SuperB Projects Status

POSIPOL 2012 Workshop, DESY-Zeuthen
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Outlook

- Motivation
- Luminosity & Crab Waist
- SuperB status
- Positrons injections
- Conclusion

Motivation

- Now that LHC pointed out the Higgs, its characteristics should measured precisely : ILC/CLIC

- A major challenge for particle physics in the next decade is to go beyond the Standard Model. Two way are possible:
  - "Relativistic" : new heavy particle produced on-shell

  Sensitivity depends on available e.c.m

  LHC, SLHC, ILC/CLIC

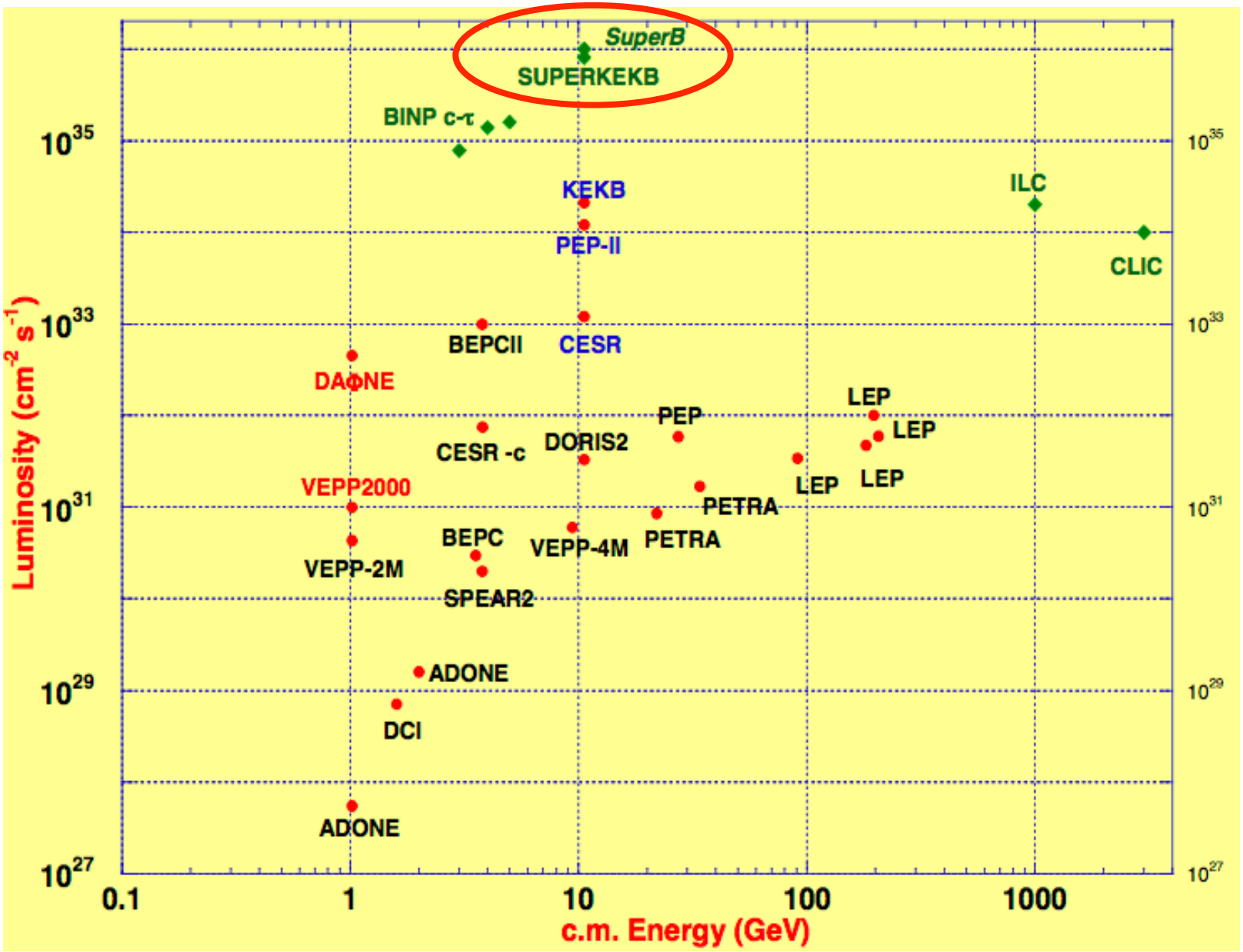
  - "Quantum" : new heavy particle produced off-shell (virtual)

  Sensitivity depends on luminosity

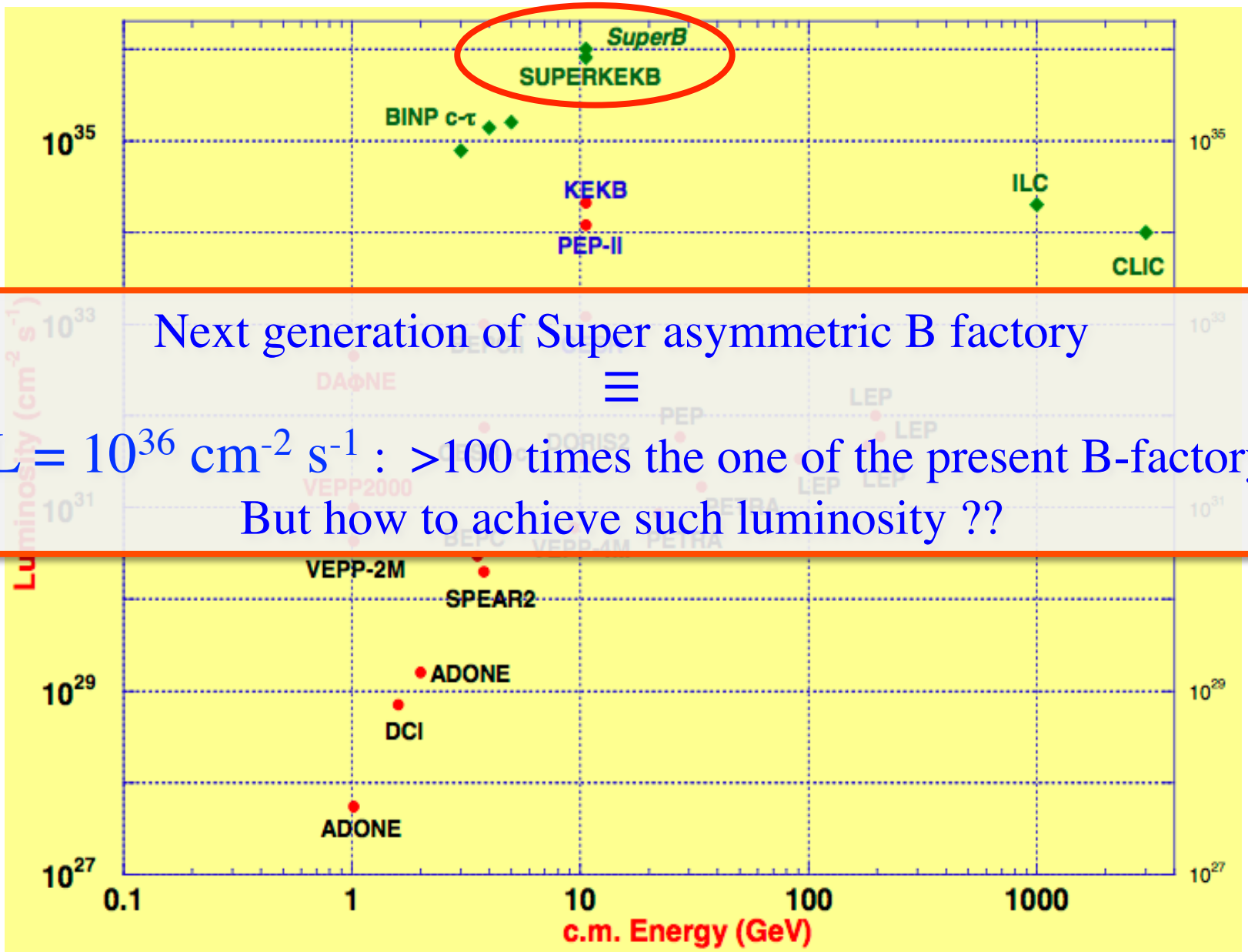
  Two Super B factories will be built in this decade (both have been funded) :

  SuperB & SuperKEKB

Next generation of Super asymmetric B factory



Next generation of Super asymmetric B factory



Next generation of Super asymmetric B factory

≡

$L = 10^{36}\ cm^{-2}\ s^{-1}$: >100 times the one of the present B-factory

But how to achieve such luminosity ??

Increasing the luminosity at colliders

$$L \propto \frac{N \xi_y}{\beta_y}$$

Vertical tune shift

$$\xi_y \propto \frac{N}{\sigma_x} \frac{\sqrt{\beta_y}}{\sqrt{1+\Phi^2}}$$

Piwinski's angle

$$\Phi = \frac{\sigma_z}{\sigma_x} tg(\frac{\vartheta}{2})$$

The keys requirements

1. Small β_y
2. Small σ_x & σ_z
3. High intensity beam

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The keys requirements

1. Small β_y BUT $\beta_y << \sigma_z$ due to the hour-glass effect
2. Small σ_x & σ_z BUT difficult to decrease σ_z in high current ring
3. High intensity beam

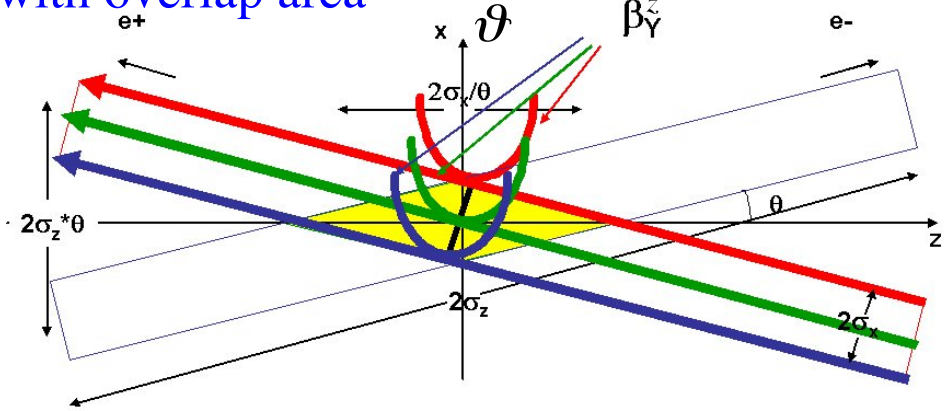
Solution proposed by P. Raimondi …

Collision scheme with large Piwinski angle and Crab Waist

1. Large Piwinski's angle

- Short overlap region & β_y^* comparable with overlap area $\approx \frac{\sigma_x}{\vartheta} << \sigma_z$
- Very low vertical tune shift
- No parasitic collision

But gives new beam-beam resonances



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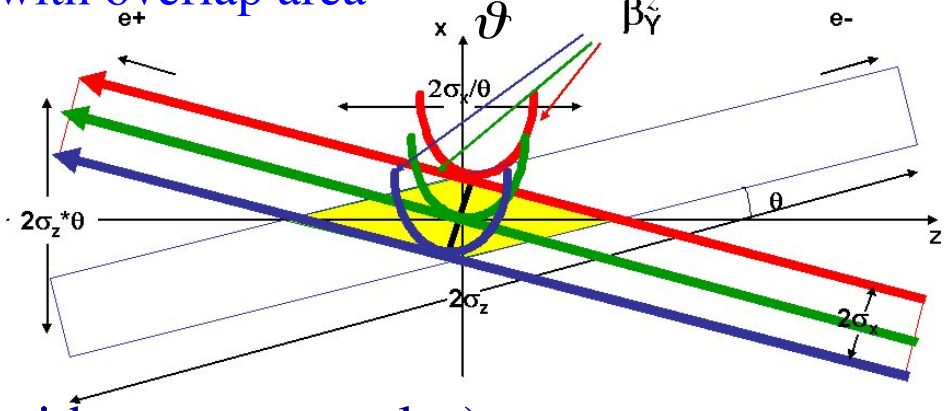
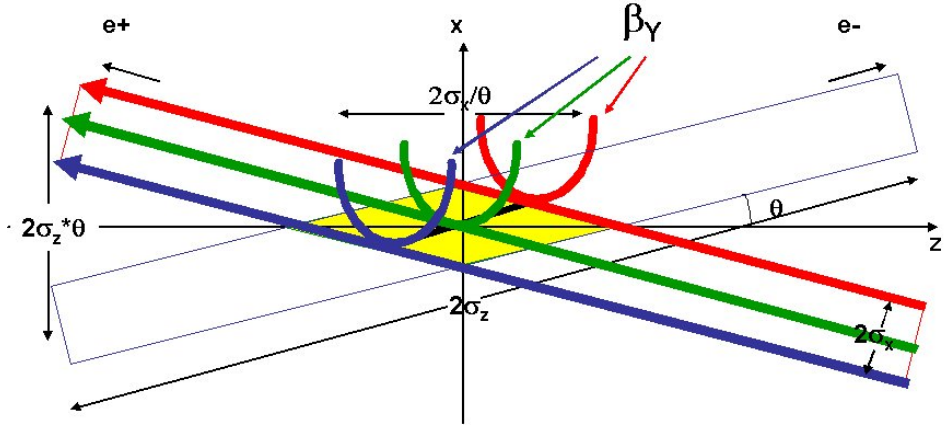


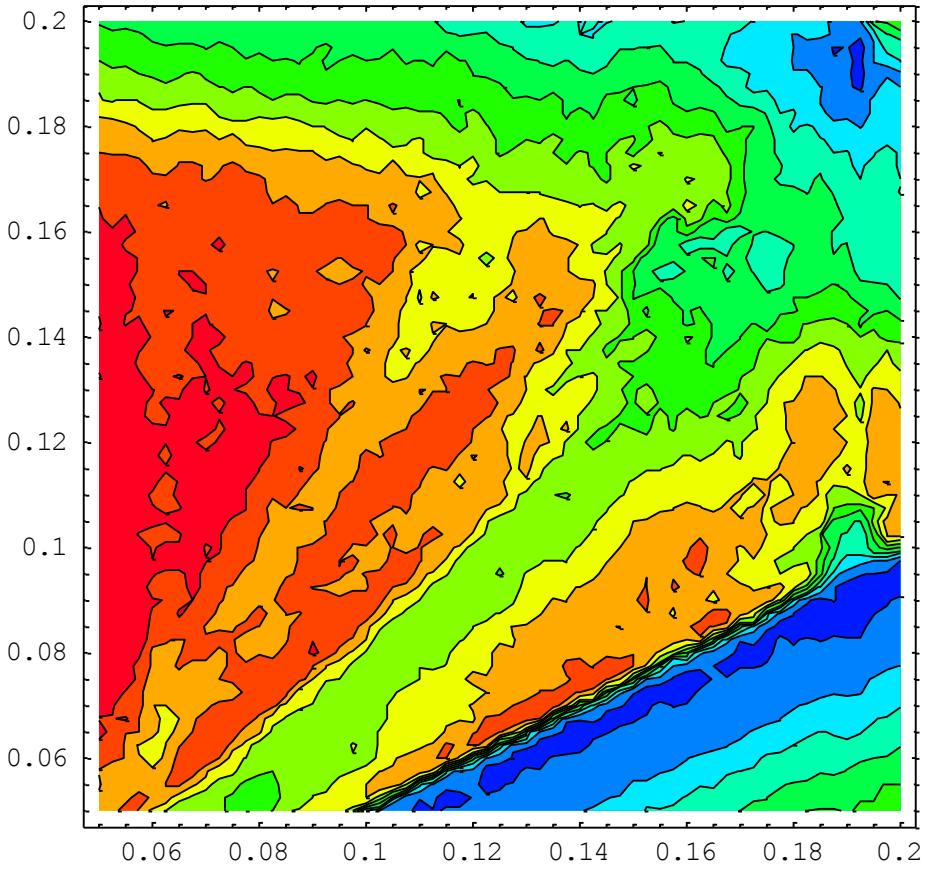
2. Crab waist transformation (realized with two sextupoles)

- Each beam collides with other @ β_y min
- Geometric luminosity gain
- Suppression of X-Y betatron resonance

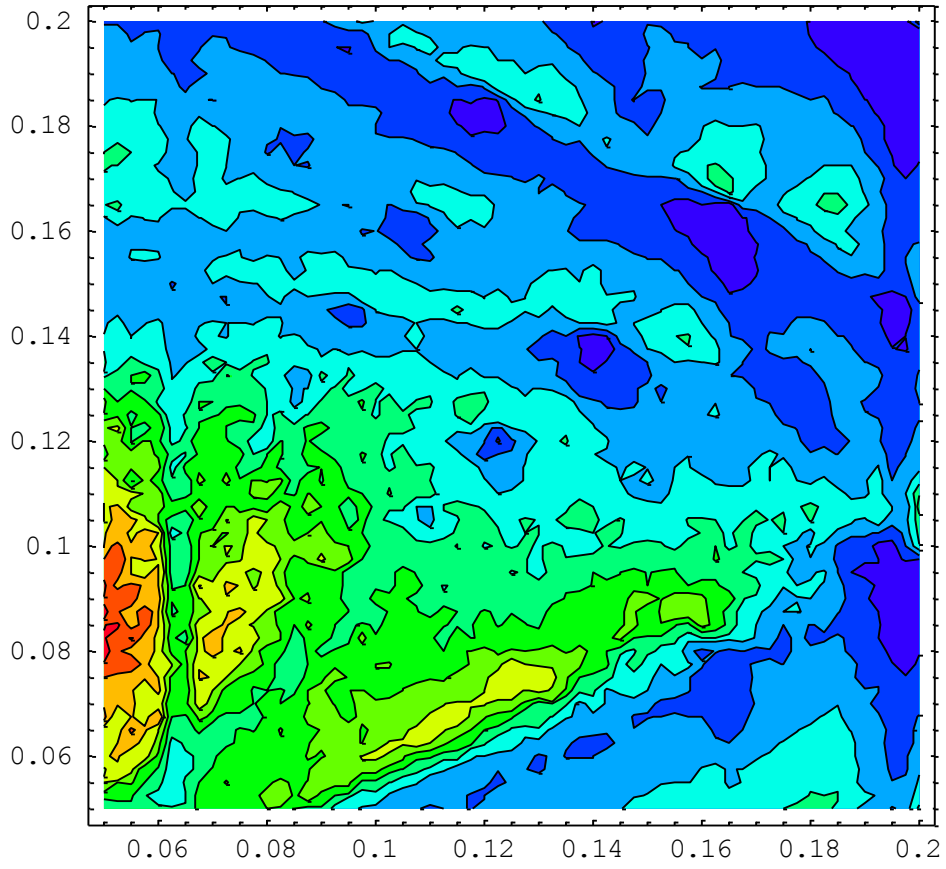


Luminosity vs tune scan

Crab ON

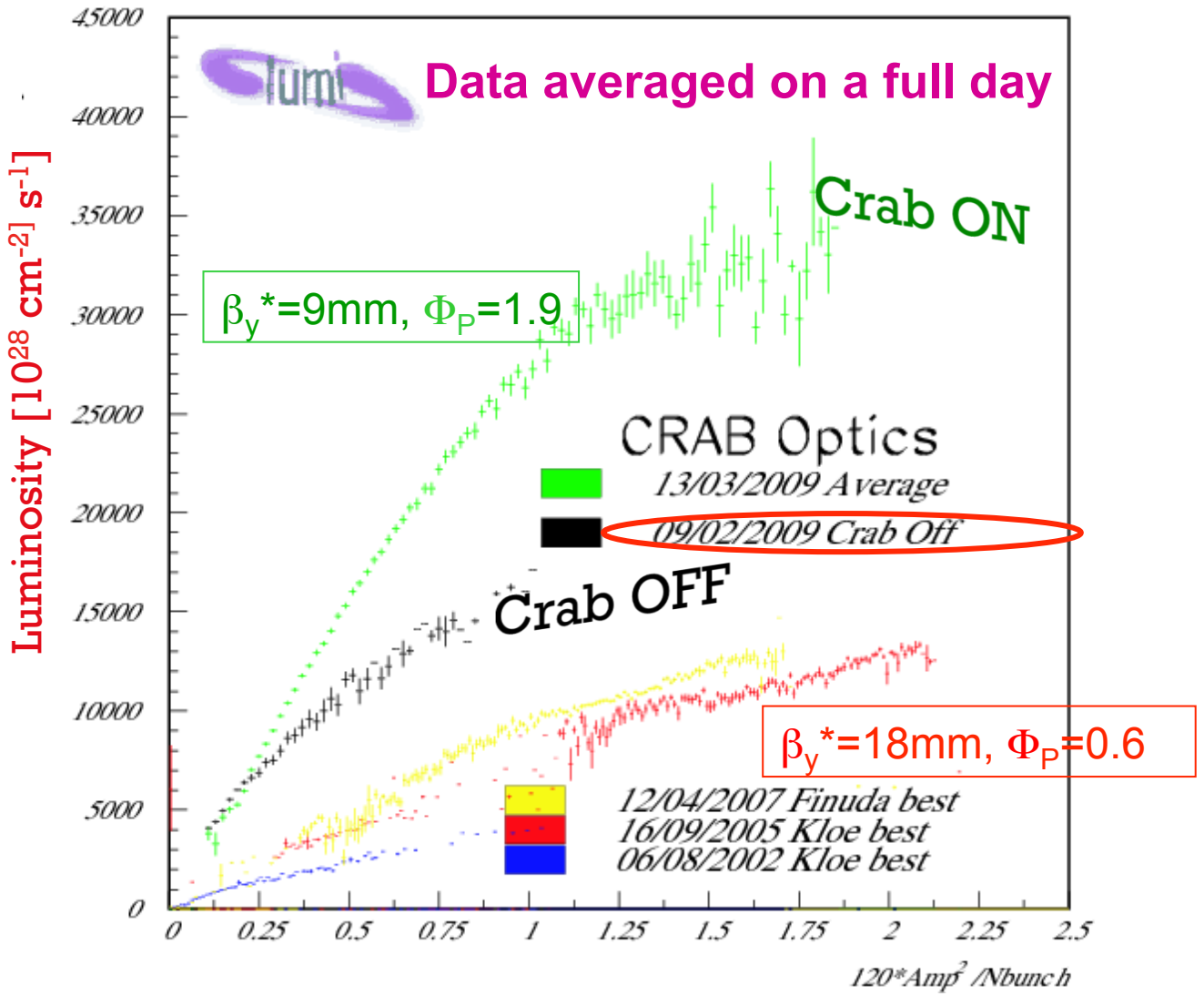


Crab OFF

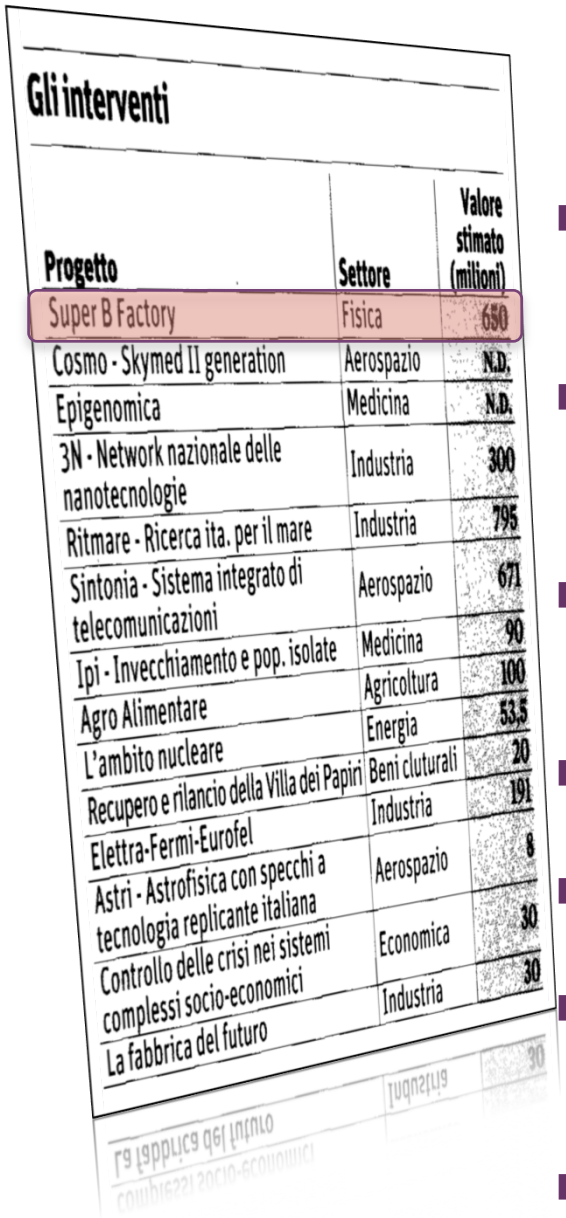


Courtesy M. Zobov

Crab Waist works
first experimental evidence @ DAFNE



With this success …



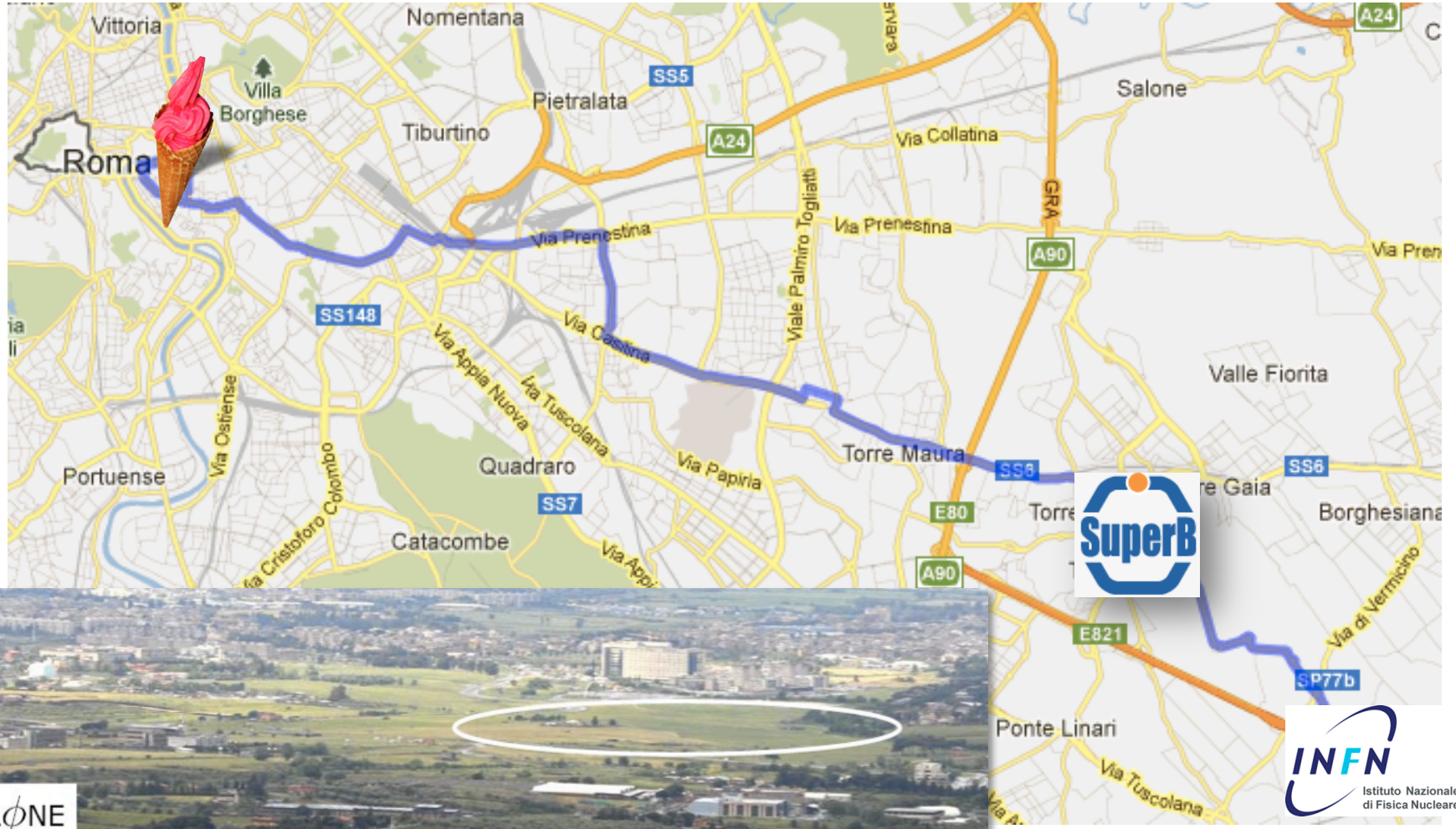
Gli interventi

Progetto	Settore	Valore stimato (milioni)
Super B Factory	Fisica	650
Cosmo - Skymed II generation	Aerospazio	N.D.
Epigenomica	Medicina	N.D.
3N - Network nazionale delle nanotecnologie	Industria	300
Ritmare - Ricerca ita. per il mare	Industria	795
Sintonia - Sistema integrato di telecomunicazioni	Aerospazio	671
Ipi - Invecchiamento e pop. isolate	Medicina	90
Agro Alimentare	Agricoltura	100
L'ambito nucleare	Energia	53,5
Recupero e rilancio della Villa dei Papiri	Beni cluturali	20
Elettra-Fermi-Eurofel	Industria	191
Astri - Astrofisica con specchi a tecnologia replicante italiana	Aerospazio	8
Controllo delle crisi nei sistemi complessi socio-economici	Economica	30
La fabbrica del futuro	Industria	30

- SuperB has been approved as the first in a list of 14 "flagship" projects within the new national research plan
- A financial allocation of 256 MEuros in 6years has been approved for the "SuperB Flavor Factory"
- Cabibbo Lab created on 10/2011

  http://www.cabibbolab.it/
- SuperB Collaboration formally in place since 03/2012
- Cabibbo Lab management in place 04/2012
- First hires in 09/2012
- Presently participation of : Italy, Canada, France, Norway, Israel, Poland, Russia, Spain, UK, US
- Site choice Summer 2011

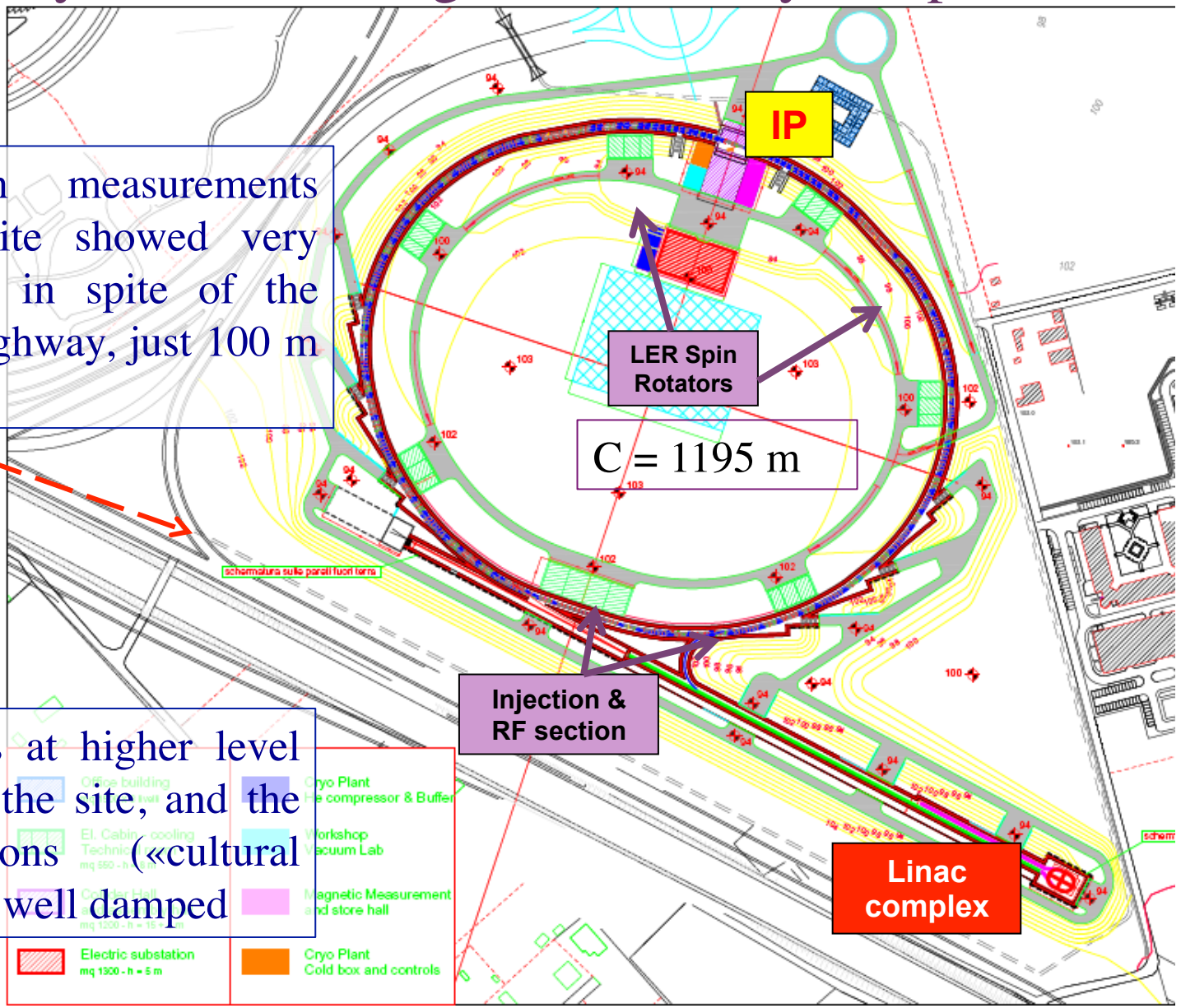
SuperB site on the University of Rome Tor Vergata campus



Layout @ Tor Vergata University campus

Ground motion measurements performed on site showed very «solid» grounds in spite of the vicinity of the highway, just 100 m away

The highway is at higher level with respect to the site, and the traffic vibrations («cultural noise») are very well damped



Courtesy M. Biagini

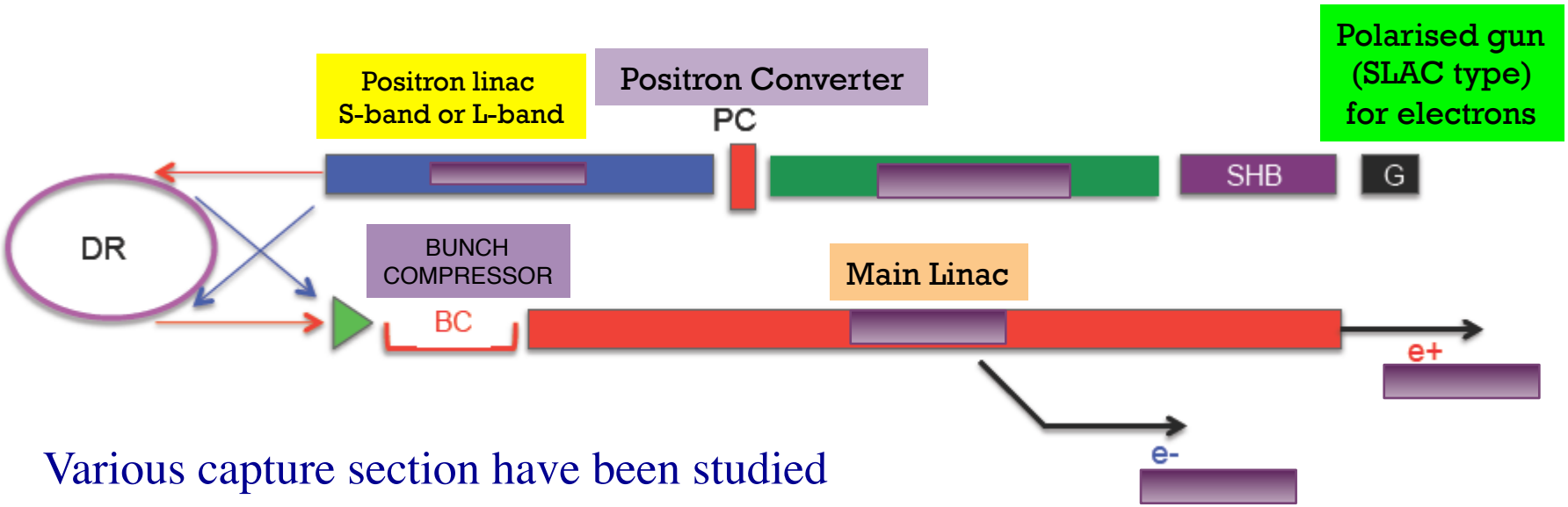
SuperB machine main parameters

Parameter	SuperB		SuperKEKB	
	HER (e^+)	LER (e^-)	HER (e^-)	LER (e^+)
Luminosity ($cm^{-2}s^{-1}$)	10^{36}		$8x10^{35}$	
C (m)	1200		3016	
E (GeV)	6.7	4.18	7.007	4
Crossing angle (mrad)	60		83	
Piwinski angle	20.8	16.9	19.3	24.6
I (mA)	1900	2440	2600	3600
$e_{x/y}$ (nm/pm) (with IBS)	2/5	2.5/6.2	4.6/11.5	3.2/8.6
IP $s_{x/y}$ (mm/nm)	7.2/36	8.9/36	10.7/62	10.1/48
s_l (mm)	5	5	5	6
N. bunches	978		2500	
Part/bunch ($x10^{10}$)	5.1	6.6	6.5	9.04
s_E/E ($x10^{-4}$)	6.4	7.3	6.5	8.14
bb tune shift (x/y)	0.0026/0.107	0.004/0.107	0.0012/0.081	0.0028/0.088
Beam losses (MeV)	2.1	0.86	2.4	1.9
Total beam lifetime (s)	254	269	332	346
Polarization (%)	0	80	0	0
RF (MHz)	476		508.9	

Same projects at first look : asymmetric colliders running at Y(4S)

SuperB : electron polarized & hybrid facility

Injection system layout

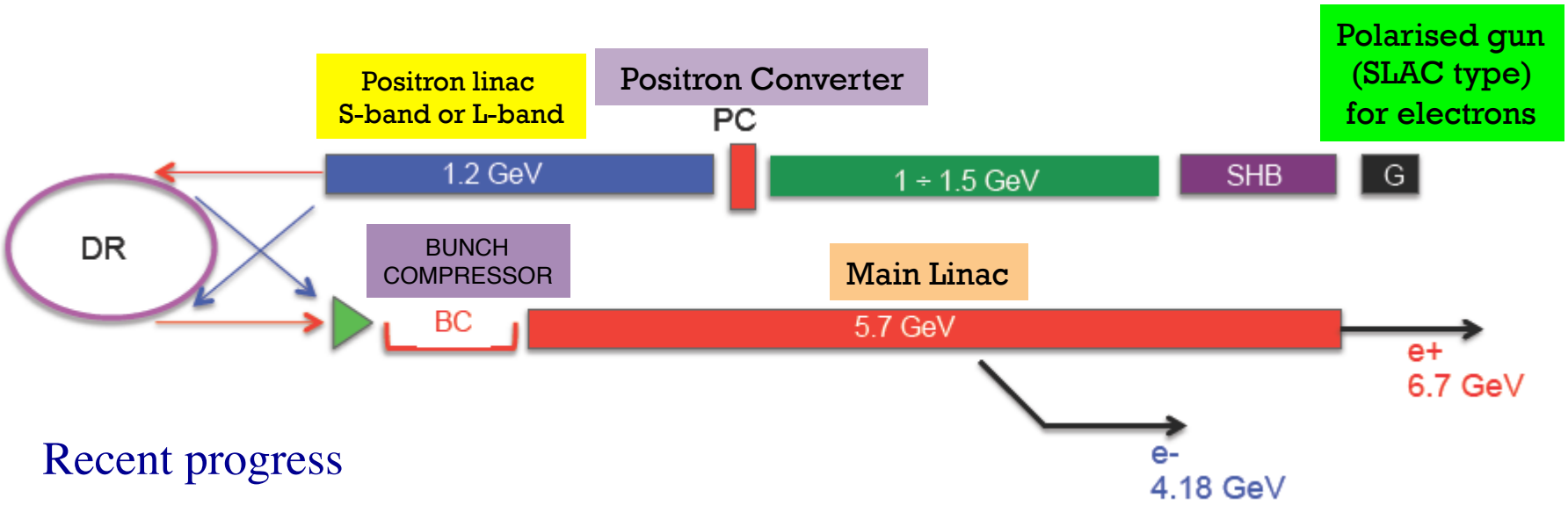


Various capture section have been studied

- Different drive beam energy
- Pure acceleration
- Deceleration + acceleration (c.f. CDR2)
- Different frequency

(see Kamitani's talk on positron source)

Latest injection system layout



Recent progress

- Final design with DR for electrons too
- Design from the e^+/e^- source to the DR (including the BC)
- e^+ linac S-band and L-Band still open
- Design of the Main Linac
- Main Linac to the HER & LER to be modified

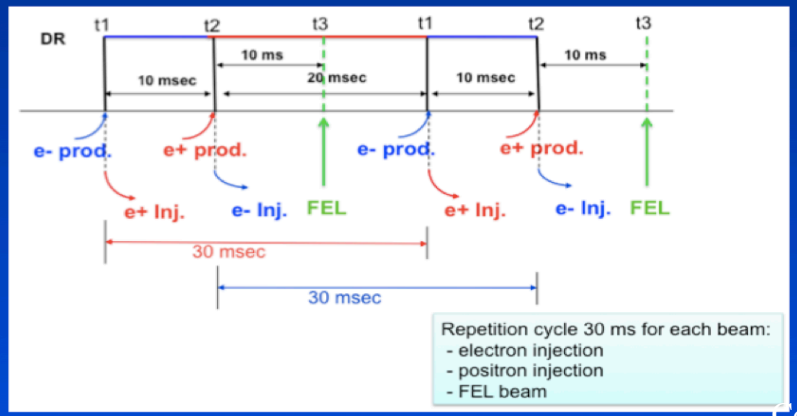
(see Kamitani's talk on positron source)

Conclusions

- Design almost finalized in all sub-systems
- The possibility to drive a SASE Hard-X FEL using the 6 GeV e^- linac has been recently considered

Shared time between FEL and SuperB injection

If the linac repetition frequency is 100 Hz it is possible to accelerate in the linac a pulse for the XFEL during the store time of the positrons in the DR without affecting the injection rate for SuperB.
As it is shown in the sketch **below it is possible to provide a repetition cycle of 30 ms for each beam: positron injection, electron injection and a dedicated linac pulse for XFEL.** The time duration available for the XFEL pulse, due to the SLED system used for the linac cavities, is of the order of 100 ns.



Courtesy M. Ferrario

Conclusions

- Design almost finalized in all sub-systems
- Cabibbo Lab in charge of construction and operation
- Management of Accelerator in place, hiring of some personnel in progress
- New full cost analysis in progress
- R&D on some specific topics still in progress
- MOU with several international laboratories in preparation

Beside the physics goals, SuperB is a great opportunity to train young people for e^+e^- collider physics before the linear collider kick off.