Importance of realistic surface related properties as input to e-cloud simulations.

R. Cimino

LNF Frascati (Italy)

- **The problem of input parameters: a detailed analysis by a test case (the cold arcs of LHC).**
- **Results of relevance for LHC and ILC**
- **Future experiments and open problems**

Static

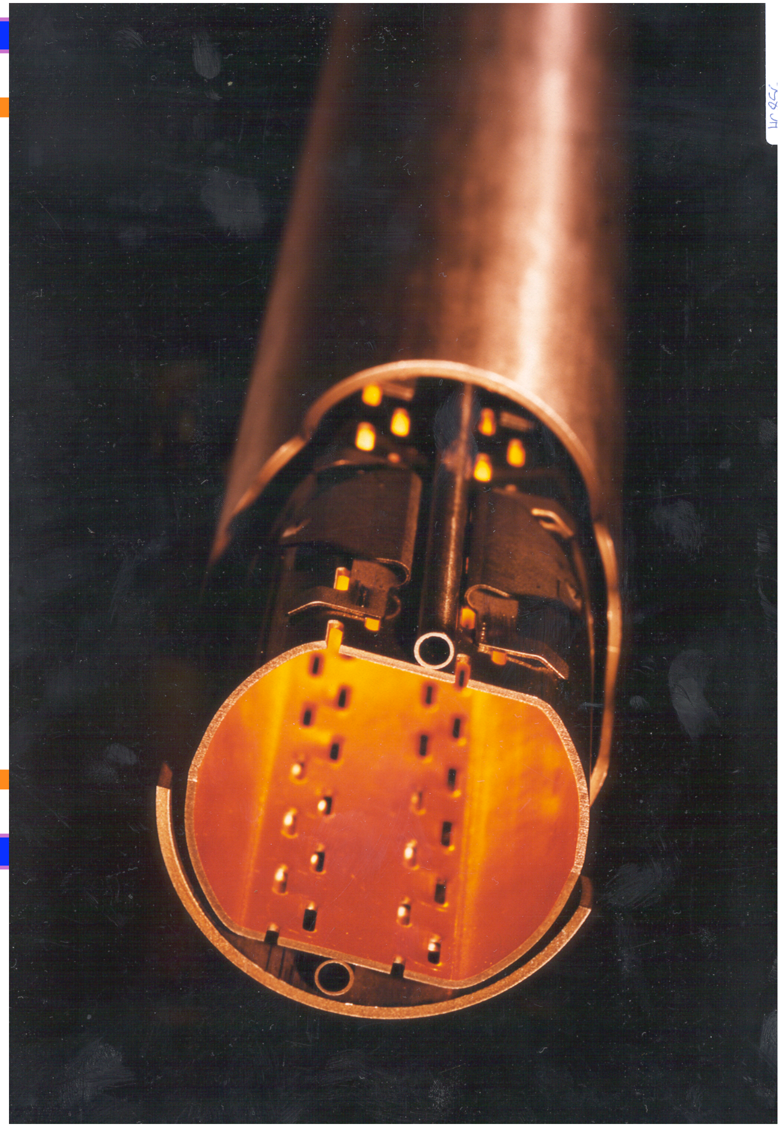
Cold Bore @ 1.9 K

Beam Screen @ 5K< T <20K

Extreme High Static Vacuum (<< 10^{-13} Torr)

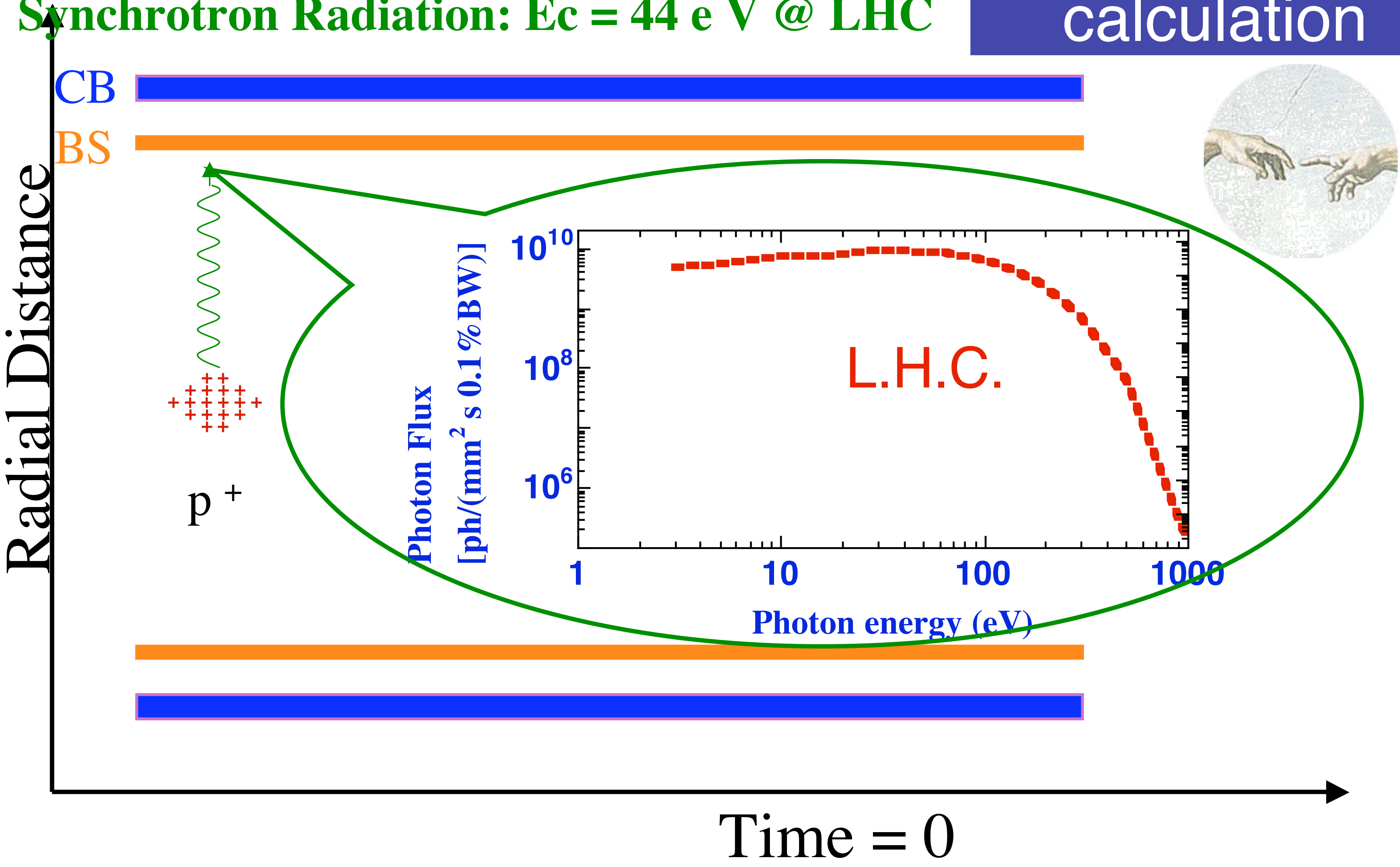
Radial Distance

T=0, without beam



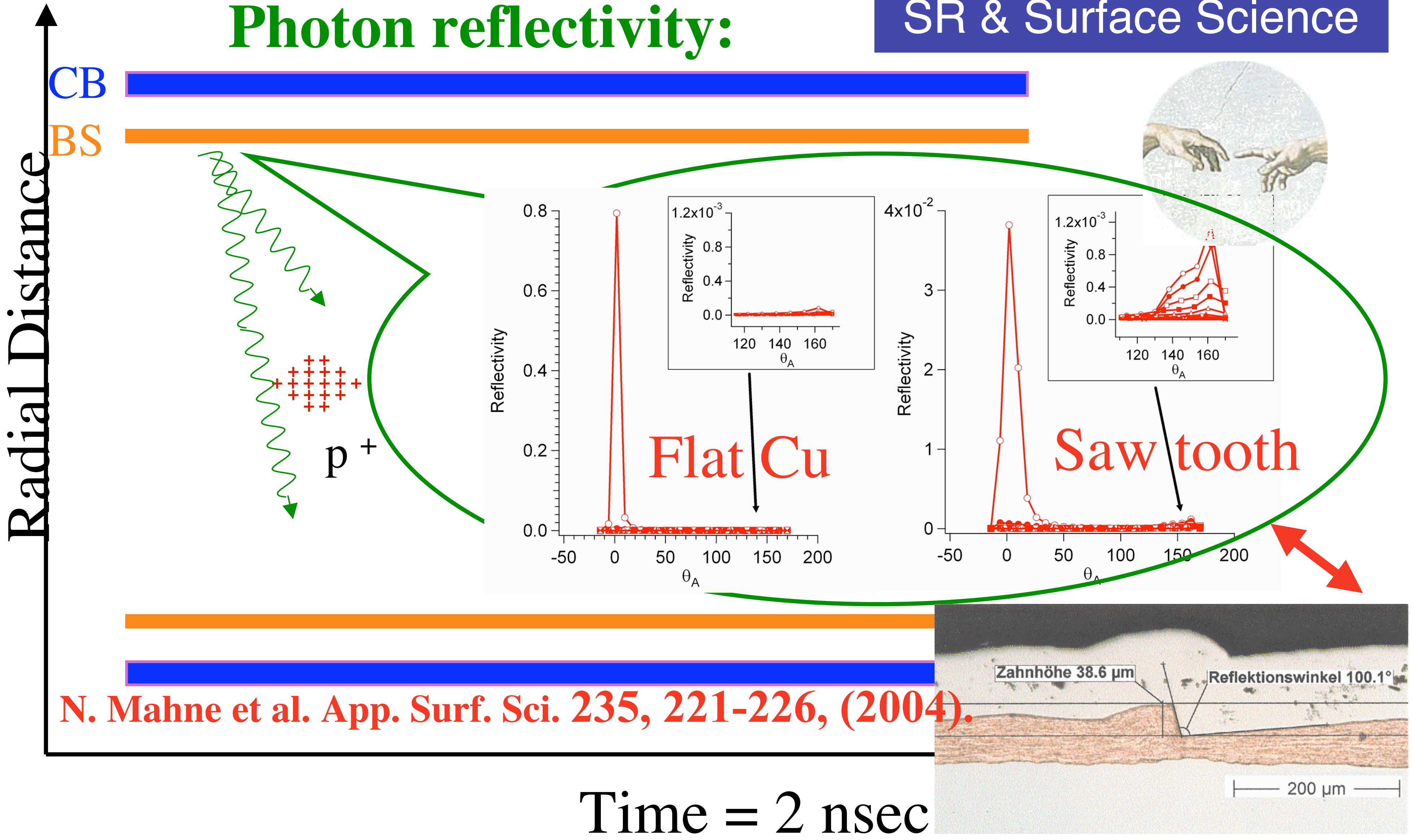
Synchrotron Radiation: Ec = 44 e V @ LHC

calculation



Photon reflectivity:

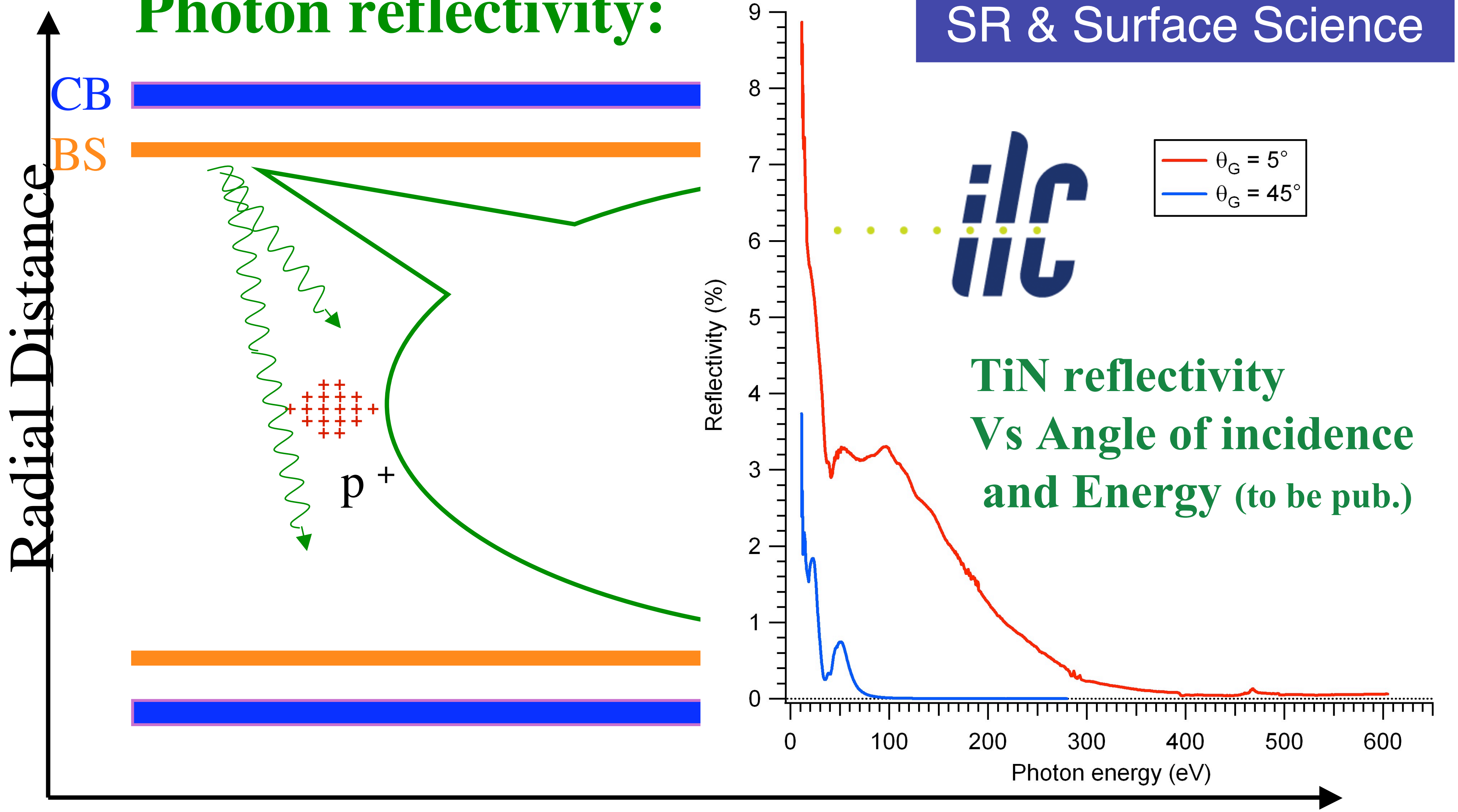
SR & Surface Science



N. Mahne et al. App. Surf. Sci. 235, 221-226, (2004).

Photon reflectivity:

SR & Surface Science

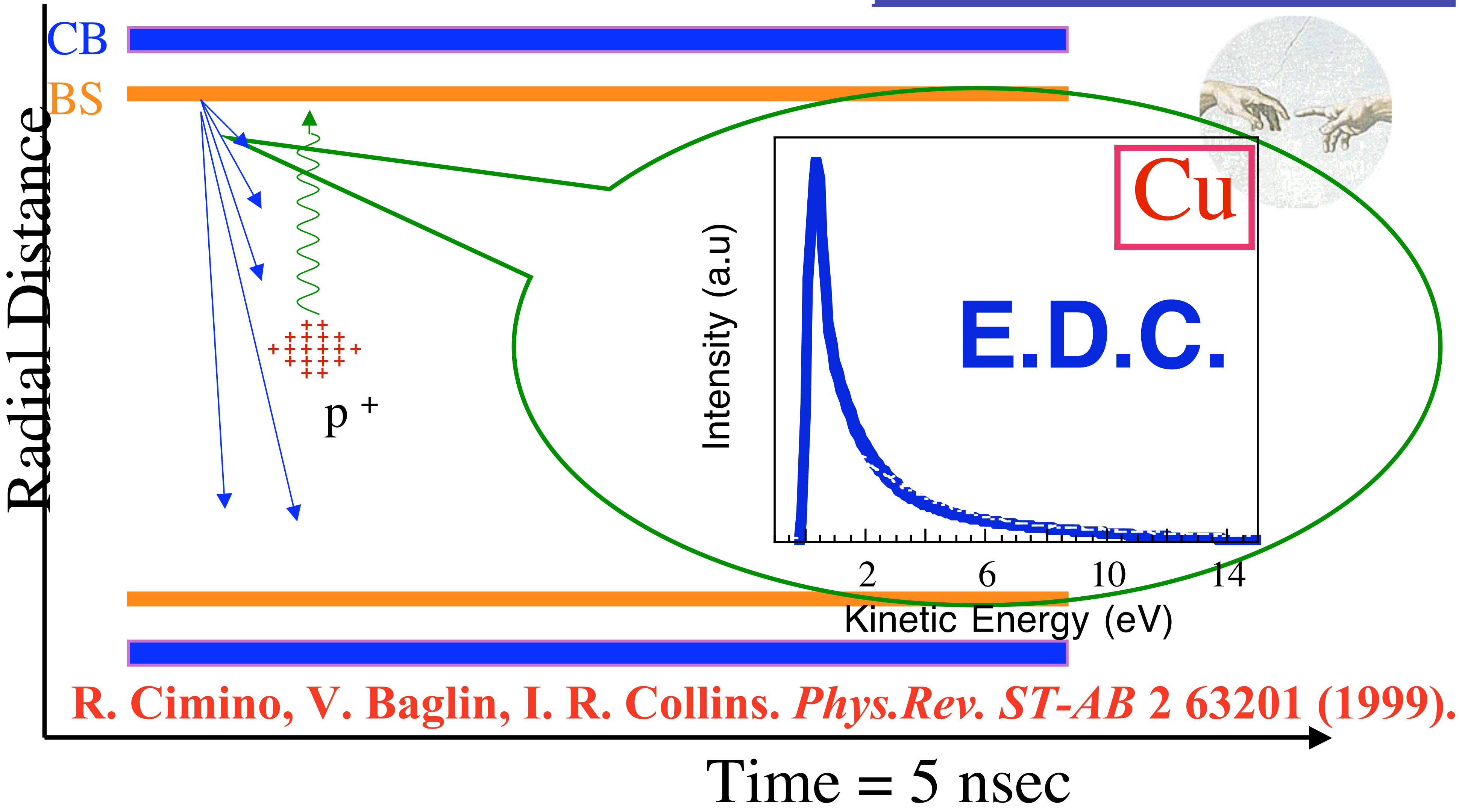


Time = 2 nsec

N. Mahne et al. App. Surf. Sci. 235, 221-226, (2004).
N. Mahne et al. To be published

Photoemission:(vs. hν, Θ, E,T, B)

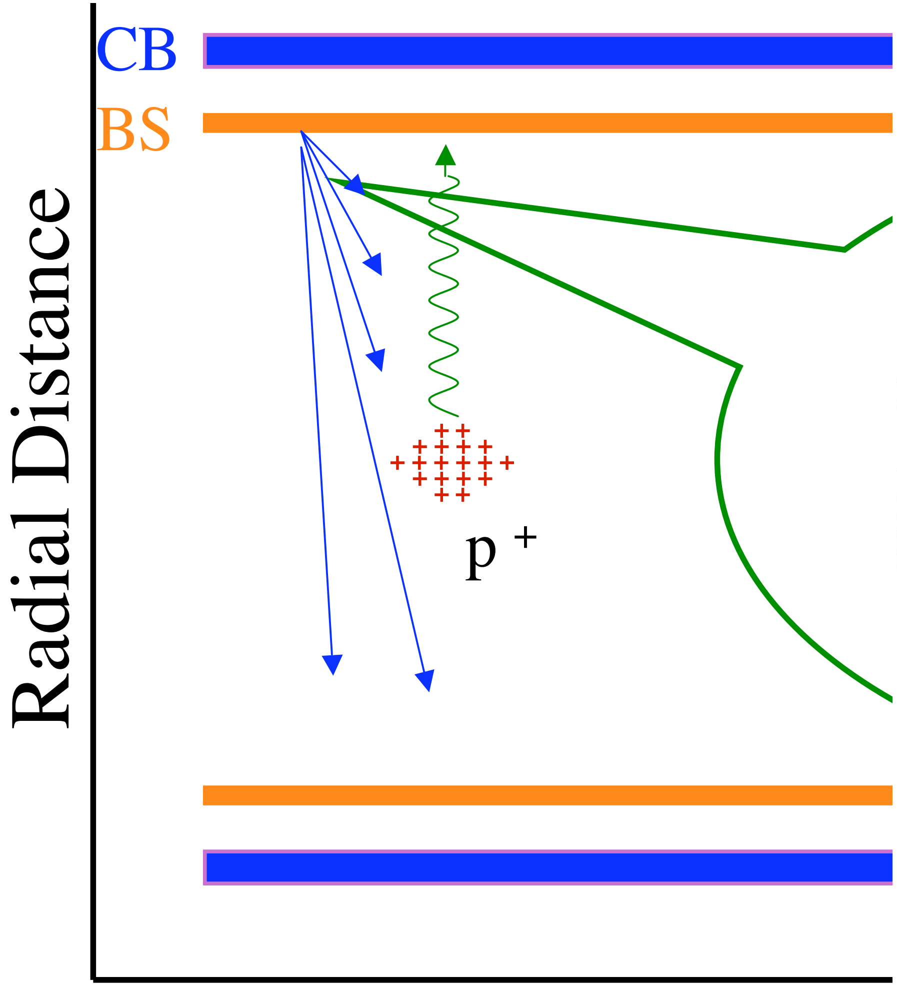
SR and Surface Science

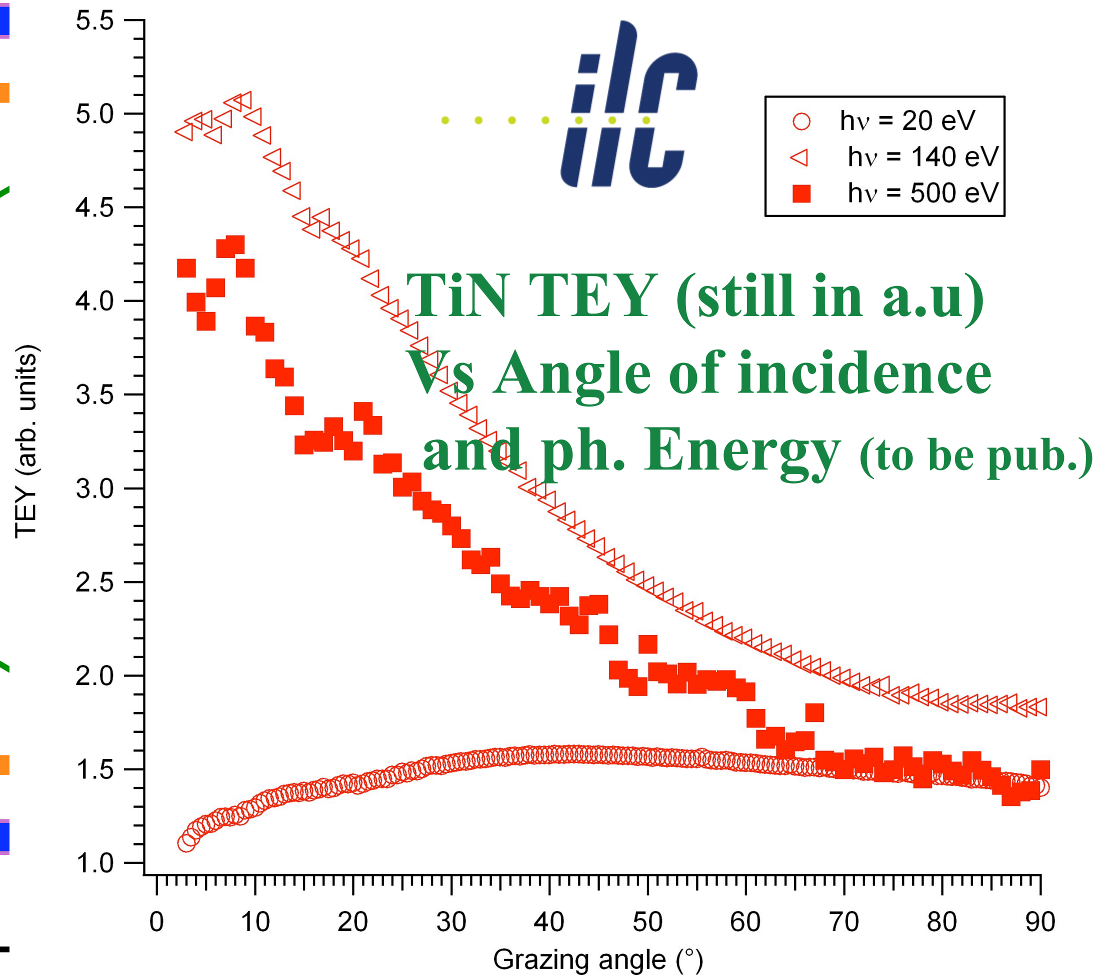


R. Cimino, V. Baglin, I. R. Collins. *Phys.Rev. ST-AB* 2 63201 (1999).

Photoemission:(vs. hν, Θ, E,T, B)

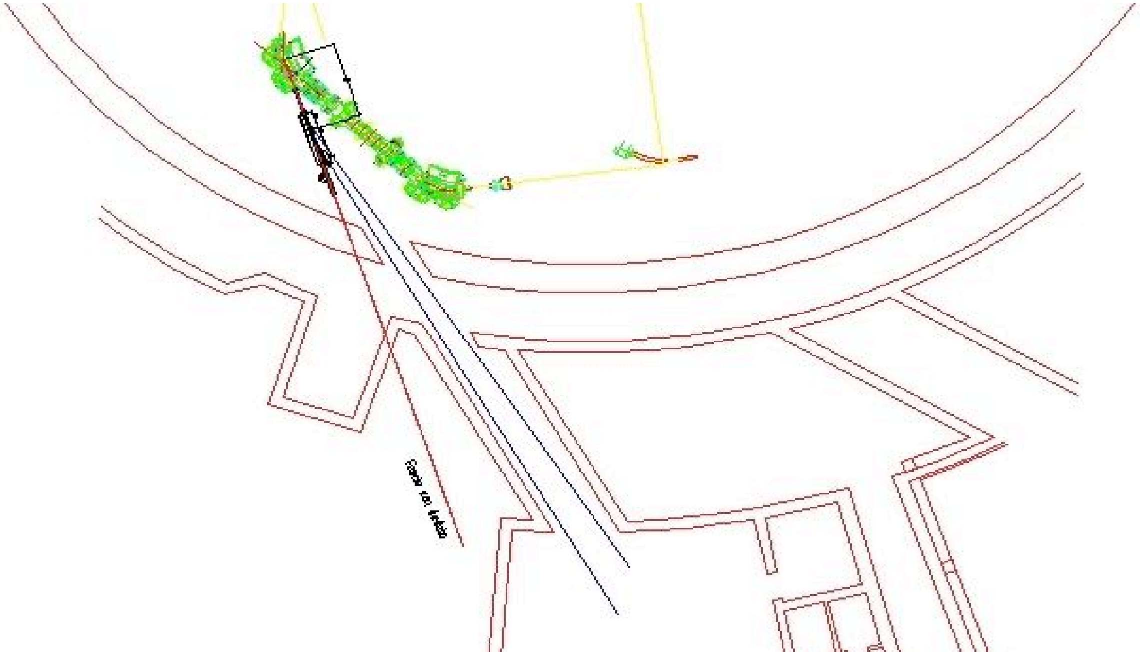
SR and Surface Science

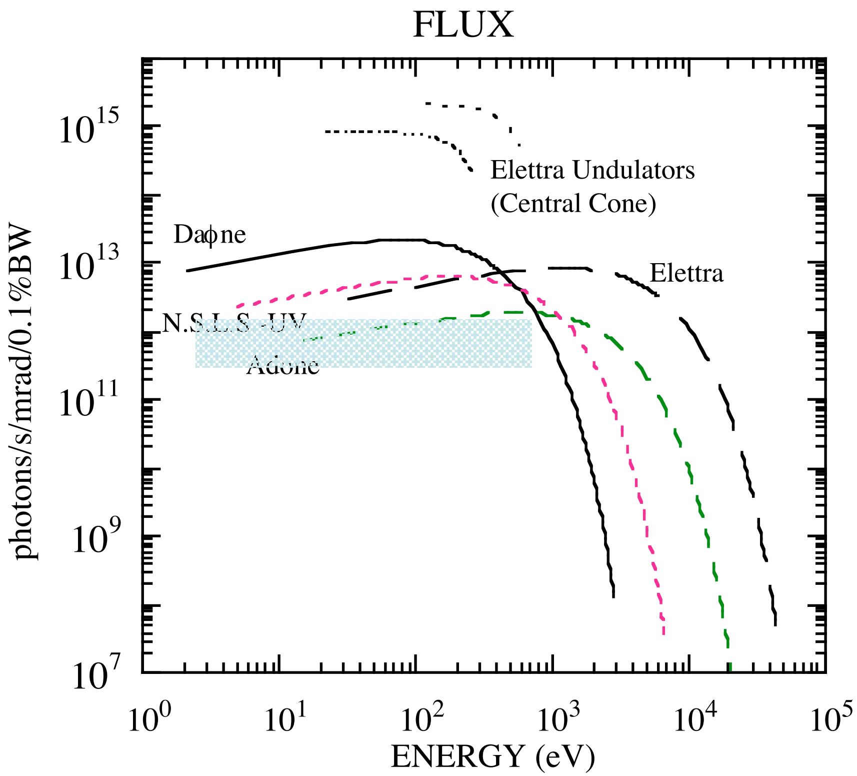




N. Mahne et al. To be finalized if possible…..

The project: two new DAΦNE-L beam lines. If partially dedicated to ILC related studies need support from this community!

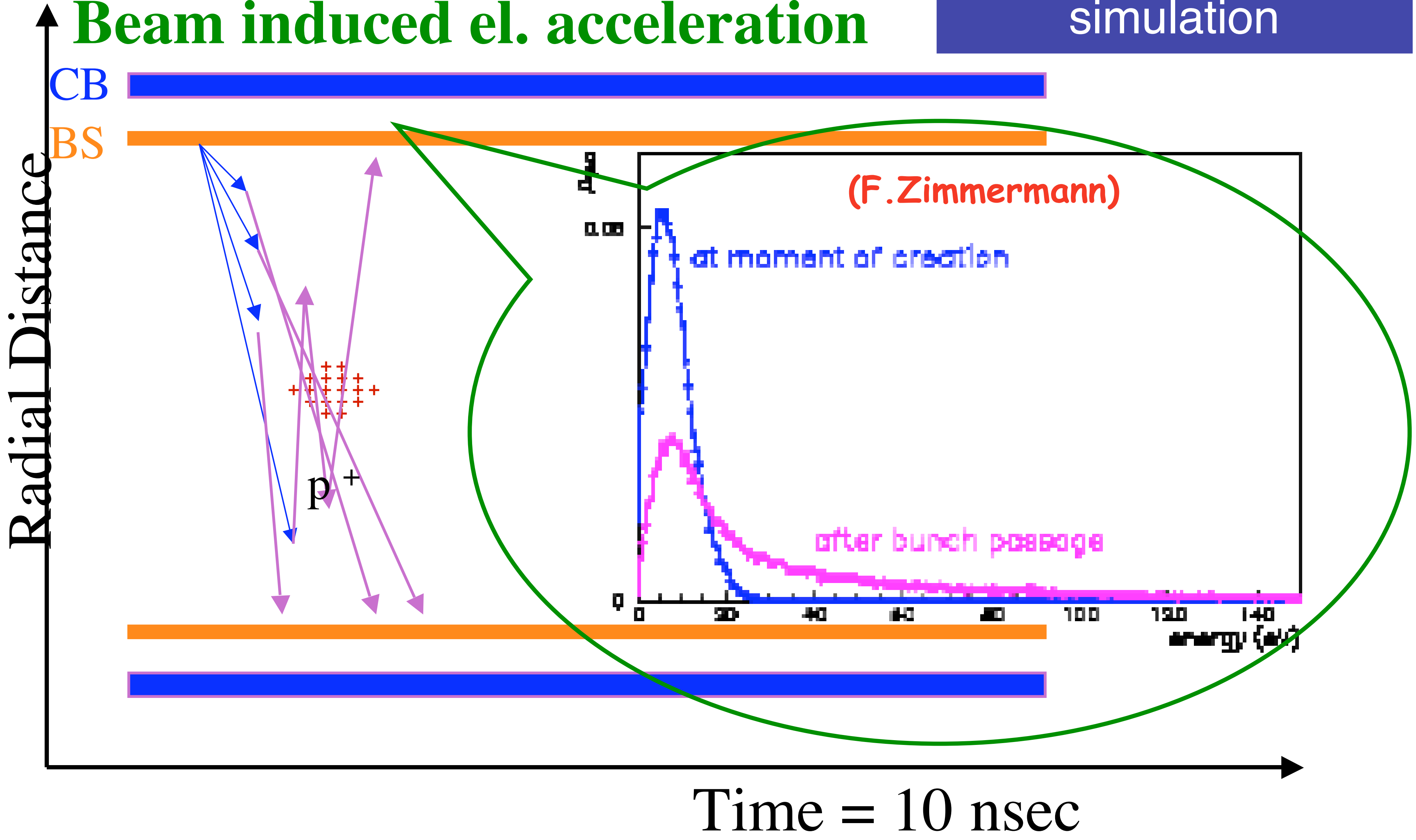




- XUV1 (60-1000 eV)
- XUV2 (5-150 eV)

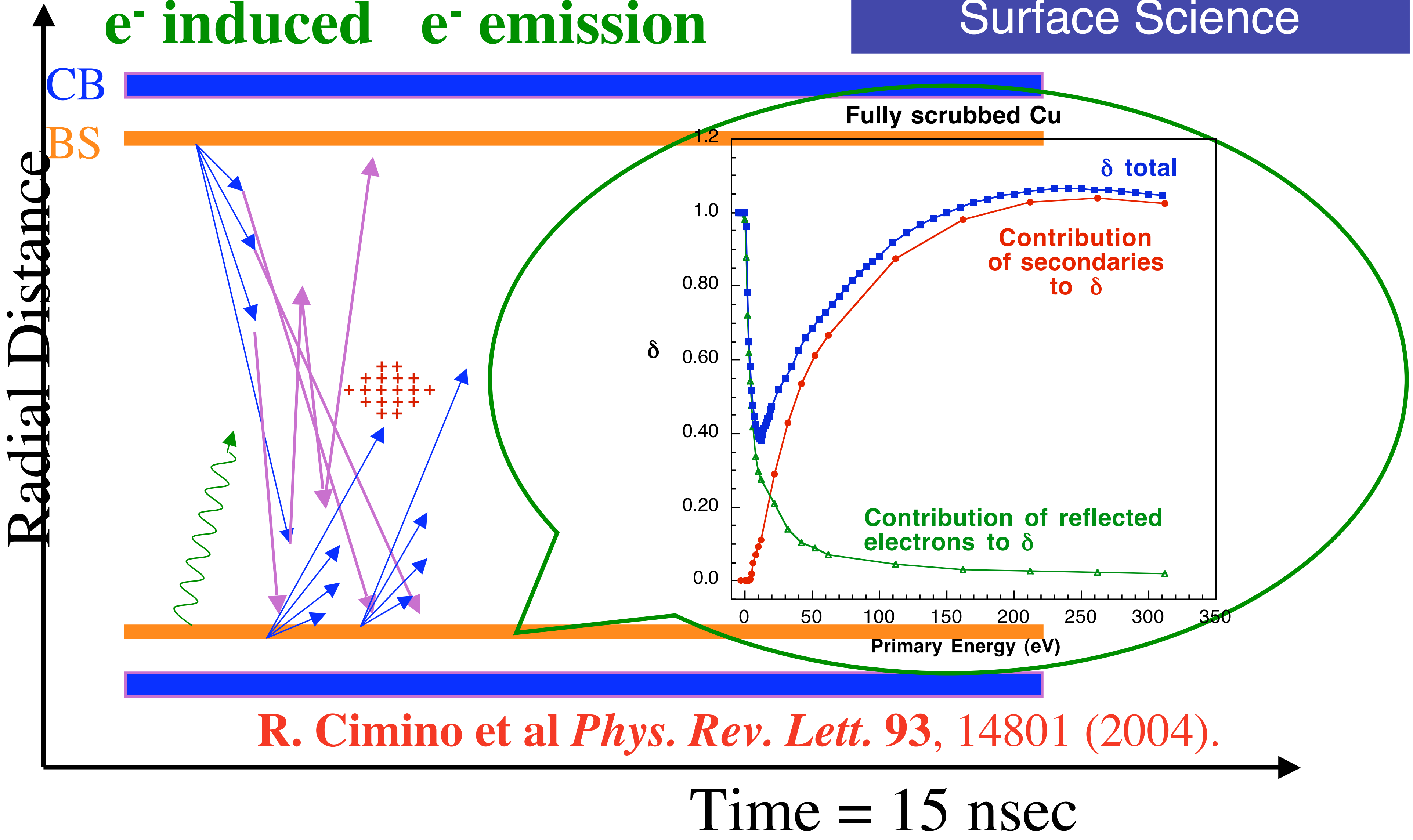
Beam induced el. acceleration

simulation



e^- induced e^- emission

Surface Science

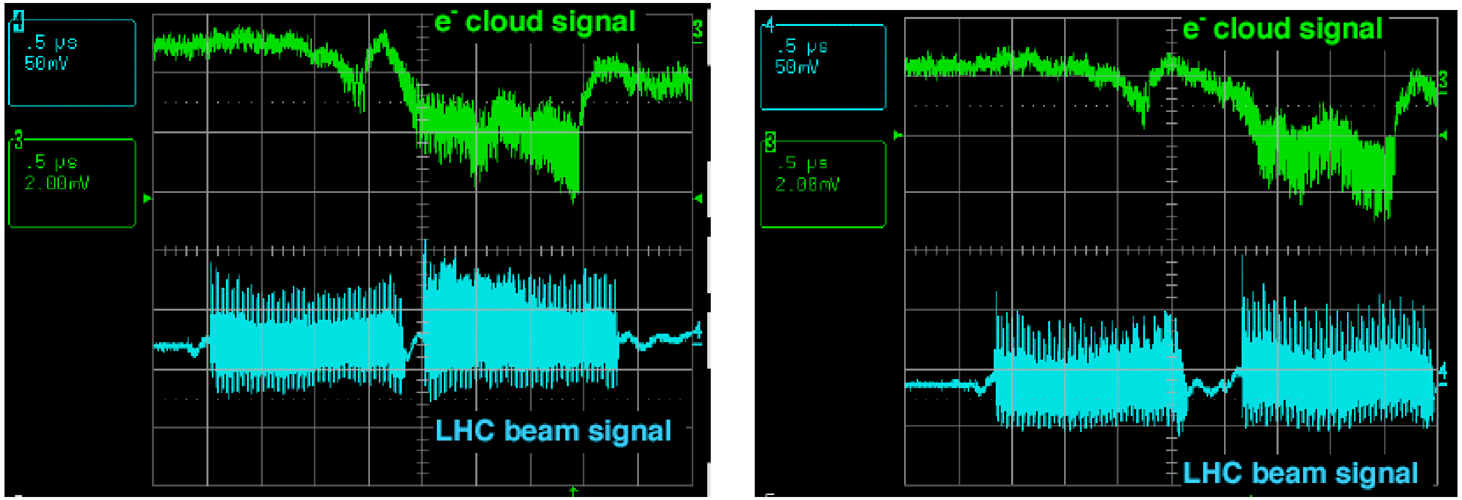


R. Cimino et al *Phys. Rev. Lett.* **93**, 14801 (2004).

Does low energy reflectivity explain the "memory effect"?

- Low energy electrons have a long survival time. This may explain observations at KEK, SPS, PSR, LANL….

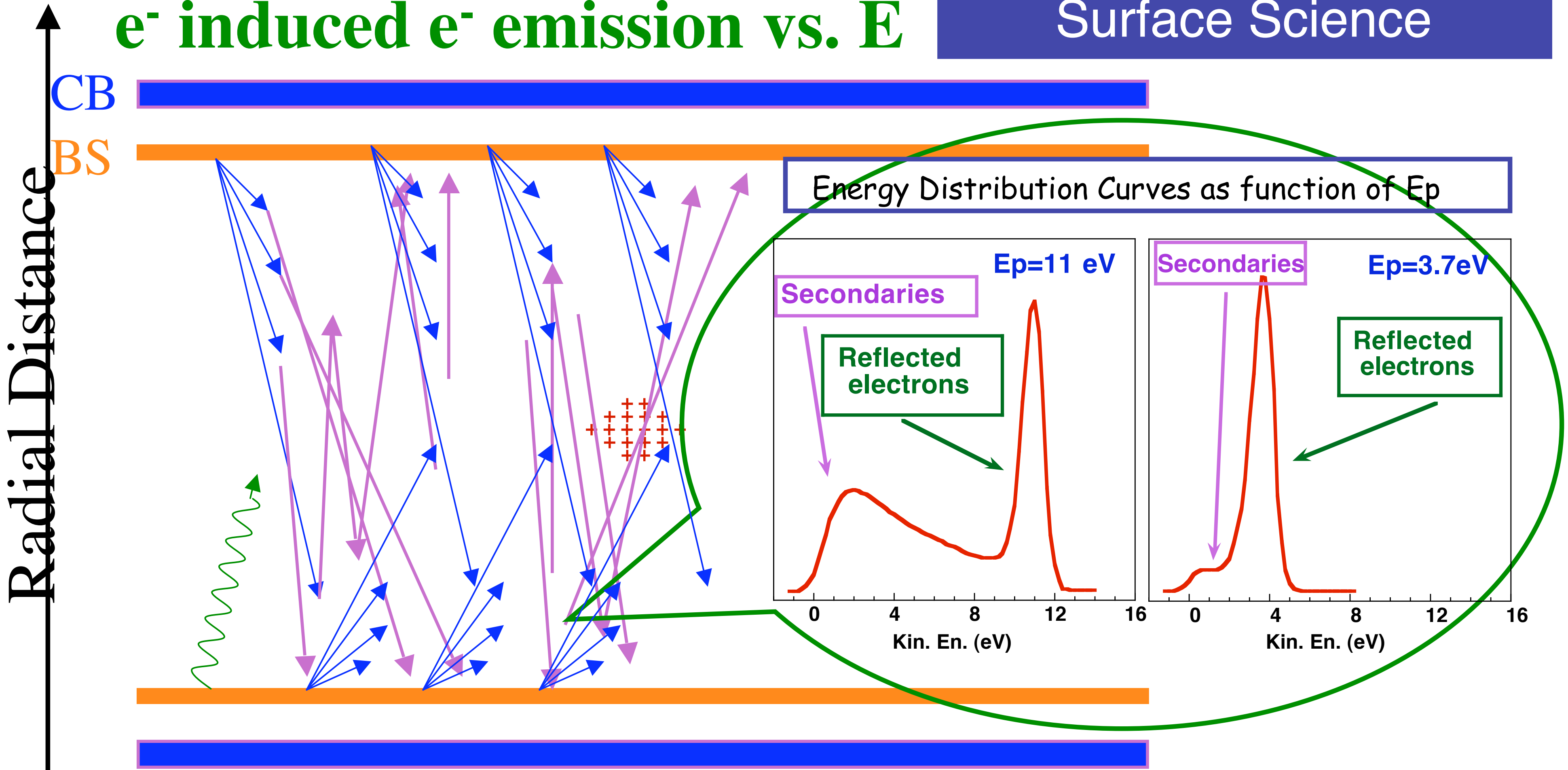
Observed Memory Between Bunch Trains: SPS 2002 (Electron Flux)



SPS pick-up signals for 225-ns and 550-ns spacing between two 72-bunch trains. Memory!

e^- induced e^- emission vs. E

Surface Science

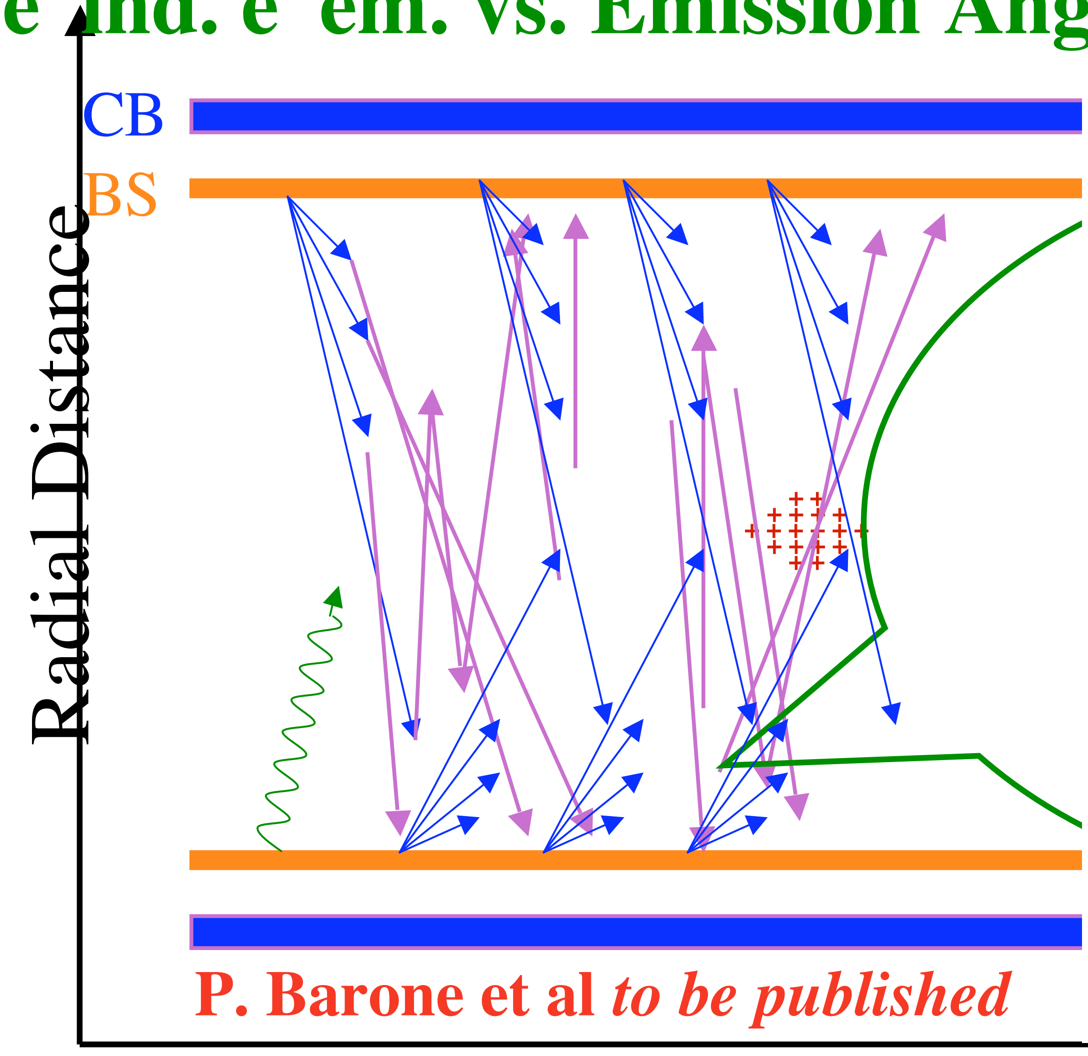


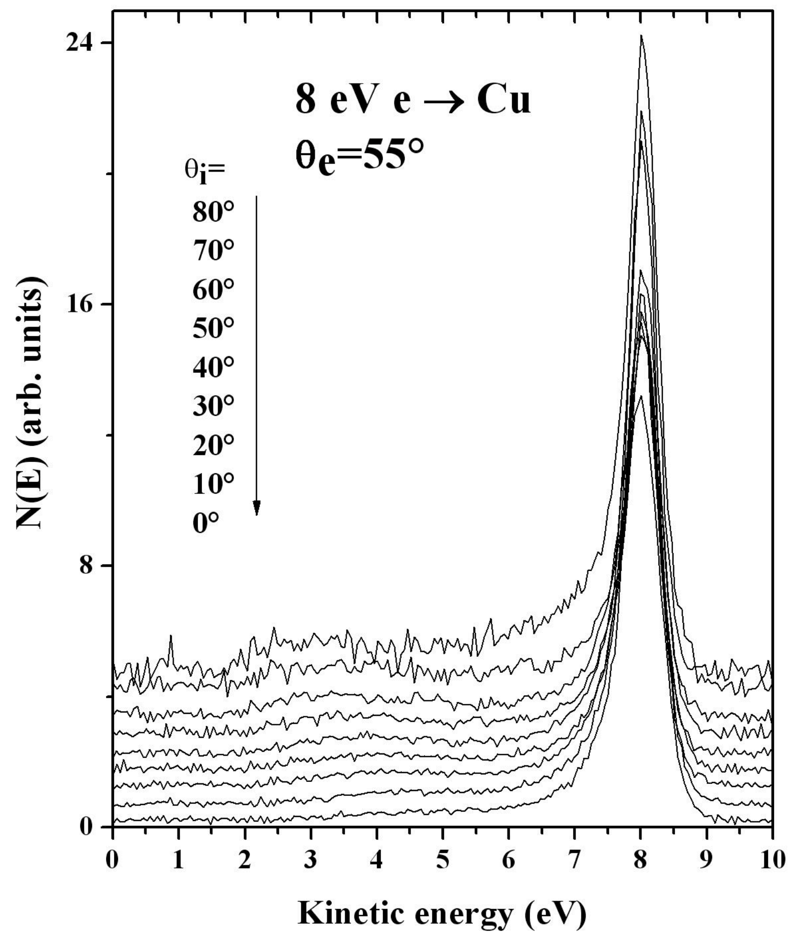
R. Cimino et al *Phys. Rev. Lett.* 93, 14801 (2004).

Time = 20 ns

e^- ind. e^- em. vs. Emission Angle

Surface Science

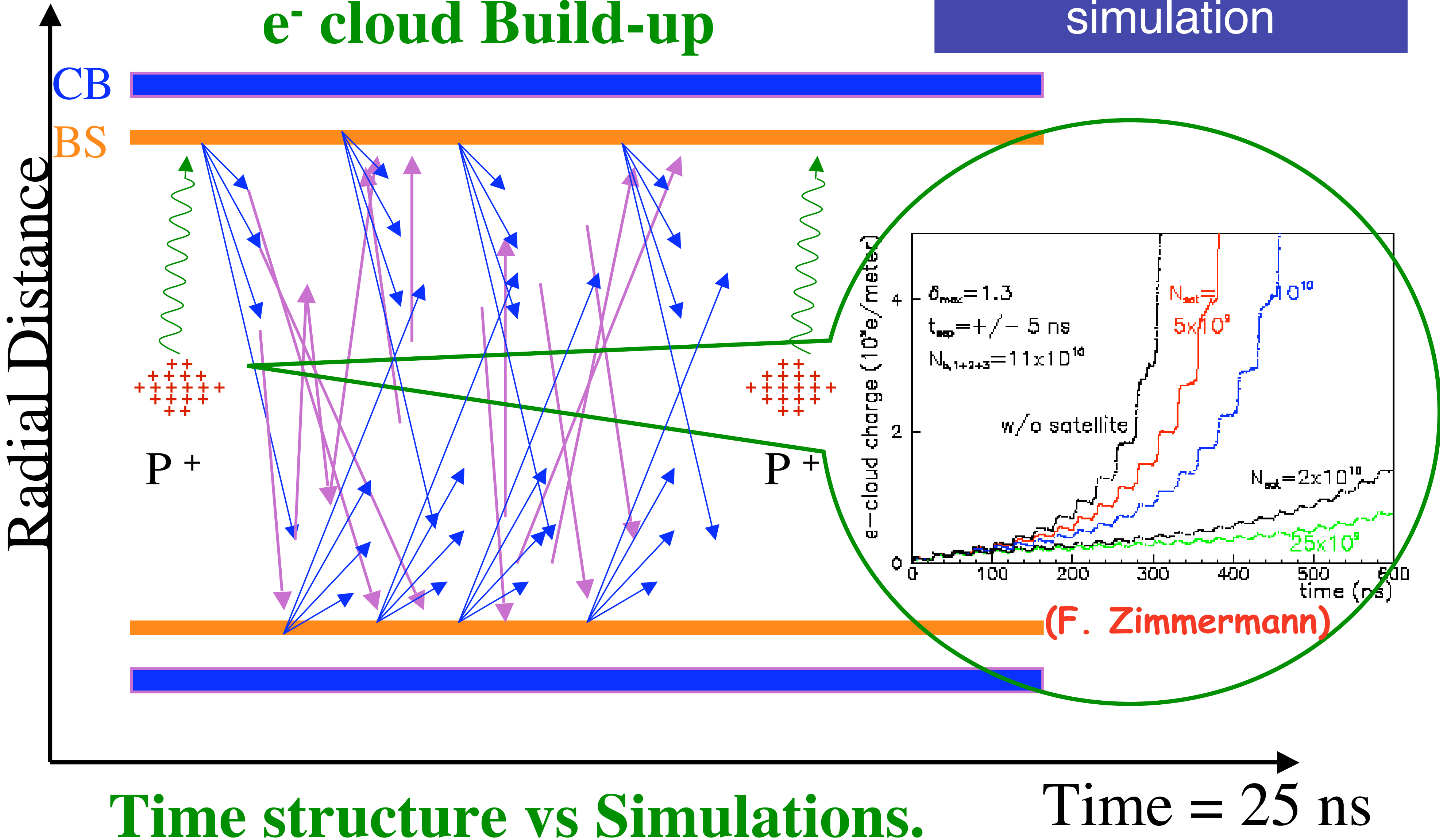




(EDC) from Cu surface vs. incident angle θ_i at a fixed observation angle θ_e=55°,

e⁻ cloud Build-up

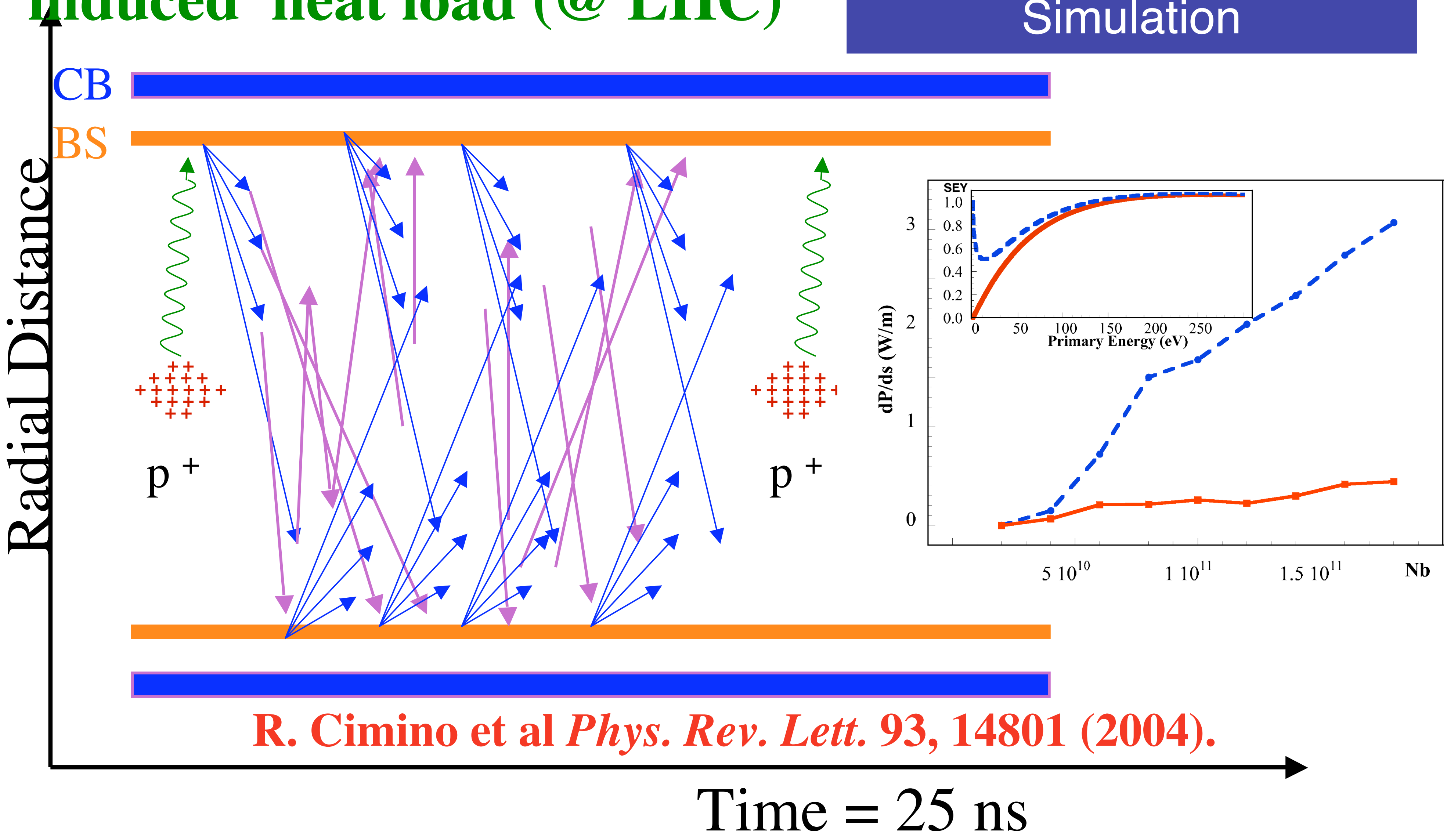
simulation



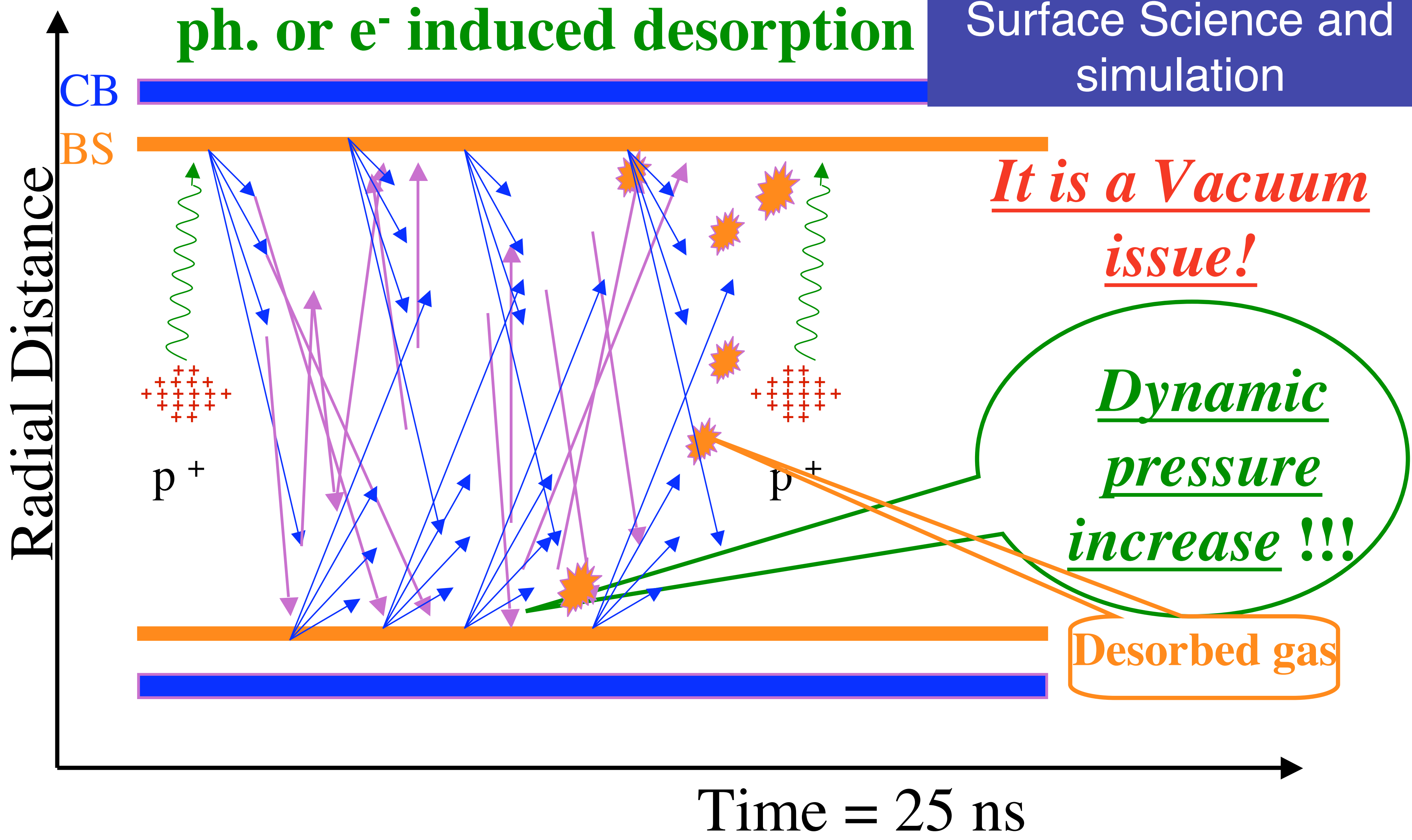
Time structure vs Simulations.

e^- induced heat load (@ LHC)

Simulation



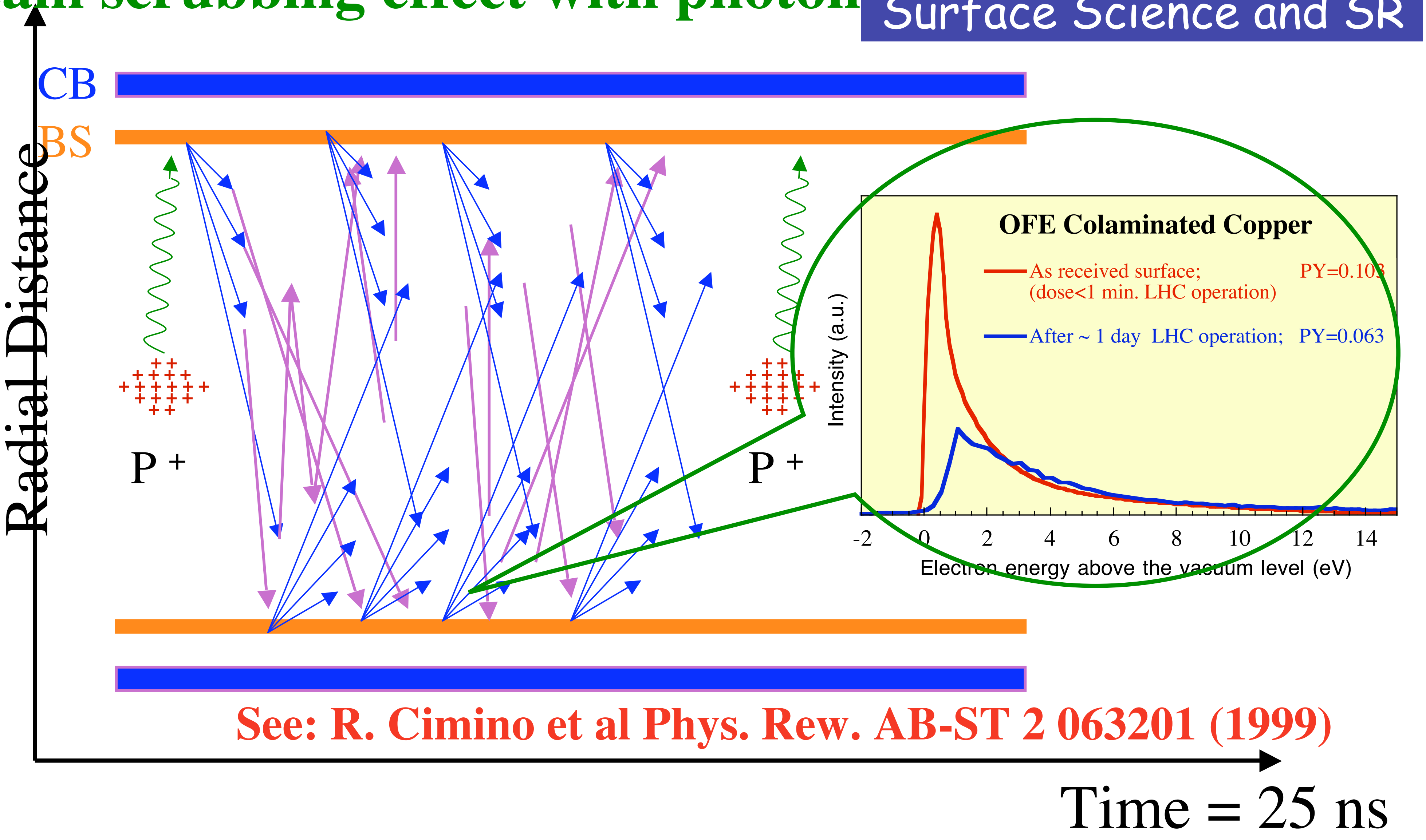
R. Cimino et al *Phys. Rev. Lett.* 93, 14801 (2004).



Surface Science and simulation

Beam scrubbing effect with photon

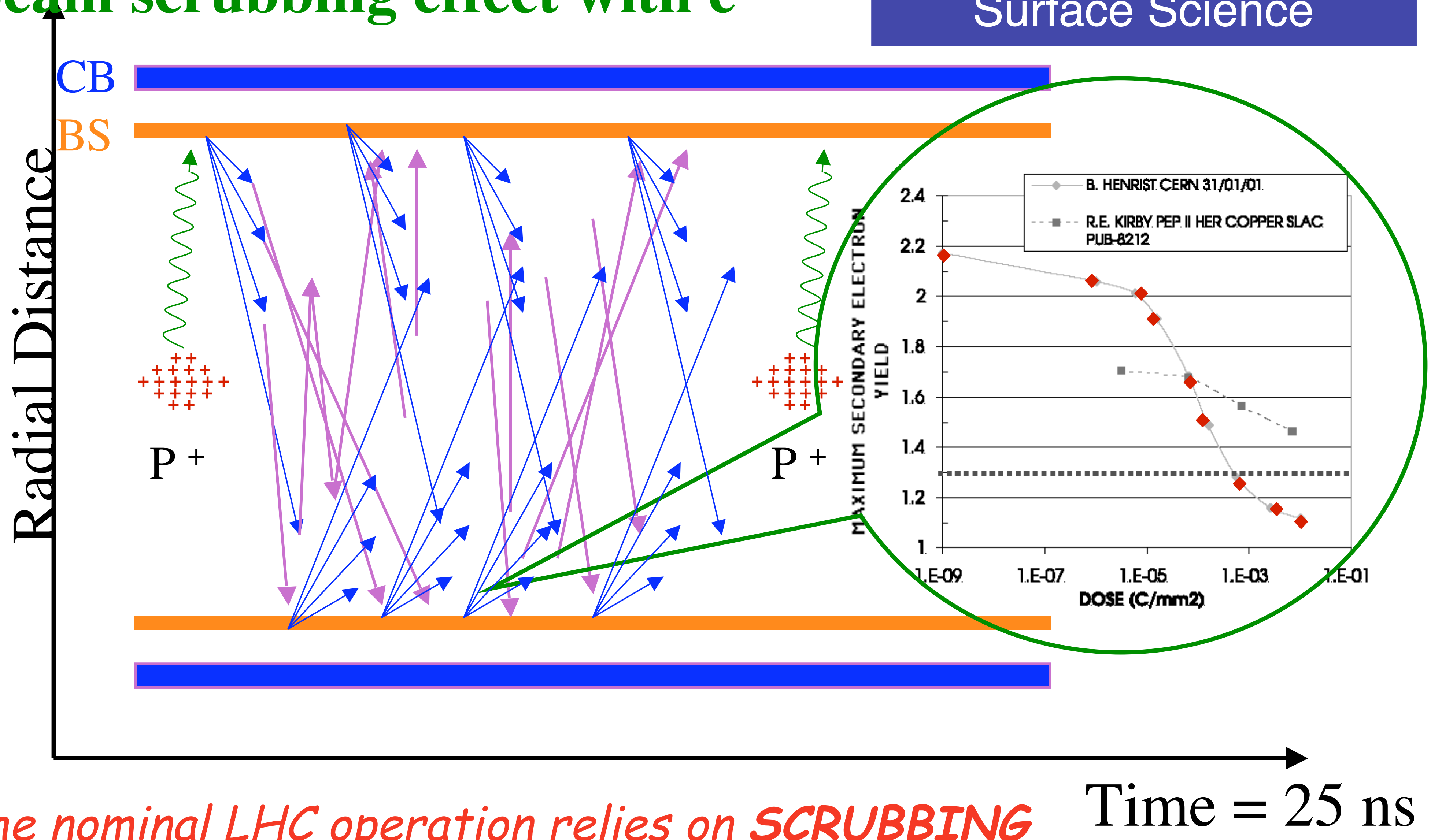
Surface Science and SR



See: R. Cimino et al Phys. Rew. AB-ST 2 063201 (1999)

Beam scrubbing effect with e⁻

Surface Science



The nominal LHC operation relies on ***SCRUBBING***

Scrubbing (LHC) and stability vs. Time(ILC)

from LHC PR 472 (Aug. 2001):

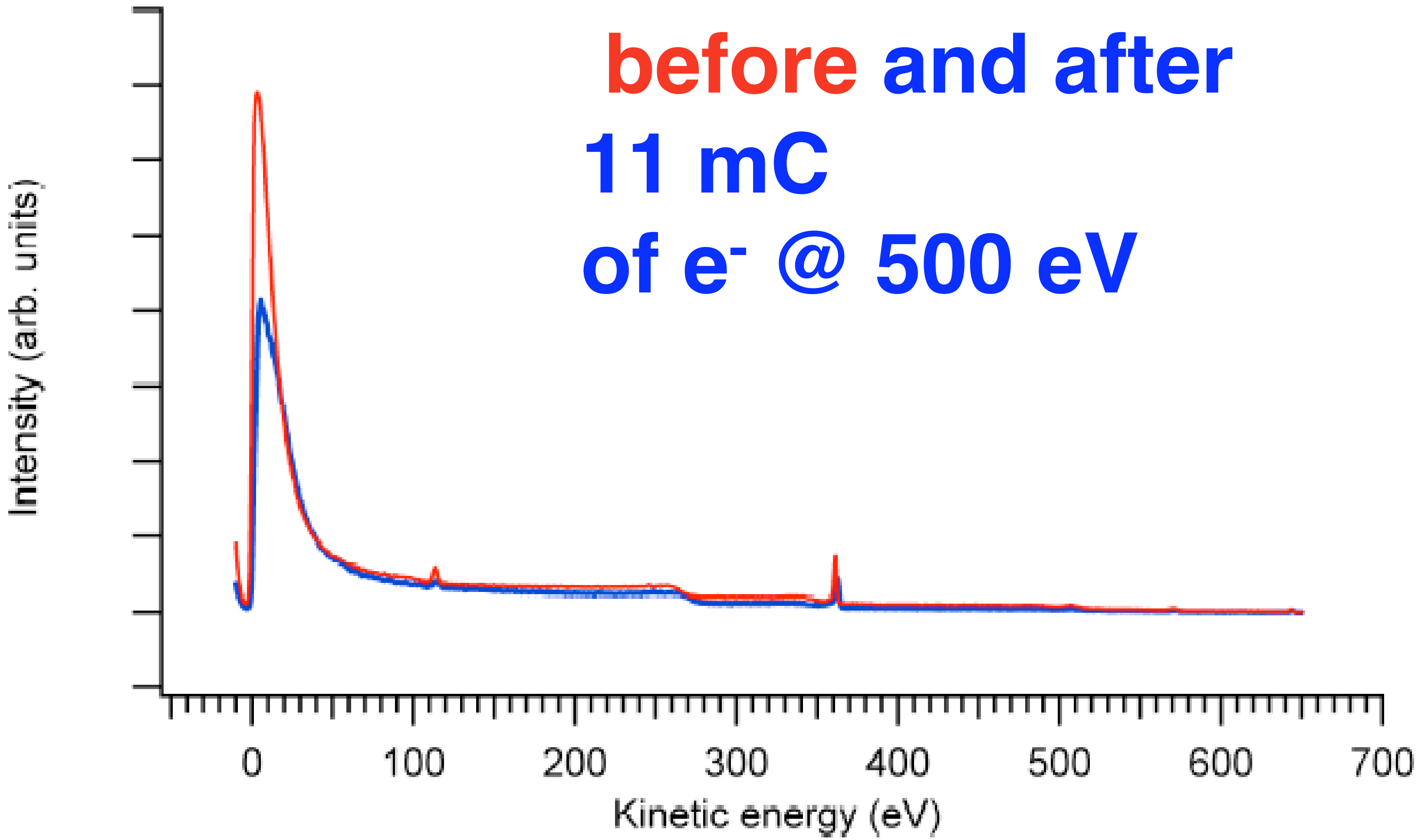
"…Although the phenomenon of conditioning has been obtained reproducibly on many samples, the exact mechanism leading to this effect is not properly understood. This is of course not a comfortable situation as the LHC operation at nominal intensities relies on this effect…"

Surface science

Can give a deeper understanding of the chemical processes occurring at surfaces.

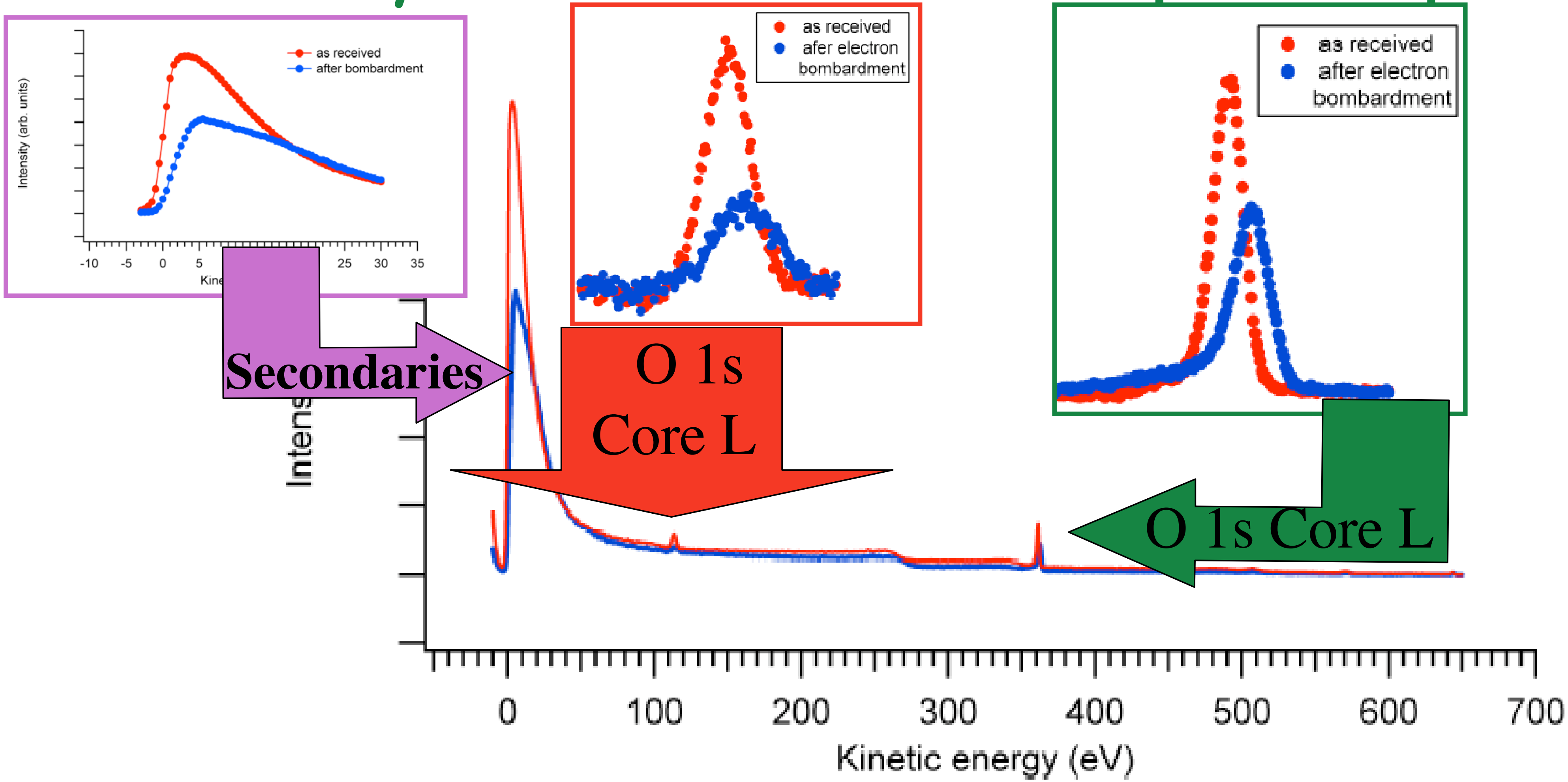
Surface Science vs. Scrubbing on Cu

We can study the chemistry with photoemission



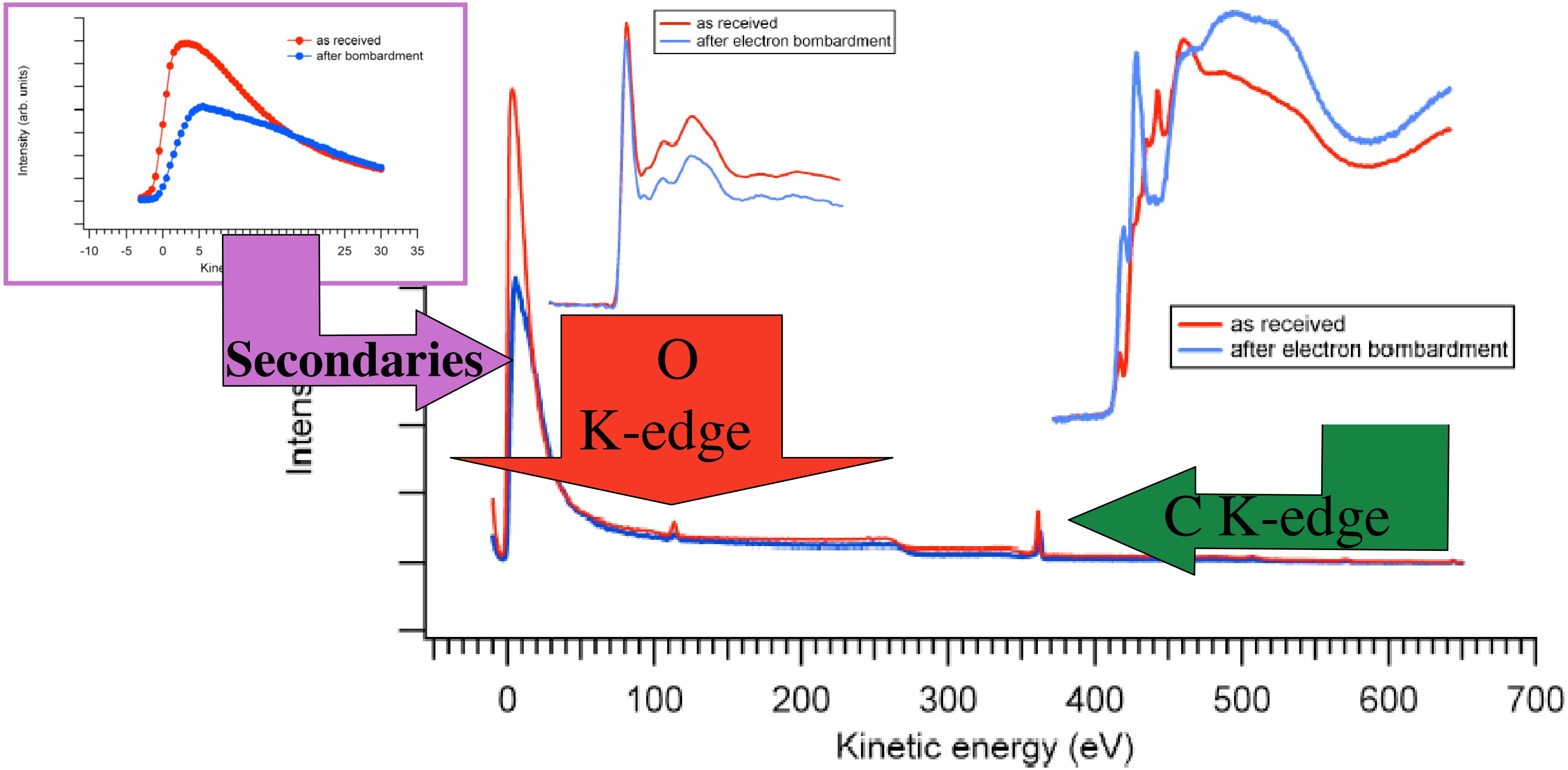
Surface Science vs. Scrubbing on Cu

We can analyze differences with SR-spectroscopies



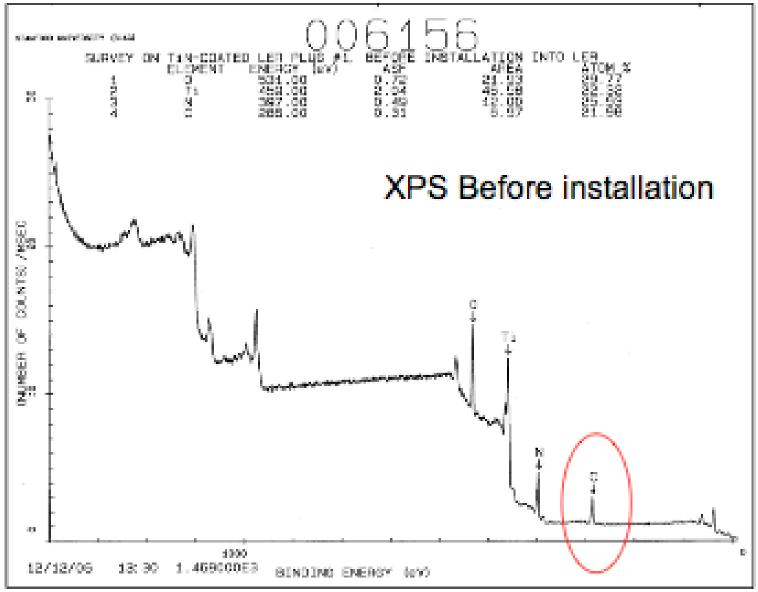
Surface Science vs. Scrubbing on Cu

We can analyze differences with X-ray Absorbtion

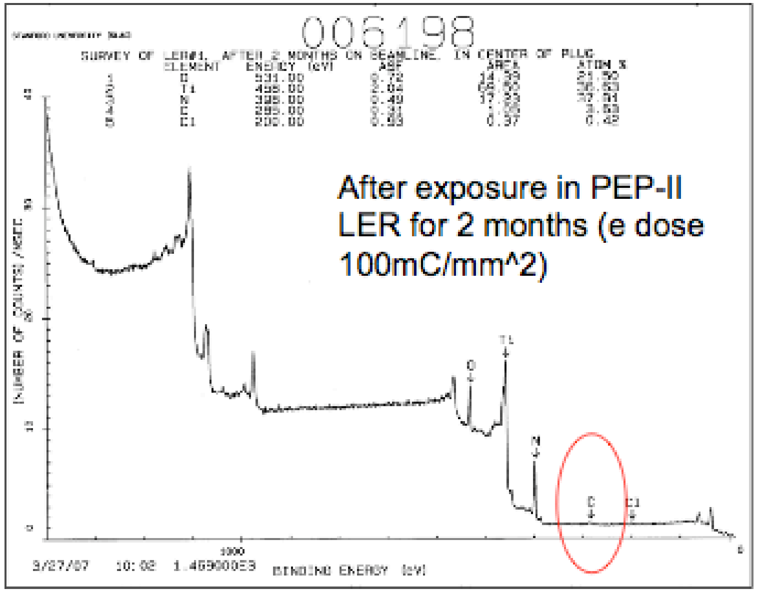


New results from M. Pivi @ e⁻cloud 07

Surface analysis: Carbon content decrease



LER#1 →



Different from electron conditioning in laboratory setup where carbon crystals grows!

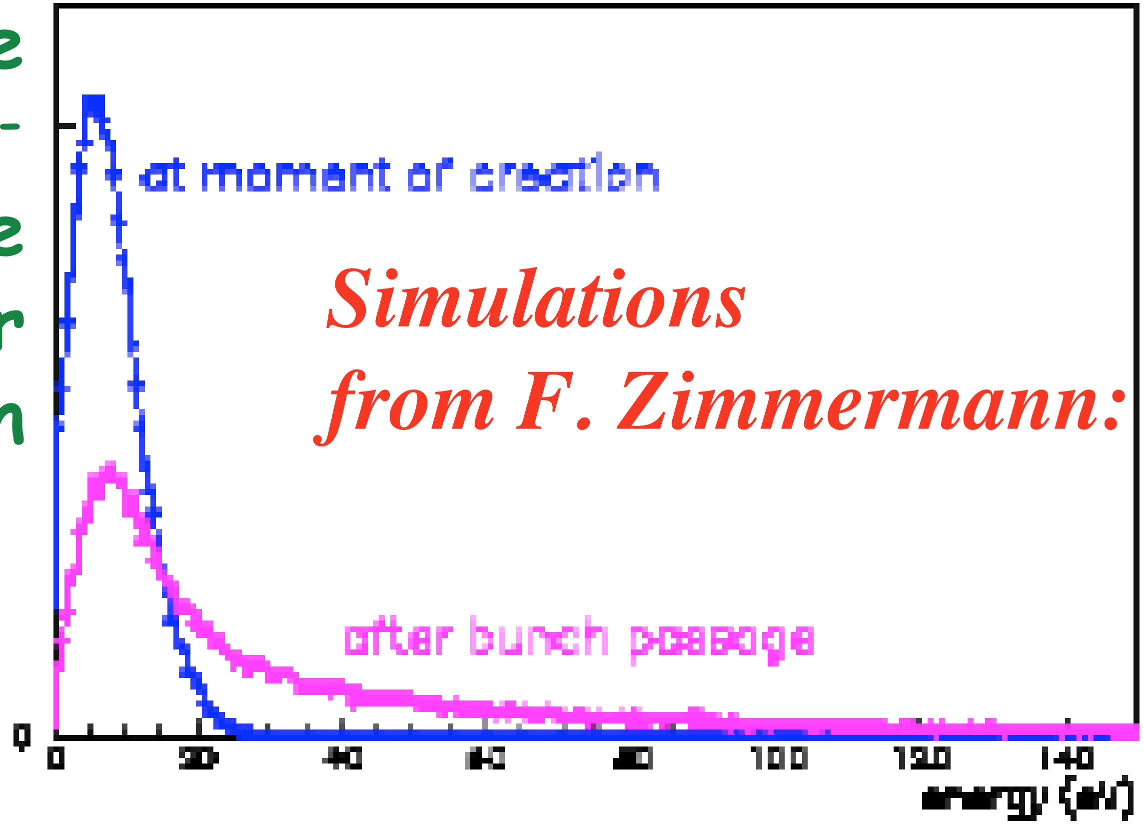
Carbon is strongly reduced if exposed to beam. Same for LER #1 and #2 samples.

Are there differences between Scrubbing (or stability studies vs time) in the laboratory and in the machine?

- **This issue need to be carefully studied, with more realistic input parameters and more powerful spectroscopy analysis.**
- **For the observed differences, we have strong evidence that the actual energy of the electrons responsible for the scrubbing does affect their scrubbing effects and efficiency.**

Are there differences between Scrubbing in the laboratory and in the machine?

We need to measure the actual energy of the e⁻ forming the cloud in the ring and measure their scrubbing efficiency in the lab for all material.



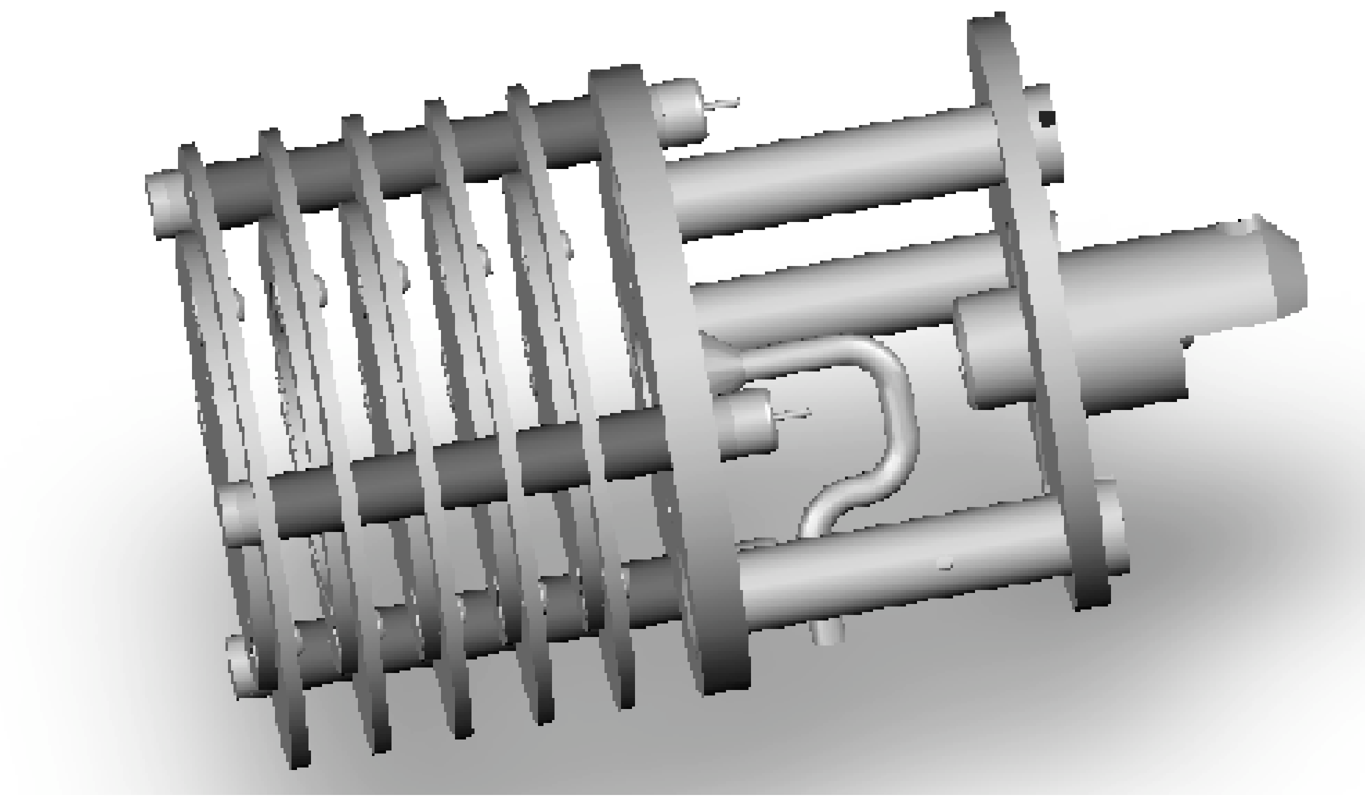
Simulations from F. Zimmermann:

The question being:

Dose= N°e^- x Ee^-(eV) x t(s) xA (mm^2)

does 1 e^- @ 500 eV scrub as 50 e^- @ 10 eV?

At DaΦne we plan to measure it by inserting in the machine Energy-resolved El. Detectors.

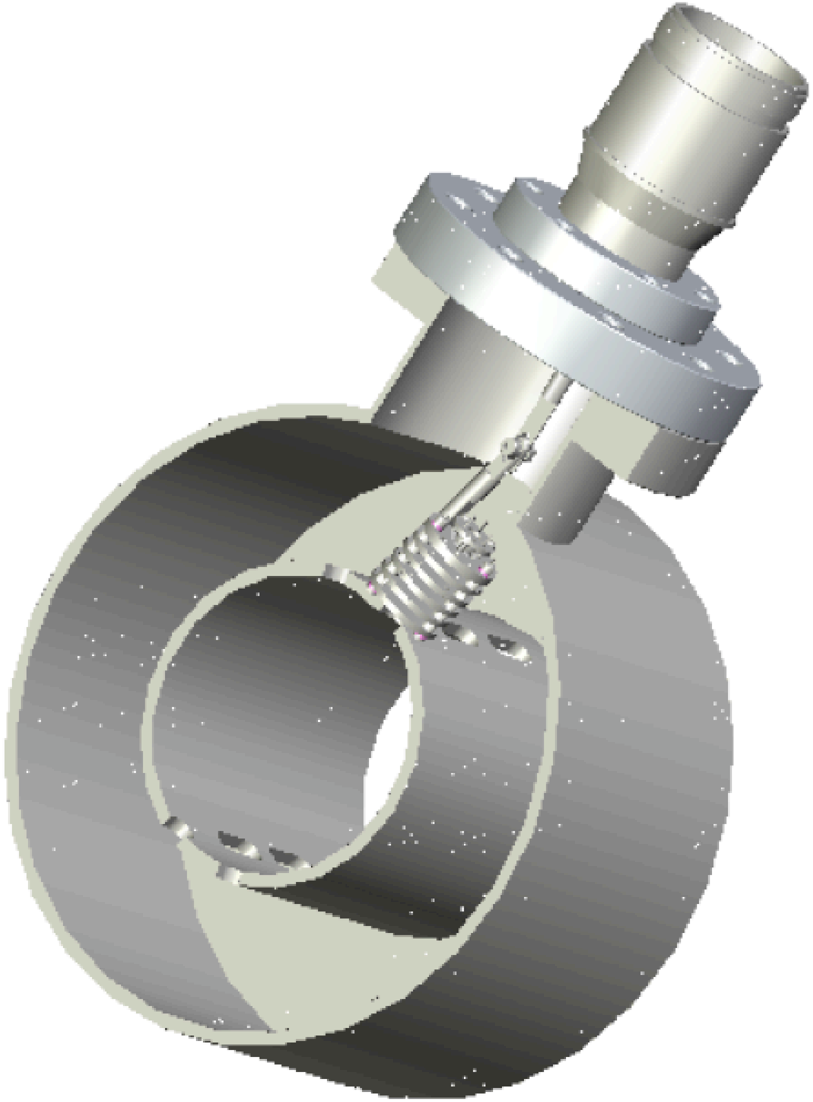


a) 5 grids for:

- mass screening
- energy resolution
- Sensitivty to low energy electrons

b) Channeltron / channelplate for high counting rate

Energy-resolved El. detectors on DaΦne



To be inserted in 3 positions looking trough the existing slots at the beam:

- electron-ring (for reference)
- Positron ring (Uncoated chambrer)
- Positron ring (TiN coated chambrer?)

CONCLUSION:

SURFACE SCIENCE can produce essential inputs to tackle the e-cloud problem.

High quality study and use of frontiers techniques like photoemission with Synchrotron radiation seems to be important to understand material properties as required to correctly predict accelerators performances in presence of an e-cloud.

For ILC-DR one need to circulate Samples, to put resources (also for SR) and manpower to study:

1) 0-1keV Electron induced el. emission yield (SEY)
2) and its angular dependence
3) Photoemission Yield and Photoemission induced el. energy distribution (also Angle resolved!)
4) Photon - reflectivity
5) Electron induced energy distribution curves
6) Heat load
7) Photon and electron induced desorption
8) Surface properties changes during conditioning.
9) Chemical modifications vs. conditioning.
10) Relation between photon and electron conditioning.

… and this on all vacuum high tech. materials…

Acknowledgments:

- C. Vaccarezza, M. Biagini, M. Commisso, P. Barone, A. Bonanno, S. Guiducci, M. Zobov, A. Drago and the LNF-INFN accelerator group
- V. Baglin, G. Bellodi, I.R Collins, M. Furman, O. Gröbner, A. G. Mattewson, M. Pivi, F. Ruggero, G. Rumolo, F. Zimmermann, etc..