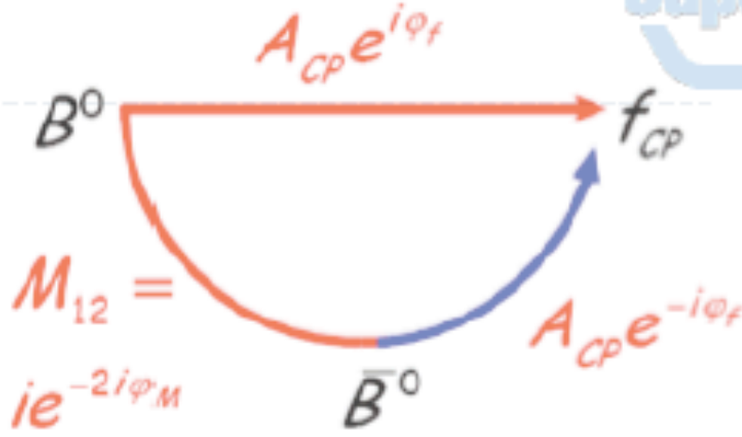
Partecipazione a Belle II

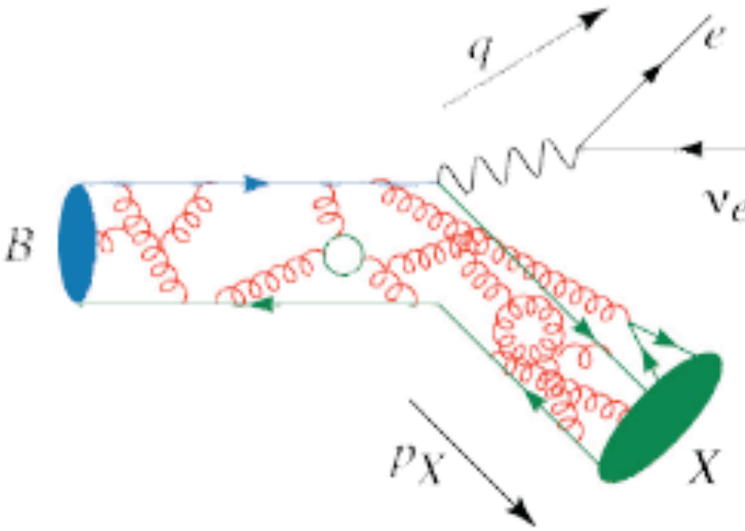
- Frontiera dell'intensità e fisica del sapore
- da KEKB a SuperKEKB
- Belle II: rivelatori
- profilo temporale
- Partecipazione italiana: persone e interessi
- Trieste

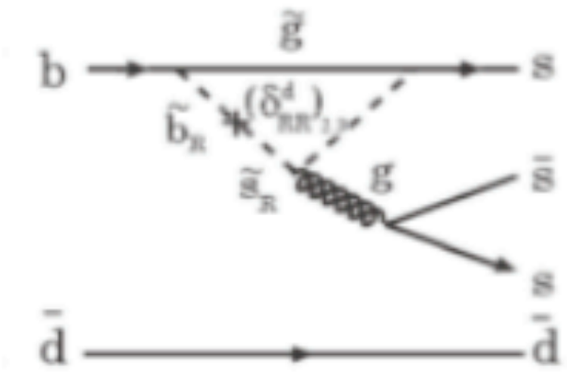
Why flavour physics

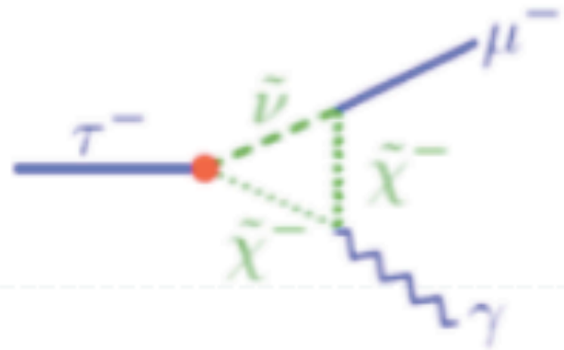
1. Explore the origin of CP violation
   - Key element for understanding the matter content of our present universe
   - Established in the B meson in 2001
   - Direct CPV established in B mesons in 2004
2. Precisely measure parameters of the standard model
   - For example the elements of the CKM quark 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

Statistics









La fisica

Fisica del flavour

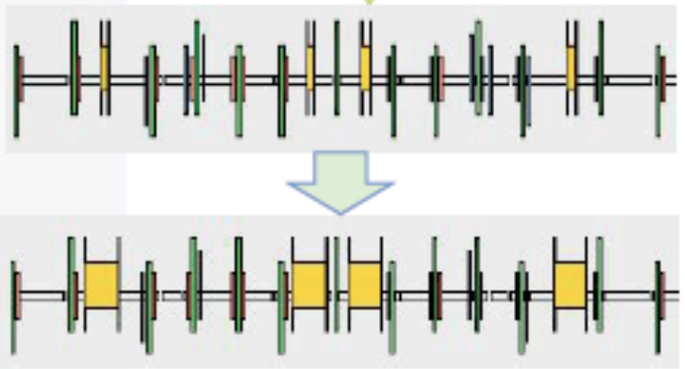
Frontiera dell'intensità

Potenziale di scoperta complementare a LHC

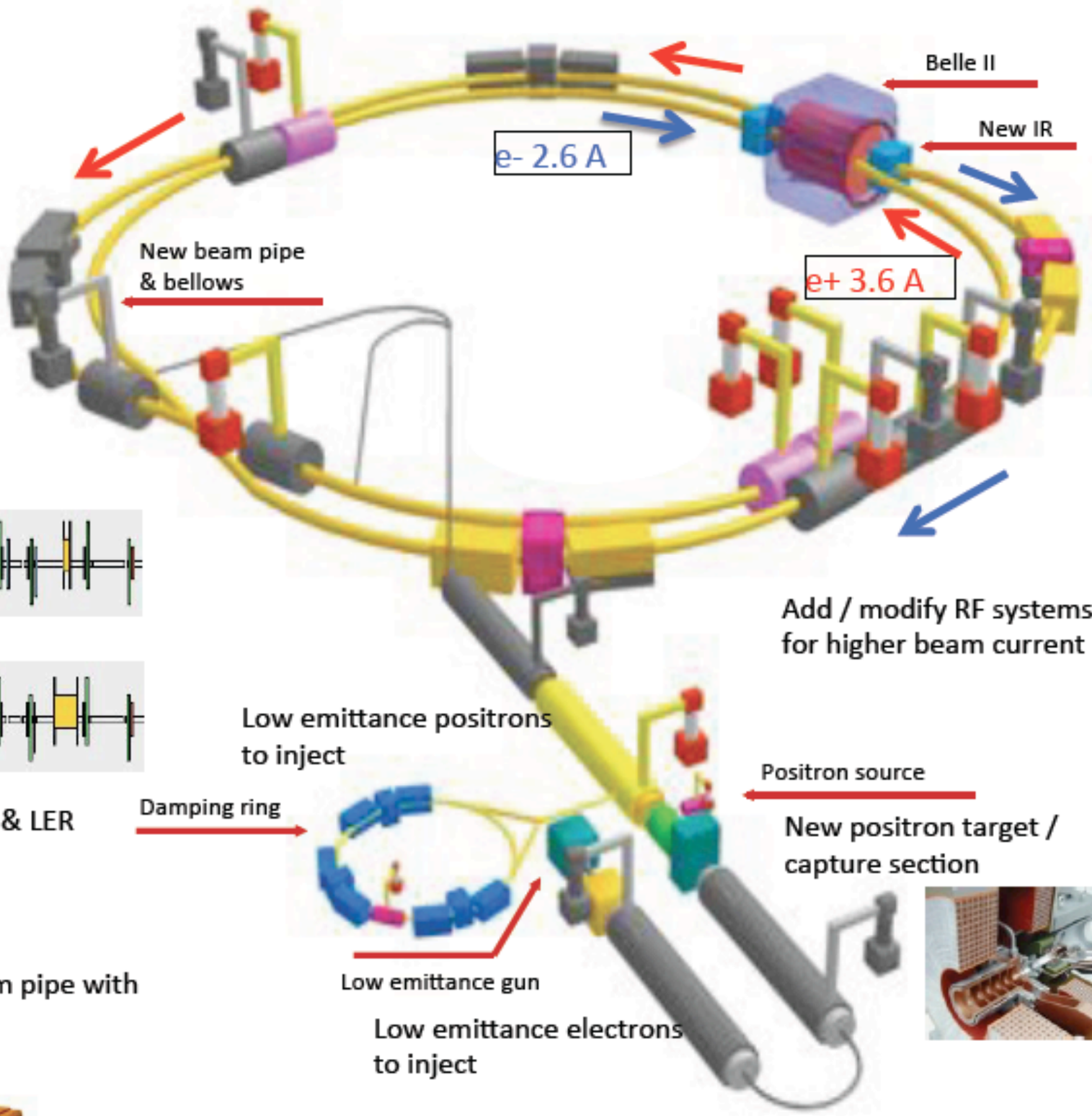
Observable	Expected th. accuracy	Expected exp. uncertainty	Facility
CKM matrix			
$\|V_{us}\|$ $[K \to \pi\ell\nu]$	**	0.1%	K-factory
$\|V_{cb}\|$ $[B \to X_c\ell\nu]$	**	1%	Belle II
$\|V_{ub}\|$ $[B_d \to \pi\ell\nu]$	*	4%	Belle II
$\sin(2\phi_1)$ $[c\bar{c}K^0_S$	***	$8 \cdot 10^{-3}$	Belle II/LHCb
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
$S(B_d \to K^*(\to K^0_S\pi^0)\gamma))$	***	0.03	Belle II
$S(B_s \to \phi\gamma))$	***	0.05	LHCb
$S(B_d \to \rho\gamma))$		0.15	Belle II
A^d_{SL}	***	0.001	LHCb
A^s_{SL}	***	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

KEKB to SuperKEKB

Replace short dipoles with longer ones (LER)

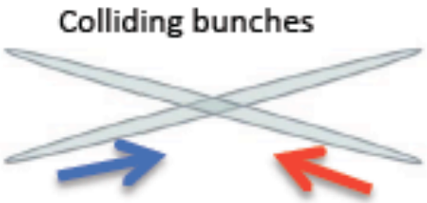


Redesign the lattices of HER & LER to squeeze the emittance

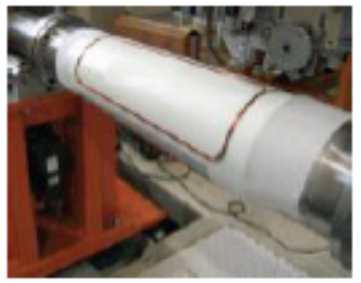


Super KEKB

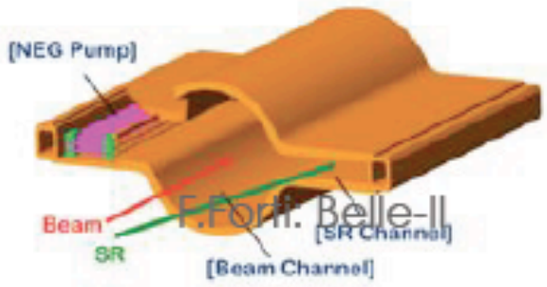
Colliding bunches



New superconducting / permanent final focusing quads near the IP



TiN-coated beam pipe with antechambers



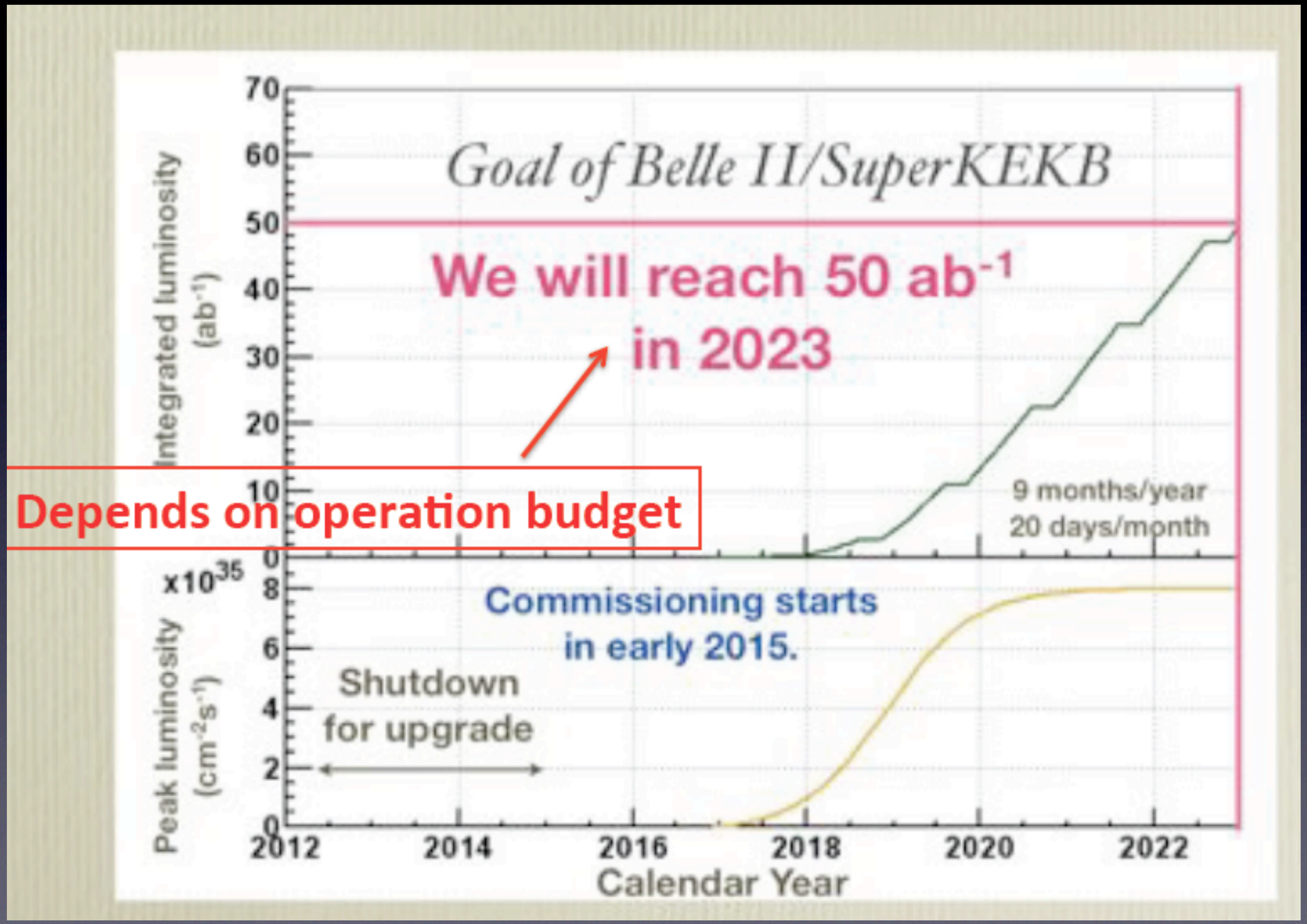
To obtain x40 higher luminosity

Machine design parameters

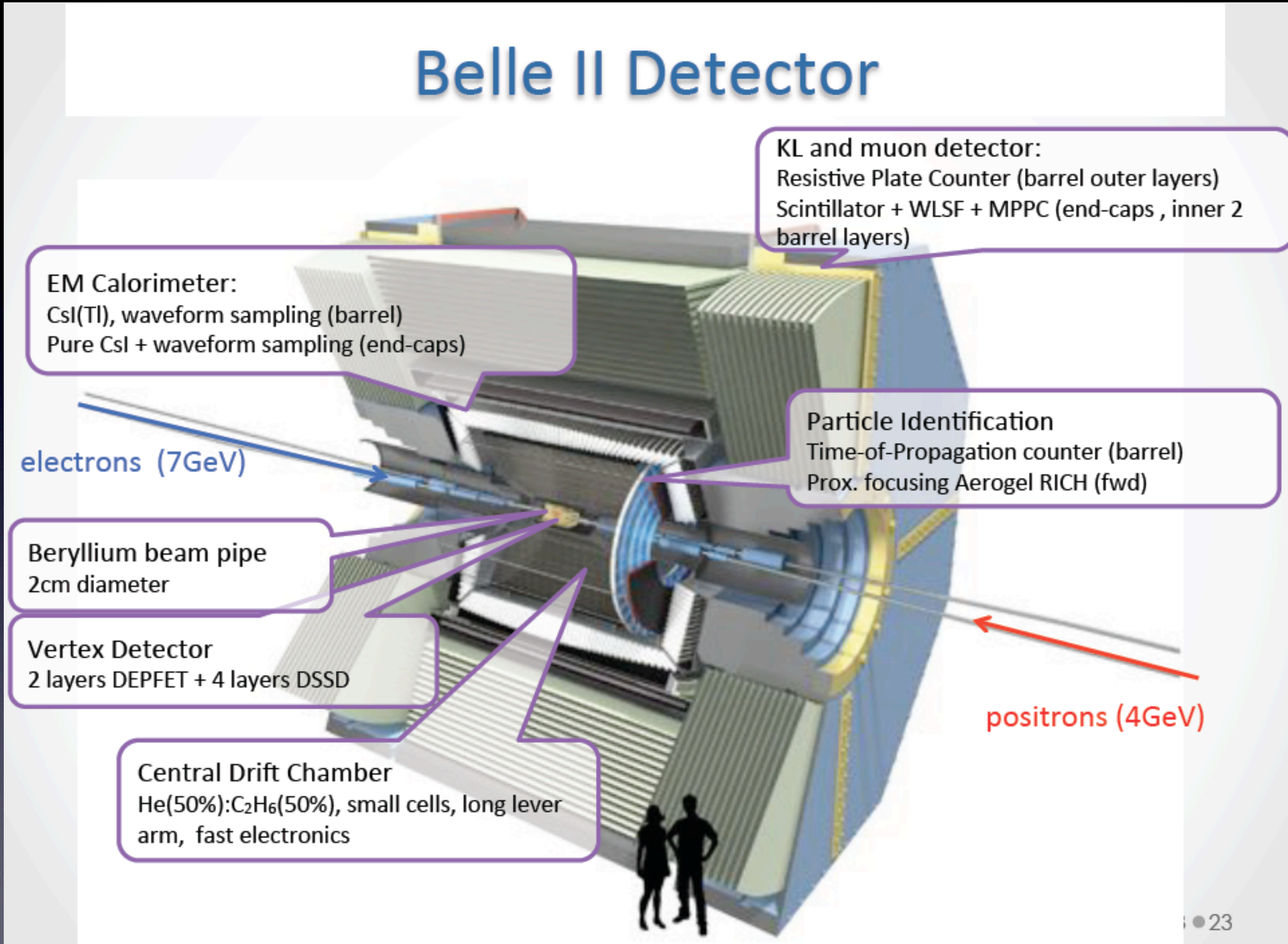
parameters		KEKB		SuperKEKB		units
		LER	HER	LER	HER	
Beam energy	E_b	3.5	8	4	7	GeV
Half crossing angle	ϕ	11		41.5		mrad
Horizontal emittance	ε_x	18	24	3.2	4.6	nm
Emittance ratio	κ	0.88	0.66	0.37	040	%
Beta functions at IP	β_x^*/β_y^*	1200/5.9		32/0.27	25/0.30	mm
Beam currents	I_b	1.64	1.19	3.60	2.60	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

Luminosity Projection



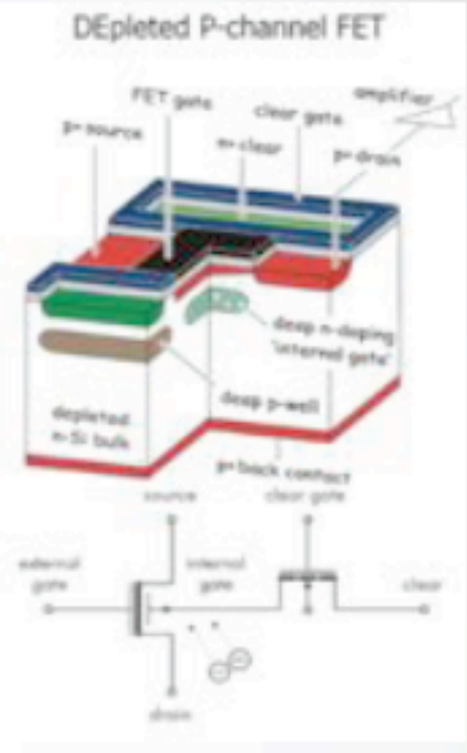
Belle II Detector



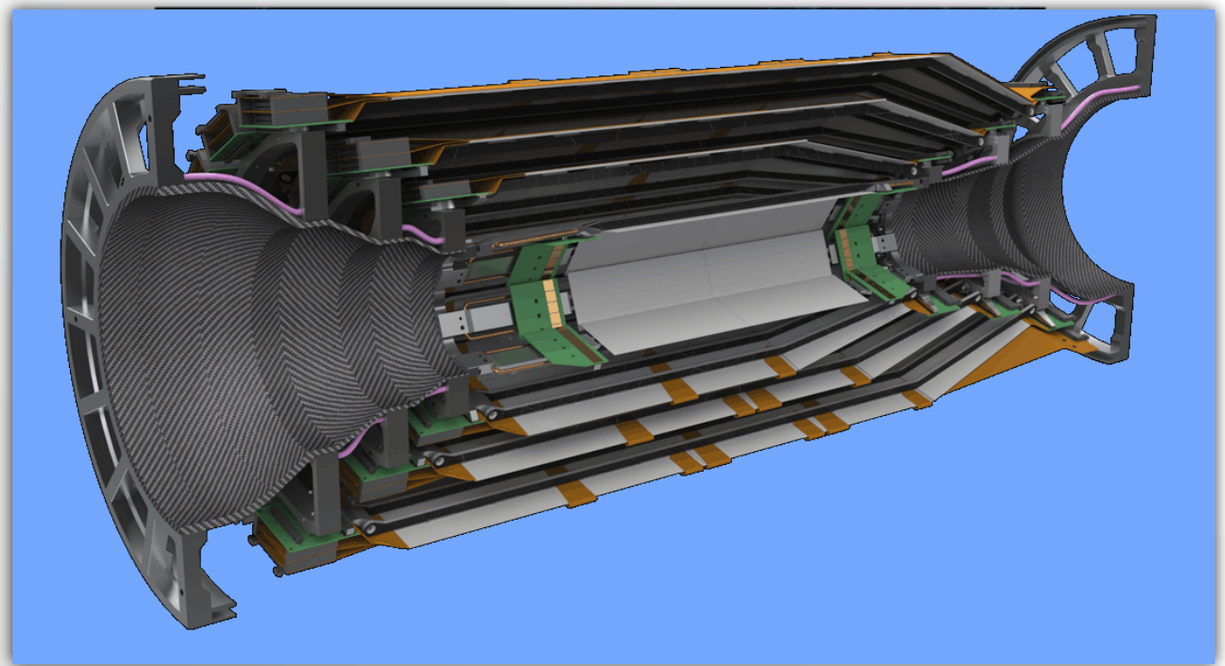
Vertex Detector

- **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

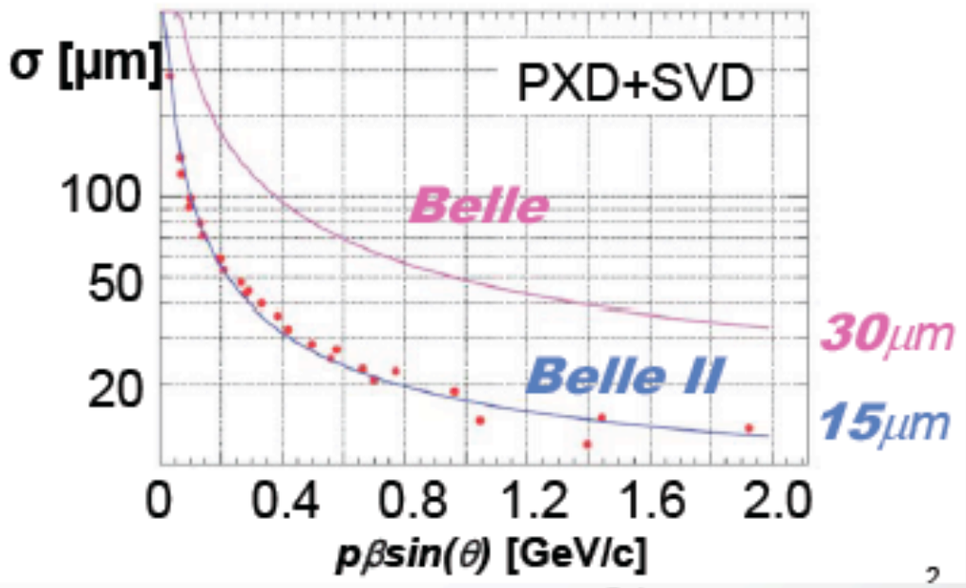


- **Silicon Vertex Detector (SVD)** – 220k strips
  - 4 DSSD layers at r = 38, 80, 104, 135 mm
  - Good spatial resolution (~12/25 µm) but ambiguities due to ghosting
  - Excellent time resolution (~3 ns)

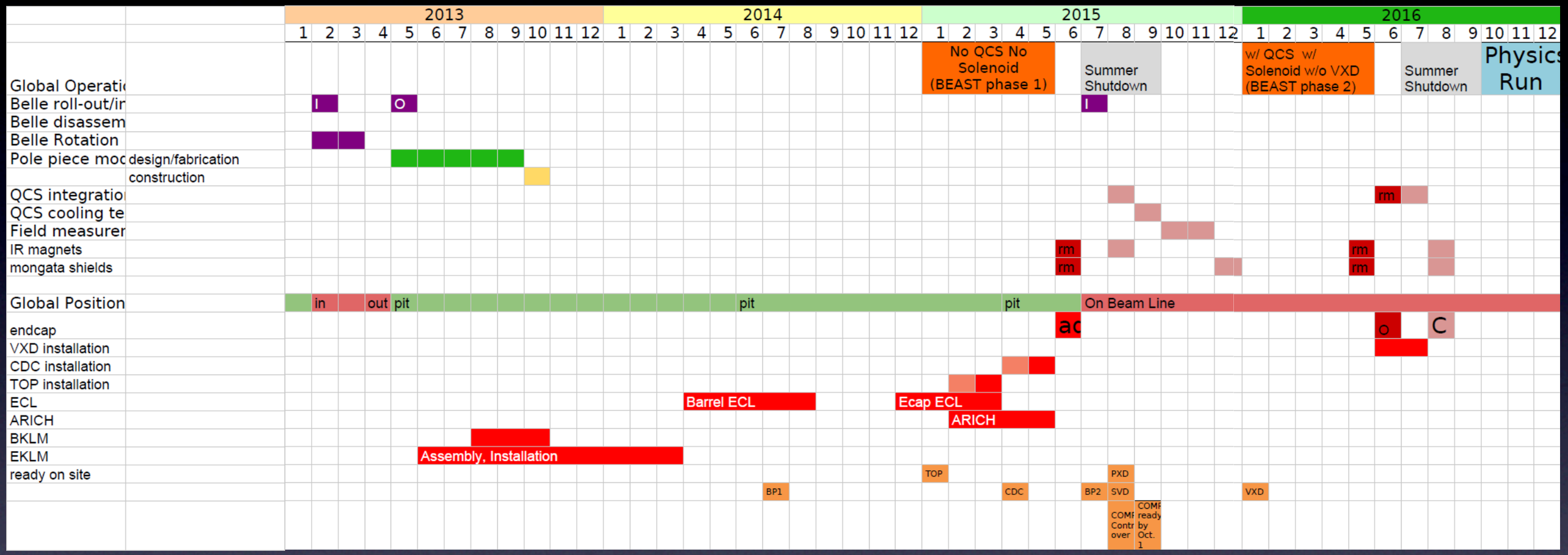


Combining both parts yields a very powerful device!

Significant improvement in z-vertex resolution



Profilo temporale



- KLM in this JFY(-March 2014), followed by barrel ECL electronics (April 2014-)
- More concrete planning for endcap necessary
- TOP (-March 2015), CDC (May 2015)

- PXD, SVD: ready to be integrated by August 2015

Partecipazione italiana

Gruppi (INFN+Univ.):

Torino
Padova
Trieste
Pisa
Perugia
Laboratori Nazionali di Frascati
Roma 3
Enea Casaccia/Roma 1
Napoli

accolta al B2GM !!!

FTE italiani

Instit.	NPhy	NEng	NTot	FTEPhy	FTEEng	FTETot
LNF	6	2	8	3	0.4	3.4
NA	6	2	8	2.7	0.5	3.2
PD	3		3	1.3		1.3
PG	5		5	3.1		3.1
PI	9	1	10	4.7	1	5.7
RM1	3		3	0.6		0.6
RM3	5	1	6	3.2	1	3.2
TO	3		3	2.2		2.2
TS	3		3	2.2		2.2
TOTAL	**43**	**6**	**49**	**23**	**2.9**	**24.9**

Foreseen activities I

- SVD
  - Contribution to silicon detector testing
  - Contribution to the assembly of strip detector modules
  - Contribution to overall mechanical design & assembly
  - Power supplies replacement for LV and HV
  - Environmental & Radiation Monitoring
  - Software development for Silicon-only tracking and Alignment

- PID (TOP)
  - Contribution to timing calibration system
  - Contribution to online and offline calibration software
  - Contribution for Power supplies

Foreseen Activities II

- ECL
  - Contribution to Simulation and Calibration software
  - R&D on Large Area APD for reading pure CsI
  - R&D on different technologies for Backward Endcap
  - Contribution to R&D and construction of front end electronics and slow control system
  - Contribution to endcap construction. Possibility of building three complete forward endcap modules.

- COMP
  - Contribution to development of distributed computing system
  - Contribution in terms of grid-enabled resources

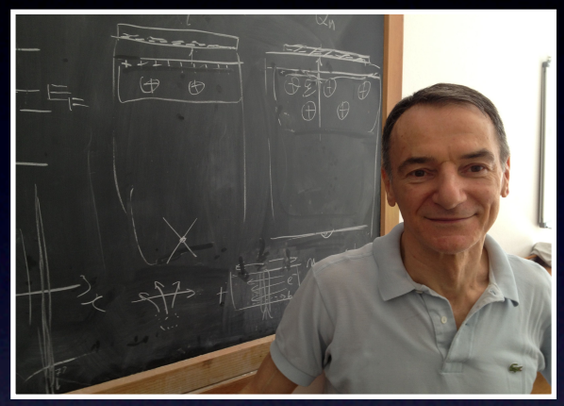
Piano finanziario

- Varie opzioni possibili
  - Modulabili sulla base della disponibilità di risorse
- Sembra non essere incompatibile con le risorse di CSN1
- Dettagli da discutere con i referee
- Per il 2013 necessari circa 400K oltre a quanto già assegnato.

SISTEMA	Item	TOTALE	2013	2014	2015	2016	2017	2018
VXD	TOTALE VXD BASE	980	87	203	332	328	0	0
PID	Totale PID	543	65	175	155	45	0	0
ECL	TOTALE ECL	1,178	5	149	161	220	273	370
COMP	TOTALE COMP	486	5	14	33	30	67	337
M&O	M&O FUNDS (Estimated)	185	5	5	25	50	50	50
	TOTAL BASE CORE	**3,372**	**167**	**546**	**706**	**674**	**390**	**757**
ALL	Meeting e metab. 20 FTE Missioni	1,800	300	300	300	300	300	300
ALL	Lab e metab. 20 FTE consumi * 5	600	100	100	100	100	100	100
	GRAND TOTALE BASE	**5,772**	**567**	**946**	**1,106**	**1,074**	**790**	**1,157**
VXD	*OPZIONE Striplets backup*	*400*		*100*	*200*	*100*		
VXD	*OPZIONE pixel upgrade INMAPS*	*1,000*		*Gr V*	*200*	*300*	*300*	*200*
ECL	Opzione-----				?	?	?	?

Il gruppo di Trieste

Luciano Bosisio PA 0.6 FTE



Livio Lanceri PO 0.8 FTE

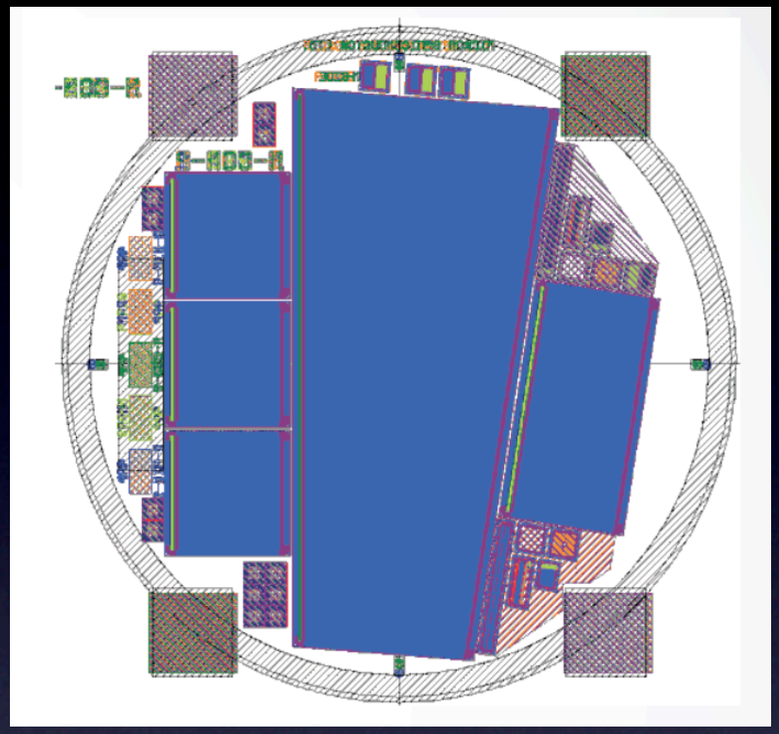
Lorenzo Vitale RU 0.8 FTE

Contributi a Belle II da TS

- SVD subdetector
  - Contributi ai test e alla caratterizzazione dei sensori
  - Sistema di monitor e interlock per la radiazione e le variabili ambientali
  - Collaborazione allo sviluppo del software di monitor e allineamento
- Analisi dei dati
  - dopo la fase costruttiva...

Hardware

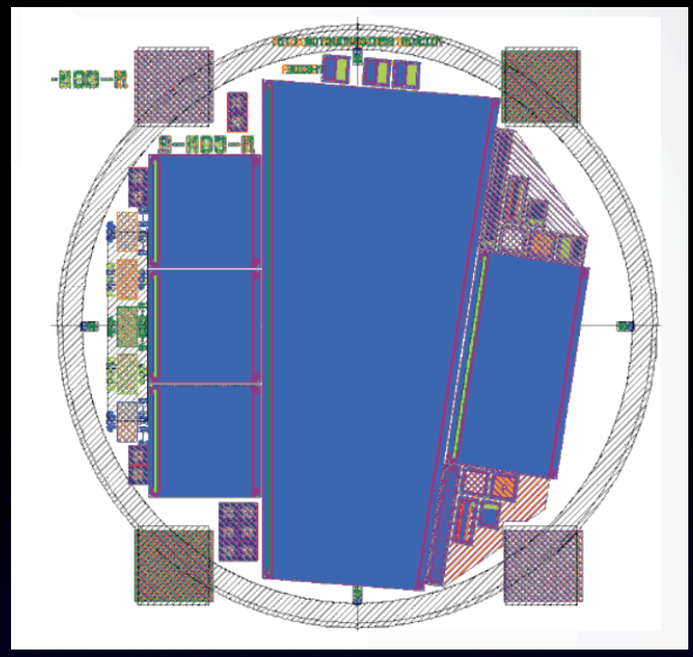
- ricevuti i primi wafer per la messa a punto delle procedure di test
- specifiche per il sistema di monitor: in preparazione
- ci stiamo procurando sensori al diamante per valutarli come sensori di radiazione
- primo passo: prototipi monitor radiazione e beam abort per le fasi di commissioning (BEAST I e 2)



	Diamond		Si
Band gap [eV]	5.48	Low leakage cur.	1.12
Electron mobility [cm^2/Vs]	2200	Fast signal collection	1450
Hole mobility [cm^2/Vs]	1600	Fast signal collection	500
Saturation velocity [cm/s]	2×10^7	Fast signal collection	0.8×10^7
Dielectric constant	5.7	Low capacitance, low noise	11.9
e-h creation energy [eV]	13	Smaller signal (typically 1/5 of Si)	3.6
e-h pairs per MIP [μm^{-1}]	36	Smaller signal (typically 1/5 of Si)	89
Displacement energy [eV]	43	High radiation hardness	13 ~ 20
Decrease in charge collection after irradiation with 1×10^{15} proton/cm^2 *	Not observed :by ~40 % at 5×10^{15} p/cm^2		No signal

Hardware

- ricevuti i primi wafer per la messa a punto delle procedure di test
- specifiche per il sistema di monito
- ci stian diamar sensor
- primo radiazi di com



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Altri impegni

- Preparazione e review di pubblicazioni BaBar (0.2+0.2 FTE)
- partecipazione a R&D su rivelatori (0.4 FTE)

Preventivo 2014 e servizi

- Preventivo 2014: 80.5 kE
  - 33.5 kE consumi
  - 42.5 kE missioni
    - 2.5 kE licenze SW
    - 2.0 kE trasporti
- Laboratorio elettronica: 11 m.u.
- Officina meccanica: 4 m.u.