Accelerator Technology Department

SUMMARY of SEY and electron cloud build-up with NEG materials

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Outline

- Motivations
- The Secondary Electron Yield of TiZr and TiZrV Non-Evaporable Getter (NEG) thin film coatings
- Simulations for different geometries (code 2002)
- ECLOUD measurements with TiZrV NEG coated chambers and LHC type beam (ECLOUD '04)
- Conclusions

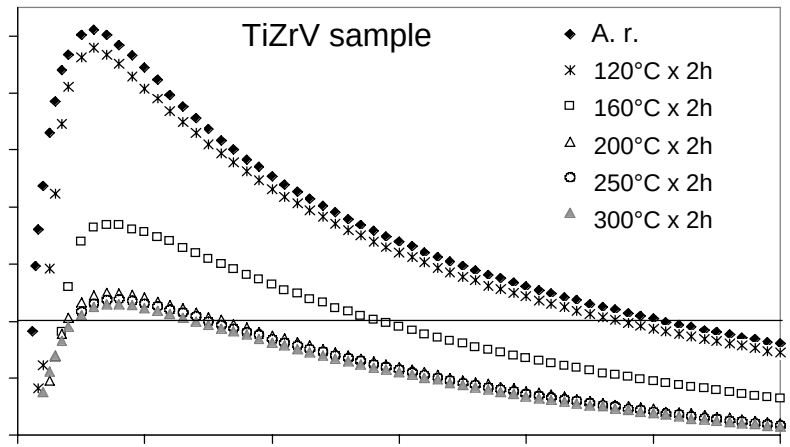
Motivations

- TiZrV Non Evaporable Getter coating baseline for experimental beam vacuum chambers and warm parts of LSS - verify experimentally its effectiveness to reduce the electron cloud build up.

- Experimental beam pipe dimensions vary from 58 mm to 450 mm diameter : study e-cloud for different geometries

The Secondary Electron Yield of TiZr and TiZrV NEG thin film coatings

- Normal PE (Primary Electrons) angle of incidence, 60 eV to 3 keV. PE ~ $5 \cdot 10^{-9}$ A, pulsed, giving a total dose < 10^{-8} C/mm^2 [1].
- TiZr and TiZrV thin film (1μm) deposited onto chemically polished copper substrates [2].
- An important δ_{max} decrease from above 2 to <1.4 already occurs after 2h at 200°C (TiZr) and 160°C (TiZrV), i.e. below the activation temperature [2].
- δ_{max} ~ 1.1 after 2h at 250°C (TiZr) and 200°C (TiZrV) [2].



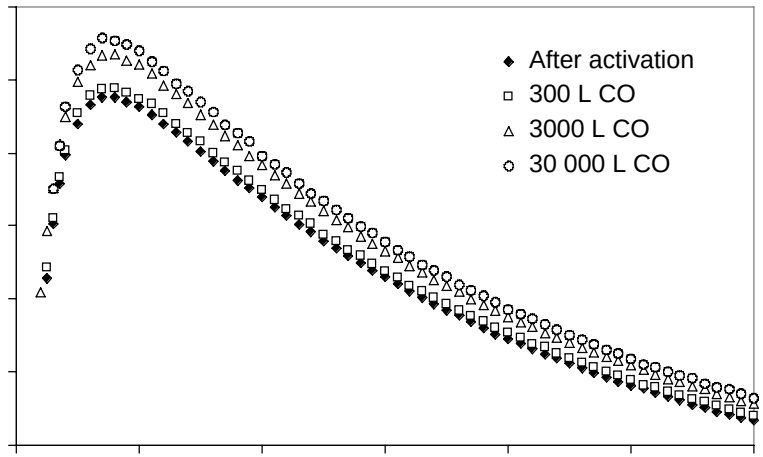
Courtesy of C. Scheuerlein

The Secondary Electron Yield of TiZr and TiZrV NEG thin film coatings

- After H_2, H_2O*, CO and CO_2* exposure (30000 L✦) $\Delta\delta_{max}<0.1$ [2], [3].
- After several times opening to air and reconditioning□ (250°C x 24h) $\delta_{max} \sim 1.4$ [4].

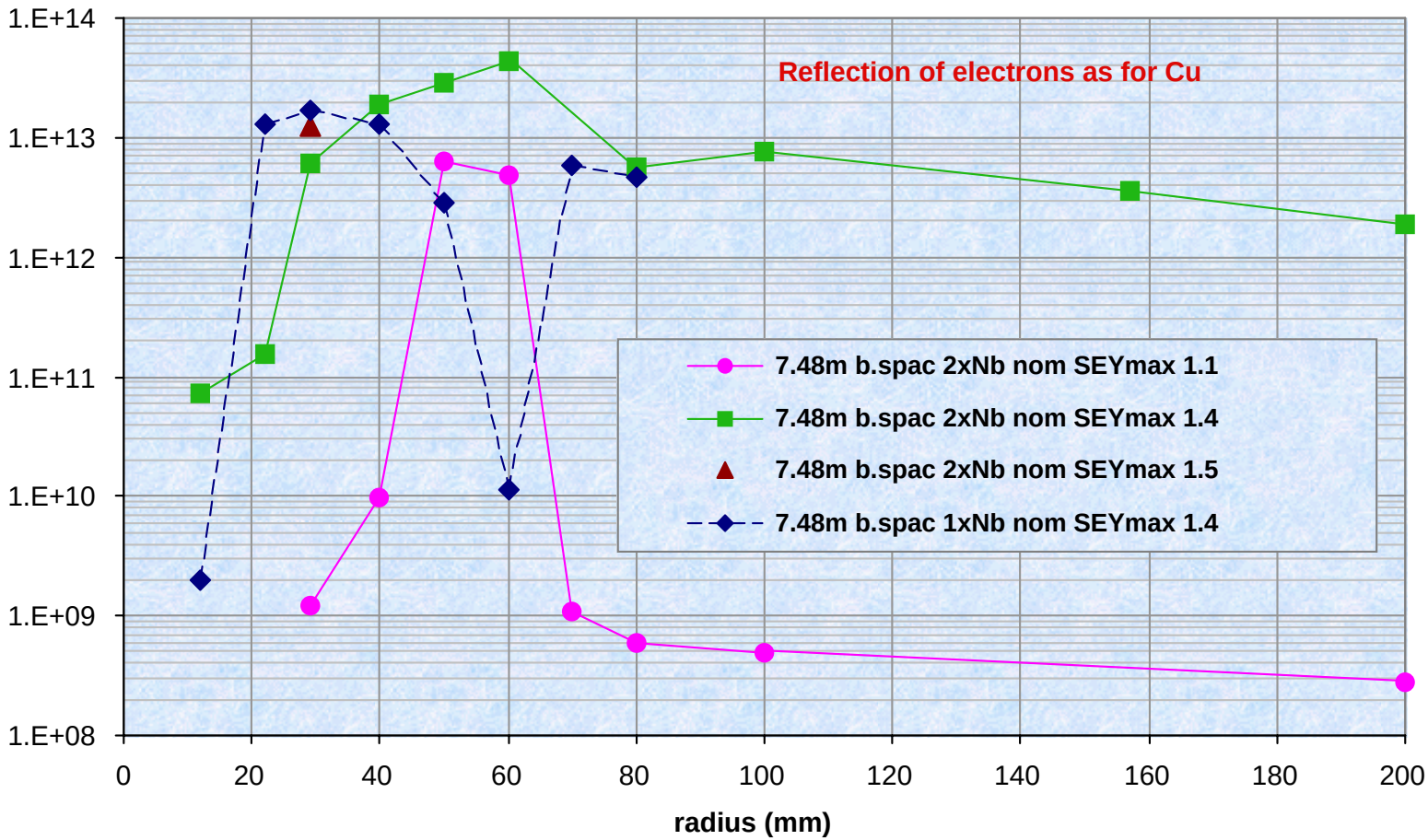
* substrate 316LN stainless steel
✦ 1 L (Langmuir) = 10^{-6} torr.s
□ small NEG sample and big stainless steel area

Influence of CO exposure on the SEY of a TiZrV coating which was activated during 2 h at 300 °C and cooled to 60 °C before the CO exposure.



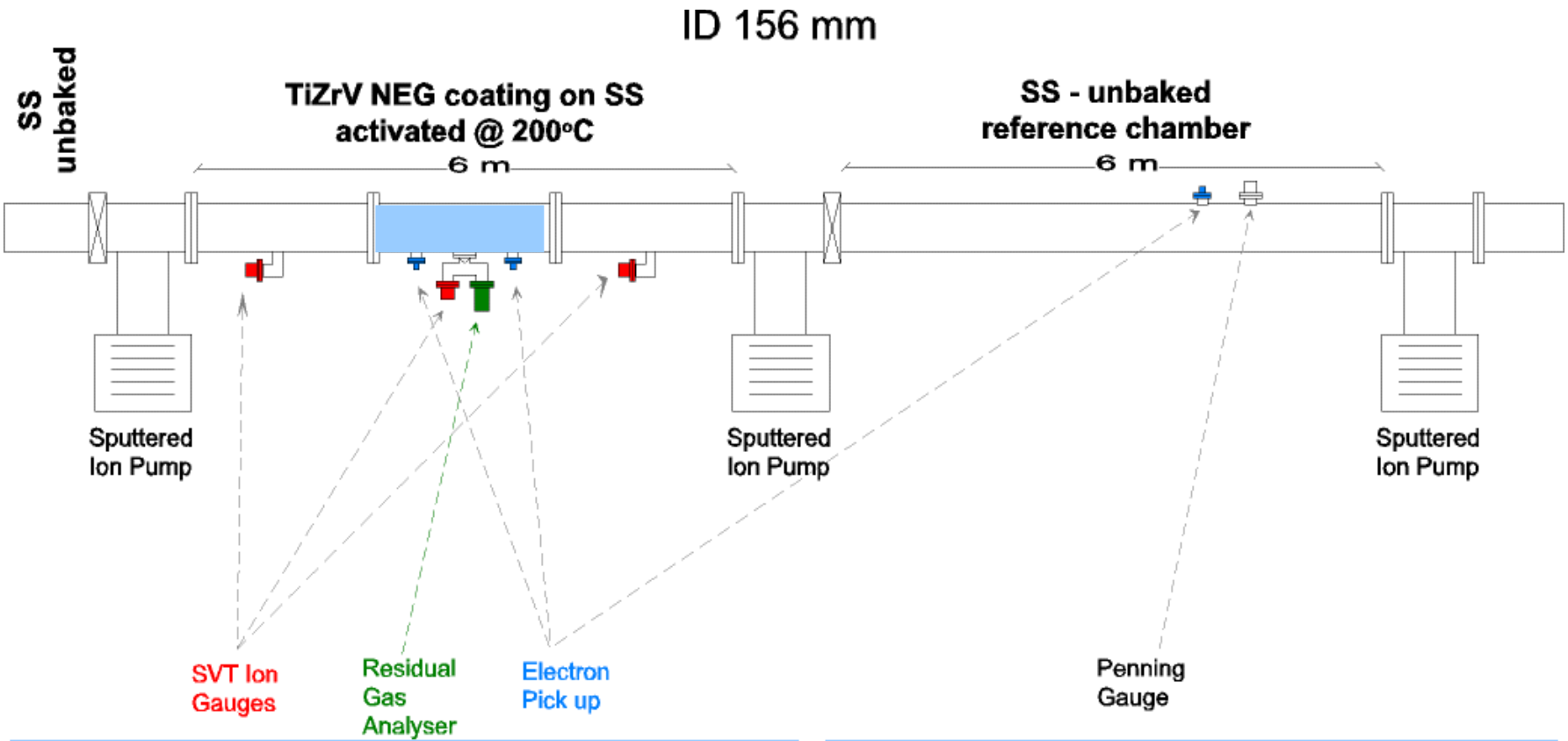
Courtesy of C. Scheuerlein

Electron cloud simulation results (code as in 2002)



A. Rossi, G. Rumolo, f. Zimmeraman, presented at ECLOUD'02

ECLOUD measurements Experimental Layout



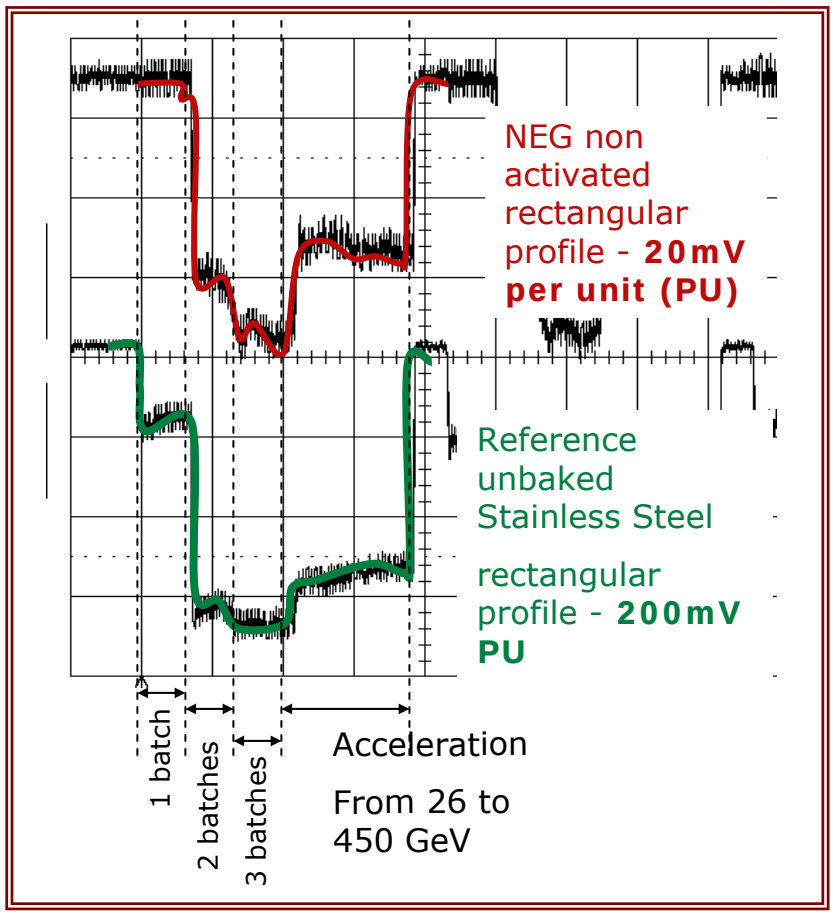
Central NEG chamber ID156mm and rectangular profile (H=129mm, V=51.5mm)

Pick up used as condenser

1. Non-activated NEG

3 batches x 72 bunches (26 to 450 GeV)

$N_b = 1 \cdot 10^{11}$ p/bunch



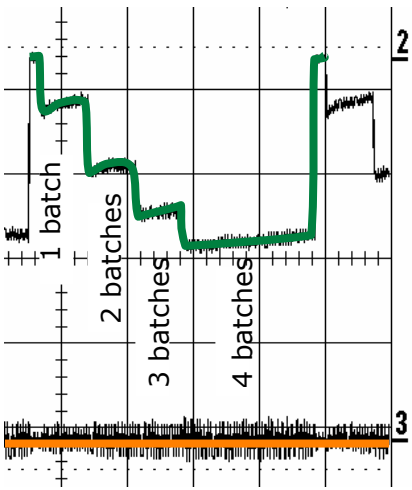
- Measured with rectangular geometry. No difference expected with cylindrical geometry.
- Unconditioned NEG shows electron activity (note the different scales for the two curves)

2. NEG activated and saturated

batches x 72 bunches (26 GeV)

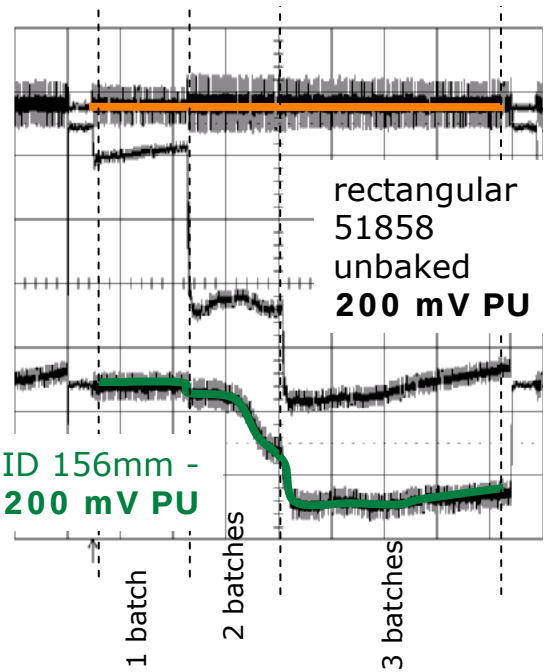
$N_b = 1 \cdot 10^{11}$ p / bunch

Reference unbaked Stainless Steel rectangular profile - **5V PU**

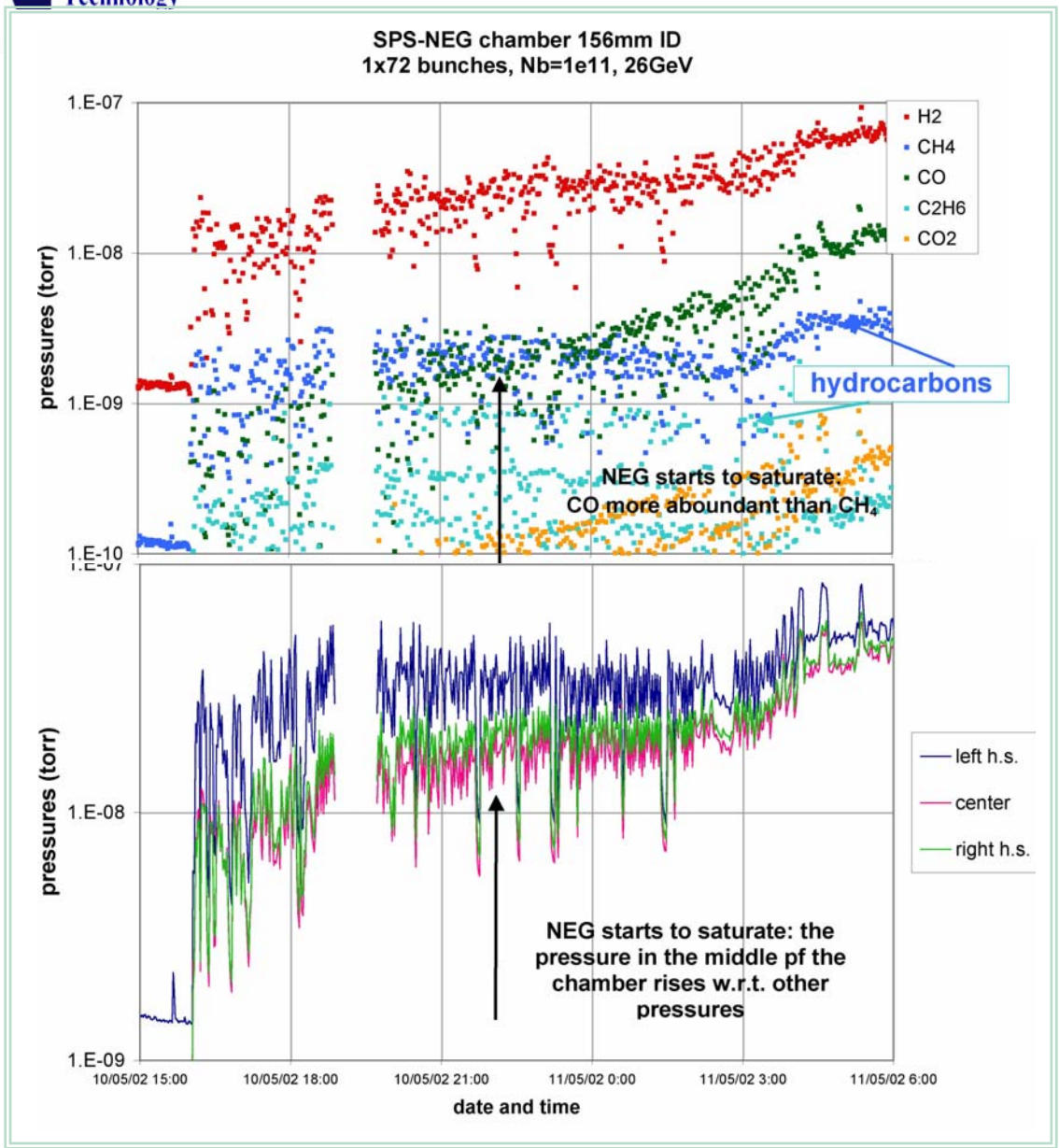


NEG - activated 250°Cx2h + saturated rectangular - **100 mV PU**

NEG - activated 200°Cx24h + saturated ID 156mm - **50 mV PU**



- Activated NEG shows **NO** electron activity (note the different scales for the curves)



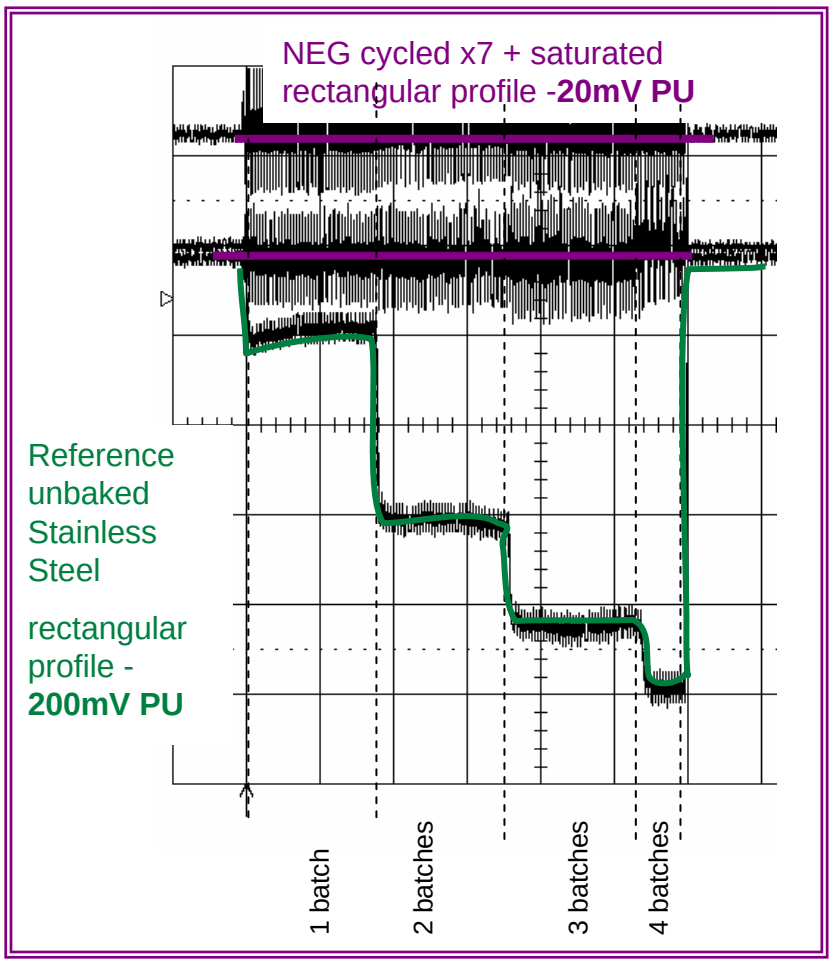
Evidence of NEG saturation

- Before saturation H_2 and CH_4 main gas species. After saturation CO signal > CH_4
- Pressure in the central chamber lowest before saturation (NEG pumping).

3. NEG cycled 7 times and saturated

4 batches x 72 bunches (26 to 450 GeV)

$N_b = 1.1 \cdot 10^{11}$ p/bunch



- Rectangular geometry.
- Cycles NEG (250°Cx3h) shows **NO** electron activity (note the different scales)

ECLOUD measurements: results

	Expected δ_{max}	
1. Non-activated NEG	> 2	ECLOUD
2. NEG activated and saturated	~ 1.2	NO ECLOUD
3. NEG cycled (exposed to air at atmospheric pressure and re-conditioned) 7 times	≤ 1.4	NO ECLOUD

Summary: lab measurements

- TiZr and TiZrV NEG coating are characterised by low SEY:
  - δ_{max} <1.4 after 2h at 200°C (TiZr) and 160°C (TiZrV)
  - δ_{max} ~ 1.1 after 2h at 250°C (TiZr) and 200°C (TiZrV).
- Saturating an activated NEG under vacuum affects the SEY much less than air exposure ($\Delta\delta_{max}$ ~ 0.1).
- After several venting cycles (250°Cx24h) δ_{max} <~ 1.4.

Summary: electron cloud measurements in an accelerator

- Evidence that TiZrV NEG coating will limit electron cloud build up after activation and saturation at low pressure.
- Exposure to air leads to SEY high enough for electron cloud build-up.
- NEG δ_{max} and E_{max} after venting cycles (250°Cx3h) does not cause multipacting.

➢ ECLOUD measurements confirm SEY results.

Future work

- Repeat simulations of e-cloud as a function of chamber geometry, in absence of magnetic field.

Acknowledgments

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References

[1] C. Scheuerlein, I. Bojko, N. Hilleret, J. Vac. Sci. Technol. A 18(3), May/Jun 2000 972-979.

[2] C. Scheuerlein, B. Henrist, N. Hilleret, M. Taborelli, Applied Surface Science 172(2001) 95-102.

[3] C. Scheuerlein, B. Henrist and N. Hilleret, CERN Vacuum Technical Note 98-08, CERN, Geneva, Apr. 1998

[4] C. Scheuerlein and B. Henrist, CERN Vacuum Technical Note 98-20, CERN, Geneva, Aug. 1998

References

[1] C. Scheuerlein, I. Bojko, N. Hilleret, J. Vac. Sci. Technol. A 18(3), May/Jun 2000 972-979.

[2] C. Scheuerlein, B. Henrist, N. Hilleret, M. Taborelli, Applied Surface Science 172(2001) 95-102.

[3] C. Scheuerlein, B. Henrist and N. Hilleret, CERN Vacuum Technical Note 98-08, CERN, Geneva, Apr. 1998

[4] C. Scheuerlein and B. Henrist, CERN Vacuum Technical Note 98-20, CERN, Geneva, Aug. 1998

NEG activation cycle