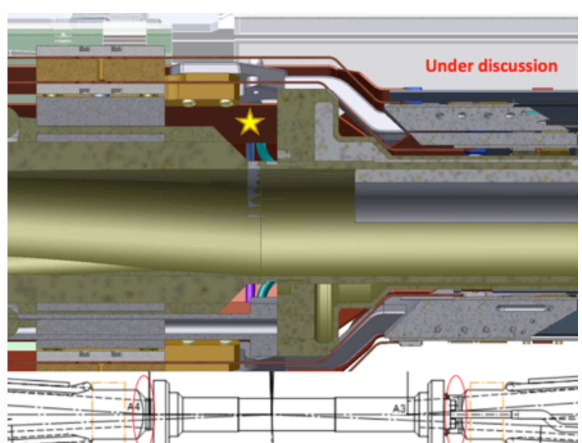


3+15 m (3+40 m) triax cables

Voltage sources (150÷500 V)

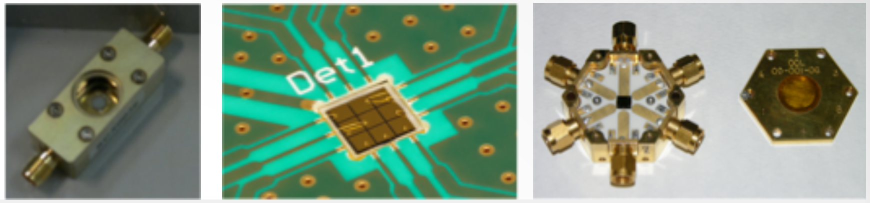
picoAmmeters

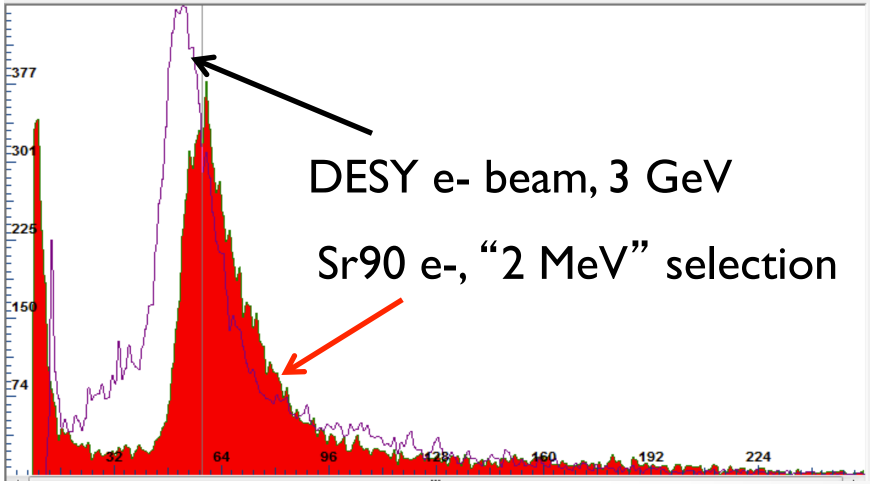


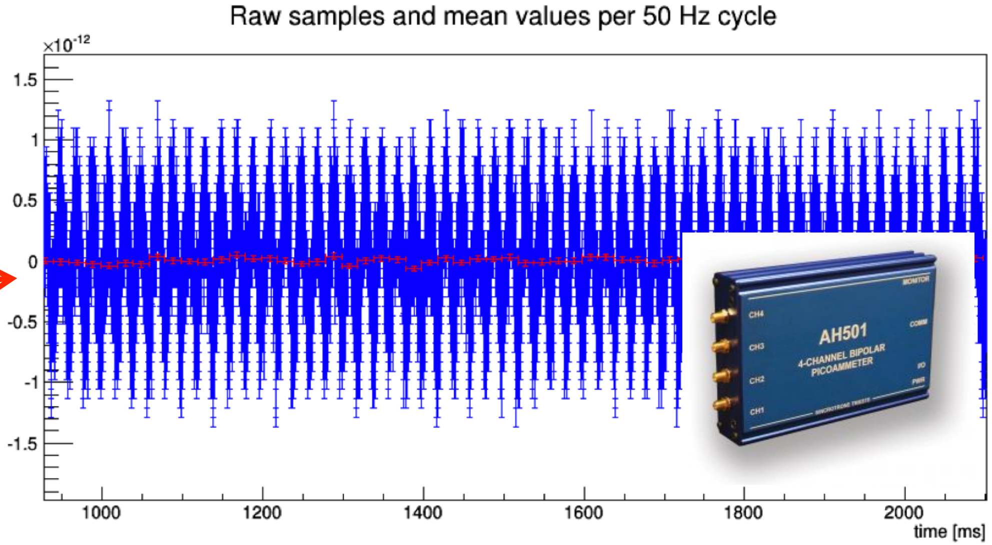


# Measurements

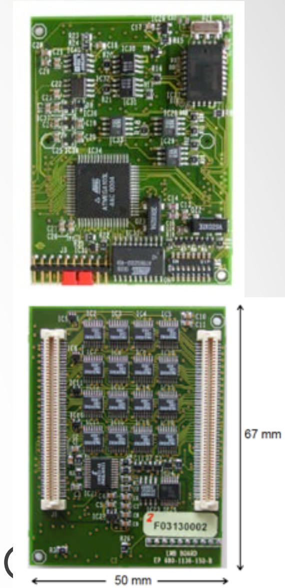
- 9 p/scCVD sensors
  - different types, vendors
  - charge collection efficiency with single particles
  - Beta source + beam test: MIPs
- Currents measurements for dosimetry and beam abort
  - collaboration with Elettra, Electronics Division
  - AH501 fast picoammeter
  - Noise measurements and optimization, different cables and grounding (a few pA level now)
  - Digital filtering studies
  - Agreement with Elettra: customization to increase sampling frequency, include Beam Abort and HV supply



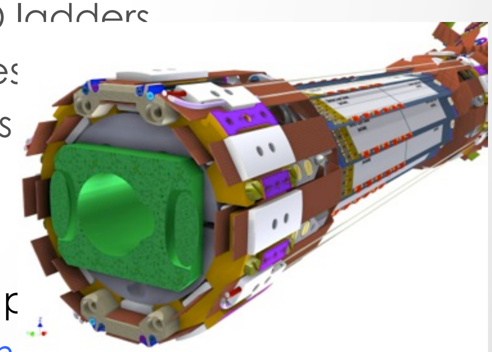



# Temperature and humidity




- Starting point: document of requirements
  - o Temperature monitoring:
    - near heat sources and at the inlets/outlets of $CO_2$ cooling pipes
    - about 1°C (0.1°C) absolute (relative) accuracy
  - o Interlocks on temperature and humidity (stand-alone, VXD)
    - Temperature above threshold, or dew point approaching -30°C
- Current activities and preliminary design
  - – Adopt rad-hard proven sensors and readout: borrowed from ( experts: ELMB board and Betatherm **NTC thermistors** for absolute T and *interlocks*
    - – 12 sensor pairs attached to the 12 half-rings supporting the SVD ladders
    - – 16 sensor pairs on the inlets and outlets of the $CO_2$ cooling pipes
    - – Under construction: 2 motherboards and 10 adapter mini-cards
  - o **Fiber Optical Sensors (FOS)** and laser interrogators
    - Based on Bragg grating reflection of specific wavelengths
    - One fiber can monitor stress, temperature, humidity at several p
    - PXD FOS R&D completed, successfully tested at the DESY beam test. One fiber per SVD ladder, can be inserted in the Airex foam, to measure temperature close to sensors and chips

New



  - o Humidity *interlock*: "**sniffers**" plus chilled mirror hygrometer outside

# SVD construction: the option "P" viability

- Build the L4-5-6 BW and FW assembly (i.e. glue the PA to det's and hybrids and u-bonding) and do their electrical characterization.

Review FW/BW Assembly Procedures & updates on jigs status, gluing & bonding tests, teststand.

- Safely shipment of the BW/FW assemblies to ladder production sites and sustain a proper production rate

Multi Purpose jig designed for shipment (bonding & testing during assembly in Pisa).

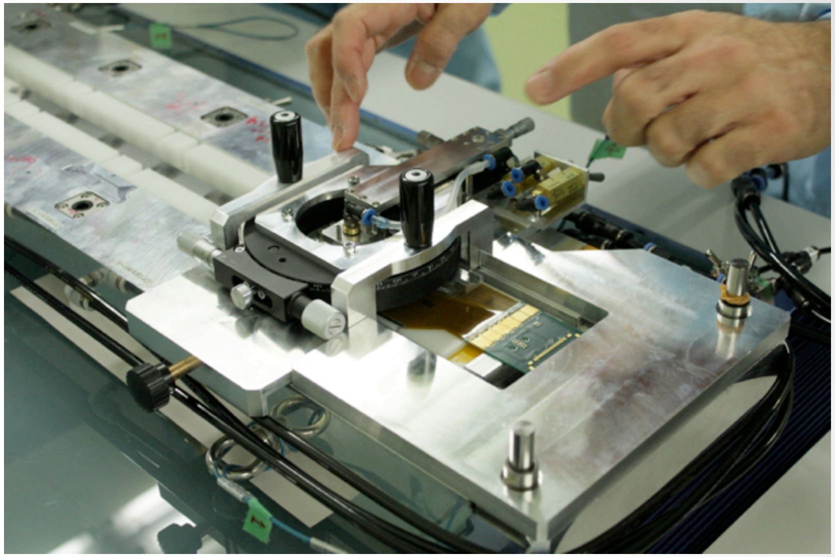
- Align the BW/FW on the assembly bench(es) and go back in stream with the original procedures

Modified xyz-θ stage built to safely align the BW/FW subassembly with the other detectors on the bench masks

At the last (Feb.) B2GM the SVD group decided that the option "P" becomes the baseline for the module prodution.

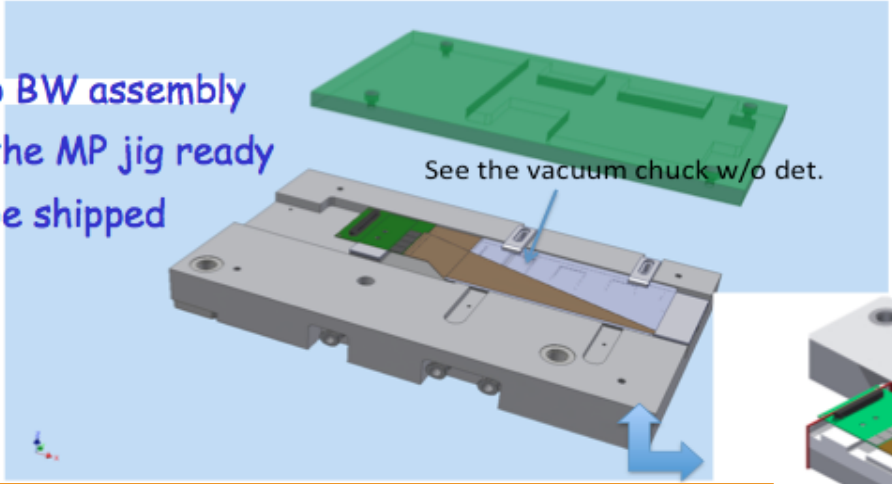
# Successful xyzθ stage test @ IPMU

- Succesful test done during the B2GM at IPMU to check the functionality of the jig on the real ladder bench mask and look for possible interference.
  1. Test angle alignment capability
  2. Test capability of positioning to nominal position
  3. Test position when assembly is

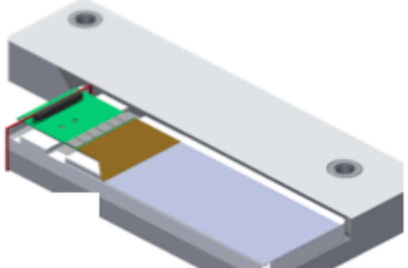


## Multi Purpose jig

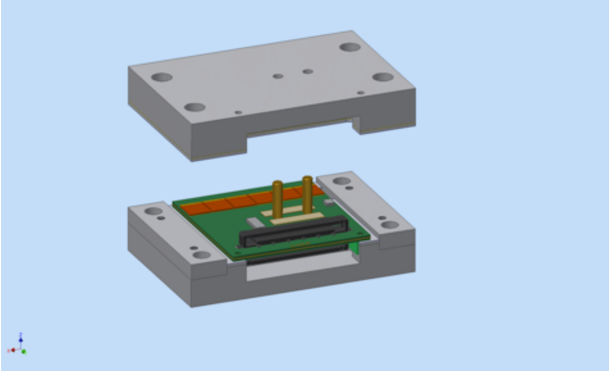
Z-up BW assembly
On the MP jig ready
To be shipped




To be used with PB2 chuck to take the BW assembly and place tha the assembly bench

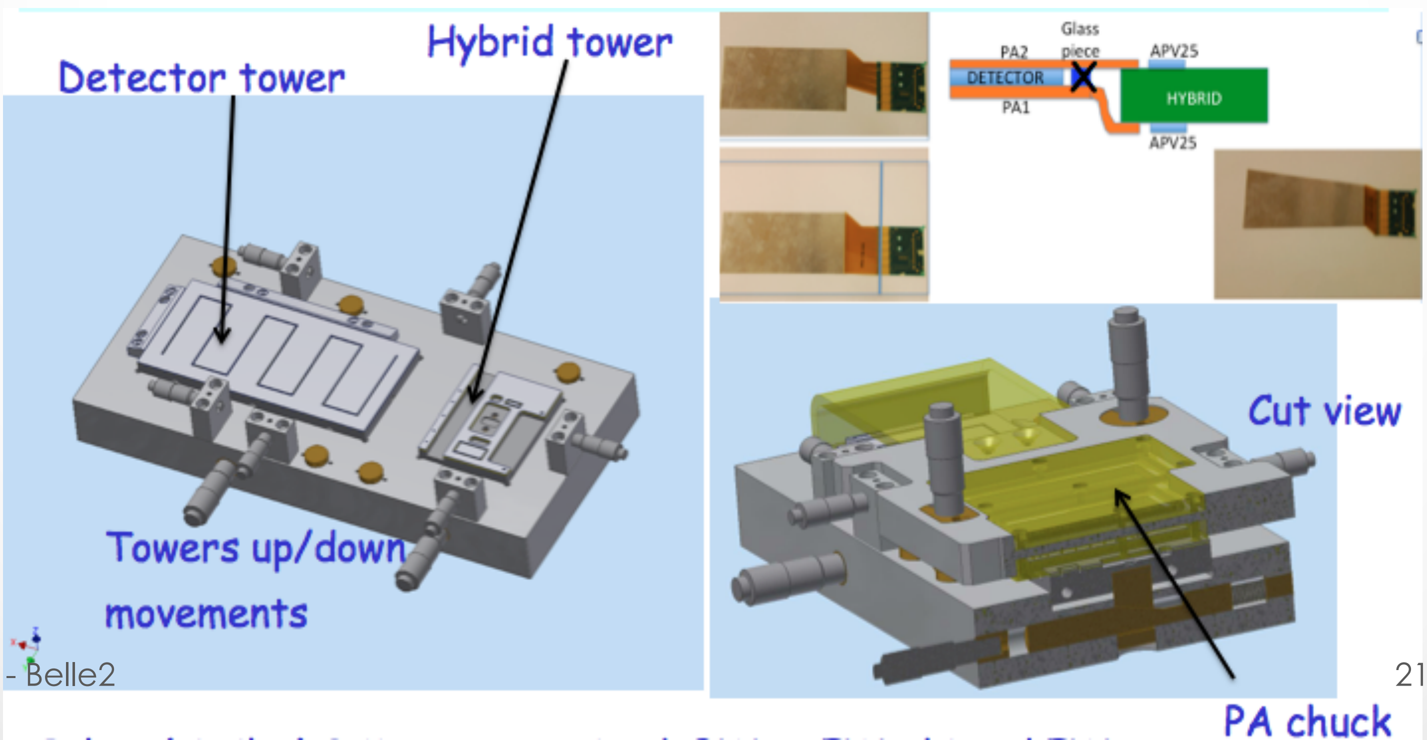


## Hybrid gluing chuck



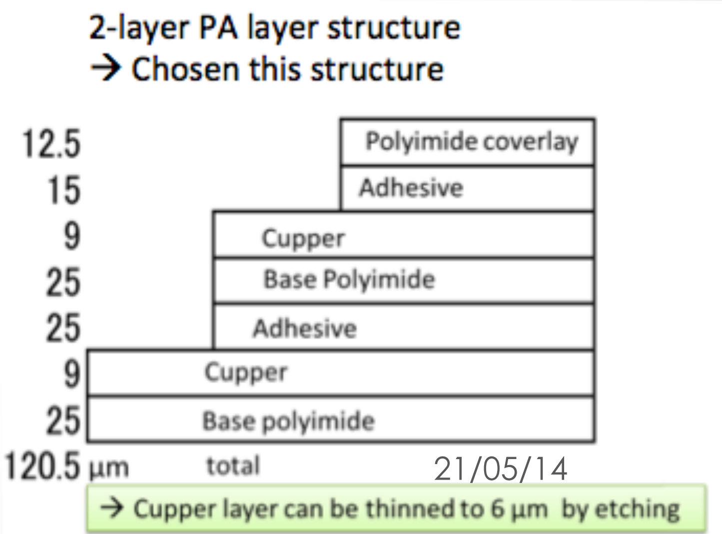
# The final det/PA/hybrid gluing jigs

- The detector/PA design implied some gluing difficulties:
  - Very small overlap between PA and det's on phy side (1.3 mm)
  - Also small overlap between PA and hybrid (3.2 mm)
  - PA pads very close to the boundary
- To cope with all these aspects, extensive gluing test performed and many critical aspects identified → a very complex gluing jig has been designed, submitted in production and delivery confirmed in mid-may.



# Un problema sui PA: soluzioni

- Da Nov. scorso individuati (Pisa) problemi sulle larghezza (<30 um) delle pads dei PAs (specialmente zona vs chip: 44 um pitch).
- Sono state rivisti i requirements, fatte varie serie di prototipi sottoponendoli a test di bonding. Esito negativo: o cattiva bondabilita' oppure bassissimo yield (→no good for production!)
- Ad oggi le soluzioni messe in campo sono:
  - presso la stessa compagnia giapponese (Tokay Denshi) e' stato sottoposto un design a sempre 1 layer ma a 3 file di pads (invece di 2) per consentire la giusta larghezza delle pads (almeno 35 um);
  - presso la compagnia che ha prodotto gli origami Taiyo (i lunghi circuiti stampati) e' stato sottoposto un design a 2 layers.
- Ad oggi i tempi per i PA nelle due soluzioni sono comparabili→inizio produzione moduli a settembre
- KEK ci sta investendo risorse importanti.
- Impatto importante sulla schedule complessiva di SVD che e' in fase di aggiornamento.



# New Power Supplies Option

- Desire to replace the Kenwood Power Supplies
  - More than 10 years old and out of production and maintenance.
  - Little flexibility in granularity because designed for another system
  - Few HV channels:
    - can become a problem with large and/or non-uniform irradiation.
    - individual sensors going haywire may affect a large group of sensors
- Option to use the CAEN Power system
  - Keep the basic LV structure:
    - 8 boxes * (6 board/box) * (2 LV/board) = 96 LV with 5V/10A channels
  - For the HV voltage:
    - 48 HV Channels 100V/1mA, powering each a group of 4 sensors
    - Need fully floating channels that can be referenced to +HV, -HV or GND.
  - Finer granularity would require significant modifications of other electronic boards.

# SVD power system requirements

- Voltage/Current requirements
  - APV chips require 2 positive voltages 1.25V / 60mA and 2.5V / 135mA
    - 2.5W/hybrid in L3 and L456 phi side; 1.65W/hybrid on L456 zed side
  - Sensor HV is below 100V, with single sensor leakage around 1uA initially, up to 100uA when irradiated (sensor area is between 50 and 75 cm2)
  - Low Voltage supplies must be floating so they can be referenced to the sensor HV
- Noise requirements
  - Power supply ripple should not add significantly to base detector noise
- Granularity requirements
  - (mainly coming from budget and cable plant considerations)
  - No requirement to power each hybrid individually
  - No requirement to power each sensor individually

Timing:
- June 2014: start tender process
- September 2014: assign contract
- Around March 2015: delivery directly to KEK so to avoid VAT.
  - Need to understand how much tax we need to pay in Japan.
  - Need to understand how much the shipment costs
- In time for SVD final commissioning.

# CAEN System


X 3

A2518 : 8 Ch 8V/10A (Power < 50W)

X 16

A1510: 12 Ch 100V/1mA

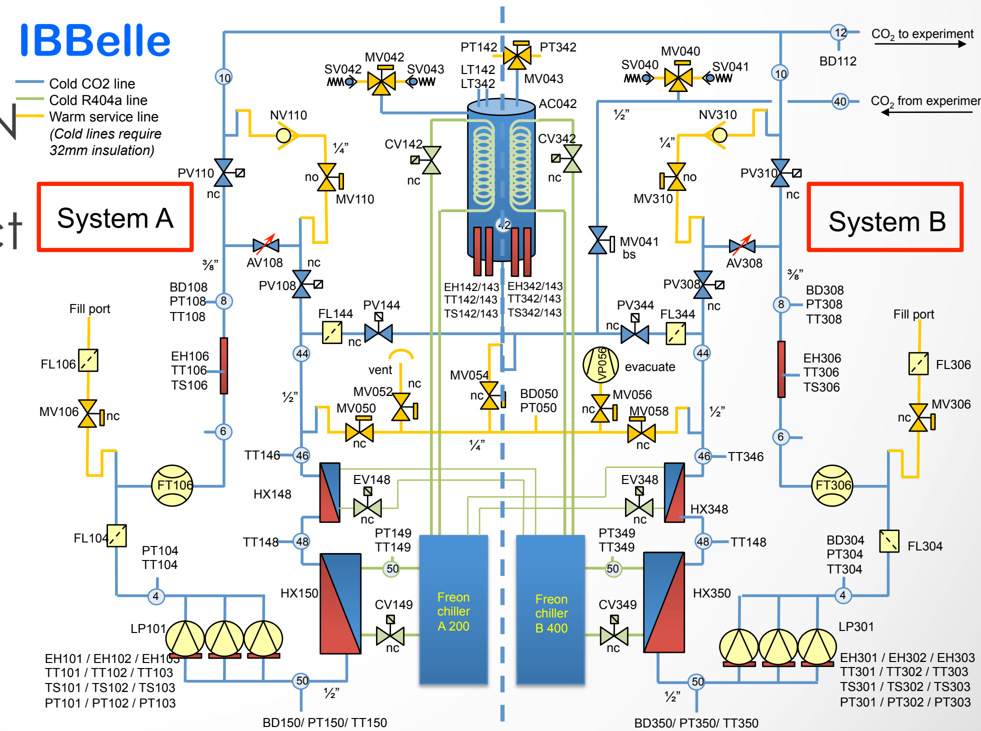
X 4

- **A2518**: use 2xA2518 for each dock (12 LV ch needed, 16 ch available)
- **A1510**: use 5xA1510: 3 BWD (30 HV Ch needed, 36 available), 2FWD (18 HV ch needed, 24 available).
- **SY4527**: need 2 boosters for power requirements. Would like touchscreen.

# VXD CO2 Cooling

- Total dissipated power of SVD
  - 1748 APV25 chips
  - ~ 0.4W / chip
  - **~ 700W in total**
- **Common $CO_2$ system with PXD**
  - Operated at -20°C
  - IBBelle developed by CERN & Nikhef (**ATLAS**)
  - MPI Munich builds an exact copy for VXD
  - Complex system


Marco = Prototipo (piccolo)



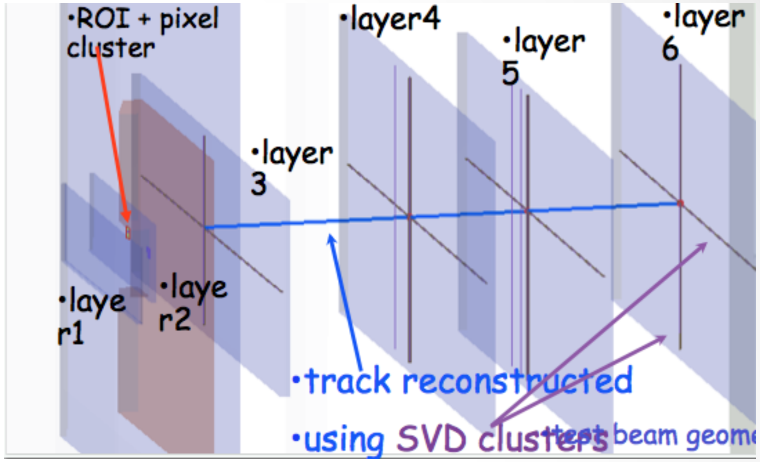

IBBelle = sistema finale. Un singolo circuito con doppio frigorifero.

# Regions Of Interest Finding

The online software for the Region Of Interest (ROI) finding runs on the HLT

➡ ROI finding algorithm:

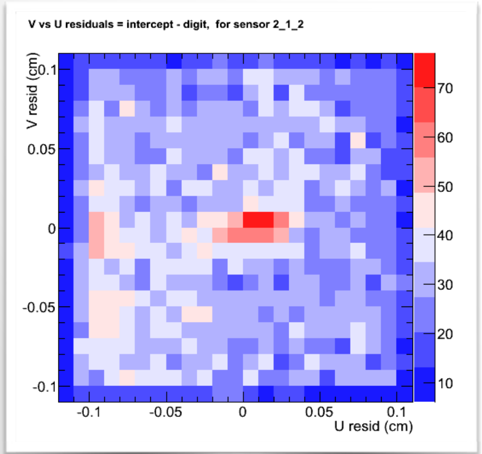
- pattern recognition using SVD data only
- track fit and extrapolation on the PXD layers
- definition of the a rectangular ROI, widths takes into account the statistical error of the extrapolation



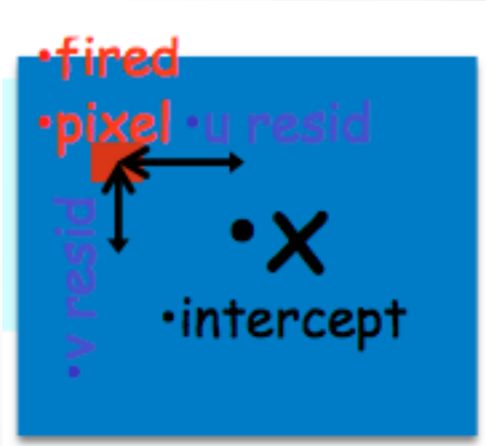

➡ estimated efficiency on the test-beam geometry is (97.5±0.7)%

- inefficiencies due to failed track fit (true also with Belle II geometry, generic events)

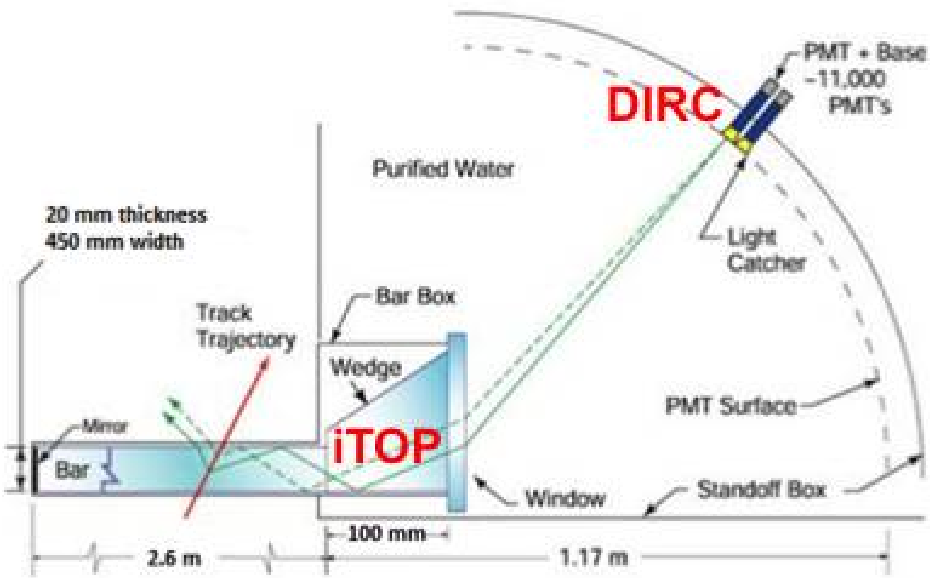
➡ The overall efficiency will depend also on the SVD patter recognition efficiency




DESY test beam proved the functioning of the software-based ROI finding

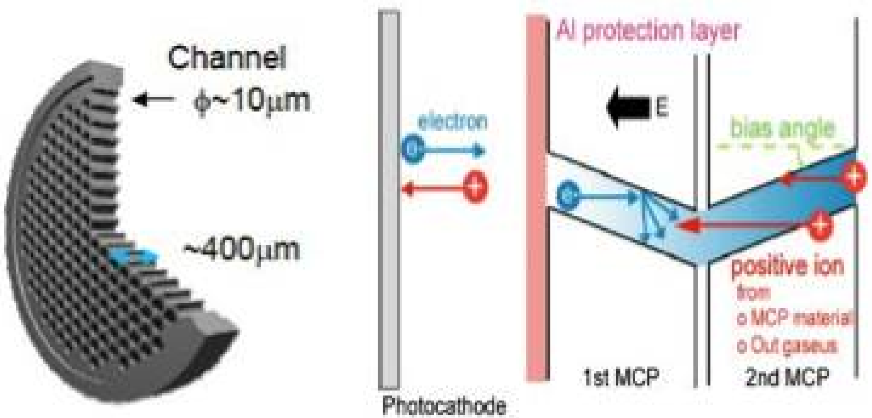


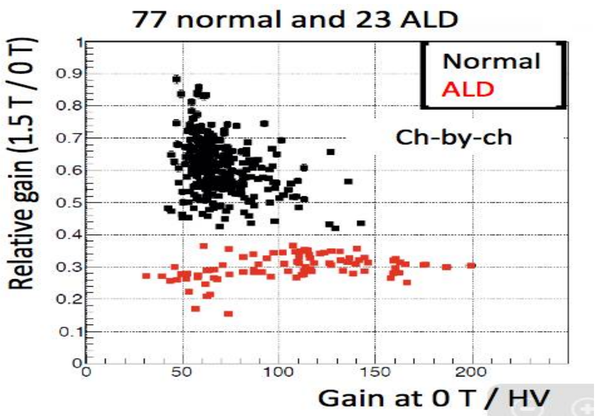
# Barrel PID: imaging Time Of Propagation (iTOP)




L' iTOP è un nuovo tipo di rivelatore Cherenkov in cui l'immagine viene ricostruita in uno spazio di 100 mm (10 volte meno rispetto al DIRC di Babar) grazie ad una combinazione tra elevata risoluzione temporale (tradotta in spazio) ed utilizzo di fotomoltiplicatori a microcanali (MCP-PMT)

Vengono utilizzati fotomoltiplicatori a microcanale di ultima generazione ALD MCP-PMT in cui uno strato protettivo del fotocatodo permette di aumentare il tempo di vita dei PMT di un fattore pari a circa 5... ma maggiore gain reduction a alto B:



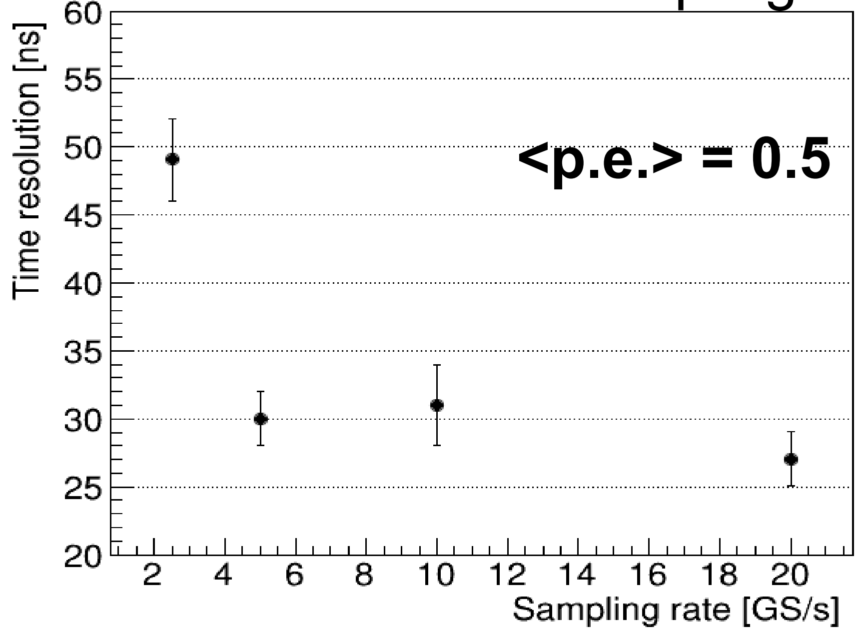
# *Time resolution in Torino*

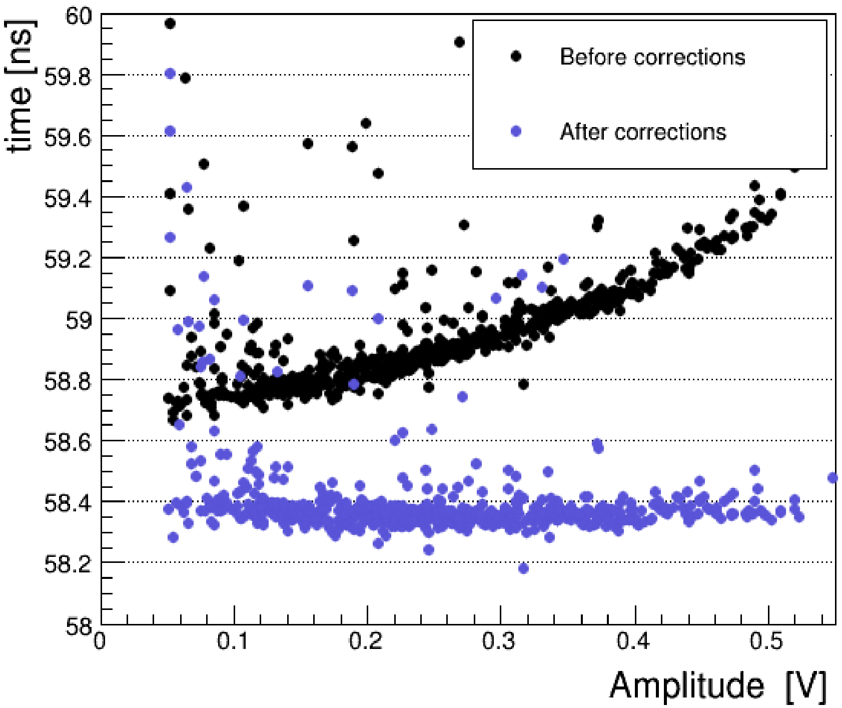
- *Vs Bandwidth della DAQ*
- *Vs High Voltage*

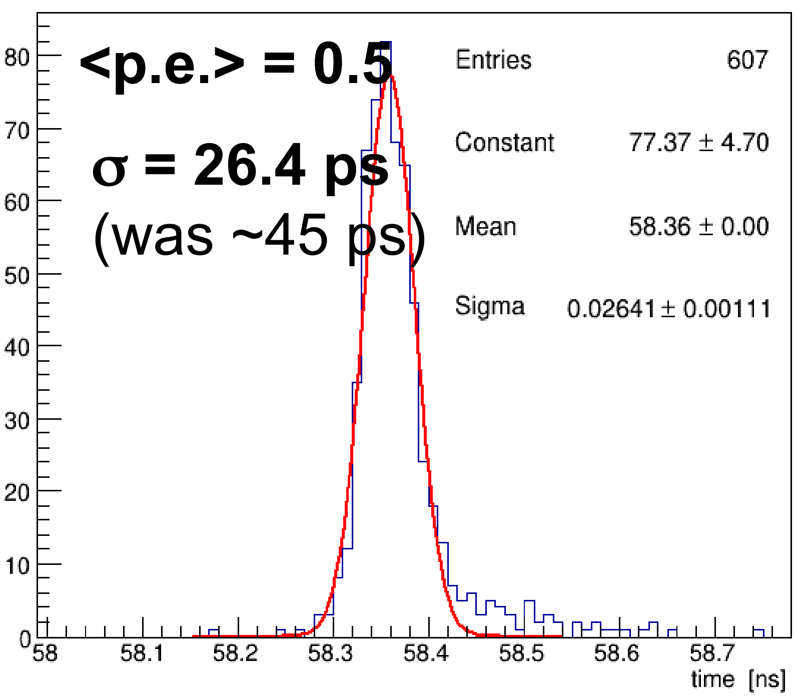
**Amplifier:** Indiana Univ. custom amplifier
**Readout:** Scope LeCroy 20 GS/s, 2.5 GHz
**Signal processing:** Offline CFD (50%)

**Upgrades:** → improved time walk correction
→ PMT screen for cross talk suppression

Resolution VS sampling rate

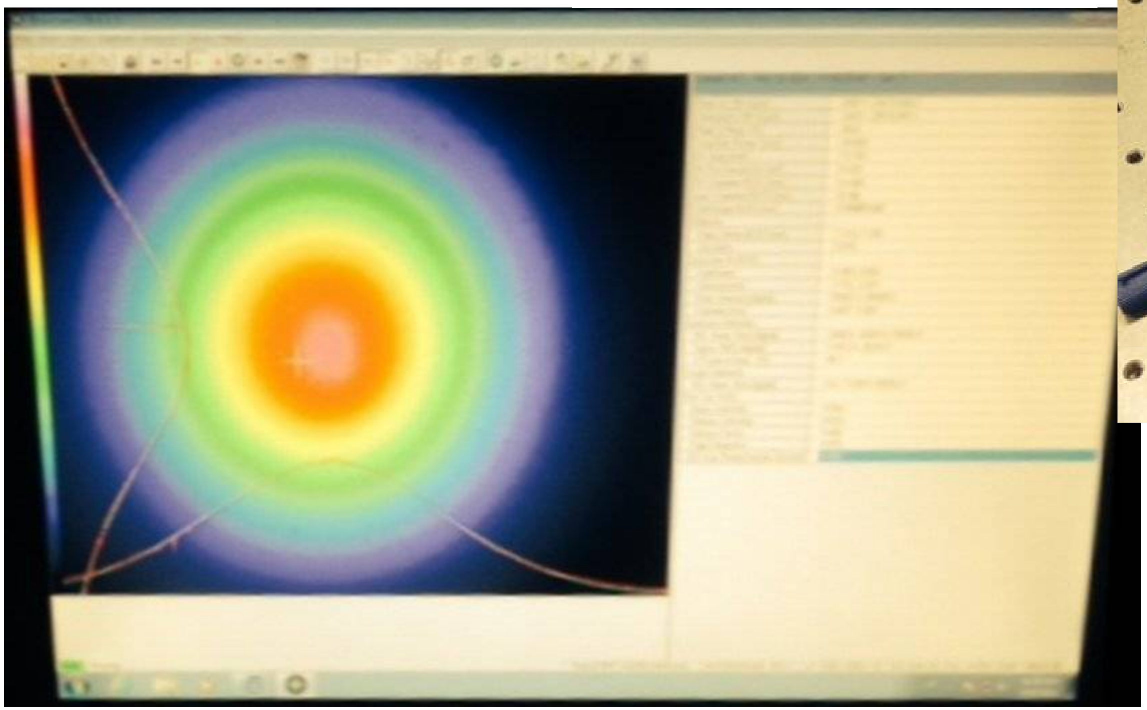


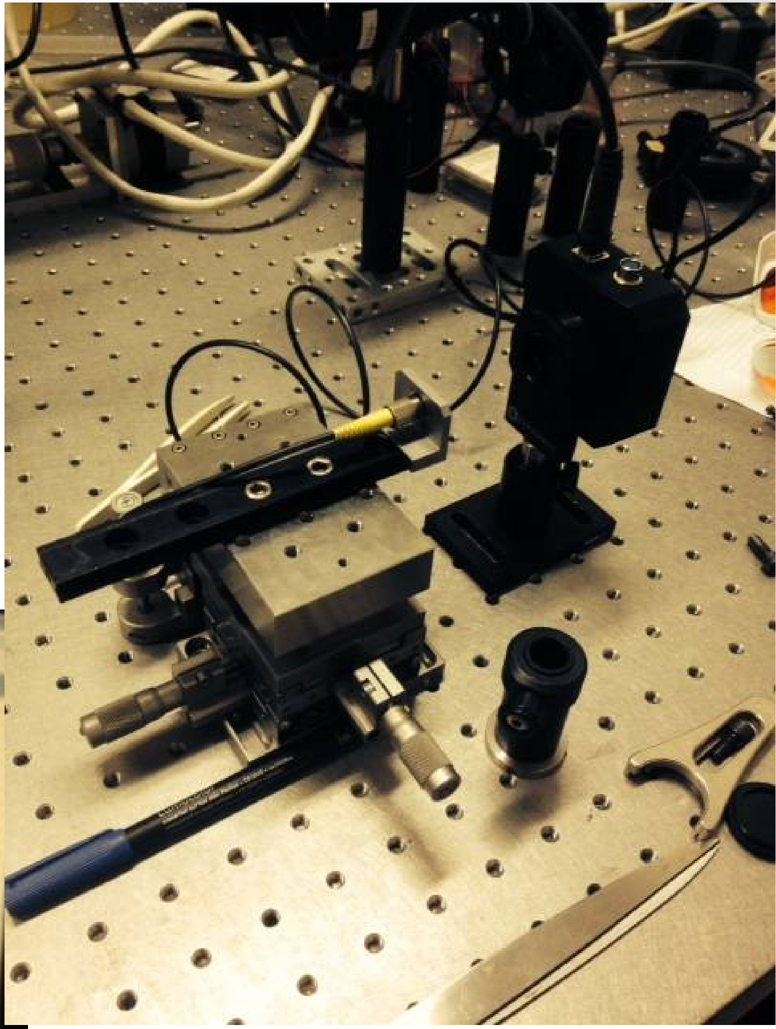



# Misure di distrib angolare (Padova)
# Studi di piping efficiency in bundles

PD sta attrezzandosi con vari CCD setups per la misura di distribuzione angolare della luce uscente da una fibra multimodo, o da una combinazione multimodo +GRIN Lens. Sono partiti gli ordini per i fiber bundles MM.
A Torino abbiamo fabbricato un fiber bundle SM che stiamo per testare.





Gradient Index (GRIN) micro lens
- Material: SELFOC® radial gradient index oxide glass
- Transmission: ≥89% 320–2000 nm
- 1.8 mm diameter
- 3.65 mm length
- NA = 0.6

# Update situazione TOP rispetto alla riunione di Aprile

23/4: Il CD/2-3 approval e' ufficiale
Fornitura PMT conclusa
ALD-MCPPMT : adesso abbiamo std/ALD=50/50
Lifetime test su 44 ALD-PMT started
Ma … ALD hanno ½ gain a 1.5 T rispetto agli std

Cambiamenti del disegno della QBB → ritardo di 2.5 mesi sulla costruzione della bar box

L'assemblaggio delle barre scivola a luglio
Il test a SLAC e' spostato a ottobre

Lavoro in Italia:
Disegno e realizzazione del sistema procede bene
Tests a TO su risoluzione temp vs sampling rate
LNL test: definire entro giugno per studiare la radiation hardness di lenti e bundles
Disponibilita' tecnici a PD e TO nell'assemblaggio delle barre, da rinegoziare. Riduzione richieste aggiuntive in missioni: almeno 1 mu in meno.

| | TO | PD |
|---|---|---|
| Sblocchi SJ | | |
| C.Apparati | 16 | 9 |
| Rich.aggiuntive | | |
| Missioni | 8(13) | 17 |
| Consumi | 0 | 5 |
| Inventario | 2.5(6.5) | 0 |
| C.Apparati | 0 | 3 |
| Totale rich.agg | 10.5 | 25 |

Assegni di Ricerca in Italia:

Bandito 1 AdR a TO (16433/2014), da Giu/Luglio

Richiesto 1 AdR(cofinanziato) a PD, da fine anno

# Introduction

ECL of Belle experiment is a CsI(Tl) calorimeter.

FWD is 1152 crystals + 960 BCKW of about 5x5 $cm^2$ x 30 cm

Belle2 will use the same calorimeter for "Day1" and will upgrade FWD and BCKW 2019

The upgrade of the calorimeter is at the moment FWD and BCKW pure CsI crystals

Read out:

- Belle2 collaboration proposes 2" photopentodes → change mechanical structure, no redundancy
- We propose APD readout reuse mechanical structure (order of 1Meuro) + redundancy

For the BCKW no study at the moment, no groups involved in the effort

# DAY1 software activities

**Reconstruction software**

**Electron identification (G. De Nardo)**

**Task force per la definizione della struttura generale del sodtware (PG + NA)**

**ECL Calibration**

**Each crystal calibration by Bhabha and e+e- -> gamma gamma**

**Development of the code is in progress. Some parts have already been committed and included in the software (new matrix inversion compatible with BelleII code is in place).**

**Discussion on**

**Number of events needed for the calibration**

**Interaction with other detectors (tracking)**

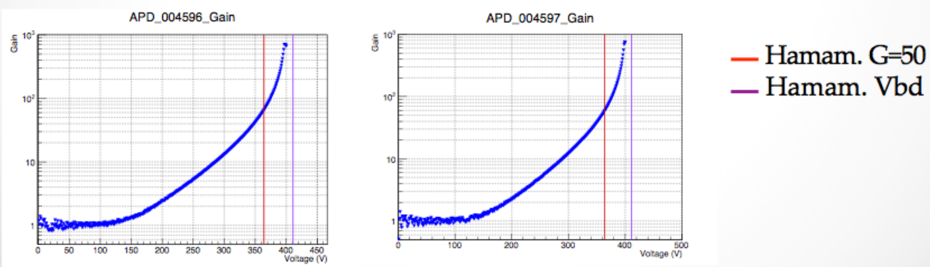
**Control plots + automatic procedure to calibrate regularly the detector**

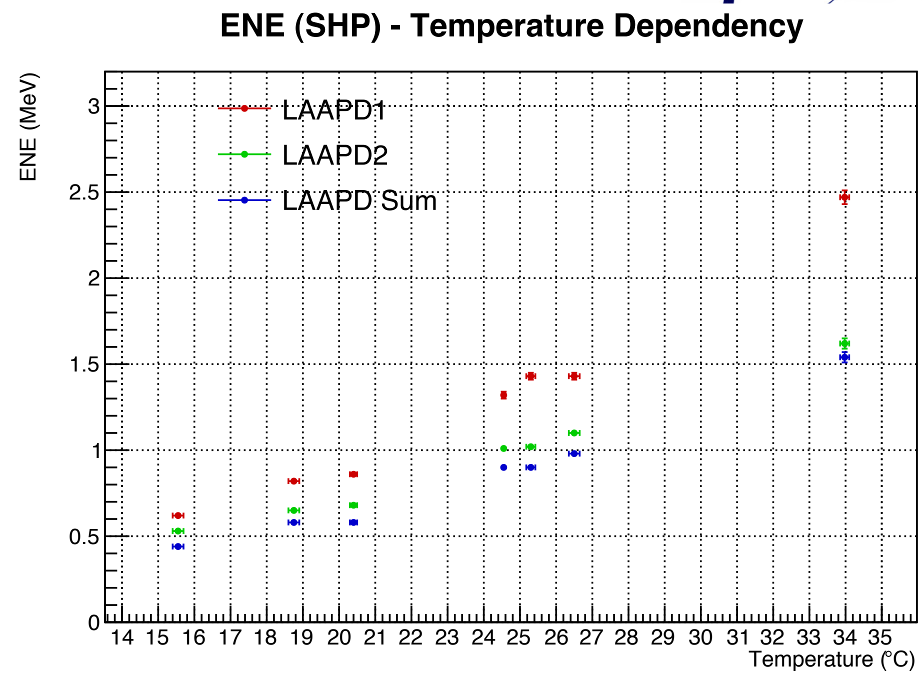
**Info to be stored in the data base**

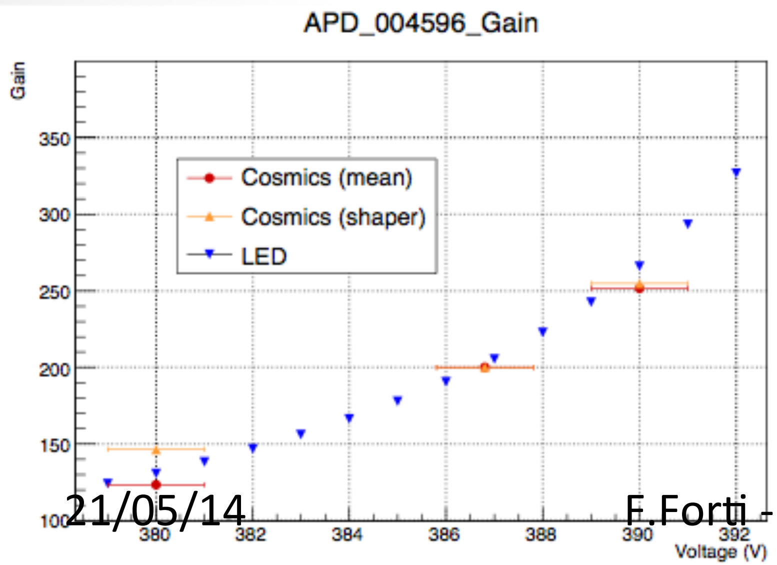
**+ ……. have been discussed in presentation at the computing/software workshop by E. Manoni + other relevant people**

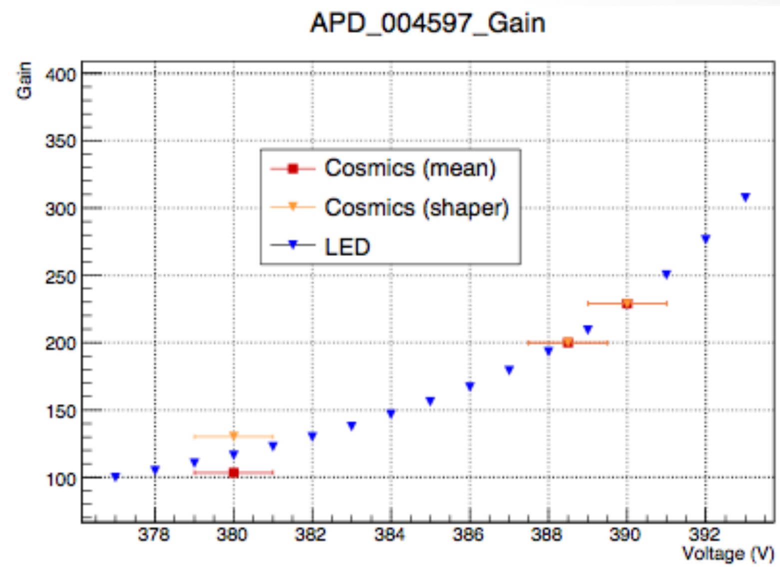
# R&D LAAPD: control of the gain + temp. dep.

- Hamamatsu data for APDs
  - G=50 HV=364V
  - Vbd=411V
  - Based on this info we measured a G=190 @ 400V
- Gain measurement performed with LED
  - Differences with hamamatsu data!
- Gain values based on new measurement
  - G=200 → HV1=385.8V HV2=388.5V
  - Vbd=400V for both APDs

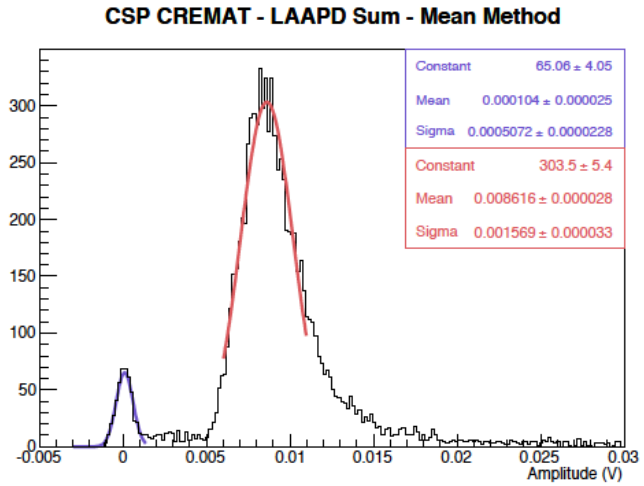


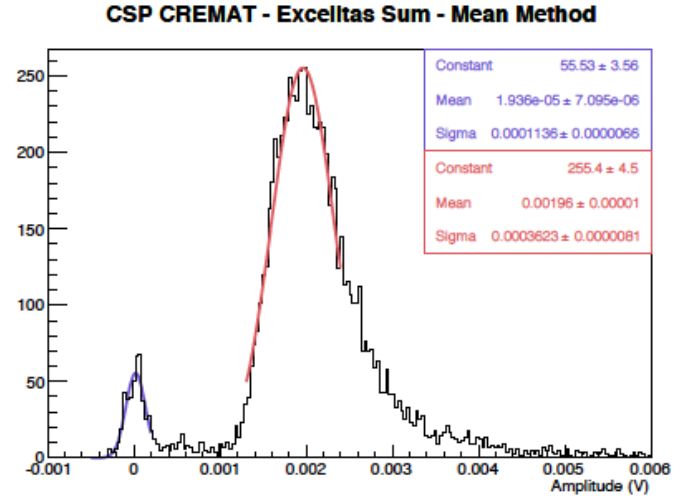



# LAAPD SUM (50Ω)




# Excelitas SUM (50Ω)




## 1 cristallo letto su 1 lato con 4 excelitas e sull'altro con 2 LAAPD (cosmici)

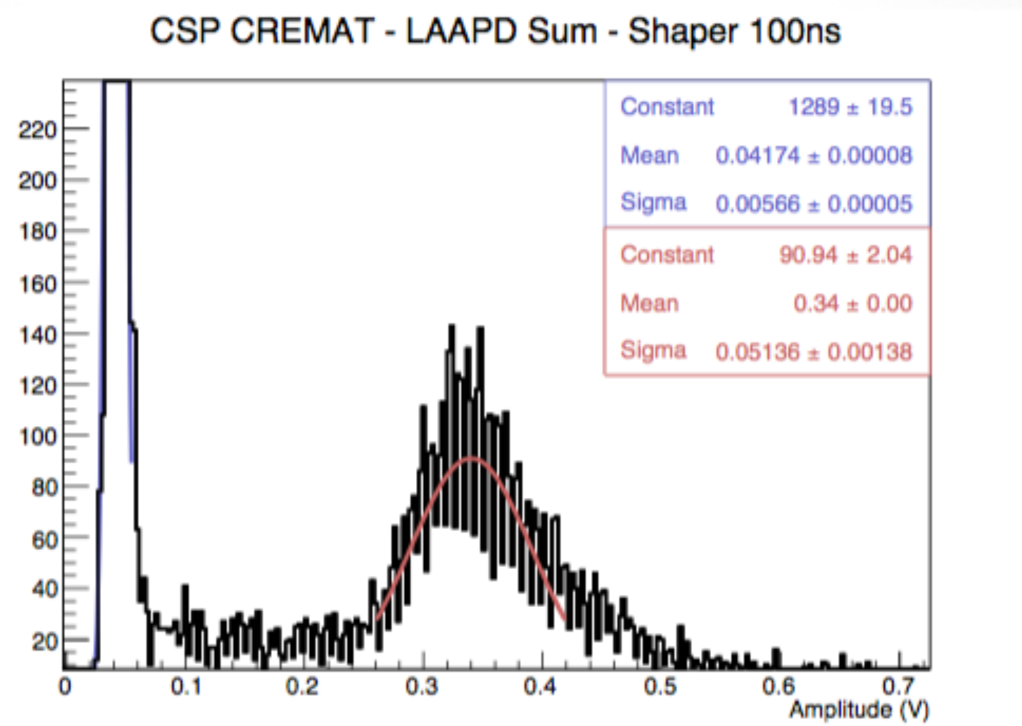
| | Signal (mV) | Noise (mV) | S/N | ENE (MeV) |
|---|---|---|---|---|
| Excelitas1 | 1.80±0.01 | 0.207±0.011 | 8.71±0.48 | 3.45±0.19 |
| Excelitas2 | 1.97±0.01 | 0.176±0.009 | 11.17±0.55 | 2.68±0.13 |
| Excelitas3 | 1.93±0.01 | 0.179±0.010 | 10.79±0.58 | 2.78±0.15 |
| Excelitas4 | 2.12±0.01 | 0.227±0.016 | 9.36±0.67 | 3.21±0.23 |
| Excelitas Sum | 1.96±0.01 | 0.114±0.007 | 17.26±1.00 | 1.74±0.10 |

| | Signal (mV) | Noise (mV) | S/N | ENE (MeV) |
|---|---|---|---|---|
| LAAPD1 | 7.15±0.03 | 0.741±0.033 | 9.64±0.44 | 3.11±0.14 |
| LAAPD2 | 9.97±0.04 | 0.704±0.031 | 14.15±0.63 | 2.12±0.09 |
| LAAPD Sum | 8.61±0.03 | 0.507±0.023 | 16.99±0.76 | 1.77±0.08 |

# R&D LAAPD: signal after shaping for the two APD's and for the sum

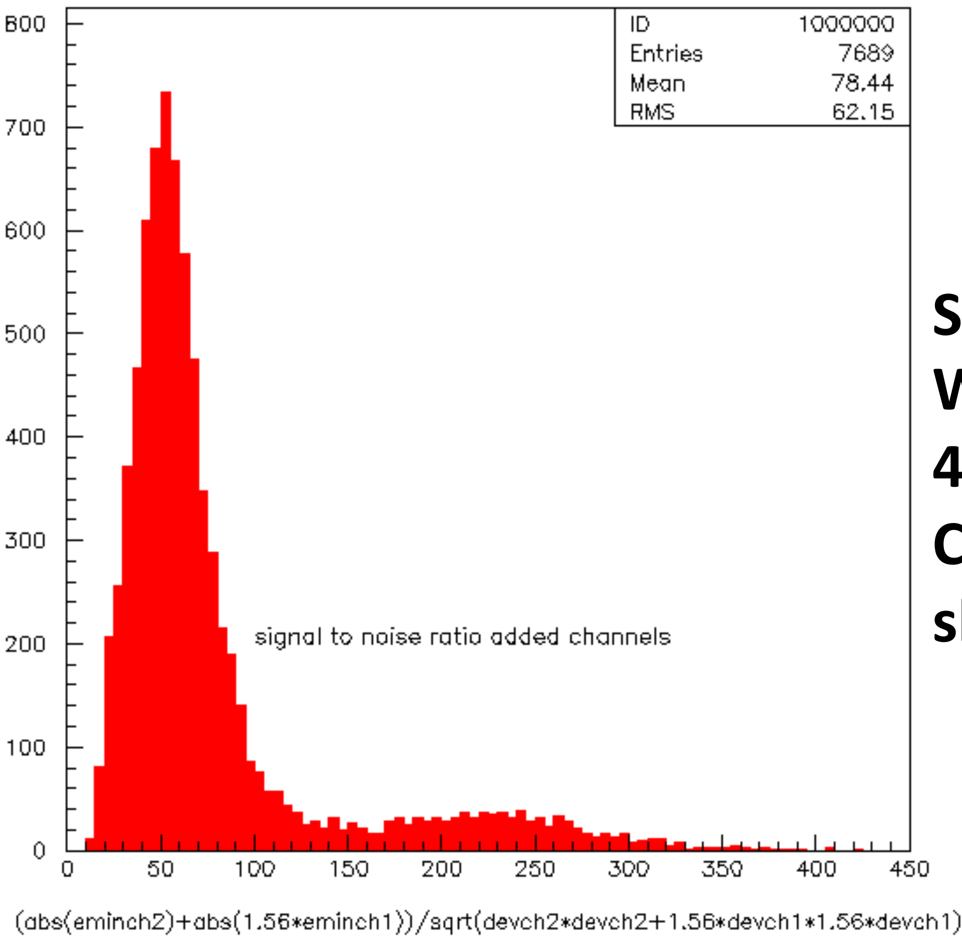
**Reference number is 200keV with photopentode, but pile-up noise coming from BG events give a contribution of about 2.0 – 2.5 MeV**

**ESEMPIO DI FILTRO HARDWARE sui dati dopo preamp. FILTRO SOFTWARE dà risultati equivalenti sui due APD**




| | Signal (mV) | Noise (mV) | S/N | ENE (MeV) |
|---|---|---|---|---|
| LAAPD1 | 121.1±0.6 | 3.71±0.03 | 32.6±0.3 | 0.91±0.02 |
| LAAPD2 | 176.8±0.8 | 4.21±0.04 | 42.0±0.5 | 0.71±0.02 |
| LAAPD Sum | 398.3±1.1 | 5.66±0.05 | 52.7±0.6 | 0.55±0.02 |

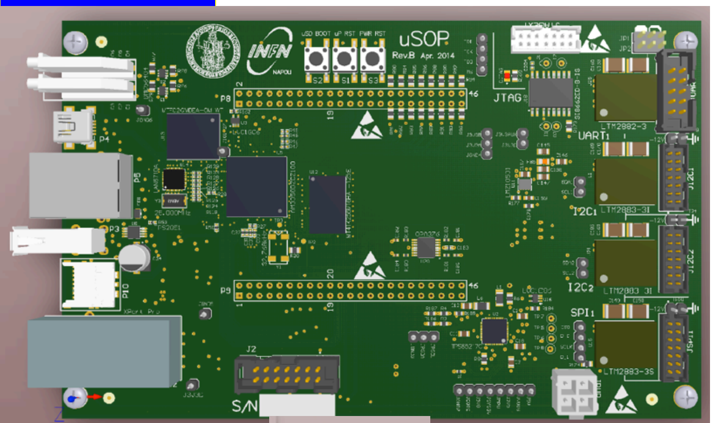
# R&D PP 1”: S/N ratio channels combination of two channels



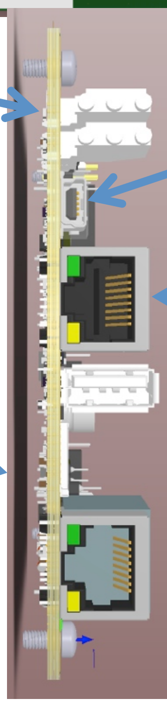

TWO 1” photopentodes instead of ONE 2” PP: maybe better mechanically

**Signal to noise ratio is 78**
**We estiate a noise level of about 400 KeV**
**Confrontabile con APD’s dopo shaping**

# uSOP (service oriented platform for slow control): REV B




- Cortex A8 uP @ 1GHz
- Linux OS (Debian)
- 2 GB Flash
- 512 MB RAM
- Designed as a possible general platform for Belle2 slow-controls




**HARDWARE:**

- **Design of first version (Rev. B) completed**
- **5 PCBs produced and received**
- **Waiting for components:**
- **Assembly completed possibly by end of June (conditioned by component availability)**
- **Then tests, debug, troubleshooting, …**

**SOFTWARE:**

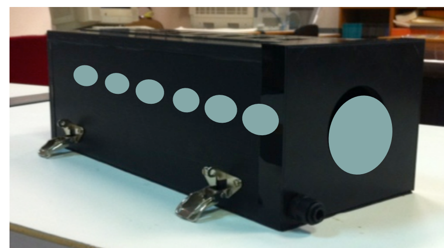
- **Linux porting is available *open-source* (Debian)**
- **Software for JTAG programming of Xilinx FPGA completed and tested successfully**

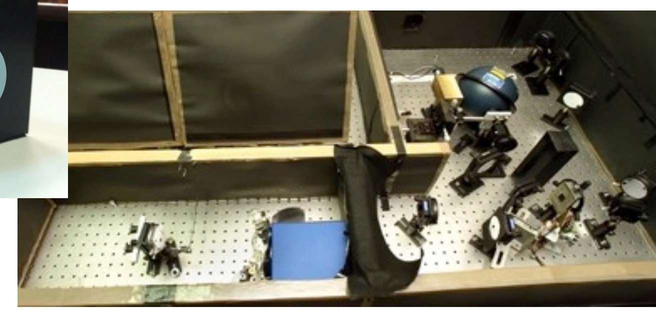
# R&D CALLIOPE: activities for BelleII

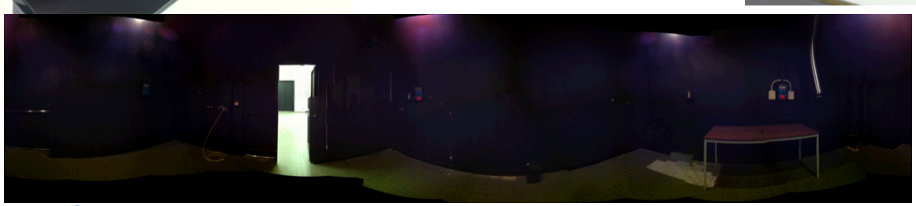
- **Optical characterization of coupling materials**
- **Transmittance *(long-trasv)* and LY measurements of CsI crystals**

Dry box for LY meas.

Dry box  and Lumen spectrophotometer



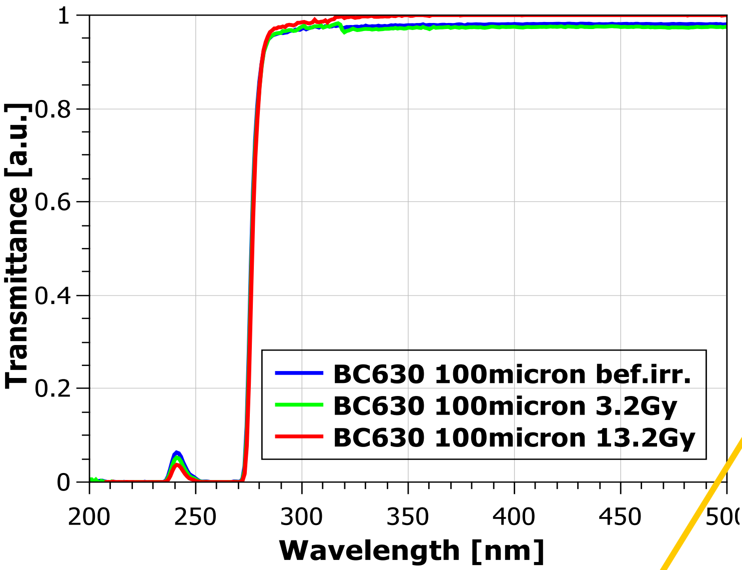


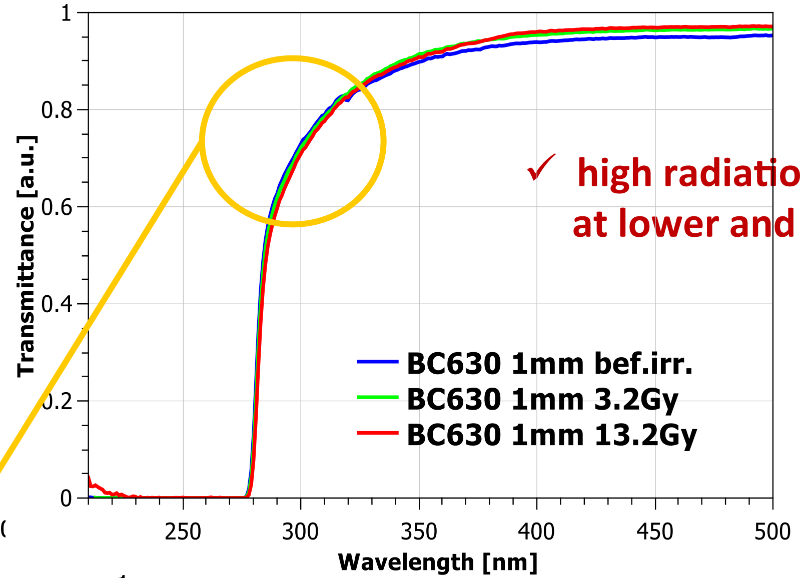


25m$^2$ dark room with air conditioning built for CMS-ECAL R&D

- **R&D on wavelength shifters *(CsI emission toward blue region)***
- **APD irradiation *(gamma, neutrons)***

# R&D CALLIOPE: BC630 after irradiation and stability

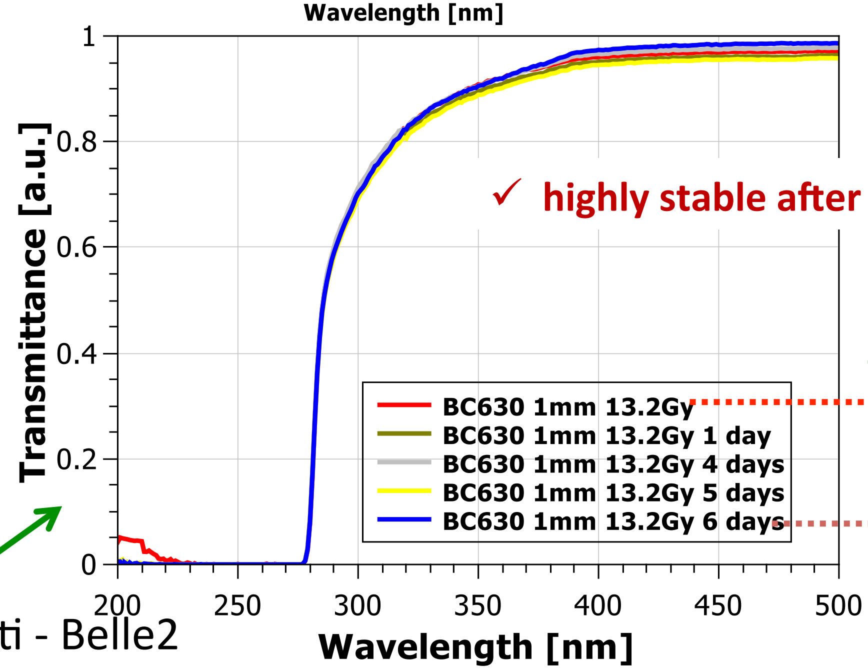



✓ high radiation hardness at lower and higher thickness

| Transmittance @ 315nm [a.u.] | | |
|---|---|---|
| Bef.irr. | 3.2Gy | 13.2Gy |
| 0.82 | 0.81 | 0.80 |

✓ highly stable after irradiation




Transmittance @ 315nm [a.u.]

0.80

0.79

*...after the end of irradiation...*

# R&D ECL FWD: futuro prossimo

- **Matrice 16 cristalli a Mainz in Settembre**

- **Un amplificatore diverso da quello utilizzato per i test è stato svluppato a RM3, la misura dei LAAPD utilizzando questo preamp dà un noise equivalente di circa un fattore 2 peggiore del CREMAT → ora che abbiamo una prima misura su APD IL DISEGNO E' IN FASE DI OTTIMIZZAZIONE (era sviluppato per PP)**

- **Irraggiamento (gamma + neutroni) da fare alla Casaccia per tutti e due I tipi di APD (alcuni sono in corso), + studi di QE per diverse lunghezze d'onda di luce**
- **studio del gain dei LAAPD in funzione della lunghezza d'onda in corso a PG**
- **test di LAAPD con WLS → 420nm dove QE è max**

- **Task force (C. Cecchi, A. Kuzmin, P. Krizan, K. Myiabayashi, M. Roney, C. Hearty, I. Nakamura) per l'upgrade di ECL FWD sta scrivendo il proposal dovrebbe esserci una prima versione per il B2GM**

# Acquisti (fatti e/o coperti) + richieste ECL

| | |
|---|---|
| - **10 APD excelitas ordinati a LNF per test + qualificazione** | **OK** |
| - **10 LAAPD ordinati per test + qualificazione** | **OK** |
| - **LED di diverse lunghezza d'onda acquistati per studiare gain** | **OK** |
| - **cristalli per matrice** | **OK** |
| - **meccanica in costruzione** | **OK** |
| - **WLS per fare test con LAAPD** | **OK** |
| - **fotorivelatori + FE da scegliere e acquistare x matrice** | **OK** |
| - **DAQ nel caso di scelta di excelitas manca 1 modulo V1720** | **NO** |

**500 euro** PIN calibrati per misure Quantum Efficiency su APD irraggiati
**500 euro** step motor controllato per automazione misure di Quantum Efficiency su APD irraggiati
**1000 euro** riparazione monocromatore (inventariato iNFN) per misure di trasmittanza su cristalli di grandi dimensioni
**1500 euro** materiale vario per mantenimento atmosfera secca per CsI puro durante misure, irraggiamento, stoccaggio (bombole, glove bags, raccordi e flussometri gas, sali essiccanti ecc.)
**500 euro** lampade spettrofotometro per misure trasmittanza su CsI

**4Keuro**

# Belle 2 ECL FWD

**1152 cristalli 5.5x5.5x30 cm^3 = 907.5 cm^3**
**≈1000 cm^3/cristallo**
**Costo CsI puro circa 4.5$/cc → 4.5K$/cristallo**
**Costo totale FWD (CRISTALLI ) → 5.2M$ = 3.9Meuro**

**APD-UV: 500 euro/pcs (2xcrystal)→ 1152 Keuro**

**FE: 70 euro/ch → 161 Keuro**

**PTD: 1152x2/32 ch →144 keuro (72 moduli)**

**uSOP: 1152x2/160 ch → 60 keuro (15 schede)**

**TOTALE ECL FWD (con ipotesi di FE da noi proposto per la lettura degli APD-UV slow control presentato alla collaborazione) il tutto si integra con il sistema di DAQ esistente 5.4 Meuro**

# Proposta che stiamo coordinando con le altre istituzioni di ECL Belle2

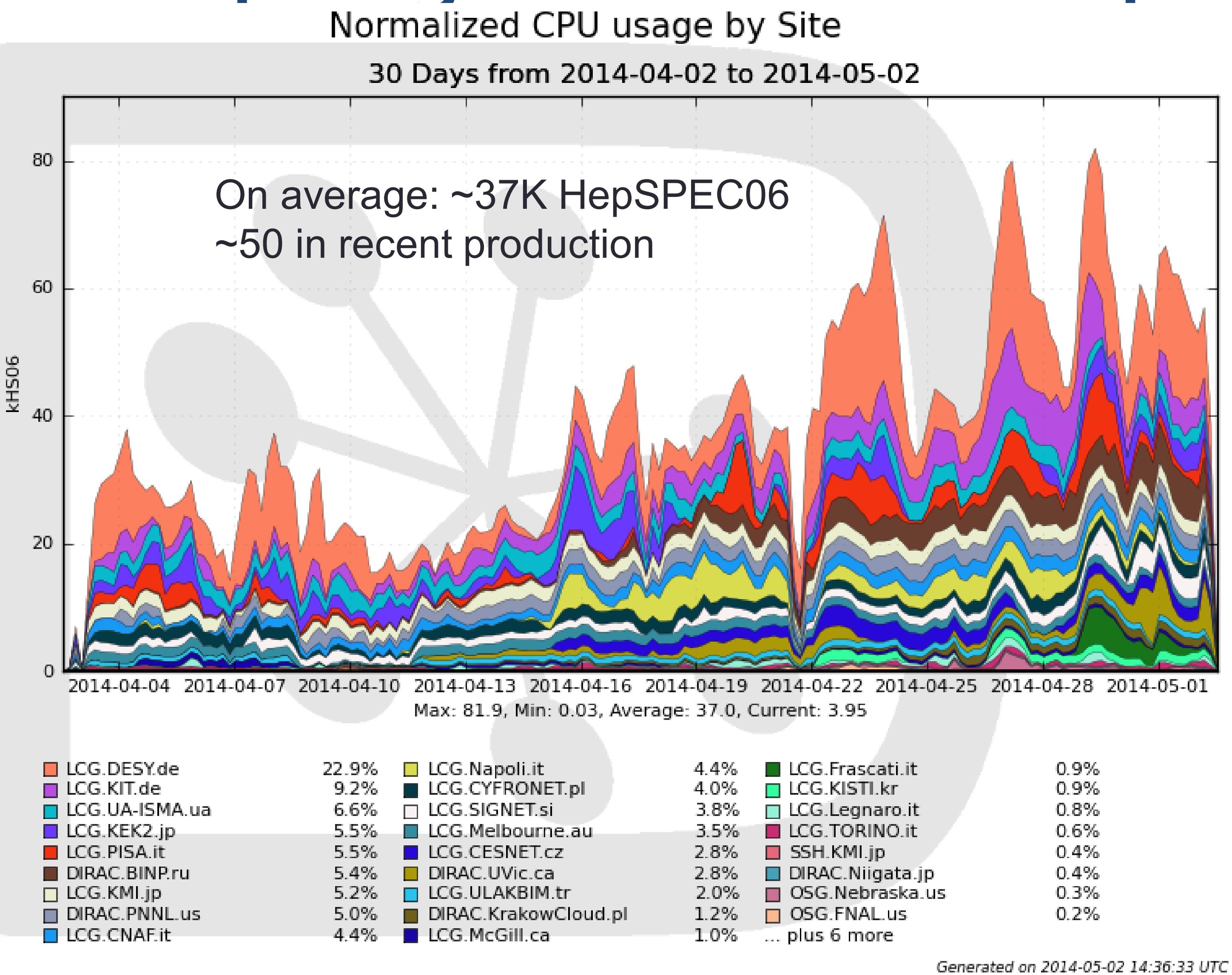
**Proposta di 3 moduli (19% di ECL FWD) completi da assemblare in ECL + commissioning a KEK**

**Costo di 3 moduli :**

| | |
|---|---|
| Cristalli | ~~670~~ 850 Keuro (ricevuta offerta + dimensione cristalli) |
| APD-UV | 219 Keuro |
| FE | 31 Keuro |
| PTD | 144 Keuro |
| uSOP | 60 Keuro |
| | |
| TOT | 1304 Keuro |

Attenzione: PTD e uSOP (slow control) è per l'intero detector ECL

# Spring 2014 MC Campaign




Pisa 5.5%
CNAF 4.4%
Napoli 4.4%
Frascati 0.9%
Legnaro 0.8%
Torino 0.6 %

# Belle II Computing Model

- Two copies of raw data
- 3 copies of miniDST for Data and MC
  - Asia, America, Europe
- Processing at KEK; reprocessing were second copy of raw data is.
  - Location of second copy is under investigation
- MC Production & Analysis everywhere according to PhD fraction
- Assumptions:
  - Sizes of event in raw data from DAQ people
  - Size of event in miniDST from estimate/measurement
  - CPU for Reco (MC generation and reconstruction) from current code
  - CPU for Analysis from scaled Belle experience

# Belle II Sites

| Country | Site | Raw Data | Has microDST | MC Prod | Analysis |
|---|---|---|---|---|---|
| Australia | Melbourne | N | Y | Y | Y |
| Austria | HEPHY-Vienna | N | Y | Y | Y |
| Canada | Uvic | N | Y | Y | Y |
| Canada | McGill | N | N | Y | Y |
| China | IHEP | N | N | Y | Y |
| Czech | CesNet | N | N | Y | Y |
| Germany | GridKa | x% of second copy | Y | Y | Y |
| Germany | Desy | N | Y | Y | Y |
| Germany | LRZ/RZG | N | N | Y | Y |
| India | TIFR | N | N | Y | Y |
| India | IITG | N | N | Y | Y |
| Italy | CNAF | x% of second copy | Y | Y | Y |
| Italy | Napoli | N | Y | Y | Y |
| Italy | Pisa | N | Y | Y | Y |
| Italy | Torino | N | Y | Y | Y |
| Japan | KEK | 100% first copy | Y | Y | y |
| Japan | Nagoya | N | N | Y | Y |
| Japan | Niigata | N | N | Y | Y |
| Korea | KISTI | x% of second copy ?? | Y | Y | Y |
| Poland | Cyfronet | N | Y | Y | Y |
| Poland | CC! | N | Y | Y | Y |
| Russia | BINP | N | N | Y | Y |
| Russia | ITEP | N | N | Y | Y |
| Slovenia | SIGNET | N | Y | Y | Y |
| Taiwan | NTU | x% of second copy ?? | Y | Y | Y |
| Turkey | ULAKBIM | N | N | Y | Y |
| Ukraine | UA-ISMA | N | N | Y | Y |
| USA | PNNL | x% of second copy | Y | Y | Y |
| USA | Virginia Tech | N | N | Y | Y |
| USA | Kennesaw | N | N | Y | Y |

# Global Resource Estimate

| Year | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 |
|---|---|---|---|---|---|---|---|---|---|
| Tape @ PNNL [PB] | 0.00 | 0.00 | 0.00 | 0.00 | 9.23 | 28.51 | 52.45 | 76.80 | 102.32 |
| Tape @ KEK [PB] | 0.00 | 0.00 | 0.33 | 1.17 | 9.23 | 28.51 | 52.45 | 76.80 | 102.32 |
| Tape KEK offset [PB] | 2.00 | 2.00 | 1.67 | 0.83 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Tape [PB] | 2.00 | 2.00 | 2.00 | 2.00 | 18.46 | 57.01 | 104.90 | 153.60 | 204.64 |
| Disk DST [PB] | 0.00 | 0.00 | 0.01 | 0.02 | 0.18 | 0.57 | 1.05 | 1.54 | 2.05 |
| Disk mDSTx4[PB] | 0.00 | 0.00 | 0.24 | 0.87 | 6.89 | 21.28 | 39.16 | 57.34 | 76.40 |
| Disk DST+mDSTx4 | 0.00 | 0.00 | 0.25 | 0.89 | 7.08 | 21.85 | 40.21 | 58.88 | 78.44 |
| Disk MCx3 [PB] | 0.00 | 0.00 | 0.70 | 2.49 | 11.09 | 21.37 | 34.14 | 47.13 | 60.74 |
| Disk Analysis[PB] | 0.00 | 0.00 | 0.03 | 0.10 | 0.82 | 2.53 | 4.66 | 6.83 | 9.09 |
| Disk Challenge[PB] | 2.00 | 4.00 | 5.00 | 2.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Disk KEK offset [PB] | 0.49 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Disk PNNL offset [PB] | 0.70 | 0.40 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Disk [PB] | 3.19 | 4.40 | 5.98 | 5.49 | 18.98 | 45.76 | 79.01 | 112.83 | 148.27 |
| CPU Data [kHS] | 0.00 | 0.00 | 1.87 | 4.79 | 46.00 | 109.98 | 136.60 | 138.93 | 145.59 |
| raw data proc @ PNNL [kHS] | 0.00 | 0.00 | 0.75 | 1.91 | 18.40 | 43.99 | 54.64 | 55.57 | 58.23 |
| CPU mDST repr. | 0.00 | 0.00 | 6.85 | 24.40 | 96.53 | 74.54 | 137.15 | 200.82 | 267.55 |
| CPU MC [kHS] | 0.00 | 0.00 | 9.85 | 25.25 | 121.30 | 145.01 | 180.11 | 183.18 | 191.96 |
| CPU MC repr. [kHS] | 0.00 | 0.00 | 27.09 | 96.52 | 143.37 | 138.15 | 220.69 | 304.65 | 392.63 |
| CPU Analysis [kHS] | 0.00 | 0.00 | 0.93 | 3.33 | 26.33 | 81.32 | 149.61 | 219.08 | 291.87 |
| CPU Challenge [kHS] | 133.25 | 133.25 | 111.04 | 161.80 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| CPU KEK offset [kHS] | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| CPU PNNL offset [kHS] | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| CPU [kHepSPEC] | 133.25 | 133.25 | 157.64 | 316.08 | 433.53 | 548.99 | 824.16 | 1,046.67 | 1,289.61 |

# Resources in Italy O(10% of previous slide)

| | | |
|---|---|---|
| Site or Tier 1 fraction Data faction | Italy | This can be a site name as given on the Sites sheet or a number<br>If this is empty the data fraction will be equal to the number given on the Sites sheet or 0 for numberical Tier 1 |
| Used Tier 1 facrion | 0.10 | *The fraction of MC production and user analysis done at the site* |
| Used data fraction | 0.40 | *The fraction of mDST data stored at the site* |

**Regional Center resources:**

| Year | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 |
|---|---|---|---|---|---|---|---|---|---|
| Disk (data) [PB] | 0.00 | 0.00 | 0.02 | 0.08 | 0.66 | 2.03 | 3.73 | 5.46 | 7.28 |
| Disk (MC) [PB] | 0.00 | 0.00 | 0.03 | 0.12 | 0.55 | 1.07 | 1.71 | 2.36 | 3.04 |
| Disk (analysis) [PB] | 0.00 | 0.00 | 0.00 | 0.01 | 0.08 | 0.25 | 0.47 | 0.68 | 0.91 |
| Disk (challenges) [PB] | 0.20 | 0.40 | 0.50 | 0.20 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| Disk [PB] | **0.20** | **0.40** | **0.56** | **0.42** | **1.29** | **3.35** | **5.90** | **8.50** | **11.22** |
| CPU (MC) [kHepSPEC] | 0.00 | 0.00 | 3.61 | 11.97 | 25.46 | 27.11 | 38.58 | 47.26 | 56.86 |
| CPU (an.) [kHepSPEC] | 0.00 | 0.00 | 0.09 | 0.33 | 2.63 | 8.13 | 14.96 | 21.91 | 29.19 |
| CPU (ch.) [kHepSPEC] | 13.32 | 13.32 | 11.10 | 16.18 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| CPU [kHepSPEC] | **13.32** | **13.32** | **14.81** | **28.48** | **28.09** | **35.24** | **53.54** | **69.17** | **86.05** |
| CPU [# of cores 14.72HS/core] | **905.21** | **905.21** | **1,006.09** | **1,934.70** | **1,908.20** | **2,393.92** | **3,637.27** | **4,698.73** | **5,845.59** |
| WAN (data) [Gbit/s] (inward) | 0.00 | 0.00 | 0.02 | 0.08 | 0.39 | 0.50 | 0.74 | 0.92 | 1.12 |
| WAN (MC) [Gbit/s] (outward) | 0.00 | 0.00 | 0.02 | 0.08 | 0.21 | 0.15 | 0.21 | 0.25 | 0.30 |
| WAN (MC) [Gbit/s] (inward) | 0.00 | 0.00 | 0.05 | 0.16 | 0.42 | 0.29 | 0.41 | 0.50 | 0.60 |
| WAN (ch.) [Gbit/s](in/out) | 0.32 | 0.64 | 0.64 | 0.48 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 |
| WAN [Gbit/s] (outward) | **0.32** | **0.64** | **0.66** | **0.56** | **0.21** | **0.15** | **0.21** | **0.25** | **0.30** |
| WAN [Gbit/s] (inward) | **0.32** | **0.64** | **0.71** | **0.72** | **0.81** | **0.79** | **1.15** | **1.42** | **1.72** |

Plus user space, plus a fraction of the raw data

# Costing of Resources in Italy

| Cost for Analysis and MC Production | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | |
| Item | Totale 2014-2022 | 2014 | 2015 | 2016 | 2017 | 2018 | 2019 | 2020 | 2021 | 2022 |
| Disco (PB) da tabella ufficiale | | 0.20 | 0.40 | 0.56 | 0.56 | 1.32 | 3.50 | 5.90 | 8.50 | 11.20 |
| Disco (PB) user space (10% e poi 5% dal 2019) | | 0.02 | 0.04 | 0.06 | 0.06 | 0.13 | 0.18 | 0.30 | 0.43 | 0.56 |
| Disco(PB) totale | | 0.22 | 0.44 | 0.62 | 0.62 | 1.45 | 3.68 | 6.20 | 8.93 | 11.76 |
| Disco(PB) da comprare (rimpiazzo dopo 5 anni) | | | 0.44 | 0.18 | 0.00 | 0.84 | 2.22 | 2.96 | 2.91 | 2.84 |
| Disco: Costo per PB in KE (-20% anno) | | | 265.00 | 212.00 | 169.60 | 135.68 | 108.54 | 86.84 | 69.47 | 55.57 |
| Disco costo totale (KE) | 1125.09 | 0.00 | 116.60 | 37.31 | 0.00 | 113.43 | 241.29 | 257.03 | 201.87 | 157.55 |
| CPU(KHEPSpec) da tabella ufficiale | | 13.00 | 15.00 | 15.00 | 28.00 | 28.00 | 36.00 | 54.00 | 79.00 | 85.00 |
| CPU(KHEPSpec) analisi n-tuple (10% e poi 5% dal 2019)*0.4 | | 0.52 | 0.60 | 0.60 | 1.12 | 1.12 | 0.72 | 1.08 | 1.58 | 1.70 |
| CPU(KHEPSpec) totale | | 13.52 | 15.60 | 15.60 | 29.12 | 29.12 | 36.72 | 55.08 | 80.58 | 86.70 |
| CPU(KHEPSpec) da comprare (rimpiazzi dopo 4 anni) | | | 15.60 | 0.00 | 13.52 | 0.00 | 23.20 | 18.36 | 39.02 | 6.12 |
| CPU: Costo Unitario per KHEPSpec in KE (-20% anno) | | | 12.00 | 9.60 | 7.68 | 6.14 | 4.92 | 3.93 | 3.15 | 2.52 |
| CPU costo totale (KE) | 615.41 | 0.00 | 187.20 | 0.00 | 103.83 | 0.00 | 114.03 | 72.19 | 122.75 | 15.40 |
| | | | | | | | | | | |
| Gran totale | 1740.50 | 0.00 | 303.80 | 37.31 | 103.83 | 113.43 | 355.33 | 329.23 | 324.62 | 172.96 |
| | | | | | | | | | | |

Frazione della seconda copia dei raw data non inclusa

# Our Proposal on the allocation of resources to sites (to be discussed)

- CNAF: 40% + fraction of raw data (including CPU to process them)
- Tier2 Federation: 60% shared between Napoli, Pisa and Torino
  - Site resources allocate to Belle II should be comparable
  - These sites are already LHC Tier2
  - Belle II will be a small perturbation

- Plan is to produce a written report with our proposal before summer

# Request for 2015

- Servono 450 TB + 15 KHEPSpec
- CNAF: Abbiamo 50 TB + 0.7 KHEPSpec. Vogliamo arrivare a 150 TB + 5 KHEPSpec. Servono:
  - 100 TB -> 28 KE
  - 4 KHEPSpec -> 48 KE
- Napoli (fornite da RECAS)
  - 300 TB
  - 10 KHEPSpec
- Risorse a Pisa e Torino nei prossimi anni

# Prospettiva

- Costo complessivo previsto 2014-2018 in leggera evoluzione, ma senza modifiche sostanziali
  - SVD Monitoring piu' costoso (+62k), parzialmente compensato da
  - SVD Power supplies piu' economico (-35k)
  - Leggera riduzione costo PID
- Per ECL rimangono due questioni fondamentali:
  - Scelta del rivelatore di luce
  - Finanziamento complessivo (specialmente Canada)
- Convergenza su MoU per l'estate
  - Definizione più precisa dei contributi SVD, PID
  - Possibile slittamento ad autunno per ECL
  - Contributi COMP su MoU dedicato
- Capire come si assorbe il problema finanziario per il 2015 e il suo impatto sulla schedule.