ECL status report

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for the ECL italian ECL group

Outline

- Status of the FWD upgrade
  - software
- BEAST
- Mainz TEST beam
- Richieste

Forward upgrade

Hardware tests have been carried out in the past years →
CsI pure + APD can fit the requested performance in terms of signal to noise ratio
FE electronics has been developed for the readout of the system

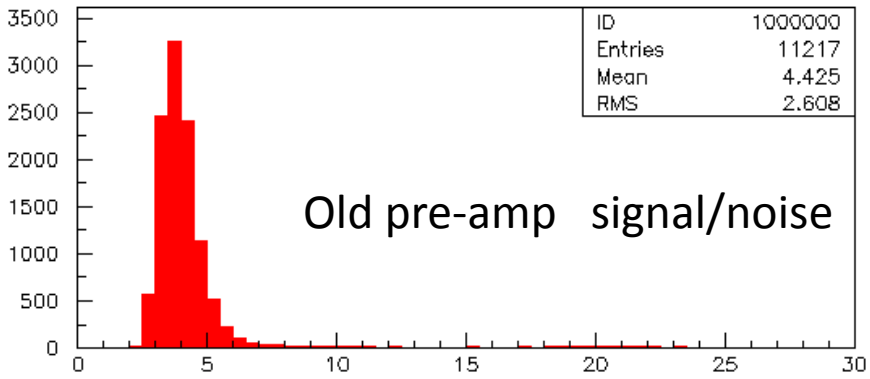
What is missing?

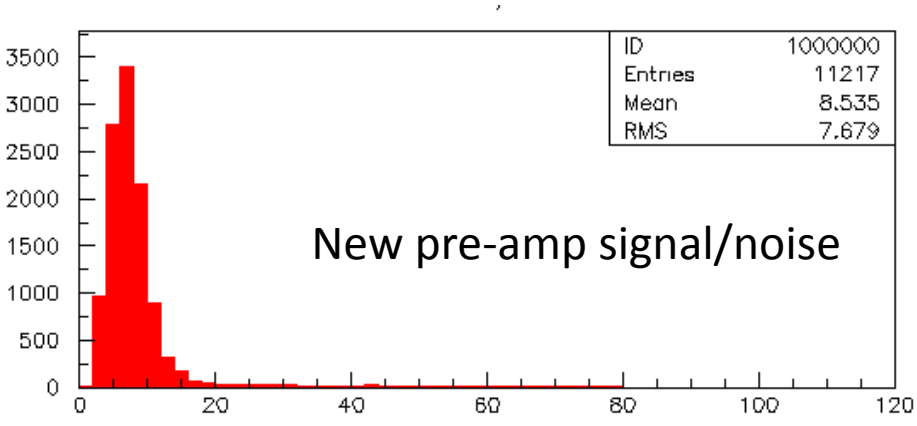
Results on simulation performances to answer the following questions:
- Is the CsI(Tl) not enough good in case of high background level and pile-up?
-Which is the resolution at low energy with pure CsI crystals?
- Which is the advantage in terms of performance with a very fast crystal (pure CsI) to cut background and pile-up?

→ Physics performance will be studied on pi zero reconstructed mass + B→tau nu, B→ K*nunu

Remind…last (good) result

New preamp has been developed at RM3 to enhance S/N for pure CsI crystals





In our setup we gain on S/N a factor 2.6 without shaping. If we had a 12 mV peak (@Test Beam) from cosmic
this would bring our ENE down to 1.5 MeV Single APD no shaping.

Short summary since last meeting

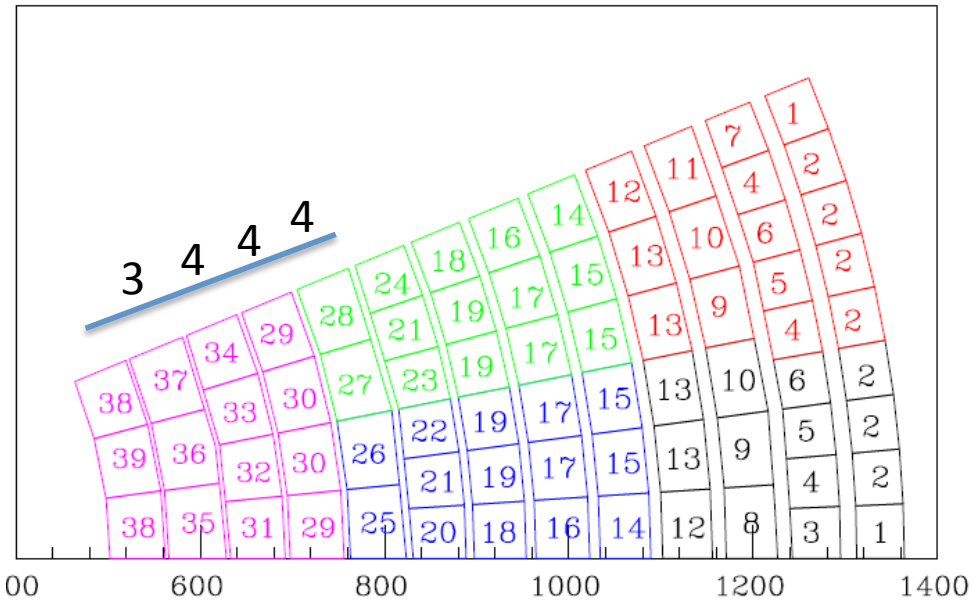
No money from Canada, new request will be prepared this year

Deadline to make the decision on FWD upgrade is fixed to February 2016

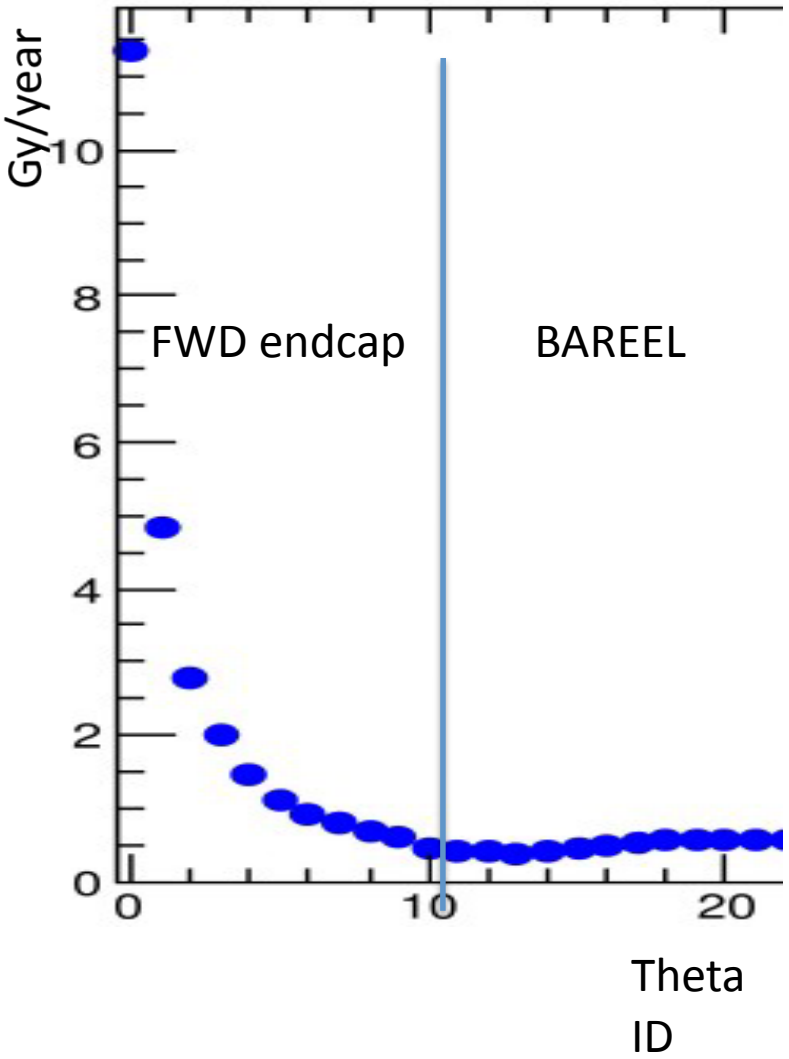
- **we have put in our request 2016 the same amount of money of last year for "APPARATI" SJ to this decision**
- **this includes the starting of the modules construction, crystals + APD + FE and test of the assembled module before the shipping to KEK**
- **our total request amount to a total which was fixed at the beginning (+ correction described in next slides)**

of the project just shifted by 2 years due to the delay of SuperKEKB and related to the more detailed studies necessary to asset the need of the upgrade.

Modules and radiation dose



1 module: 3 + 4 + 4 + 4 = 15 crystals
Replacing only the 4 innermost rings
(excluding the first one)



Remind

Proposta di 4 ring (x 16 moduli in phi) completi da assemblare in ECL + commissioning a KEK

Costo di 4 ring: cristalli per ring dalll'interno (48+64+64+64 = 240)

850 keuro/240 = 3.5keuro/crystal
AMCRYS 3.7 keuro/cristallo for few crystals
OPTOMATERIALS costo cristalli italiani 7keuro/cristallo

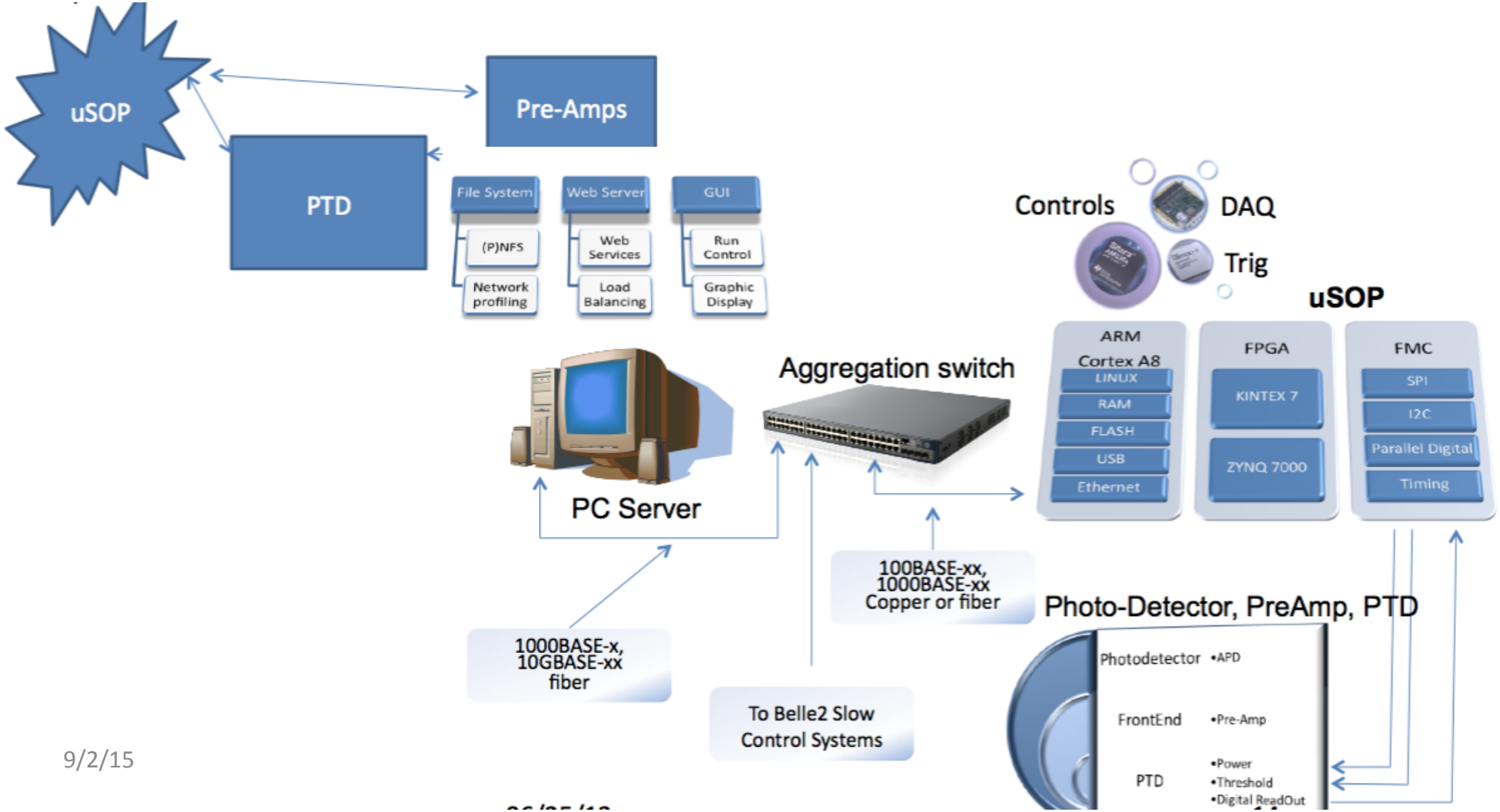
Cristalli	~~670~~ 850 Keuro (ricevuta offerta + dimensione cristalli)
APD-UV	219 Keuro
FE	31 Keuro
PTD	144 Keuro
uSOP	60 Keuro
TOT	1304 Keuro

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

THE COLLABORATION ASKED FOR USOP ALSO IN THE BACKW ENDACAP

USOP

Slow control system for APD Voltage + environment control temperature and humidity. The request of having USOP as monitoring system is independent from the UPGRADE choice



Costing review USOP

PTD 144 Keuro (1152 channels all FWD)
uSOP 60 Keuro (1152 channels all FWD)
Request for the whole endcap FWD (see previous slide)

Now USOP is x2 → about 120 keuro

PTD is related to the FE boards, for the communication with USOP
Dividing the part of PTD necessary for the FE (240 channels) → 104 keuros
→40 Keuros of the 144 can be allocated to USOP: 60 + 40 = 100 keuro

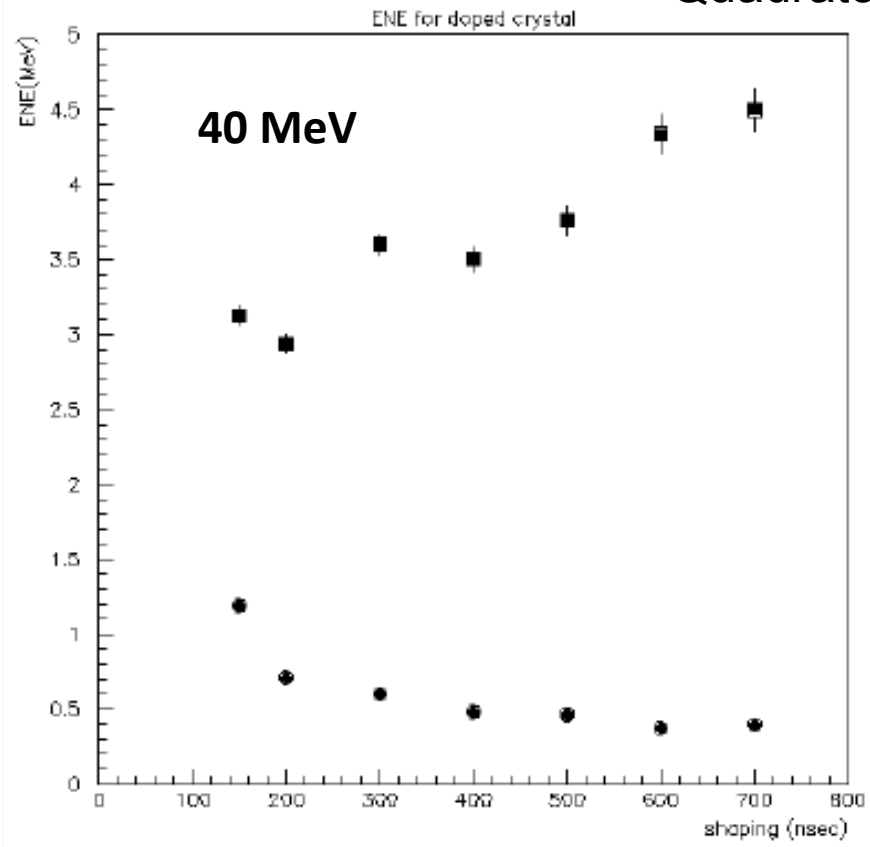
→20 keuro have to be added to the total envelope to fulfill the request of the USOP monitor control for FWD + BACKWD endcap

TOT 1304 Keuro + 20keuro = 1324 Keuro

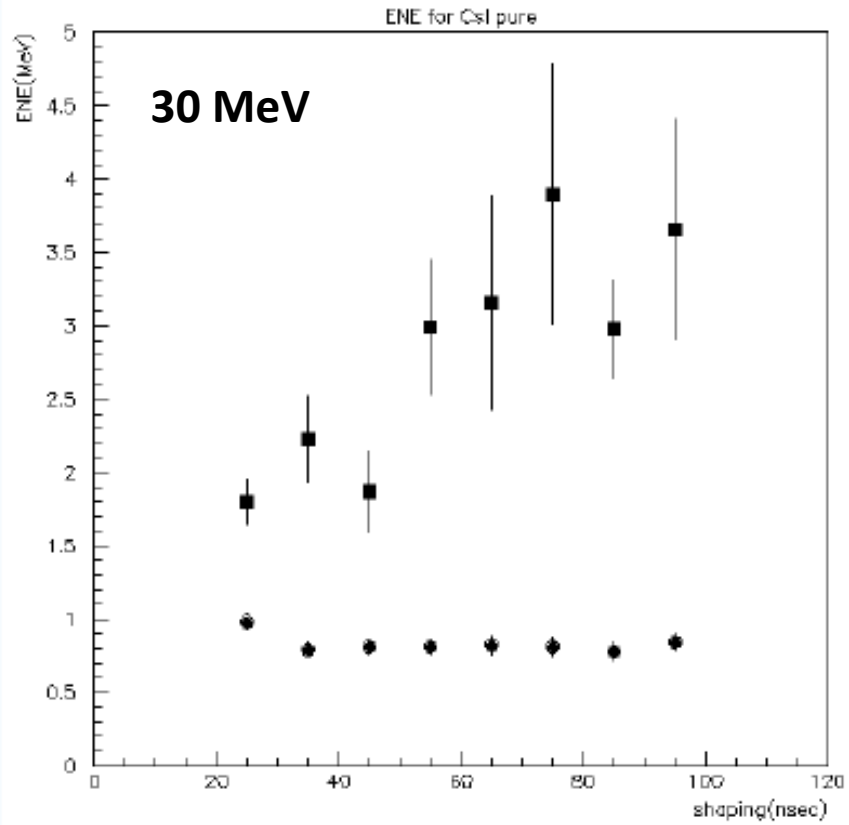
Simulation of pile-up

ENE for CsI(Tl)

Cerchio no pile-up
Quadrato pile-up



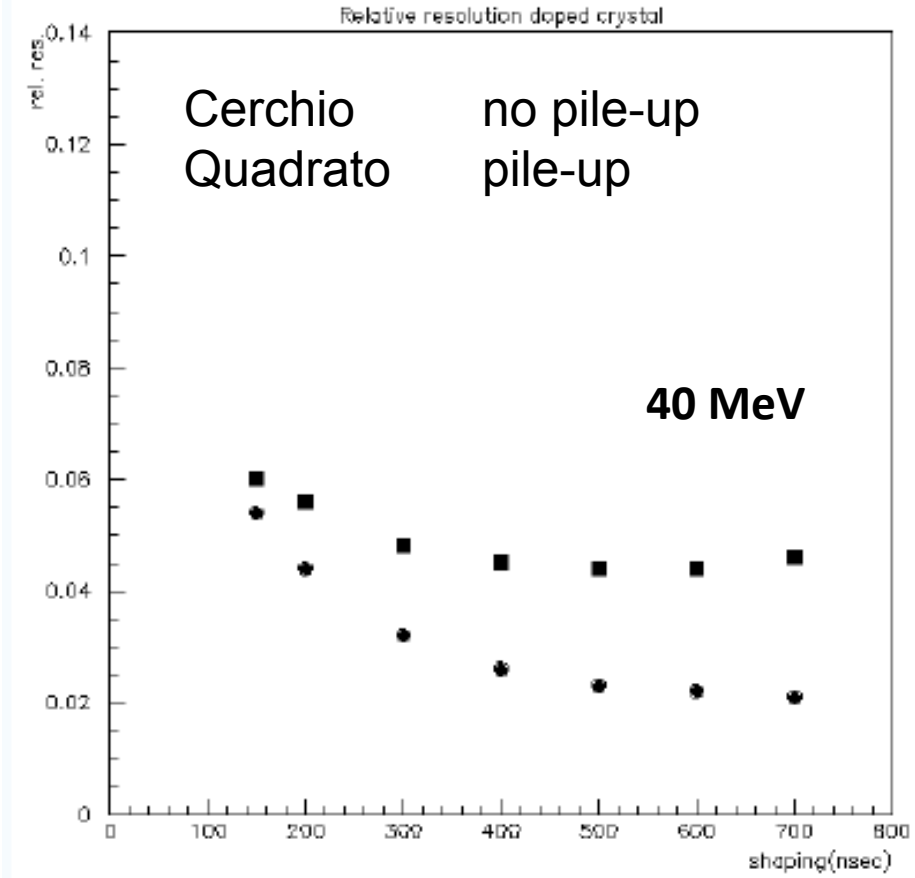
ENE for CsI pure



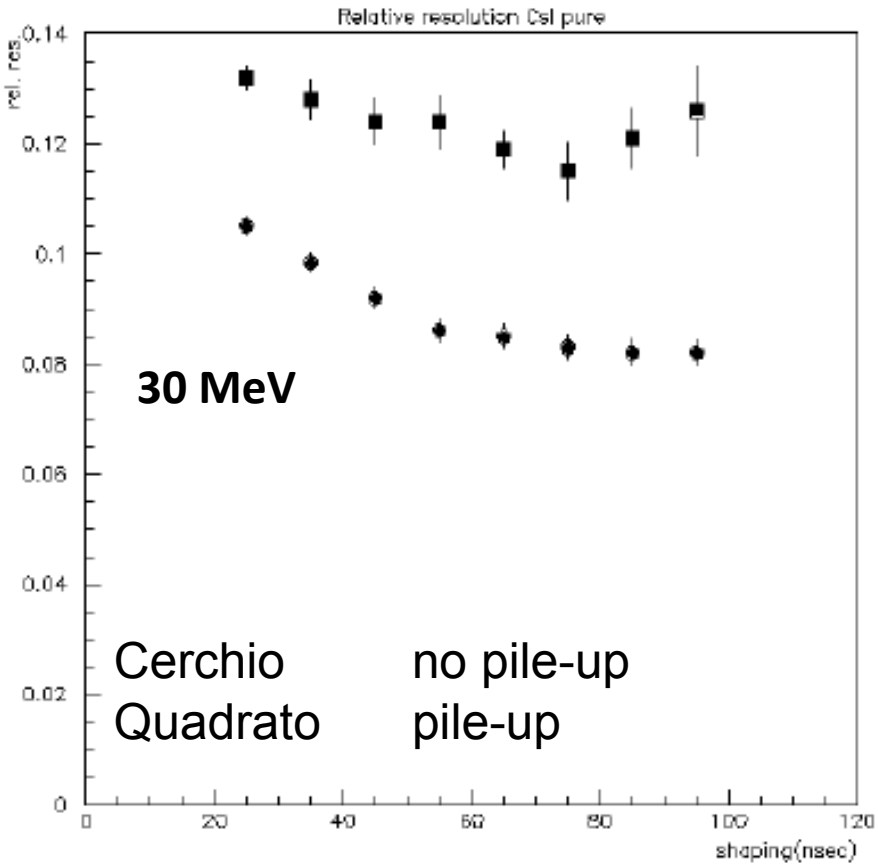
Cosmic data + pile-up added according to the background MC simualtion

Simulation of pile-up

Resolution for CsI(Tl)

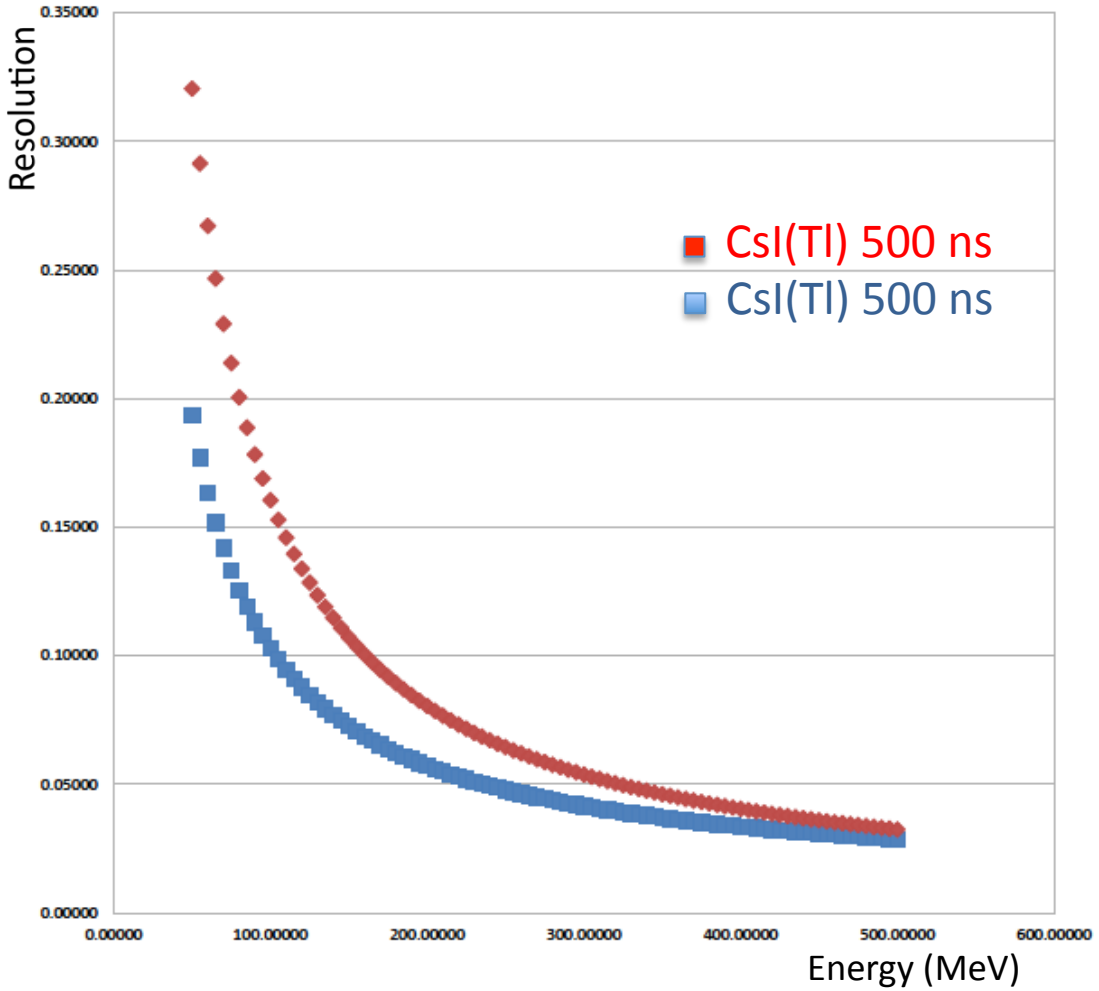


Resolution for CsI pure



Cosmic data + pile-up added according to the background MC simualtion

What about the expected resolution?



Evaluation of the relative resolution vs. energy:
Blue plot: pure CsI @ 55 nsec
Red plot: CsI(Tl) @ 500 nsec

Isolated gamma's : 25 crystals added
No constant term has been used;
(Don't believe should make much difference.)

Configs and technology dependent params

- Configs:

Xtal	photodet	τ_{sh}/ENE
CsI	LAAPD	50-100ns / 1 MeV
CsI(Tl)	LAAPD	100-200 ns / to be measured
CsI(Tl)	PIN	500 ns / 0.35 MeV
CsI	PP	30 ns / 0.1 MeV

- Tech-dependent params:
  - Crystal light yield
  - photodetector electronic noise
  - electronic shaping time

- NB: a detailed study of the different configs needs precise inputs from lab measurement, we'll provide them by ~ September, here we give some suggestions on how to make preliminary test changing some of the digitizer params

Matrices and array used in the Digitizer (I)

- Params used when converting Hit into digitized signal (cat. A)
  - m_ft[1250]: signal parameterization vector
  - m_elecNoiseM[31][31]: covariance matrix

- These does not depend on machine background since parameterize the signal itself (accounting for electronic noise, used shaping time)
  - they can be extracted from:
    - lab set-up (xtal+phtodet+el chain) with cosmic data --> m_ft
    - lab set-up (xtal+phtodet+el chain) with random trigger --> m_elecNoiseM

  using the machinery Guglielmo and Alex B are setting up

- At first attempt:
  - the covariance matrix elements, as contained in the config root file, are computed with an arbitrary scale factor of 20, to change the effect of the electronic noise this scale factor can be changed.
  - the light yield is currently fixed, multiplying the Geant energy deposit by a scale factor of 20000, this can be changed to decrease the light yield.

BEAST

Goals:

1. Protect Belle II: Ensure radiation levels safe before Belle roll-in
2. Measure individual beam background components
3. System tests (beam abort, VXD occupancy, cooling, mask control system)
4. Provide real-time feedback to SuperKEKB

Phase 1 Jan 2016

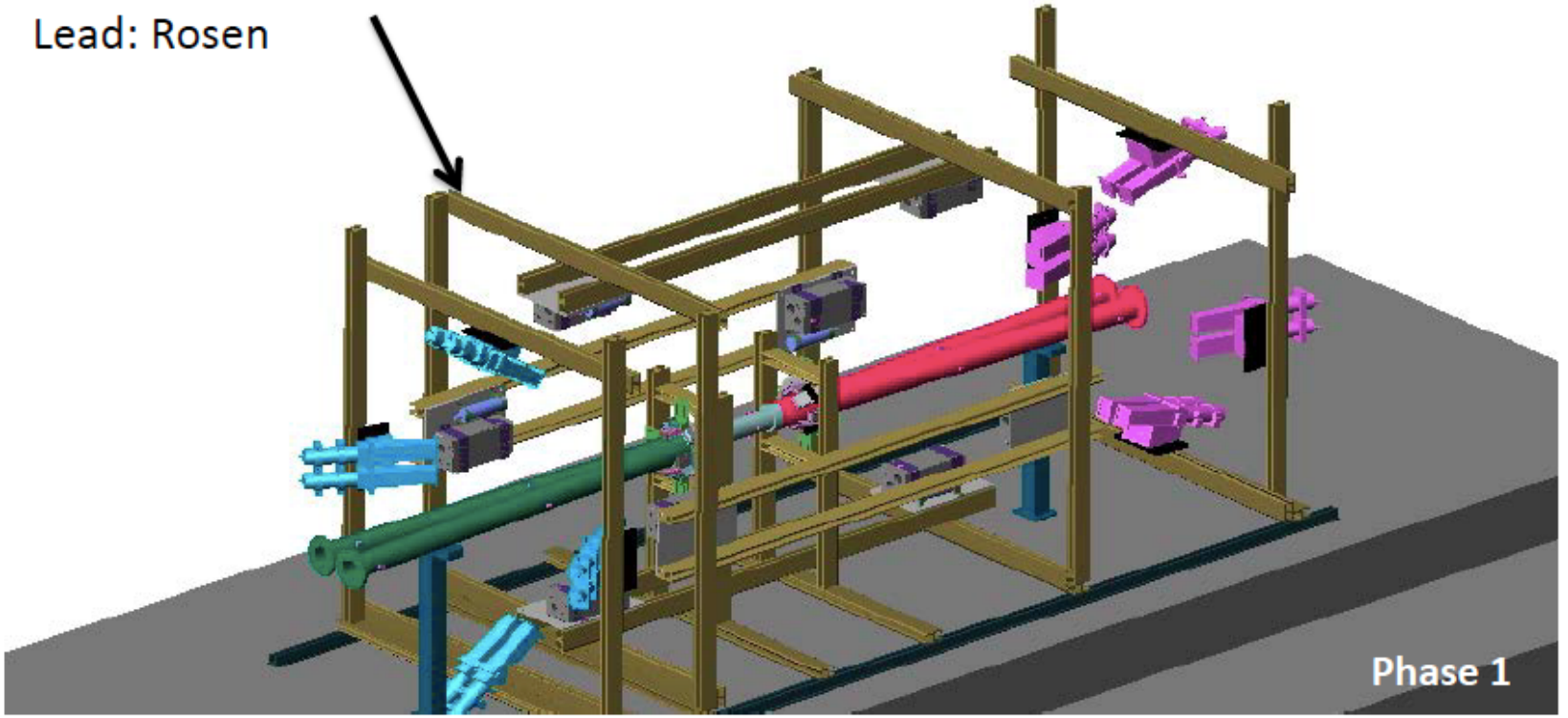
Scrubbing of beam pipe
No collisions, Belle will not roll in
Variety of subsystems on fiberglass support structure

Phase 2 Feb 2017

Belle rolled in
VXD BEAST
He-3 and TPC neutron detectors in VXD dock space

Phase 1: design

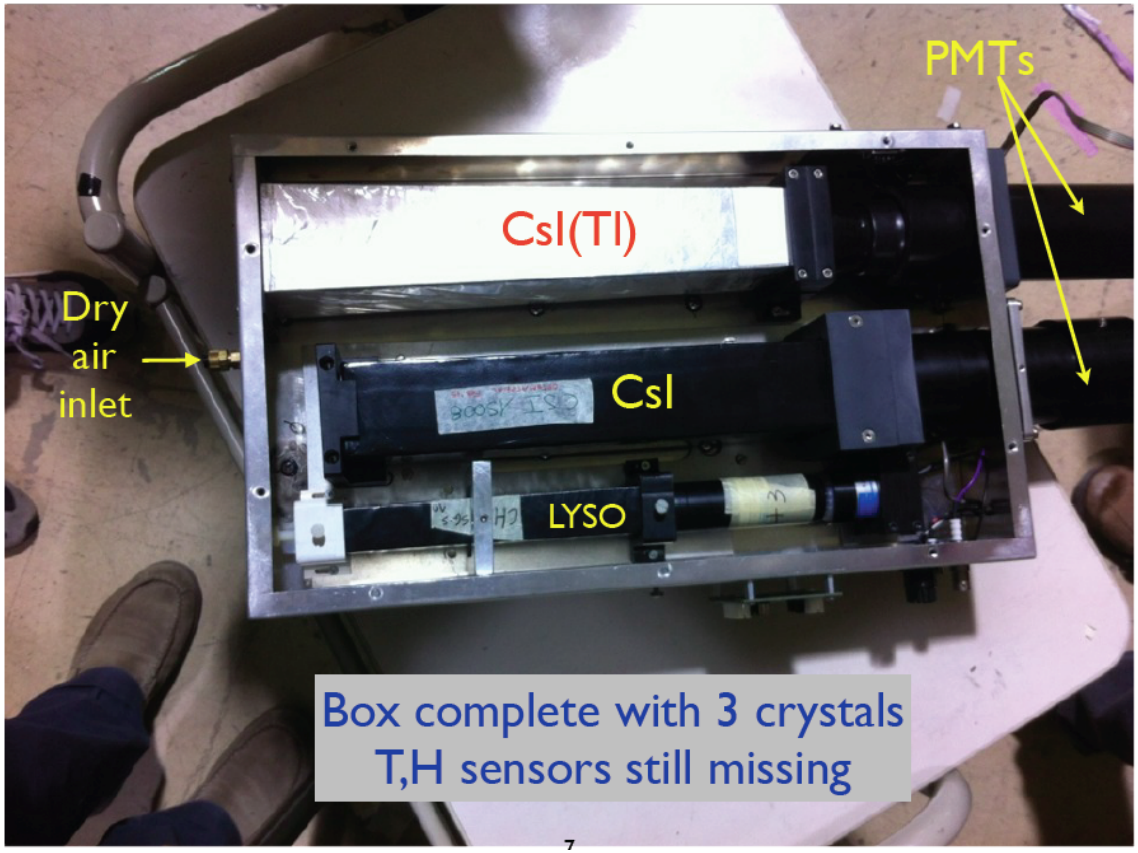
- Hawaii delivering phase 1 mechanical mounting structure
- Lead: Rosen



- Variety of detector systems on fiberglass support structure
- Some detectors (TPCs, He-3 tubes, PIN diodes) can be easily moved manually
- Full 3D CAD exists (Rosen). Also has been incorporated in the Belle II simulation (Jaegle).
- All parts procured, most assembly, to be used for "MiniBEAST" system test January 2015.
- Disassemble and ship to KEK August 2015.

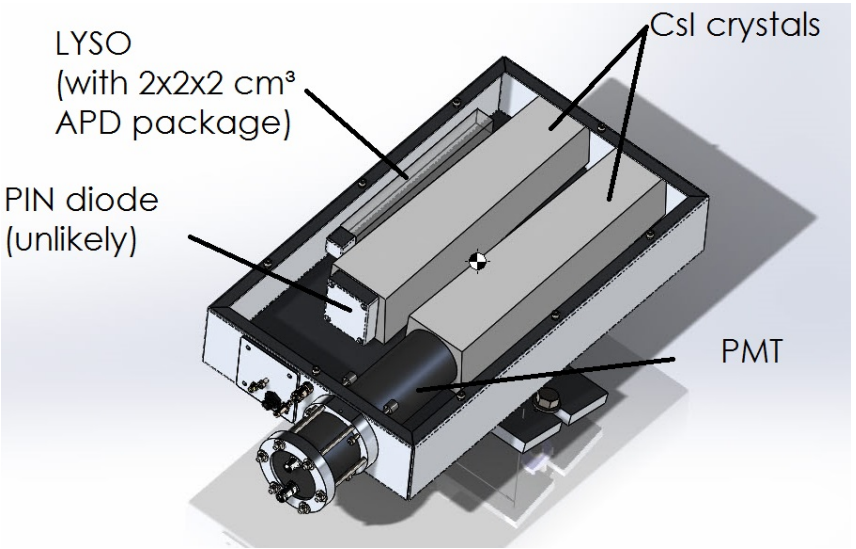
Crystals: CsI + LYSO

Use 6 CsI pure + 6 CsI(Tl) + 6 LYSO for BCKG and dose measurement (validation simualtion)

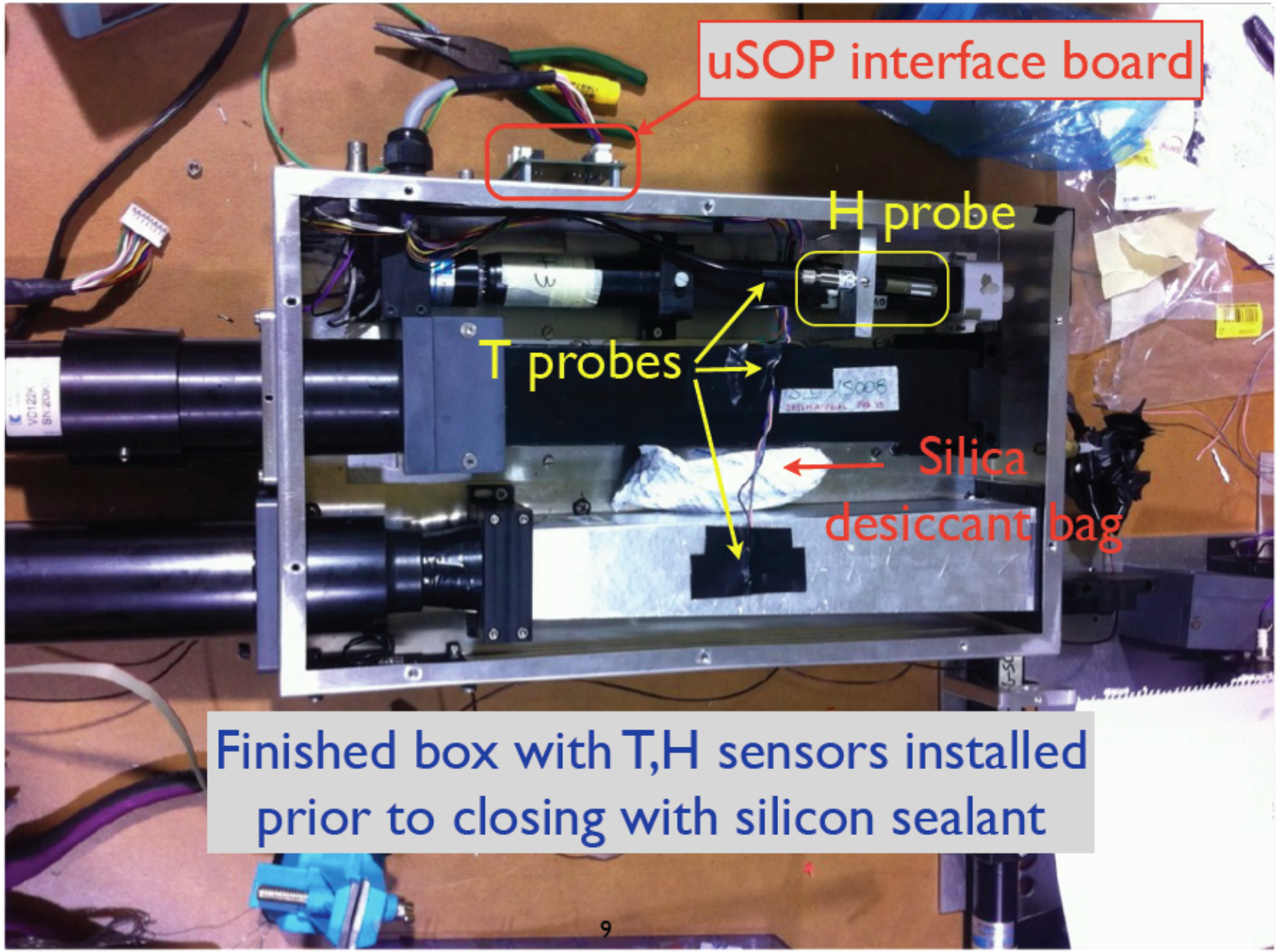


REALITY!

CAD



Box completed



Installation @ IP

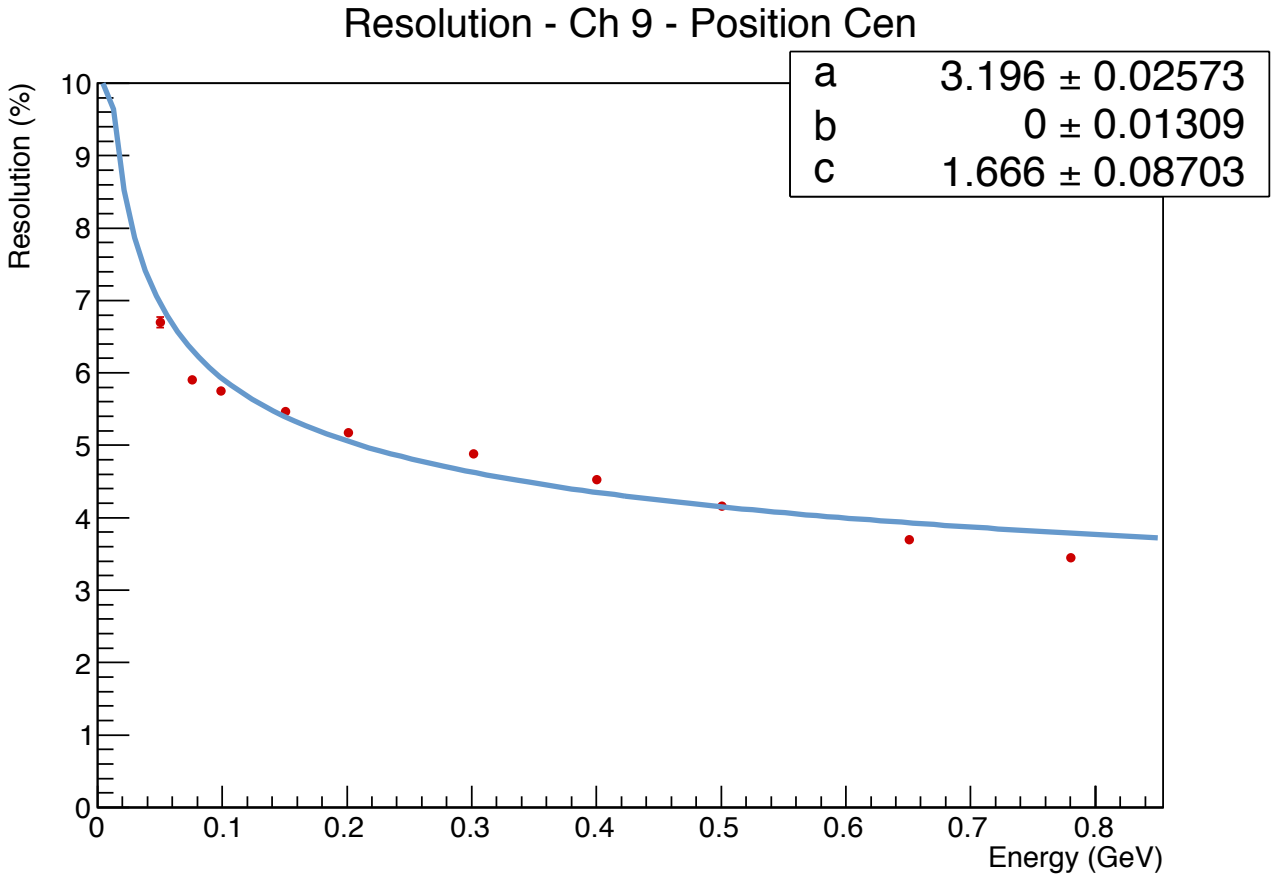
- All six boxes have been installed on the support structure, we have connected all the HV, signal and uSOP.
- We have successfully powered the PMT and read out signals in the counting room of all LYSO, CsI and CsI(Tl) crystals.
- We have routed dry air tubing from the Hall to the boxes as a backup solution in case the humidity inside the boxes should be excessive

TEST BEAM 2014 @Mainz

Matrix of 16 pure CsI crystals with LAAPD readout

NO SHAPING APPLIED!

Ch0	Ch1	Ch2	Ch3
Ch4	Ch5	Ch6	Ch7
Ch8	Ch9	Ch10	Ch11
Ch12	Ch13	Ch14	Ch15



Conclusions

- Upgrade decision is approaching → physics results coming soon → BPAC Feb. 2016
  - Software activities progressing fast
- Activities on BEAST are proceeding very well
- USOP as monitoring system will be installed for the whole endcap
- Test Beam Mainz, first results are very good, detailed analysis soon

CONSUMI

PG

1. ECL: tooling per assemblaggio meccanica	**5.00 (SJ)**
2. ECL: struttura meccanica x test su cristalli costruzione	**30.00 (SJ)**

RM1

1. ECL:Irraggiamenti gamma e neutroni su APD e cristalli	**6.00 (SJ)**
2. ECL:Consumi di laboratorio	**4.00 (SJ)**

RM3

1. ECL:consumo per chiusura R&D sul sistema HV	12.00

APPARATI

Item	Belle2	BEAST	K€
uSOP boards (uSOP + T-Controller + Cable_Adapter + Carrier board + box)	8	2	40
Crate + power supply + backplane	2	1	5
Patchpanels (materiali, lavorazione mecc., connettori, cablaggi)	2	1	7
Switch	4	2	36
Power Distribution Unit	4	2	9
Cavi (patch to crate) (cavi, connettori, cablaggi)	32	6	7
PC server da rack	2	1	5
Spedizioni			8
Cavi (sectors to uSOP)	32	-	10 s.j.

NA 109 Keuro + 10SJ: USOP

APPARATI

PG 55 Keuro:

costruzione primo modulo (SJ approvazione upgrade FWD)
Cristalli + APD + FE

MISSIONI LNF

1. ECL:workshop Belle2-ECL (3 pers x 2 mtg) 5.50
2. ECL:Partecipazione turni presa dati BEAST (2 m.u.) 12.00
3 . ECL:Spostamento, assemblaggio, test inizio costruzione ECL a KEK **6.00** (SJ)

MISSIONI NA

1. ECL:turni beast (2 m.u.) 12.00
2. ECL:installazione uSOP su FWD e BWD endcaps ECL a KEK (2 m.u.) 12.00
3. ECL:Meeting ECL Italia (6 persone) 4.00
4. ECL:Workshop ECL Belle II (2 persone x 2 workshops) 3.50

MISSIONI PG

1. ECL:Coordinatore ECL 5.00
2. ECL:Spostamento, assemblaggio, test inizio costruzione ECL a KEK **6.00** (SJ)
3. ECL:turni beast (2 m.u.) 12.00
4. ECL:workshop Belle2-ECL (2 pers x 2 mtg) 3.50
5. ECL:ECL Italia meeting 4.00
6. ECL:Contatti produttori cristalli italiani 3 viaggi 2 pers **6.00** (SJ)

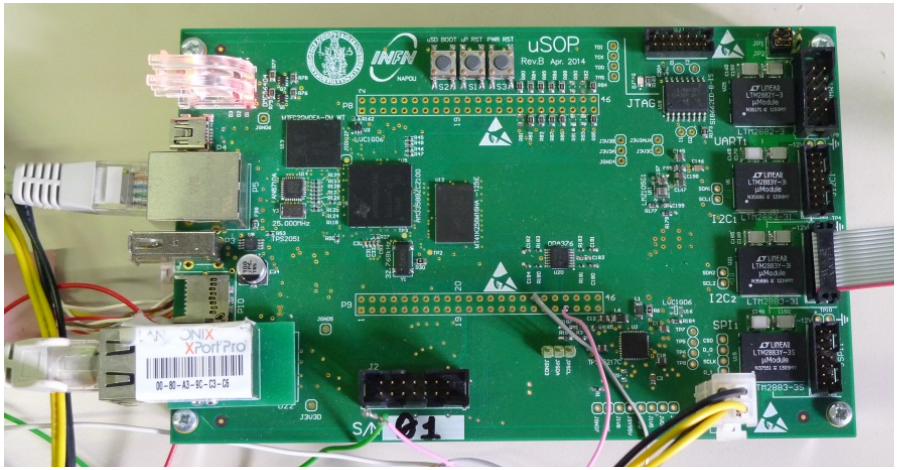
MISSIONI RM1

1. ECL:Contatti produttori cristalli italiani 3 viaggi 2 pers	**6.00** (SJ)
2. ECL:workshop Belle2-ECL (2 pers x 2 mtg)	3.50

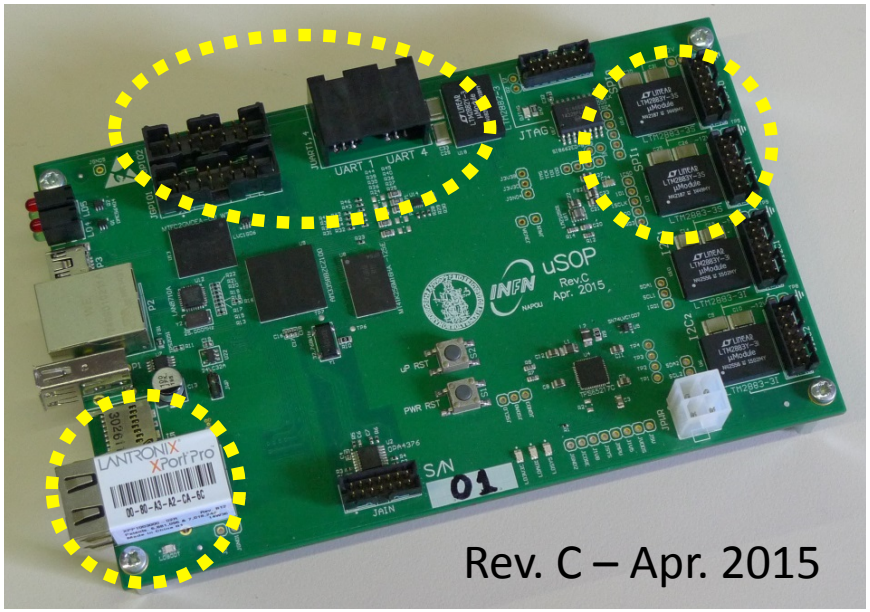
MISSIONI RM3

1. ECL:Presenze per turni di beast 2 m.u.	12.00
2. ECL:presenza esperto di rete 0.5 mu	3.00

uSOP Rev. C



Rev. B – Apr. 2014

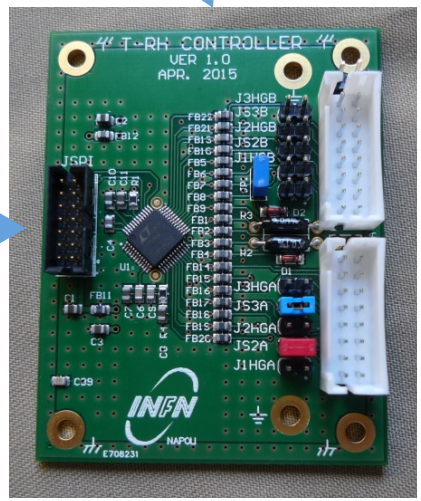


Rev. C – Apr. 2015

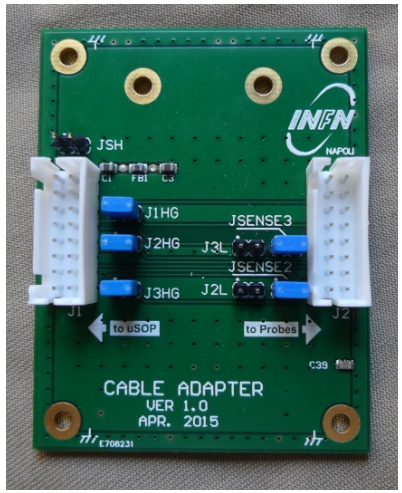
- Rev. C fixes all minor bugs found in Rev. B
- 2x SPI, 2x I2C, 2x UART, 1x JTAG, GPIO with advanced features
- 4 GB Flash (was 2GB)
- Full remote control of boot options and power

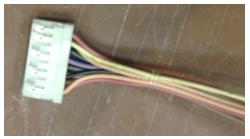
Schema di lettura

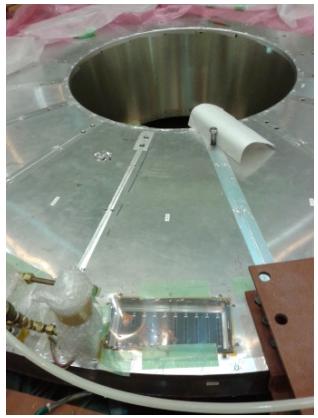
T-Rh Controller

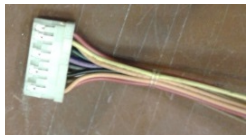


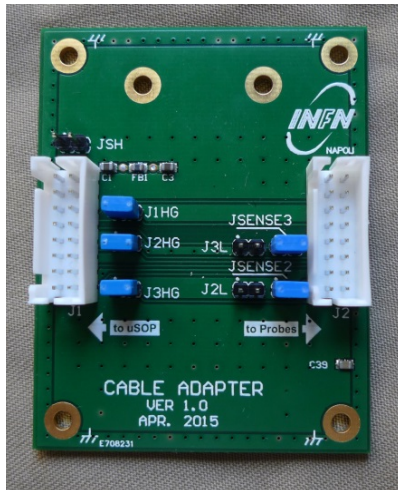
To uSOP







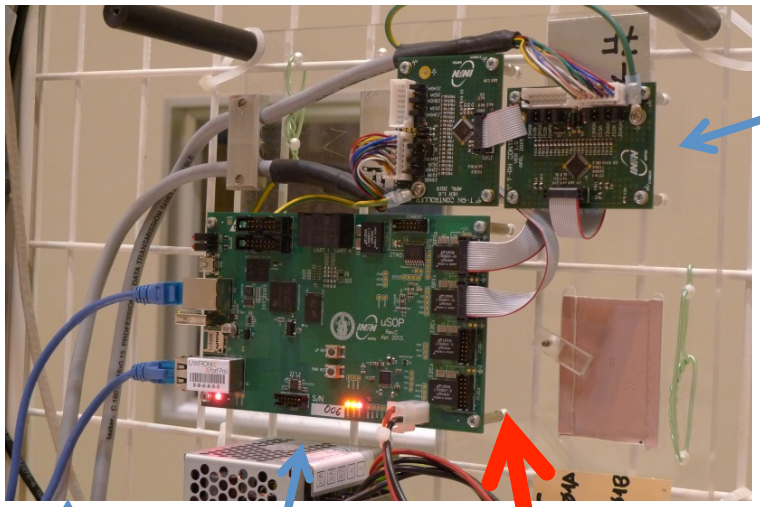




Cable Adapter (passive):

- Selects grounding scheme
- Filters the power to the VAISALA Rh probe
- Sets 2, 3 or 4 wire (Kelvin) read-out

Cablaggi con il Forward



T-Rh Controller

Sectors 7F and 8F

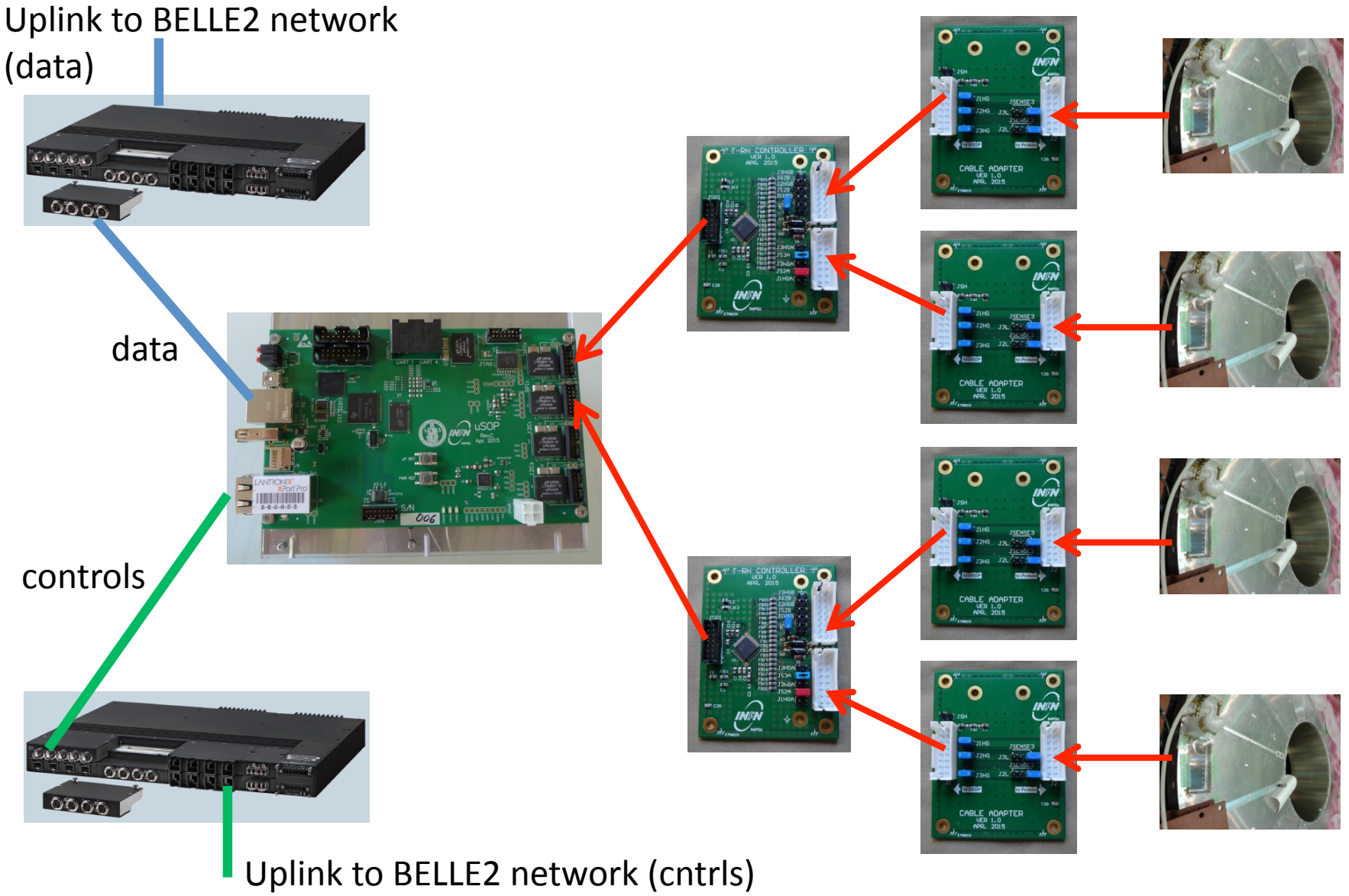
uSOP Rev. C

Cable harness
to sectors

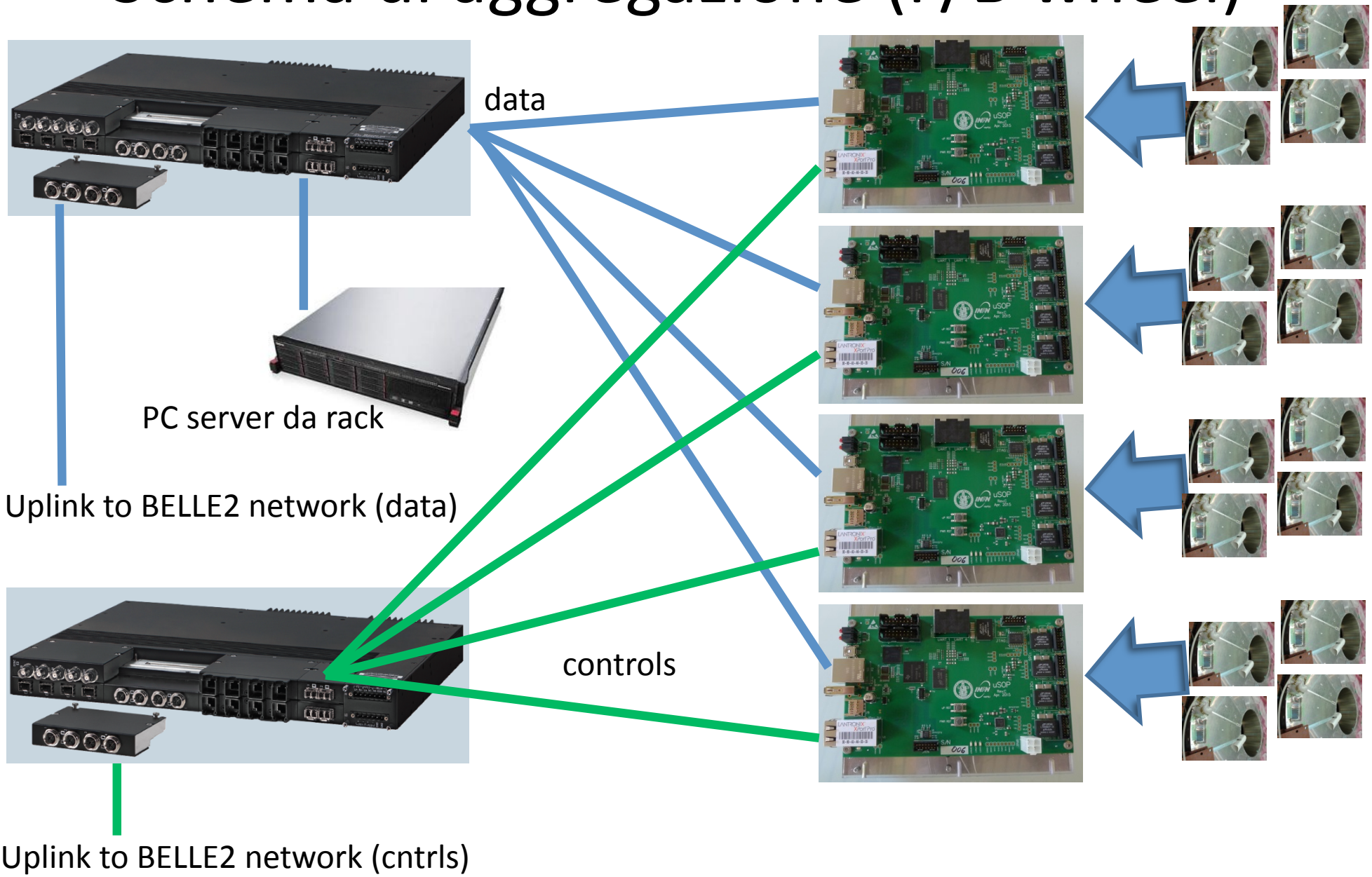
Cable Adapters

Endcap wheels in the
Fuji Hall , KEK– CSI booth
(Jun. 2015)

Schema di aggregazione (4 settori)



Schema di aggregazione (F/B wheel)



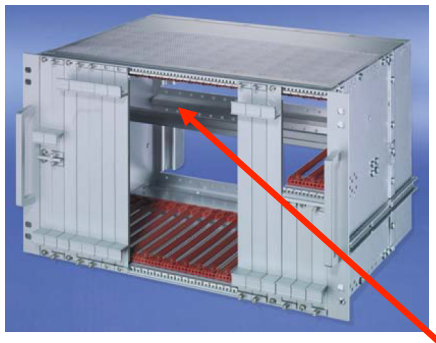
Aggregation switch: RSG2488

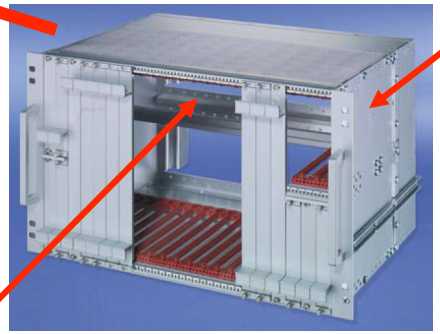
- Modular architecture
  - Field upgradable
  - Mixed O/E ports
  - Supports IEEE1588 time synch

- Rugged performance
  - Immunity to EMI and heavy electrical surges
  - Hot swap power supply
  - Remote monitor
  - Managed
  - Port configuration, status, statistics, mirroring, security

Hardware Layout

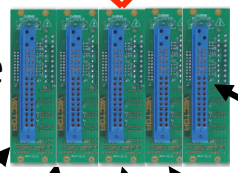
Belle2 E-hut (Jun.2015)



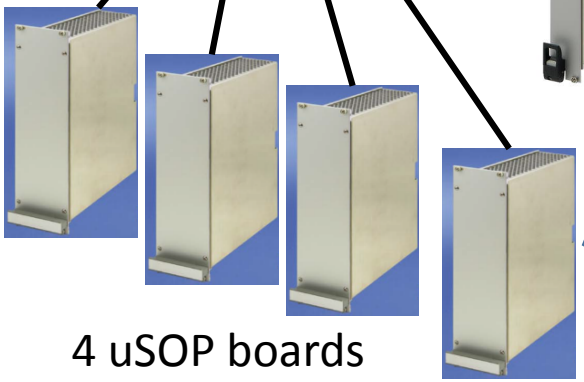


6U Eurocard crate (per wheel)

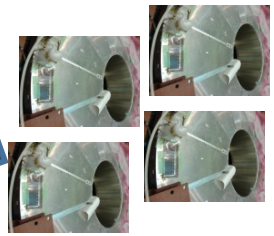
Backplane



Power supply

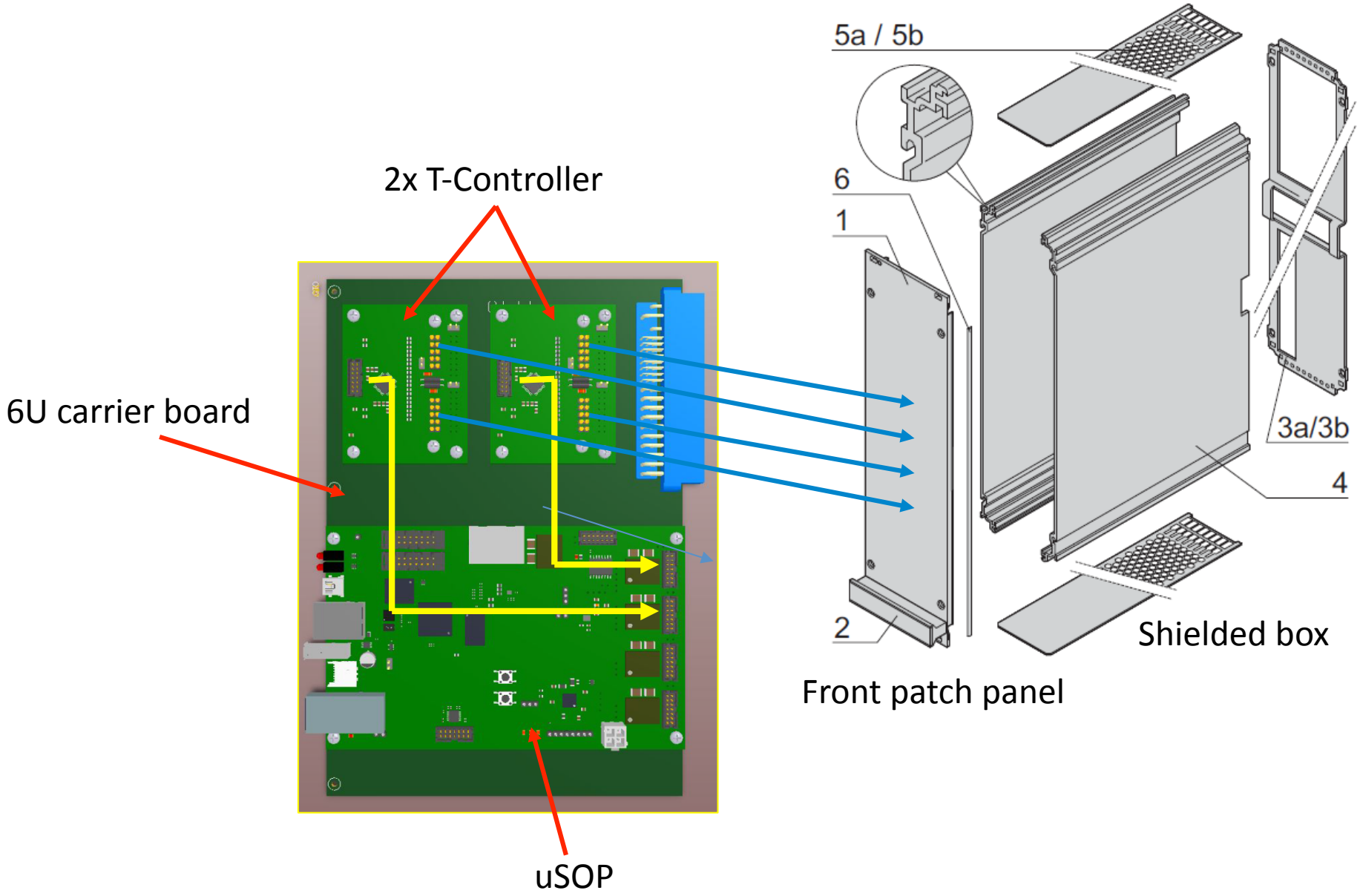


4 uSOP boards



4 sectors per uSOP

uSOP Board (6U Eurocard)



Monitoring Architecture (per wheel)

uSOP	4
T-Rh Controller	8
Cable Adapter	16
Switch	2
Power Distribution Unit	1
Crate	1
Power Supply	1
Patch Panel	1