- update on impedance of LHC flanges
- on broadband model for e- cloud
- news on e-cloud in DAFNE
- Chamonix-05 follow-up: draft slide on He-leak detection for S. Myers

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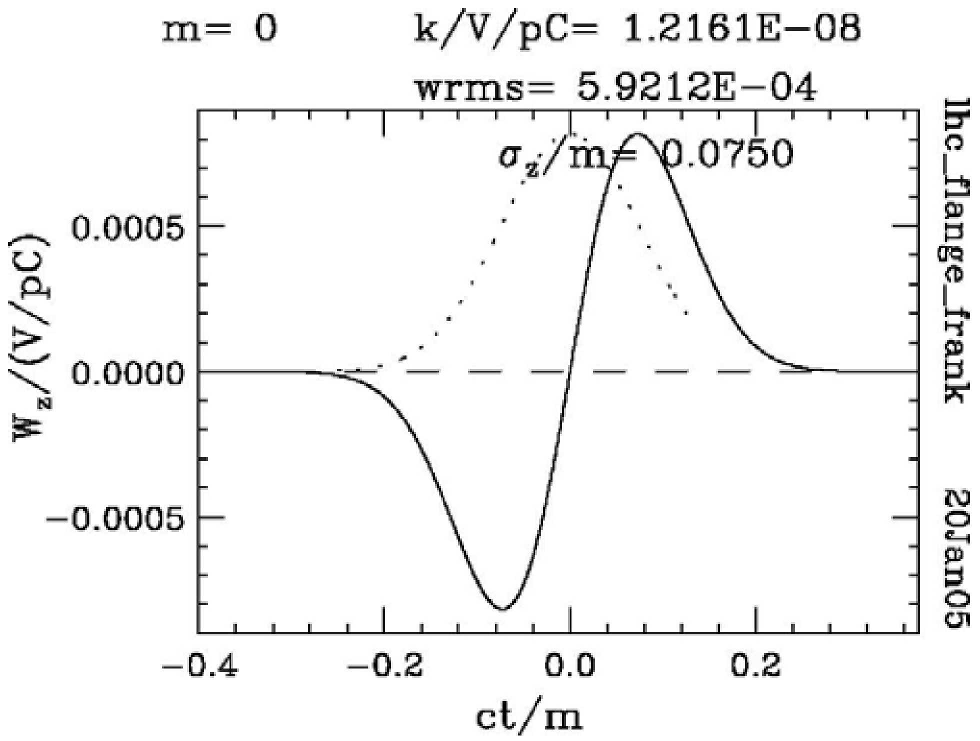
TBCI run for LHC flange by Karl Bane

taking σ_z= 7.5cm
wake is very similar to the derivative of a Gaussian, i.e. it is inductive
TBCI gets an inductance of L= 0.21 nH;
Bill Ng's formula gets 0.20 nH. Not a bad agreement!



b : original pipe radius
d: depth of the flange cavity
g: length of the flange cavity
C: ring circumference

exact formula from Bill Ng
(Fermilab-TM-1847 (1993))

$$\frac{Z}{n} = -i\frac{g}{C}Z_0 \ln\frac{b+d}{b}$$

assuming
b~3 cm, d~2 cm, g~2 mm

e.g., 2000 flanges:
-> Z/n ~ 29 mΩ

total in DR: 70-76 mΩ w/o flanges

questions sent to Miguel Jimenez on 14.01.05

- what is the total number of flanges (2000?)

- are these flanges only in the long straight sections or also in the arcs?

- is there a beam screen at the location of some or most of these flanges?

- are the chambers mostly elliptical or mostly circular?
  (and what are the most common dimensions of adjacent beam pipes?)

- what is the material of the flanges?

- what is the dark box inside the flange in your drawing (copper?)

no answer so far and not reachable by phone

E-cloud & broad-band resonator; excerpts from Francesco's email to Chamonix'05

Single-bunch effects depend critically on the electron cloud density seen by the beam and the ***challenge will be to perform beam scrubbing without exceeding a threshold value of about 4x10^{11} electrons/m^{3}***, when the single bunch instability can still be cured by a modest chromaticity Q'~2. After scrubbing the electron density is predicted to be below this threshold.

For a larger electron density of say 6x10^{11} electrons/m^{3} a much larger chromaticity Q'~30-40 is needed to cure the TMCI-like instability and, according to multi-particle simulations performed by Frank Zimmermann and Elena Benedetto with the HEAD-TAIL code, there may still be a slow emittance growth. These simulation results refer to field-free regions and include the electron-oscillation frequency variation and electron pinch along the bunch, which both have a stabilizing effect. In the LHC arcs most of the electrons are located near the two stripes away from the beam axis and the electron density seen by the beam will be lower than in field-free regions.

Predictions based on the broad-band impedance model fitted observations at the SPS and KEKB; but the adequacy of a conventional stability analysis based on this model for the LHC is under scrutiny in view of the ***much larger electron pinch effect (3.3 e- oscillations over 2 σ_z in the LHC instead of 0.78 for the SPS).*** The corresponding ***z-dependent betatron tune spread*** can be as large as ~0.1 thus providing an ***effective Landau damping*** and possibly reconciling the predictions of the conventional stability analysis by Elias Metral with the higher threshold found by HEAD-TAIL simulations.

Email from M. Zobov, on 27.01.2005:

I have read your Review in PRSTAB and your article with K. Ohmi in PRL on single bunch instabilities due to e-cloud. And I am getting more and more convinced that we have a kind of beam break up instability in DAFNE:

1) the instability rise time depends on the bunch current (not total current).

2) the instability rise time is faster than the synchrotron period.

3) the instability is very sensible to the injection conditions. We managed to store about 200 mA more in the positron beam by shortening the kicker pulse length and making better injection closed bump. The dependence on the injection errors is a typical feature of the beam break up instability.

For DAFNE suits the formula for "short" bunches, i. e. eg.11 on page 21 of your Review, last raw. According to it the rise time scales as the emittance. This is what exactly was done during the long shut down: the emittance was decreased by about a factor of 2 in order to avoid parasitic crossings and to store bunches without empty buckets. Practically, the threshold also reduced by the same factor (or only a bit higher).

Could it be a plausible explanation, in your opinion?

detection of helium leaks in the cold arcs

localized He leak causing quenches likely not visible in beam lifetime or emittance; *e.g.,* 10-m long *He* bump with local proton loss rate of 8e6/m/s (= quench limit at 7 TeV) reduces beam lifetime from 100 to 99 hr & emittance growth time at 450 GeV/c from 14.2068 hr to 14.2064 hr.

helium front propagates slowly (few cm/hr) - only after weeks or months arriving at closest pressure gauges (placed every 300-400 m); beam-loss monitoring system (every 53 m) may be unable to detect or localize leak

possible solution (proposed by A. Poncet in 1995, CERN MT/95-01 (ESH)): debunch a test proton beam at injection and measure the electron current from gas ionization; large ionization cross section (Mbarn vs. barn) yields several orders of magnitude higher sensitivity than BLM system; method was used at ISR and AA; response at remote collecting electrode is fast due to high *e*- drift velocity; *e*- *ExB* drift speed ~1 km/s for 10 mA beam current; ionization current 5 nA per meter *He* & per 10 mA beam current;
clearing voltage >> beam potential ~ 1 V at 10 mA
ionization-e^- scheme requires low-impedance clearing electrodes
(practical implementations (?): temporarily bias the BPMs? use of mobile electrode stations?, e.g., ones mountable at the pumping ports??)