PSB IMPEDANCES

Michel CHANEL

PSB

- 4 rings

- 50 MeV to 1.4 GeV (β= 0.31 to 0.92, γ=1.05 to 2.5)
- γ_{tr}~4...psb below transition
- Multiturn injection up to 10^{13}/ring accelerated, 1.4 10^{13} after injection
- No chromaticity compensation, remains largely negative
- ε_l=1 to 2.0 eVs(blow-up)
- $\varepsilon_{h,v}$=2.5µm/ 2$10^{12}$ at low N
- N/sqrt(εh εv)~10^{12}/µm
- Strong space charge regime

TUNE SHIFTS and SPREADS

Incoherent effects

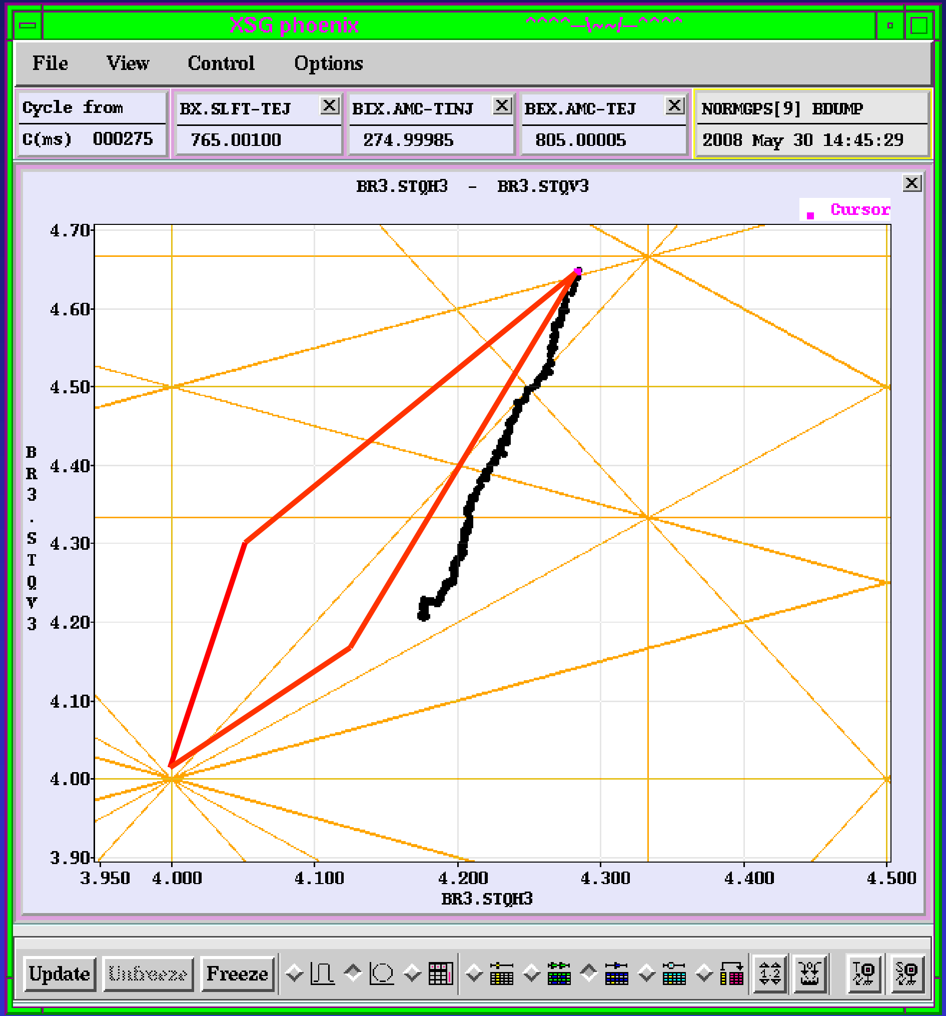
Tune shift max >0.5

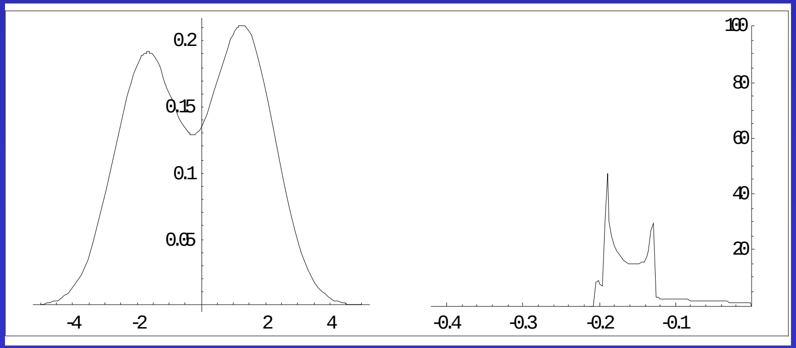
Tune spread 0.5

Coherent effects

tune shifts up to 0.15(v)

tune spreads ~0.05

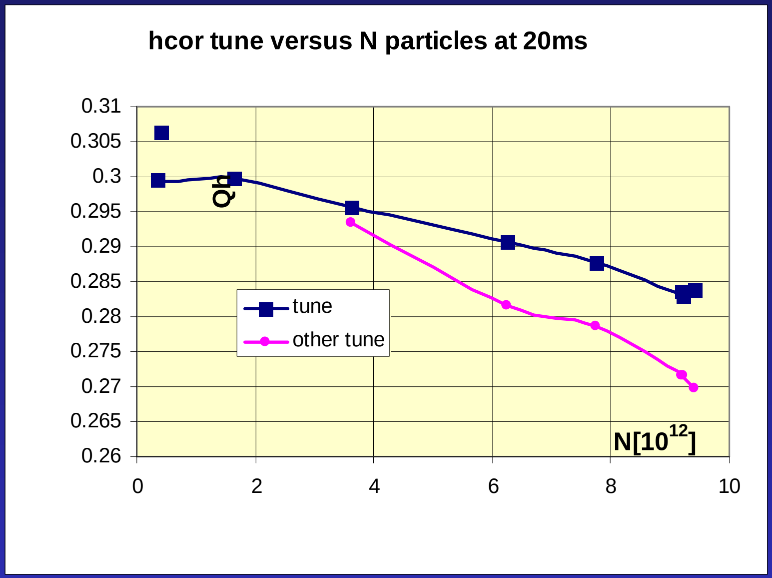


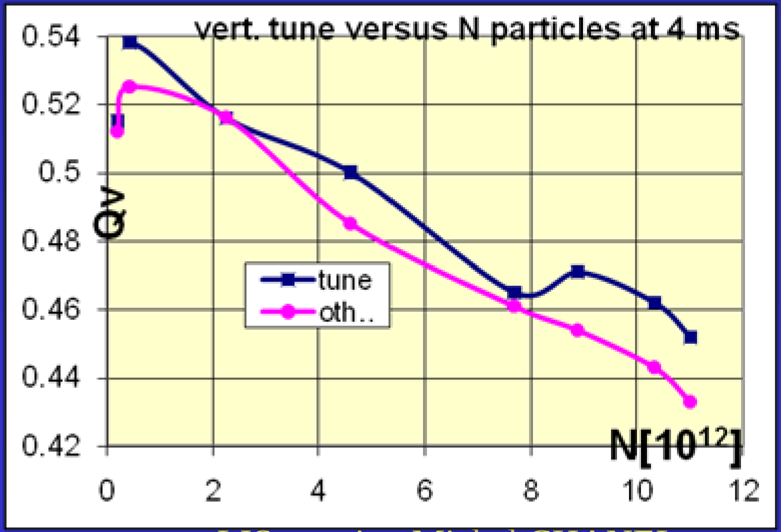


Space charge regime (low T)

Vertical coherent tune change by -0.15 with 10^{13} particles

This correspond to a vertical space impedance of 1 MΩ/m or $Z_{//}/n \sim 1k\Omega$

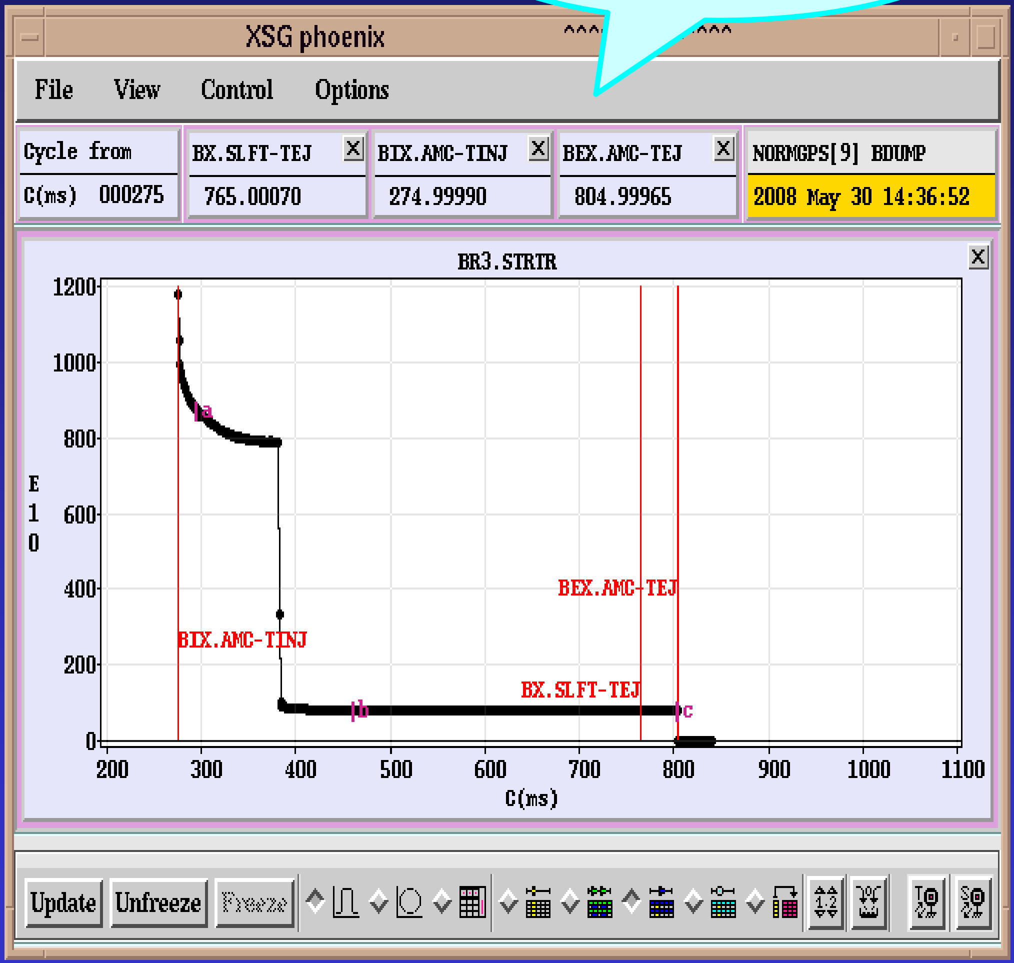




Damper

Damper off

- Only H plane used so far (v nor needed)
- Bandwith used about 13 MHz
- Used since injection at C275 but not needed before C380-430



GENERALITIES

- the vacuum pipe and its discontinuities were summarized by a broad-band impedance with magnitude, $|Z_{\parallel}/n| = 20\Omega$ at low frequencies, resonant frequency, $f_c = 1.3$ GHz and quality factor, $Q = 1$,

- the fundamental and second-harmonic RF cavities (as detuned by beam loading) were represented by two resonators with estimated values of (damped) Q and shunt resistance, R_s, of 4 and 400 Ω, respectively,

- a low-Q resonator with $f_c = 12.5$ MHz and $R_s = 30\ \Omega$ was used to describe the envelope of the rather complicated impedance structure of the ejection kicker plus its open-circuited cables (cf. the transverse impedance plotted in fig. 4).

BEAM	Injection			Mid-cycle			Flat Top		
	T [MeV]	m	τ [ms]	T [GeV]	m	τ [ms]	T [GeV]	m	τ [ms]
ISO[a] (h=5)	50	3	400	0.44	3	41	1	1	10.8
ISO	50	< 4	LD[b]	0.44	3	130	1	2	176
SFT (p) before bunch splitting	50	< 4	LD[b]	0.61	3	250	1.4	1	27
SFT (p) after bunch splitting							1.4	1	37

Table 7: Calculated growth times, τ, for single- and/or multi-bunch longitudinal instabilities in the PSB.

Kickers

The low-loss cables to be installed in 1994 within the framework of the lead ion programme will tend to reduce the above e-folding times and their impact on the stability of the five bunches will have to be studied with a more refined model.

For the h=1 RF system of the LHC era, all head-tail modes up to oscillation mode number, $m \lesssim 10$ are unconditionally stable, that is, in the absence of any damping and for the pessimistic kicker model. This may be explained by:

- the longer bunches which result in a correspondingly narrower spectrum confined to the harmless positive real part of the impedances,
- the denser spectrum (lines every revolution frequency cancel resistive wall impedances).

Some of the higher modes (checked up to $m = 33$) appear unstable but can safely be stabilized with the slightly upgraded transverse damper and are, anyway, probably Landau damped.

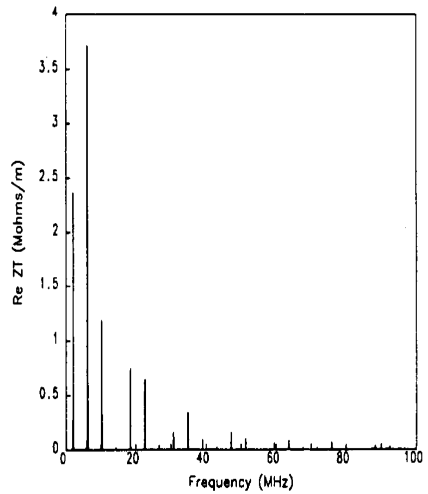
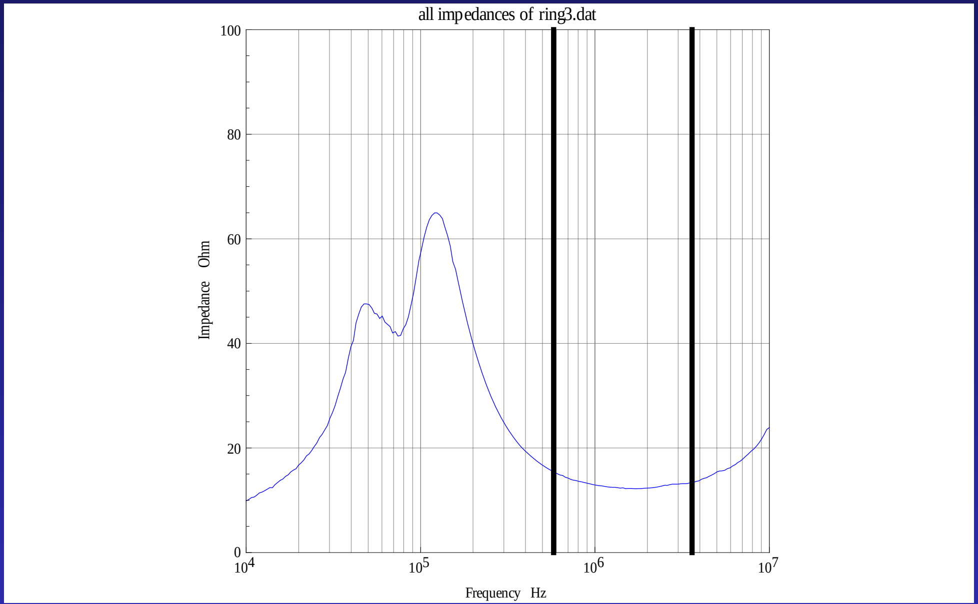
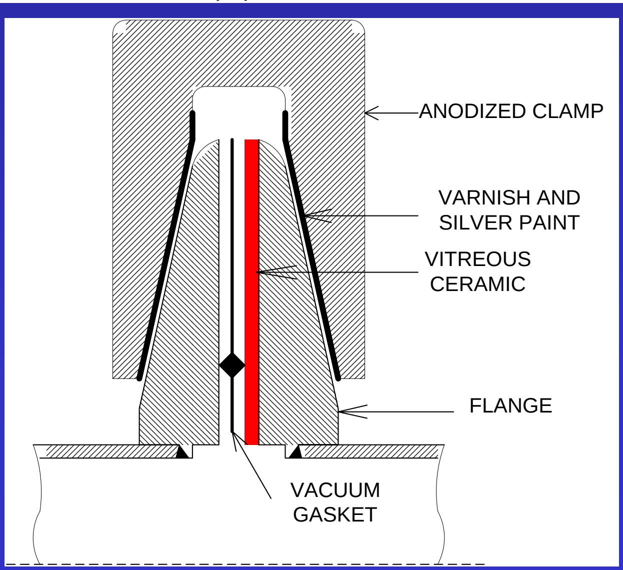


Figure 5: As fig. 4 but with the HT cable configuration of the LHC era. (Note the factor of twenty change in the vertical scale.)

Flanges

- The flanges have been renewed when RF was changed to h=1
- The impedance in the h=1 frequency range is about 17Ω for the whole ring
- http://cern.ch/AccelConf/e00/PAPERS/TUP6B06.pdf





Others cavities

- Pumping manifolds equipped with manchons to avoid resonant frequency around 1.3 GHz (dilution in longitudinal plane) Rs~10kΩ, Rs/Q~10Ω (http://cern.ch/AccelConf/pac97/papers/pdf/2V005.PDF)
- Septa equipped with pseudo vacuum chambers which insures walls continuity
- Tanks for screens or Flying wires equipped with damping ferrite blocks

REFERENCES

- Landau damping by space charge and octupoles D MOHL CERN/PS 95-08 and subsequent references
- Beams in the PS during the LHC era, CERN/PS 93-08, H Schönauer&all and subsequent references, particularly F.J. Sacherer, Transverse Bunched Beams Instabilities, CERN/PS/BR 76-21
- Different papers on different CAS (A. Hofmann-77, J.L. Laclare-92, J. Gareyte SL 91-9, F. Pedersen PS 93-36, S. Myers SL-97-48……)
- Book : A.W. Chao, Physics of collective instabilities in high energy accelerators. John Wiley&sons, 1993