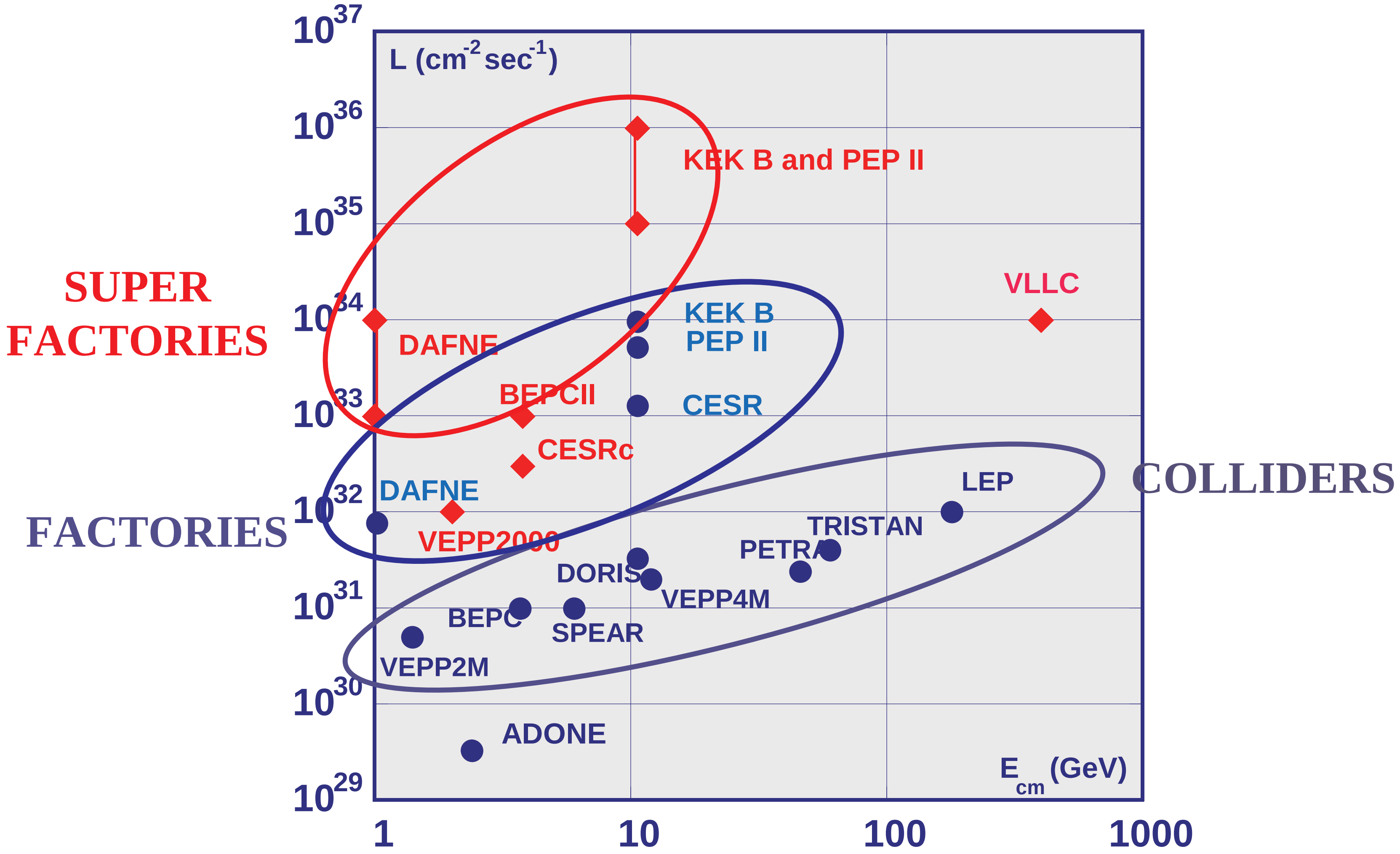
Report on e+e- factories workshop at SLAC

Christoph Montag and Vadim Ptitsyn

- 62 participants, mainly from electron accelerator laboratories
- Plenary sessions and three working groups:
  - Beam-Beam interaction. Interaction region. Optics.
  - RF, Feedback, and Collective Effects
  - Operations, Reliability, Injection and Instrumentation

PAST, PRESENT AND FUTURE



Some Machine Parameters

	PEP-II	KEKB	
LER energy	3.1	3.5	GeV
HER energy	9.0	8.0	GeV
LER current	1.55	1.38	A
HER current	1.18	1.05	A
β_y^*	12.5	6.5	mm
β_x^*	25	60	cm
X emittance	50	20	nm-rad
Estimated σ_y^*	5	2.2	µm
Bunch spacing	1.89	2.4	m
Number of bunches	1034	1284	
Collision angle	head-on	±11	mrads
Beam pipe radius	2.5	2.0	cm
Luminosity	6.6×10^{33}	10.6×10^{33}	$cm^{-2}\ sec^{-1}$

PEP-II Goal for Jul 2004

J. Seeman's parameters

	June 03	Jul 2004	
LER energy	3.1	3.1	GeV
HER energy	9.0	9.0	GeV
LER current	1.45	**2.7**	A
HER current	1.15	**1.6**	A
β_y^*	**12.0**	**9.0**	mm
β_x^*	28	28	cm
X emittance	50	40	nm-rad
Estimated σ_y^*	4.5	3.4	μm
Bunch spacing	1.89	1.26	m
Number of bunches	1034	**1450**	
Collision angle	head-on	head-on	mrads
Beam pipe radius	2.5	2.5	cm
Luminosity	6.5×10^{33}	$\mathbf{1.2\times10^{34}}$	$cm^{-2}\ sec^{-1}$

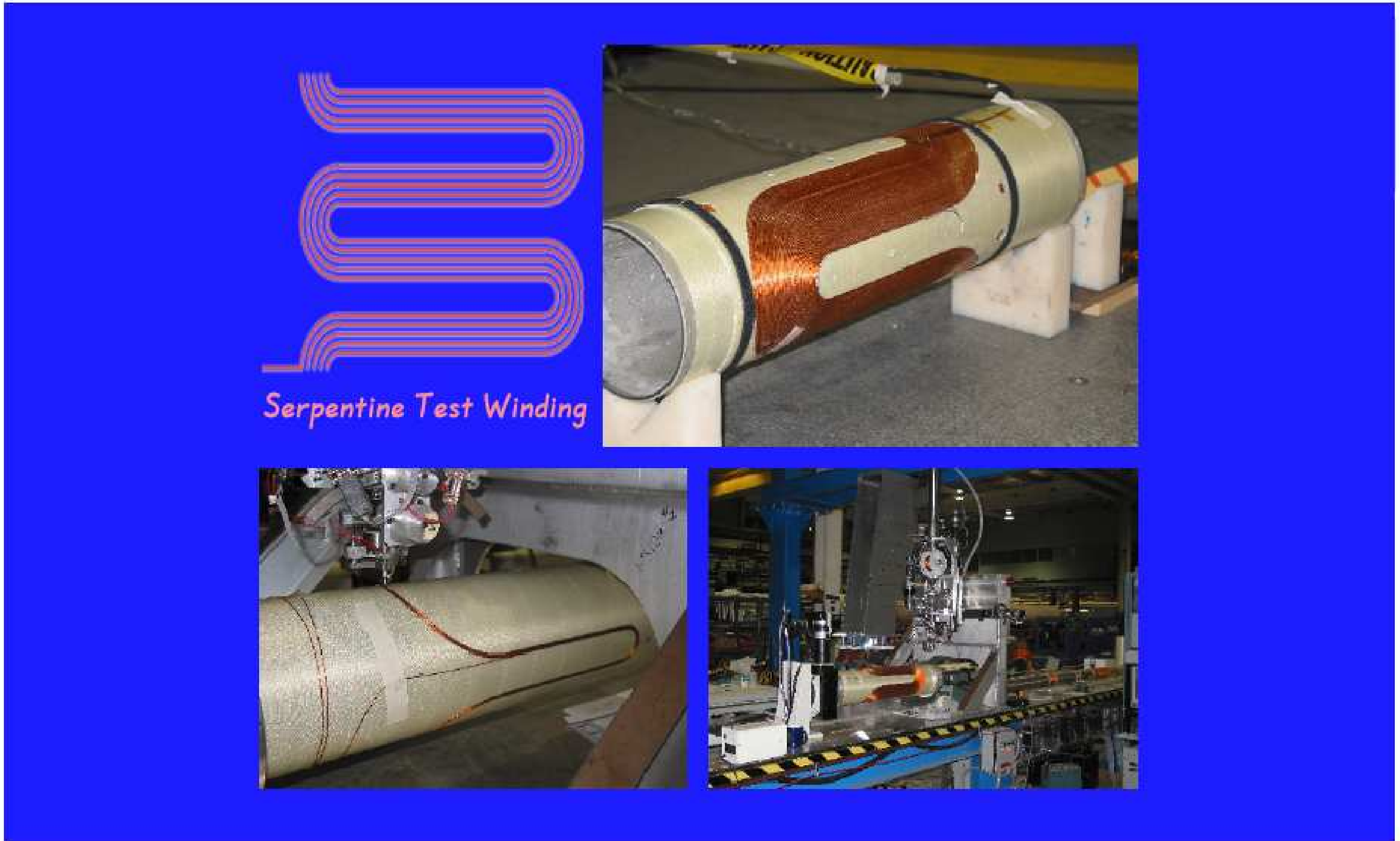
B.Parker

BROOKHAVEN NATIONAL LABORATORY
Superconducting Magnet Division

"A Review of BNL Direct-Wind Superconducting IR Magnet Experience."

- Overview of Past and Current Projects.
  - HERA-II Luminosity Upgrade IR Magnets.
  - NLC Superconducting Final Focus Magnets.
  - BEPC-II Luminosity Upgrade IR Magnets.
- Winding Technology Overview.
  - New Types of "Serpentine" Coil Windings.
  - Winding Test of BEPC-II Serpentine Coil.
- Some Issues Relevant for Super B-Factory.
  - Cryostat & Warm Bore Allowance.
  - Quadrupole Coil Layout Options.
  - Magnetic Length Vs. Slot Length.
  - Dipole Torque Considerations.

B.Parker



BROOKHAVEN NATIONAL LABORATORY
Superconducting Magnet Division

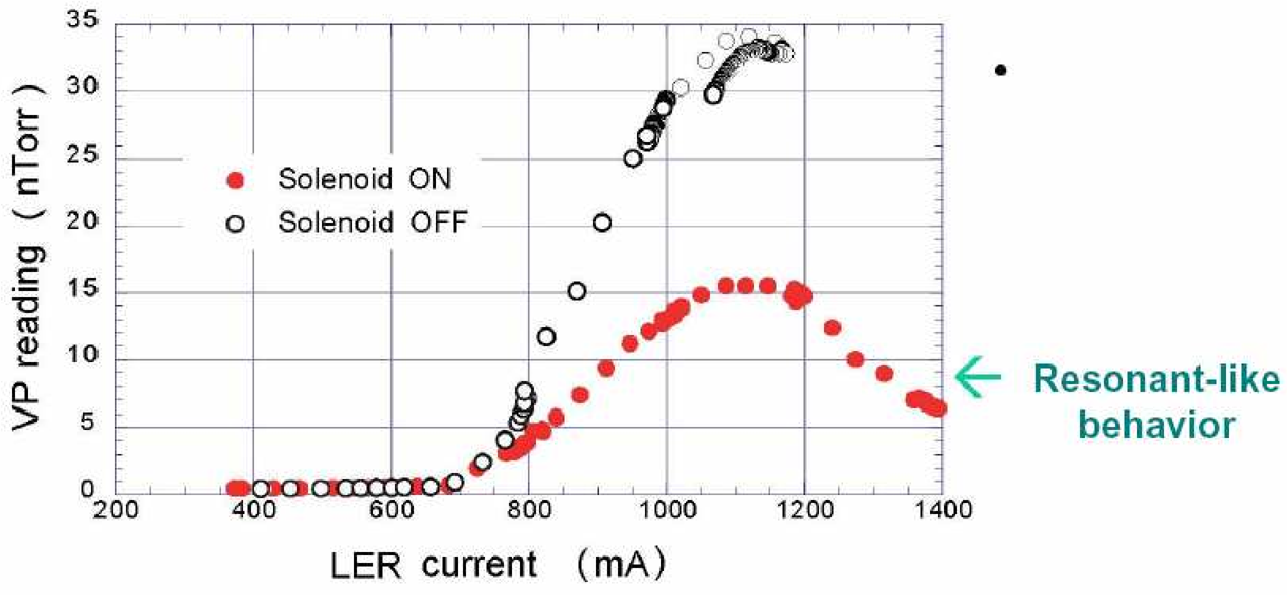
A Demonstration How the BNL Coil Winding Machine Works: Serpentine Coil Example.

Experimental observations

- Cloud build-up and saturation
- Vacuum pressure rise
- Surface conditioning
- Z-dependence
- Secondary electron (SE)- vs. photoelectron (PE)-dependence
- Proton rings
  - CERN SPS with LHC-type beams
  - Proton Storage Ring (PSR)
- Electron decay time
- EC-induced collective effects

Vacuum pressure rise

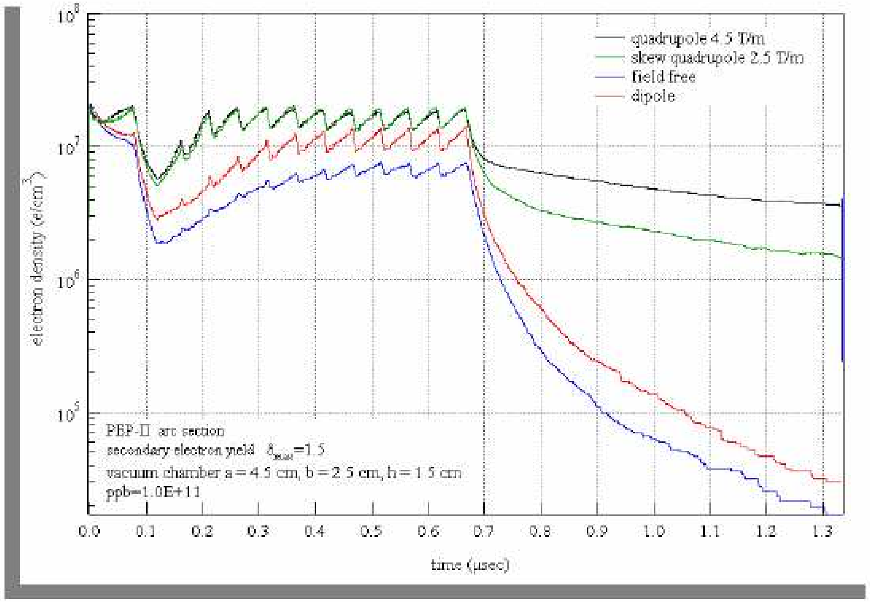
PEP-II: courtesy of A. Kulikov et al., PAC 2001, 1903 (2001)

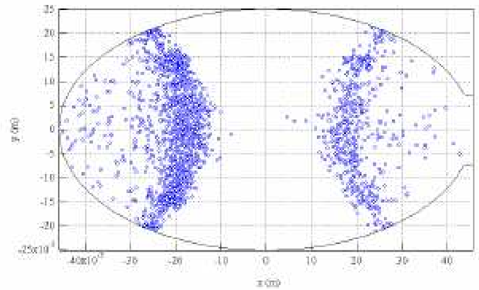


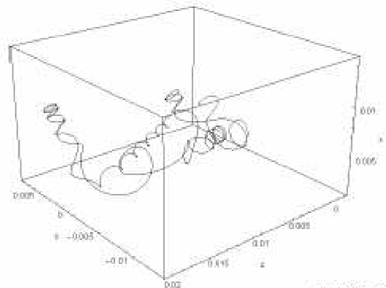
Pressure rise also observed in KEKB, SPS, APS (and RHIC?)

Electron trapping mechanism in quadrupole

Particular attention at quadrupoles where electron trapping mechanism is possible (magnetic mirror, see also Jackson .. !)







(ex: NLC MDR quad)

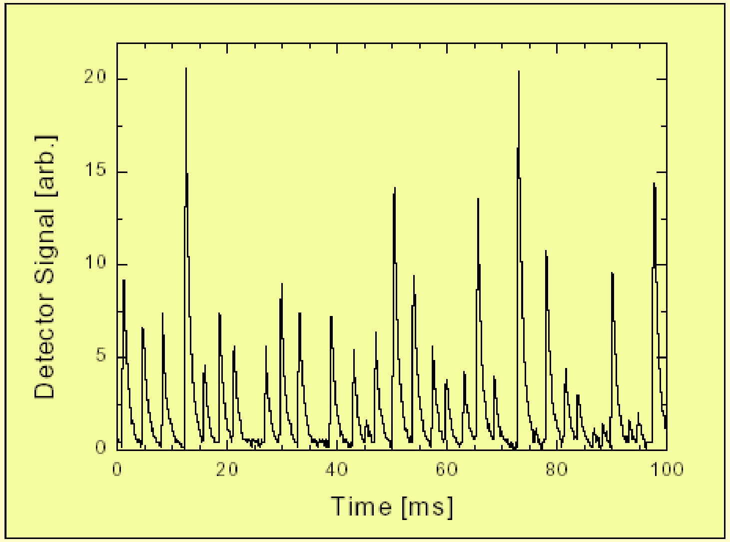
PEP-II arc simulations + skew quadrupole. Decay time after long gap. By-2 bucket spacing, 10 out of 12 bunches with mini-gaps, 10^{11} ppb. Arc quadrupole gradient 4.5 T/m and skew quarupole 2.5 T/m. Elliptic vacuum chamber 4.5 x 2.5 cm with antechamber.

$$\left|\frac{v_{\|,0}}{v_{\perp,0}}\right| = \left(\frac{B_{pipe}}{B_0} - 1\right)^{1/2}$$

Cures

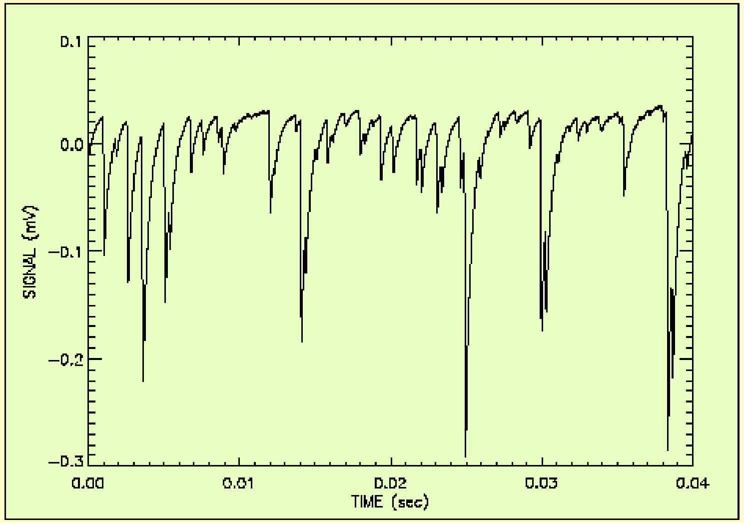
- Avoid BIM resonance through choice of bunch spacing, bunch current, and chamber height; include SE emission energy in analysis
- Minimize photoelectron yield through chamber geometry (antechamber, normal incidence)
- Consider passive cures implemented in existing machines:
  - Surface conditioning or surface coatings to minimize δ; e.g. TiN, TiZrV NEG
  - Solenoidal B-field to keep SEs generated at wall away from beam; this works in machines dominated by ECs in the straights (i.e., *not* in the dipoles)
- Implement fast beam feedback
- Continue to refine models and continue to develop and implement electron cloud diagnostics, especially in B-fields

Observations

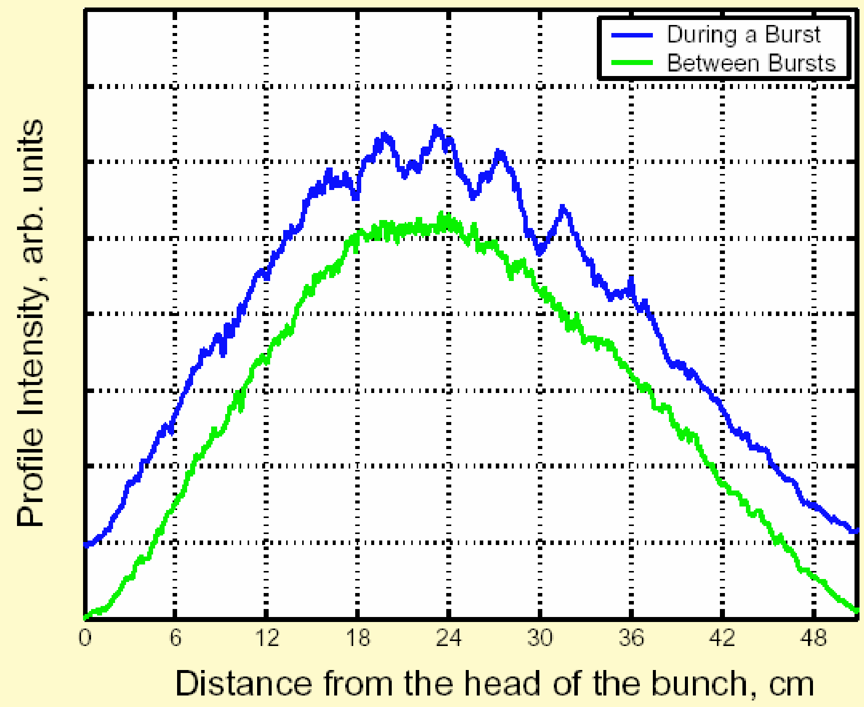


Bursts of CSR (far infrared) in NSLS VUV ring [Carr et al., NIM, 387, (2001)]. Frequency range from $\sim$ 6 to $\sim$ 60 GHz.

Bursts of CSR in BESSY II [G. Wustefeld et al.]. Typical wavelength $\sim$ 0.5 mm.

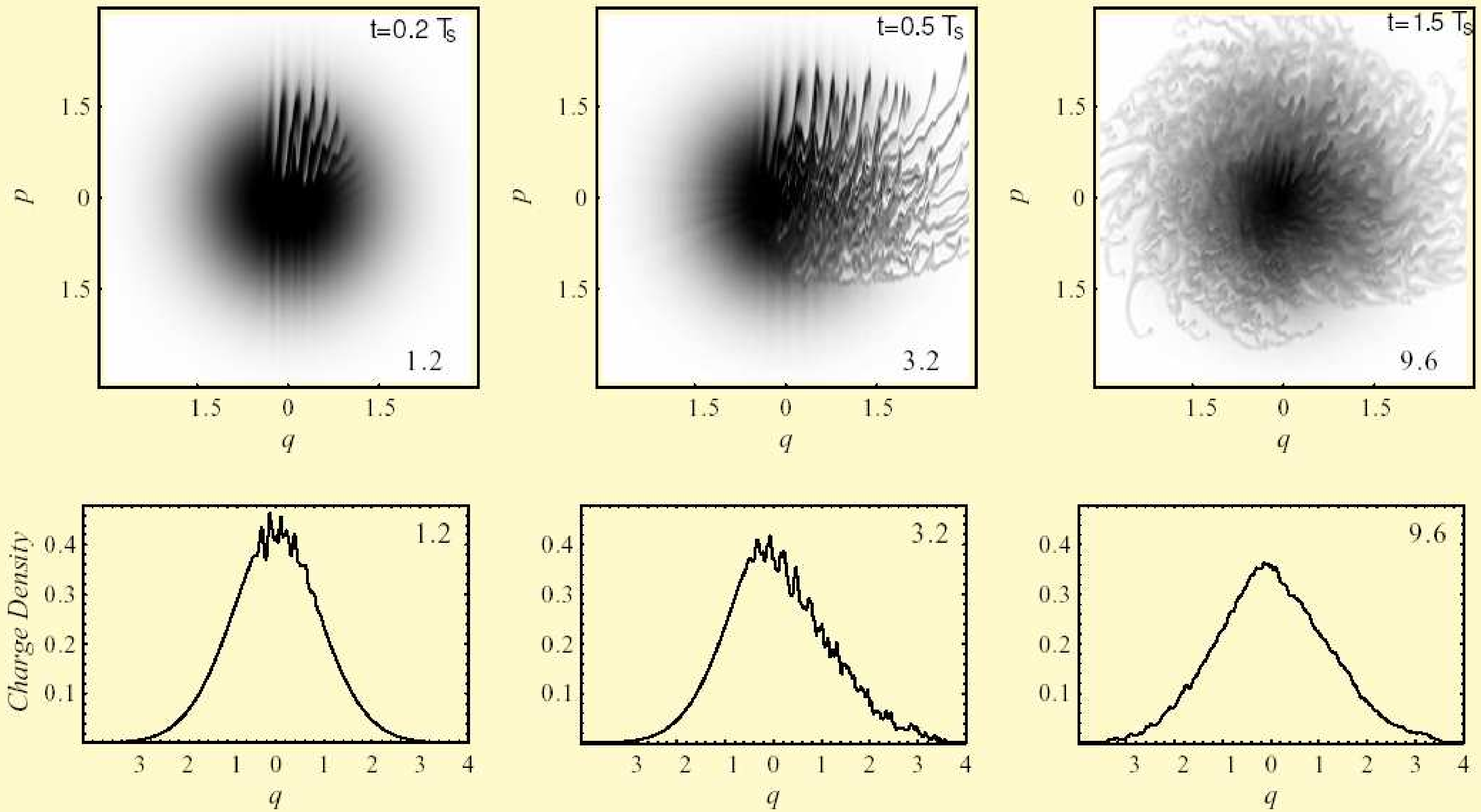


Observations



Typical bursting and non-bursting beam profiles in NSLS-VUV ring [Podobedov et al., PAC 2001]. Modulation corresponds to $f = 6 - 7$ GHz.

Nonlinear Regime—Computer Simulations



Courtesy of R. Warnock

G.Stupakov

CSR Instability in Existing Rings

Accelerator	ALS	LER PEP-II	LER PEP-IIU	LER KEKB*
E (GeV)	1.5	3.1	3.1	3.4
η	$1.41 \cdot 10^{-3}$	$1.31 \cdot 10^{-3}$	$1.0 \cdot 10^{-3}$	$1 \cdot 10^{-4}$
δ_0	$7.1 \cdot 10^{-4}$	$8.1 \cdot 10^{-4}$	$8.1 \cdot 10^{-4}$	$7 \cdot 10^{-4}$
$\langle R \rangle$ (m)	31.3	350	350	480
R (m)	4	13.7	13.7	16.3
a (cm)	2	2.5	2.5	2.5
I_b (mA)	30	2	2	1
σ_z (cm)	0.7	1.2	0.6	1
$\lambda\!\!\!^{-}_{\text{shield}}$ (cm)	0.14	0.1	0.1	0.1
$\lambda\!\!\!^{-}_{\text{th}}$ (cm)	$4.7 \cdot 10^{-3}$	1.3	0.3	0.015

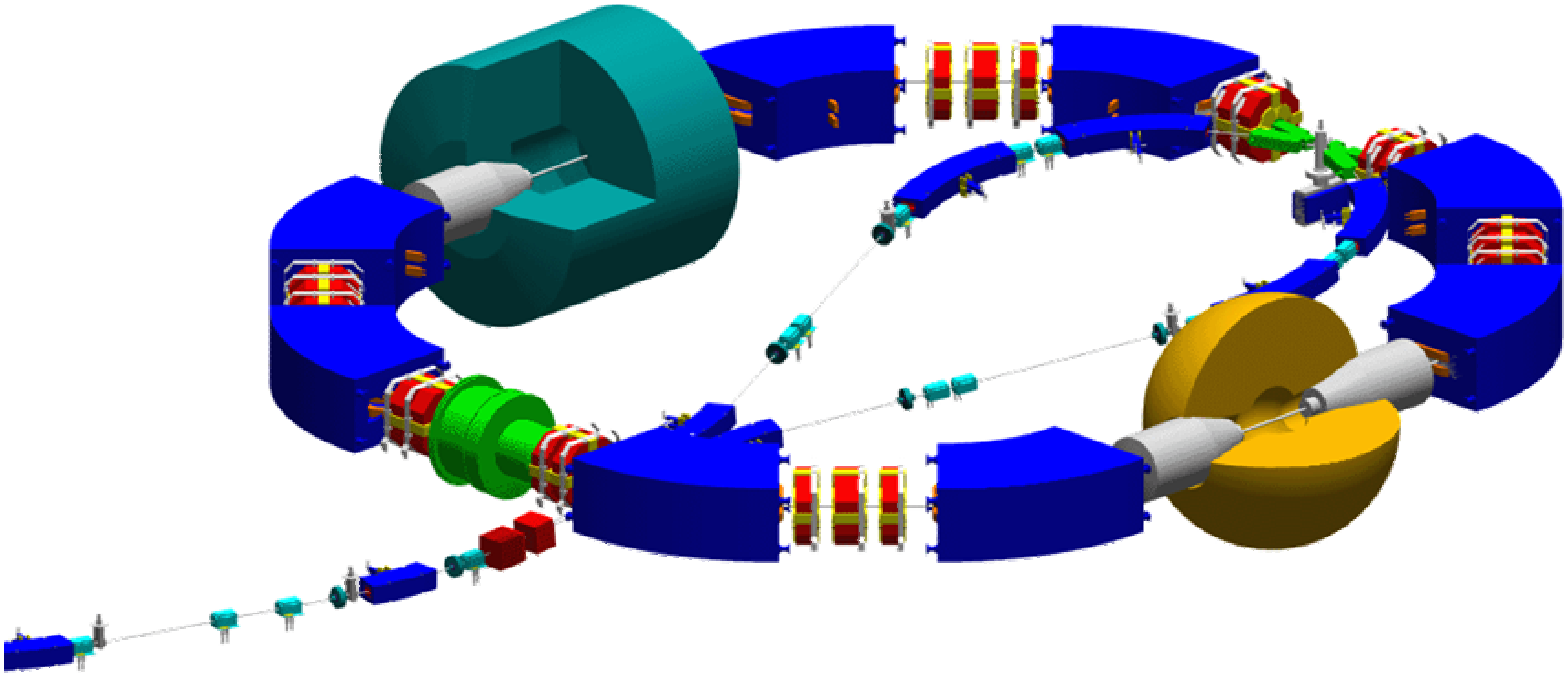
*) Parameters from K. Ohmi.

K.Ohmi

Beam-beam limit for various machine. Simulation results.

- Equilibrium distribution of two beams is estimated by PIC based quasi-strong-strong simulation.
- Beam-beam limit is function of damping time.
- The limit also depends on tune.
- The limit is 0.1 for B factories, 0.06 for τ-charm factories.
- The results are not quite stable. Need more studies.

View of the VEPP2000 Collider



A.Skrinsky

Concept of Round Beams

Conservation of the z-component of angular momentum

$$M_z = yp_x - xp_y$$

Requirements:

- ü Round cross-section of beams at IP
- ü Machine optics has rotational symmetry

4×4 transfer matrix

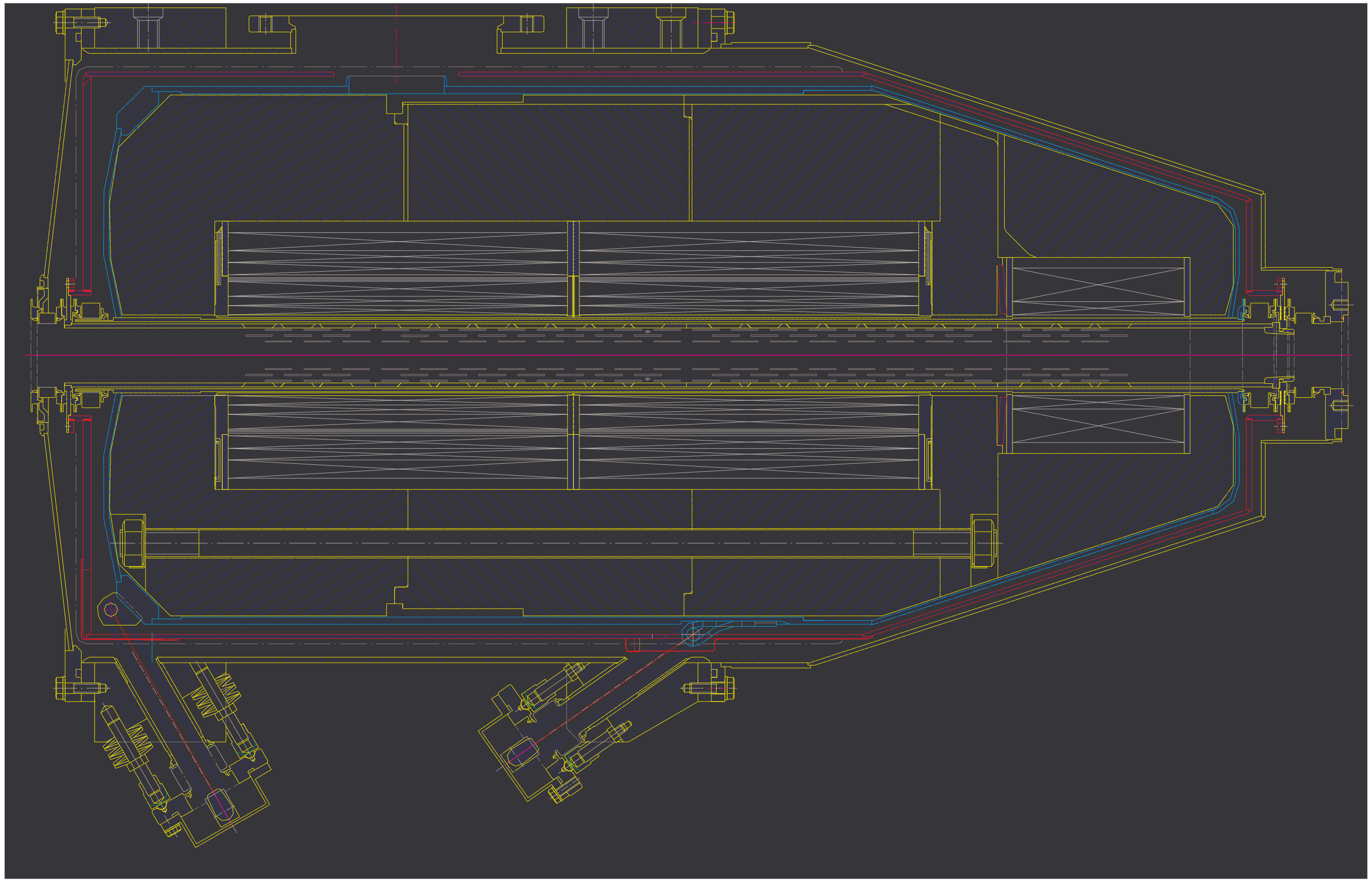
$$T = \begin{pmatrix} A & -B \\ B & A \end{pmatrix}$$

Motion in central field with additional integral of motion <u>reduces the transverse oscillations from 2D to 1D!</u>

(V.V.Danilov *et al*, Frascati Physics Series Vol. X (1998), p.321)

A.Skrinsky

Solenoid 13.0 T

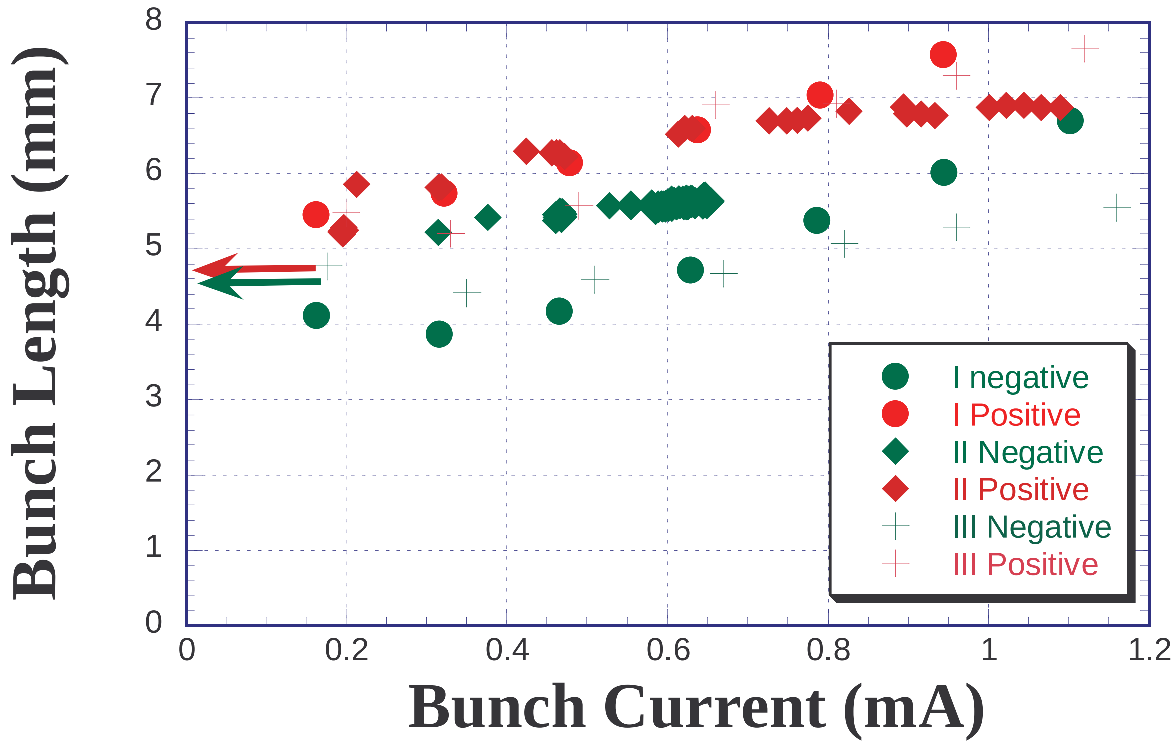


Beam Dynamics with $\alpha_c < 0$

- Bunch is shorter with a more regular shape
- Longitudinal beam-beam effects are less dangerous
- Microwave instability threshold is higher (?)
- Sextupoles can be relaxed since head-tail disappears

M. ZOBOV

Negative alfa tests at KEKB

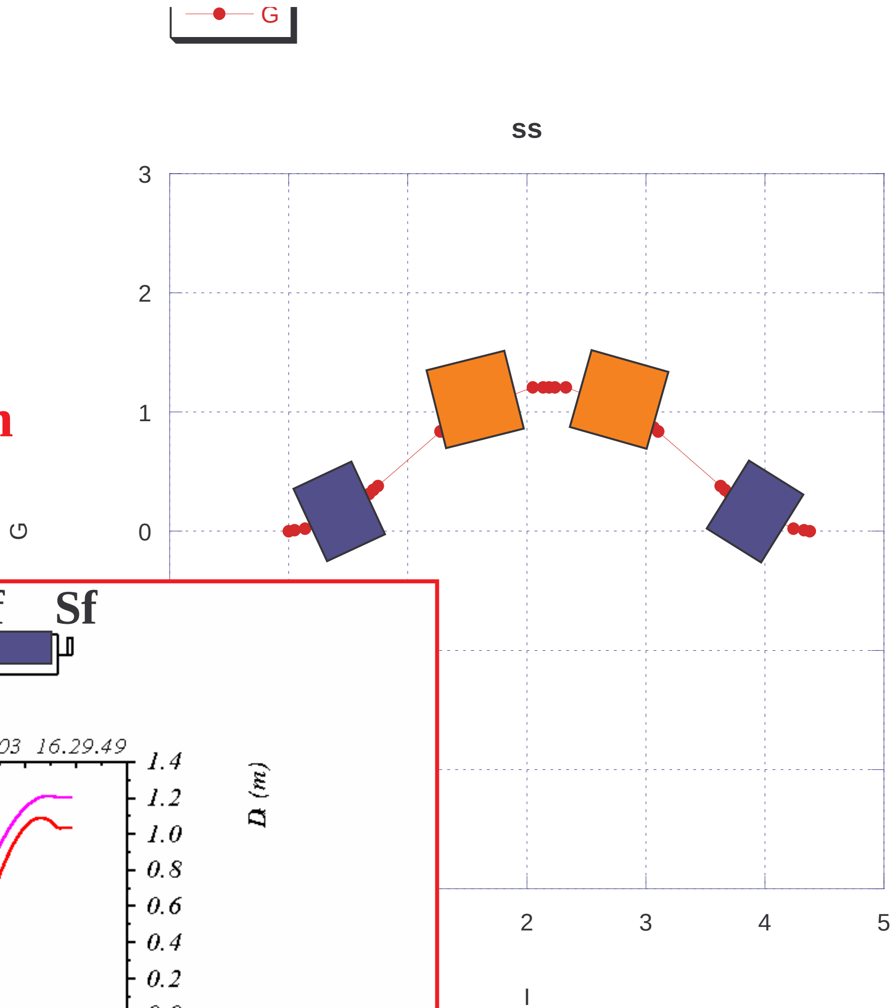


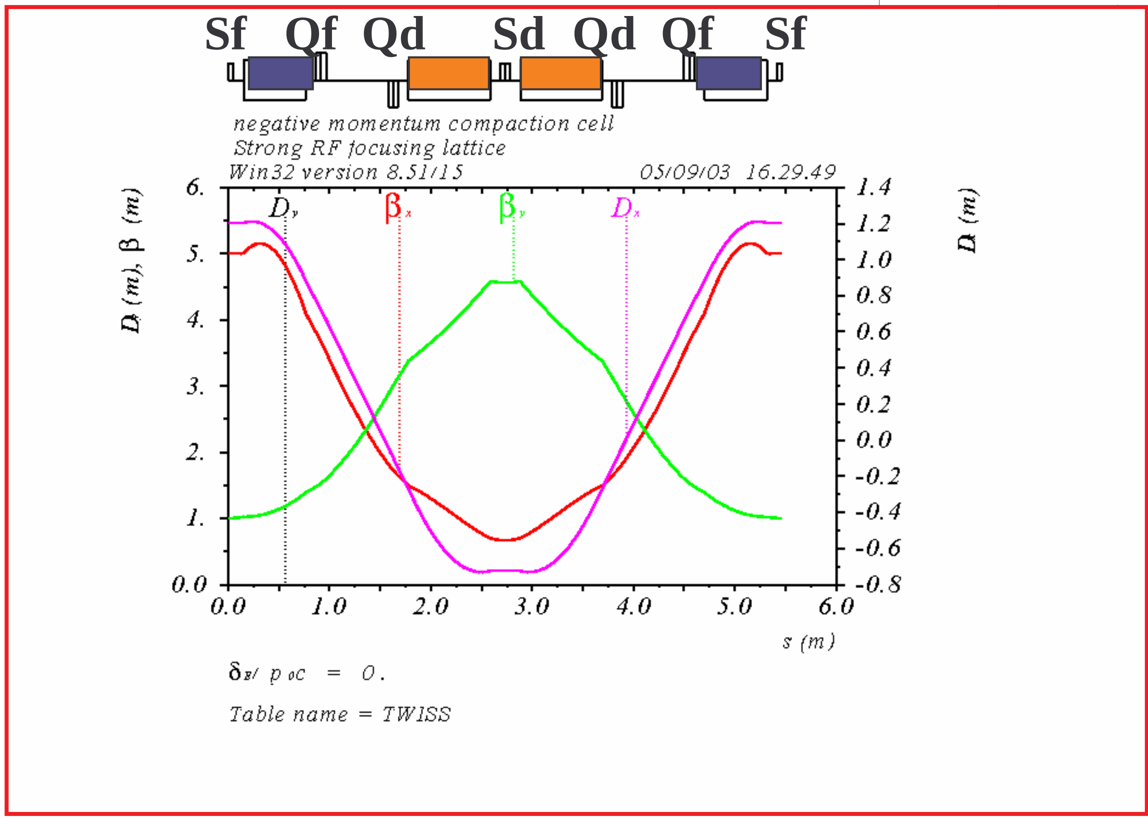
Ikeda, KEKb

HIGH and NEGATIVE MOMENTUM COMPACTION

strong RADIATION emission

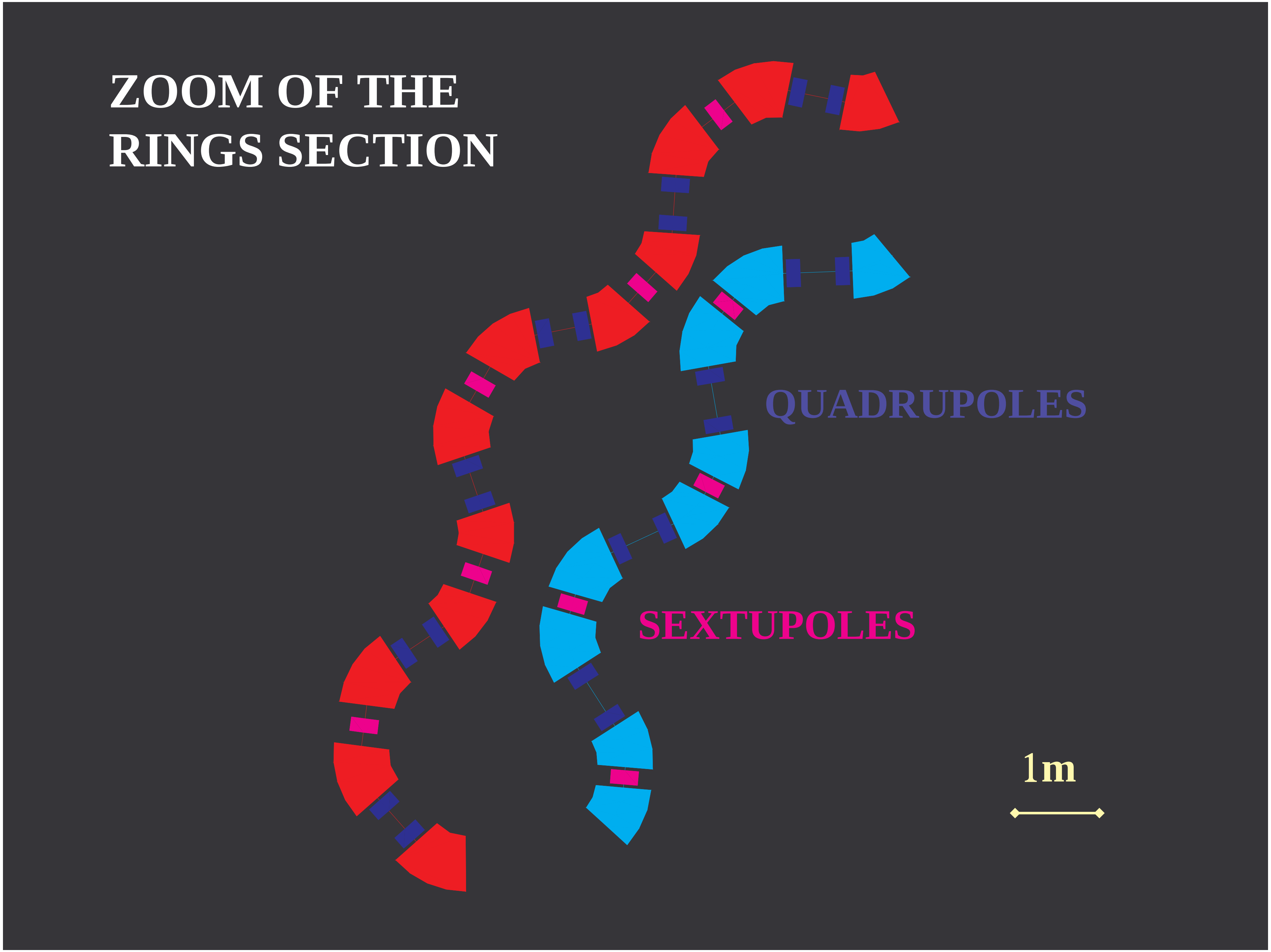
$\alpha_c = -0.171$





Alternating positive and negative bending dipoles

(proposed by Raimondi)


ZOOM OF THE
RINGS SECTION
QUADRUPOLES
SEXTUPOLES
1m

Strong RF fosucing at DAΦNE:

One IR

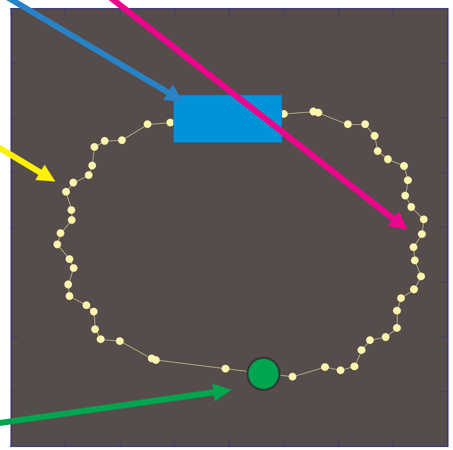
Second crossing for injection, rf, diagnostics

Short inner arc and long outer arc with the condition of equal longitudinal phase advance between cavity and IP in both directions

$$R_{56}(rf \rightarrow IP) = R_{56}(IP \rightarrow rf)$$

V_{rf}=10MV

$\nu_s \sim 0.6$



rf

A.Gallo, P.Raimondi, M.Zobov