PS e-Cloud Studies

(Effect of e-cloud on Bunch Shapes)

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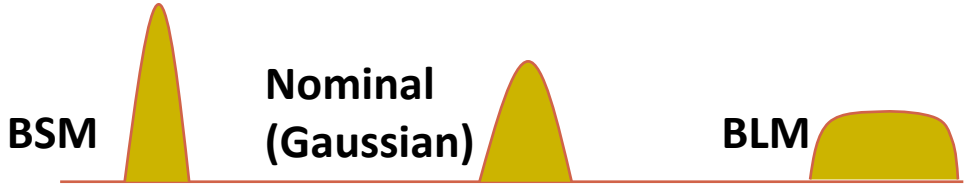
Motivation

- Characterize e-cloud effects on the LHC-type beam with bunches of different shapes in longitudinal phase space
  - By barying V(h=2)/V(h=1)=0.2-0.6, BLM & BSM



  - bunch spacing of 25nsec and 50nsec.
  - Bunch intensities: Nominal → ultimate → beyond
- In this regard, an **experiment is proposed** (now being carried out) in the **PS** that has all the necessary tools ← Experiment at 26 GeV
- Next: Simulate the observed e-cloud effects in the PS

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

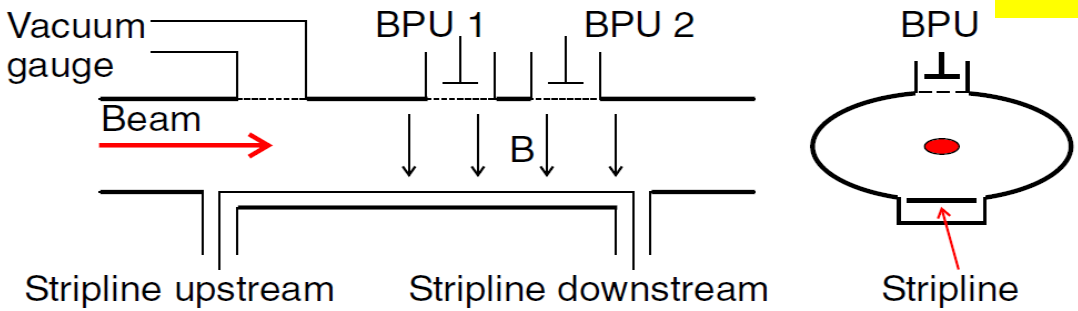
PS- e-Cloud Measurements
(June 6, 8 and10th during parallel MD. Thanks to Giovanni)

- Used the LHC25
- Used a **modified rf voltage waveform** during the last 5 ms before the beam ejection
- Used the beam intensity 1.28-1.37E11/bunch)
- Collected
  - e-cloud data from **Edgar's e-cloud monitors in the PS**
  - Tomo-scope data (Longitudinal profiles)
  - Transverse emittance, Beam Intensity.*

* While analyzing the data I realized that there were some problems with "PS Easy Wire Scanner" program: a) was using incorrect $\beta\gamma$ and b) was not sure of the lattice function in the vertical plane. Communicated with Simone Gilardoni. Now the problem is taken care off.

Edgar's e-cloud Monitor in the PS straight section 98

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



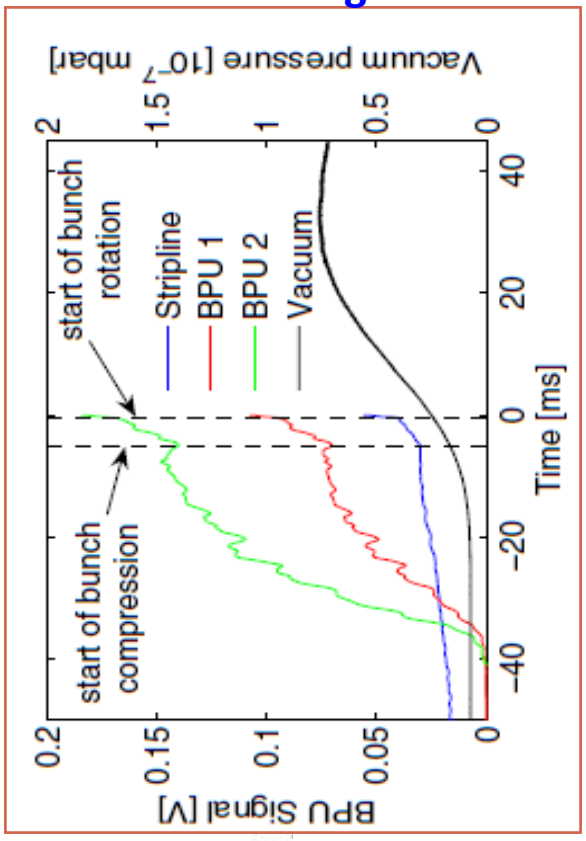
The line Density

$$\lambda = 2.3\times10^{8}\,\frac{U_{pu}}{mV}\,(e^{-}/meter)$$

The system is capable of applying magnetic field (0-100 Gauss) to study e-cloud suppression

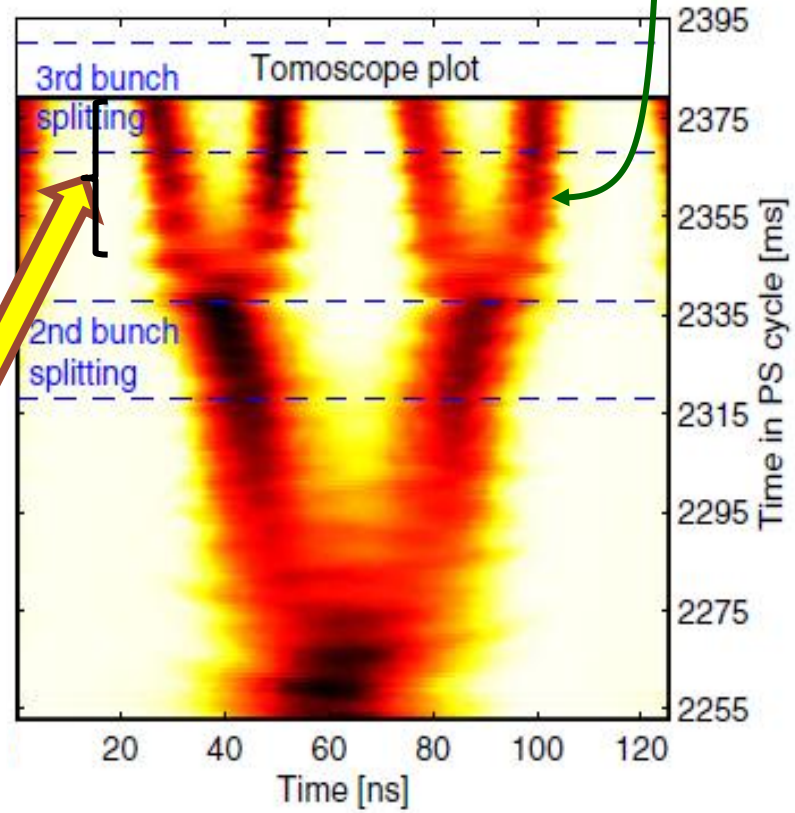
During 2007 PS MD e-cloud is observed in the LHC25 Beam after the quadrupole splitting

e-Cloud Signals



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

Varying bunch-length, shape and inter-bunch distances

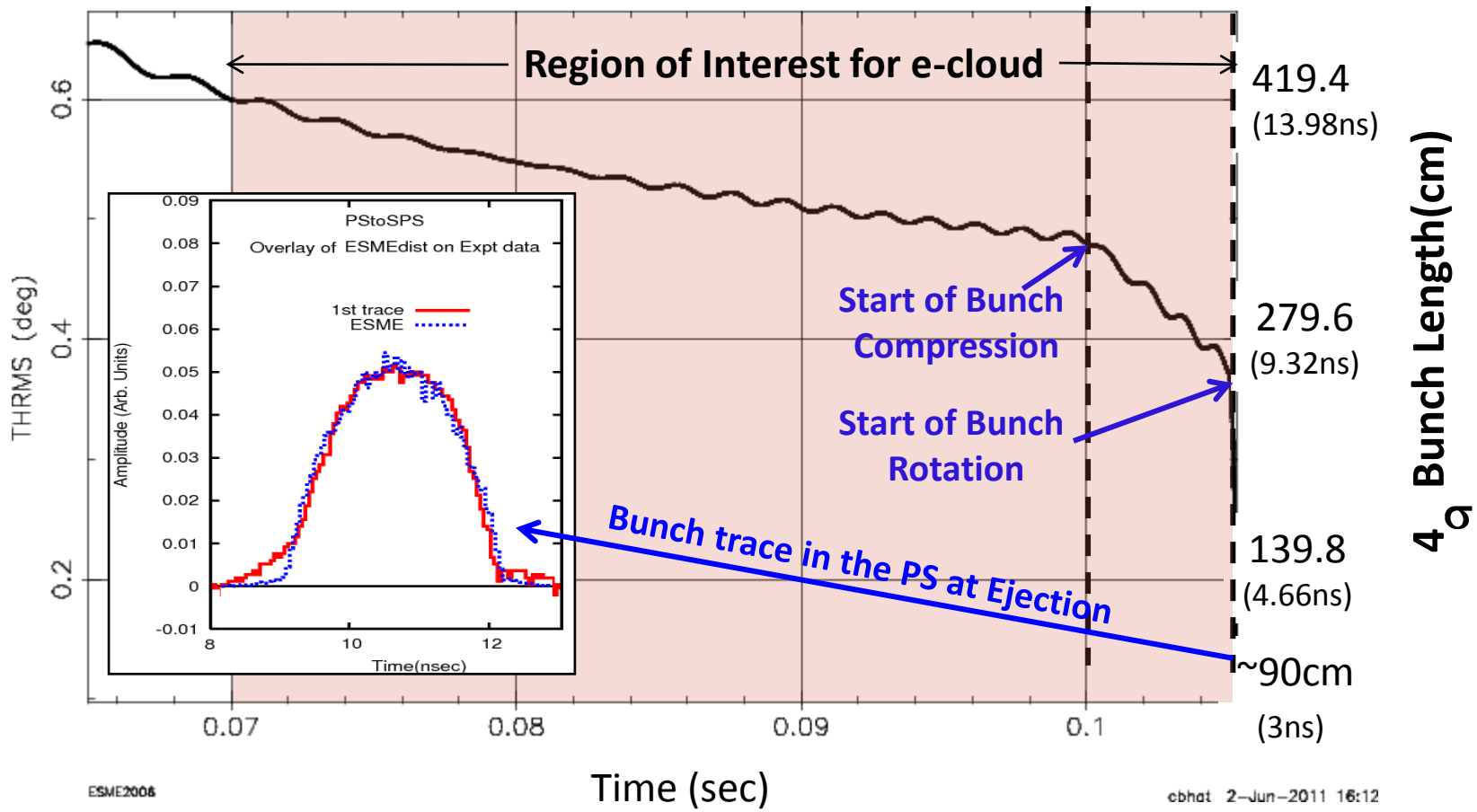


PS RF Systems

- 40MHz(+80MHz)
- 40MHz
- 40MHz+ 20MHz
- 20MHz
- 20MHz+ 10MHz
- 10MHz

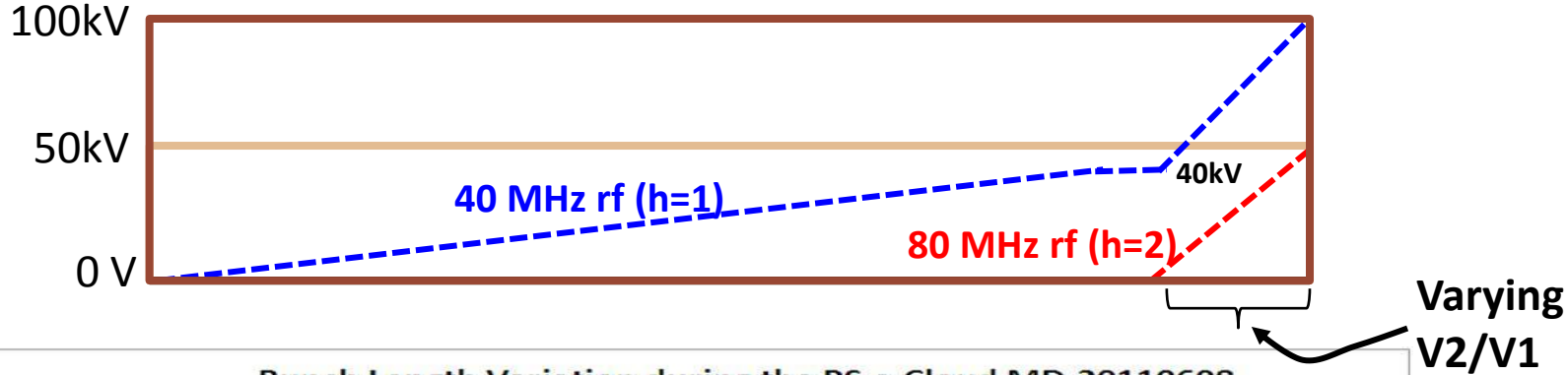
Variation of Bunch Length in the PS on LHC25

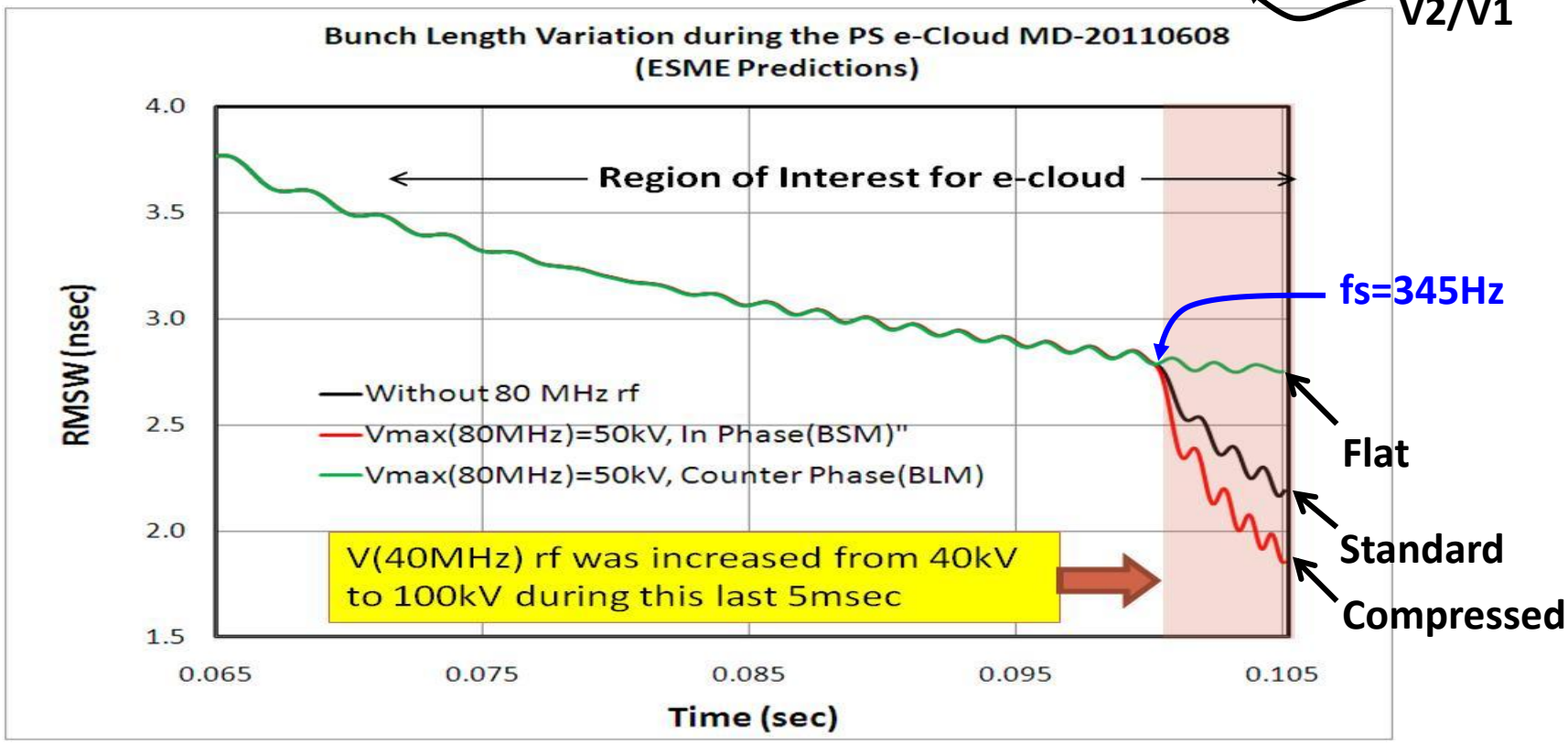
40 msec before extraction (ESME simulations)



PS e-cloud Measurements (cont.)

Modified RF waveform in the PS at 26 GeV; last 40 msec





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PS e-cloud Measurements (cont.)

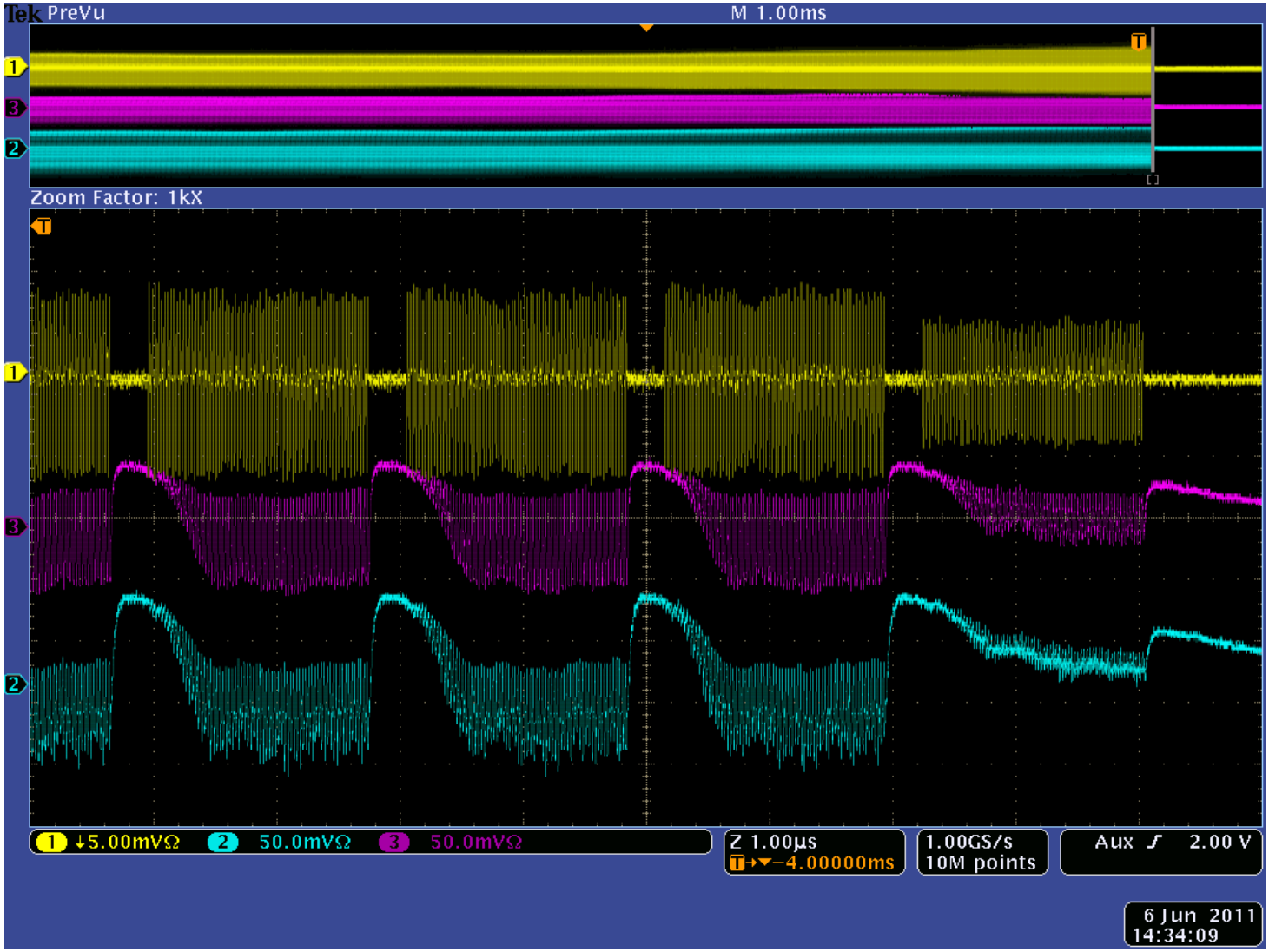
Without 80 MHz RF for the **last 4.5 turns** before ejection

Signals from

Strip-line Det.

BPU1
10% transparency

BPU2
37% and 23% transparency



PS e-cloud Measurements (cont.)

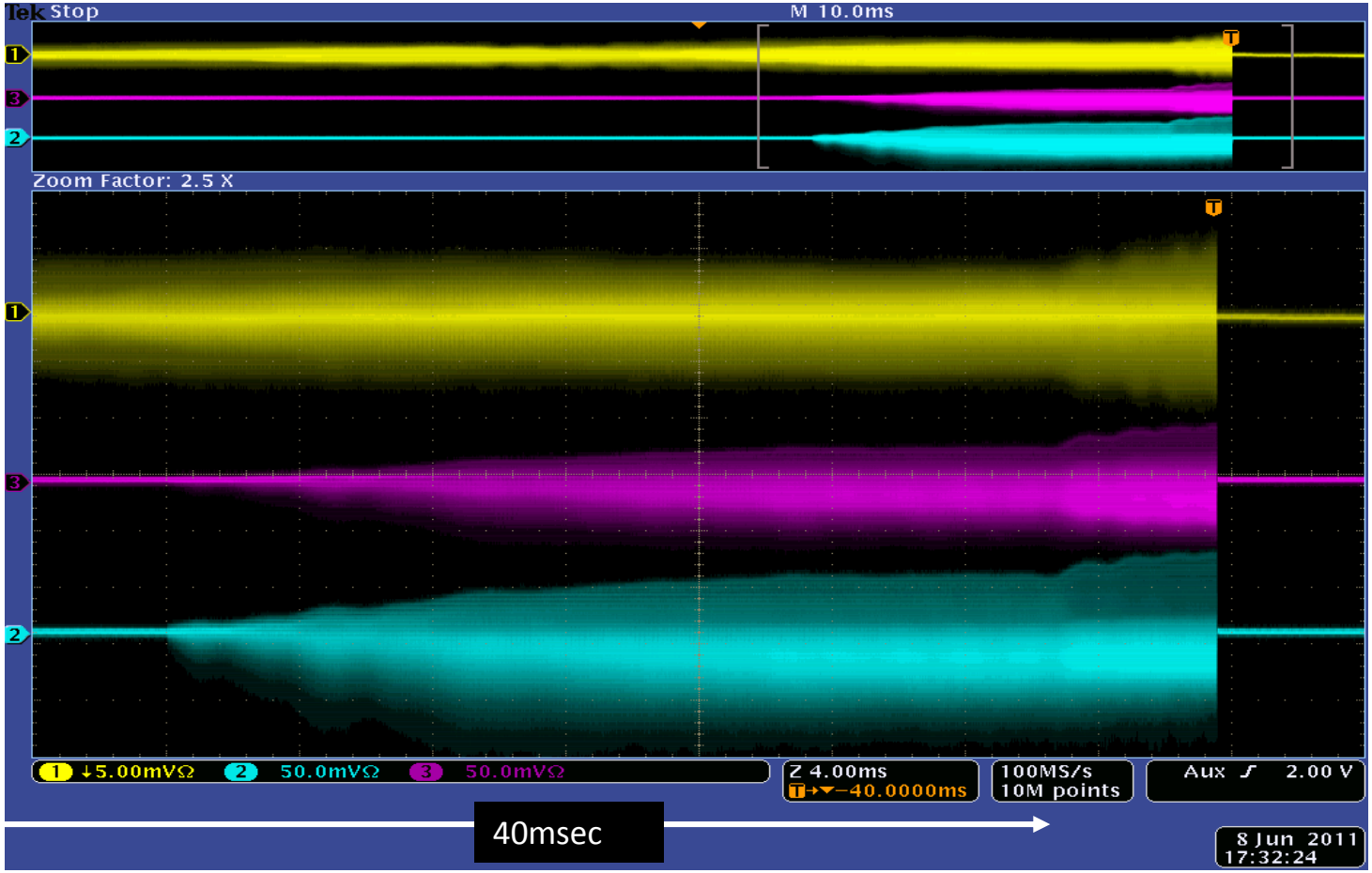
Without 80 MHz RF Last 40 msec before Ejection

Signals from

Strip-line Det.

BPU1
10% transparency

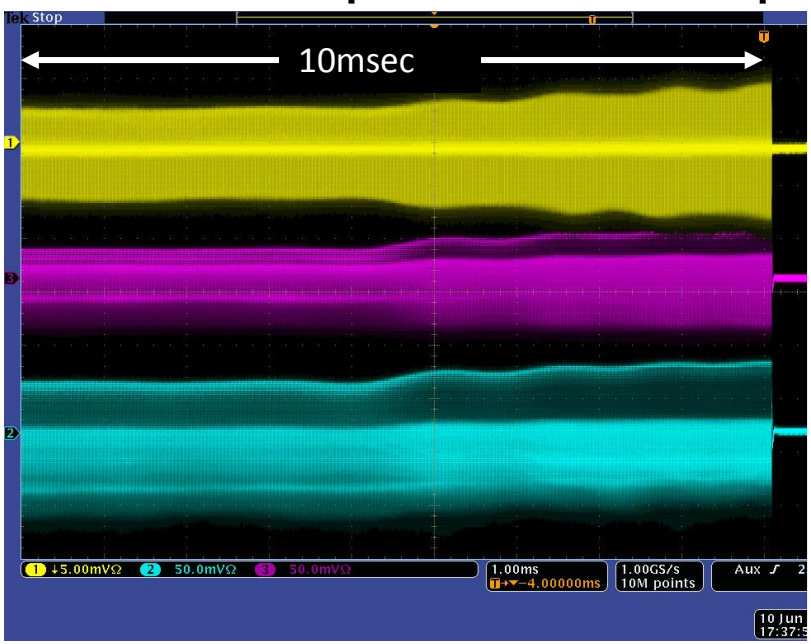
BPU2
37% and 23% transparency



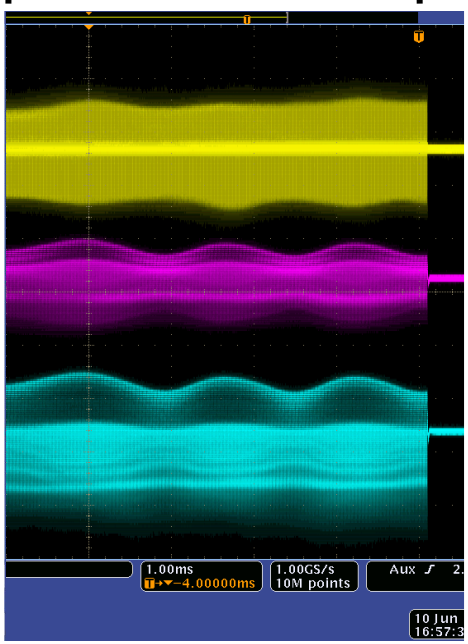
PS e-cloud Measurements (cont.)

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

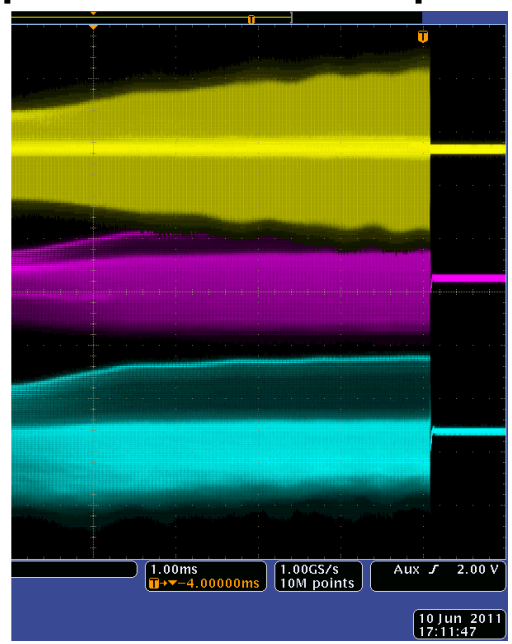
Last 5 msec
Region of Interest



Without 80MHz



Counter Phase(BLM)



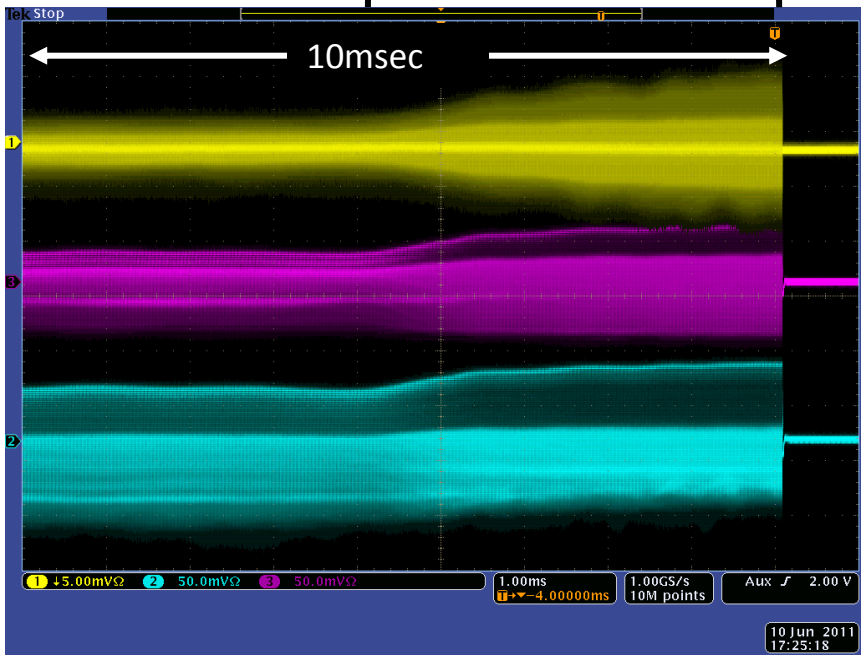
In Phase (BSM)

PS e-cloud Measurements (cont.)

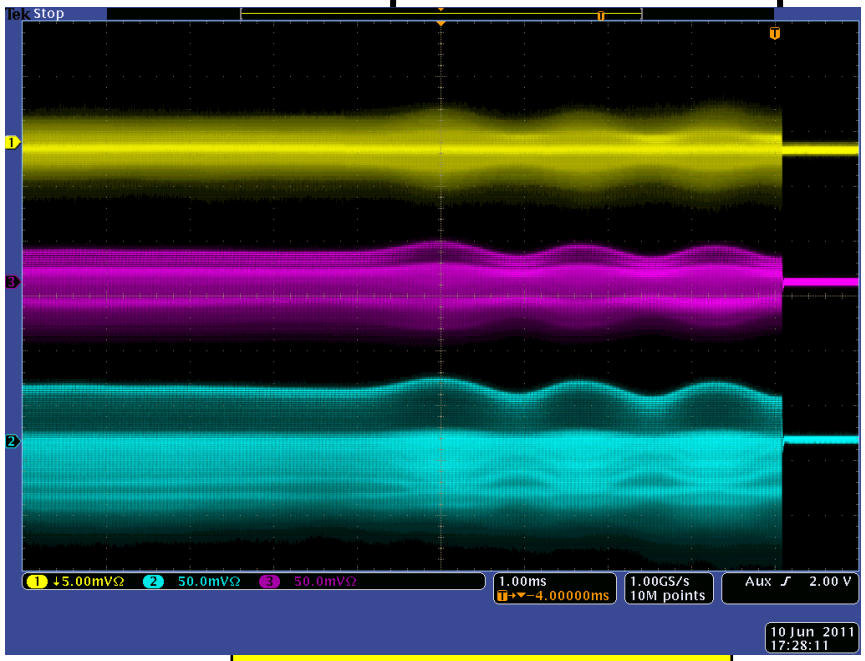
V(80MHz): **0 to 25 kV**, V(40MHz): 40kV to 100 kV

Last 5 msec

Region of Interest



In Phase (BSM)



Counter Phase(BLM)

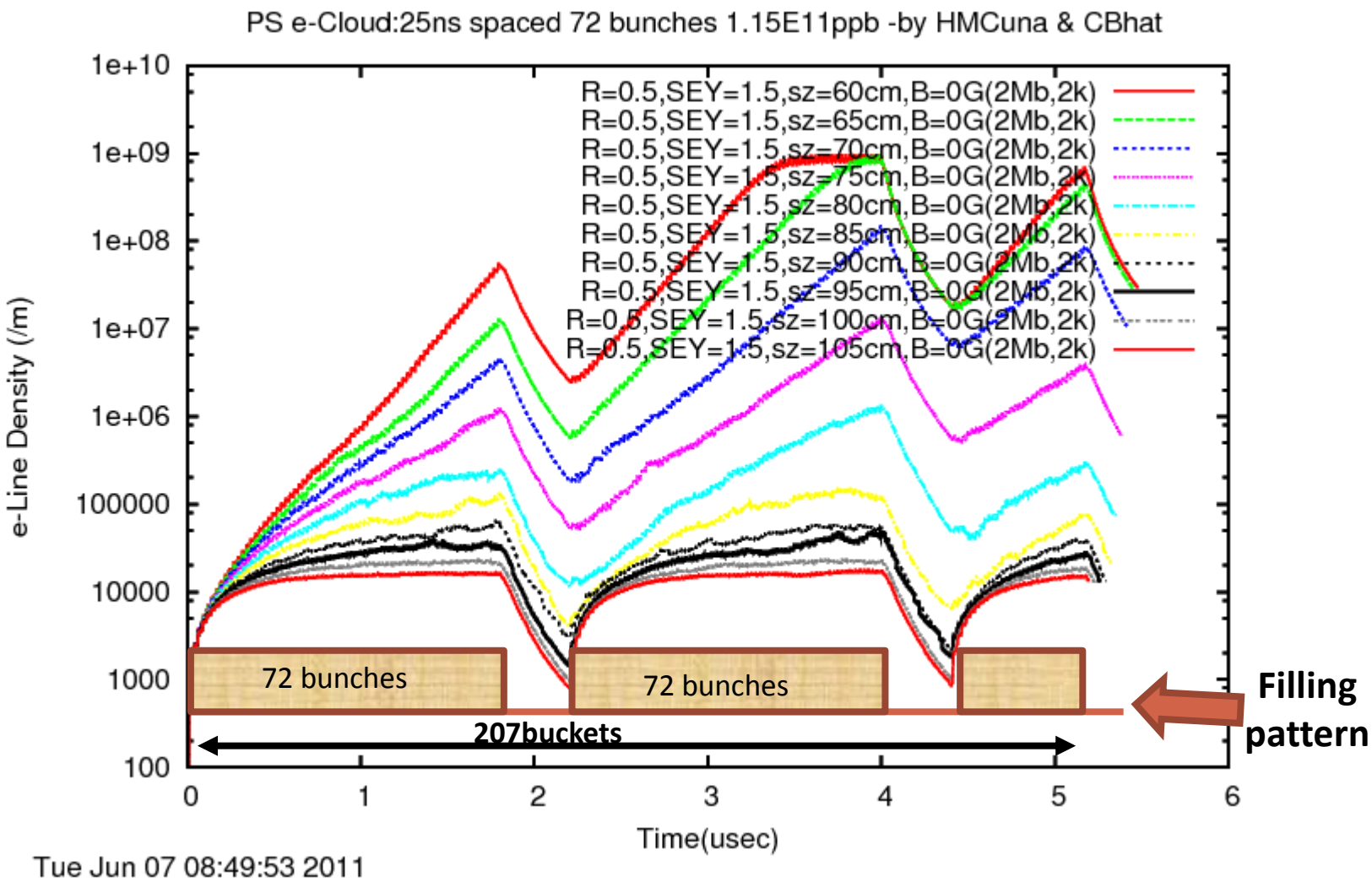
Conclusions: Experimentally we see bunch shape effect on the e-cloud density;
Large e-cloud density with BSM and Reduced e-cloud density with BLM

PS- e-Cloud Simulations

- We are using the **ECLOUD** to study the observed effects
- So far we have studied
  - Seed dependence ← no strong dependence is seen
  - # of macro-particles ← strong dependence is seen, suggests **>2000** macro-particles in our case
  - Dependence on the σ_{Ion}: **1.0**-2.9 Mbarn ← past 2MBarn (?)
  - SEY=1.0 to 1.6 (**1.5**) and R=0.3-1.0 (**0.6**)
  - Bunch Length (1σ)=60cm-175cm
  - Effect of Transverse beam size: σ_x and σ_y
  - Effect of bunch shapes (work in progress)

Simulation Examples

PS e-Cloud: σ_{ion}=2 MBarn, SEY=1.5, R=0.5, BF=0G, sz=60-105cm, Gaussian bunch



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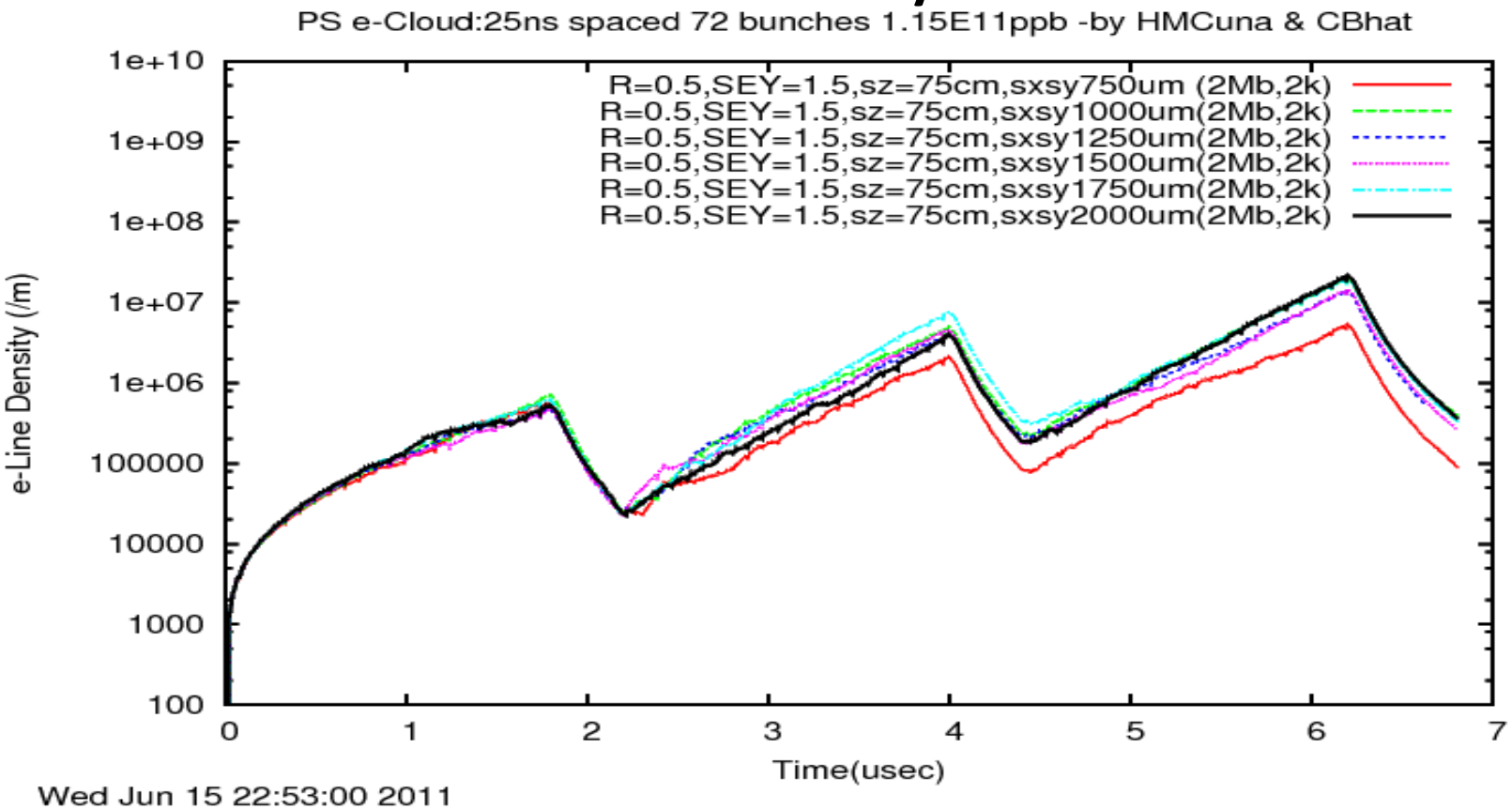
Simulation Examples

PS e-Cloud: σ_{ion}=2 MBarn, SEY=1.5, R=0.5, BF=0G, Gaussian bunch

$\sigma x = \sigma y$



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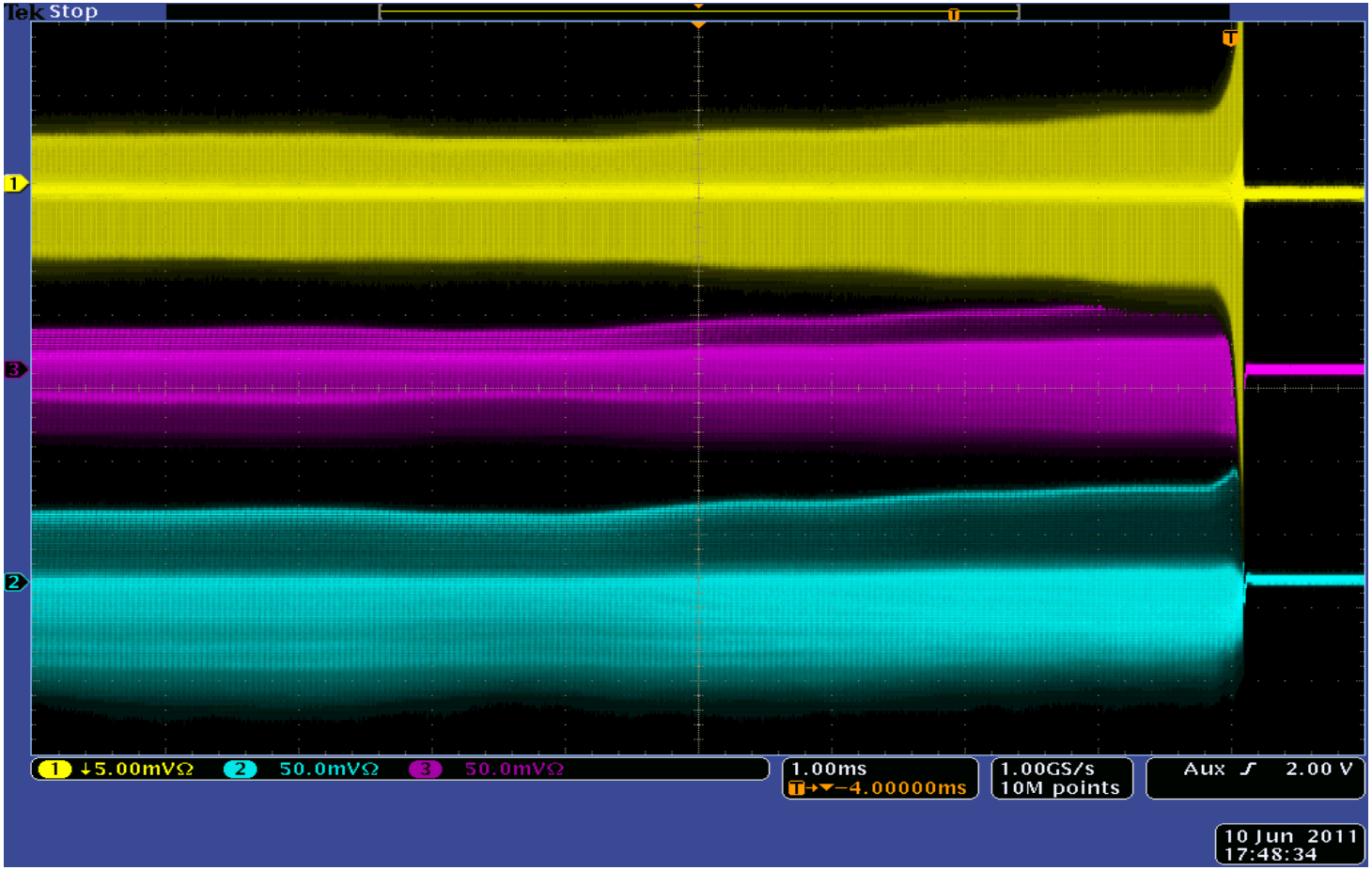
Summary/Conclusions

- An experiment is being carried out in the PS to study the e-cloud effects as a function of
  - Bunch profile shapes, Bunch intensity and Bunch spacing on the LHC type beam
- ECLOUD Simulations are being conducted to reproduce the observed e-cloud buildup in the PS

PS e-cloud Measurements (cont.)

Observed e-cloud on LHC25 (standard Cycle)