Status of the Super B Project and Beam Polarization Issues

Sergei A. Nikitin
BINP, Novosibirsk
on behalf of the SuperB Accelerator Team

SPIN 2012, Dubna, 20 sept. 2012

M. E. Biagini, R. Boni, M. Boscolo, B. Buonomo, T. Demma, A. Drago, M. Esposito, S. Guiducci, G. Mazzitelli, L. Pellegrino, M. A. Preger, P. Raimondi, R. Ricci, U. Rotundo, C. Sanelli, M. Serio, A. Stella, S. Tomassini, M. Zobov
Laboratori Nazionali di Frascati dell'INFN, I-00044 Frascati, Italy

K. Bertsche, A. Brachman, Y. Cai, A. Chao, R. Chestnut, M. H. Donald, C. Field, A. Fisher, D. Kharakh, A. Krasnykh, K. Moffeit, Y. Nosochkov, A. Novokhatski, M. Pivi, C. Rivetta, J. T. Seeman, M. K. Sullivan, S. Weathersby, A. Weidemann, J. Weisend, U. Wienands, W. Wittmer, M. Woods, G. Yocky
SLAC National Accelerator Laboratory, Stanford, California 94025, USA

A.Bogomiagkov, I. Koop, E. Levichev, S. Nikitin, I. Okunev, P. Piminov, S. Sinyatkin, D. Shatilov, P. Vobly
Budker Institute of Nuclear Physics, Novosibirsk 630090, Russia

F. Bosi, S. Liuzzo, E. Paoloni
INFN Pisa, Università di Pisa, Dipartimento di Fisica, I-56127 Pisa, Italy

J. Bonis, R. Chehab, O. Dadoun, G. Le Meur, P. Lepercq, F. Letellier-Cohen, B. Mercier, F. Poirier, C. Prevost, C. Rimbault, F. Touze, A. Variola
Laboratoire de l'Accelerateur Lineaire, IN2P3/CNRS, Universite Paris-Sud 11, F-91898, Orsay, France

B. Bolzon, L. Brunetti, A. Jeremie
Laboratoire d'Annecy-le-Vieux de Physique de Particule, IN2P3/CNRS, F-74941, Annecy-le-Vieux, France

M. Baylac, O. Bourrion, J.M. De Conto, Y. Gomez, F. Meot, N. Monseu, D. Tourres, C. Vescovi
Laboratoire de Physique Subatomique et de Cosmologie, **IN2P3/CNRS**, F- 38026, Grenoble, France

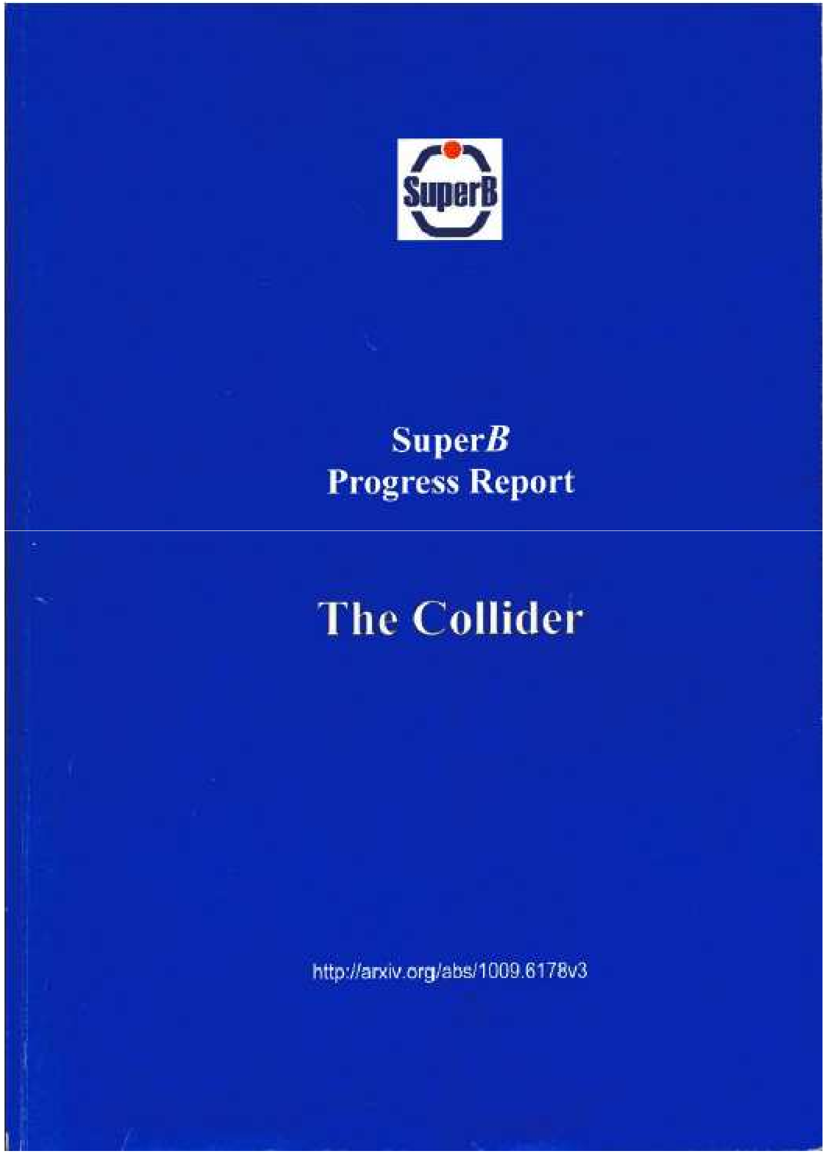
A. Chancé, O. Napoly
CEA, IRFU, Centre de Saclay, F- 91191, Gif sur Yvette, France

G. Wormser
LAL , 91989 Orsay France;

D.P. Barber,
Deutsches Elektronen-Synchrotron (DESY), 22607 Hamburg, Germany, and **Cockcroft Institute, Daresbury Science and Innovation Centre,** Warrington WA4 4AD, UK, and **University of Liverpool**, Liverpool L69 7ZE, UK

S. Bettoni, D. Quatraro,
CERN, CH-1211, Geneva, Switzerland

Present status – Blue Book



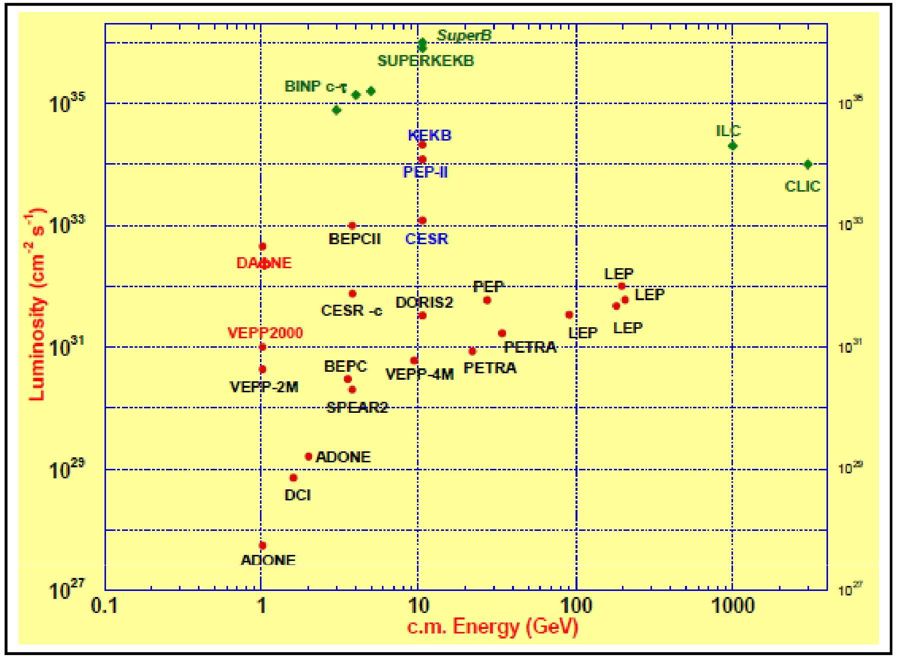
http://arxiv.org/abs/1009.6178v3

159 pages

Description of the accelerator systems only

Physical and detector aspects will be in coming documents

Motivation

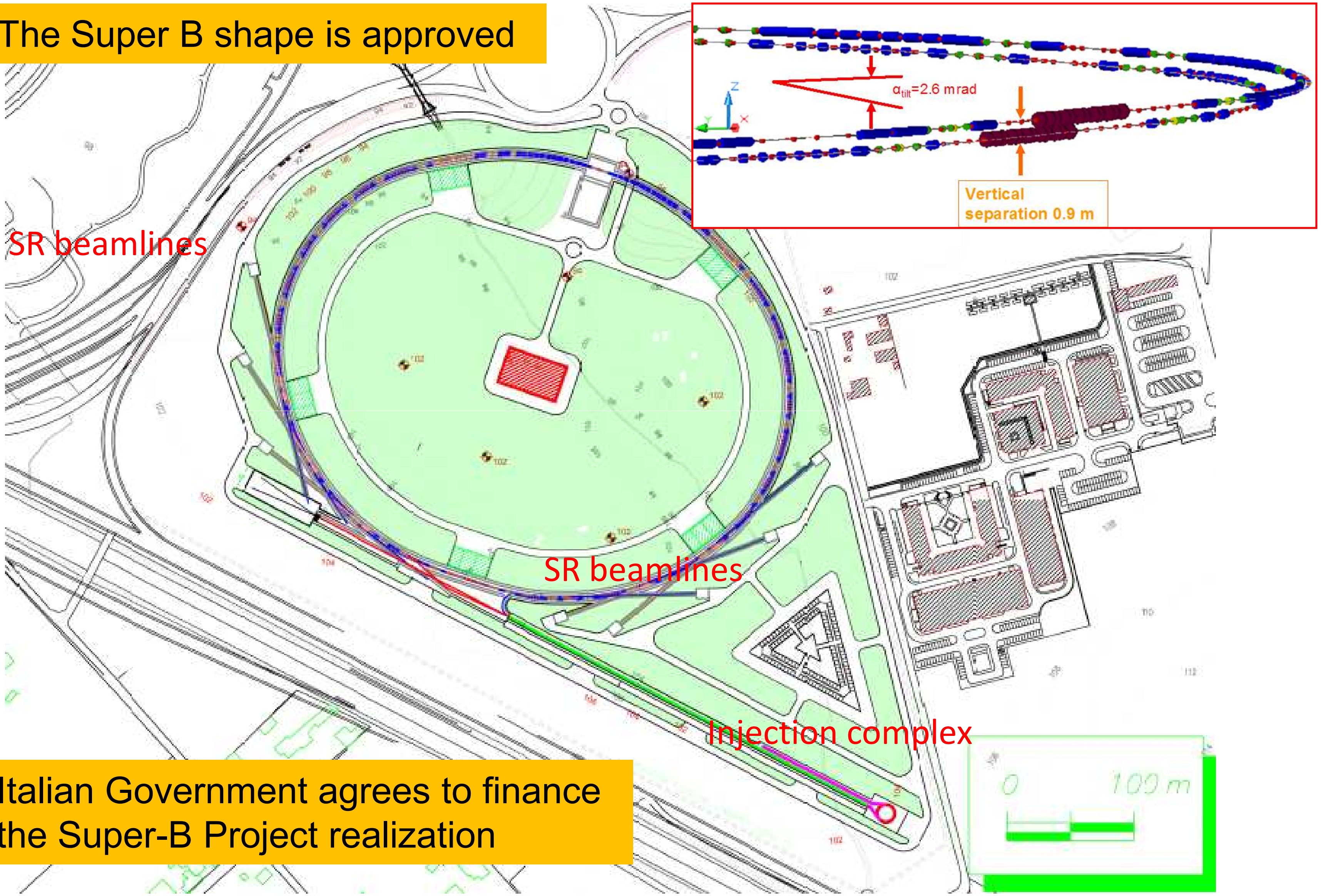


With an integrated luminosity goal larger than 75 ab-1, the SuperB factory, to be built on the Tor Vergata Campus, near Roma (Italy) by 2016, has the very ambitious goal to unravel the detailed structure of the new physics soon to be discovered at the LHC, or to explore BSM physics beyond the LHC … . This goal will be reached using a large number of rare B , charm and tau decays very sensitive to the presence of new heavy particles via virtual loops. … The challenges in the machine design brought by the requirement of a polarized electron beam will be emphasized.

(from the abstract at SPIN2012 by Gyu Wormser, LAL , 91989 Orsay France)

Schematic SuperB layout

The Super B shape is approved



Italian Government agrees to finance the Super-B Project realization

SuperB parameters

Table 3.1: Super*B* parameters for baseline, low emittance and high current options, and for tau/charm running.

		Base Line		Low Emittance		High Current		Tau-charm	
Parameter	**Units**	**HER (e^+)**	**LER (e^-)**	**HER (e^+)**	**LER (e^-)**	**HER (e^+)**	**LER (e^-)**	**HER (e^+)**	**LER (e^-)**
LUMINOSITY	$cm^{-2}\,s^{-1}$	**1.00E+36**		**1.00E+36**		**1.00E+36**		**1.00E+35**	
Energy	GeV	6.7	4.18	6.7	4.18	6.7	4.18	2.58	1.61
Circumference	m	1258.4		1258.4		1258.4		1258.4	
X-Angle (full)	mrad	66		66		66		66	
β_x @ IP	cm	2.6	3.2	2.6	3.2	5.06	6.22	6.76	8.32
β_y @ IP	cm	0.0253	0.0205	0.0179	0.0145	0.0292	0.0237	0.0658	0.0533
Coupling (full current)	%	0.25	0.25	0.25	0.25	0.5	0.5	0.25	0.25
Emittance x (with IBS)	nm	2.00	2.46	1.00	1.23	2.00	2.46	5.20	6.4
Emittance y	pm	5	6.15	2.5	3.075	10	12.3	13	16
Bunch length (full current)	mm	5	5	5	5	4.4	4.4	5	5
Beam current	mA	1892	2447	1460	1888	3094	4000	1365	1766
Buckets distance	#	2		2		1		1	
Ion gap	%	2		2		2		2	
RF frequency	MHz	476.		476.		476.		476.	
Revolution frequency	MHz	0.238		0.238		0.238		0.238	
Harmonic number	#	1998		1998		1998		1998	
Number of bunches	#	978		978		1956		1956	
N. Particle/bunch (10^{10})	#	5.08	6.56	3.92	5.06	4.15	5.36	1.83	2.37
σ_x effective	μm	165.22	165.30	165.22	165.30	145.60	145.78	166.12	166.67
σ_y @ IP	μm	0.036	0.036	0.021	0.021	0.054	0.0254	0.092	0.092
Piwinski angle	rad	22.88	18.60	32.36	26.30	14.43	11.74	8.80	7.15
Σ_x effective	μm	233.35		233.35		205.34		233.35	
Σ_y	μm	0.050		0.030		0.076		0.131	
Hourglass reduction factor		0.950		0.950		0.950		0.950	
Tune shift x		0.0021	0.0033	0.0017	0.0025	0.0044	0.0067	0.0052	0.0080
Tune shift y		0.097	0.097	0.0891	0.0892	0.0684	0.0687	0.0909	0.0910
Longitudinal damping time	msec	13.4	20.3	13.4	20.3	13.4	20.3	26.8	40.6
Energy Loss/turn	MeV	2.11	0.865	2.11	0.865	2.11	0.865	0.4	0.17
Momentum compaction (10^{-4})		4.36	4.05	4.36	4.05	4.36	4.05	4.36	4.05
Energy spread (10^{-4}) (full current)	dE/E	6.43	7.34	6.43	7.34	6.43	7.34	6.43	7.34
CM energy spread (10^{-4})	dE/E	5.0		5.0		5.0		5.0	
Total lifetime	min	4.23	4.48	3.05	3	7.08	7.73	11.4	6.8
Total RF Wall Plug Power	MW	16.38		12.37		28.83		2.81	

SUPER*B* COLLIDER PROGRESS REPORT

Novosibirsk group contributes:

- main ring magnetic structure design
- DA calculation and optimization
- chromaticity correction at FF region
- Beam-Beam simulation
- polarization issues

Essence of the Crab Waist Collision Scheme

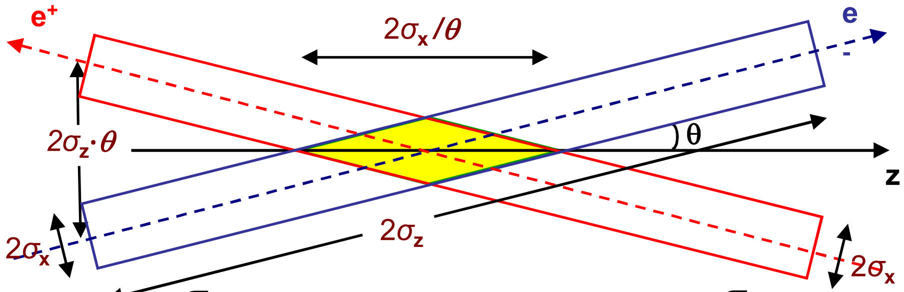
1. **Large Pivinski's angle Ψ_p** greatly shortens the interaction region.

2. Shortening the interaction region allows to decrease considerably the **beta-function** value β_y^* at IP (for instance, 20 timies!).

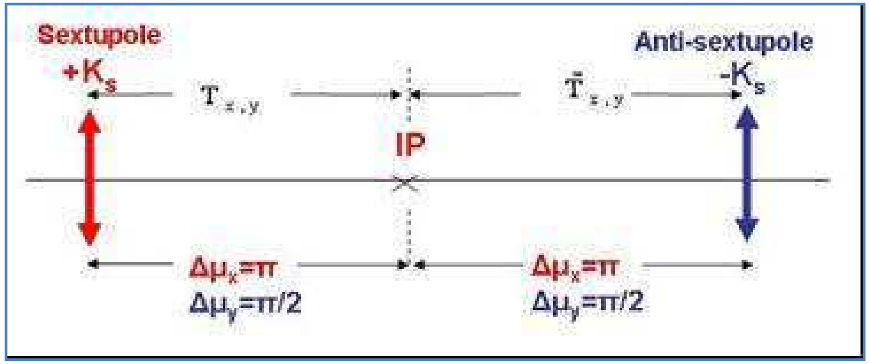
3. On the other hand, the assets 1 and 2 lead to a strong vertical betatron phase modulation at IP by the horizontal betatron oscillations (the coupling resonances mQx+nQy=k due to Beam-Beam). To suppress that negative impact the system of two **crab sextupole** is applied. Their forces and locations are chosen in such a way that the vertical phase advance from the sextupole azimuth to the **"collision point"** does not depend upon the horizontal coordinate of particles at that azimuth.

1. P. Raimondi, "Status of the SuperB Effort", presented at the 2nd Workshop on Super B-Factory, LNF-INFN, Frascati, Mar. 2006.

2. P. Raimondi, D. Shatilov, M. Zobov, "Beam-Beam Issues for Colliding Schemes with Large Piwinski Angle and Crabbed Waist", LNF-07/003 (IR), 2007, e-print: arXiv:physics/0702033.



$$\Psi_p = tg\theta \cdot \frac{\sigma_z}{\sigma_x}, \quad \sigma_x << \beta_x^*, \ \sigma_z >> \sigma_x, \ \beta_y \approx \frac{\sigma_x}{\theta} << \sigma_z$$

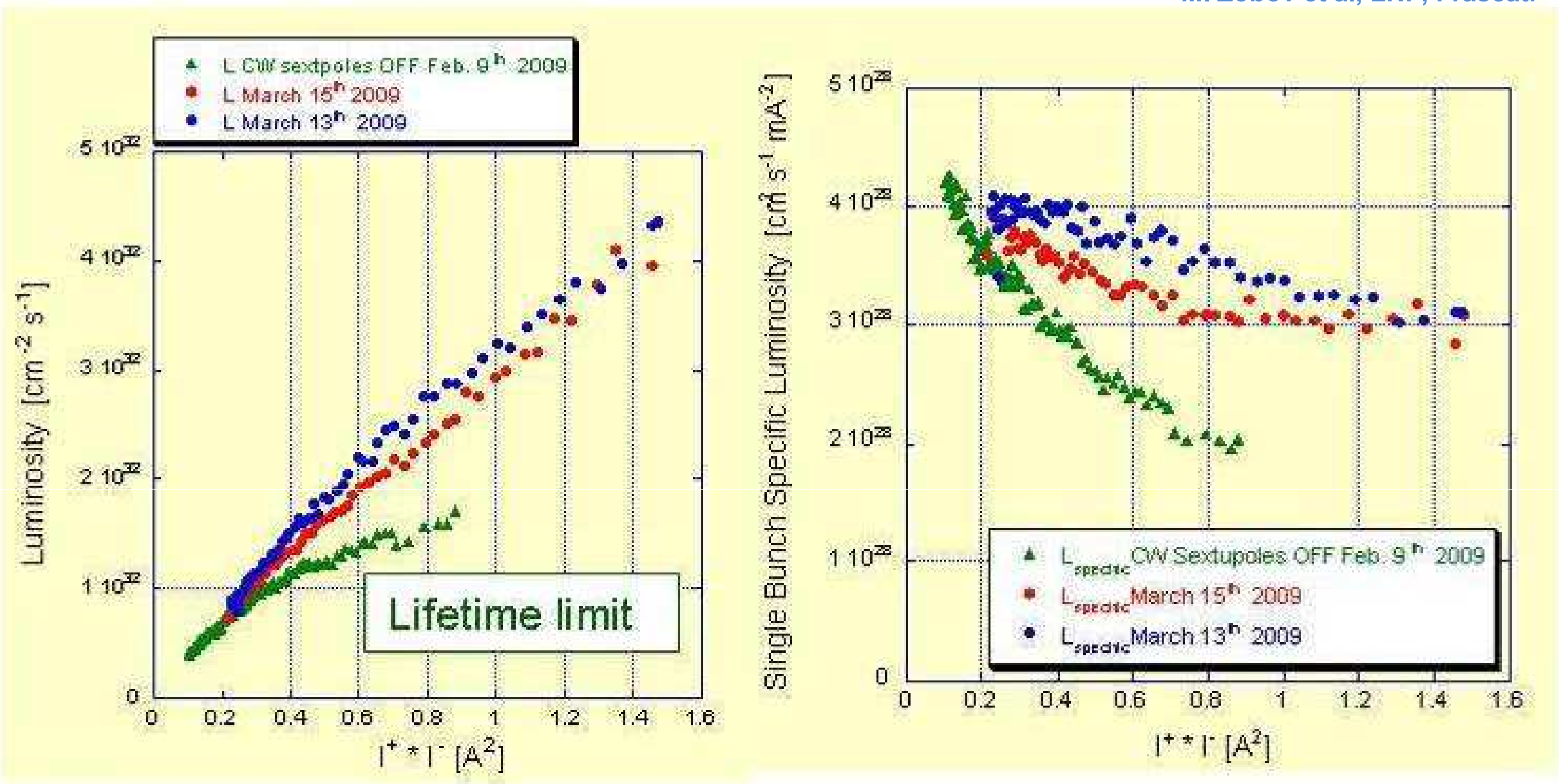


Increase the maximal beam-beam tune shift and minimize the beta to increase the luminosity: $L \propto \frac{I}{\beta_y^*} \cdot \xi_y$

Super B: βy=0.02 cm + the nominal beam-beam tune shift ξy=0.1 at max ξy=0.2 (increased due to crab sextupoles) → the beam-beam effects are practically absent!*

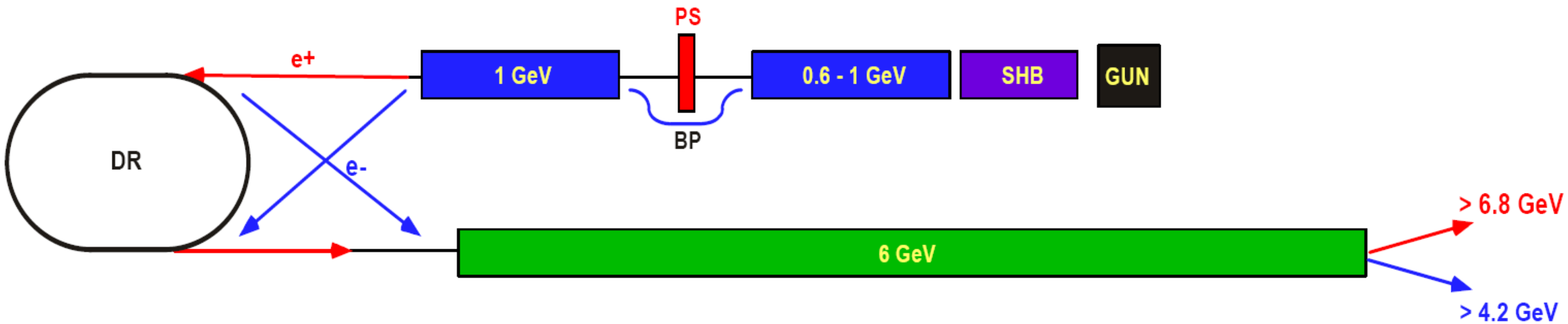
Test of Crab Waist concept: DAFNE upgrade results

M. Zobov et al, LNF, Frascati

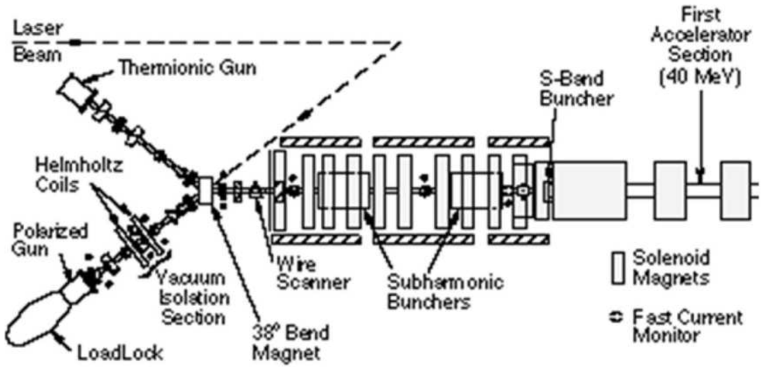


Luminosity vs. product of beam currents (left) and specific luminosity vs. product of beam currents (right), for two record shifts with crab sextupoles ON (read and blue dots) and with crab sextupoles OFF (green)

Injection Complex



At full luminosity and beam currents, up to 4 A, the Beam Lifetime ~3-8 min → continuous injection process ("top-up" injection). Linac operates at 50 Hz. Short train of 5 bunches at a time are produced for each beam type, stored for 20 msec in the shared damping ring and then extracted and accelerated to full injection energy



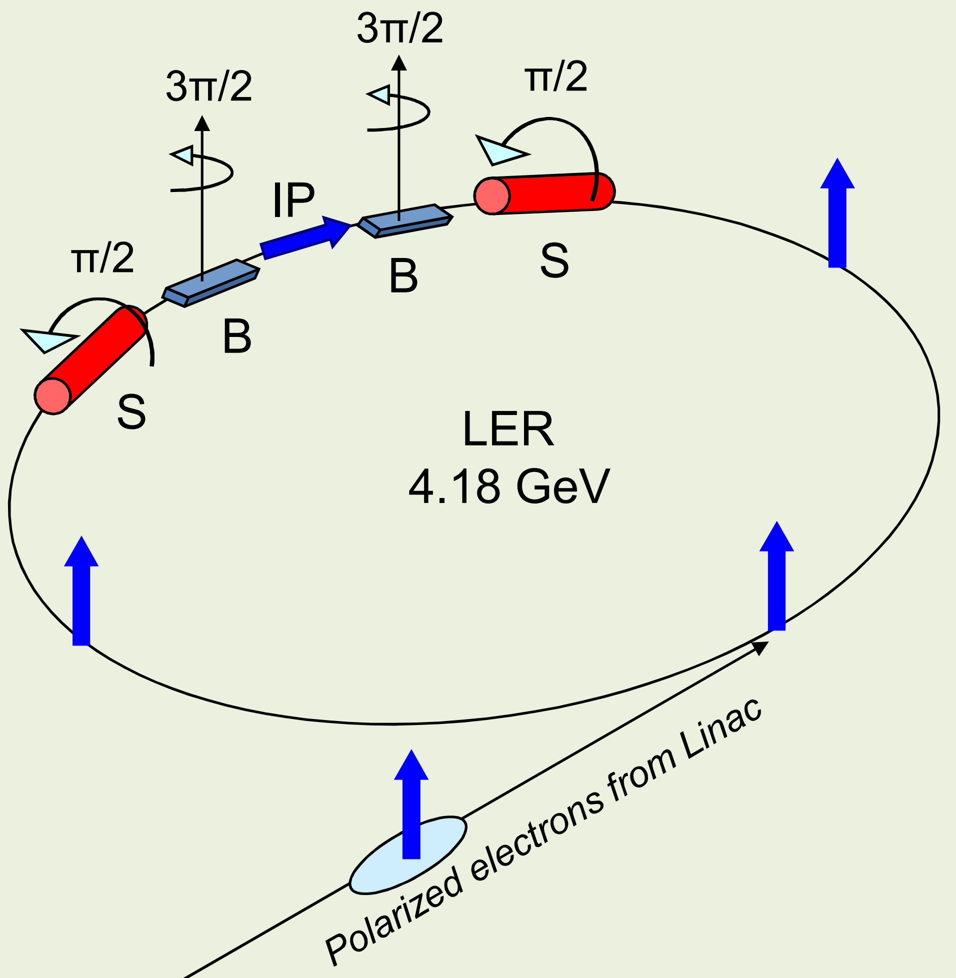
Polarized electron source developed and applied at SLAC

Electrons from the gun source are longitudinally polarized. The spins are rotated to the vertical plane in a special transport section downstream of the gun. At present this section is still under development. Variants under consideration:

a) Wien's Filter

b) Z-manipulator includes two bends by E-field and solenoids between them

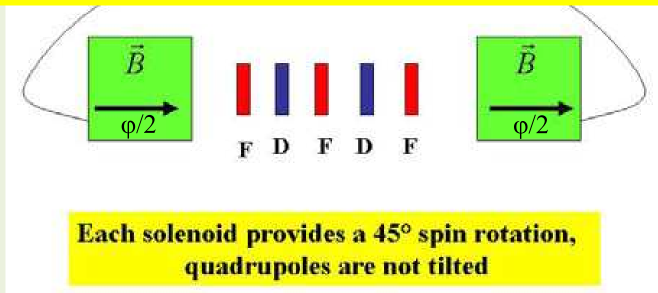
Spin kinematics and rotators at SuperB



Why 3/2π bend but not 1/2π one?

Solenoid insert optics

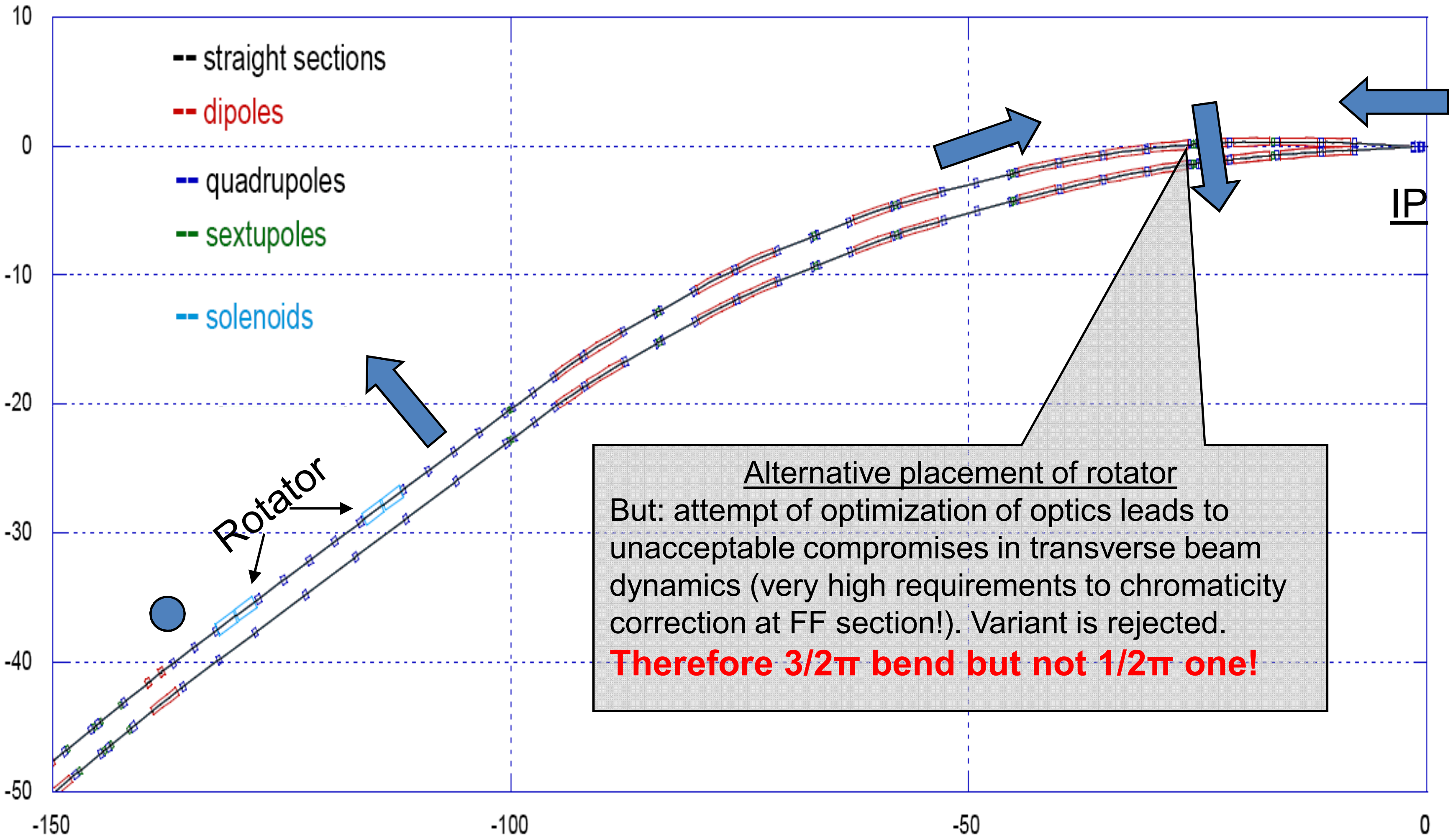
Decoupling: T=Tx=-Ty (V.Litvinenko)
Spin transparency (I.Koop): $T = \begin{vmatrix} -\cos\varphi & -2r\sin\varphi \\ (2r)^{-1}\sin\varphi & -\cos\varphi \end{vmatrix}$
(r=pc/eB)



Rotator parameters

Parameter	Value	Unit	Comment
Energy	4.18	GeV	
Spin rotation in solenoids	90	°	one side
Solenoid field integral	4· 10.94	Tm	4 individual solenoids
Solenoid field	2.39	T	
Total length of solenoid section	23.07	m	Includes decoupling optics
Spin rotation of dipoles	270	°	one side
Bending of dipoles	28.4	°	one side

Layout of the LER Spin Rotator section



Kinetics of polarization at SuperB

Equilibrium polarization degree under conditions of the continuous injection :

$$P = P_i \cdot \frac{\tau_r}{\tau_r + \tau_l} + P_r \cdot \frac{\tau_l}{\tau_r + \tau_l}$$

$P_i \approx 90\%$ – polarization of the injected portion of particles

$$\tau_r = \tau_0 \cdot \frac{\left\langle |\dot{\vec{v}}|^3 \right\rangle}{\left\langle |\dot{\vec{v}}|^3 \left[1 - \frac{2}{9}(\vec{n}\cdot\vec{v})^2 + \frac{11}{18}\vec{d}^2\right] \right\rangle}, \text{ the radiative relaxation time (D - K)}$$

$$\tau_0[hour] \approx 2.74 \times 10^{-2} \frac{\rho^2 R[m^3]}{E^5[GeV^5]} \approx 4\,h \text{ @ } 4.18\text{ GeV}, \rho = 29\text{ m}, R \approx 200\text{ m}, \text{the S - T time}$$

τ_l, the beam life time due to Bhabha Bremsstrahlung at high luminosity ($\approx 3 - 8$ min)

$$P_r = \frac{8}{5\sqrt{3}} \frac{\left\langle \dot{\vec{v}}^3 \left(\vec{n} - \vec{d}\right) \right\rangle}{\left\langle |\dot{\vec{v}}|^3 \left[1 - \frac{2}{9}(\vec{n}\cdot\vec{v})^2 + \frac{11}{18}\vec{d}^2\right] \right\rangle} \overset{\text{for SuperB}}{\approx} 0.92\frac{\tau_r}{\tau_0}, \text{ the D - K equilibrium extent}$$

$$P \approx \frac{\tau_r}{\tau_r + \tau_l} \cdot \left(P_i + 0.92\frac{\tau_r}{\tau_0} \right), \text{if } \tau_r << \tau_0 \text{ and } \tau_r >> \tau_l, \text{ then } P \to P_i$$

Analytic estimate of radiative relaxation time

Main depolarizing factor is a spin-orbit coupling due to Spin Rotators:

$$\tau_r \approx \frac{\tau_0}{1 + \frac{11}{18} < \vec{d}^2 >},$$

Dispersion of spin rotation in bend magnets

Betatron term

$$< \vec{d}^2 > \approx \frac{< |h|^2 > [(A\beta_{x,1})^2 + B^2][1 - \cos 2\pi\nu_0 \cos 2\pi\nu_x]}{4\beta_{x,1} \sin^2 \pi(\nu_x + \nu_0) \sin^2 \pi(\nu_x - \nu_0)} + \frac{D^2}{4 \sin^2 \pi\nu_0.}$$

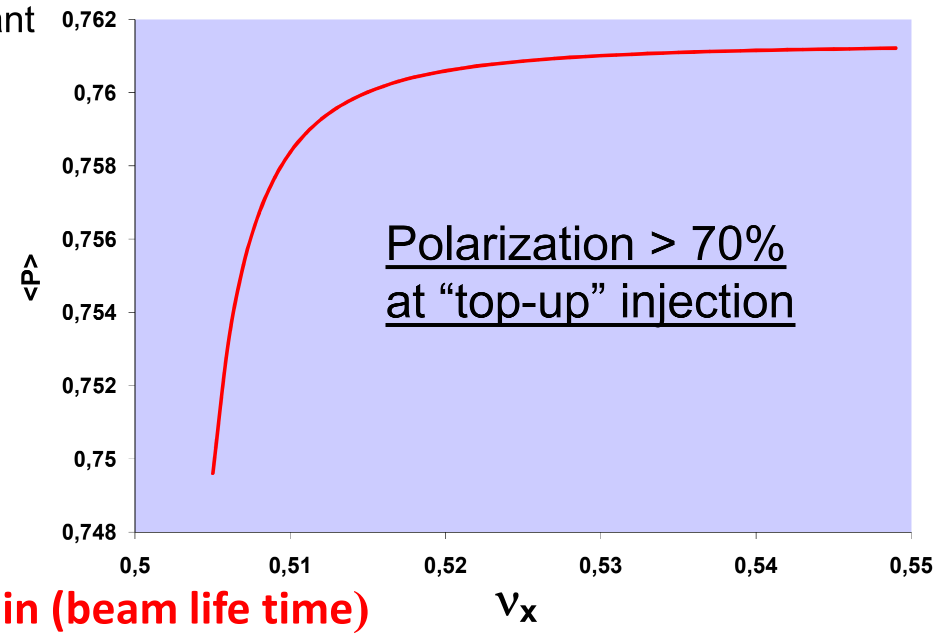
A and ***B*** coefficients are calculated using the transport matrix elements for several points at the solenoid inserts; $\beta_{x,1}$, the beta value at input of the insert; **$<|h|^2>$**, the Courant-Snyder's invariant averaged over the arcs

D=-π spin rotation angle in bend magnets from one rotator to another with IP between
and
D=-3π that angle in actual version

Spin tune $\nu_0=\nu=\gamma a$ (only for 4.18 GeV)

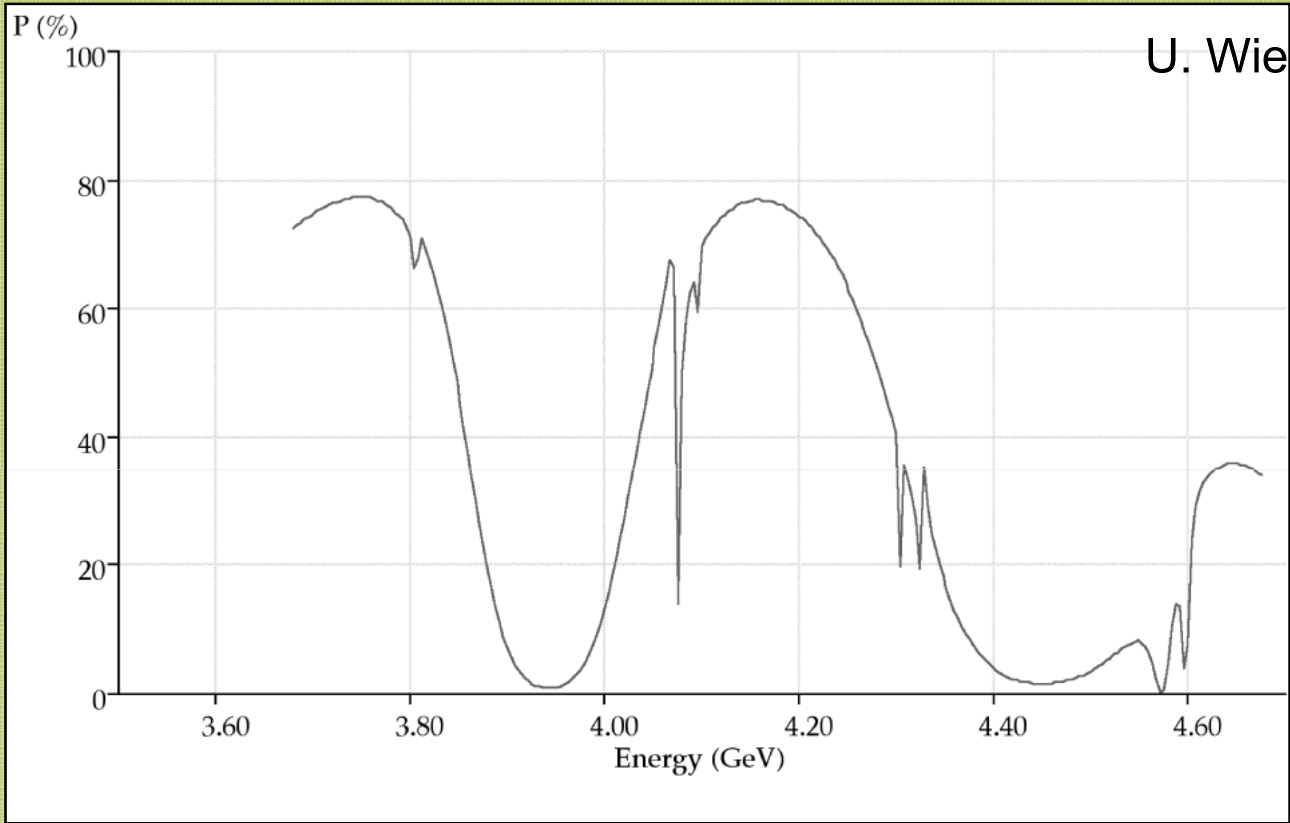
Term with ***D*** is determinative far from $\nu_x \pm \nu_0 = k$ resonances where the first term in d^2 matters

Time-averaged longitudinal polarization degree at the beam lifetime of 3 min



At $\tau_0 \approx$4h and *D=-3π* τ_r=20 min >> 3 min (beam life time)

Evaluation of equilibrium polarization at SuperB



U. Wienands et al.

Code SLICKTRACK (based on approaches of SLIM code by A.Chao)

•comprises a Monte-Carlo spin-orbit tracking algorithm for simulating full 3-d spin-orbit motion in the presence of synchrotron radiation

•limited set of misalignments (in the arcs only) was implemented

•orbit correction was done using a reduced set of correctors.

Note

Radiative relaxation time τ_r is scaled by Sokolov-Ternov time τ_0 which depends on the arc bend magnet field squared if mean machine radius=const. The larger this field → the smaller τ_0 and τ_r → polarization extent drops. At the same time, radiation decrement rises →more easier to achieve low emittance needed for high luminosity. SuperB LER magnetic structure is still under optimization. So, up to date, some current parameters can differ from those in Blue Book.

Problem of the beam-beam depolarization effect

Very high density of the longitudinally polarized colliding beams makes us to concern about the estimation of beam-beam depolarization (BBD) effect

BBD mechanism is based on the spin resonant diffusion. Spin-orbit resonances of high order may fall into the footprint of the betatron tune shift caused by counter beam field. Tune shift for a given particle is determined by a square of its betatron amplitude – "action". Incoherent chaotic crossing of the spin resonances due to diffusion and damping processes leads, in principle, to the depolarization effect.

BBD rate was estimated for the first time by A.M. Kondratenko (1974) as applied to conventional storage ring colliders with the vertical polarization. Main conclusion was: It is possible to conserve the beam polarization provided that BB effects do not crucially disturb the orbital motion ("no beam blow up").

This conclusion needs a quantitative verification *wrt* the features of the Crab Waist IR and the magnetic structure with the polarization rotator inserts.

About naive approach to BBD

Particle trajectory spread $\rightarrow$ the polarization decrease in a single pass of IP:

$\Delta P_{s.p.} \sim \frac{1}{2}\langle \chi^2 \rangle$, χ – an angle of spin rotation in a counter bunch field.

Numerical "single-pass" simulation result discussed at SuperB Meeting, 2010:

$\Delta P_{s.p.} \sim 10^{-7} \div 10^{-6}$. Depolarization in $\sim 10^6$ turns (3 sec)?

- Answer is most likely NO. Otherwise one must propose a too short correlation time in orbital and spin motions - from turn to turn (non-realistic!)
- Correlation of spins is limited by rather longer time ~ 10 msec (radiation damping).

Over this time, an averaging of all "single-pass" perturbations is available

- Simple estimate: $\Delta P_{s.p.} \sim \frac{1}{2}\left(\frac{\nu\sigma_y^*}{F_y^*}\right)^2$, $\nu = a\gamma$, $F_y^* \sim \frac{\beta_y^*}{4\pi\xi_y}$ – focal length

Super B (4.2 GeV): $\Delta P_{s.p.} \sim 5\cdot 10^{-7}$ at $\xi_y \sim 0.1$, $\beta_y^* = 0.02$ cm, $\nu \approx 10$, $\sigma_y^* \sim 0.02\ \mu$m

VEPP-4M (1.8 GeV): $\Delta P_{s.p.} \sim 10^{-7}$ at $\xi_y \sim 0.04$, $\beta_y^* = 5$ cm, $\nu \approx 4$, $\sigma_y^* \sim 10\ \mu$m

Super and conventional machines do not differ strongly in this parameter!

- Polarization was remaining in luminosity runs at VEPP-2M, VEPP-4, SPEAR, HERA
- Obviously, the parameter $\Delta P_{s.p.}$ can not definitly characterize BBD

Criterion for the spin-orbit resonances

Caution! Here ***z*** *means vertical !*

Maximal nubmer $|k_z|$ of "working" resonance is found from the condition (*A.M.Kondratenko*, 1974) : $\nu + k_x \nu_x + k_z \nu_z = k$

$$\lambda_{BBD}^{(k)} \approx \frac{4}{\pi} \cdot \frac{N r_e}{\gamma} \cdot \frac{\nu^2}{\beta_z^*} \cdot |F^\nu|^2 \cdot A \cdot \left[\frac{< a_z^2 >}{< a_z^2 > + z_0^2 + z_0 \sqrt{z_0^2 + 2 < a_z^2 >}} \right]^{|k_z|} \le \lambda_r$$

$< a_z^2 >$ an averaged square of vertical oscillation amplitude

z_0 a vertical beam size

$|F^\nu|_{I.P.}$ Spin Response Function (SRF) shows the spin perturbation amlification/reduction resulting from oscillations excited over the ring by a kick in I.P. (if $F^\nu \to 0$ then $\lambda_{BBD}^{(k)} \to 0$ for any k)

A a factor depending on amplitude distribution

$\lambda_r = \max\{\lambda_{BLT}, 1/\tau_p, ...\}$ a reference rate $\sim \lambda_l$

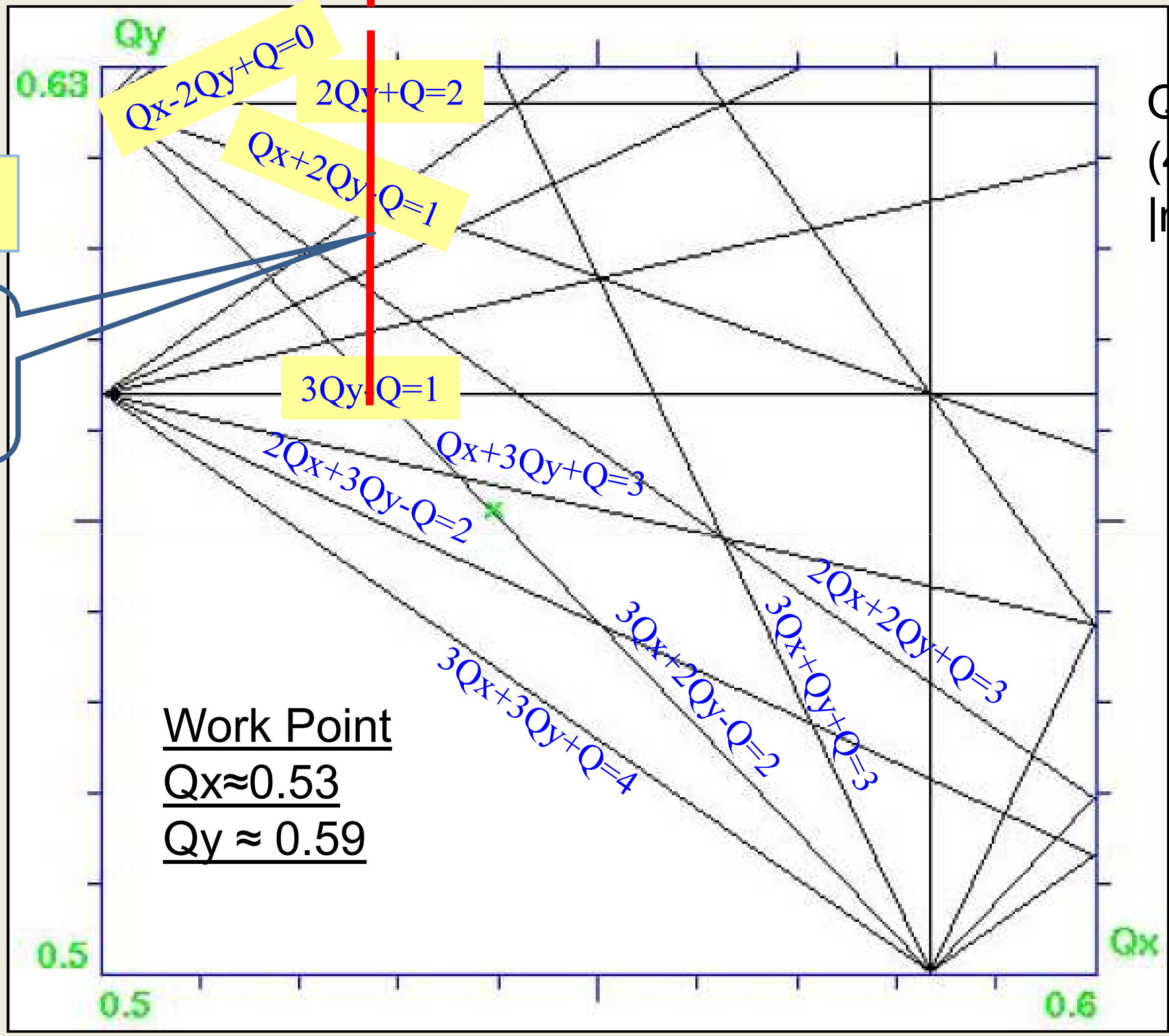
Generally, $\lambda_{BBD} \sim \sum_k \lambda_{BBD}^{(k)}$, a sum over all working resonances

Estimated max{k_z}=3 for case under consideration

Spin resonances Q+mQx+nQy=k

Most dangerous resonances

ξ_y=0.1
SBF Vertical Tune Shift



Q=ν=9.49
(4.18 GeV)
|m|+|n|≤6

Modulation spin resonances with a synchrotron frequency are not shown!

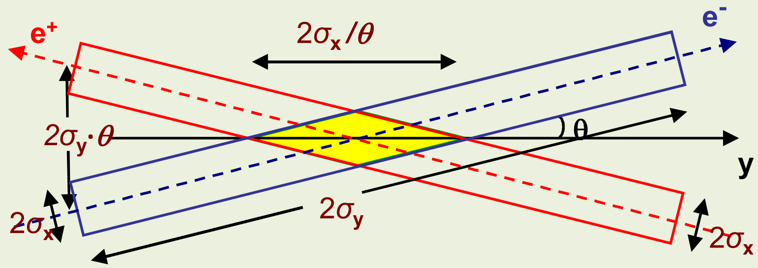
BB footprint may overlap several resonances of the same order!

Account of interaction length reduction

$w_k = 2\nu \left\langle H_x F^{\nu_k} e^{i\nu_k \tilde{K}_z} \right\rangle$, the spin harmonic

$\nu = \nu_{\mathrm{k}} = k + k_z \nu_z + k_x \nu_x$, the spin resonance condition

$$\left| w_k \right| \propto \frac{N_e r_e \nu \left| F^{\nu_k} \right|}{\gamma V_b} \cdot l_i,$$



V_b, the counter bunch volume

$$l_i = \begin{cases} \sim \sigma_l, & \text{the beam length (head-on collision)} \\ \sim \dfrac{\sigma_x}{\theta}, & \text{the interaction length (Crab Waist)} \end{cases}$$

For the resonance $\nu_{\mathrm{k}} = k + k_z \nu_z$, the BBD rate is in order $\lambda_{\mathrm{BBD}} = \dfrac{1}{\tau_{BBD}} \sim \dfrac{\pi \left\langle \left| w_k \right|^2 \right\rangle}{\sigma_b}$, $\sigma_b = \left| k_z \cdot \Delta\nu_z \right|$

The higher number
→ the lower rate

$$\Delta\nu_z = \frac{2 N_e r_e \beta_z^*}{\pi\gamma\sigma_z^* (\sigma_x^* + \sigma_z^*)} \propto \frac{N_e r_e}{\gamma V_b} \cdot l_i, \quad \text{the tune shift}$$

As result, $\lambda_{\mathrm{BBD}} \propto \dfrac{N_e r_e \nu^2 \left| F^{\nu_k} \right|^2}{\gamma} \times \dfrac{l_i(\mathrm{CW})}{l_i(\mathrm{head-on})}$, $\quad \dfrac{l_i(\mathrm{CW})}{l_i(\mathrm{head-on})} \sim \dfrac{\sigma_x}{\theta\sigma_l} = \dfrac{1}{\Psi_P}$, Ψ_P – Pivinski's angle

Estimate of λ_{BBD} by Kondratenko's "head-on" formula reduced by factor $\dfrac{1}{\Psi_P} << 1$

*Caution! Here **z** means vertical !*

Summary of BBD features at SuperB Factory

1. The dangerous spin resonances of high order in betatron tunes are unavoidable due to elongated BB foot print. Simultaneously several resonances may be overlapped by the print

2. Very strong collective field of the counter bunch due to very small beam transverse sizes

3. Large Piwinski's angle → length of interaction is reduced (positive fact!)

4. Spin perturbations from BB impact in two planes

5. Spin Response Factor (finally increasing or decreasing BBD) determined by excited in IP oscillations depends on the chosen rotator scheme

Preliminary BBD rate estimates

Collider	E MeV	Beta_x (IP) Cm	Beta_y (IP) Cm	Horizon. Size (IP) Micron	Vertical Size (IP) Micron	Beam Length cm	N per bunch 10^10	Cross. Angle (full) mrad	SRF $\|F^{\nu}\|^2$	BBD Time $1/\lambda_{BBD}$ min
SuperB	4180	2.6	0.0253	7.2	0.036	0.5	5.08	66	1(?)	32
VEPP-4M	1890	70	4	290	4	4.5	2	0	0.08	2500

for $\nu \pm 3\nu_y = k$, the considered spin resonance type

Estimate obtained for one of the potentially dangerous resonance is based on unit value of Spin Response Function (F^{ν}). That is not realistic, but allows to produce a BBD scaling.

To have a more accurate analysis, we plan in nearest future:

a) to calculate an actual value of the SRF for SuperB with longitudinal polarization

b) to perform the spin diffusion simulation with account of BB

BBD simulation

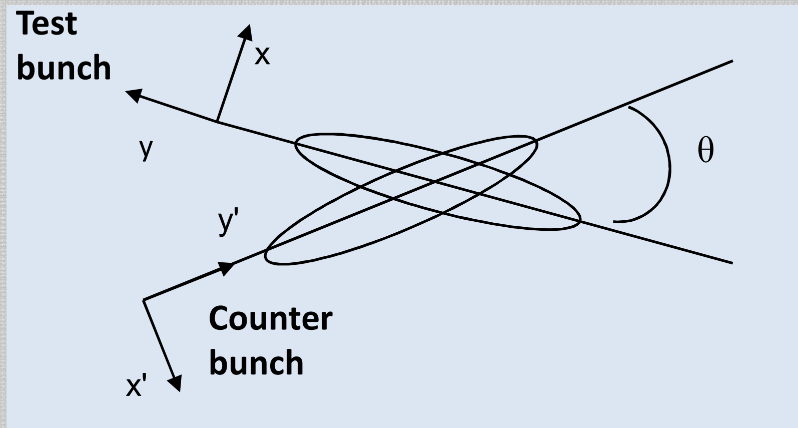
- Usual BB simulation (D.Shatilov) with particle tracking (P.Piminov) over the ring and accounting radiation diffusion and damping
- Turn-to turn evolution of spin vector of model particles in fields of ring and counter bunch
- Find rate <d S_n/dt> of particle ensemble

Spin rotation angle α of Test Particle in the Counter Bunch Slice field:

$$\alpha_z = (1+\nu)\left(\Delta p_{x'} - \Delta p_{y'} \sin\theta - \frac{\Delta p_{x'}}{1+\cos\theta} \sin^2\theta \right),$$

α_x=(1+ν)$\otimes p_{z'}$

$$\alpha_y = \frac{\Delta p_{z'}}{1+\cos\theta} \sin\theta.$$



Δp is increment (r.u.) of test particle momentum wrt axes of Counter Bunch reference frame

Spinor transformation at interaction region: $M_{bb} = I - \frac{i}{2}(\vec{\sigma}\cdot\vec{\alpha}).$

Calculation of Spin Response Function

- **Turn-to-turn simulation using particle tracking and spin rotation matrix algebra (case of a conventional storage ring):**

$$F^{\nu}(\theta) = \left\langle -\frac{i \cdot e^{-i2\pi\nu \cdot N}}{\nu \cdot h} \cdot \delta S_{\perp}^{(k)} \right\rangle - 1$$

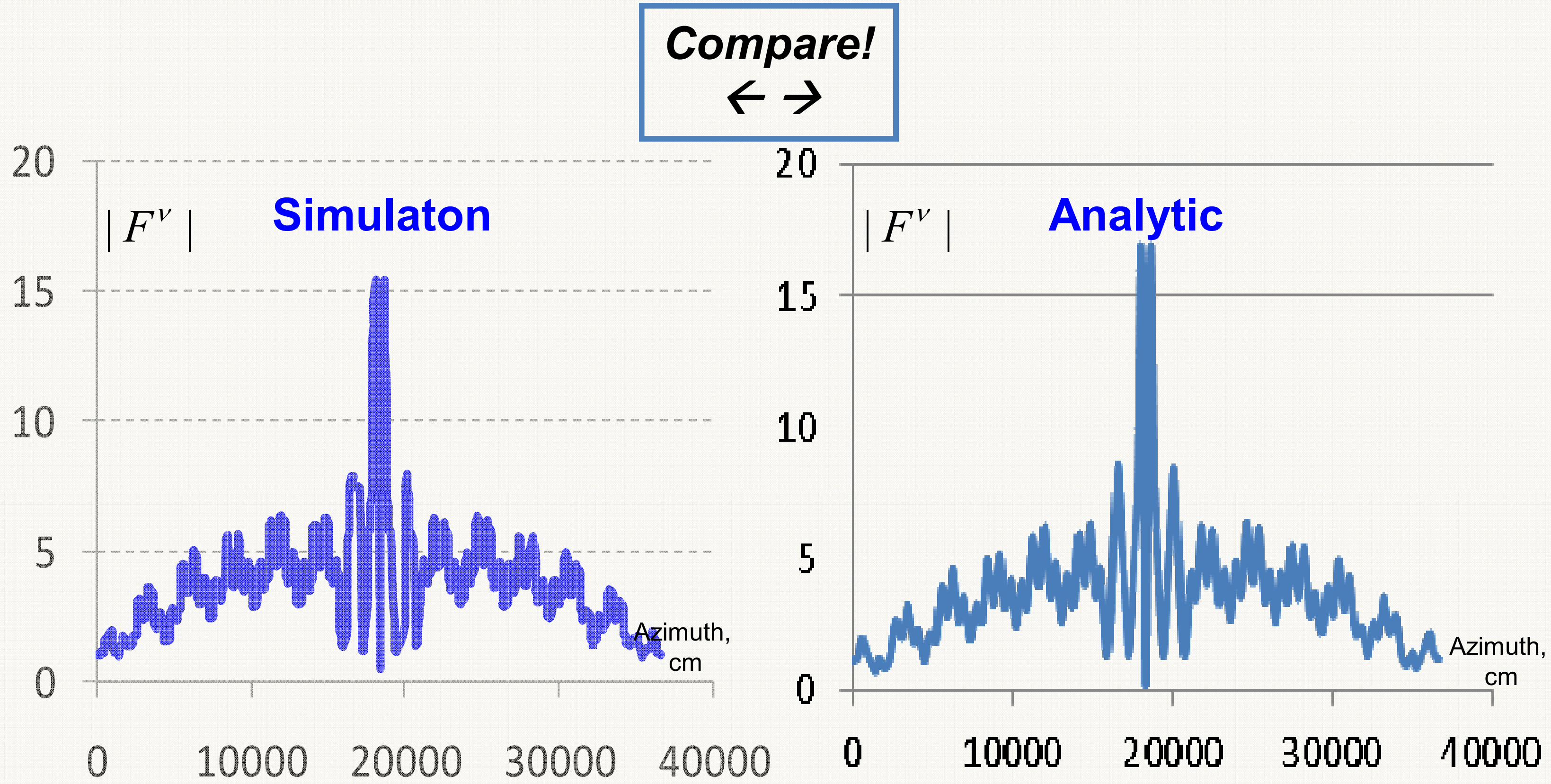
$\delta S_{\perp}^{(k)}$ – a spin vector perturbation transverse to $\vec{n}$ at kth turn after a vertical kick of strength h at an azimuth θ; $N >> 1$, number of turns done; $< \dots >$, averaging over turns. No damping and diffusion required

- **Analytic approach based on solving the spin precession equations. In particular, there is the Derbenev-Kondratenko formula for SRF valid for conventional storage rings:**

$$F^{\nu} \approx \frac{\nu \cdot e^{i\nu\theta}}{2} \left\{ \left[1 - e^{\frac{i2\pi}{m}(\nu+\nu_z)} \right]^{-1} \cdot f_z \int_{\theta-\frac{2\pi}{m}}^{\theta} K f_z^{*\prime} e^{-i\nu\Phi} d\theta' - \left[1 - e^{\frac{i2\pi}{m}(\nu-\nu_z)} \right]^{-1} \cdot f_z^{*} \int_{\theta-\frac{2\pi}{m}}^{\theta} K f_z^{\prime} e^{-i\nu\Phi} d\theta' \right\}$$

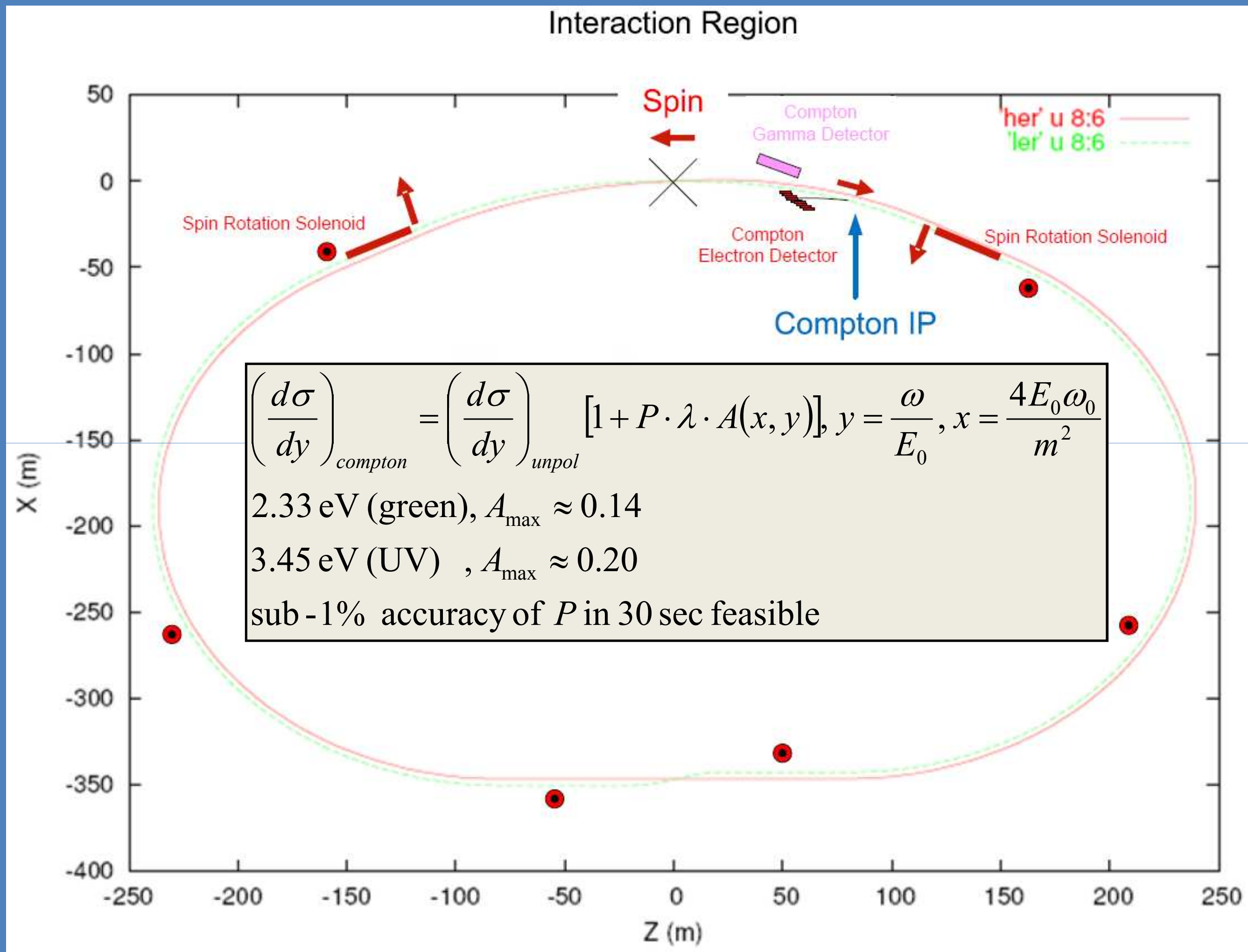
$f_z(\theta)$, vertical Flouquet function; ν_z, vertical betatron tune; $K(\theta)$, orbit curvature; m, number of super-periods

Test of SRF simulation for 1.84 GeV VEPP-4M



Generally, analytical calculation of SRF in the ring with spin rotators is hard. Simulation as a regular method is preferable for this aim. Comparison of two approaches for conventional rings is a preliminary test of simulation method

Compton polarimeter



$$\left(\frac{d\sigma}{dy}\right)_{compton} = \left(\frac{d\sigma}{dy}\right)_{unpol}\left[1+P\cdot\lambda\cdot A(x,y)\right],\ y=\frac{\omega}{E_0},\ x=\frac{4E_0\omega_0}{m^2}$$

2.33 eV (green), $A_{\max} \approx 0.14$

3.45 eV (UV) , $A_{\max} \approx 0.20$

sub-1% accuracy of P in 30 sec feasible

Summary

- Preliminary variant of the SuperB Project in all accelerator aspects is elaborated and exists now in the document
- Territory of Tor Vergato Univ. near Rome is approved as a place for SuperB
- Italian Government made a decision to finance SuperB
- International SuperB Team of accelerator physicists is formed and is in activity
- Contribution of Novosibirsk Group from BINP is one of determinative
- Longitudinal polarization scheme is determined and studied. Its optimization in a progress
- Study of Beam-Beam depolarization effect at SuperB started
- Compton polarimeter is implied to measure longitudinal polarization of electrons in LER SuperB

Thank you!