e-cloud in SPS

Present situation of the development of mitigation methods

- MD 2011 results (clearing electrodes, half coated chambers, Q20/Q26)
- Carbon coating of dipoles
- Plans
Summary of previous measurements of electron cloud monitors (ECM) in SPS MD for various SEY (StSt, a-C, DLC..)
ECM for MD in 2011: two configurations in SPS

Do clearing electrodes work up to nominal B-fields?

Would it be sufficient to coat half of the pipe or insert a coated “gutter”?
At 25 ns the half coated has only 10 times lower current (500 times lower for 50 ns) than StSt, whereas a full carbon coating has at least 1000 times lower current.

Conditioning has a similar slope for both (6.5 hours, 3 batches x 72b)
Half-coated vertical: predicted effect by simulations of G. Rumolo (uncoated part $\delta_{\text{max}} = 1.8$)

The result from the MD fits with the prediction of the simulation if we assume an SEY around 1 and a reflection or a zero energy reflection above 0.5.

StSt liner extracted from SPS: 1.8 is realistic.
Clearing electrode (StSt)

From KEK (Y. Suetsugu) to CERN

2011, StSt

alumina plasma spray, to be tested in 2012
Clearing electrodes: as a function of voltage for different B fields, 25 ns

Effective suppression at all tested B fields with low voltage <100V
NB: the effect on pressure is almost invisible (the electrode is short 0.4 m) compared to the conductance of the pipe
Comparison of e-cloud in Q20/Q26 settings in e-cloud monitor

No significant difference in the measured e-cloud current between the two settings neither at 50 ns nor at 25 ns
Emittance effect on e-cloud: 50 ns, StSt ECM

Lower emittance at equal intensity leads to larger e-cloud current.
- Should we redo it by disentangling vertical and horizontal emittance effect?
Coatings of SPS dipole chambers

**MBB chambers** (disassembling/assembling the dipole-yoke):
- We have the technology to coat 7m chambers in “magnetron” (new cathode being rebuilt), 3 dipoles already in SPS since 1 year

**MBA chambers** (disassembling/assembling the dipole-yoke):
- Same technology as MBB, 1 prototype in MBA in progress (next week)

**NB:** at present we do not have a technique for magnetic measurements in coated pipes, which avoids damaging the coating!
Coatings in dipole

MBB in dipole (without disassembling):
- We have the technology to coat 7m chambers in “hollow cathode” (2 prototype tubes)

MBA in dipole (without disassembling):
- Same technology as MBB, cathode under construction (March 2012)
Direct measurement of e-cloud and pressure in dipoles

Insert a screened pick-up electrode directly in the dipole by drilling a hole in the yoke: local measurement of e-cloud and pressure

Calculations (J.Bauche) confirm that the effect of two symmetric holes on the magnetic length can be compensated by shims
Diagnostics in the lab: Multipactor in StSt dipole

RF diagnostics: reflected power

Pressure rise diagnostics: RGA signal
Planning

Plan for winter 2011-12 TS
- Insert in SPS a half cell (or part of it) with carbon coated chambers in magnetron
- Clearing electrode in alumina plasma-spray

By mid 2012
- Complete the half-cell and add a second half-cell coated in “hollow cathode”
- Equip it with more detailed pressure diagnostics
- Insert pick-up diagnostics in dipoles (1 coated + 1 uncoated)

Plan for LS1
- Insert 2 cells with coating
All this would not have been possible without the contributions of:

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…….
Measurements of currents in electron cloud monitors

B-field (0.12 T = field of SPS at injection)

Coated liner

proton beam

magnet chamber

e-cloud current
48 strips spaced 1.5 mm
Pressure calculation

Assumptions:
- only StSt dipole have dynamic outgassing
- pumping speed of ion pumps is the nominal one

Result of the analytical calculation:

The dynamic pressure rise in the coated dipoles is between 3 and 5 times lower than in StSt

We never observed this!
Pressure measurements between coated/uncoated MBB dipoles

1 and 2 batches, 25 ns, 2011

Uncoated

carbon coated
Residual gas analyser installed in SPS (MD May 2011) close to ECM

Beam on: 25 ns, 3 batches, 72 bunches, 450 GeV

Gas ratios typical for particle induced desorption: no change for water and p dominated by CO and H$_2$. (approximate calibration of RGA)