LHC Injectors Upgrade

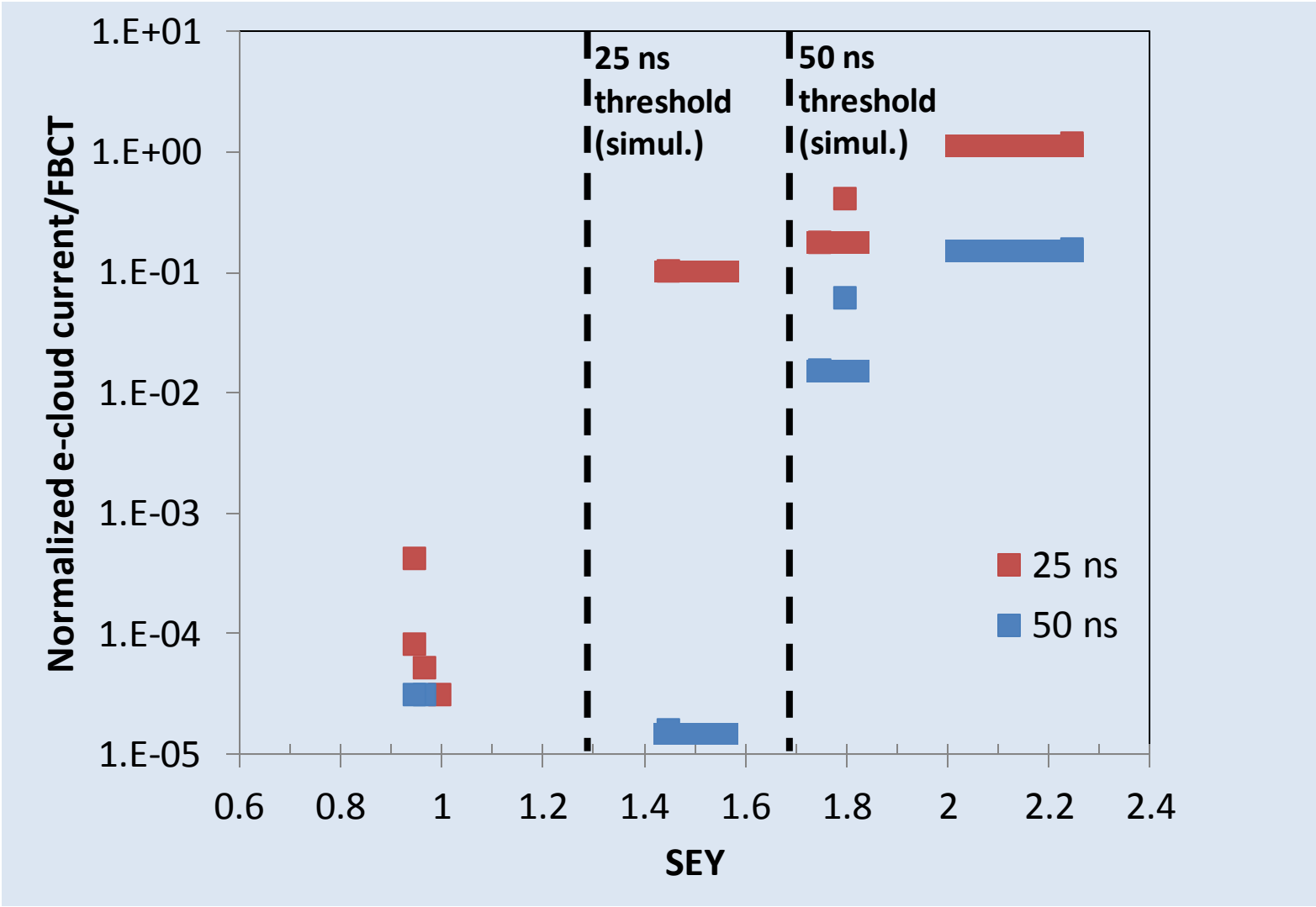
e-cloud in SPS

Present situation of the development of mitigation methods

-MD 2011 results (clearing electrodes, half coated chambers, Q20/Q26)
-Carbon coating of dipoles
-Plans

CERN

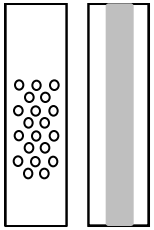
Summary of previous measurements of electron cloud monitors (ECM) in SPS MD for various SEY (StSt, a-C, DLC..)



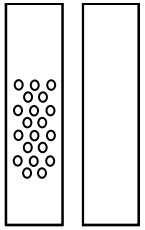
ECM for MD in 2011: two configurations in SPS

MD w19
MD w21

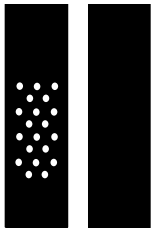
Clearing electrode (StSt)



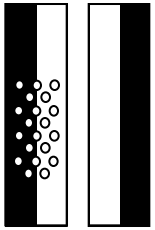
StSt8



Carbon coated 3y in SPS



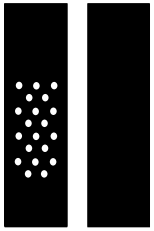
Carbon/StSt Half coated H



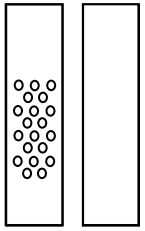
Do clearing electrodes work up to nominal B-fields ?

MD w33
MD w35

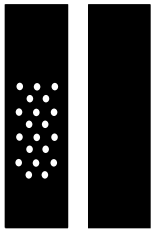
Carbon coated hollow cathode



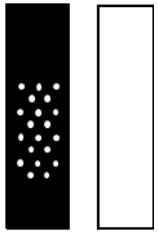
StSt 9



Carbon coated 3y in SPS

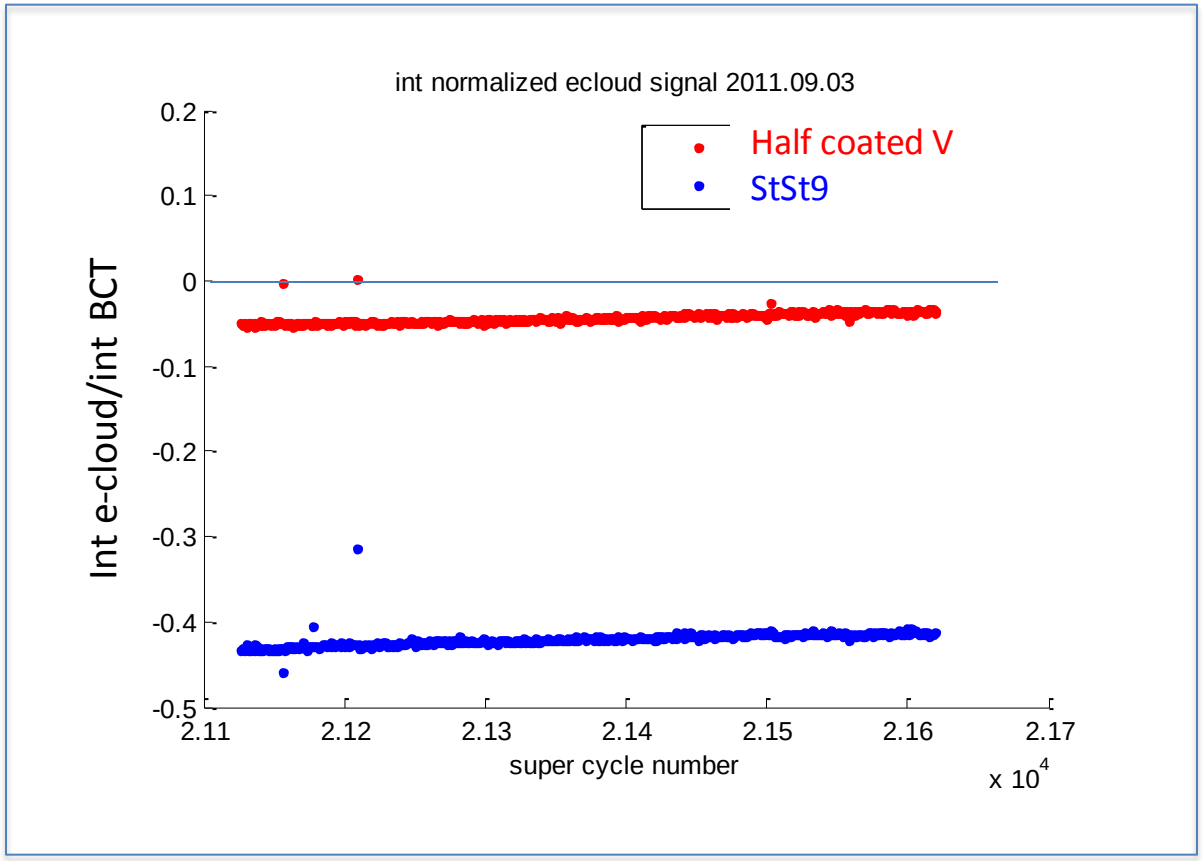


Carbon/StSt Half coated V

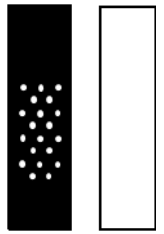


Would it be sufficient to coat half of the pipe or insert a coated “gutter” ?

25 ns, half carbon-coated vs StSt



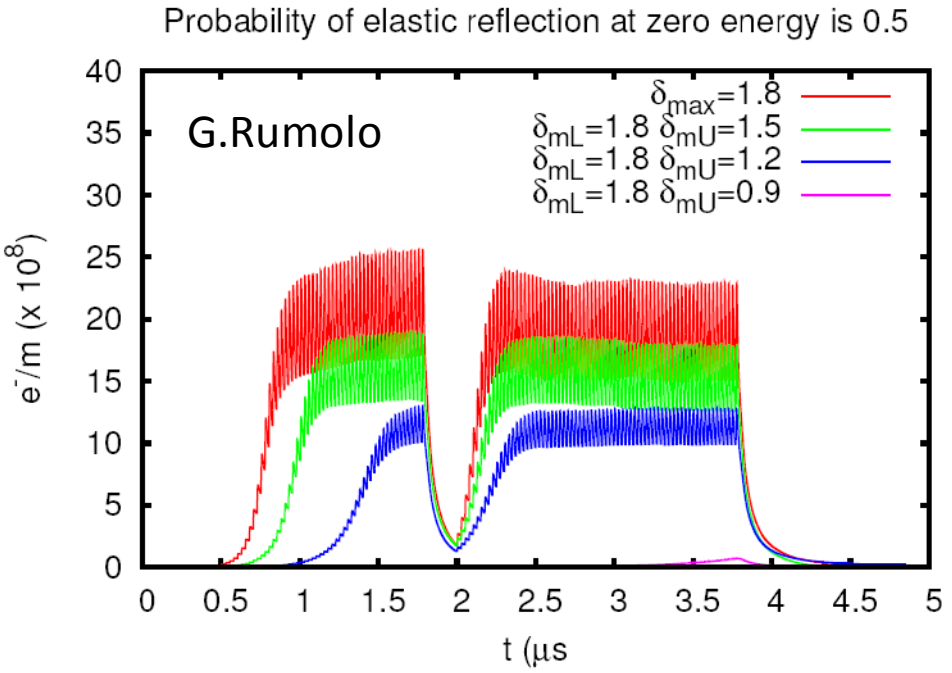
Half coated V

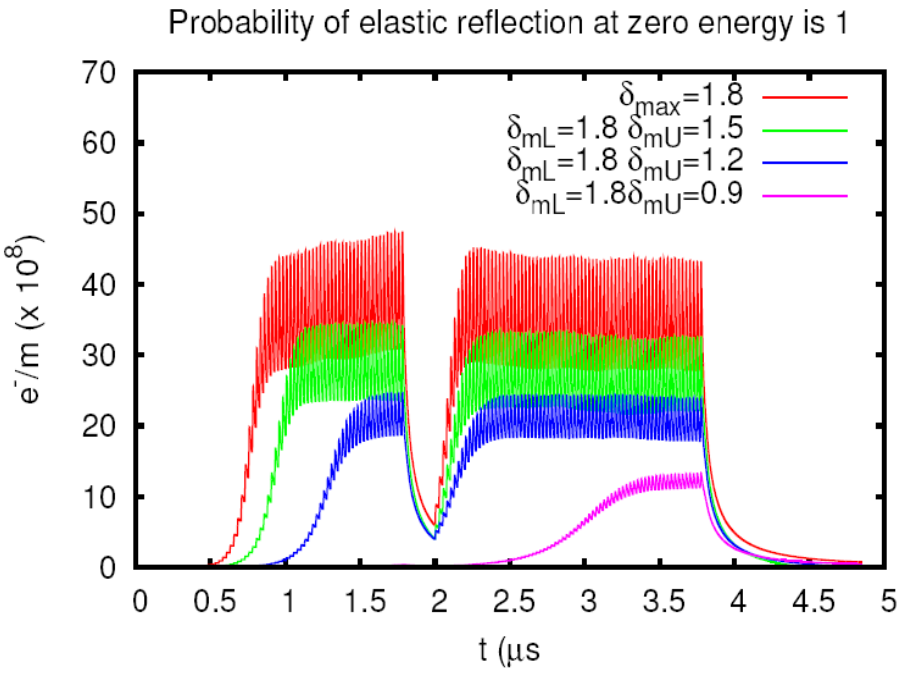


At 25 ns the half coated has only 10 times lower current (500 times lower for 50 ns) than StSt, whereas a full carbon coating has at least 1000 times lower current

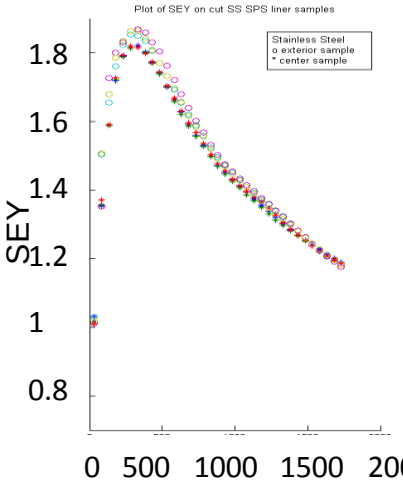
Conditioning has a similar slope for both (6.5 hours, 3 batches x 72b)

Half-coated vertical : predicted effect by simulations of G.Rumolo (uncoated part δmax=1.8)





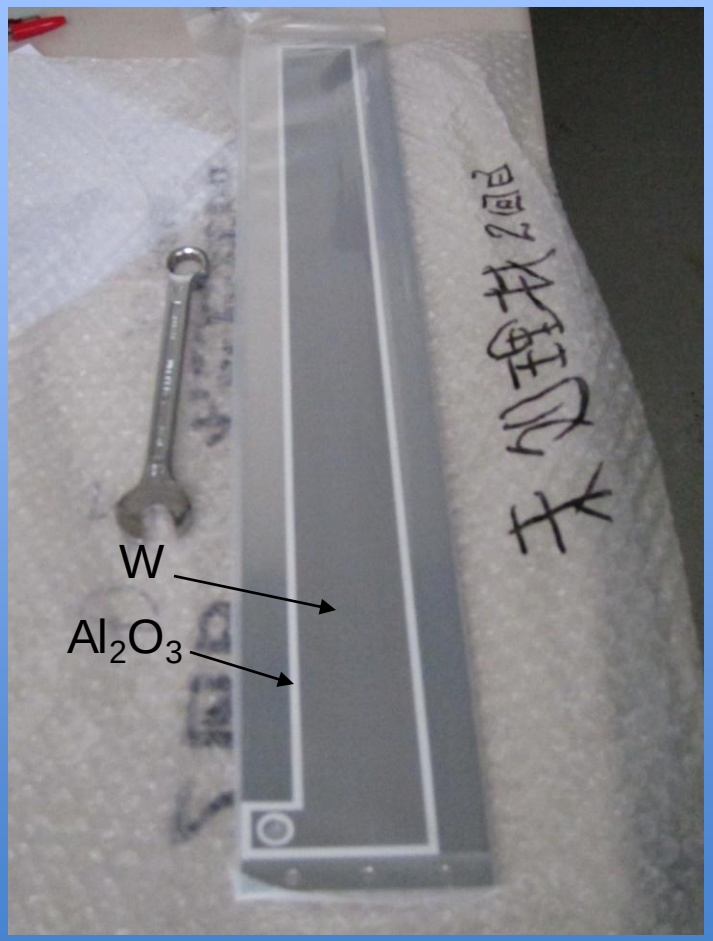
The result from the MD fits with the prediction of the simulation if we assume an SEY around 1 and a reflection or a zero energy reflection above 0.5



StSt liner extracted from SPS:
1.8 is realistic

Clearing electrode (StSt)

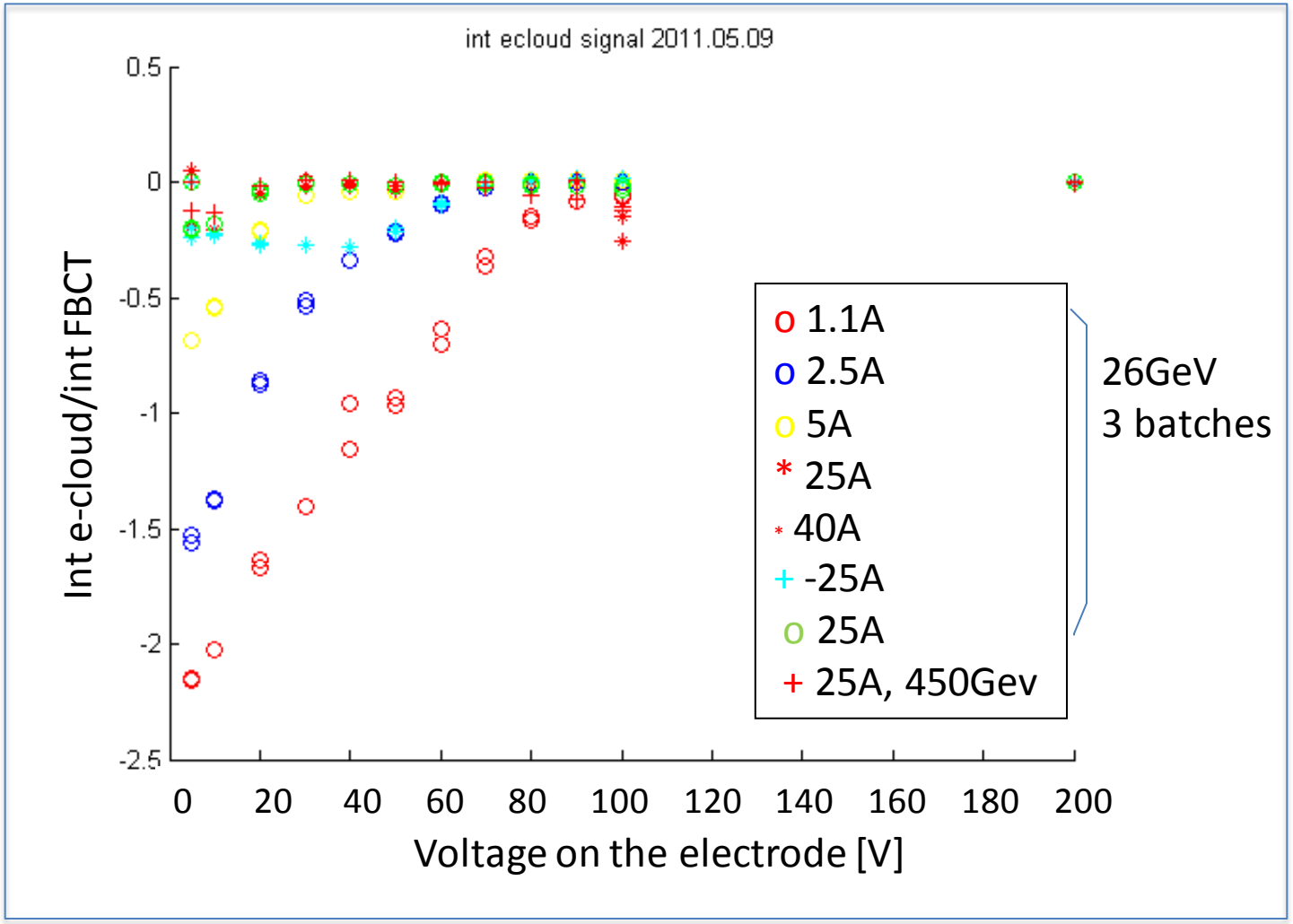
From KEK (Y. Suetsugu) to CERN



2011 , StSt

alumina plasma spray, to be tested in 2012

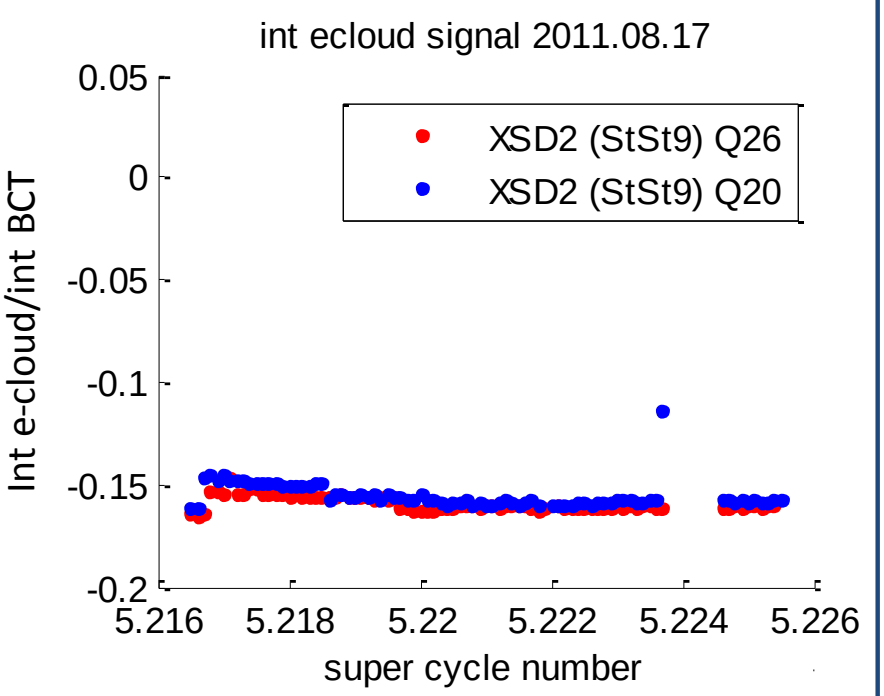
Clearing electrodes: as a function of voltage for different B fields, 25 ns



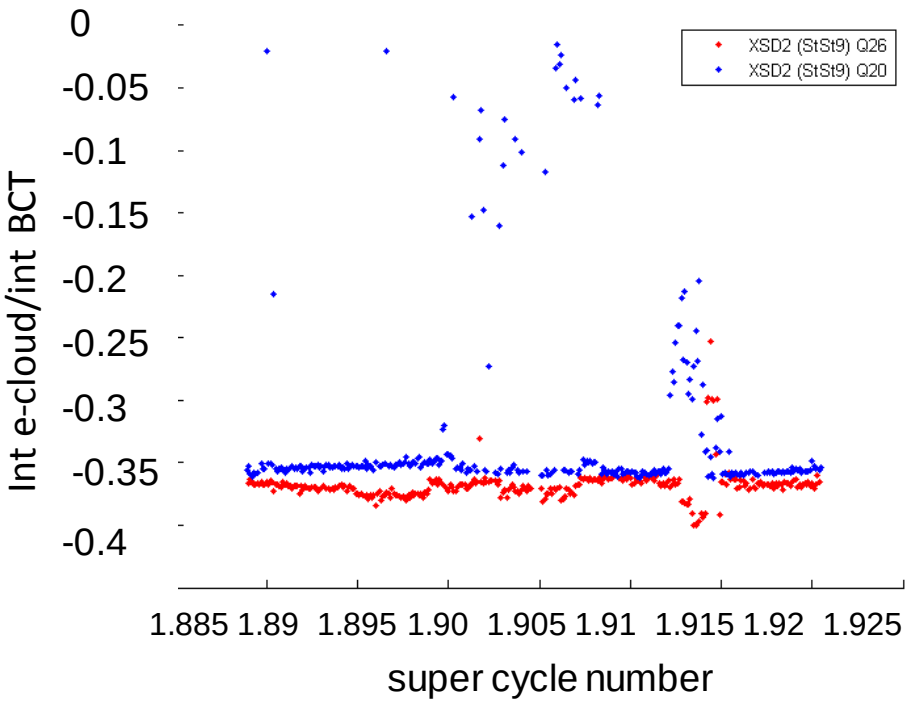
- Effective suppression at all tested B fields with low voltage <100V
- NB: the effect on pressure is almost invisible (the electrode is short 0.4 m) compared to the conductance of the pipe

Comparison of e-cloud in Q20/Q26 settings in e-cloud monitor

50 ns
3 batches Q26 + 2 batches Q20

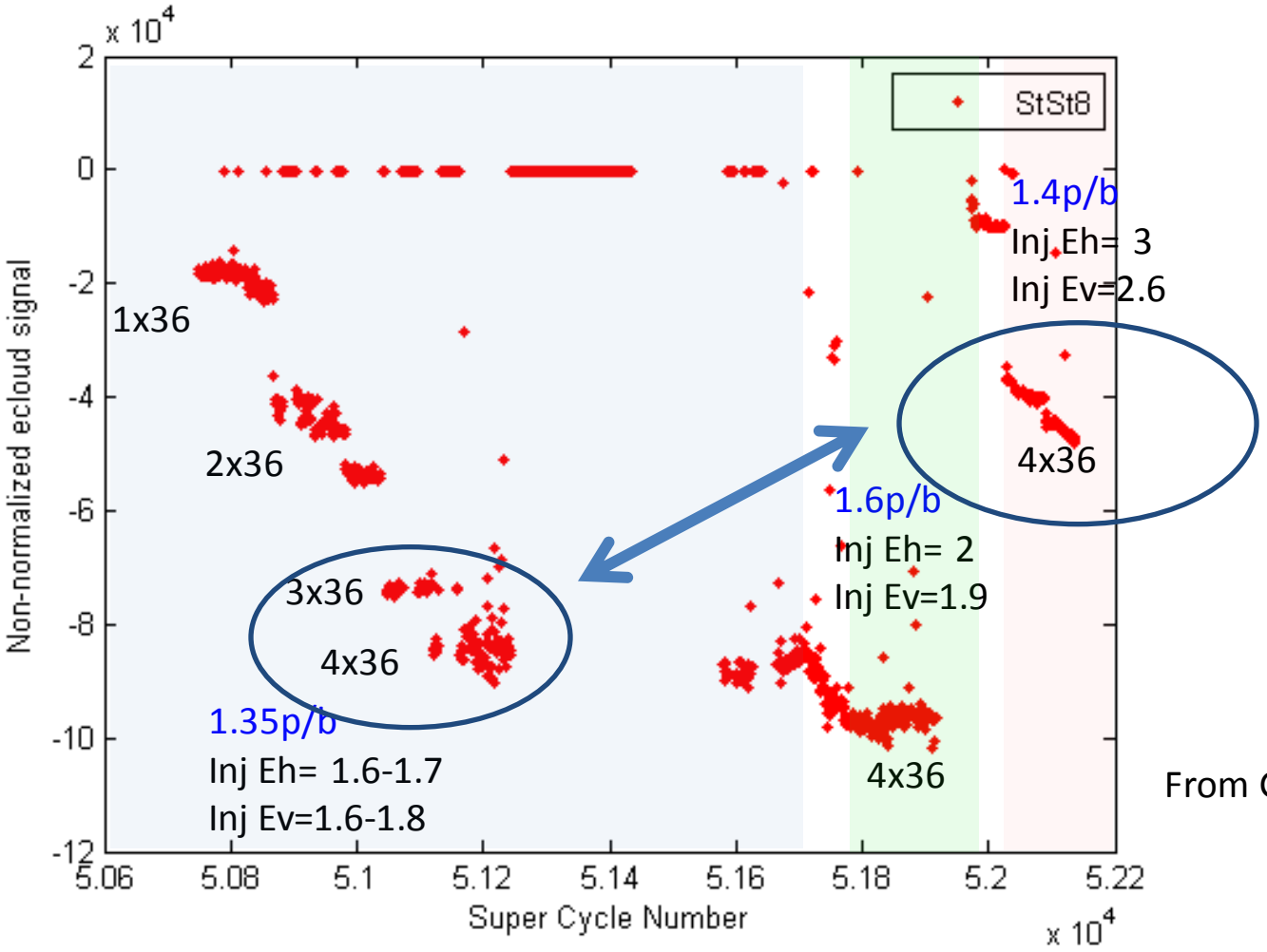


25 ns
2 batches Q26 + 2 batches Q20



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

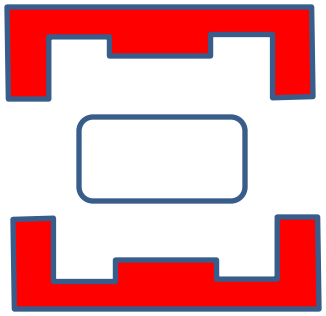


From G.Rumolo

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):

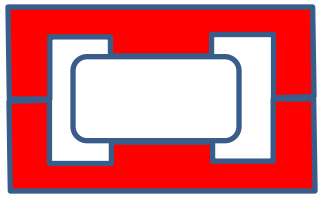
-We have the technology to coat 7m chambers in “magnetron” (new cathode being rebuilt), 3 dipoles already in SPS since 1 year

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

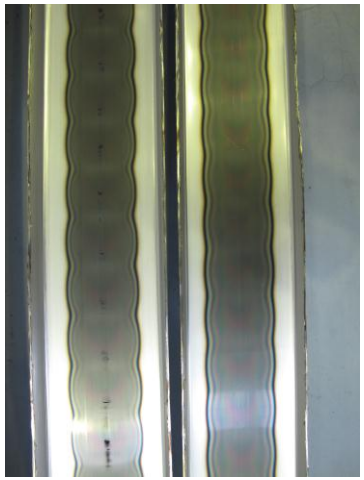


MBB in dipole (without disassembling):

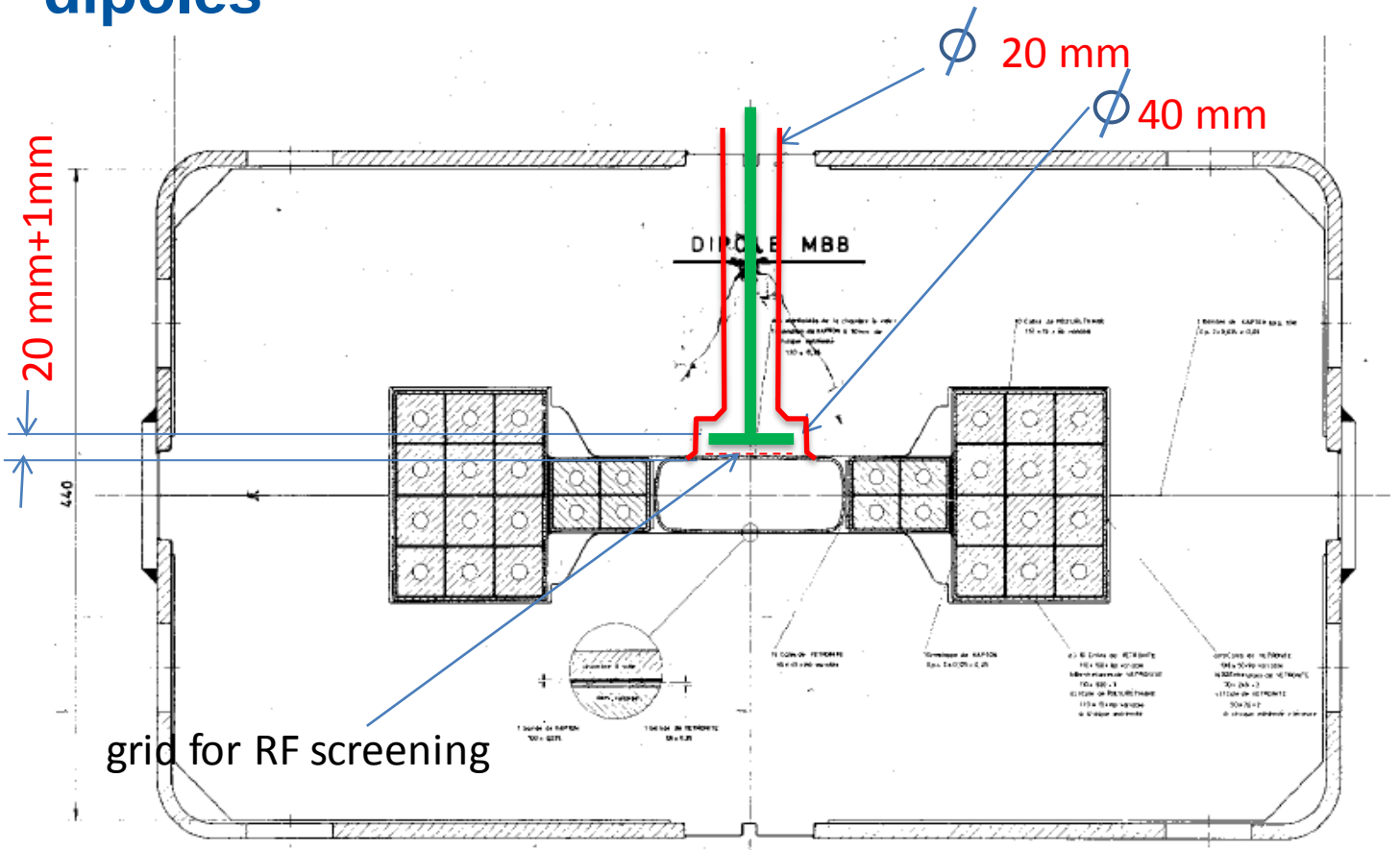
-We have the technology to coat 7m chambers in “hollow cathode” (2 prototype tubes)

MBA in dipole (without disassembling):

-Same technology as MBB, cathode under construction (March 2012)



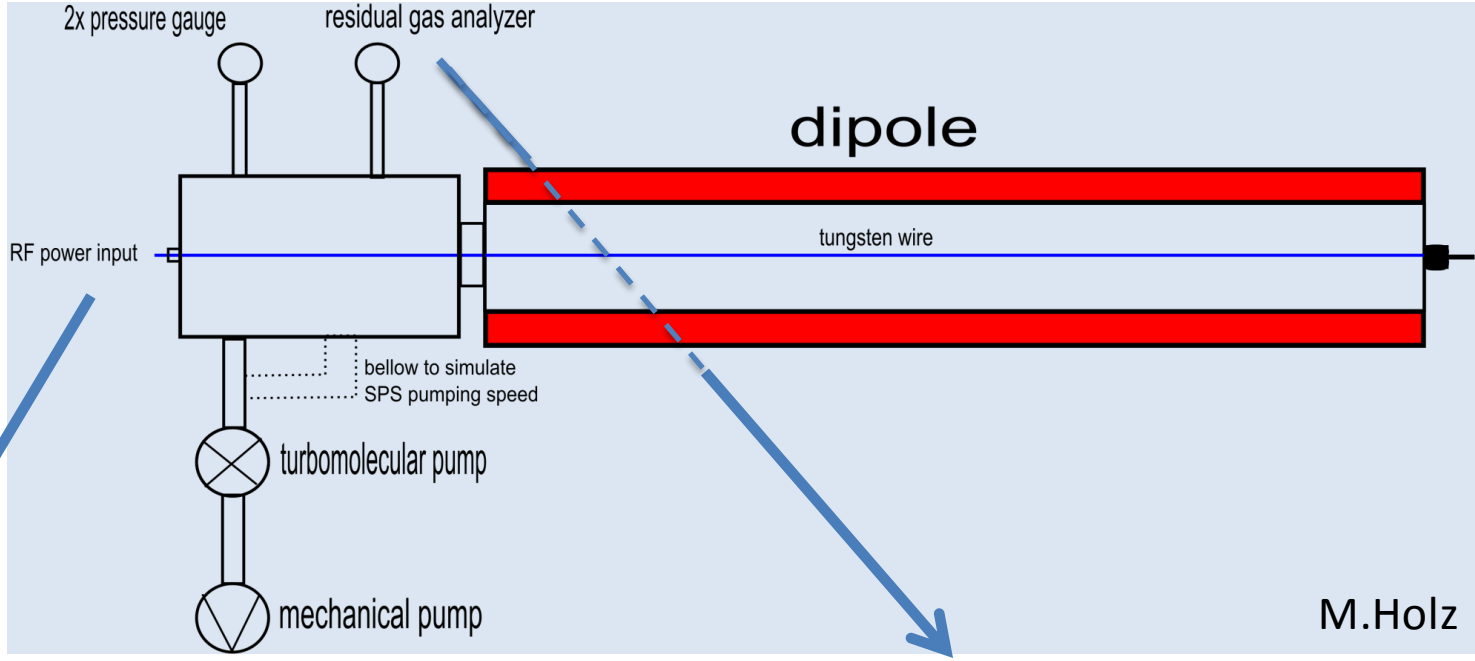
Direct measurement of e-cloud and pressure in dipoles



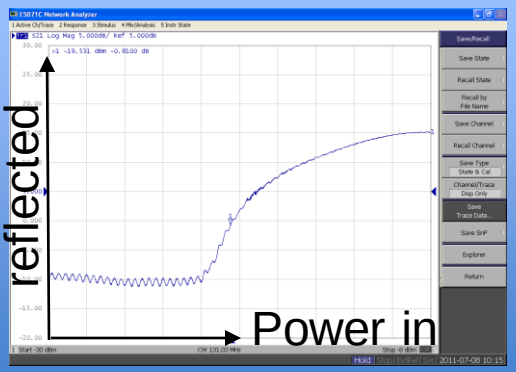
Insert a screened pick-up electrode directly in the dipole by drilling a hole in the yoke: local measurement of e-cloud and pressure

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

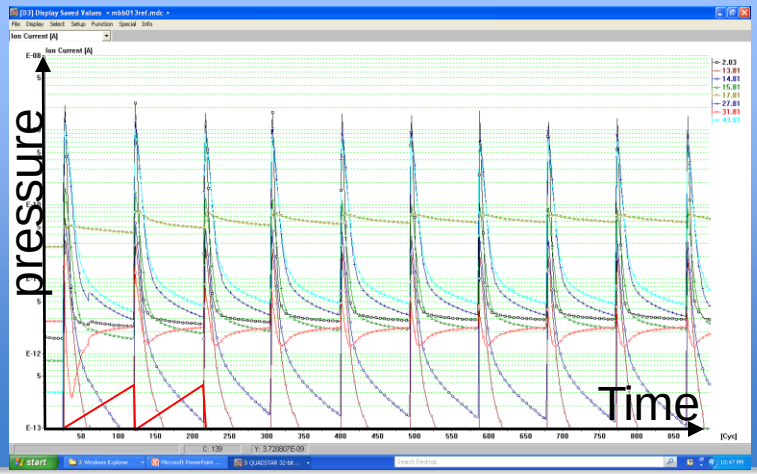


RF diagnostics: reflected power



M.Holz

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)

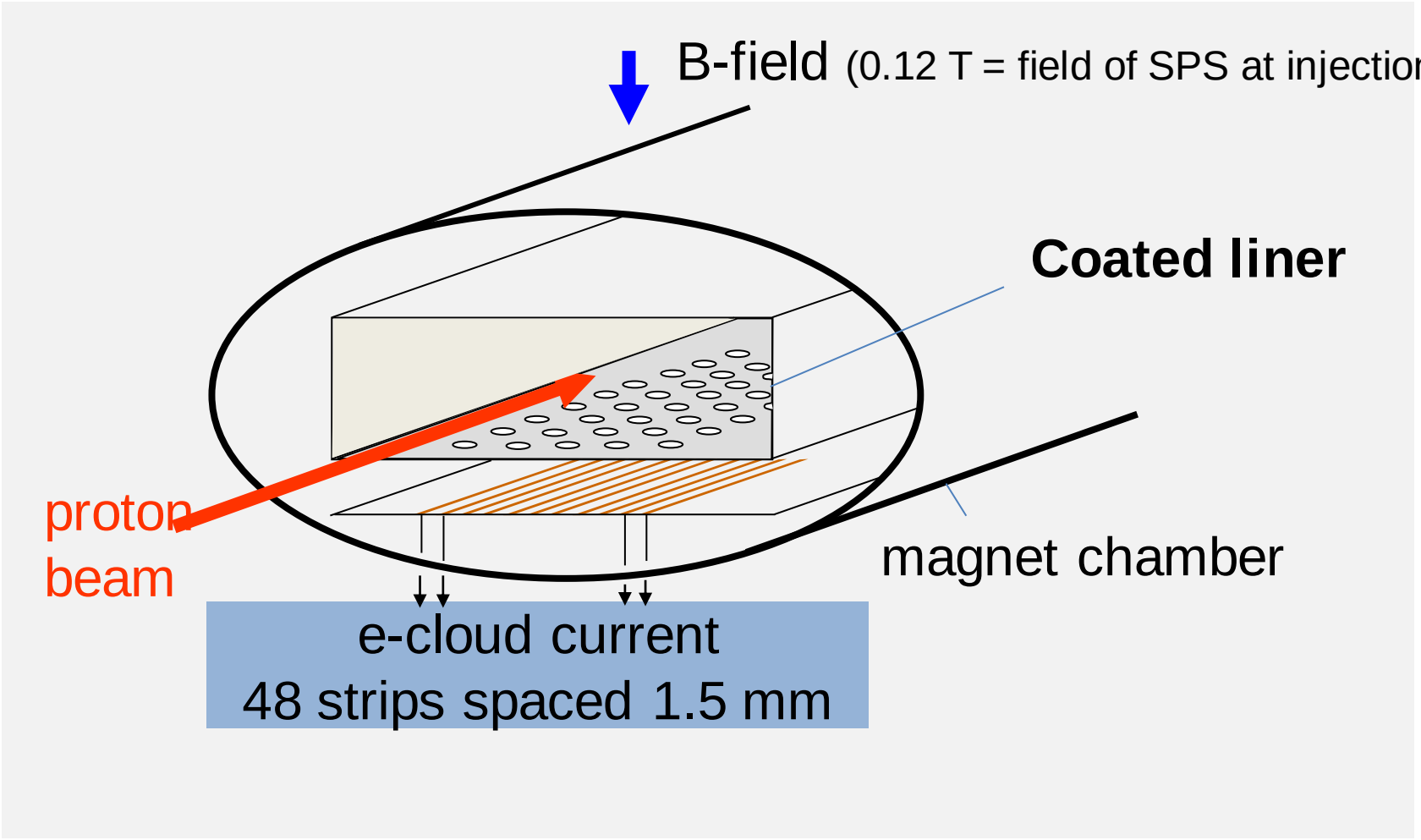
Plan for LS1

- Insert 2 cells with coating

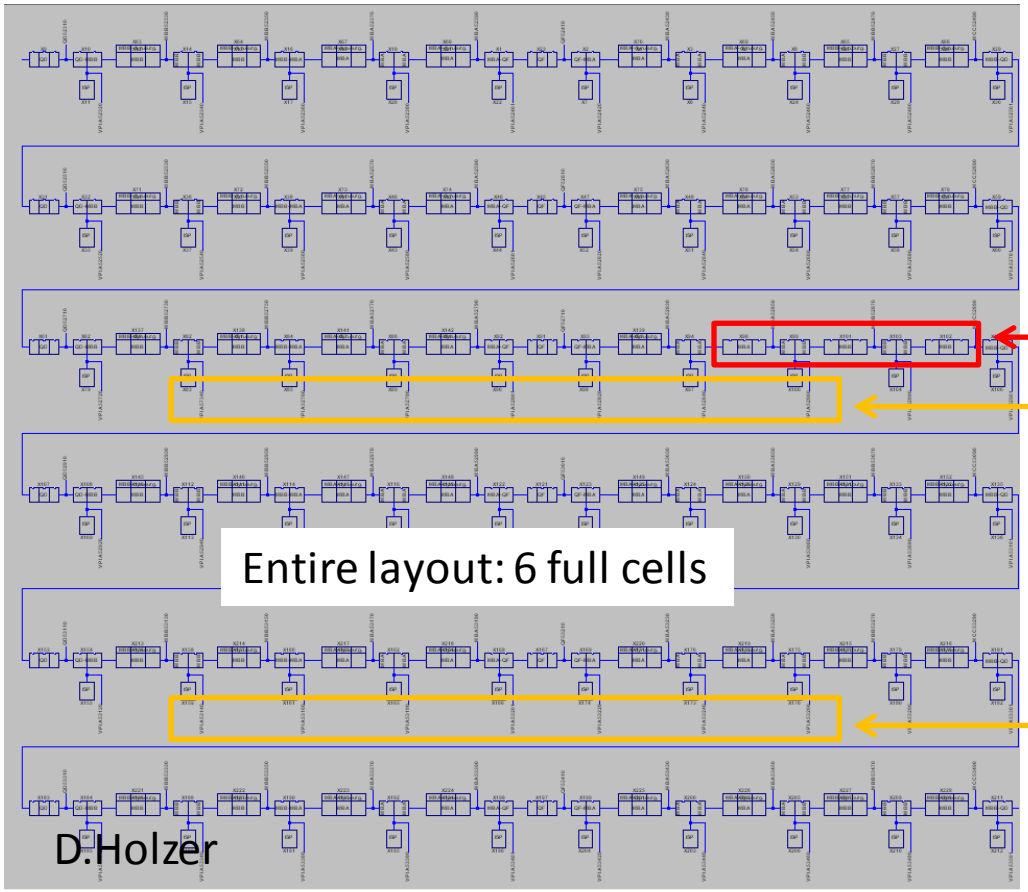
All this would not have been possible without the contributions of :

J.Bauche
P.Costa Pinto,
F.Caspers,
P.Edwards,
M.Holz,
D.Holzer,
M.Jimenez,
L.Leggiero,
M.Mensi,
H.Neupert,
G.Rumolo,
E.Shaposhnikova,
C.Yin-Vallgren
…….

Measurements of currents in electron cloud monitors



Pressure calculation



Coated dipoles without dyn. outgassing

Measured p

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

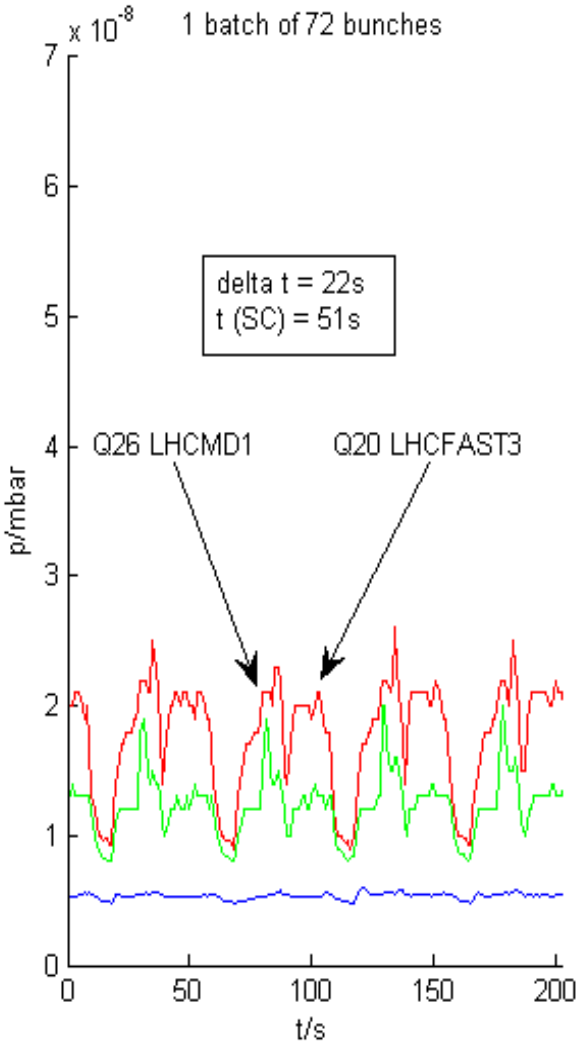
Result of the analytical calculation:

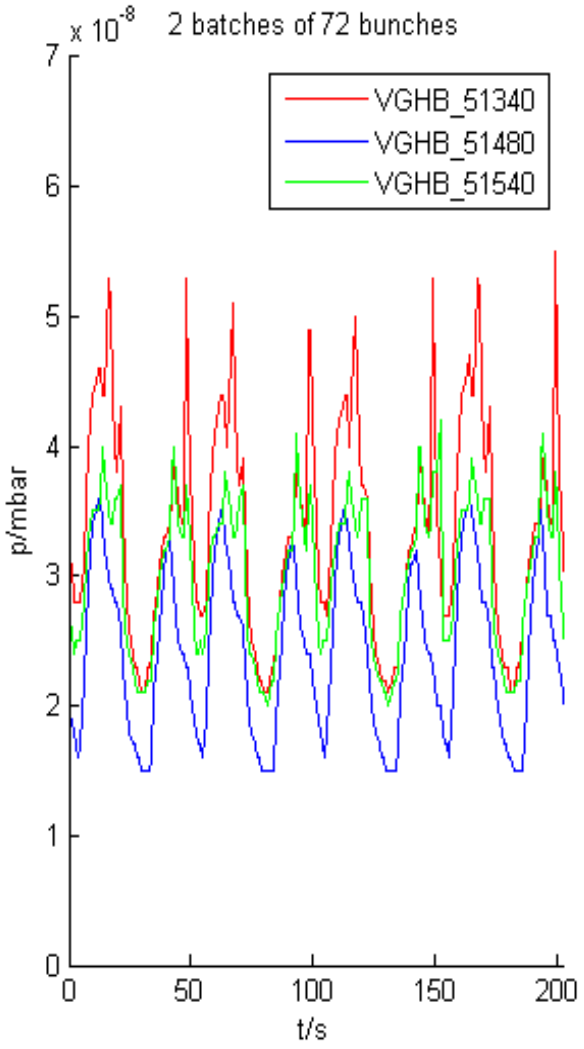
The dynamic pressure rise in the coated dipoles is between 3 and 5 times lower than in StSt

We never observed this!

Pressure measurements between coated/uncoated MBB dipoles

1 and 2 batches, 25 ns, 2011

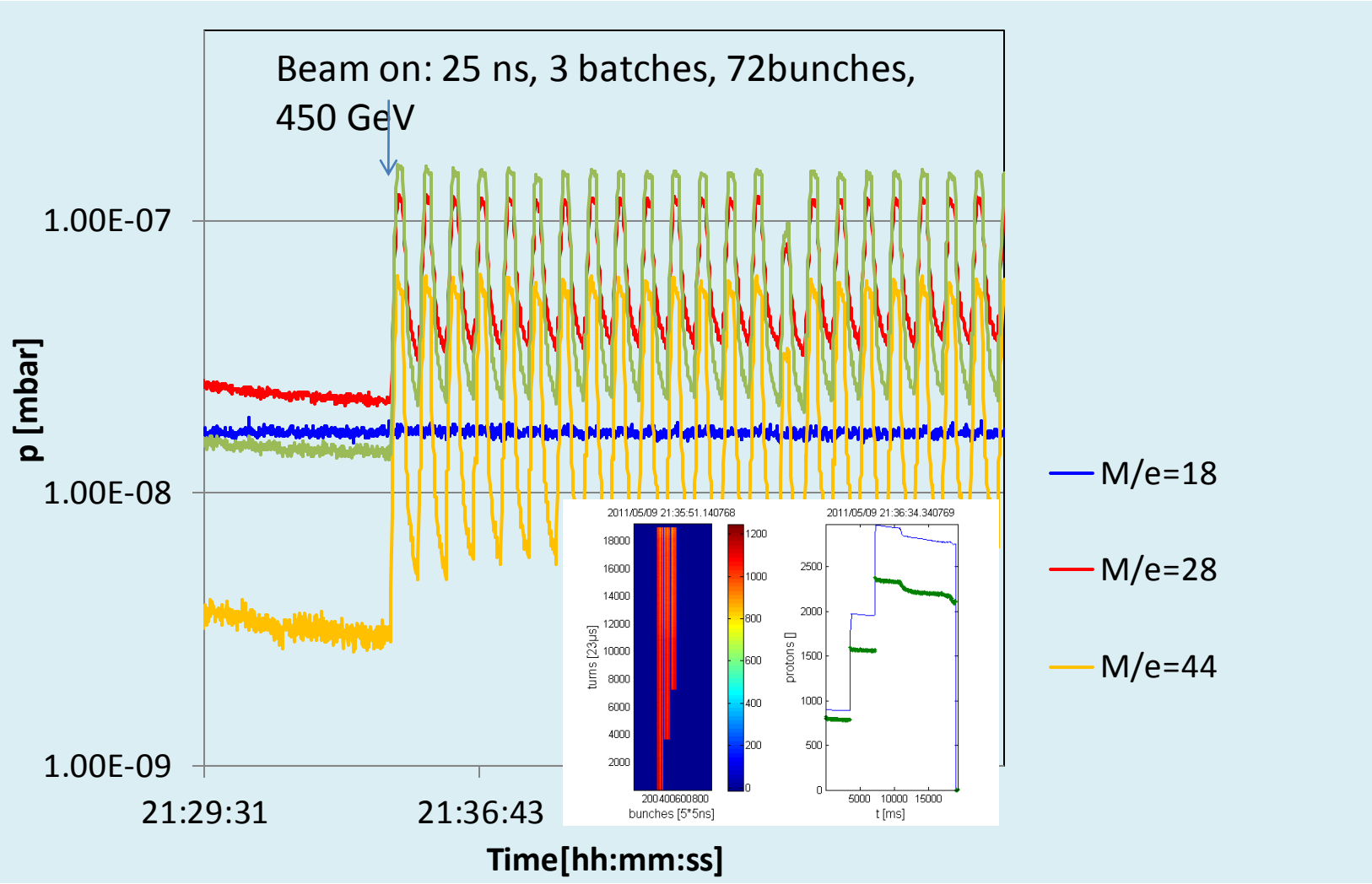




Uncoated

carbon coated

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



Gas ratios typical for particle induced desorption: no change for water and p dominated by CO and H_2. (approximate calibration of RGA)