

Bethe's Ionization Cross Section for CERN Accelerators & PS e-Cloud Simulations

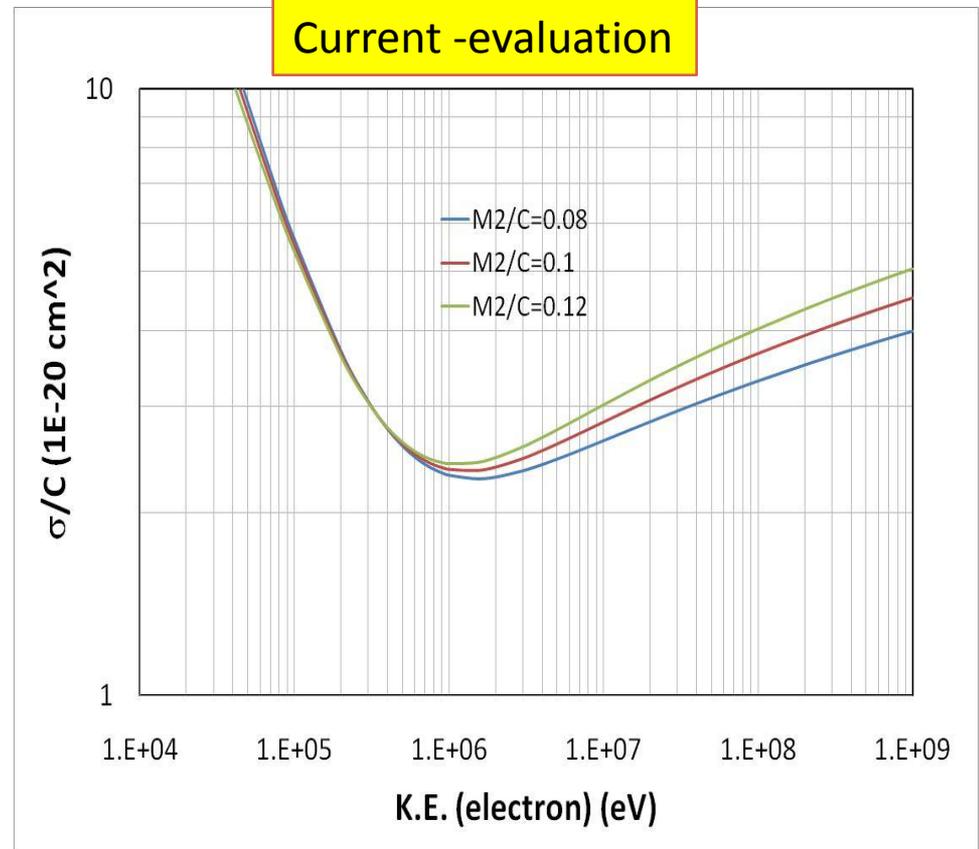
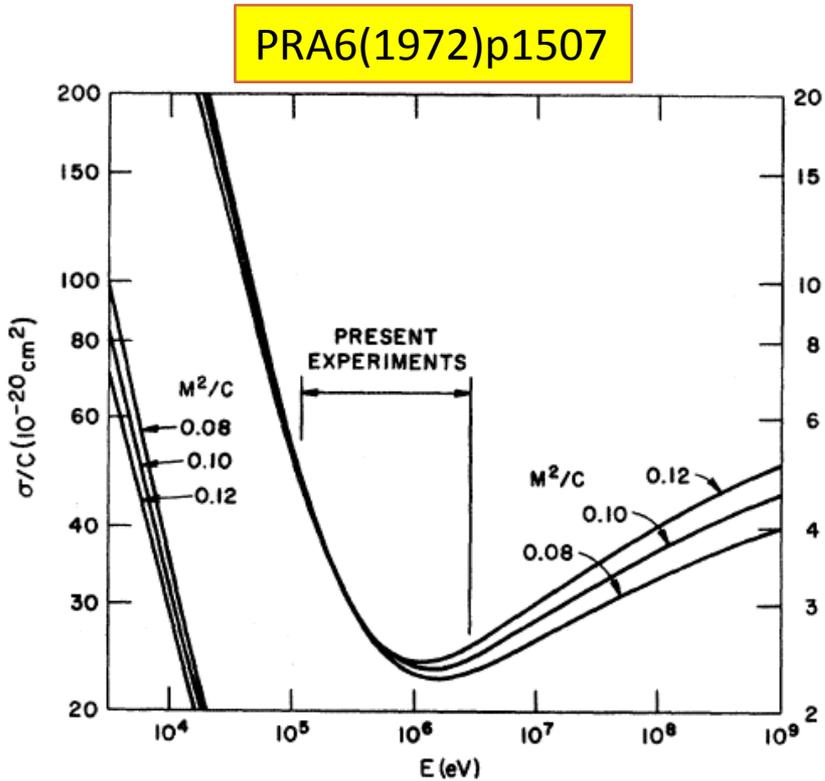
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H. Maury Cuna, H. Damerau, S. Hancock, E. Mahner,
F. Caspers and F. Zimmermann

e-cloud simulation meeting

June 27, 2011

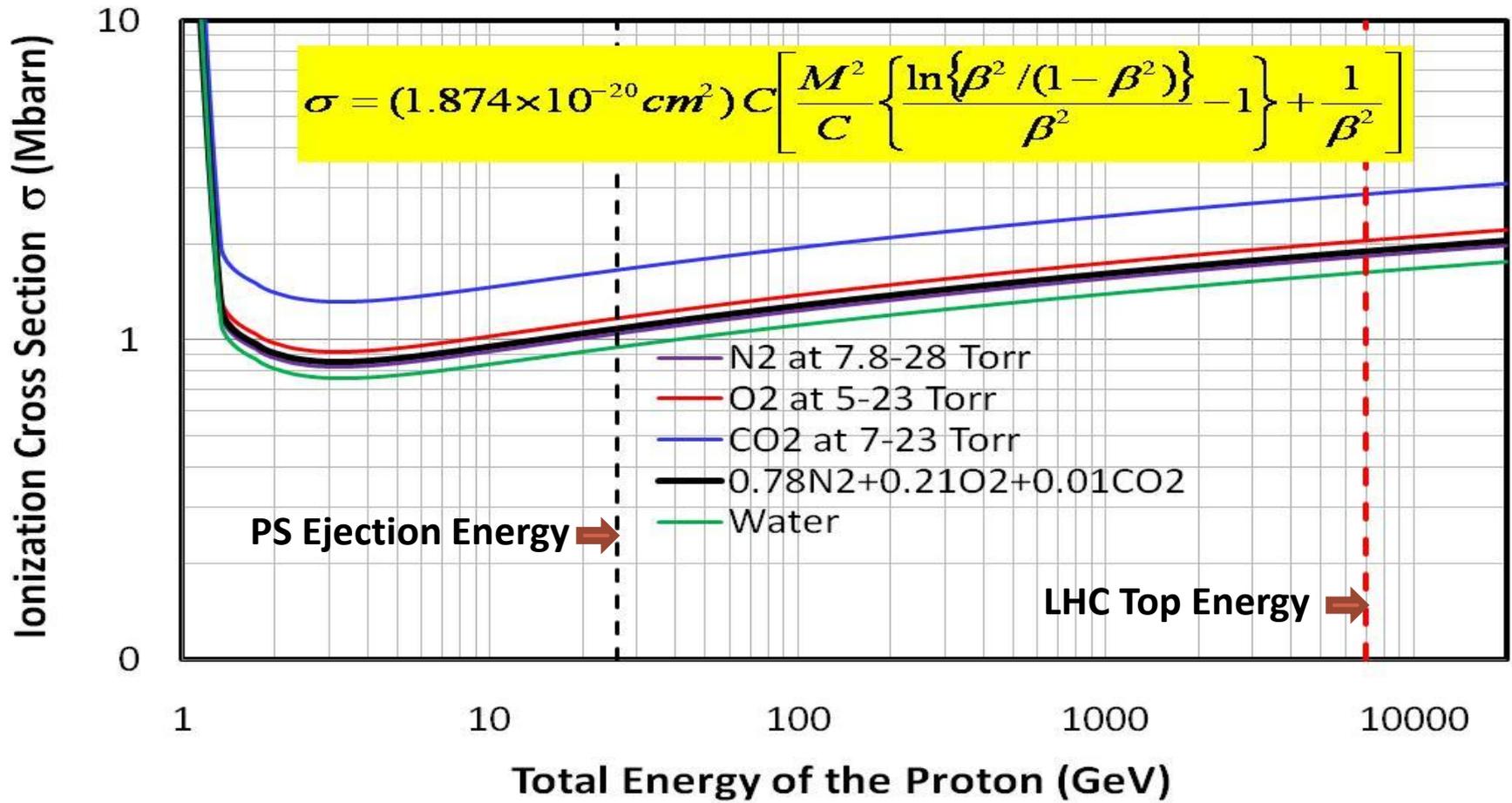
Reproduction of F. Rieke & W. Prepejchal PRA6(1972)p1507, Fig.2



This gives confidence in my calculations

Ionization Cross Section σ

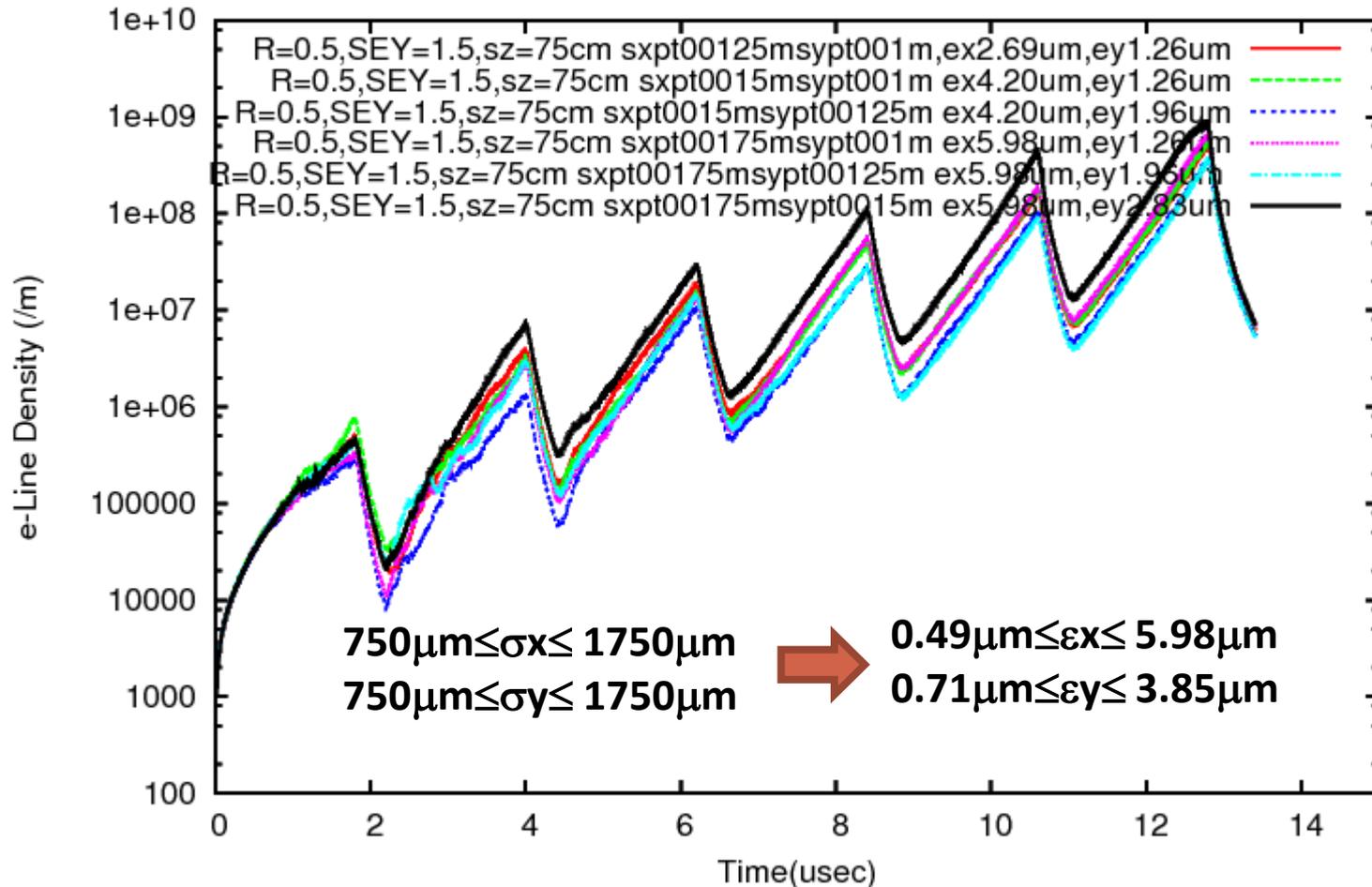
Bethe's Formula for Ionization Cross Section
PRA6(1972)1507 and PRA51(1995)4631



Searching for Saturation

$$\sigma_x \geq \sigma_y$$

PS e-Cloud: 25ns 72 bunches 1.15E11 ppb, 2MB, 2k -by HMCuna & CBhat

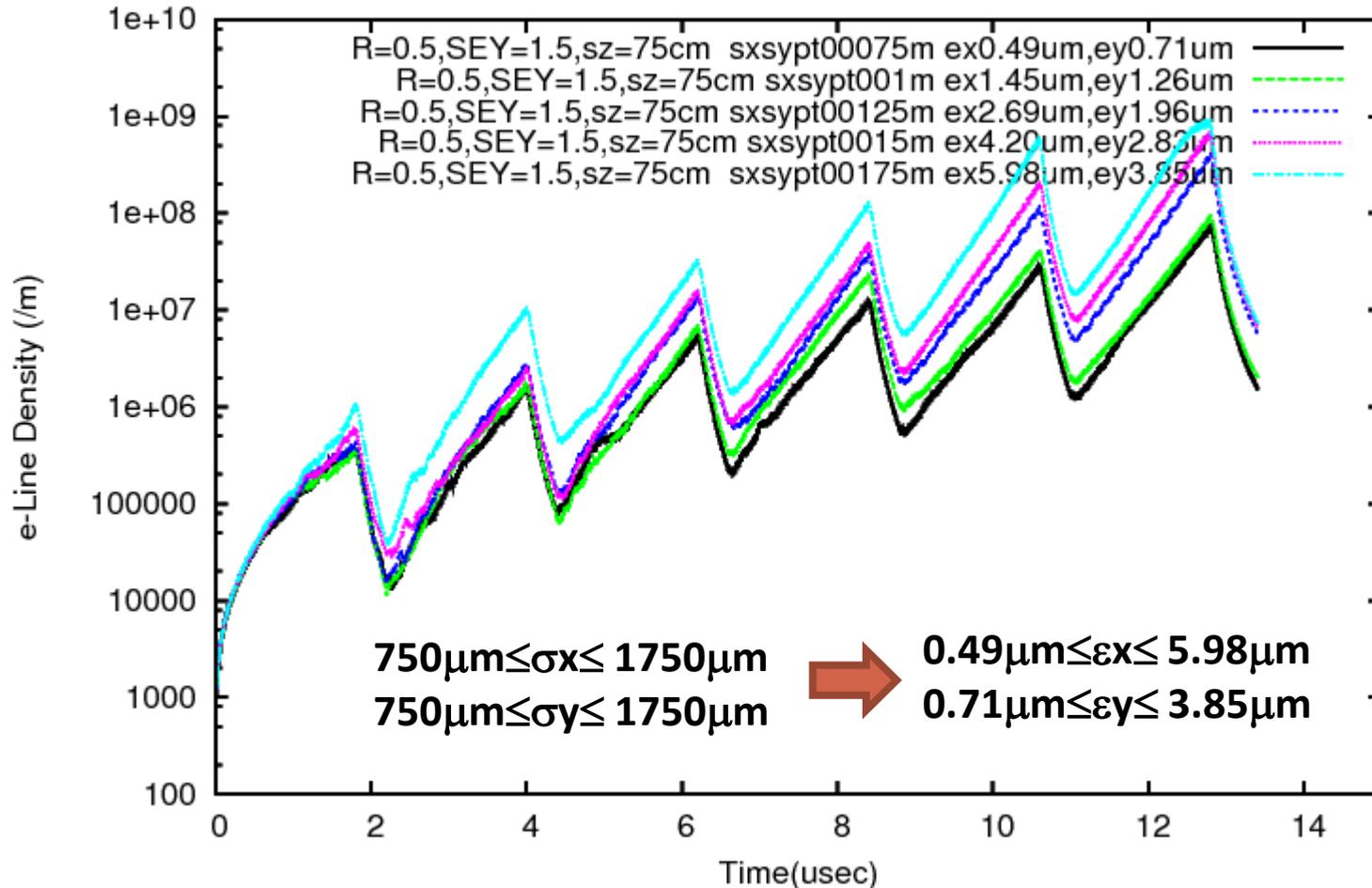


Mon Jun 27 01:15:10 2011

Searching for Saturation

$$\sigma_x = \sigma_y$$

PS e-Cloud: 25ns 72 bunches 1.15E11 ppb, 2MB, 2k -by HMCuna & CBhat



Mon Jun 27 01:15:14 2011

Summary and Plans

- Were able to reproduce the σ_{ion} presented by F. Rieke & W. Prepejchal PRA6(1972)p1507.
- Extended the calculations for σ_{ion} upto 20 TeV.
 - $\sigma_{\text{ion}} = 1 \text{ Mbarn}$ recommended for the PS at 26 GeV ejection
- Extended the ELOUD simulations up to 6 PS turns looking for saturation for cases with $\sigma_x \geq \sigma_y$
 - Find that the dependence of e-cloud density on transverse beam size is not insignificant
 - Larger the beam size faster the growth of the e-cloud density for the PS conditions ← why
 - Saw indentions of saturations for the beam with $\sigma_x = \sigma_y = 1.75 \text{ mm}$ at the end of 6th turn (SEY=1.5, R=0.5, $\sigma_z = 75 \text{ cm}$)
- Extend the simulations for more number of turns : 10,15?
- Experimental data analysis is in progress.

Studies in Progress

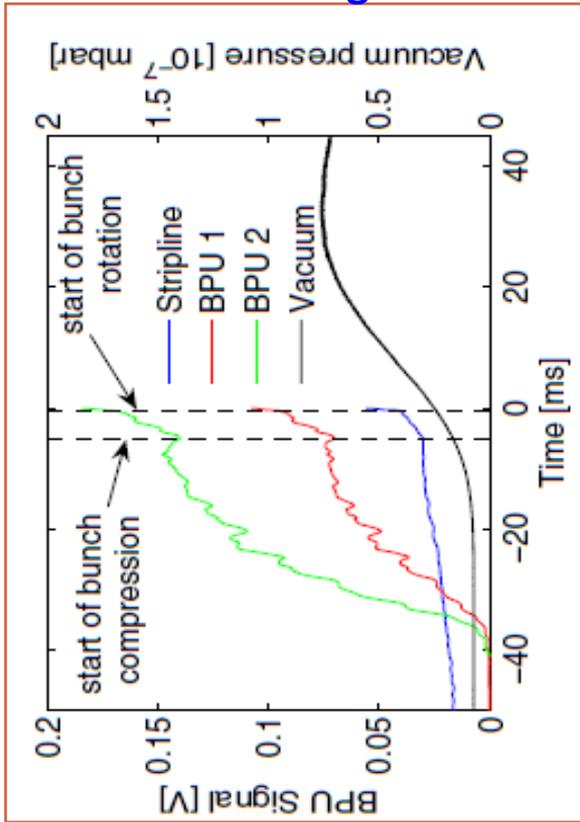
- Characterize e-cloud effects on the **LHC-type** beam with bunches of different shapes
 - bunch spacing of 25nsec and 50nsec.
 - Bunch intensities: Nominal → ultimate → beyond

An **experiment is proposed** (now being carried out) in the **PS** at 26 GeV using LHC25 and LHC50

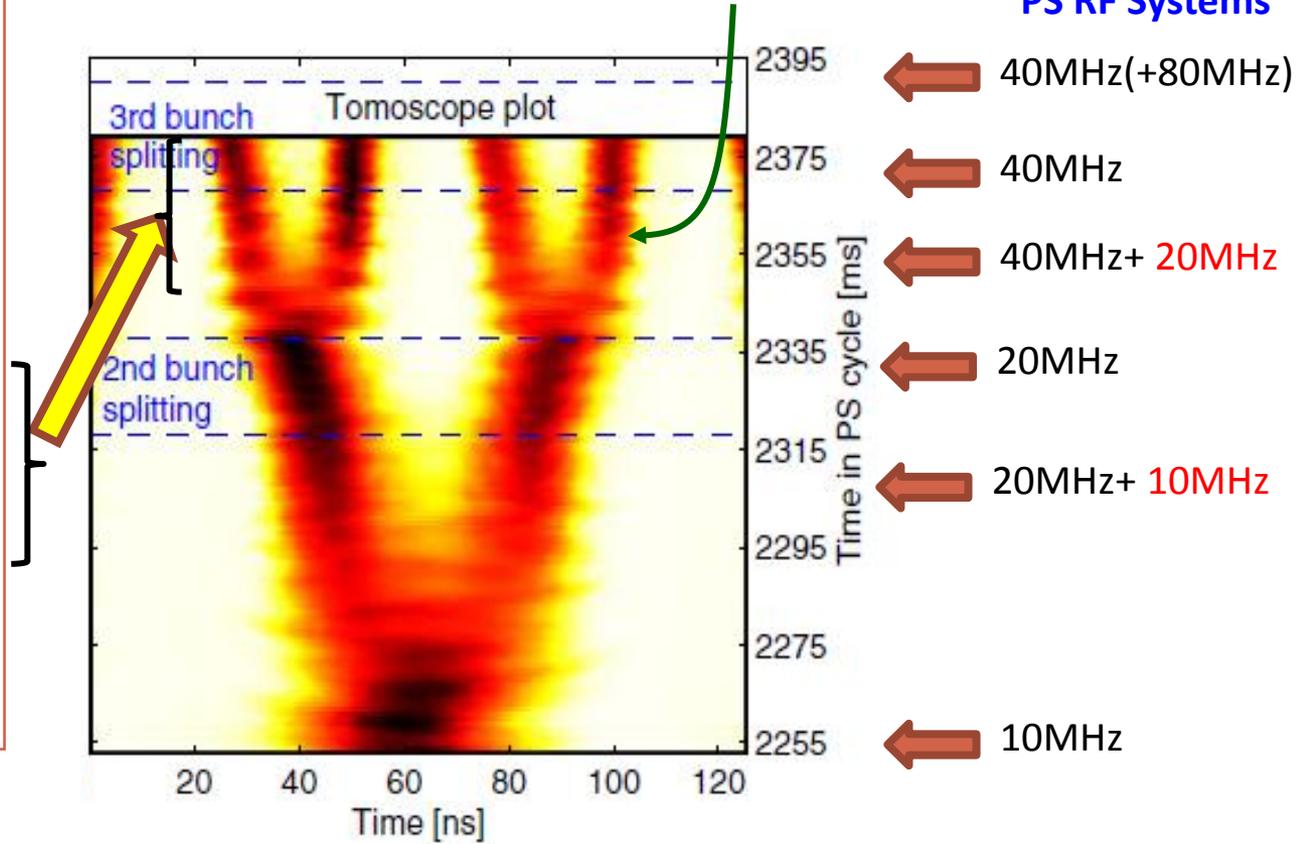
& extend the findings to the **LHC/SLHC high luminosity** upgrade
← investigate the possibility for bunch shaping at higher bunch intensities in the LHC

During 2007 PS MD e-cloud is observed in the LHC25 Beam after the quadrupole splitting

e-Cloud Signals



Varying bunch-length, shape and inter-bunch distances



E. Mahner et.al,
PRSTAB Vol. 11, 094401(2008)

PS e-cloud Measurements (cont.)

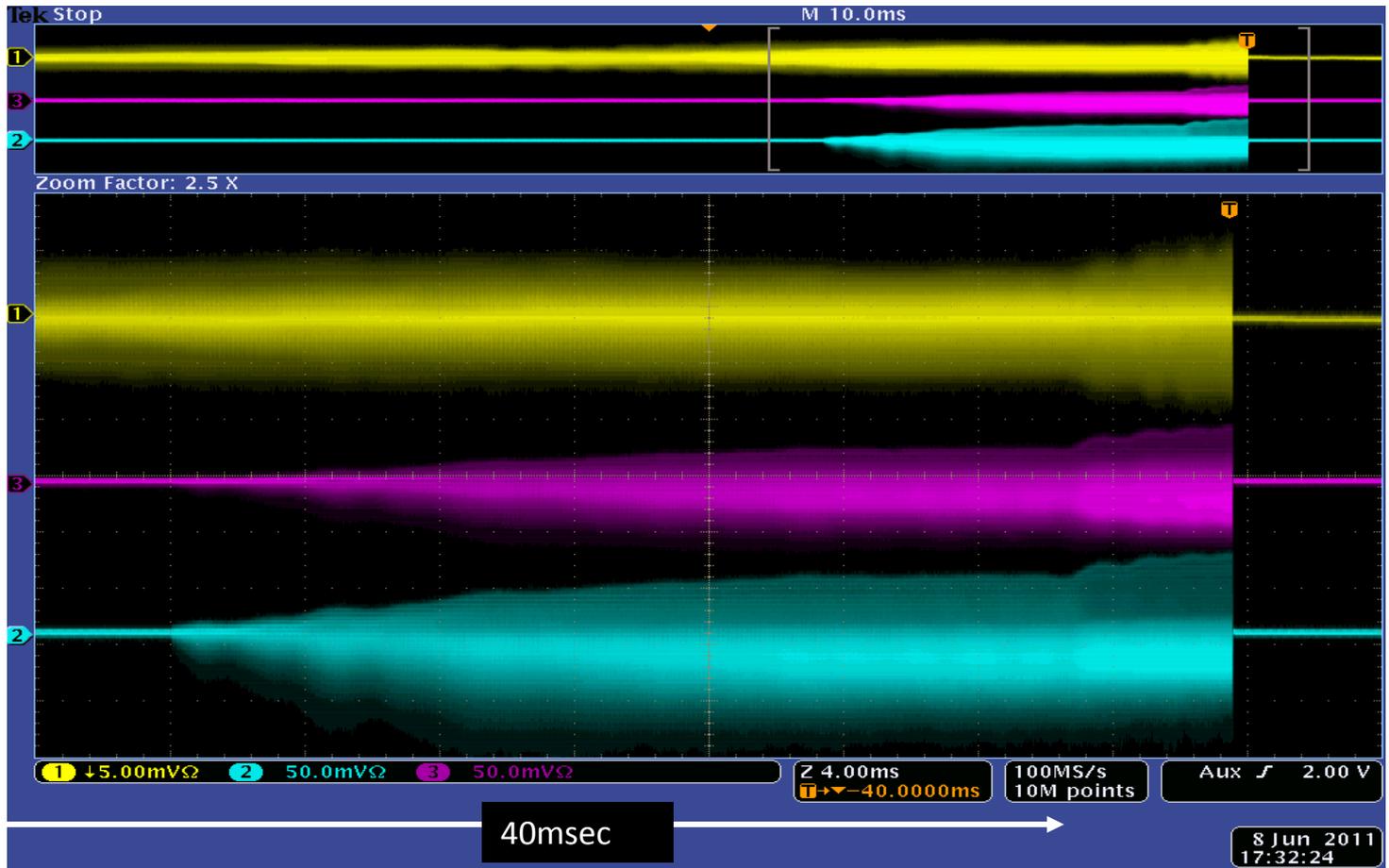
Without 80 MHz RF Last 40 msec before Ejection

Signals from

Strip-line Det.

BPU1
10% transparency

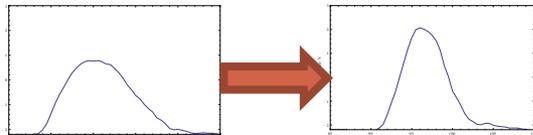
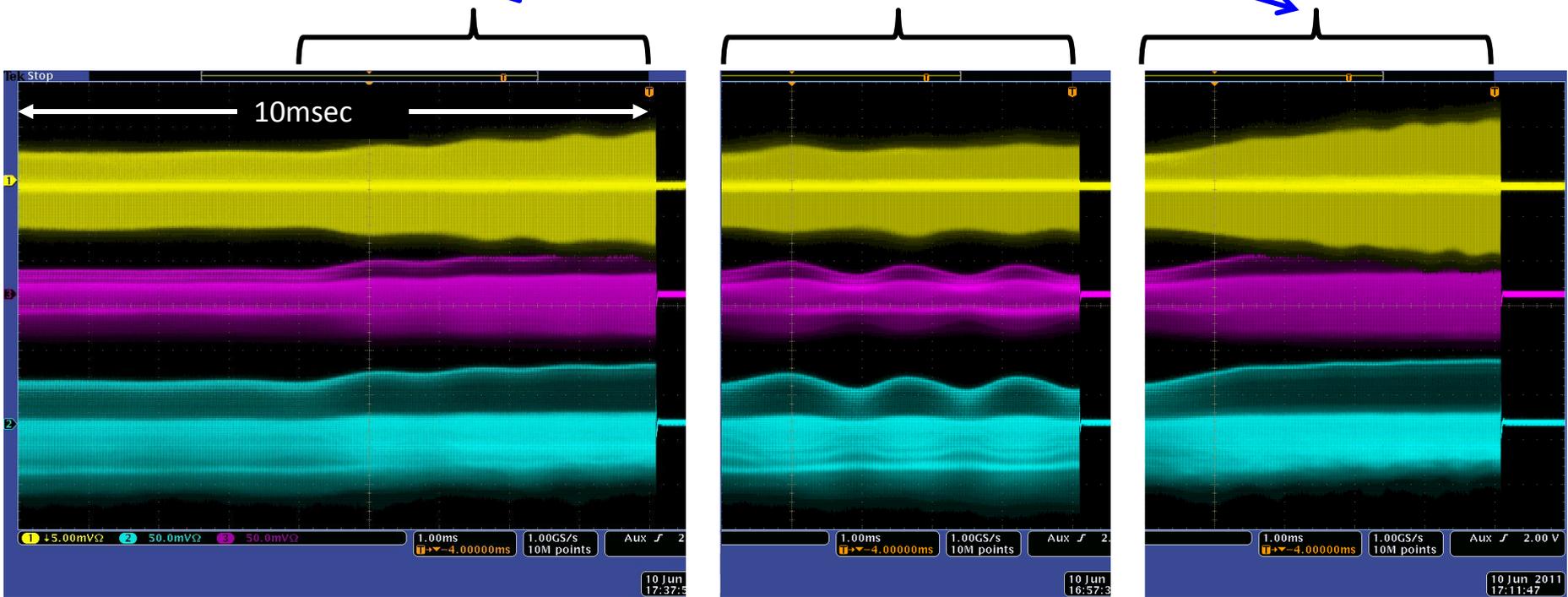
BPU2
37% and 23% transparency



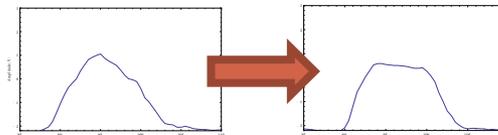
PS e-cloud Measurements (cont.)

V(80MHz): **0 to 50 kV**, V(40MHz): 40kV to 100 kV

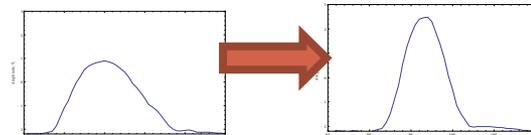
Last 5 msec
Region of Interest



Without 80MHz



Counter Phase (BLM)



In Phase (BSM)