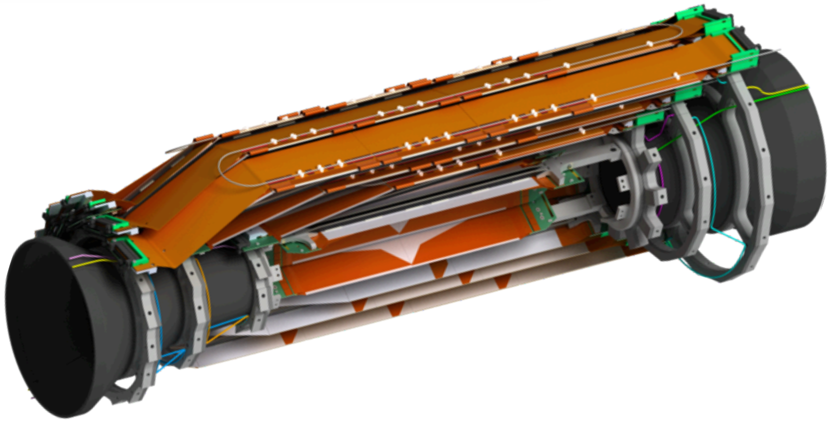
Presentazione in sezione preventivi 2016



S.Bettarini

per il gruppo Belle-II Pisa

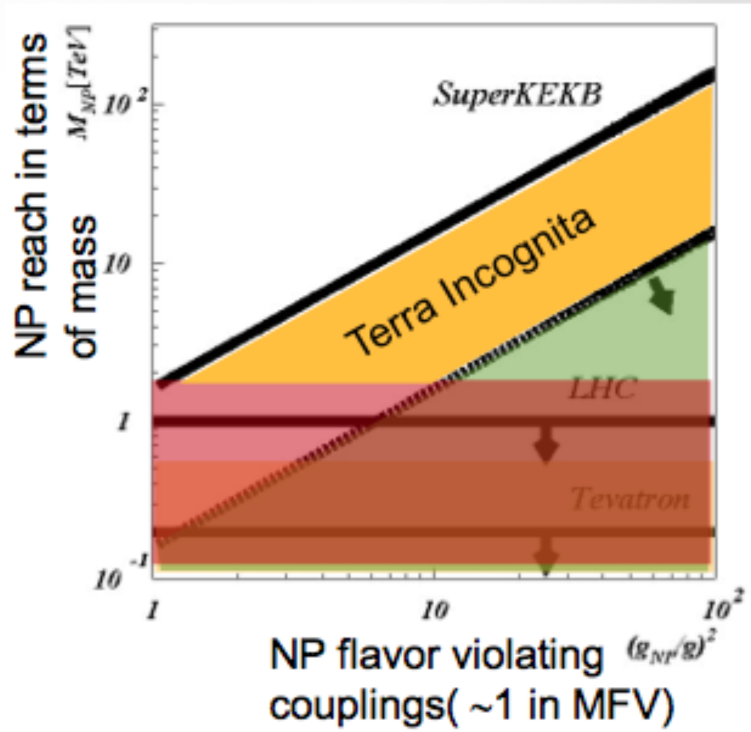
8 Luglio 2015

Sunto

- Introduzione: la fisica del flavour
- L'acceleratore SuperKEKB :
  - Status/Schedule/Luminosity profile
- Il detector Belle-II / la partecipazione italiana
- Attivita' gruppo di Pisa:
    - SVD: costruzione moduli
    - SW Tools
    - Computing
- Richieste ai servizi di sezione
- Manpower & Richieste INFN ($)
- Conclusioni

Flavour Physics: Power of Intensity

- Precision measurements in the flavour sector are sensitive to New Physics (NP)
  - Intereference effects in known processes
  - SM Rare or forbidden decays
- NP effects are controlled by
  - NP scale Λ and effective couplings: C
    - Different coupling intensity (different interactions)
    - Different patterns (e.g. because of simmetries)
- With 5 to 10 x 10^{10} bb, cc, ττ pairs (50-100 ab^{-1}) one can:



LHC finds NP(Λ)

- Determine detailed structure of couplings of NP
- Look for heavier states
- Study NP flavour structure

LHC does not find NP(Λ)

- Look for indirect NP signals
- Connect them to models
- Exclude regions in parameters space

Some channels, such as the LFV decays of τ are unambiguous signals of NP

$L \sim 10^{34}\ cm^{-2}\ s^{-1} \leftrightarrow$ EW scale ~100GeV

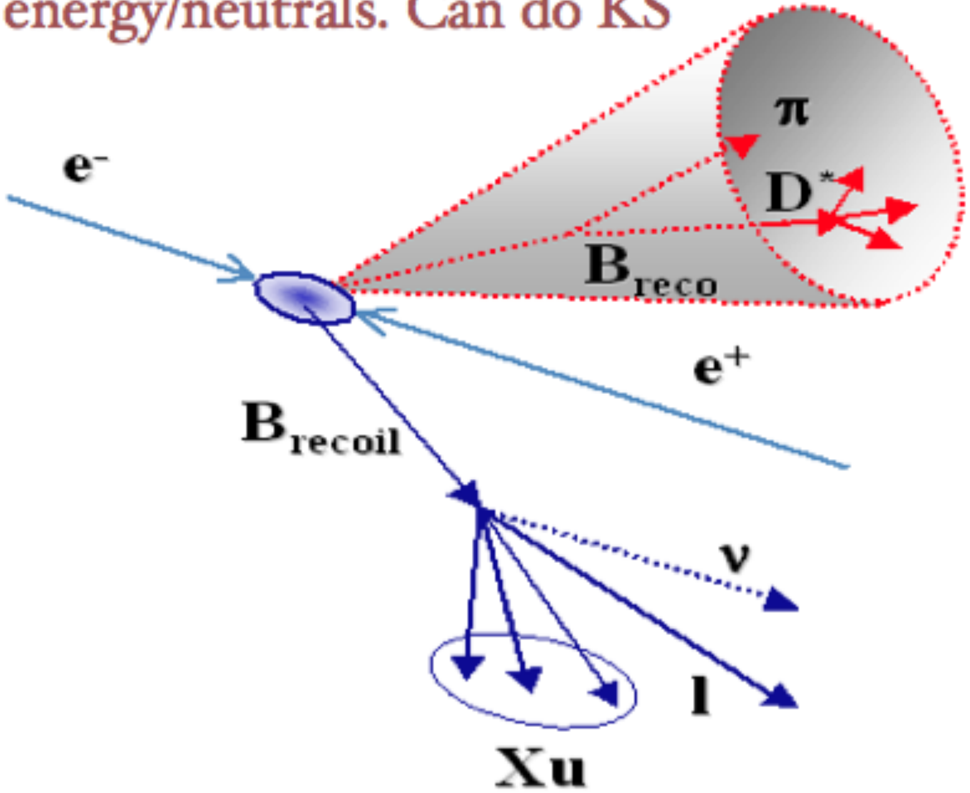
$L \sim 10^{36}\ cm^{-2}\ s^{-1} \leftrightarrow$ TeV scale

Cross section is not everything

- Hadron machines do have the advantage of an enormously larger B production cross section, ...BUT...
- Belle-II have a super-easy ½ track trigger (or even single photon...)
- Initial state is coeherent, allowing interference measurements
- Can do states with a lot of missing energy/neutrals. Can do KS
- Belle-II can do τ physics.

B-Beam Method

- Fully reconstruct one the two Bs in hadronic modes
  - High efficiency: a few per mille
  - > 10^7 recoil Bs in $10ab^{-1}$
- Obtain a pure B Beam on the other side
  - High purity sample
  - Can look at channels with a lot of missing energy.
  - For example BR(B→nothing) measured.



Recoil kinematics well known
Recoil flavor and charge is determined

Physics at Belle II

Since NP is not discovered yet, its manifestations are unknown. We should look everywhere. Our focus is on

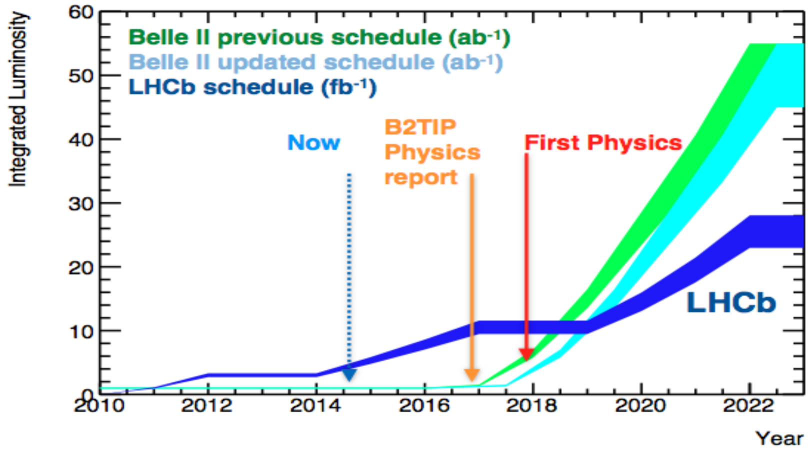
- Precise CKM measurements
- CPV in quarks and charged leptons
- Missing energy:
  - $B\to\ell\nu$
  - $B\to D^{(*)}\tau\nu$
- Charged LFV: $\tau\to\ell\gamma$, $\tau\to\ell\ell\ell$, ℓ=e, μ
- Quarkonium
- Low multiplicity

Comparison

- Luminosity assumptions
- Belle-II: $50ab^{-1}$

f

- LHCb: $10ab^{-1}$



Observable	Expected th. accuracy	Expected exp. uncertainty	Facility
CKM matrix			
$\|V_{us}\|$ $[K \to \pi \ell \nu]$	**	0.1%	K-factory
$\|V_{cb}\|$ $[B \to X_c \ell \nu]$	**	1%	Belle II
$\|V_{ub}\|$ $[B_d \to \pi \ell \nu]$	*	4%	Belle II
$\sin(2\phi_1)$ $[c\bar{c}K_S^0$	***	$8 \cdot 10^{-3}$	Belle II/LHCb
ϕ_2		1.5°	Belle II
ϕ_3	***	3°	LHCb
CPV			
$S(B_s \to \psi\phi)$	**	0.01	LHCb
$S(B_s \to \phi\phi)$	**	0.05	LHCb
$S(B_d \to \phi K)$	***	0.05	Belle II/LHCb
$S(B_d \to \eta' K)$	***	0.02	Belle II
$S(B_d \to K^*(\to K_S^0\pi^0)\gamma))$	***	0.03	Belle II
$S(B_s \to \phi\gamma))$	***	0.05	LHCb
$S(B_d \to \rho\gamma))$		0.15	Belle II
A_{SL}^d	***	0.001	LHCb
A_{SL}^s	***	0.001	LHCb
$A_{CP}(B_d \to s\gamma)$	*	0.005	Belle II
rare decays			
$\mathcal{B}(B \to \tau\nu)$	**	3%	Belle II
$\mathcal{B}(B \to D\tau\nu)$		3%	Belle II
$\mathcal{B}(B_d \to \mu\nu)$	**	6%	Belle II
$\mathcal{B}(B_s \to \mu\mu)$	***	10%	LHCb
zero of $A_{FB}(B \to K^*\mu\mu)$	**	0.05	LHCb
$\mathcal{B}(B \to K^{(*)}\nu\nu)$	***	30%	Belle II
$\mathcal{B}(B \to s\gamma)$		4%	Belle II
$\mathcal{B}(B_s \to \gamma\gamma)$		$0.25 \cdot 10^{-6}$	Belle II (with 5 ab^{-1})
$\mathcal{B}(K \to \pi\nu\nu)$	**	10%	K-factory
$\mathcal{B}(K \to e\pi\nu)/\mathcal{B}(K \to \mu\pi\nu)$	***	0.1%	K-factory
charm and τ			
$\mathcal{B}(\tau \to \mu\gamma)$	***	$3 \cdot 10^{-9}$	Belle II
$\|q/p\|_D$	***	0.03	Belle II
$arg(q/p)_D$	***	1.5°	Belle II

Belle2-Theory Interface Platform

The "Belle II-Theory Interface Platform" is an initiative to coordinate a joint theory-experiment effort to study the potential impacts of the Belle II program.

2 meetings a year, gathering theory experts and Belle II members, starting from June 2014.

What's new in Belle II compared to Babar/Belle?
- ➡ Efficiencies and precision of the new hardware
- ➡ New analysis softwares and methods

What's new in theory after Babar/Belle & LHCb result?
- ➡ Progresses in QCD
- ➡ New physics models and their constraints
- ➡ New observables

NEW IDEAS

Deliverable: "KEK yellow report" by the end of 2016

8 working group + New physics working group

I. Inclusive semi-leptonic (Vub, Vcb, mb) & Exclusive semi-leptonic and pure leptonic (Vub, Vcb, new physics)

II. Electroweak penguins (inclusive, exclusive, semi-inclusive b->s l+l-, angular analysis, very rare) & Radiative penguins (inclusive, exclusive b-> s/d gamma, CP violation, polarisation, very rare)

III. Hadronic decays (charmless decays, direct CP violation)

IV. Phi_1 (tree, penguins, new physics) & Phi_2 (penguin/tree interference)

V. Phi_3 (time dependent/independent)

VI. Charm (CPV, hadronic, leptonic, semi-leptonic decays, spectroscopy)

VII. Tau (LFV, CPV, alphas) & Low multiplicity & EW

VIII. Upsilon (nS) (dark matter, mb measurements etc, energy scan)&Charmonium (conventional, exotics XYZ)

➡ **Belle II & New Physics**

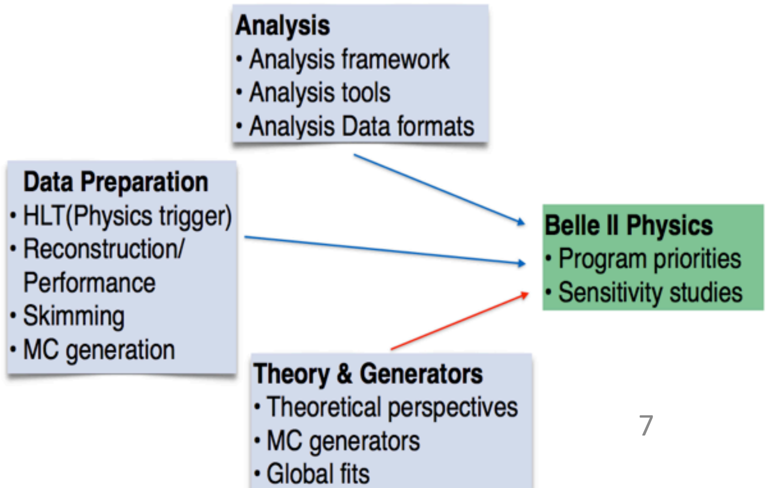
Recent Key Reports

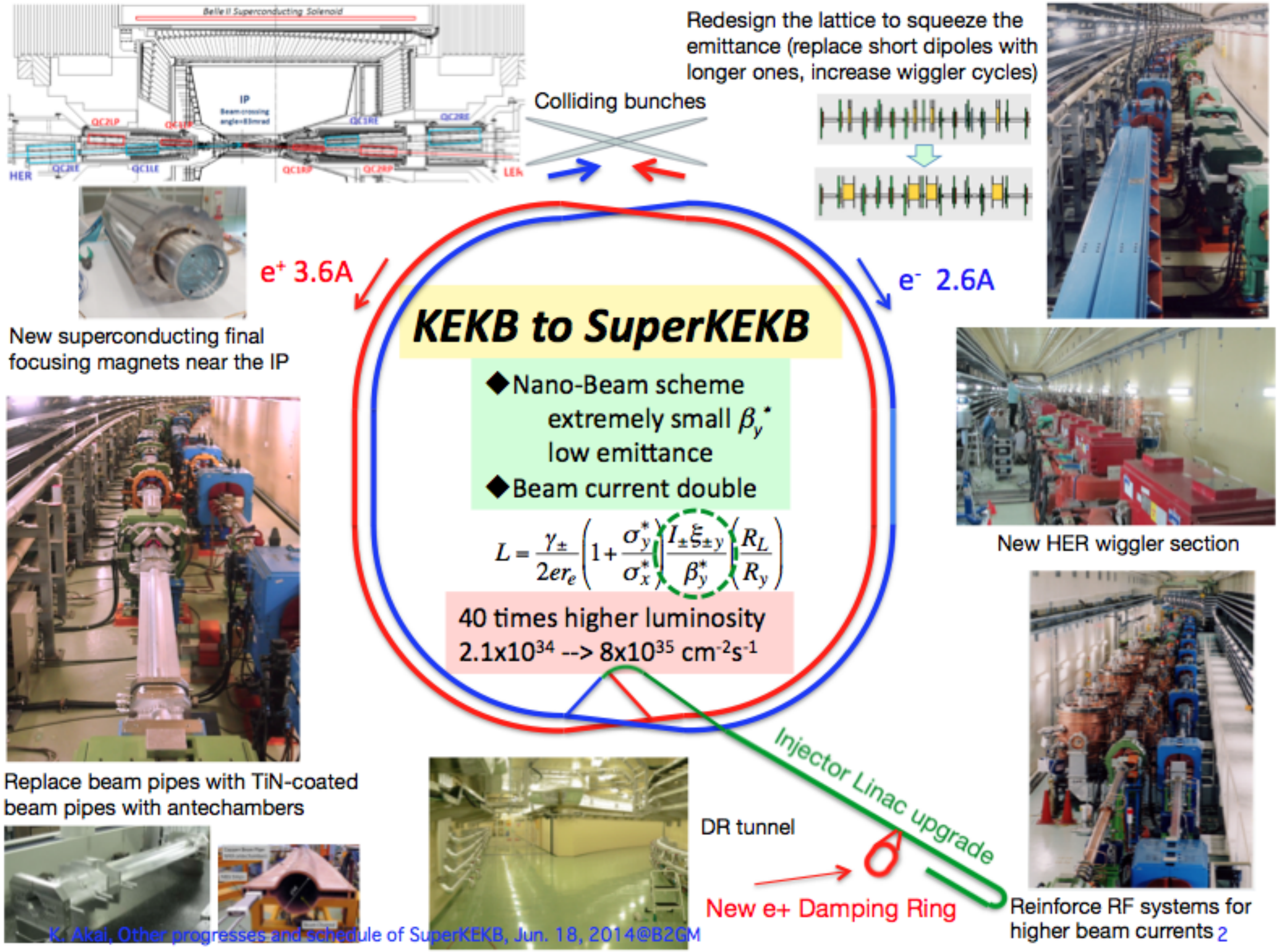
2010 Belle II TDR | 2010 Physics at Super B Factory | 2013 SuperB TDR | 2014 SuperKEKB TDR in preparation (Physics Chapter Avail.) | 2014 Belle II Physics (Naive Projections, In Prep.)

2012 LHCb Upgrade physics implications | 2013 LHCb Upgrade physics update

Near future Belle II (pub) notes:
First physics program→ *Task force.*
Non-flavour topics:
Quarkonium.
Direct NP searches.
EW, fragmentation, Low multi.

B2TIP report in 2016: Major deliverable for physics groups. ->*Publish.*



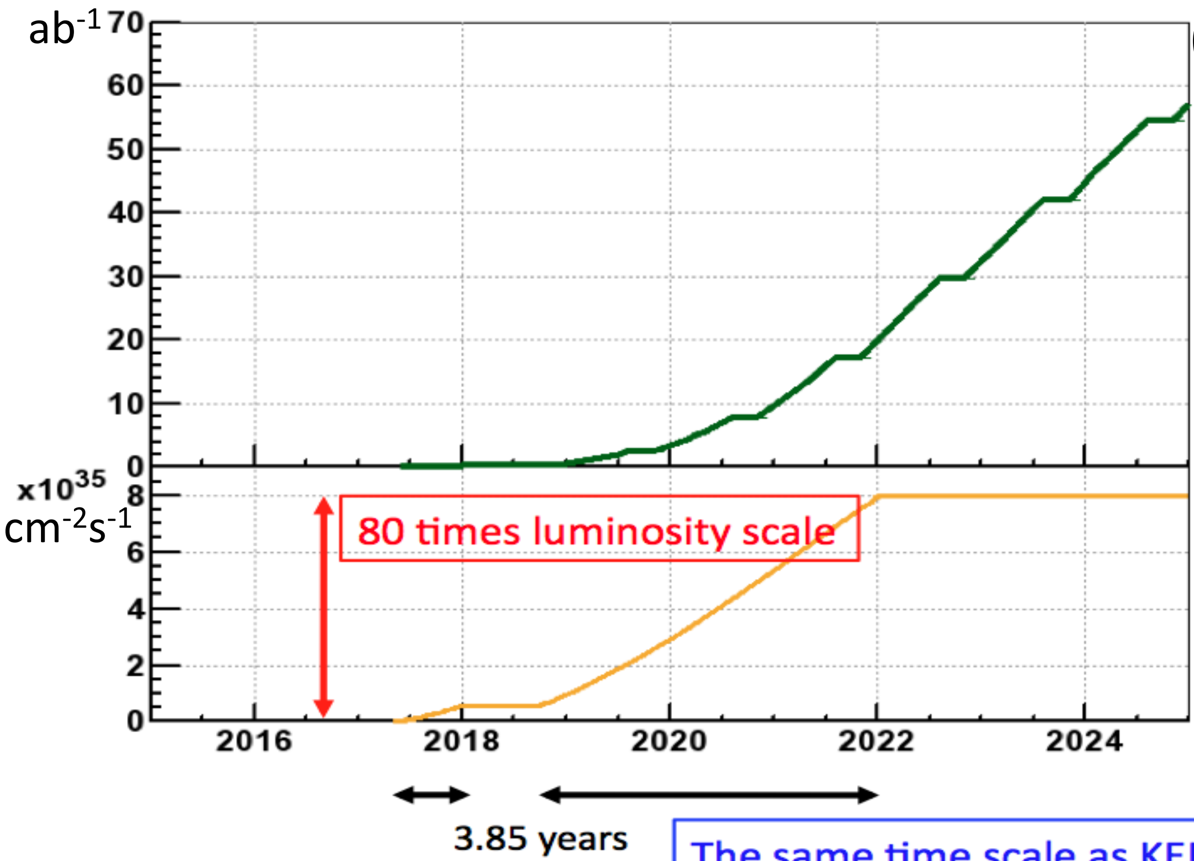

Belle II Superconducting Solenoid
IP
QC2LP
QC1LP
QC1RE
QC2RE
HER
QC2LE
QC1LE
QC1RP
QC2RP
LER
Colliding bunches
Redesign the lattice to squeeze the emittance (replace short dipoles with longer ones, increase wiggler cycles)
e+ 3.6A
e- 2.6A
New superconducting final focusing magnets near the IP
KEKB to SuperKEKB
◆Nano-Beam scheme
extremely small β_y^*
low emittance
◆Beam current double
$L = \frac{\gamma_\pm}{2er_e}\left(1+\frac{\sigma_y^*}{\sigma_x^*}\right)\left(\frac{I_\pm\xi_{\pm y}}{\beta_y^*}\right)\left(\frac{R_L}{R_y}\right)$
40 times higher luminosity
2.1×10^{34} --> 8×10^{35} $cm^{-2}s^{-1}$
New HER wiggler section
Replace beam pipes with TiN-coated beam pipes with antechambers
DR tunnel
Injector Linac upgrade
New e+ Damping Ring
Reinforce RF systems for higher beam currents

SuperKEKB/Belle-II Commissioning phases

- Phase 1
  - No QCS, No Belle II solenoid
  - Basic machine tuning; Low emittance tuning
  - Vacuum scrubbing
    - Need enough vacuum scrubbing in this stage, before Belle II roll in.
    - At least one month at beam currents of 0.51A /ring.
  - DR commissioning starts before Phase 2.
- Phase 2
  - with QCS and Belle II (w/o Vertex detectors)
  - Low beta optics tuning; Small x-y coupling optics tuning; Beam collision tuning
  - Belle II background study
  - Target luminosity at this stage is 1×10^{34} $cm^{-2}s^{-1}$
- Phase 3
  - Physics run (Vertex detectors installed)
  - Increase beam currents
  - Beam tuning continued to increase luminosity

A target luminosity profile of SuperKEKB/Belle II

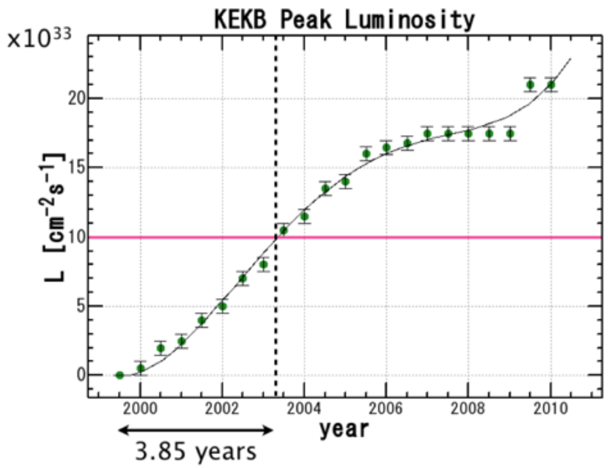
(by K.Akai, KEK Accelerator
May 13, 2015 @B2EB)



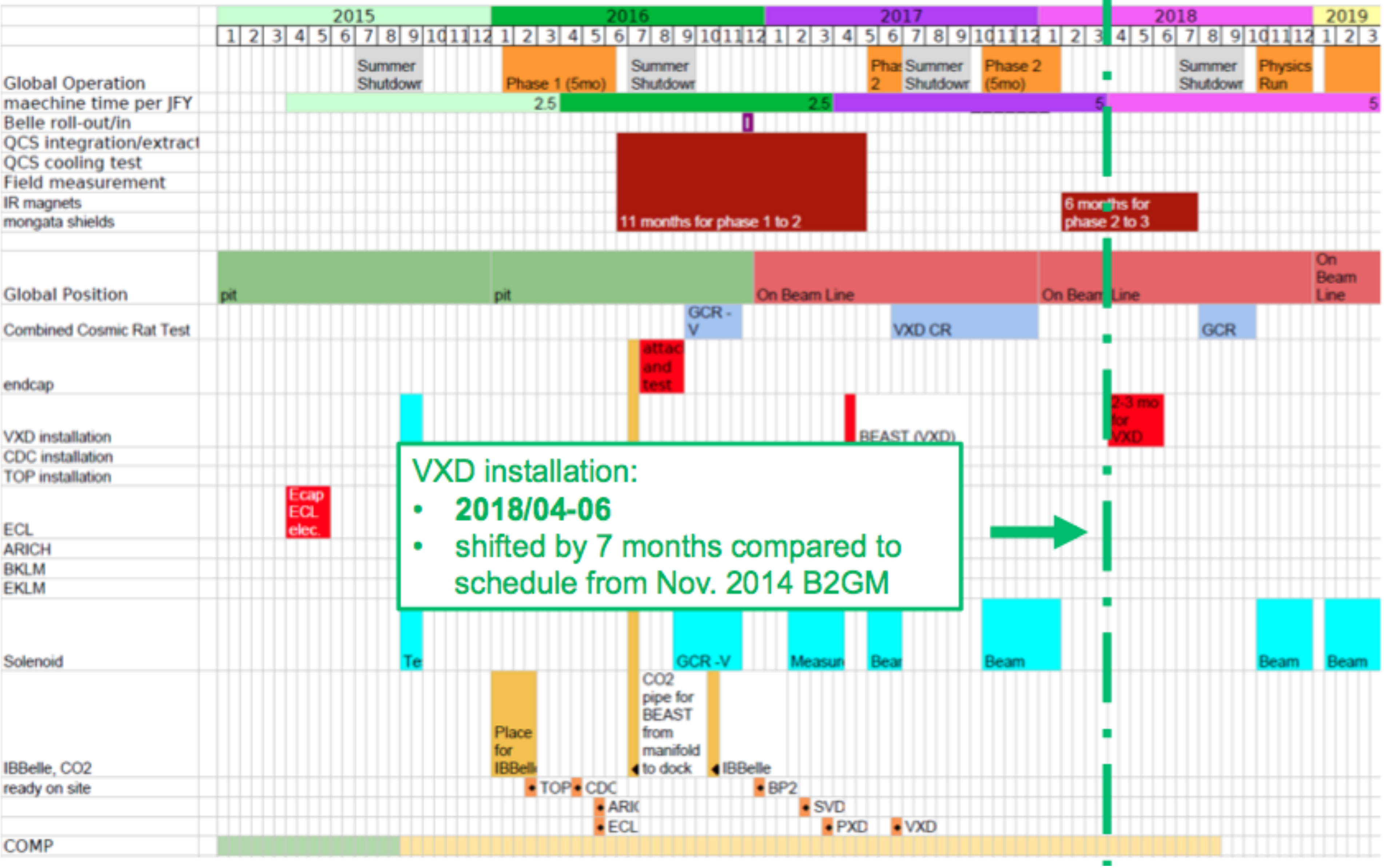
The same time scale as KEKB

Assumes full operation funding profile

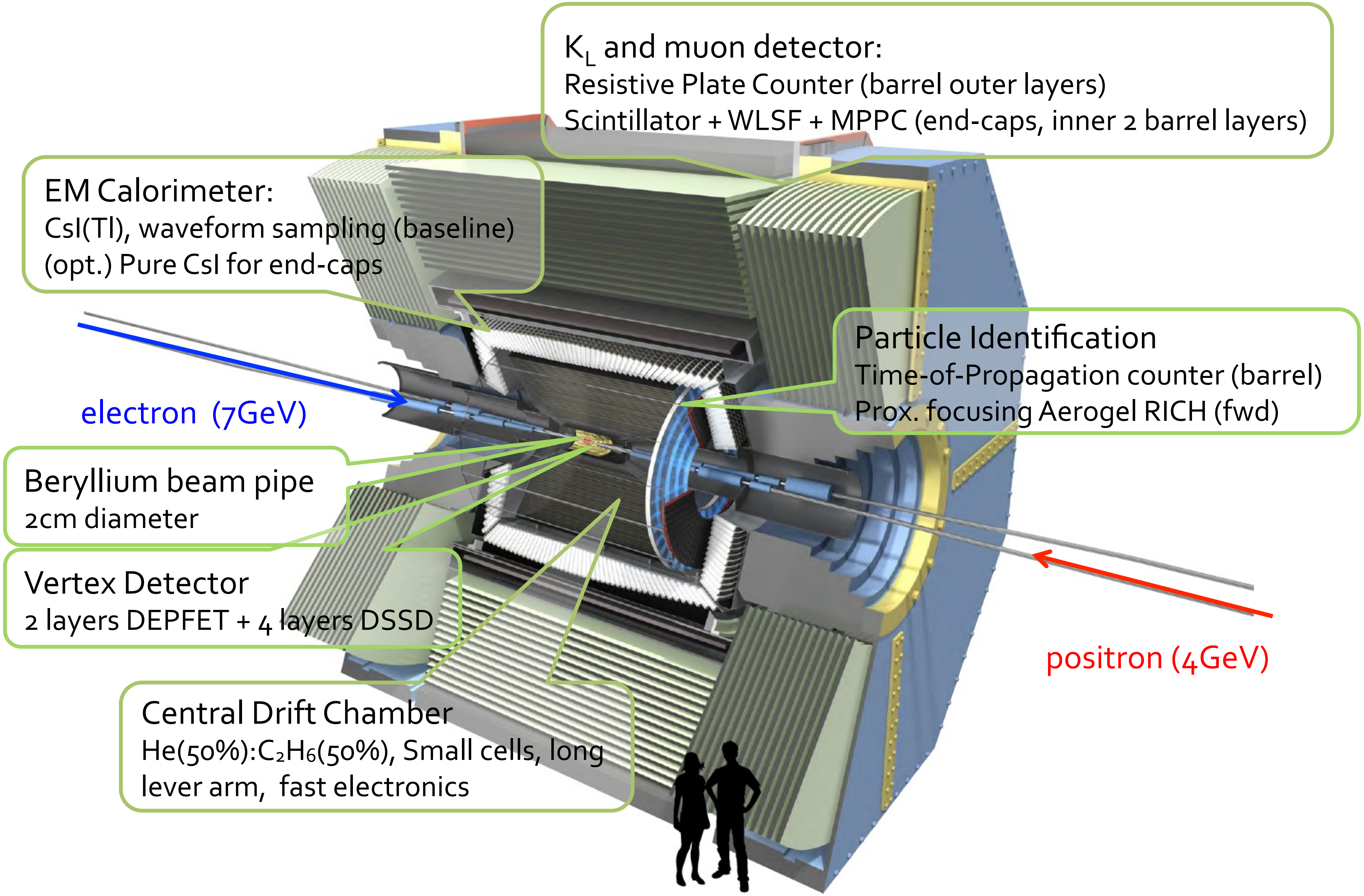
- Explanation of the updated target luminosity profile
  - The learning curve of KEKB operation in the first four years until we reached the design luminosity (1 x 10^{34} $cm^{-2}s^{-1}$) is used. The same learning curve is used for SuperKEKB to make the target profile by simply scaling the luminosity 80 times.
  - Since SuperKEKB is a much more challenging machine, we regard this luminosity profile as a most aggressive and optimistic target where everything (i.e., budget, human resources, machine performance, beam quality, no serious accident, etc.) is ideal for us.



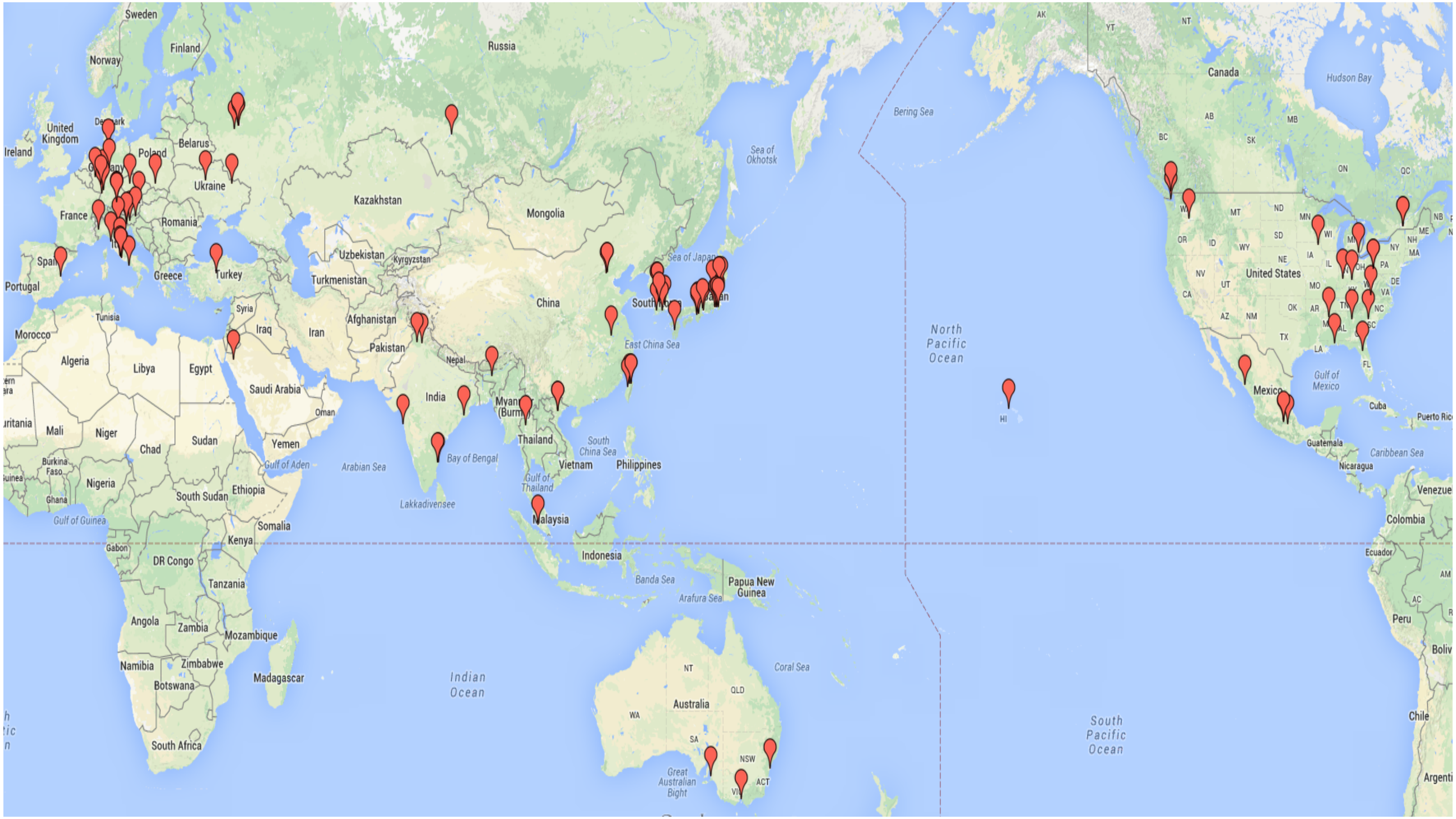
Belle II Schedule



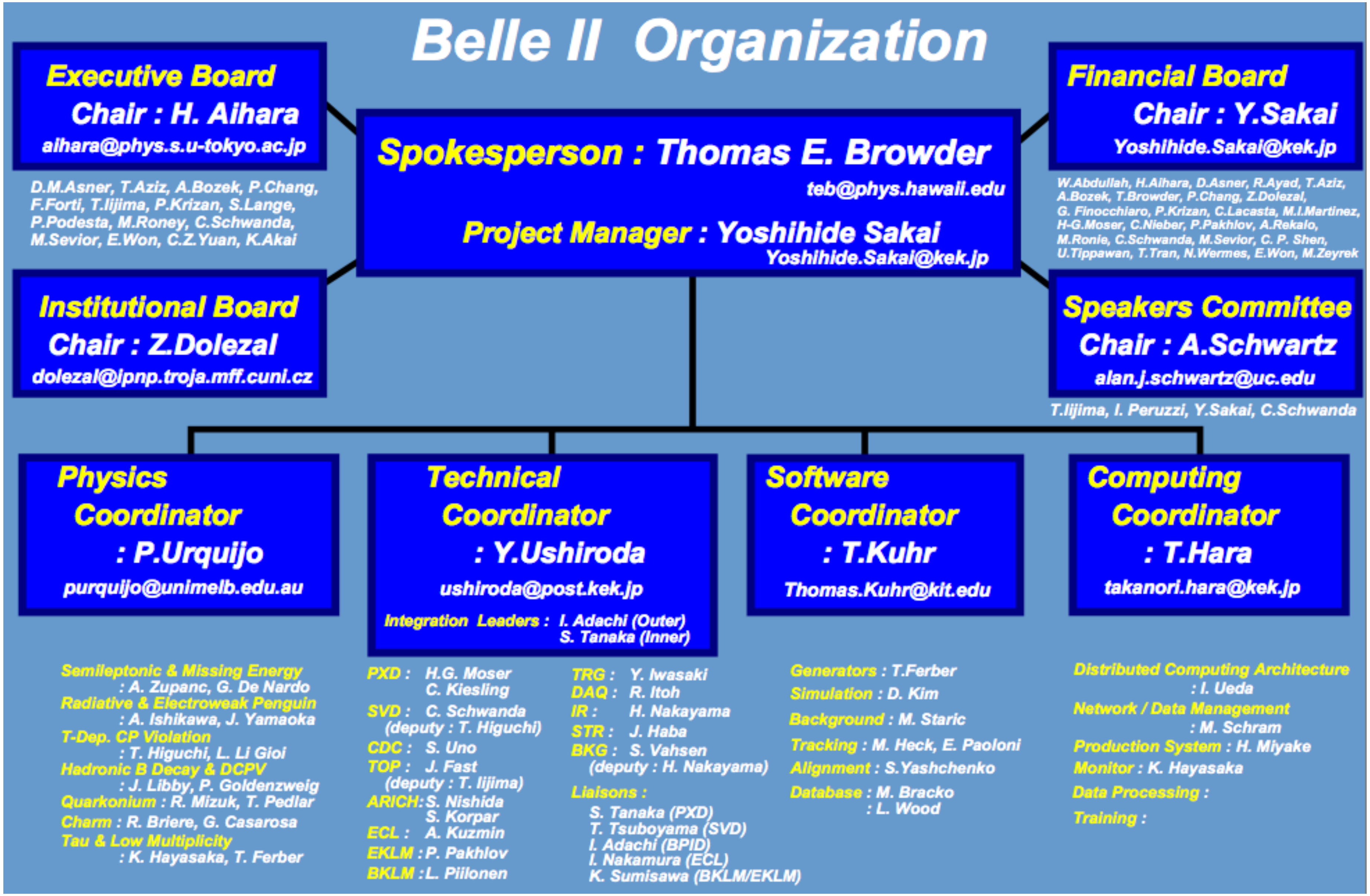
Belle II Detector



The Belle-II Collaboration



615 colleagues, 98 institutions, 23 countries/regions (July 2015)



Recent updates→

Executive Board	Francesco Forti (chair)
Computing Steering Group	F.Bianchi

Partecipazione Italiana

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

Physics Groups

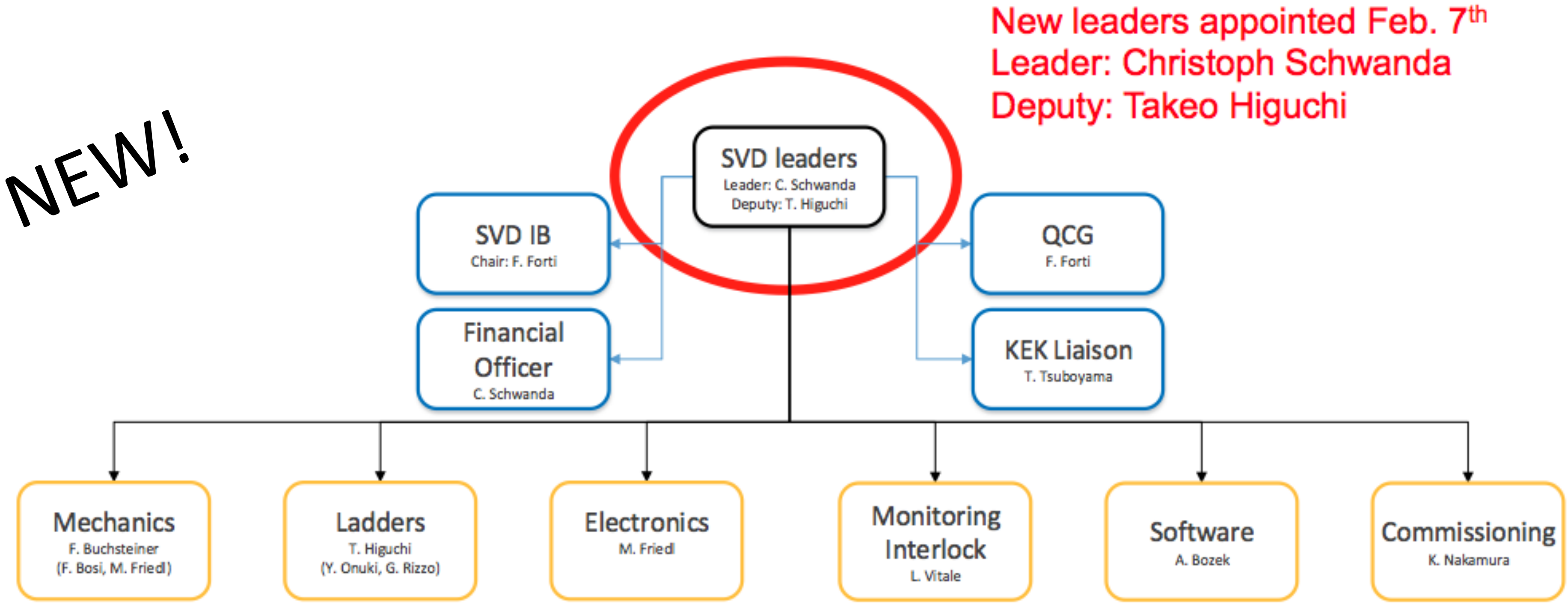
Semileptonic and Missing Energy Decay WG	Anze Zupanc, Guglielmo De Nardo
Electroweak Penguin WG	Akimasa Ishikawa, XXX
Time Dependent CP Violation WG	Takeo Higuchi, XXX
Hadronic B Decay WG	Jim Libby, Pablo Goldenzweig
Y(nS) WG	Roman Mizuk, XXX
Charm and Charmonium WG	Roy Briere, Giulia Casarosa
Tau and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

Rappresentante nazionale: G. Finocchiaro (LNF)

SVD Group Organization



SVD Sub-Group Coordinators

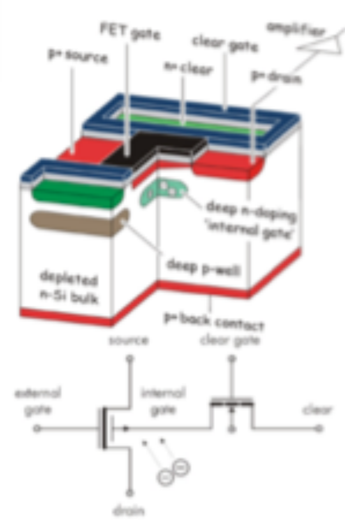
Sub-group	Coordinator	Deputy	Advisor
Mechanics	Florian Buchsteiner	Markus Friedl	Filippo Bosi
Ladders	Takeo Higuchi	Yoshiyuki Onuki	Giuliana Rizzo
Electronics	Markus Friedl		
Monitoring & Interlocks	Lorenzo Vitale		
Software	Andrzej Bozek		
Commissioning	Katsuro Nakamura		

Vertex Detector

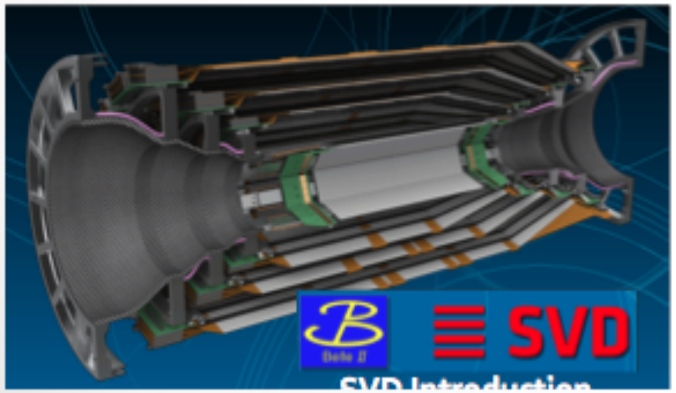
- **Pixel Detector (PXD)** – 8M pixels
  - 2 DEPFET layers at r = 14, 22 mm
  - Excellent and unambiguous spatial resolution (~15 μm)
  - Coarse time resolution (20 μs)

Mechanical mockup of pixel detector

DEpleted P-channel FET

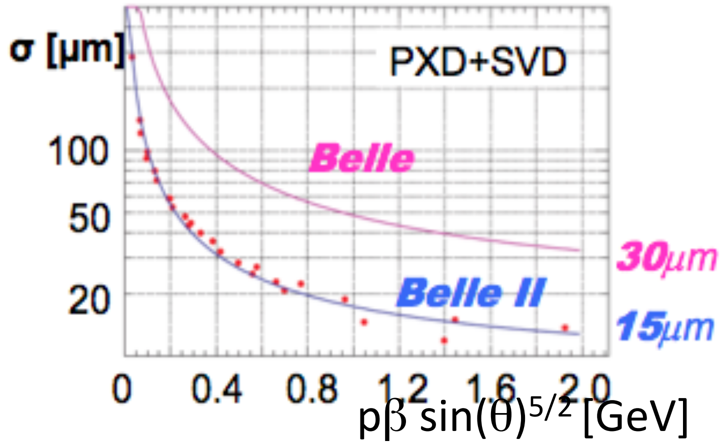


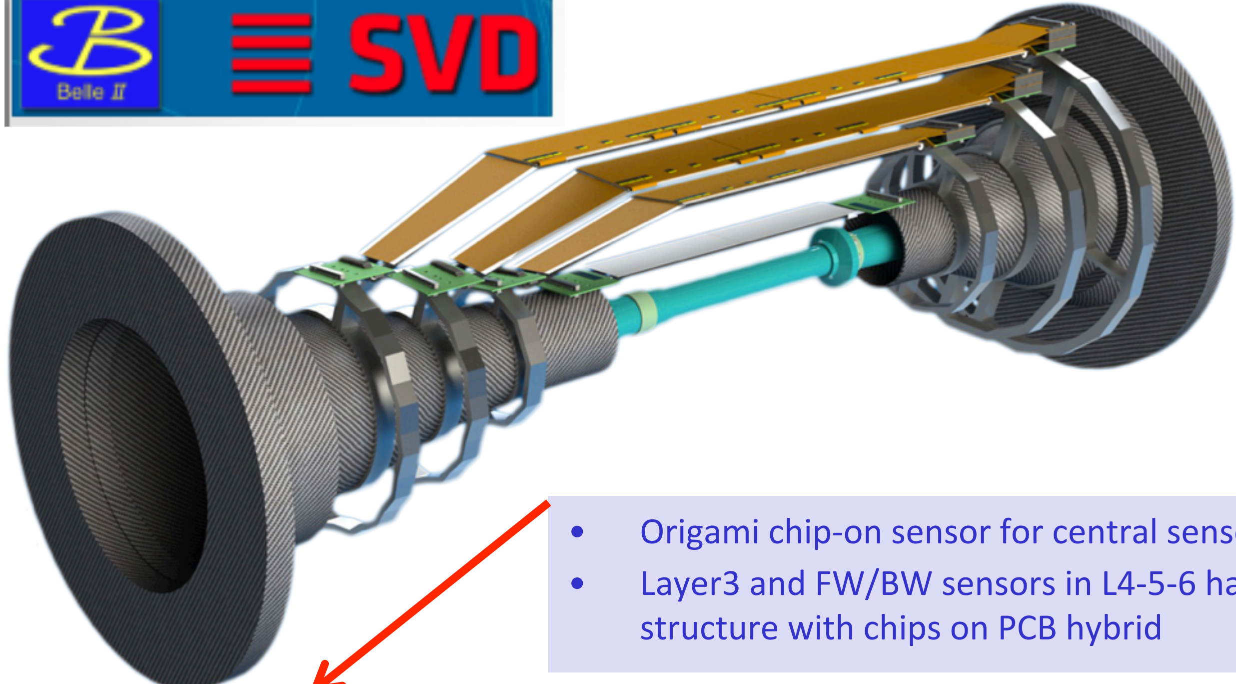
- **Silicon Vertex Detector (SVD)** – 220k strips
  - 4 DSSD layers at r = 38, 80, 104, 135 mm
  - Good spatial resolution (~12/25 μm) but ambiguities due to ghosting
  - Excellent time resolution (~3 ns)



Combining both parts yields a very powerful device!

Significant improvement in z-vertex resolution



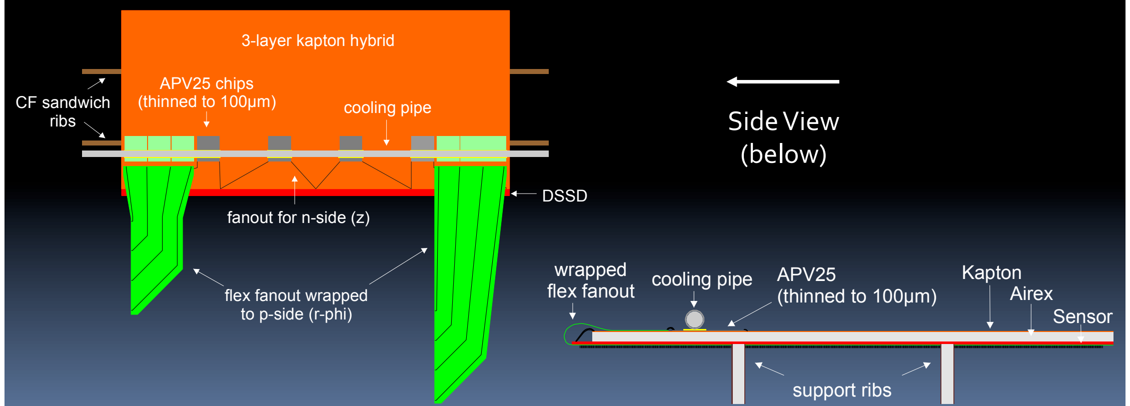


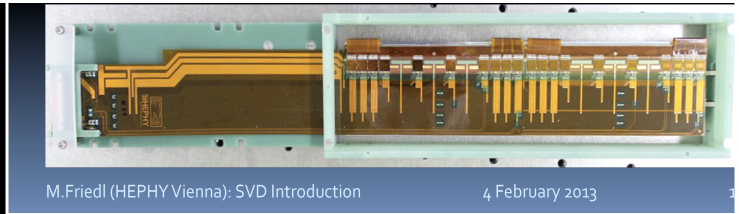
- 4 layers with silicon strips (DSSD) with APV25 read out
- Individual sensors connected to APV25 chips, to reduce capacitive load

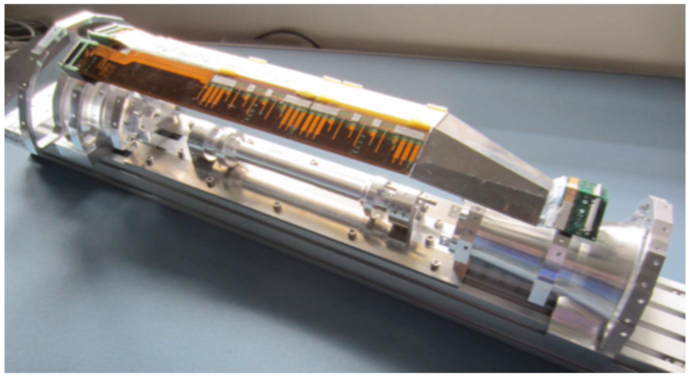
- Origami chip-on sensor for central sensors in L4-5-6
- Layer3 and FW/BW sensors in L4-5-6 have more conventional structure with chips on PCB hybrid

Origami Chip-on-Sensor Concept

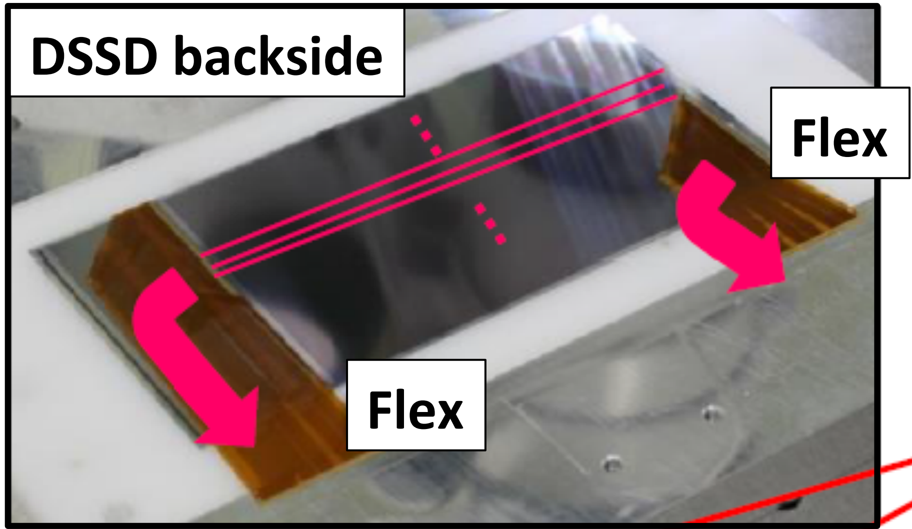
- Low-mass double-sided readout
- Flex fanout pieces wrapped to opposite side
- All chips aligned on one side → single cooling pipe (D = 1.6 mm)

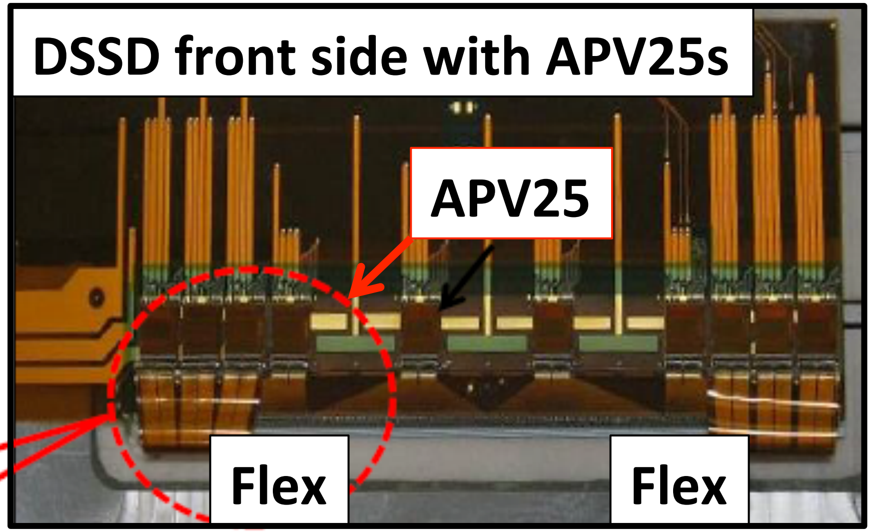


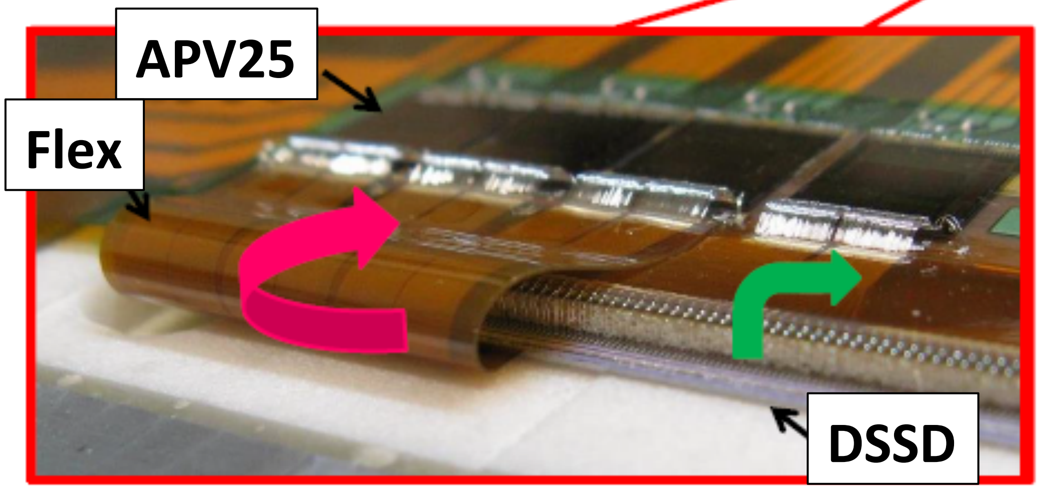




The “Origami” Concept



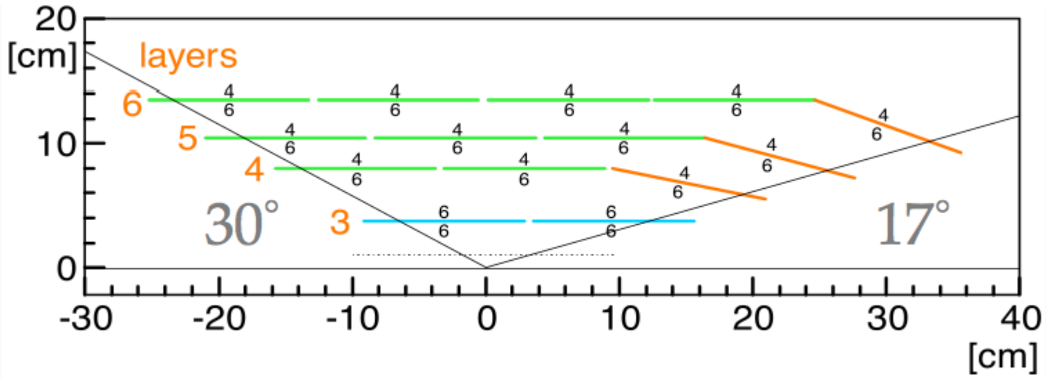




The backside signals are transmitted to the APV25 via *bent* (and glued) flex circuits.

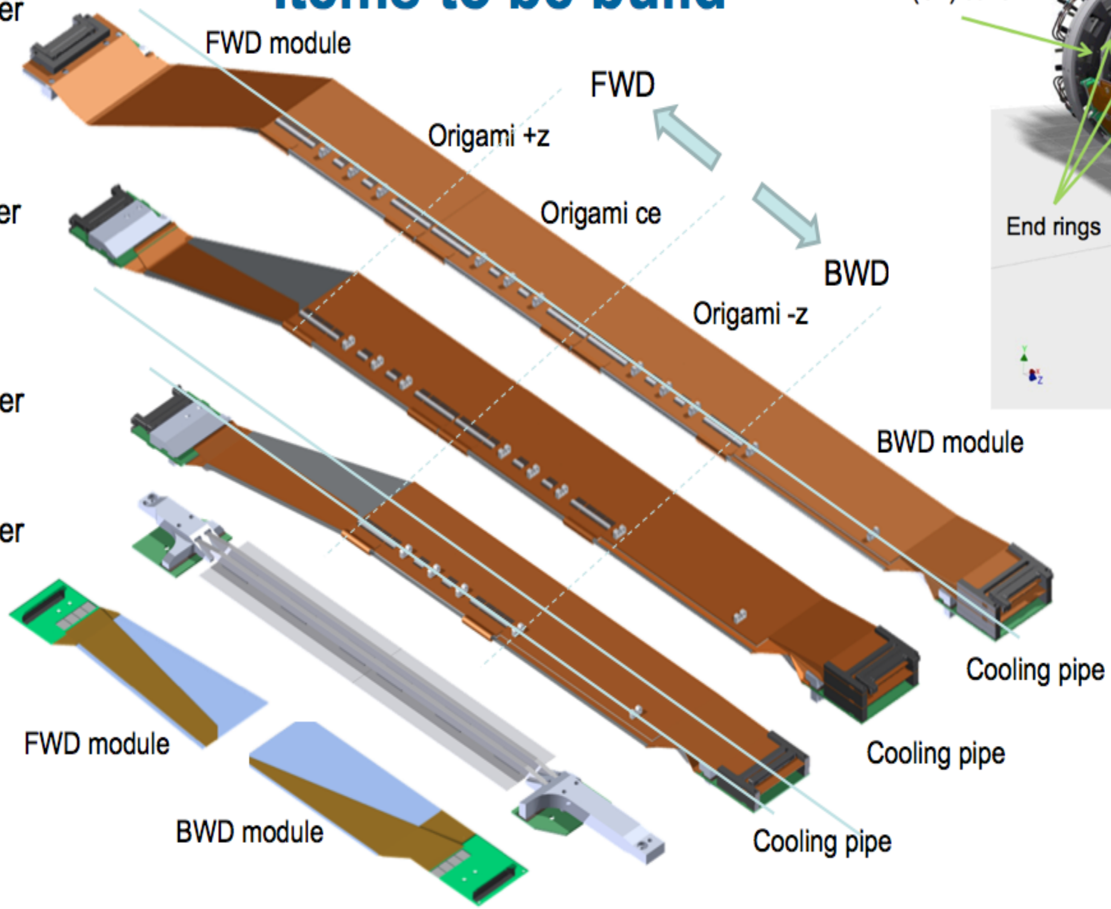
Belle II SVD Overview

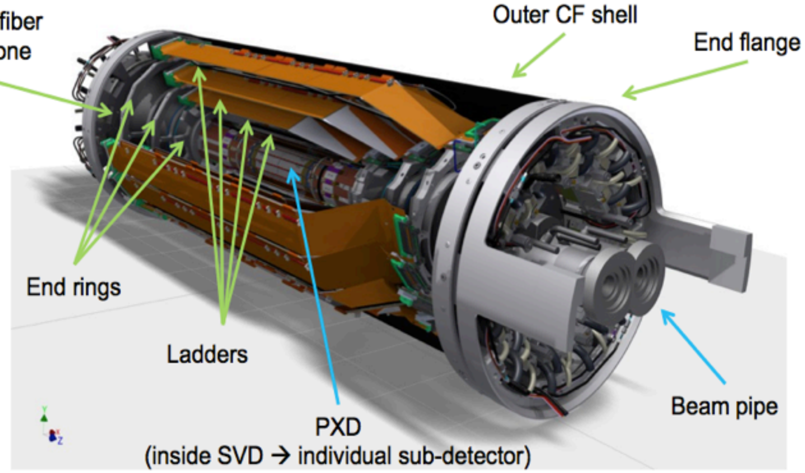
- Four DSSD layers
  - 2, 3, 4, 5 sensors (L3 to L6)
- Only three variants of sensor made from 6" wafers
  - Large rectangular DSSD (HPK)
  - Small rectangular DSSD (HPK)
  - Trapezoidal DSSD (Micron)
- Fast readout based on
  - APV25 chips 50ns shaping time
  - Origami chip-on-sensor concept
  - FPGA for pulse processing, zero-suppression, common-mode corr., hit time finding
- Low material budget 0.6%X_0 per layer
  - Very light mechanical structure
  - Thin cooling pipes (CO_2)



Layer	Ladders	Sensors / Ladder	APVs
6	16	5	800
5	12	4	480
4	10	3	300
3	7	2	168

Items to be build





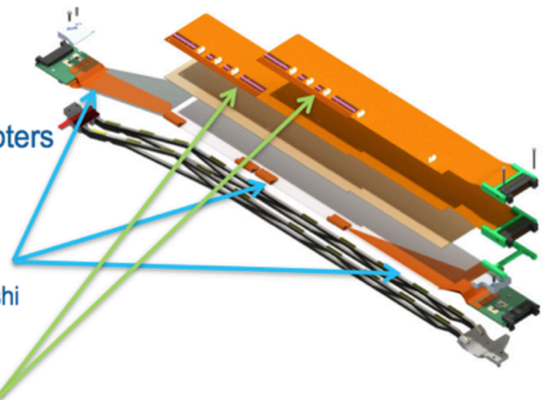
SVD Ladder Assembly Sites

- L3 ladders: Univ. of Melbourne
- L4 ladders: TIFR (@ IPMU)
- L5 ladders: HEPHY Vienna
- L6 ladders: Kavli IPMU
- FWD/BWD sub-assemblies: INFN Pisa

Pitch Adapters

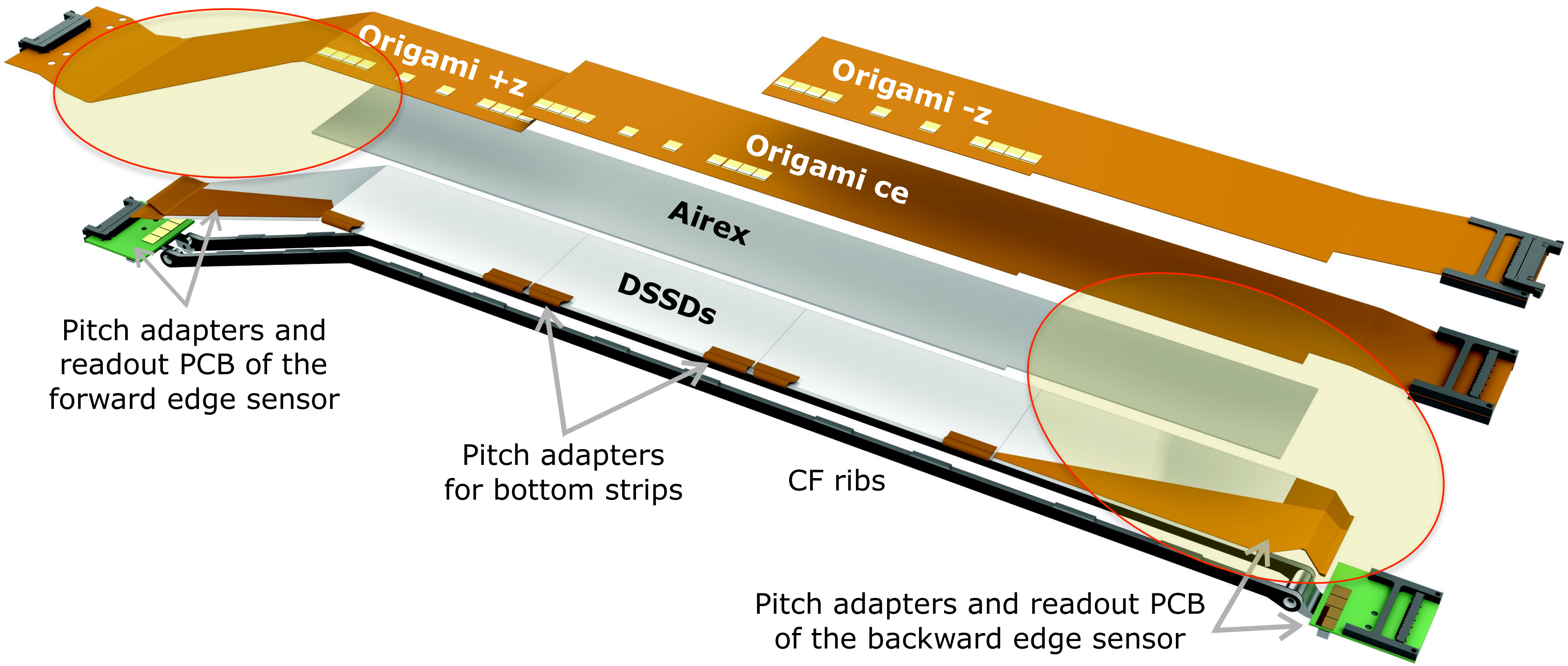
connect sensor strips to APV25 chips

- Two types of pitch adapters
- **FlexPA**
  - Flexible, single-layer
  - PF,PB,P3F,P3B,PA
  - Produced by Tokai Denshi
- **PA0**
  - Flat, dual-layer
  - Glued onto Origami hybrids
  - Produced by Taiyo

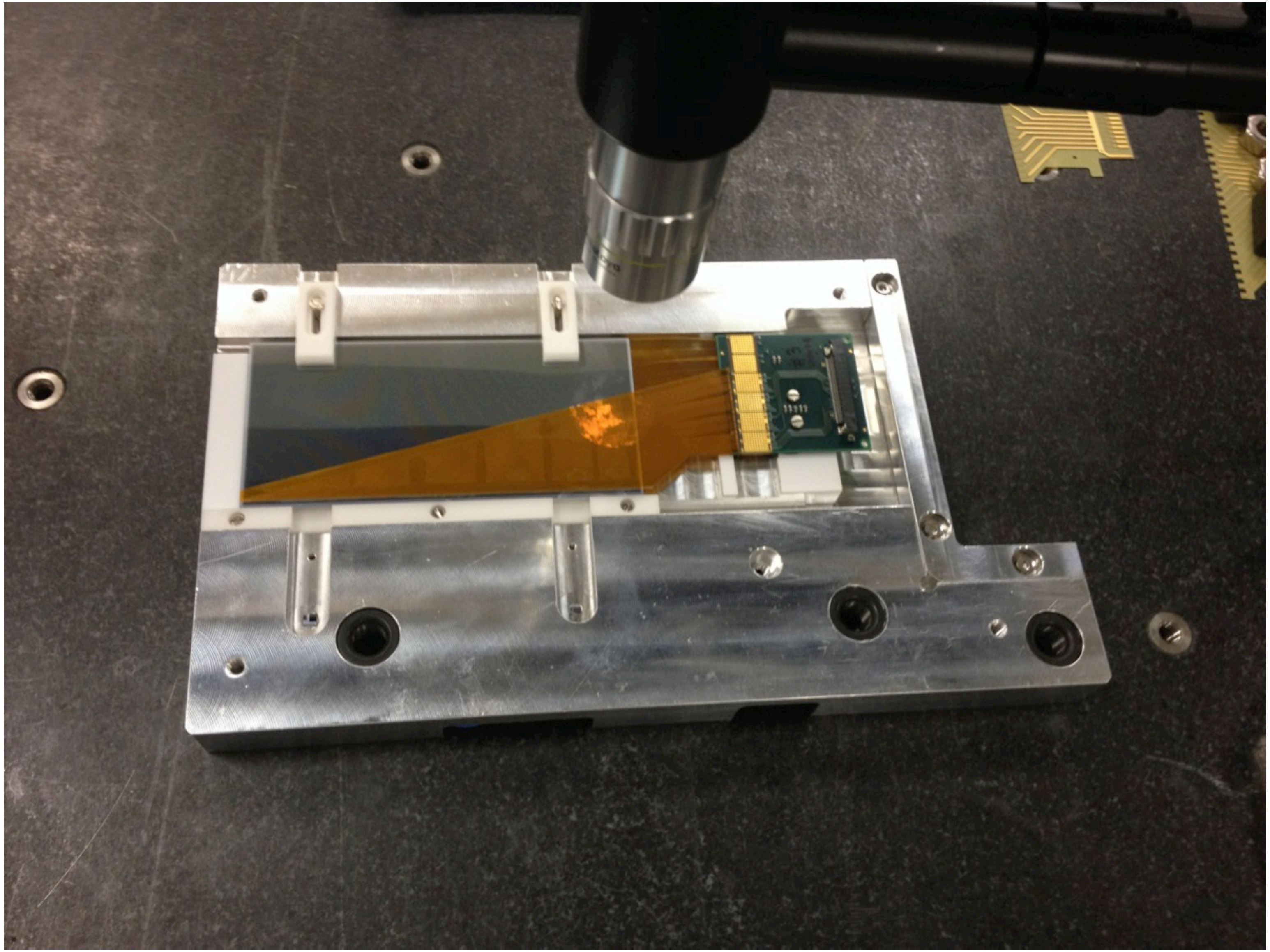


Forward/Backward Assembly

- Produce single-sensor subassemblies of the forward and backward sensors.
- Connect sensor to pitch adapter, pitch adapter to hybrid
- Ship the tested sensor sub-assembly to the module assembly sites



MPC with BW mech. assembly under survey before shipping



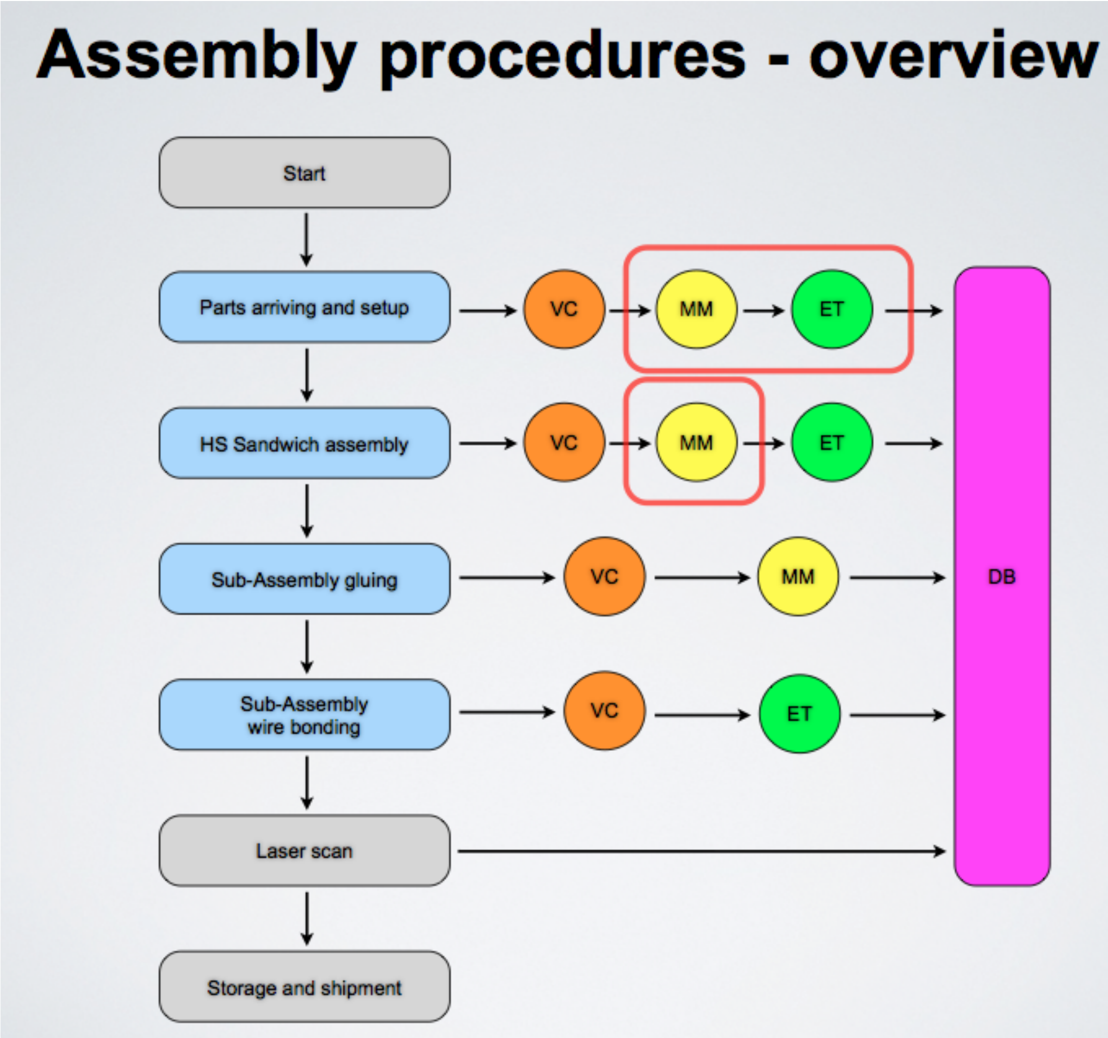
Numeri ed elementi

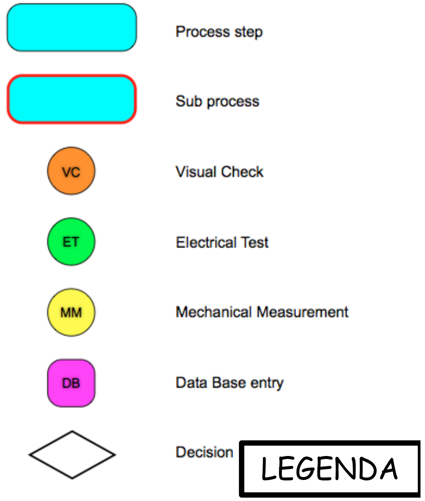
Layer	Radius	ladders	Sens/ladder	Sensors	RO/sensor	RO chips
6	135	16	5	80	10	800
5	104	12	4	48	10	480
4	80	10	3	30	10	300
3	38	7	2	14	12	168
				172		**1748**

- Da produrre in totale 47 forward + 47 backward subassemblies (inclusi spares: 4,3,2 per Layer 6,5,4)
- Ritmo per sostenere la produzione dei ladder:
  - Necessario 8 + 8 / mese = 2 + 2 / settimana.
- Piano:
  - Per assemblare ciascun modulo ci vuole in totale circa una settimana
    - Incollaggi – 2 giorni; Microsaldatura – 2 giorni; Test – 1 giorno
  - Si possono tenere **2+2 moduli in lavorazione**
    - Fino a 2 stazioni di allineamento sotto la macchina di misura
    - Jigs sufficienti per mantenere il parallelismo
- Micro saldature
  - 1 modulo (fwd o bwd) = 10 chip * 128 * 2 = 2560 saldature
  - A regime dovremmo microsaldare 4 moduli/settimana = circa 2000 saldature al giorno

Sub-assembly procedures scheme

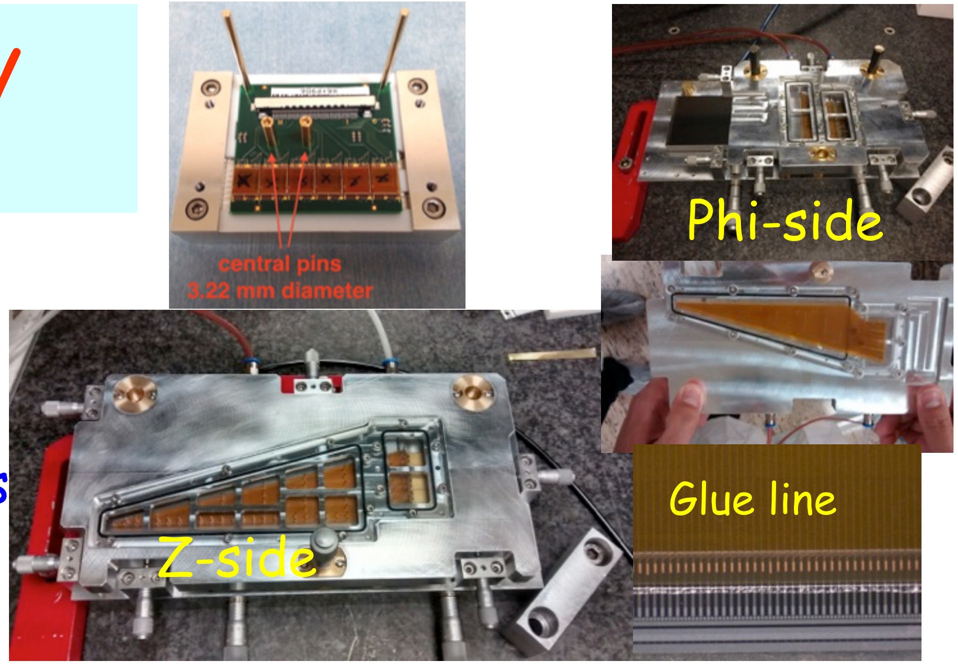
Written schematically by/for the expert operators who developed them and who will build/test the assembly.





Il 29/5 Pisa ha superato la full review interna all'SVD, OK per la produzione dei moduli classe A.

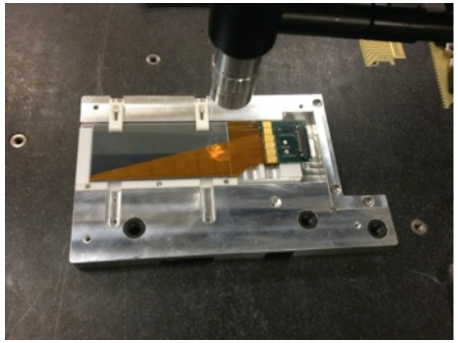
BW/FW sub-assembly developed tools



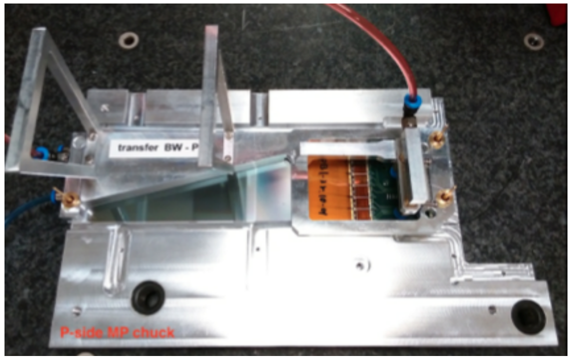
- Hybrid gluing jigs: sandwich single side hybrids

- Gluing jigs: det<->PA<->hybrid
Required high planarity for the chucks
Two (detector and hybrid) towers raising to squeeze the glue on the PA

- Multi Purpose Chuck: designed for bonding/ testing sub-assemblies in Pisa and their safe shipment (Z-side up). P-side up MPC are used to perform upside-down operation.



- Tranfer jigs: to safely transfer the subassembly
  - after the the P-side gluing to the MPC, perform the upside-down operation and take that on the Z gluing jig
  - after the Z-side gluing to the MPC



FW/BW sub-assembly production status

So far, Pisa produced:

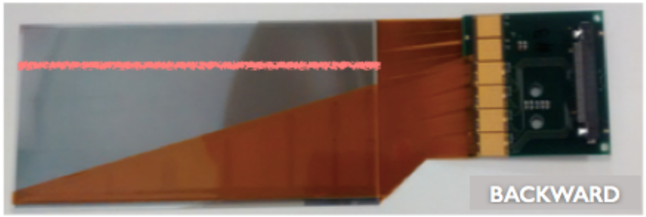
- BW (all with final procedure and jigs)
  - 3 class C SBW (see Pisa review in Oct.)
  - 4 class C SBW
  - 3 class B SBW
  - 3 class B+ SBW
- FW
  - 3 class C SFW (temporary jigs)
  - 1 class B SFW (the test-beam one, with temp. jigs)
  - 4 class C SFW (3 for the Ladder Sites + 1 for Pisa mech. Test, with final FW jigs and procedures)
  - 2 class B SFW (with final FW jigs and procedures)
  - 2 class B+ SFW (with final FW jigs and procedures)

- Ready to start production of class A subassemblies

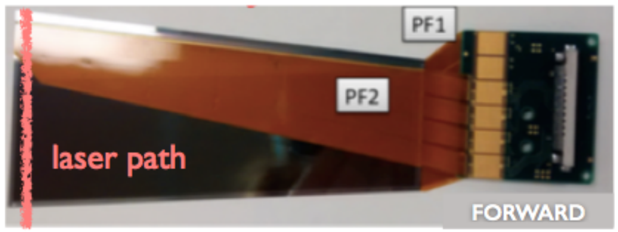
Sub-assembly electrical characterization and laser-scan

- After the unique bonding phase (N&P side w/o any intermediate test) a complete electrical test is foreseen with the sub-assembly Z-up on the MP chuck, to eventually spot new defects (and verify the known ones!).
- The final qualification of the sub-assembly is the functional characterization by a laser scan.

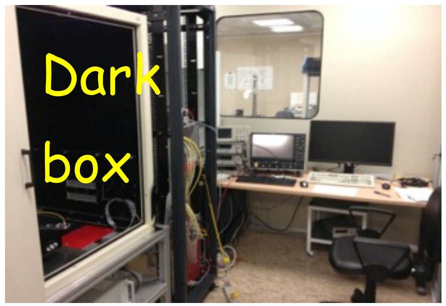
- **scan of the N strips** (~10 minutes, 1500 hits per strip on average):
  - move the laser at a constant speed ~orthogonal to the N strips, away from PA if possible.



- **scan of the P strips** (~10 minutes, 1500 hits per strip on average):
  - move the laser at a constant speed ~orthogonal to the P strips, away from PA if possible.

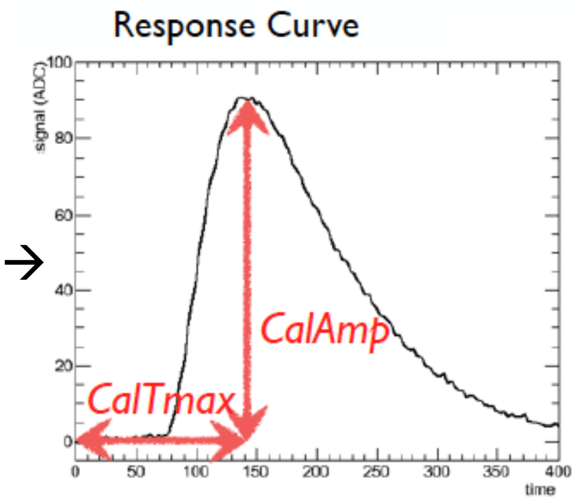


1060 nm laser (developed @CERN)



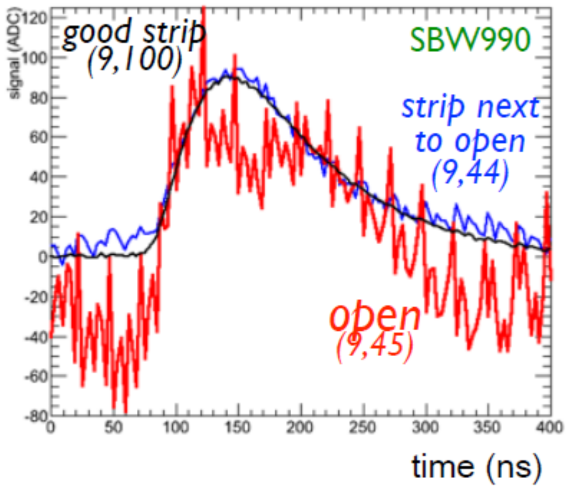
Automated Offline EQA

Typical response to injection of a good channel →

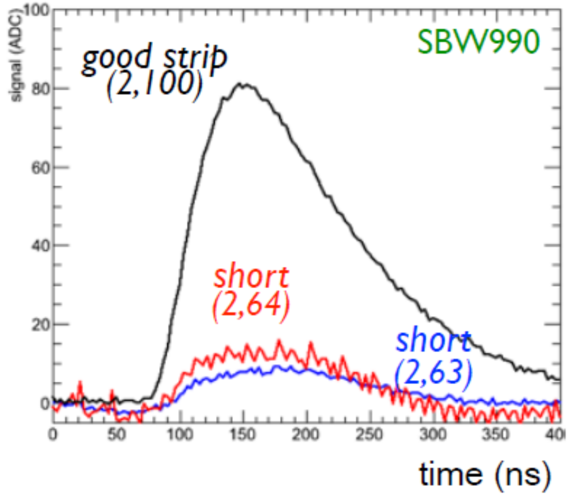


In case of defect, the channel behaves differently:

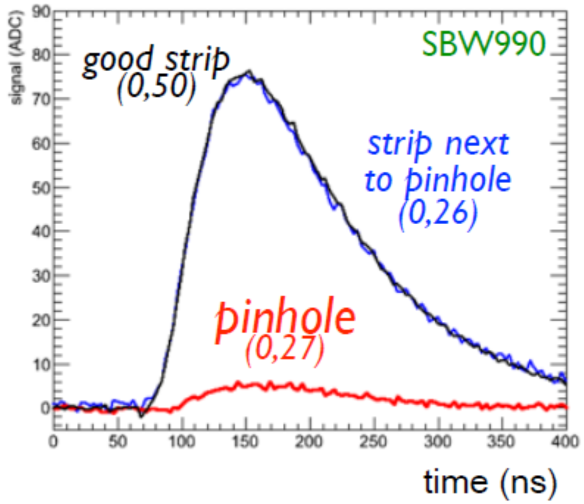
Open fingerprints | **Short fingerprints** | **Pinhole fingerprints**



High noise



Low gain (adjacent strips)



Low gain

Fingerprints can be used to automatically detect faults in a ladder/subassembly, and to rate it.

Subassembly characterization

Summary of the 6 BW Subassemblies

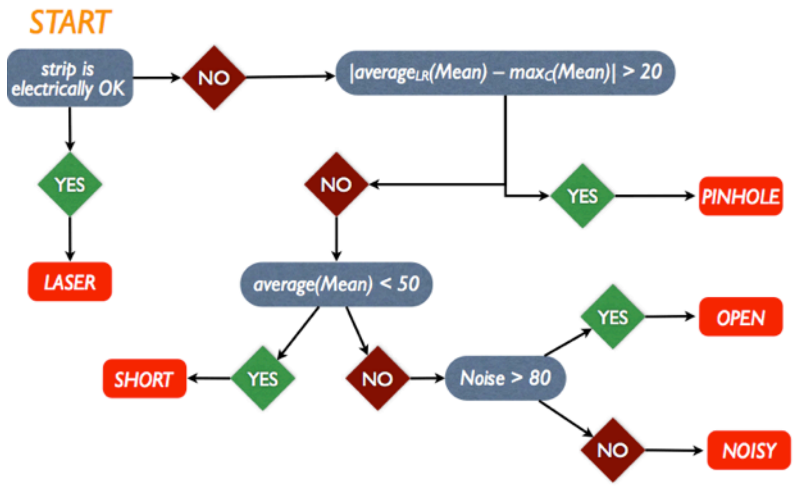
BACKWARD		opens	shorts	pinholes	noisy	low laser resp.	tot
SBW993	P	No Vsep scan performed ⇒ aDefectFinder unreliable					
	N						
SBW991	P	1	–	–	8	x	9 (1.17%)
	N	–	–	–	9	x	9 (1.76%)
SBW990	P	1	–	2	5 - 1	x	7 (0.91%)
	N	3	–	–	14	x	17 (3.3%)
SBW001	P	–	–	1	121	–	122(15.9%)
	N	4	–	1	7	–	12 (2.35%)
SBW002	P	–	–	1	4	1	5(0.65%)+1
	N	–	–	–	3	–	3 (0.69%)
SBW003	P	–	–	1	4	–	5 (0.65%)
	N	–	2	–	6	–	8 (1.17%)

- SBW990 and SBW991: no laser scan included in the analysis
- SBW002: one pinhole missed because normal at Vsep = 0
- SBW990: an open recognised as noisy

- 1.3% average defects, excluding the P-side of SBW001

NOTE: SBW001 is under study

Defects-Classifier Algorithm



Good match with the defects resulting from the det's tests.

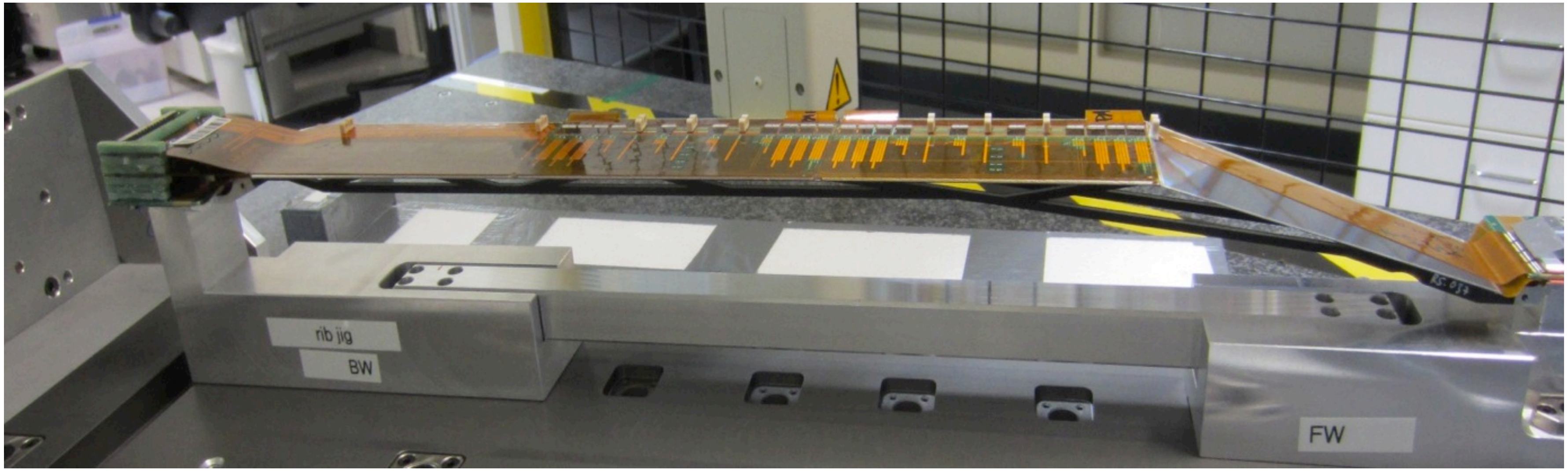
Summary of the 3 FW Subassemblies

FORWARD		opens	shorts	pinholes	noisy	low laser resp.	tot
SFW993	P	No Vsep scan performed ⇒ aDefectFinder unreliable					
	N						
SFW989	P	6	4	6	11	–	27 (3.52%)
	N	–	–	–	3	–	3 (0.6%)
SFW988	P	–	6	3+1	2	–	11(1.4%)+1
	N	0	0	1	5	–	6 (1.17%)

The new 2 SFWs class A under bonding phase.

Costruito il primo ladder elettricamente funzionanate (L5)

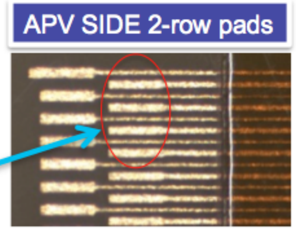
- Vienna ha finito (24/3) di costruire il primo ladder class B:

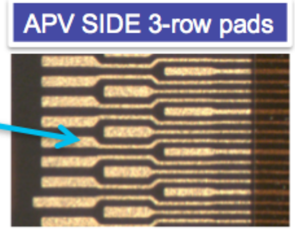


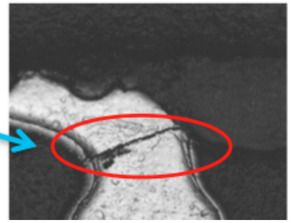
- Usati i tools meccanici e procedure finali
- Caratterizzazione elettrica → completamente funzionante
- Una milestone importante!

Pitch Adapters Issues

- **Problem #1**
  - Related to **FlexPA**
  - Arose end of 2013
  - Size of pads on APV side were too small for wire bonding
  - Could be solved by design change
- **Problem #2**
  - Related to **PA0** only
  - Disconnected lines due to cracks close to bond pads of PA0
- **PA task force formed to solve issues**

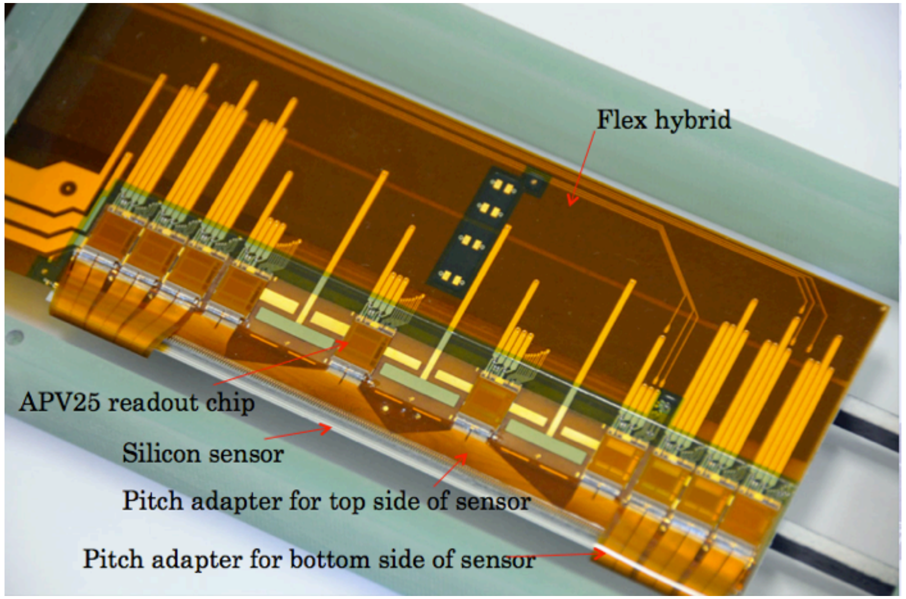






#1:

- Tested samples of the flex new production have been delivered in mid-March
- OK (~80% yield) after the pad survey@IPMU

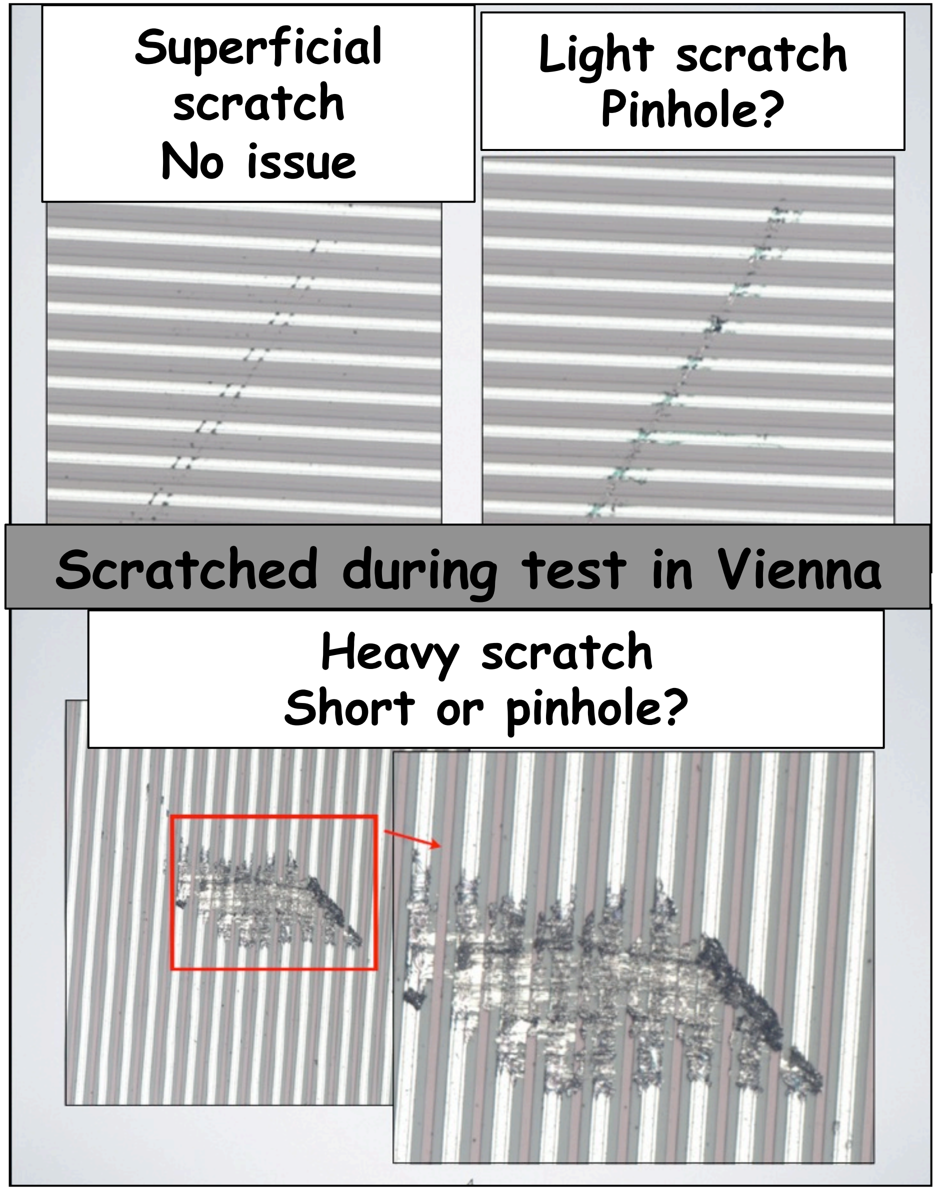


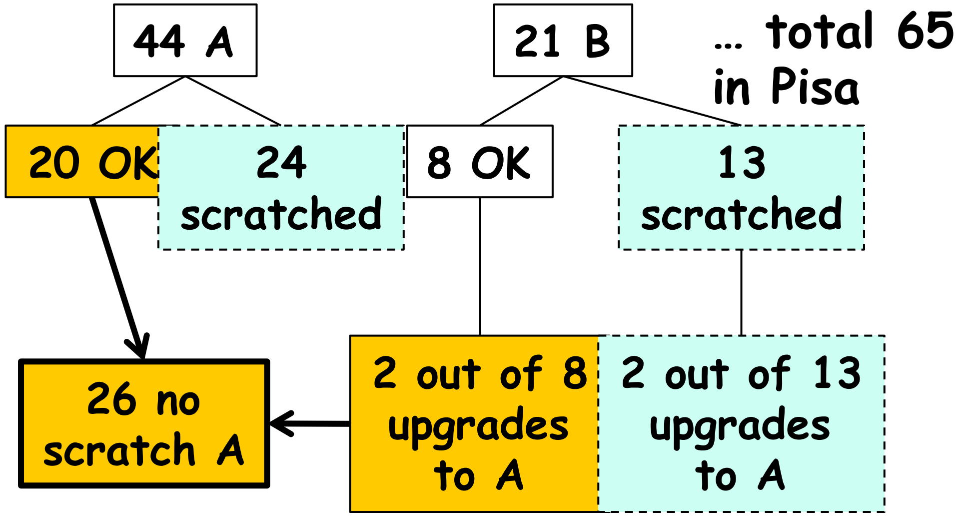
PA0

#2:

- Required re-production of all Origami hybrids with thinned APV chips
- More robust design against cracks implemented

Micron Sensor Inspection (Pisa)

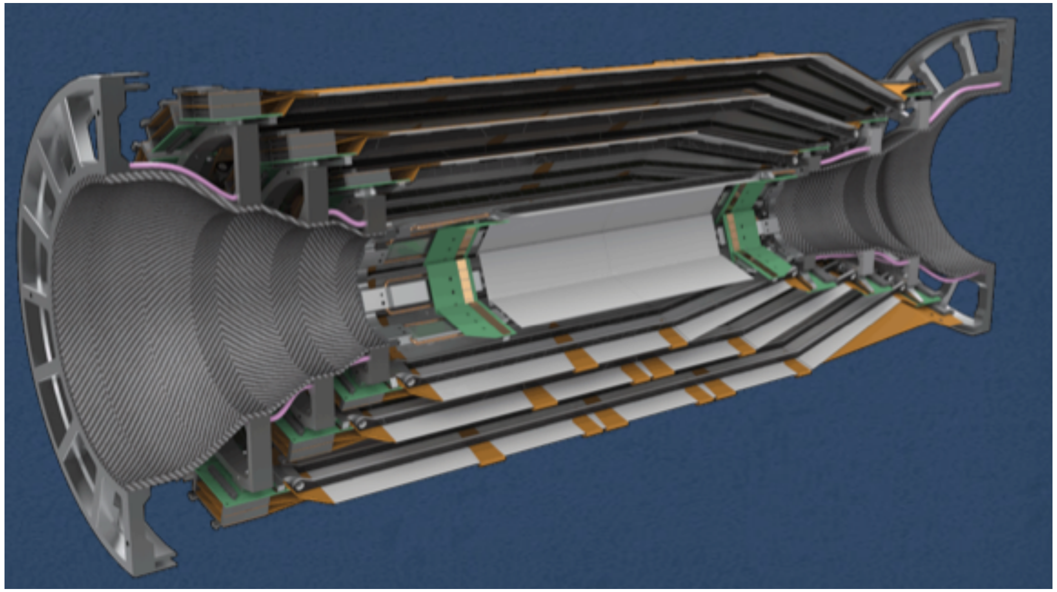


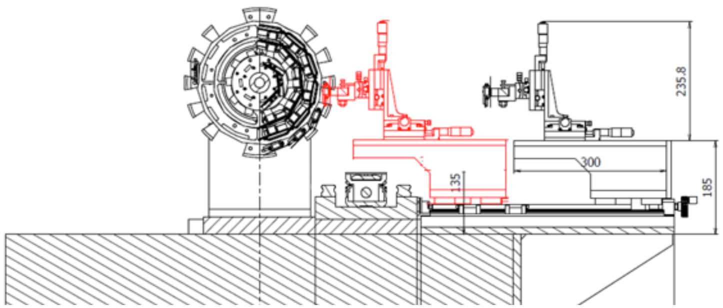


of the trapezoidal sensors is limited. We make the AC test in Trieste to know the real quality of the scratched sensors.

Installazione moduli SVD

- Al termine della produzione dei FW/BW assemblies, Pisa partecipa al ladder mounting e commissioning del rivelatore SVD.





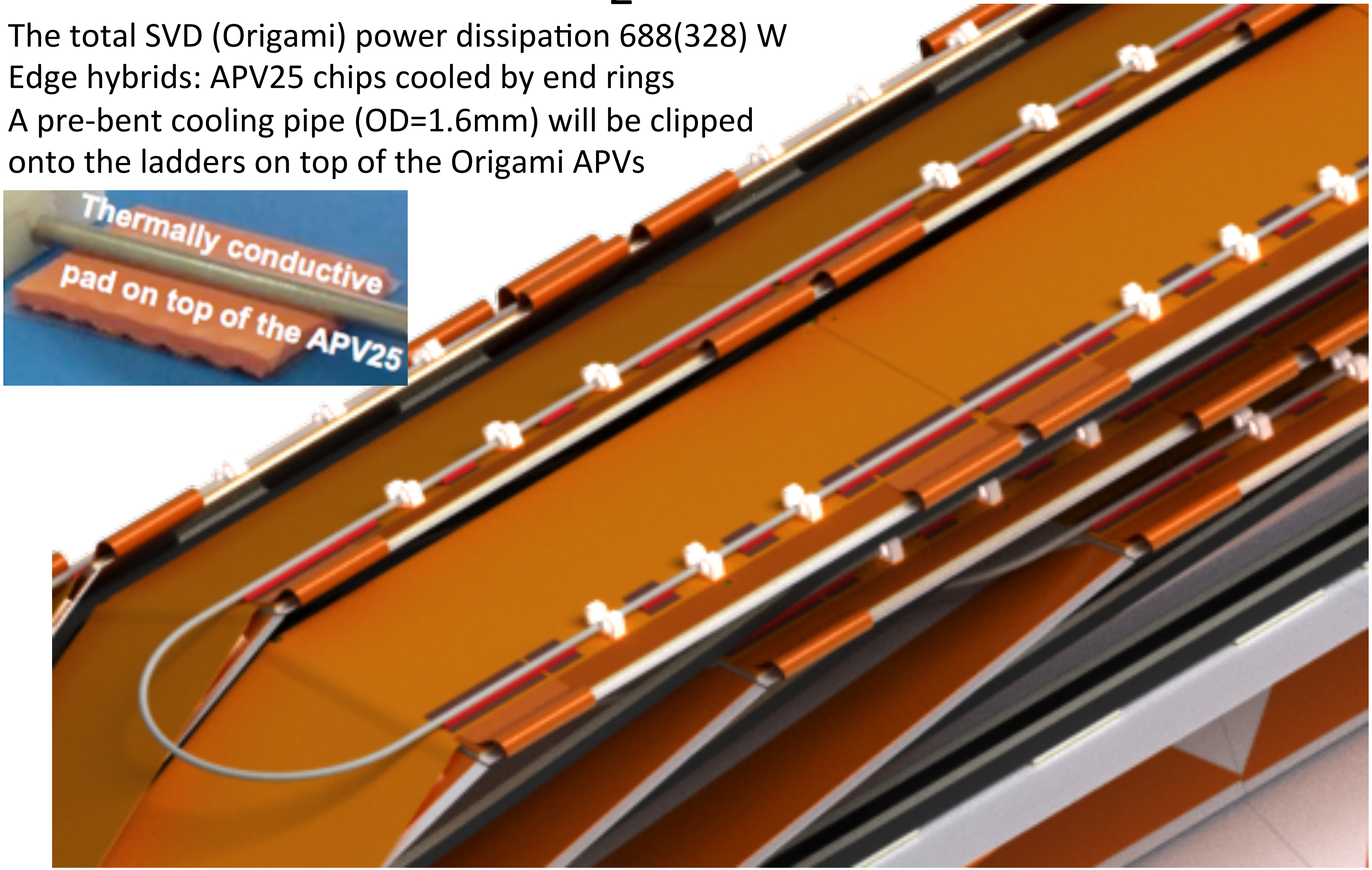
- Il metodo adottato per il ladder mounting e' quello orizzontale (by KEK).

- Il posizionamento della (pre-bent) pipe per il raffreddamento deve avvenire per ogni half layer:

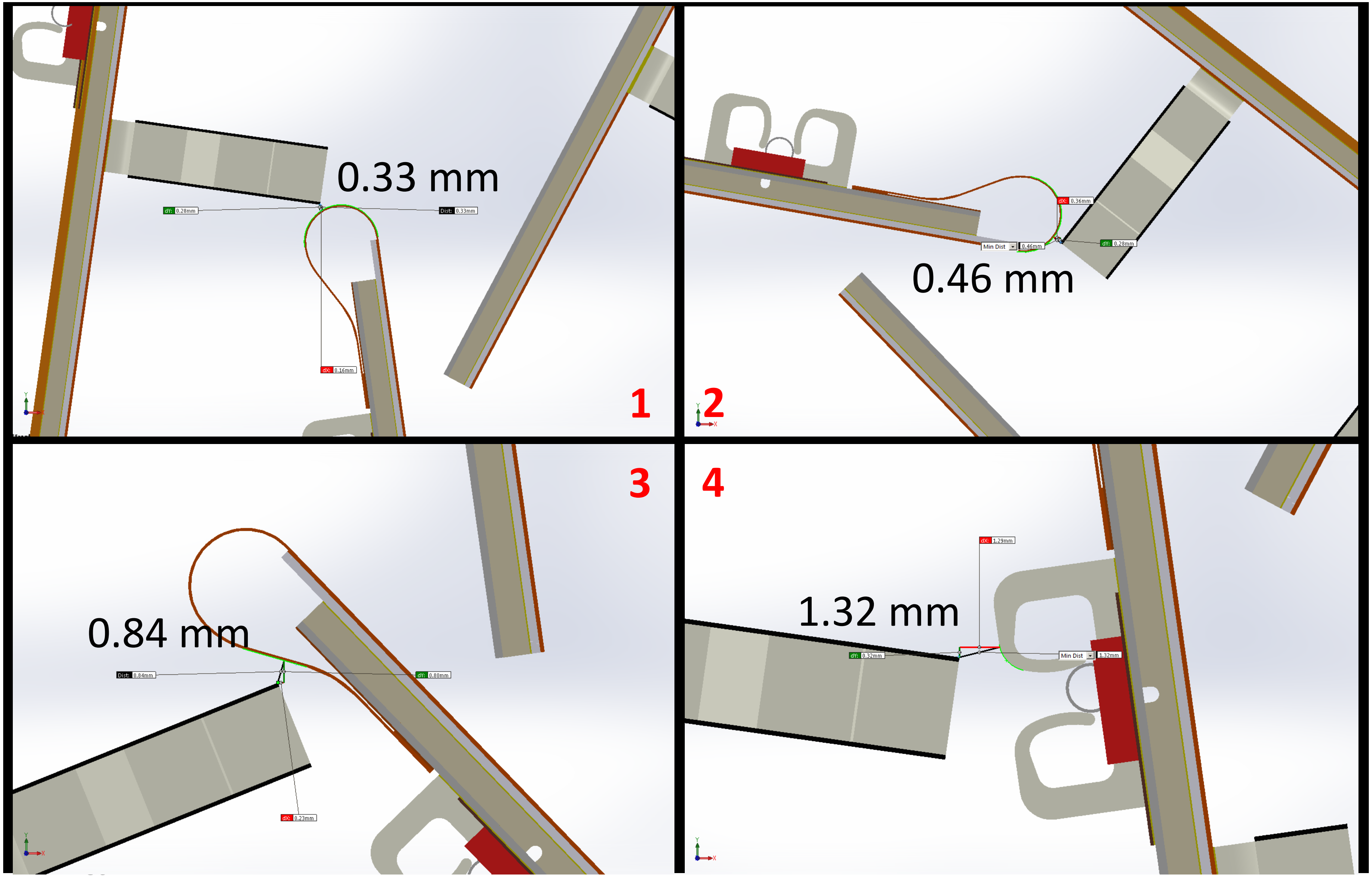
1. Pipe calata dall'alto fissata ad una struttura di supporto
2. clamping sul ladder per rotazioni successive (la presenza dei cavi rende difficile questa operazione)

CO_2 Cooling

The total SVD (Origami) power dissipation 688(328) W
Edge hybrids: APV25 chips cooled by end rings
A pre-bent cooling pipe (OD=1.6mm) will be clipped onto the ladders on top of the Origami APVs



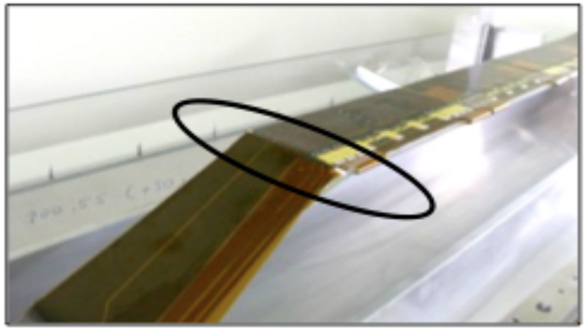
SVD "collision analysis"



Module Mechanical Characterization (PISA)

Issues in the Stress Tests

- **Thermal cycling test**
  - Study items (open issues):
    - Permanent deformation.
    - Permanent damage (e.g.: wire break).
    - Component aging (e.g.: glue at the PA1/2 bend).
    - Thermal fatigue (e.g.: sharply folded part in the Origami+Z).



The folded part in the Origami+Z

  - The thermal excursion program for the studies above needs defined.
    - Suggestion: x100 cycles of $(-30 \leftrightarrow 60)^{o}$C at about $\pm 2^{o}$C/min.

- **Mechanical stress test**
  - Study items (open issues):
    - Stress from the end-rings and CO_2 pipe.
    - Gravity sag.
    - Vibration in the transportation.

Pisa's vibration tester

SVD Power Supplies

CAEN System

SY4527

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.

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

- Required numbers of channels

Layer	Num Ladders	FW Hybrid/ ladder	BW Hybrid/ ladder	N FW groups	N BW groups	TOTAL
3	7	2	2	2	2	
4	10	2	4	4	6	
5	12	2	6	4	10	
6	16	4	6	8	12	
			Total groups	18	30	48
			LV channels	36	60	96
			SEP channels	18	30	48
			HV channels	18	30	48

- CAEN Purchased products: Added boards for N-side sep voltage and spares

Product	Description	Nch/ board	Qty base	Spare	Total boards	Total ch
SY4527	Universal multichannel Power supply system - Basic 600W		2	1	3	
A4533	Optional double power supply unit 1200W		2	1	3	
A2519A	(LV) LV Channels 15V 5A (50W) - DB37 conn - Individually floating (8ch)	8	12	3	15	120
A1510	(SEP) HV Channels 100V 10mA floating (12ch)	12	2	0	2	24
A1519B	(HV) HV Channels 250V 0.1/1mA floating (12ch)	12	4	1	5	60

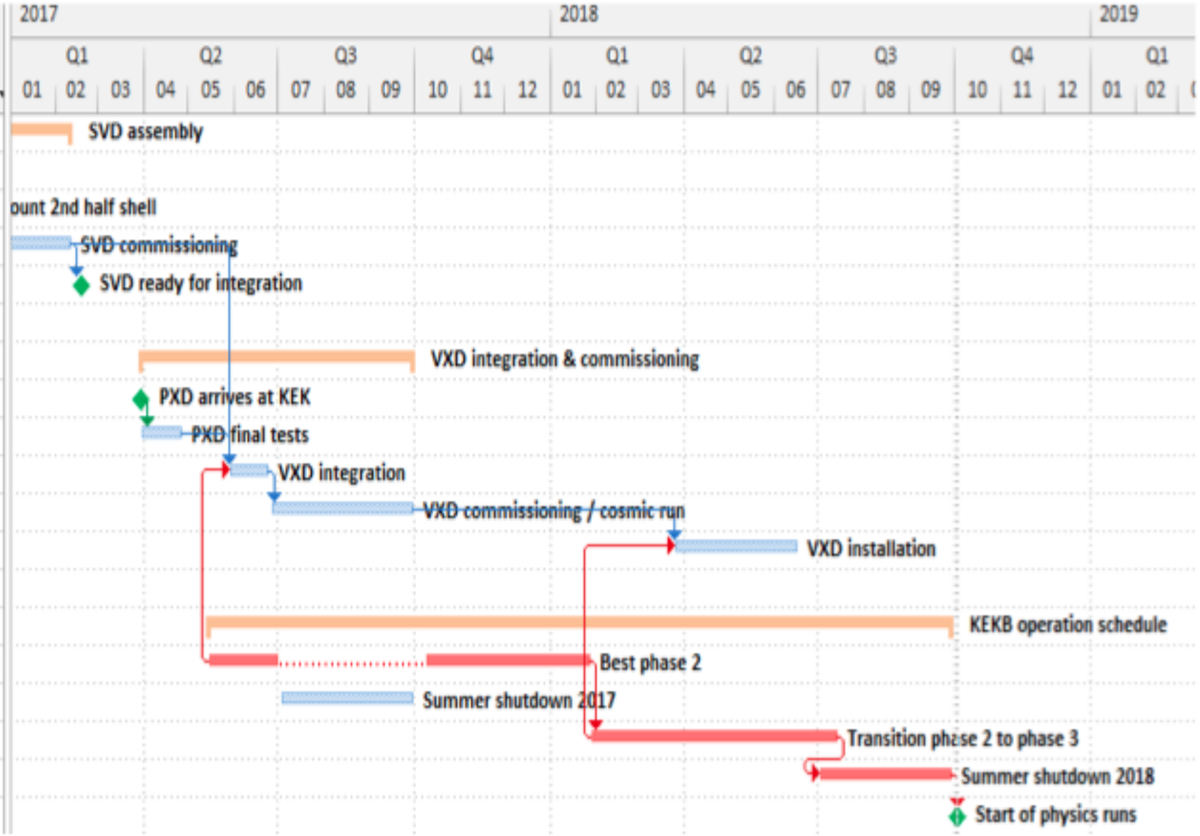
+3

PS System delivery and test plans

- The final test of the PS boards performed in Vienna (1 July): modification effective to filter out switching noise.
- The boards are basically produced.
- Final modifications should be completed in July
  - Including test with stacked power supplies
- End of July: Shipment to KEK
- Mid August: test at KEK with FADC system and real module
  - FF will be at KEK Aug 15-31 for this test
  - Need a working FADC system a module, and cables

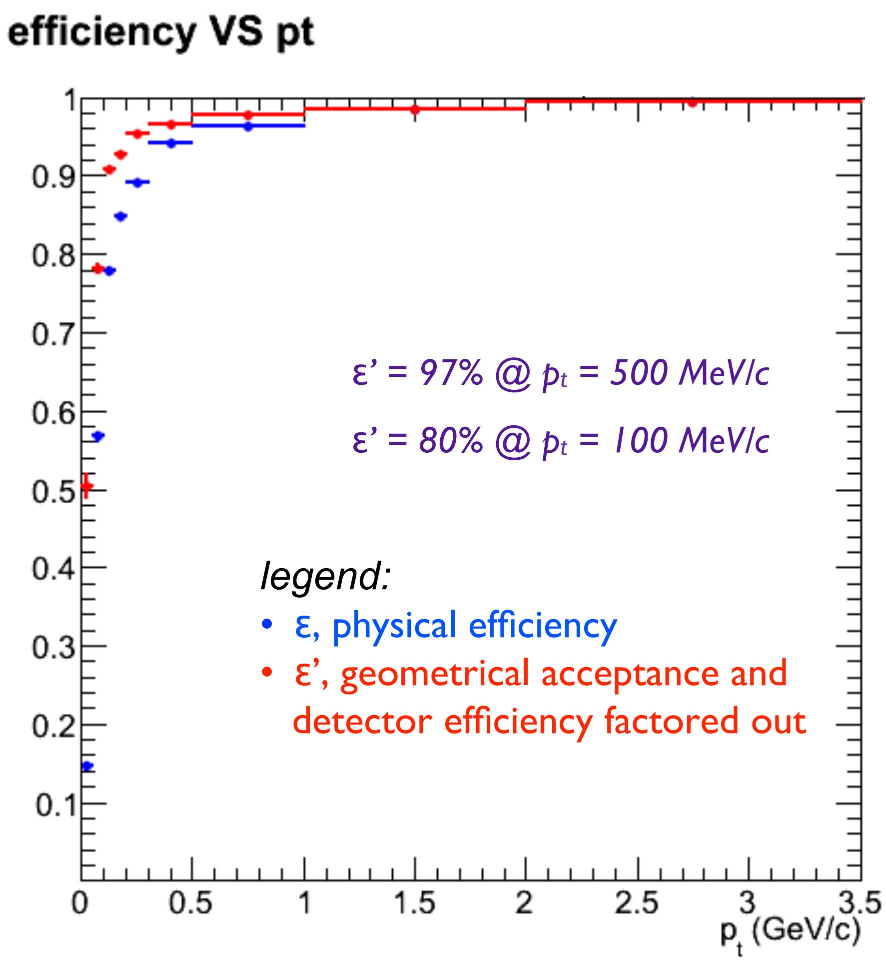
SVD Commissioning Schedule

	Name	Start	Finish	Durati
185	**SVD assembly**	**Mon 28.03.16**	**Fri 10.02.17**	**230 d**
186	Ladder mount 1st half shell	Mon 28.03.16	Fri 08.07.16	75 d
187	Ladder mount 2nd half shell	Mon 25.07.16	Fri 04.11.16	75 d
188	SVD commissioning	Mon 21.11.16	Fri 10.02.17	3 mo
189	SVD ready for integration	Fri 17.02.17	Fri 17.02.17	0 d
190				
191	**VXD integration & commissioning**	**Thu 30.03.17**	**Fri 29.09.17**	**132 d**
192	PXD arrives at KEK	Thu 30.03.17	Thu 30.03.17	0 d
193	PXD final tests	Thu 30.03.17	Wed 26.04.17	4 w
194	VXD integration	Mon 29.05.17	Fri 23.06.17	4 w
195	VXD commissioning / cosmic rur	Mon 26.06.17	Fri 29.09.17	14 w
196	VXD installation	Mon 26.03.18	Fri 15.06.18	3 mo
197				
198	**KEKB operation schedule**	**Mon 15.05.17**	**Fri 28.09.18**	**360 d**
199	Best phase 2	Mon 15.05.17	Fri 26.01.18	5,75 mo
200	Summer shutdown 2017	Mon 03.07.17	Fri 29.09.17	65 d
201	Transition phase 2 to phase 3	Mon 29.01.18	Fri 13.07.18	6 mo
202	Summer shutdown 2018	Mon 02.07.18	Fri 28.09.18	65 d
203	Start of physics runs	Tue 02.10.18	Tue 02.10.18	0 d



Tracking Efficiency Study

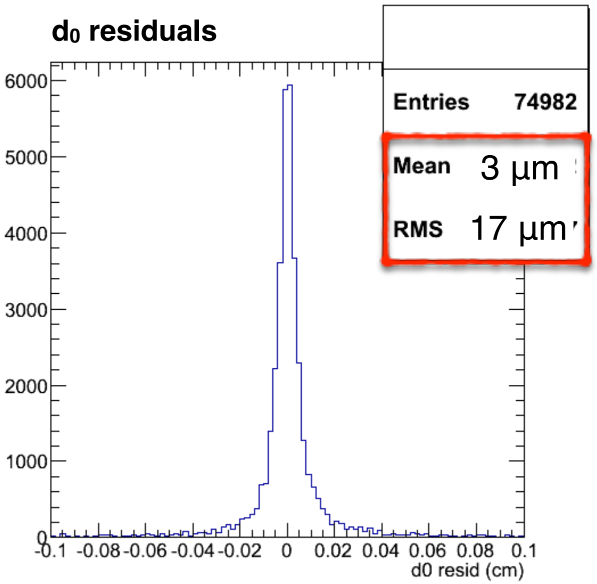
- physical efficiency
  - $\varepsilon = (85.7 \pm 0.1)\%$
- efficiency factoring out geometrical acceptance and detector efficiency
  - $\varepsilon' = (94.3 \pm 0.1)\%$
- patter recognition efficiency
  - $\varepsilon_{PR} = (96.8 \pm 0.1)\%$
- pattern recognition inefficiency reduced by 20%, physical inefficiency reduced by 10% with respect to begin of the year

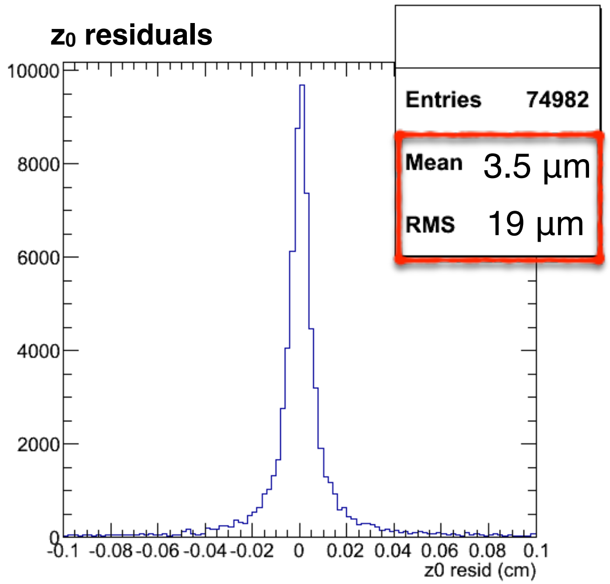


(*) numbers and plots shown are based on a simulation of 8k Y(4S) events

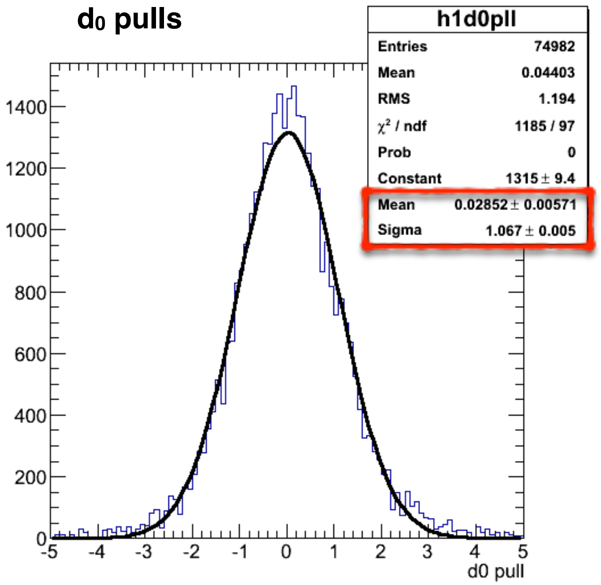
Impact Parameters Study

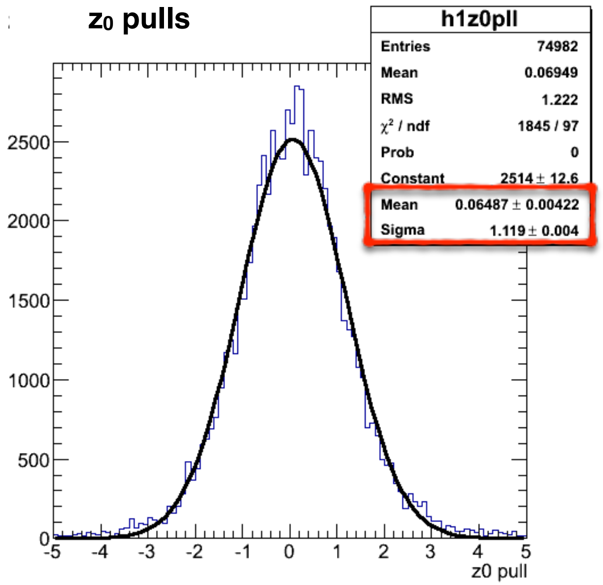
- Resolution on the impact parameters matches TDR expectations (<20 μm)
- a small bias is present, it's under study



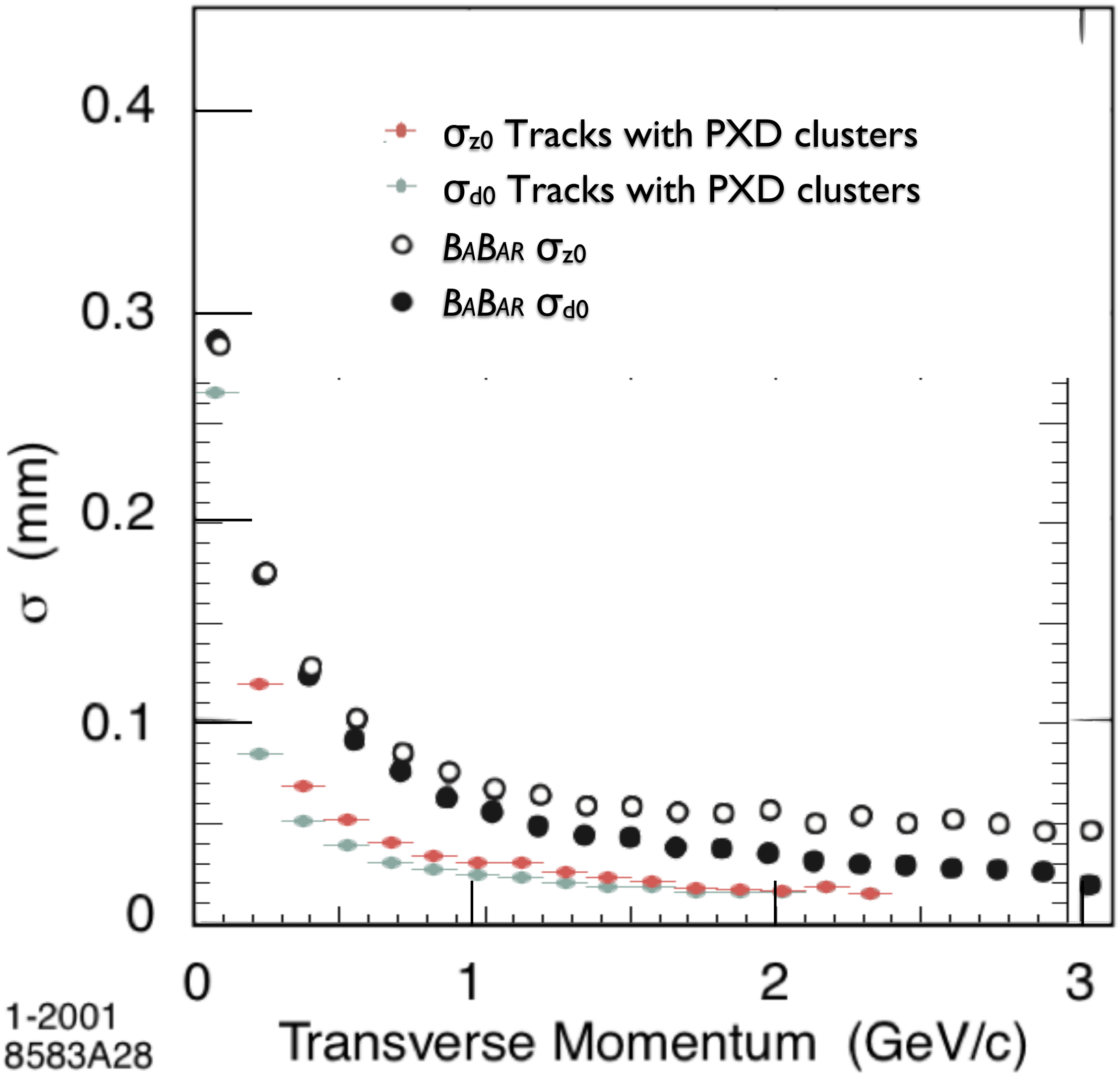


- Error estimation is correct within to 5-10%



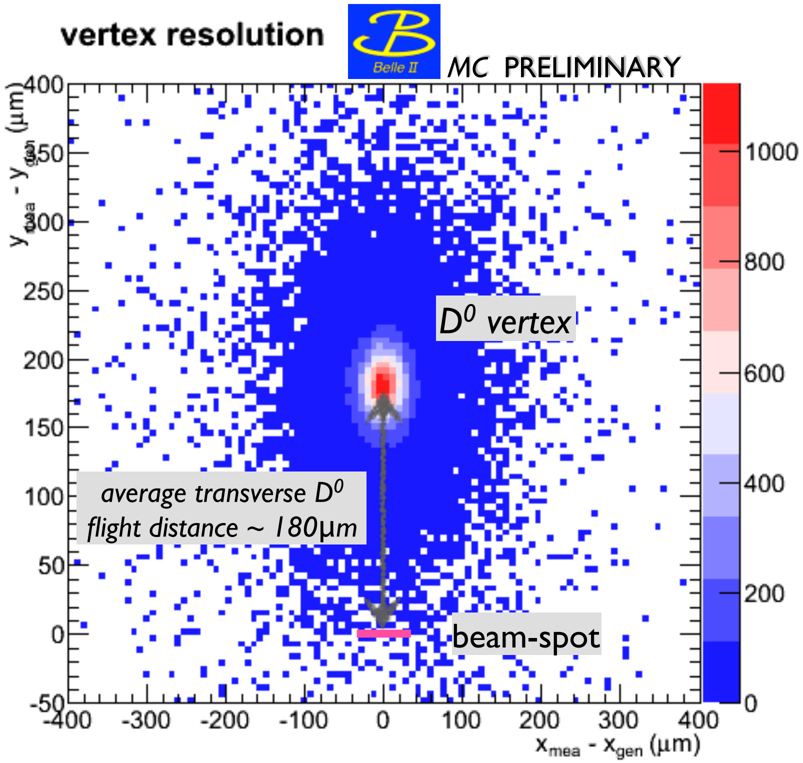


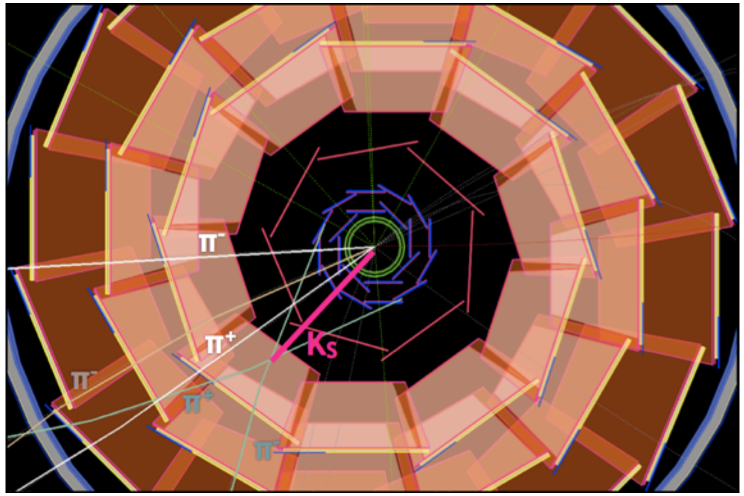
Comparison with *BABAR* Tracking

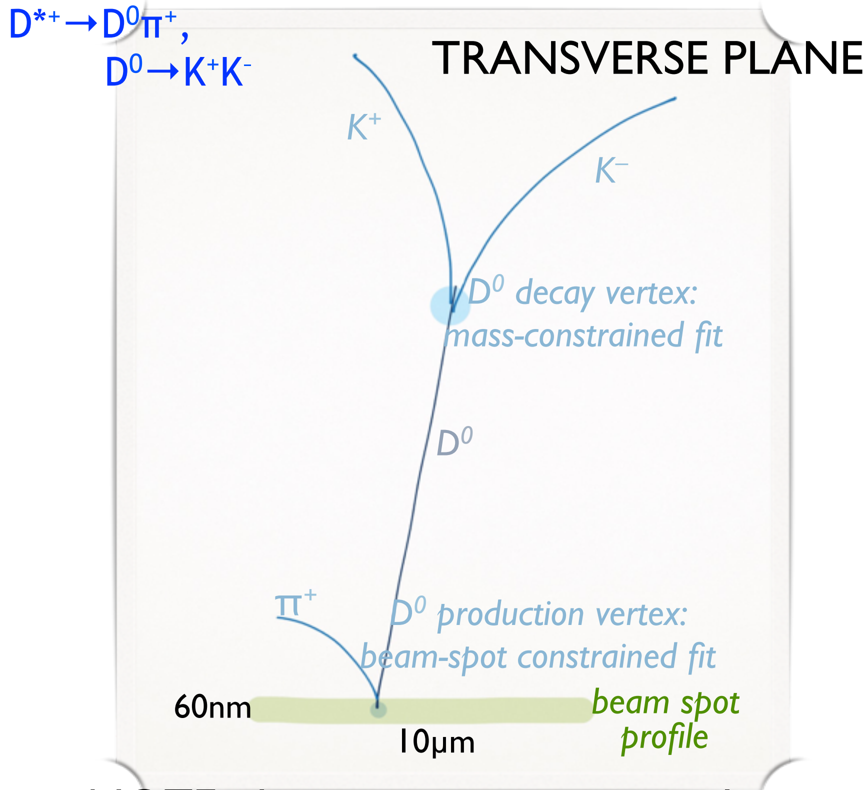


- *Belle II* VXD Tracking (when PXD clusters are attached to the track) performs a factor ~2 better than *BABAR*

D*-tagged D^0 Production & Decay Vertex





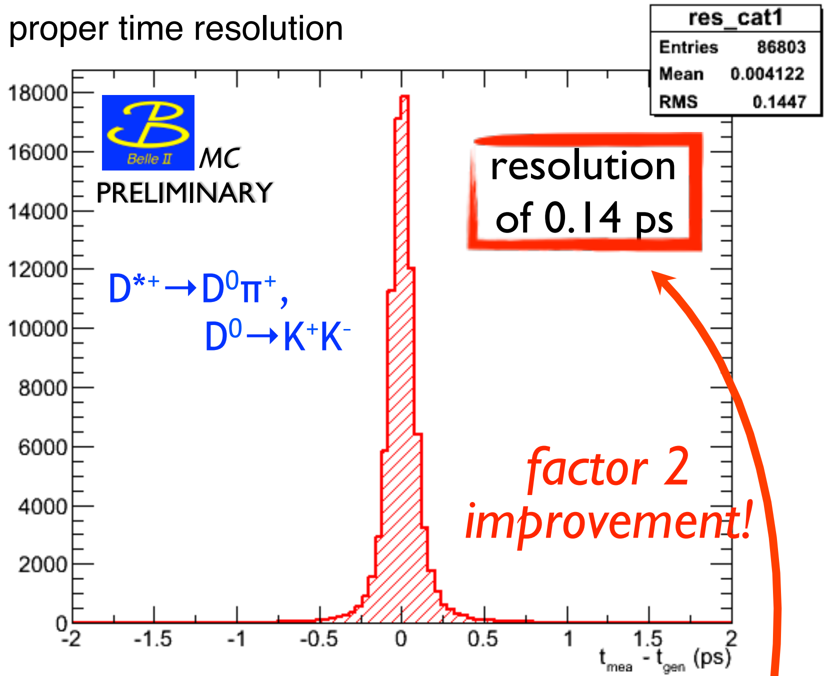


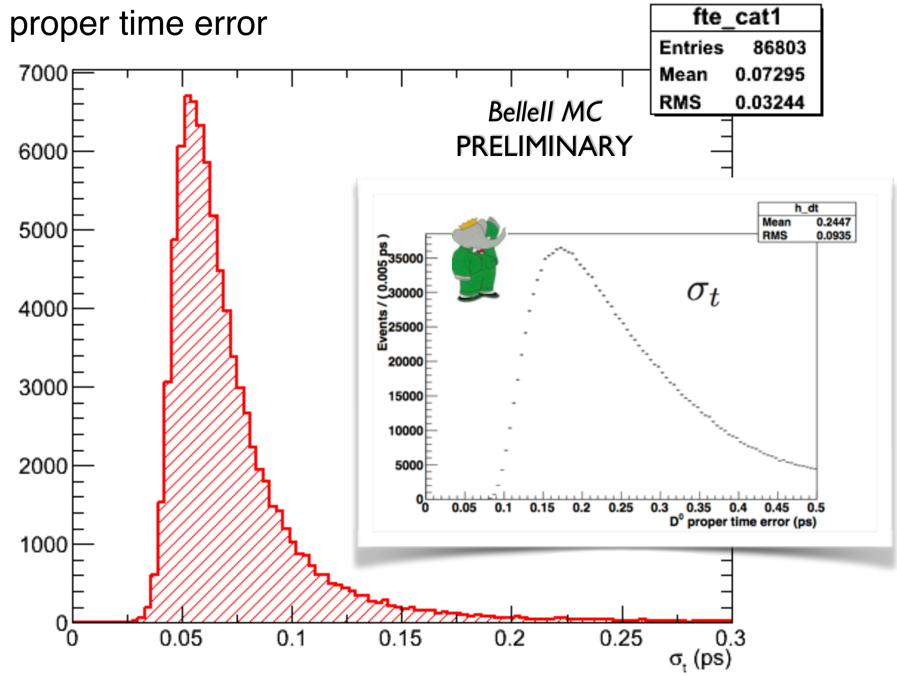
- ➡ D^0 *mass–constrained* vertex fit yields a resolution of the vertex position of ~40µm in transverse plane and also in the longitudinal direction
- ➡ $D^{*+} \to D^0\pi^+$ beam-spot constrained fit yields an *unprecedented* precision of the determination of the D^0 production vertex

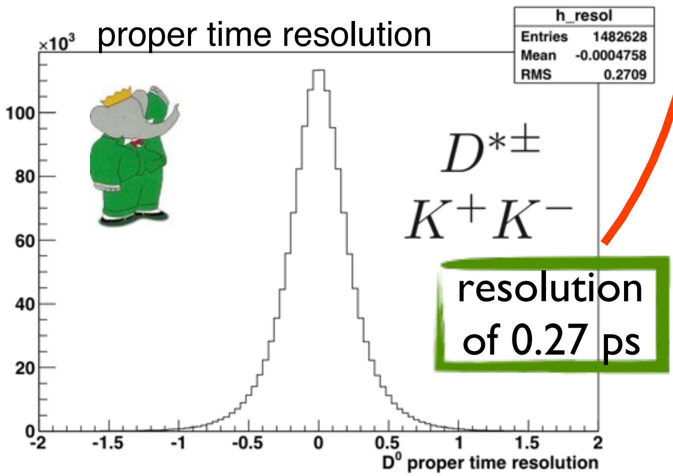
NOTE: the cartoon is not to scale

BaBar *beam-spot*: 6µm x 110 µm

D^0 Proper Time: Resolution and Error







- ➡ factor 2 improvement in the proper time resolution
- ➡ factor 3.5 improvement in the estimation of σ_t
  - average σ_t = 0.07 ps VS 0.25 ps for BABAR
  - RMS σ_t = 0.03 ps VS 0.09 ps for BABAR
- ➡ factor 3 improvement in the D^0 proper time significance
  - average t/σ_t = 6 VS 2 for BABAR

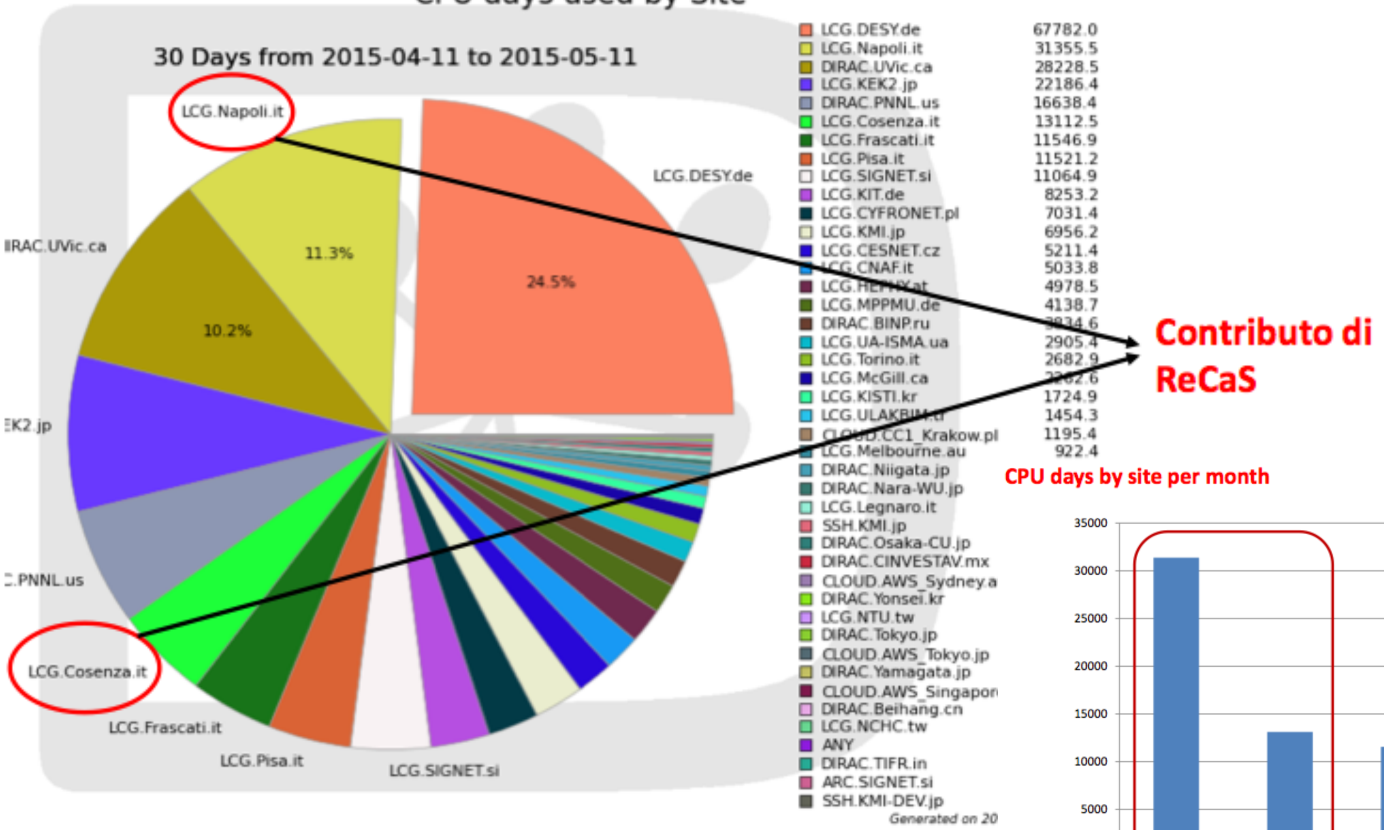
results confirmed in $D^{*+} \to D^0\pi^+, D^0 \to \pi^+\pi^-$

Belle2- Computing

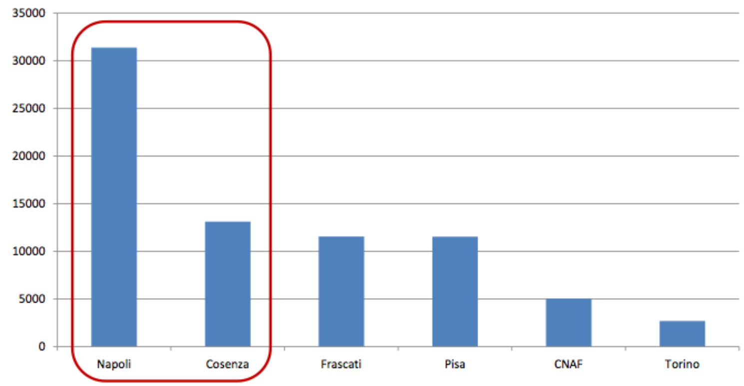
L'Italia è riuscita, nell'ultima campagna, a fare molto più di quanto concordato (il 28.2% invece del 10%)

Belle II quinta campagna MC
(aprile-maggio 2015)

CPU days used by Site



CPU days by site per month



ReCaS infrastructure

Belle2 Computing Resources Estimate

Year	CPU (kHEPSpec06)	Tape (TB)	Disk (TB)
2016	220	815	4036
2017	314	3076	10534
2018	315	5642	11143

Italian share (12%) for 2016-2018

Year	CPU (kHEPSpec06)	Tape (TB)	Disk (TB)
2016	26.4		480
2017	38		1264
2018	38		1337

SVD Pisa activities 2016

- Complete the construction of the FW/BW assemblies. Prod. Rate: 2 SFWs + 2 SBWs / week. Start next week →needed ~8 months. In Silicon Lab. :
  - gluing
  - u-bonding
  - electrical characterization
  - shipping to the production sites.
- Contribution (1 ENG 30% + 1 tech. 20%) to the ladder mounting (start April 2016) and cooling pipes installation.
- Testing ladder/half layer after mounting.

Pisa Manpower 2016 (preliminare)

Nome	Posizione	%	Ruolo
Angelini C.	PO	100	
Batignani G.	PO	80-->70	contact calcolo PI
Bettarini S.	RU	70	Resp.Loc. & SVD-IT coord.
Casarosa G.	Ass. Ric.	80	Charm Phys. Coord.
Forti F.	PA	70	SVT-IB & EB chair, QCG
Paladino A.	Ass. Ric.	70	
Paoloni E.	RU	70-->60	Tracking coord.
Rizzo G.	PA	50	PA task force
		5.9-->5.7	Tot. FTE phys.
		74-->71	<%>

Mazzoni E.	Techn INFN	tbd	computing T2-PI

Non entrano nel DB:

- 1 nuovo assegnista di Ric.: T. Lueck (prende servizio dal 15/10/2015)
- 1 laureando: G. De Pietro (laurea spec. in Fisica)

Richieste servizi di sezione: 2016

- Calcolo: supporto per il Tier2 di Belle2
- Alte Tecnologie:
  - Bosi: 30% (+ 20% tecnico x montaggio)
    - Design tools meccanici per installazione cooling pipes
    - Caratterizzazione meccanica ladder L4/6
    - Intervento in caso di necessita' di aggiustaggi jigs in produzione
  - Tecnico per assemblaggio FW/BW assemblies (2 teams/day con 1 tecn+1 phys): 1 FTE per i primi 6 mesi
  - Tecnico (u-saldatura): 1 FTE per i primi 6 mesi
- Officina meccanica:
  - 2 m.u. per modifica/aggiustaggio chucks/jigs
  - Esecuzione/ottimizzazione tools montaggio

Pisa: richieste finanziarie 2016 (preliminari: da discutere in Belle2-IT)

Per il sottosistema SVD:

Sys	Sede	Capitolo	Categoria	Descrizione	Richiesta
SVD	PI	missioni	A	2 x SVD workshop 2kE x 4 pers	16
SVD	PI	missioni	A	Test Beam VXD Desy (1 week x 2 pers)	3
SVD	PI	missioni	A	2 m.u. (6 kE/m.u.) per ladder/cooling pipe mounting incluso tecnico	12
SVD	PI	missioni	A	2 m.u. (6 kE/m.u.) per test ladders/layers durante il mounting	12
SVD	PI	trasporti	A	spedizioni finali FW/BW	5
SVD	PI	consumo	A	consumabili di laboratorio	3
SVD	PI	consumo	A	contributo manutenzioni laboratorio	3
SVD	PI	consumo	A	tools meccanici per pipe mounting	5
SVD	PI	missioni	C	Coordinamento SVD	5

Missioni (PH-Tools):

- 5 kE + 5 kE per coordinamento tracking + Charm-Phys.
- 3 kE per i face2face tracking meeting

Missioni (Computing):

- 2 workshops x 2 persone

Missioni (collaboration):

- 5 kE per chair EB

Generali (missioni - consumi metabolismo) secondo “formula” (1 m.u. + 1.5 kE/FTE – 1.5 kE/FTE)

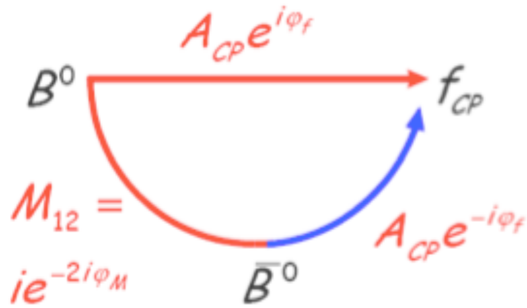
Conclusioni

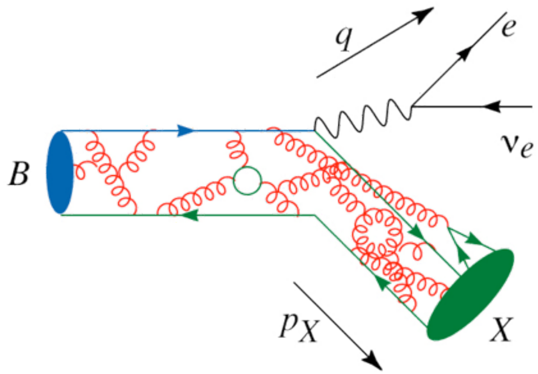
- L'esperienza del gruppo di Pisa ha permesso di individuare alcune criticita' del progetto (Flex PA, PA0, scratch durante la fase di test dei rivelatori) e ha contribuito non poco a stabilire un metodo sistematico per la soluzione dei problemi, potendo cosi' arrivare all'inizio della fase di produzione dei ladder di SVD.
- Da ora fino alla meta' del 2016 l'attivita' di maggiore impegno per il gruppo di Pisa riguarda ancora la costruzione (assemblaggio/test) dei FW/BW assemblies. Successivamente l'esperienza di BaBar-SVT sara' messa a frutto nella partecipazione al montaggio dei moduli e nella successiva fase di commissioning del rivelatore.
- L'attivita' del gruppo si e' articolata su molti fronti, ricoprendo responsabilita' (tracking, analisi, costruzione moduli).
- La nostra presenza sul SW (tracking) e nei gruppi di Fisica (charm) ha lo scopo di far crescere il gruppo stimolando l'interesse per l'analisi dei dati.

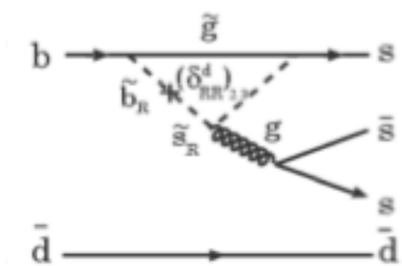
Back-up

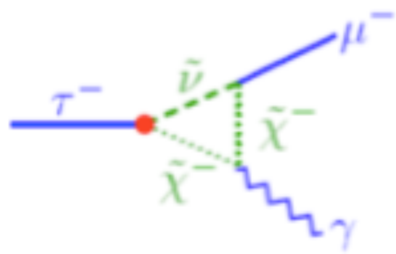
Why flavour physics

1. Explore the origin of CP violation
   - Key element for understanding the matter content of our present universe
   - Established in the B meson in 2001
   - Direct CPV established in B mesons in 2004
2. Precisely measure parameters of the standard model
   - For example the elements of the CKM quark mixing matrix
   - Disentangle the complicated interplay between weak processes and strong interaction effects
3. Search for the effects of physics beyond the standard model in loop diagrams
   - Potentially large effects on rates of rare decays, time dependent asymmetries, lepton flavour violation, …
   - Sensitive even to large New Physics scale, as well as to phases and size of NP coupling constants









Physics at 50 ab^{-1}

Belle II
Note 21
9th Belle PAC
P.Urquijo talk

	Observables	Belle or LHCb*	Belle II		LHCb	
		(2014)	5 ab^{-1}	50 ab^{-1}	8 fb^{-1}(2018)	50 fb^{-1}
UT angles	$\sin 2\beta$	$0.667 \pm 0.023 \pm 0.012 (1.4^\circ)$	0.7°	0.4°	1.6°	0.6°
	α [°]	85 ± 4 (Belle+BaBar)	2	1		
	γ [°] ($B \to D^{(*)}K^{(*)}$)	68 ± 14	6	1.5	4	1
	$2\beta_s(B_s \to J/\psi\phi)$ [rad]	$0.07 \pm 0.09 \pm 0.01^*$			0.025	0.009
Gluonic penguins	$S(B \to \phi K^0)$	$0.90^{+0.09}_{-0.19}$	0.053	0.018	0.2	0.04
	$S(B \to \eta' K^0)$	$0.68 \pm 0.07 \pm 0.03$	0.028	0.011		
	$S(B \to K_S^0 K_S^0 K_S^0)$	$0.30 \pm 0.32 \pm 0.08$	0.100	0.033		
	$\beta_s^{\rm eff}(B_s \to \phi\phi)$ [rad]	$-0.17 \pm 0.15 \pm 0.03^*$			0.12	0.03
	$\beta_s^{\rm eff}(B_s \to K^{*0}\bar{K}^{*0})$ [rad]	–			0.13	0.03
Direct CP in hadronic Decays	$\mathcal{A}(B \to K^0\pi^0)$	$-0.05 \pm 0.14 \pm 0.05$	0.07	0.04		
UT sides	$\lvert V_{cb}\rvert$ incl.	$41.6 \cdot 10^{-3}(1 \pm 2.4\%)$	1.2%			
	$\lvert V_{cb}\rvert$ excl.	$37.5 \cdot 10^{-3}(1 \pm 3.0\%_{\rm ex.} \pm 2.7\%_{\rm th.})$	1.8%	1.4%		
	$\lvert V_{ub}\rvert$ incl.	$4.47 \cdot 10^{-3}(1 \pm 6.0\%_{\rm ex.} \pm 2.5\%_{\rm th.})$	3.4%	3.0%		
	$\lvert V_{ub}\rvert$ excl. (had. tag.)	$3.52 \cdot 10^{-3}(1 \pm 10.8\%)$	4.7%	2.4%		
Leptonic and Semi-tauonic	$\mathcal{B}(B \to \tau\nu)$ [10^{-6}]	$96(1 \pm 26\%)$	10%	5%		
	$\mathcal{B}(B \to \mu\nu)$ [10^{-6}]	< 1.7	20%	7%		
	$R(B \to D\tau\nu)$ [Had. tag]	$0.440(1 \pm 16.5\%)^\dagger$	5.6%	3.4%		
	$R(B \to D^*\tau\nu)^\dagger$ [Had. tag]	$0.332(1 \pm 9.0\%)^\dagger$	3.2%	2.1%	...	
Radiative	$\mathcal{B}(B \to X_s\gamma)$	$3.45 \cdot 10^{-4}(1 \pm 4.3\% \pm 11.6\%)$	7%	6%		
	$A_{CP}(B \to X_{s,d}\gamma)$ [10^{-2}]	$2.2 \pm 4.0 \pm 0.8$	1	0.5		
	$S(B \to K_S^0\pi^0\gamma)$	$-0.10 \pm 0.31 \pm 0.07$	0.11	0.035		
	$2\beta_s^{\rm eff}(B_s \to \phi\gamma)$	–			0.13	0.03
	$S(B \to \rho\gamma)$	$-0.83 \pm 0.65 \pm 0.18$	0.23	0.07		
	$\mathcal{B}(B_s \to \gamma\gamma)$ [10^{-6}]	< 8.7	0.3	–		
Electroweak penguins	$\mathcal{B}(B \to K^{*+}\nu\bar{\nu})$ [10^{-6}]	< 40	< 15	30%		
	$\mathcal{B}(B \to K^+\nu\bar{\nu})$ [10^{-6}]	< 55	< 21	30%		
	C_7/C_9 ($B \to X_s\ell\ell$)	~20%	10%	5%		
	$\mathcal{B}(B_s \to \tau\tau)$ [10^{-3}]	–	< 2	–		
	$\mathcal{B}(B_s \to \mu\mu)$ [10^{-9}]	$2.9^{+1.1*}_{-1.0}$			0.5	0.2

The case for new physics manifesting in Belle II

Issues (addressable at a Flavour factory)

→ NP beyond the direct reach of the LHC

- Baryon asymmetry in cosmology
  → New sources of CPV in quarks and charged leptons
- Quark and Lepton flavour & mass hierarchy
  → higher symmetry, massive new particles, extended gauge sector
- 19 free parameters
  → Extensions of SM relate some, (GUTs)

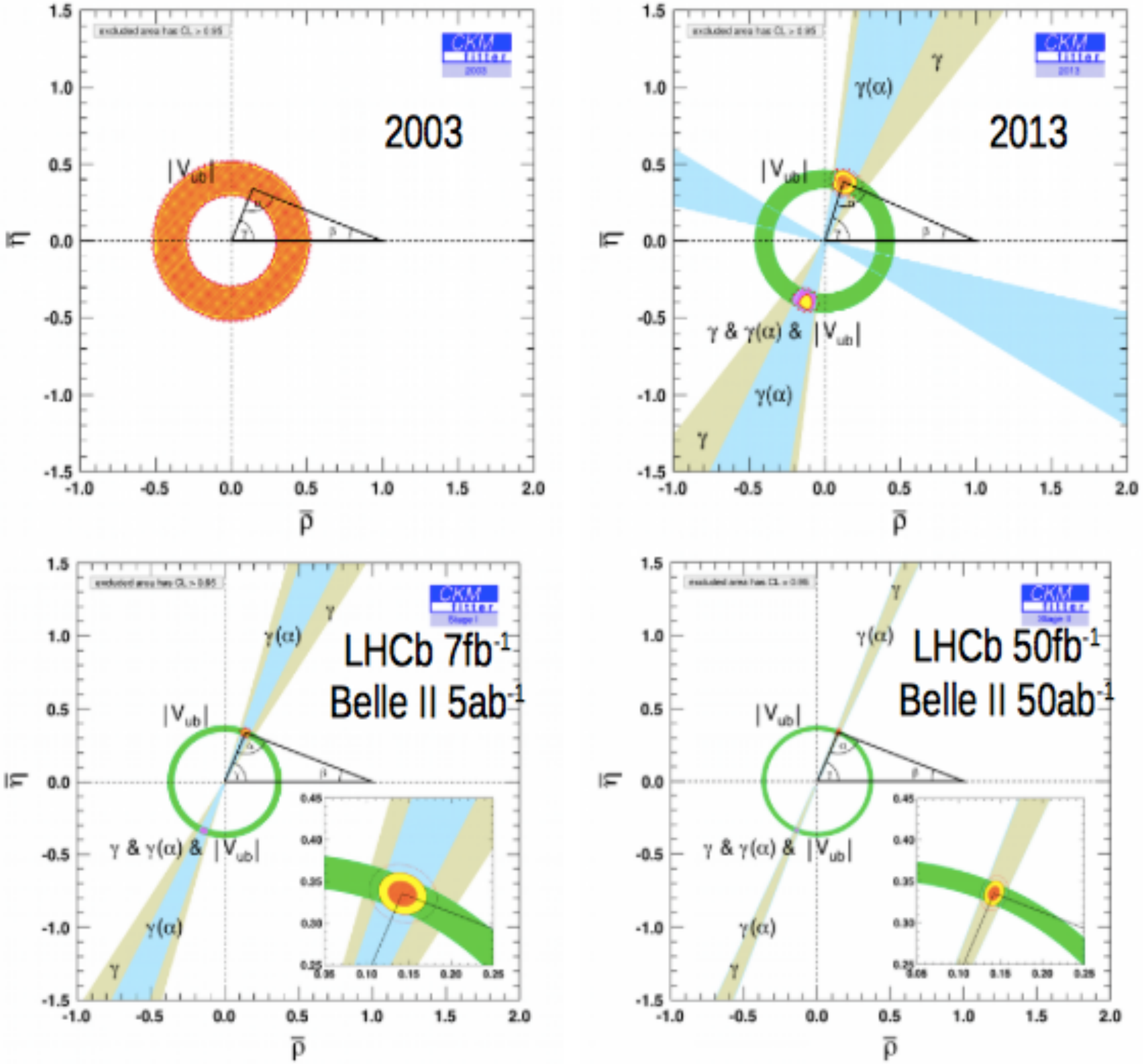
$$\mathcal{L}_{\rm Yukawa} = g_u^{ij}\,\bar{u}_R^i\,H^T\,\epsilon\,Q_L^j - g_d^{ij}\,\bar{d}_R^i\,H^\dagger\,Q_L^j - g_e^{ij}\,\bar{e}_R^i\,H^\dagger\,L_L^j \quad + \text{h.c.}\,,$$

$$\mathcal{L}_{W^\pm\,\text{quark int.}} = \frac{g_2}{\sqrt{2}}\,W_\mu^+\,\bar{u}'_L\,\gamma^\mu\,V_{\rm CKM}\,d'_L + \text{h.c.}\,,$$

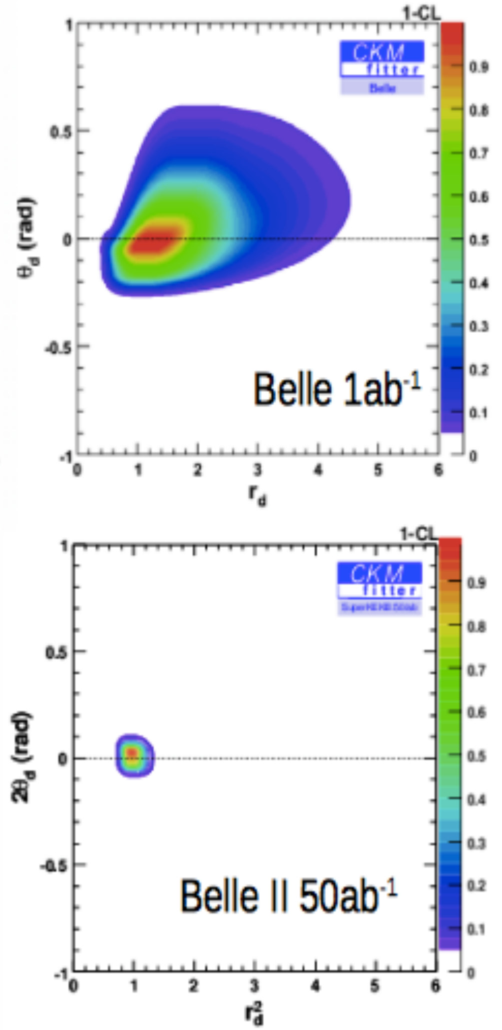
- No (WIMP) candidates for Dark Matter
  → Hidden dark sector
- Finite neutrino masses
  → Tau LFV.
- \+ Puzzling nature of exotic “new” QCD states.

Physics at 50 ab^{-1}

Unitarity triangle in the presence of NP arXiv: 1309.2293



NP parameters in b→d box diagram arXiv:1011.0352

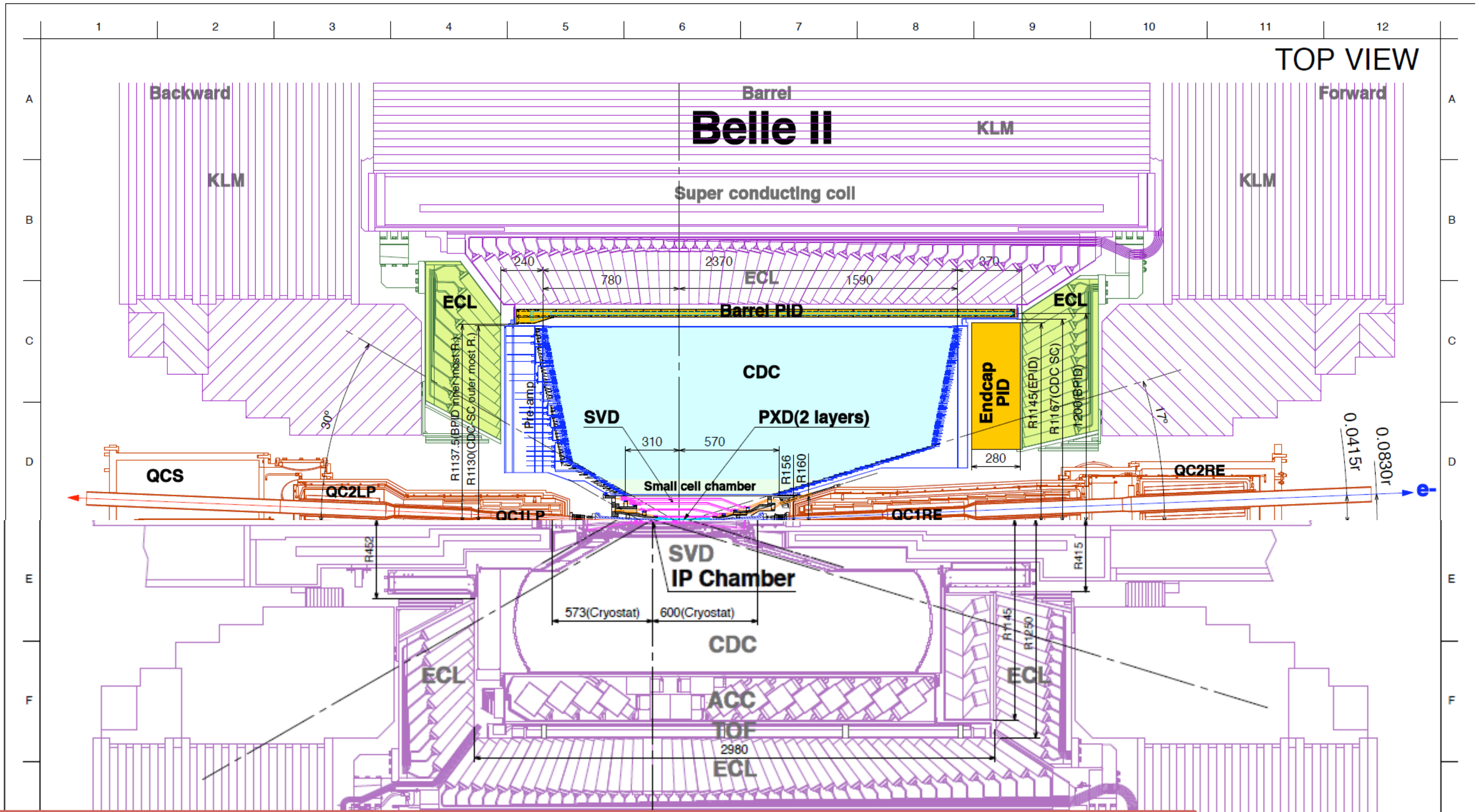


Machine design parameters

parameters		KEKB		SuperKEKB		units
		LER	HER	LER	HER	
Beam energy	E_b	3.5	8	4	7	GeV
Half crossing angle	ϕ	11		41.5		mrad
Horizontal emittance	ε_x	18	24	3.2	4.6	nm
Emittance ratio	κ	0.88	0.66	0.37	0.40	%
Beta functions at IP	β_x^*/β_y^*	1200/5.9		32/0.27	25/0.30	mm
Beam currents	I_b	1.64	1.19	3.60	2.60	A
beam-beam parameter	ξ_y	0.129	0.090	0.0881	0.0807	
Luminosity	L	2.1×10^{34}		8×10^{35}		$cm^{-2}s^{-1}$

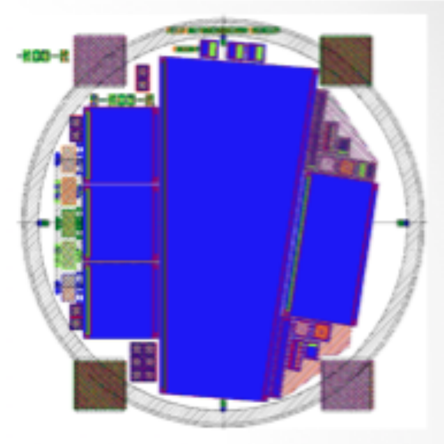
- **Nano-beams and a factor of two more beam current** to increase luminosity
- **Large crossing angle**
- **Change beam energies** to solve the problem of short lifetime for the LER

Belle II Detector (in comparison with Belle)



SVD: 4 DSSD lyrs → 2 DEPFET lyrs + 4 DSSD lyrs
CDC: small cell, long lever arm
ACC+TOF → TOP+A-RICH
ECL: waveform sampling (+pure CsI for endcaps)
KLM: RPC → Scintillator +MPPC (endcaps, barrel inner 2 lyrs)

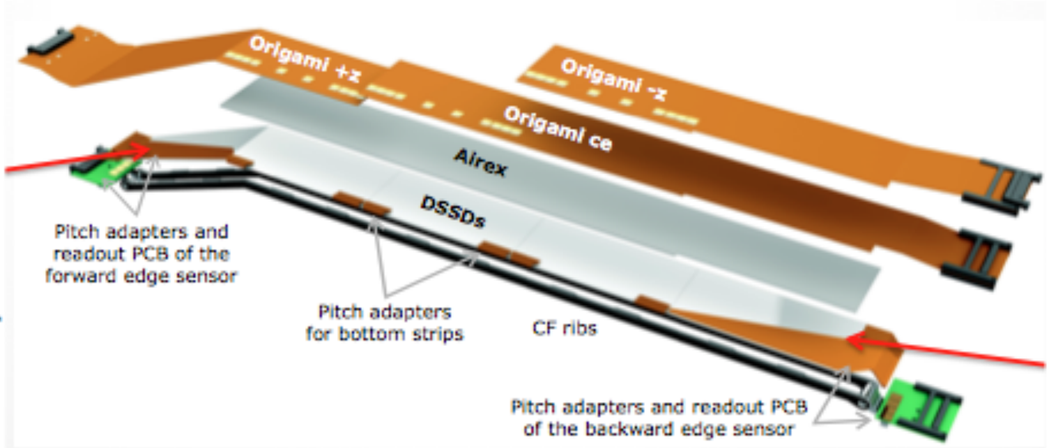
Vertex Detector (PXD+SVD)



Trieste:

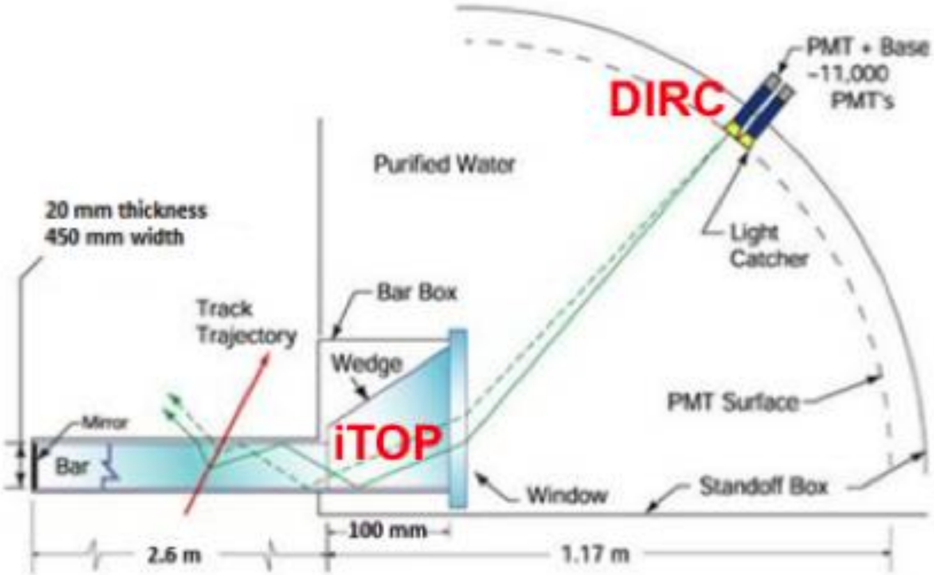
- Contribution to silicon detector testing (Micron)
- Environmental & Radiation Monitoring
  - Take advantage of development funded in SuperB for diamond detectors with fast remote readout

Pisa:



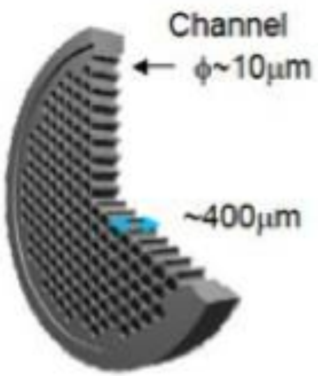
- Contribution to assembly of strip detector modules:
  - On critical path
  - Assemble FW and BW sensors of Layer 4-5-6 & ship to other assembly sites (Vienna, IPMU-Tokyo, TATA at IPMU lab)
- Replacement of the old Power-Supply
- SVD software development:
  - Si only tracking & PXD data reduction with ROI (region of interest) selection
  - Alignment

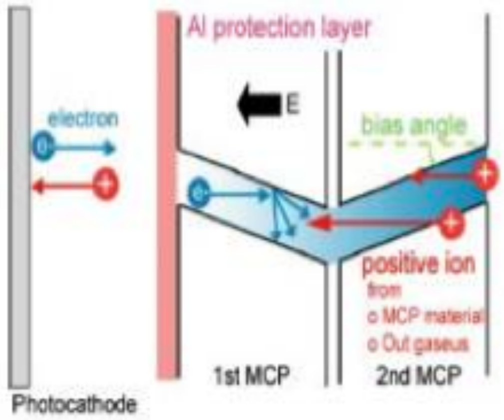
Barrel PID: imaging Time Of Propagation (iTOP)

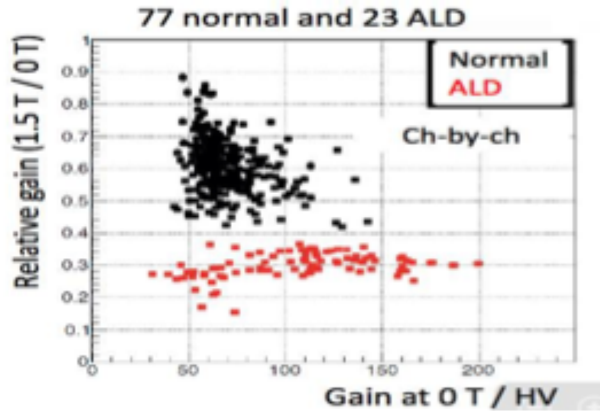


L' iTOP è un nuovo tipo di rivelatore Cherenkov in cui l'immagine viene ricostruita in uno spazio di 100 mm (10 volte meno rispetto al DIRC di Babar) grazie ad una combinazione tra elevata risoluzione temporale (tradotta in spazio) ed utilizzo di fotomoltiplicatori a microcanali (MCP-PMT)

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:





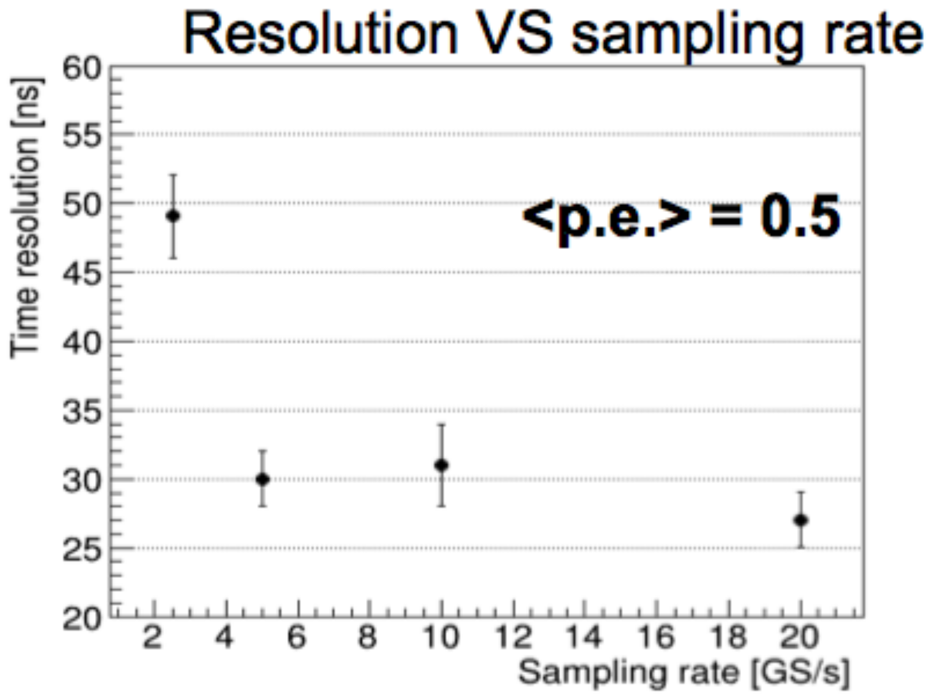


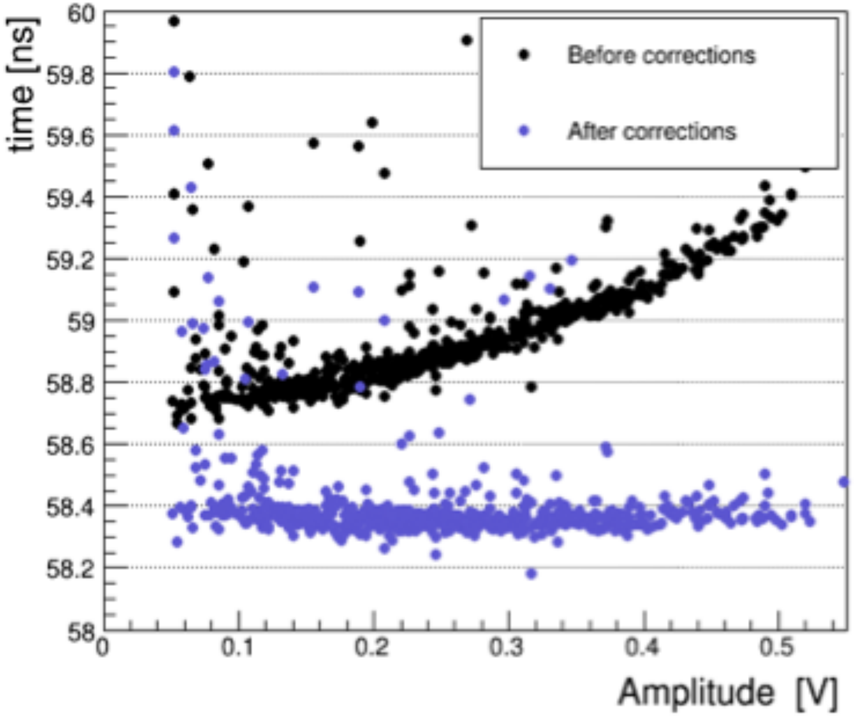
Time resolution in Torino

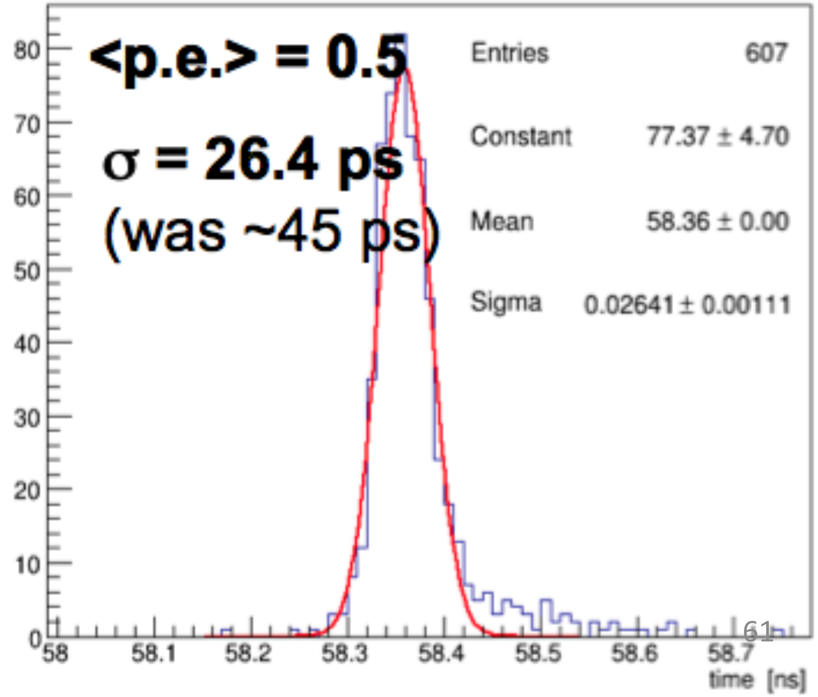
- *Vs Bandwidth della DAQ*
- *Vs High Voltage*

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

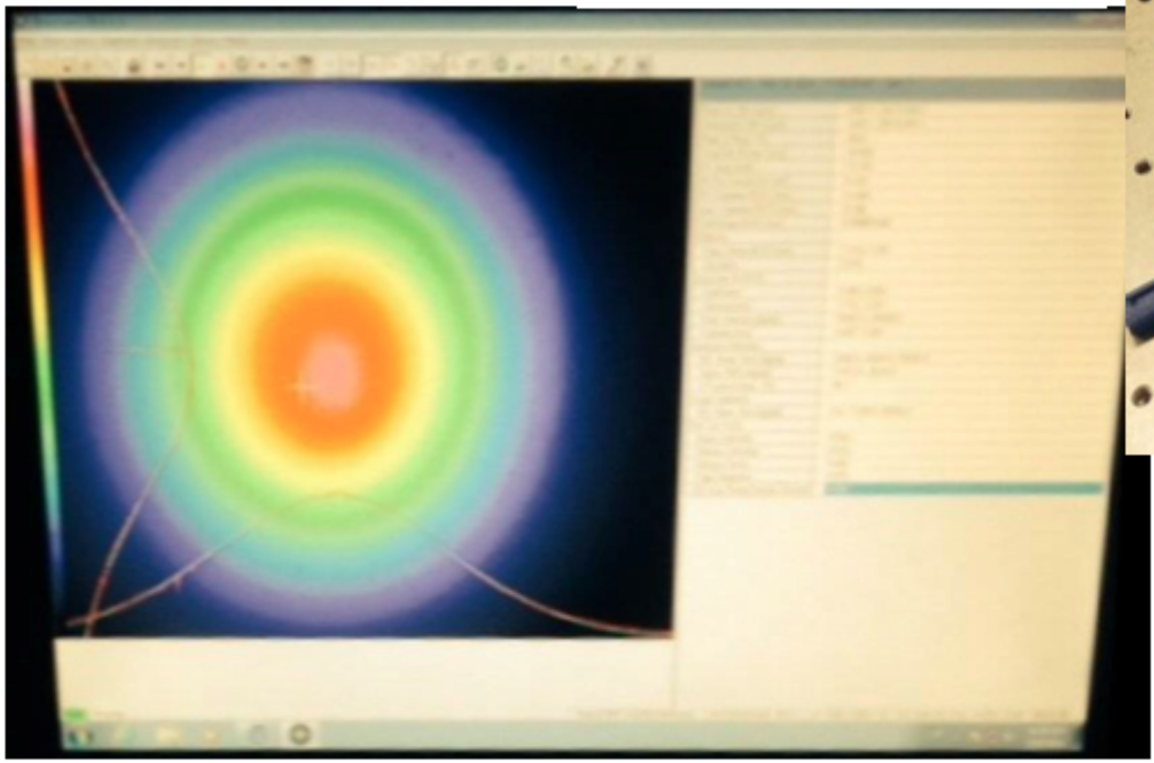


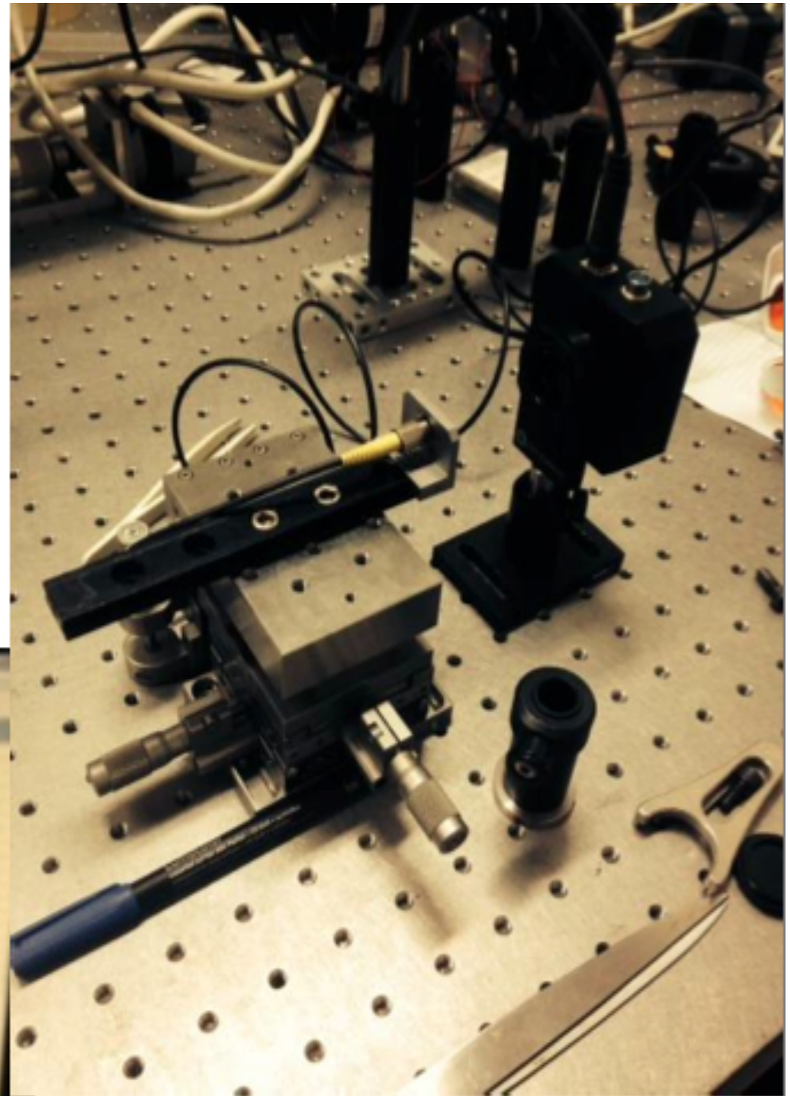




Misure di distrib angolare (Padova) Studi di piping efficiency in bundles

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

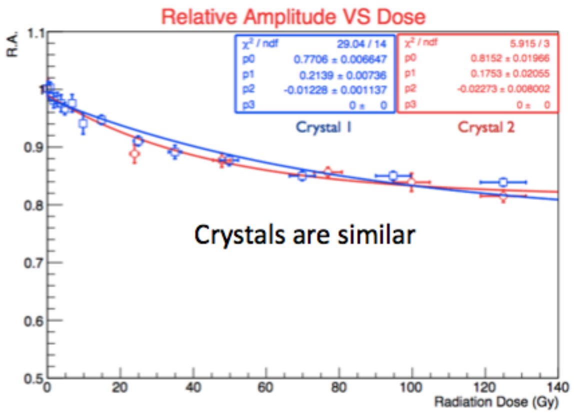
ECL FWD upgrade

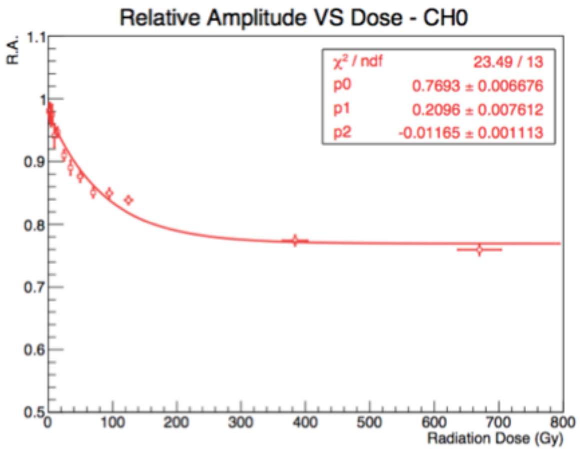
The decision on the upgrade has been postponed to February 2016

- Rad hard of crystals → 20% LY loss and then saturation
- Rad hard PiN diodes →

- Necessary to have results from performance and physics we are on the way on….the estimation of February is based on this item

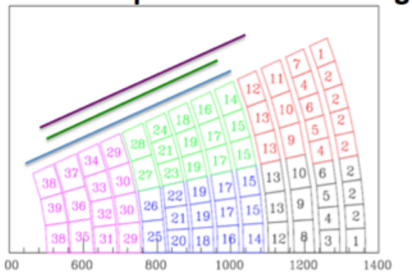
Crystals rad-hard



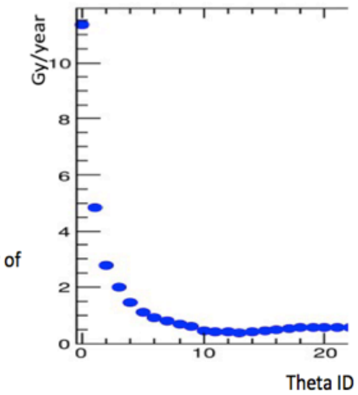


Ipotesi di upgrade

Replacement of the rings: complete or partial?



a) 672 pure CsI + 480 CsI(Tl)
b) 48 CsI(Tl) + 624 pure CsI + 480 CsI(Tl)
c) 48(?) + 720 pure CsI + 384 CsI(Tl) (exclude 1st layer from trigger and maintain same number of trigger cells)

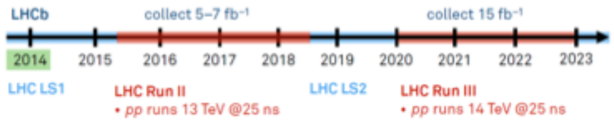


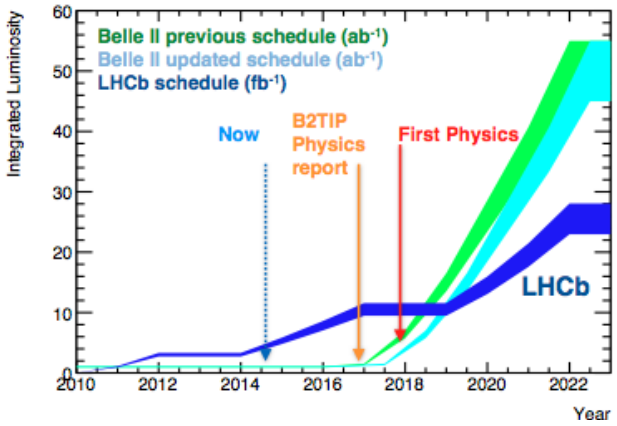
Conclusions

- Upgrade yes/no → more work is necessary to have the final answer (new preamp, software studies, test beam@Mainz….)
- Many other activities are ongoing in particular to extract the real performance for BelleII with the CsI(Tl) calorimeter → is this detector performant enough for the new phase and for the high luminosity? This is strictly related to the upgrade issue and then very important

Estratto dal talk di P. Cecchi a Belle2-Italia (maggio 2015)

Our Competition: LHCb





Note on LHCb

- **$\sigma(bb@14TeV)/\sigma(bb@8TeV) = 3$**
- **LHCb fb^{-1}/BelleII ab^{-1} ~ $O(1)$ (for many interesting modes, but not a rule)**
- **Run-2**: Efficiency loss at higher Lumi. & E
- **Run-3:** Upgraded detector: Efficiency losses decrease ↓ 0.1

We'll have the upgraded LHCb to contend with, very early on.

Similar comparisons on:

- (semi)leptonic
- EWP & Radiative
- Charm & Tau

CPV & mixing

- LHCb's ~50fb^{-1} may be collected by 2026-2027

	Observables	Belle or LHCb (2014)	Belle II $5\ ab^{-1}$	Belle II $50\ ab^{-1}$	LHCb $8\ fb^{-1}$ (2018)	LHCb $50\ fb^{-1}$
UT angles	$\sin 2\beta$	$0.667 \pm 0.023 \pm 0.012 (1.4^\circ)$	0.7°	0.4°	1.6°	0.6°
	α [°]	85 ± 4 (Belle+BaBar)	2	1		
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	$S(B \to K^0_S K^0_S K^0_S)$	$0.30 \pm 0.32 \pm 0.08$	0.100	0.033		
	$\beta_s^{\rm eff}(B_s \to \phi\phi)$ [rad]	± 0.18			0.12	0.03
	$\beta_s^{\rm eff}(B_s \to K^{*0}\bar{K}^{*0})$ [rad]	± 0.19			0.13	0.03
Direct CP in hadronic Decays	$\mathcal{A}(B \to K^0\pi^0)$	$-0.05 \pm 0.14 \pm 0.05$	0.07	0.04		

Test on Micron and HPK DSSD

Bottleneck for the production was testing at Micron

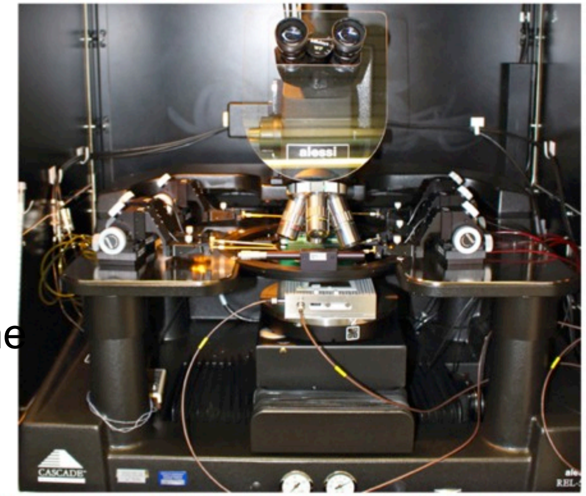
- **Trieste**/Vienna decided to take over these tests
- 3 pre-series and 15 (final prod.) tested
- 10 are under test now

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

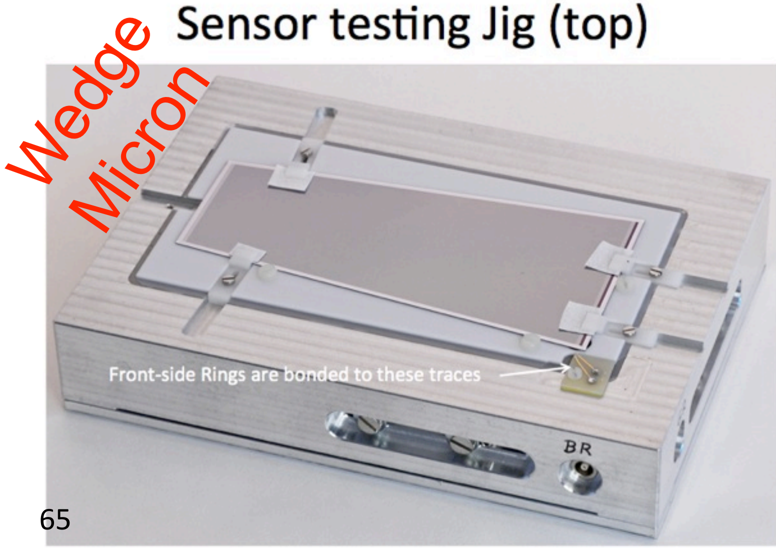
Sensor testing set-up



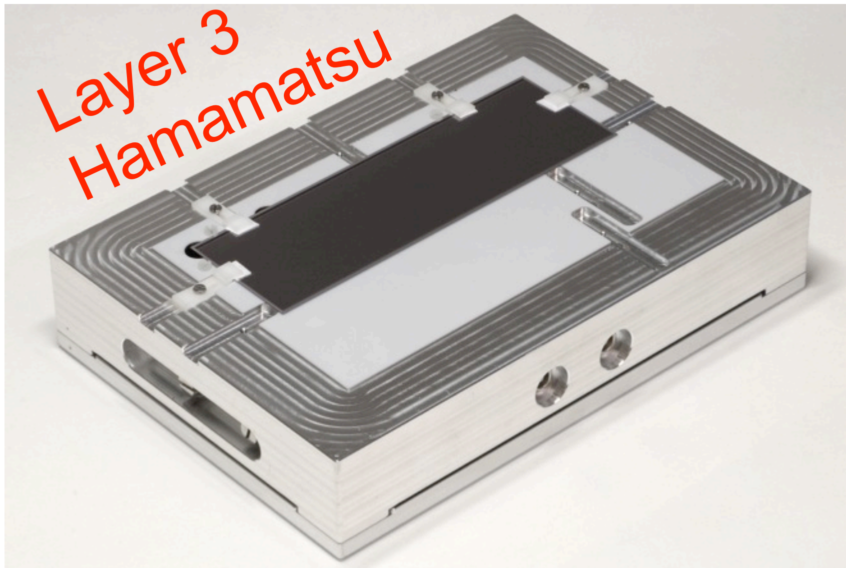
- Front and Back-side Rings are connected through cables
- Strips are contacted by a 40-needle Probe Card

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

Sensor testing Jig (top)



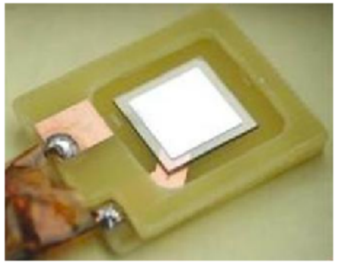
5th Belle II PXD/SVD Workshop 23-01-2014 -- L. Bosisio - Test of Micron Trapezoidal Sensors 3

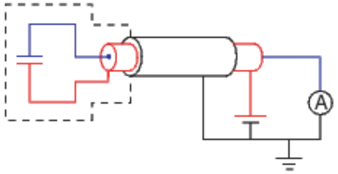


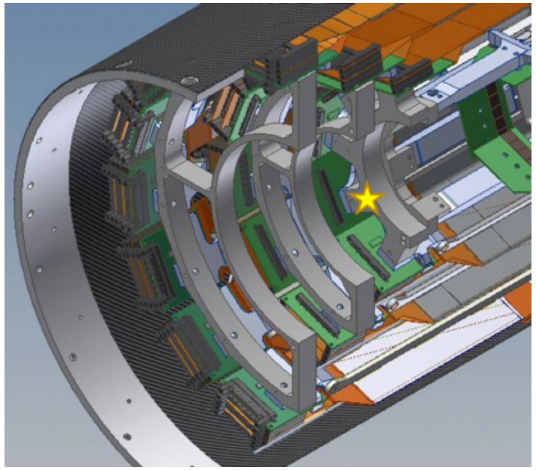
Radiation Monitoring and Beam Abort

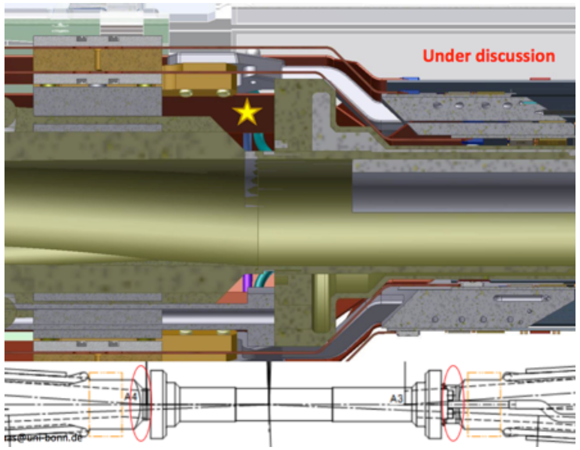
- A document with Requirements prepared
  - Measurement of instantaneous dose rates & integrated doses
    - sensitivity O(1 mrad/s), sampling rate O(100 KHz), etc
  - Beam Abort for excessive beam losses affecting PXD, SVD
    - "Fast" (10 μs), "slow" (ms - s) Beam Abort triggers with programmable thresholds
- 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



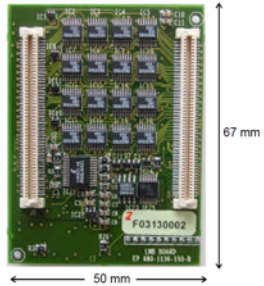




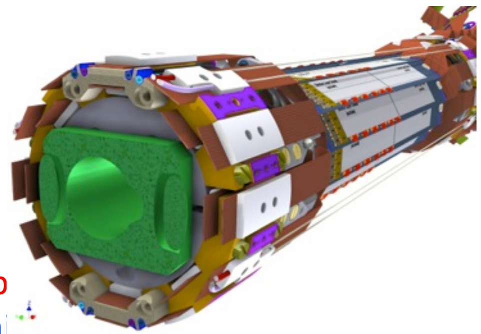


3+15 m (3+40 m) triax cables
Voltage sources (150÷500 V)
picoAmmeters

Temperature and humidity



- Starting point: document of requirements
  - Temperature monitoring:
    - near heat sources and at the inlets/outlets of CO_2 cooling pipes
    - about 1°C (0.1°C) absolute (relative) accuracy
  - 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 CMS experts 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
  - **Fiber Optical Sensors (FOS)** and laser interrogators
    - Based on Bragg grating reflection of specific wavelengths
    - One fiber can monitor stress, temperature, humidity at several points
    - New: PXD FOS R&D completed, successfully tested at the DESY beam test. One fib inserted in the Airex foam, to measure temperature close to sensors and chi



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

PS System delivery and test plans

- The final test of the PS boards performed in Vienna (1 July): modification effective to filter out switching noise.
- The boards are basically produced.
- Final modifications should be completed in July
  – Including test with stacked power supplies
- End of July: Shipment to KEK
- Mid August: test at KEK with FADC system and real module
  – FF will be at KEK Aug 15-31 for this test
  – Need a working FADC system a module, and cables

Thanks to the hard work of the PA-task force the flex issue seems to be solved…

PAFlex shipment to sites

- Measurement already done @ IPMU on 130 pieces with an average yield of 80%
- Considering our needs, and pieces ordered for each type, we might need to ask for reproduction for some pieces (our of specs!):
  - L3 probably OK
  - FW/BW & PA1/PA2 marginal

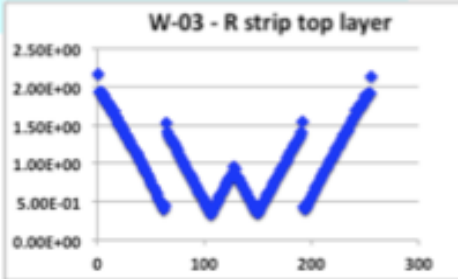
Type	Piece ordered	needed including more spare and class B no safety	needed including All + safety 35%	acceptable yield without asking for reproduction ???
3PF1	30	14	19	0.63
3PF2	30	14	19	0.63
3PB1	30	14	19	0.63
3PB2	30	14	19	0.63
PA1	205	140	189	0.92
PA2	205	140	189	0.92
PF1	100	65	88	0.88
PF2	100	65	88	0.88
PB1	100	65	88	0.88
PB2	100	65	88	0.88
TOT	930	596	806	

130 Flex Measured

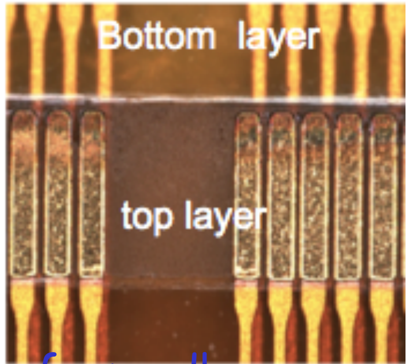
Type	# of total pcs.	# of OK pcs.	yield (pads> 30um)
PF1	30	24	0.80
PF2	30	20	0.67
3-PB2	15	14	0.93
3-PF2	20	14	0.70
3-PF1	10	10	1.00
PA2	25	23	0.92
Total	130	105	

- 800 Flex still to be measured
- Assuming 6pieces/hour, 6hours/day & 2 days/ week to avoid full saturation of the CMM → 11 weeks.
- Measurement will go on until mid August (see next slides)
- Can finish earlier if in July CMM can be used for more days/week

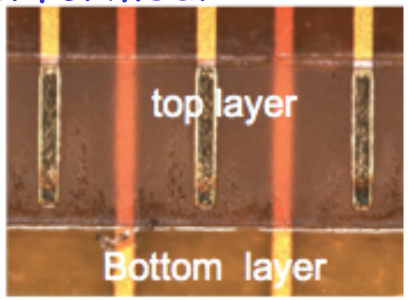
Evaluation of new PAO produced



- **24 PAO with new design**
  - No cracks found: no opens, from electrical test, no small cracks seen by visual inspection.
  - A few shorts found on 6/24 pieces
  - Yield 75%, acceptable



- **Unexpected new issues on PAO: "glue spread"**
  - PAO are made of 2 layers: interlayer glue spreads onto edge of the top layer, covering part of the APV pads and with a lot of residuals on sensor side pads.
  - PAO have been wiped and then bonding tests successfully performed!



- **Assembly of 12 PAO/ORIGAMI with present PAO**

– no cracks until the end of stress-full assembly steps

- Verification OK all the ORIGAMI assembly procedure up to SMD and reflow
- Go on with the chip loading/bonding and el. tests (July)

- **Build/test the 1st class B+ (L5) ladder before end-August**
- **The 1st batch of the new origami production is expected in mid-November, the last one 2 months later.**