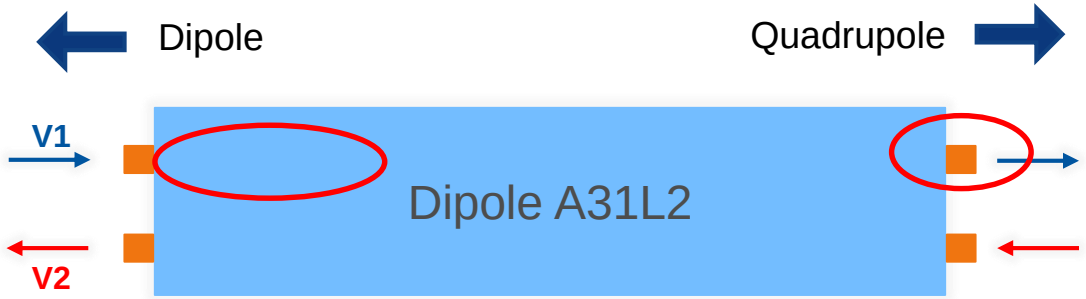
SEY measurements of the arc 1-2 removed-magnet beam screen

Valentine Petit 05.04.2017

Outline

- Global configuration and aim of the study
- Characterisation techniques
- Analysed components
- Results
- Conclusions and perspectives

Global configuration and aim of the study



04.01.17
- Nitrogen venting
- Filtered air (RF ball)

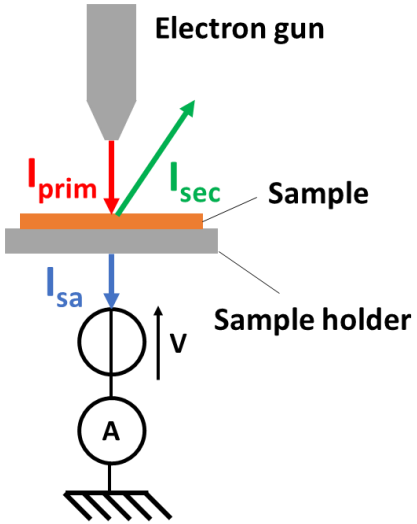
10.01.17
- Dipole extraction

Investigate surface modifications due to exposure to the e-cloud in the machine
- Secondary Electron Yield reduction (conditioning)
- Surface chemistry modification

Air exposure : deconditioning

Characterisation techniques

- SEY measurements

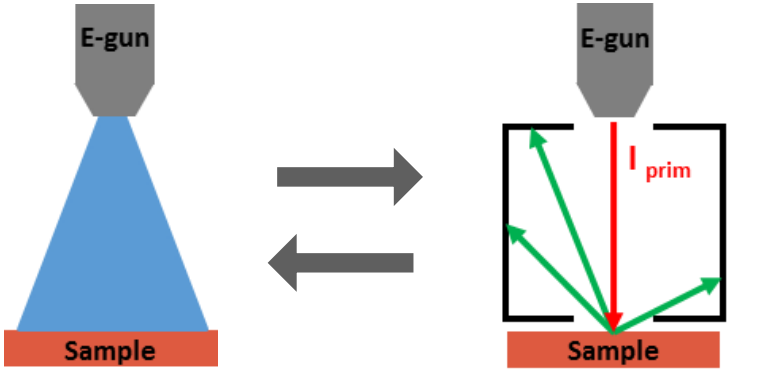


- $\delta(E) = \frac{I_{sec}(E)}{I_{prim}(E)}$
- $I_{prim} = I_{sec} + I_{sample}$
- Dose received by the sample during a measurement : 10^{-7} C/mm² (no conditioning effect)
- Reproducibility (twice the same point) : ± 0.02
- Reproducibility (day by day) : ± 0.05

Characterisation techniques

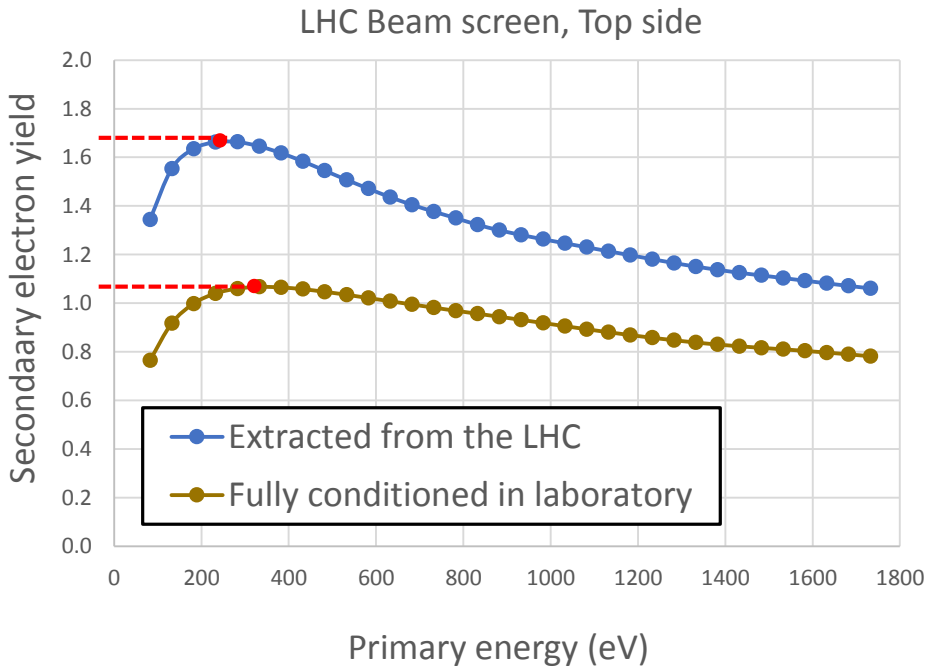
- Conditioning in laboratory

Follow up of maximum SEY versus irradiation dose



Irradiation by electrons
E_p = 250 eV

SEY measurement



Characterisation techniques

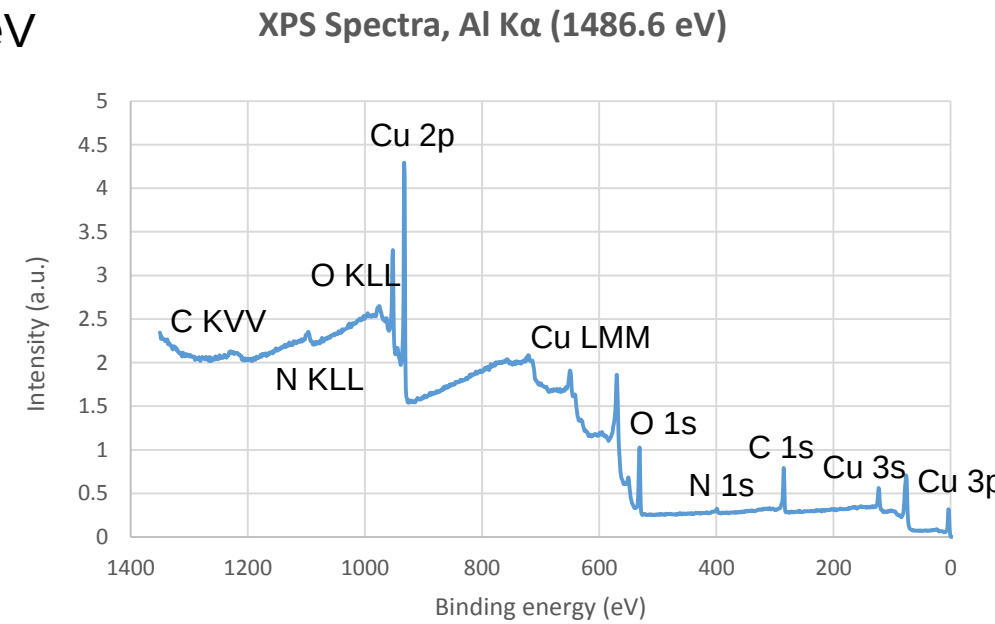
- X-Ray photoelectron spectroscopy

  - Analysis of surface chemical composition

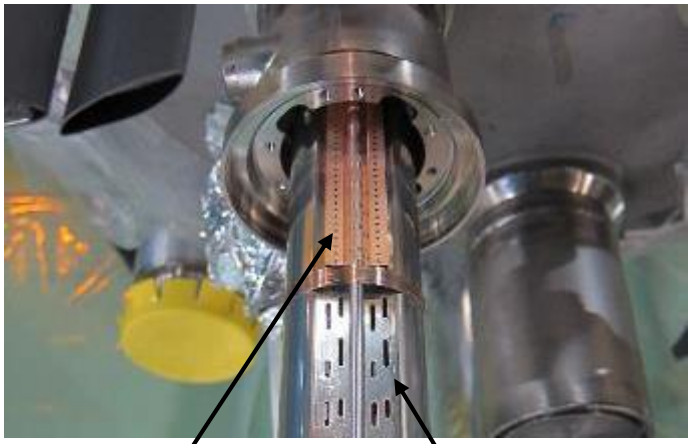
    Probed thickness : few nm
  - Irradiation with photons E = 1486.6 eV
  - Emission of photoelectrons

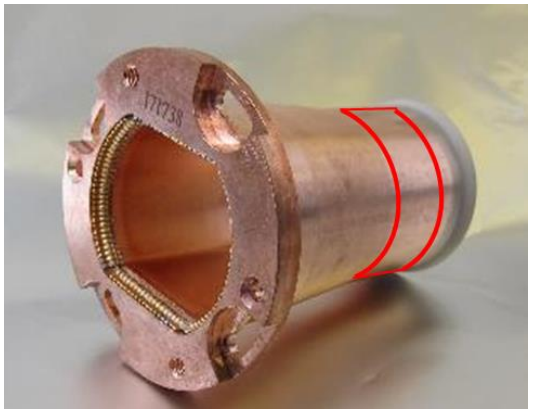
$$E_k = h\nu - E_{binding} - \Phi_s$$

  - chemical environment
  - specific for each element

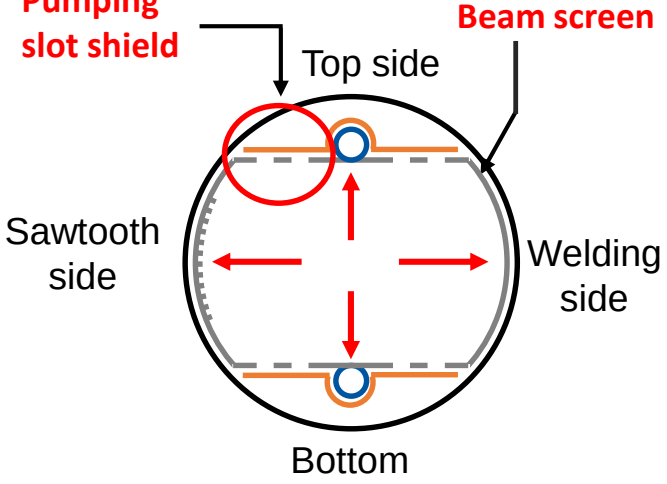


Analysed components



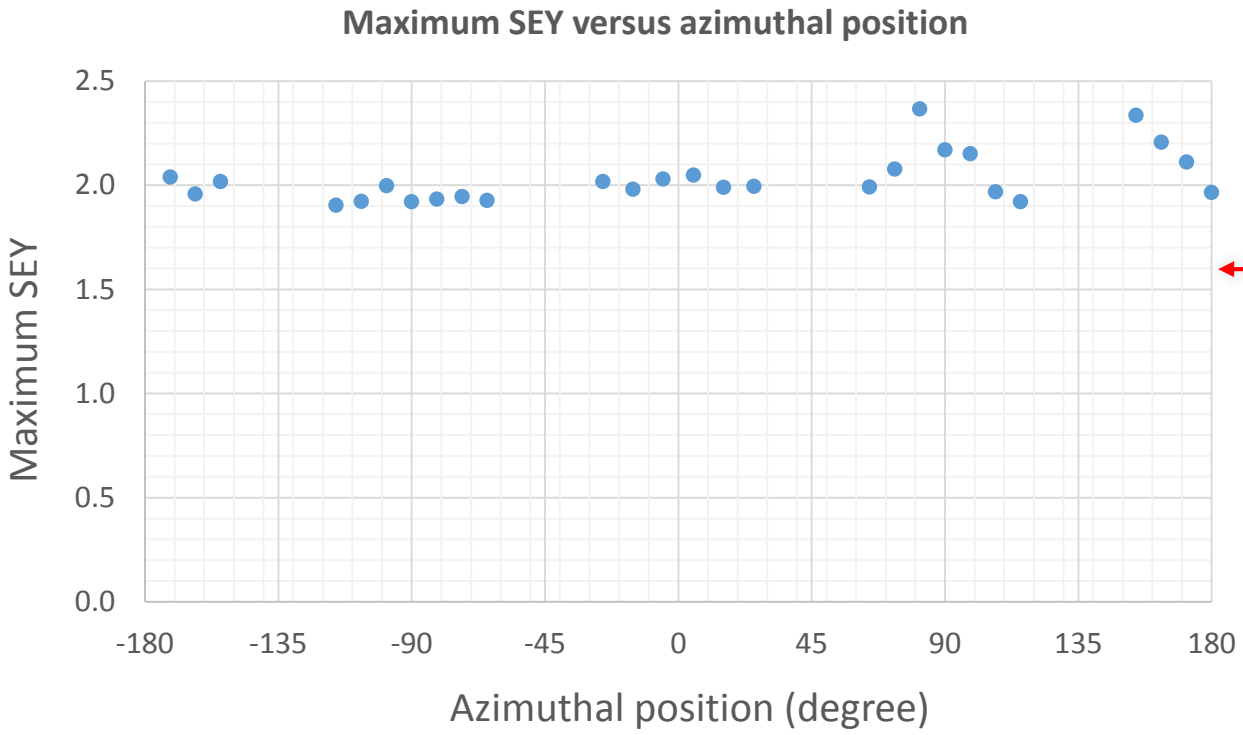


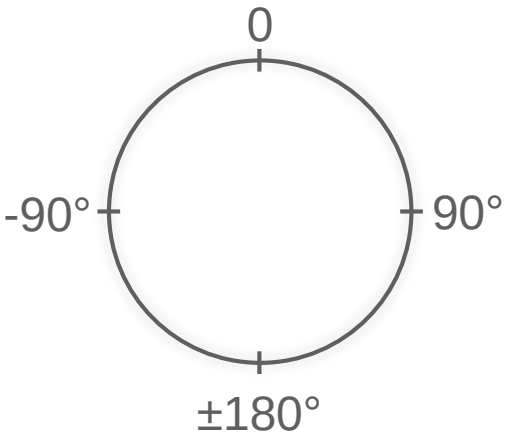
Transition tube (Dipole – Quadrupole)



- Transition tube (copper)
  magnetic field free region
- Beam screen (colaminated copper on stainless steel)
  Looking for SEY differences due to electron confinement and synchrotron radiations
- Pumping slot shield (copper – beryllium alloy)
  Looking for SEY differences due to masking by beam screen

Transition tube

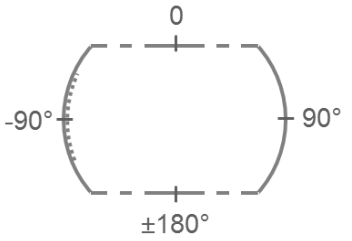


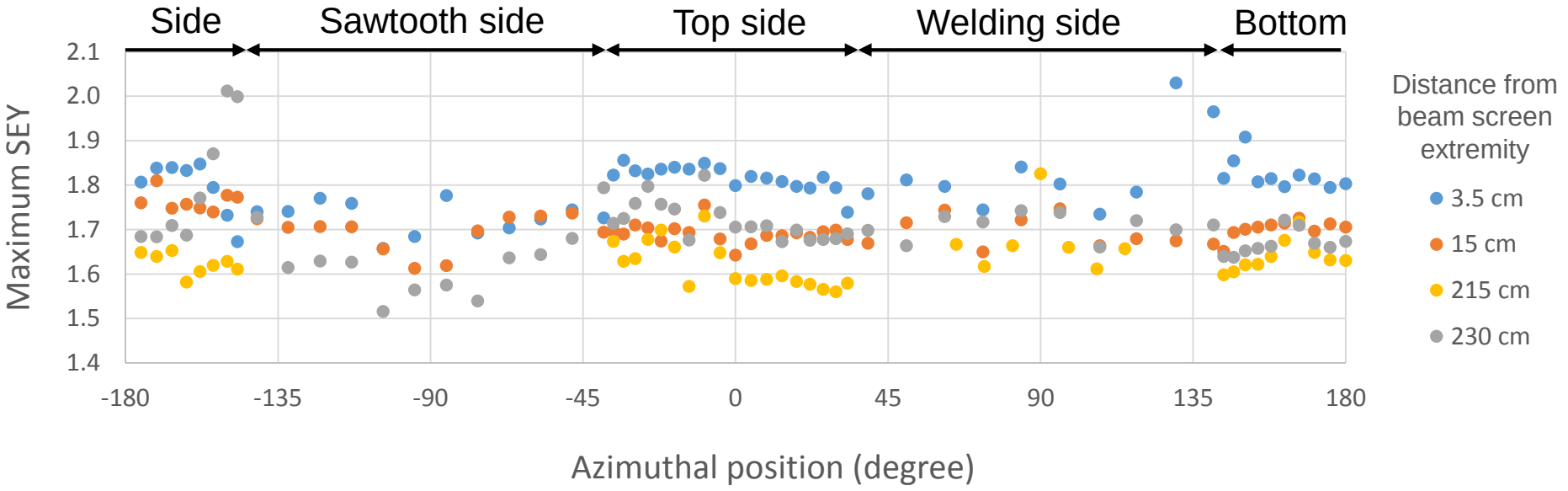


Fully conditioned + 3 weeks air exposed sample: lowest possible limit

No difference between 0°/180° and ±90° positions

Beam Screen : A31L2 magnet

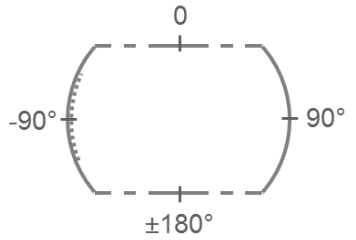


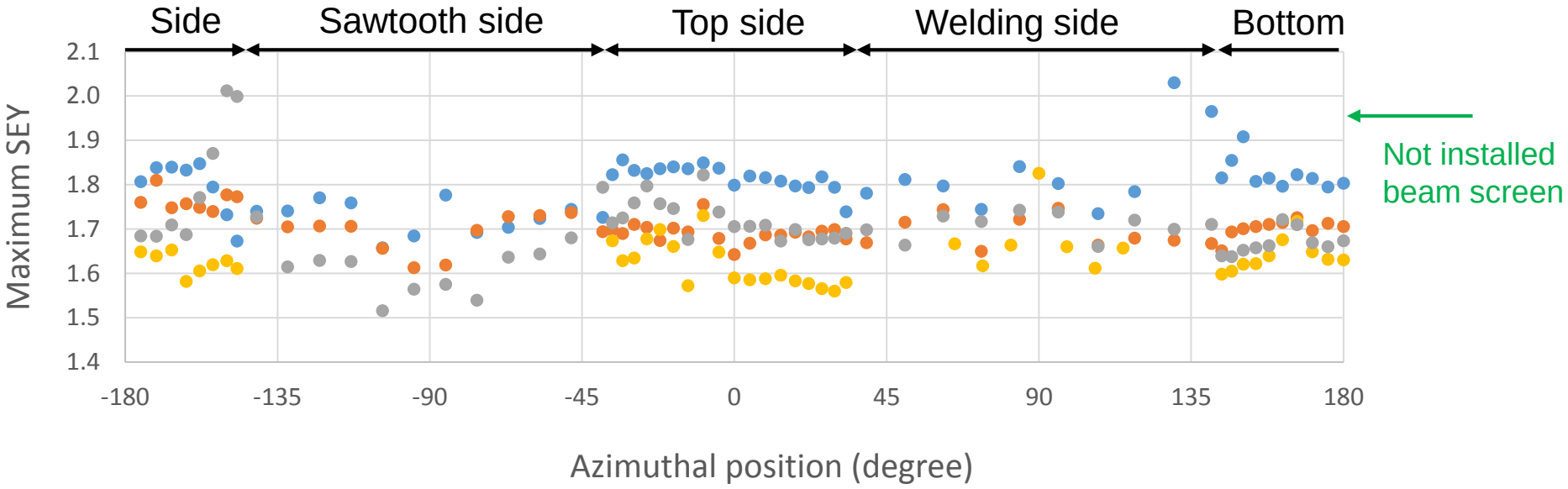


- No difference between flat sides / welding side in spite of dipole field

NB : ranking of SEY of samples does not correspond to chronology of measurements

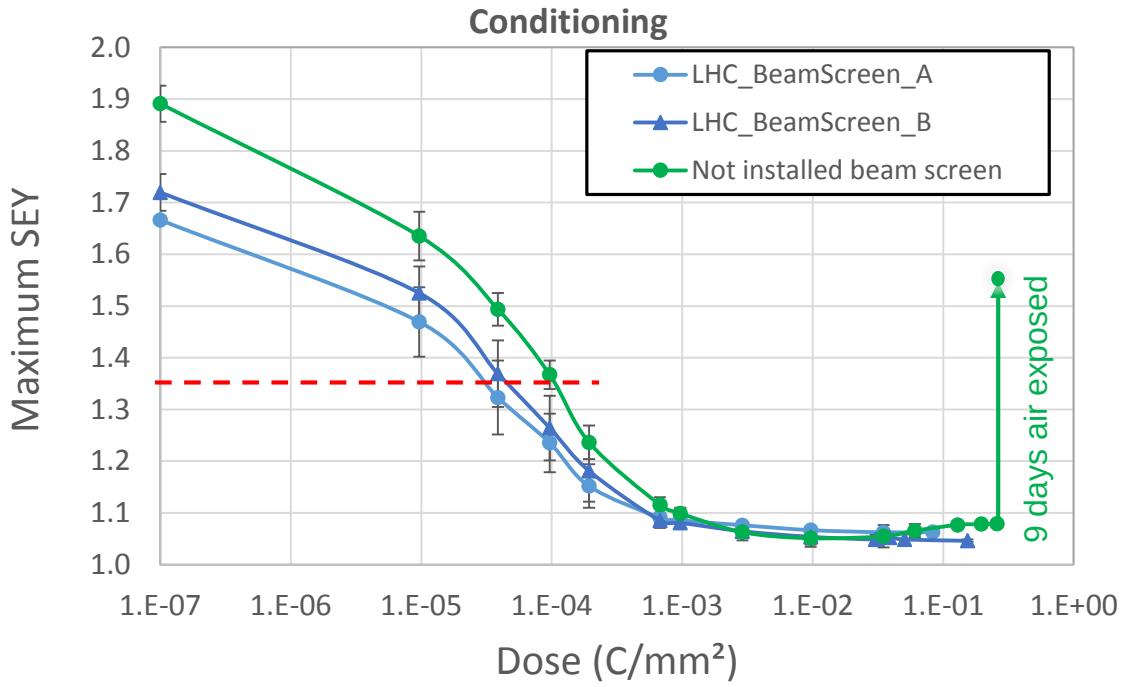
Beam Screen : A31L2 magnet





- Maximum SEY below « not installed » beam screen

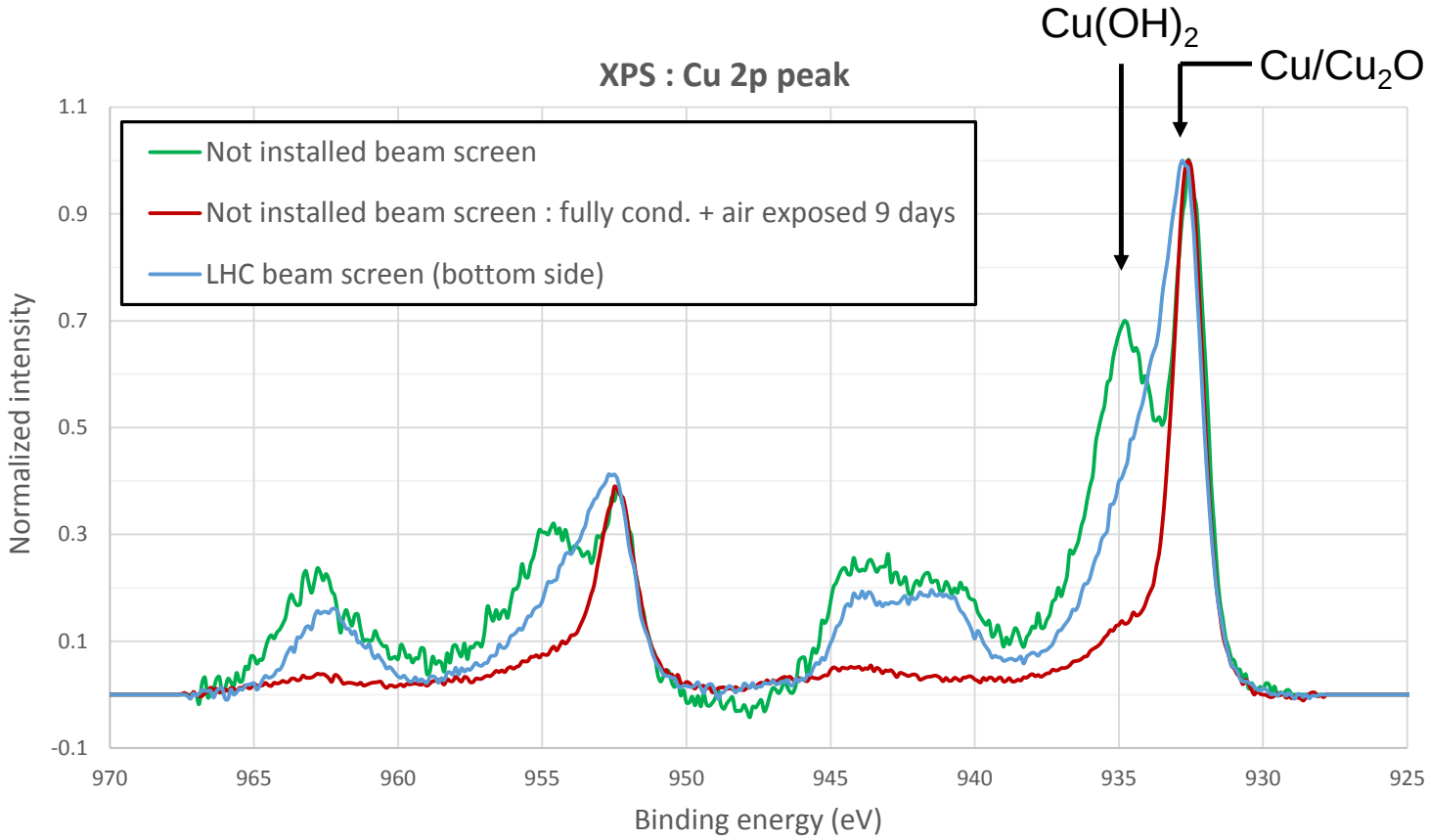
Beam Screen : comparison LHC A31L2 and “not installed”



- Conditioning at E_p = 250 eV
- Room temperature
- Base pressure P = 2.10^{-9} mbar
- Error bars : dispersion over 4 measurement points

- LHC beam screen samples
  - Identical conditioning path for both samples
  - Ultimate limit δ_{max} = 1.05
- LHC versus «not installed » beam screen
  - extracted LHC beam screen needs a lower dose to reach δ_{max} =1.35 (threshold for e-cloud in dipole) than « not installed » one

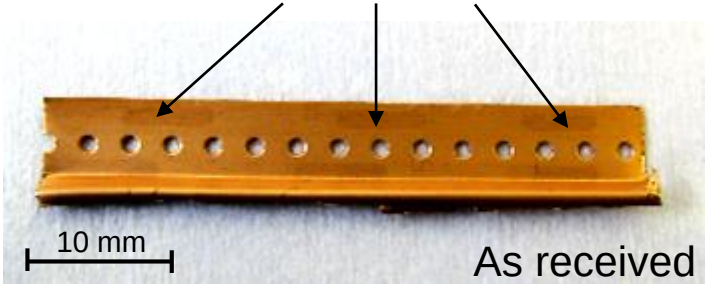
Beam Screen : comparison LHC A31L2 and “not installed”



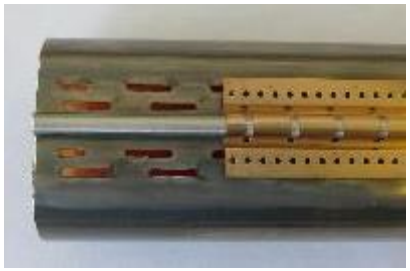
LHC beam screen : intermediate Cu 2p peak shape between « not installed » and deconditioned beam screen

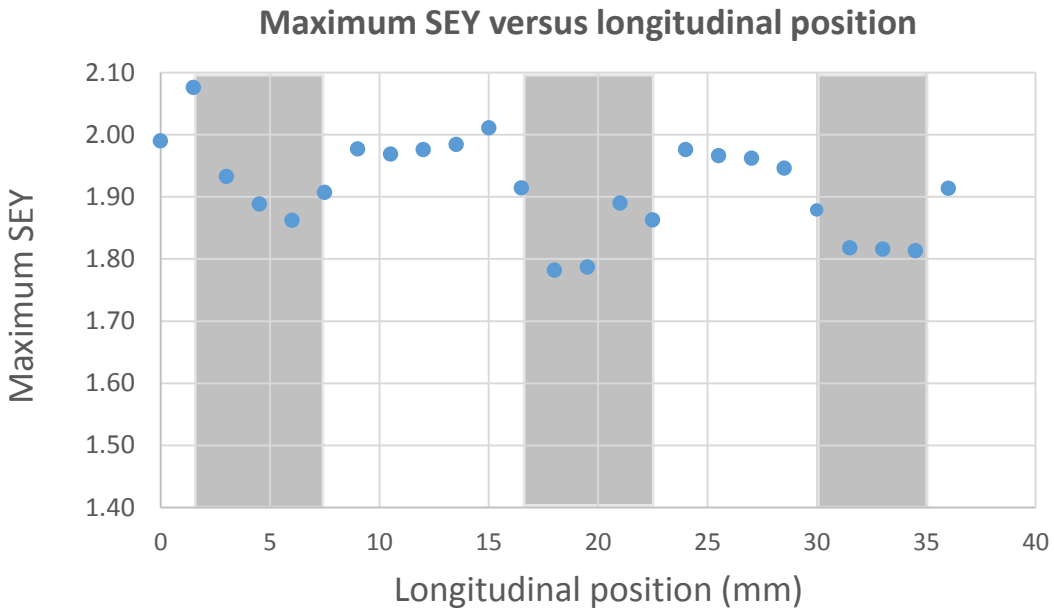
Pumping Slot Shield

Dark traces corresponding to pumping slot shield shape and spacing



Baked to enhance colour contrast

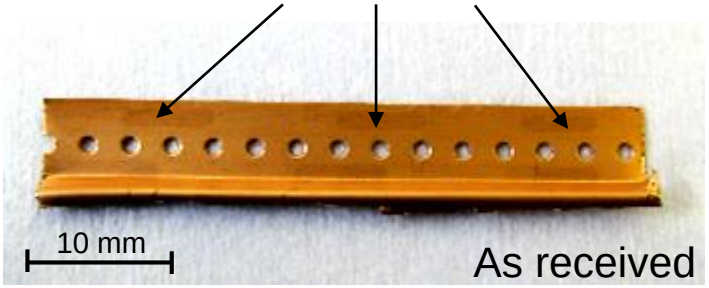




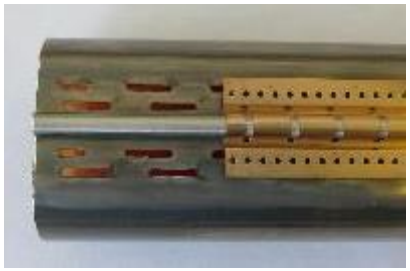
- Dark traces
  - Low SEY regions
- Out of dark traces
  - High SEY regions

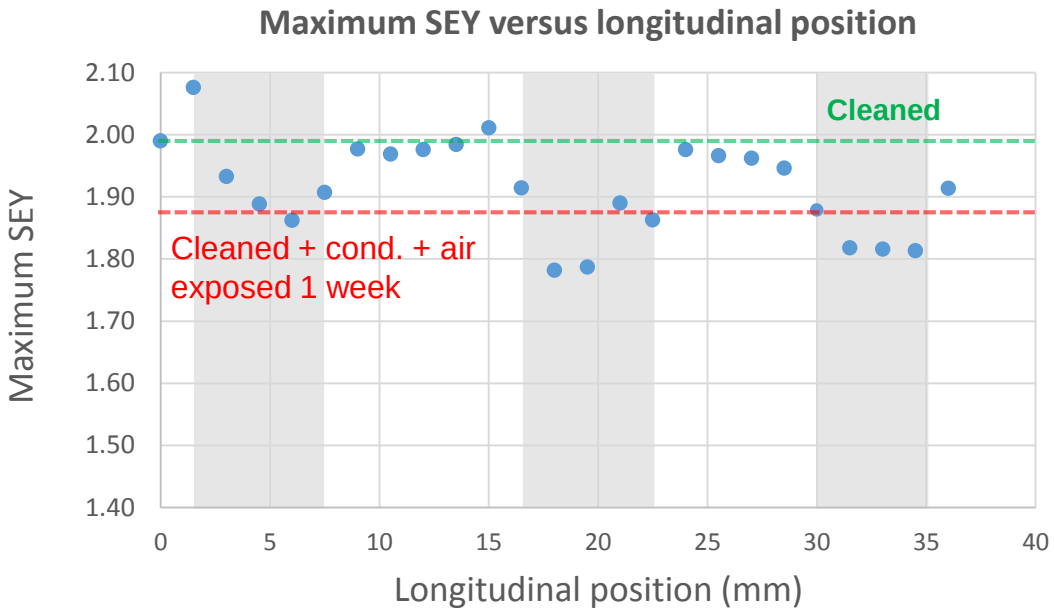
Pumping Slot Shield

Dark traces corresponding to pumping slot shield shape and spacing



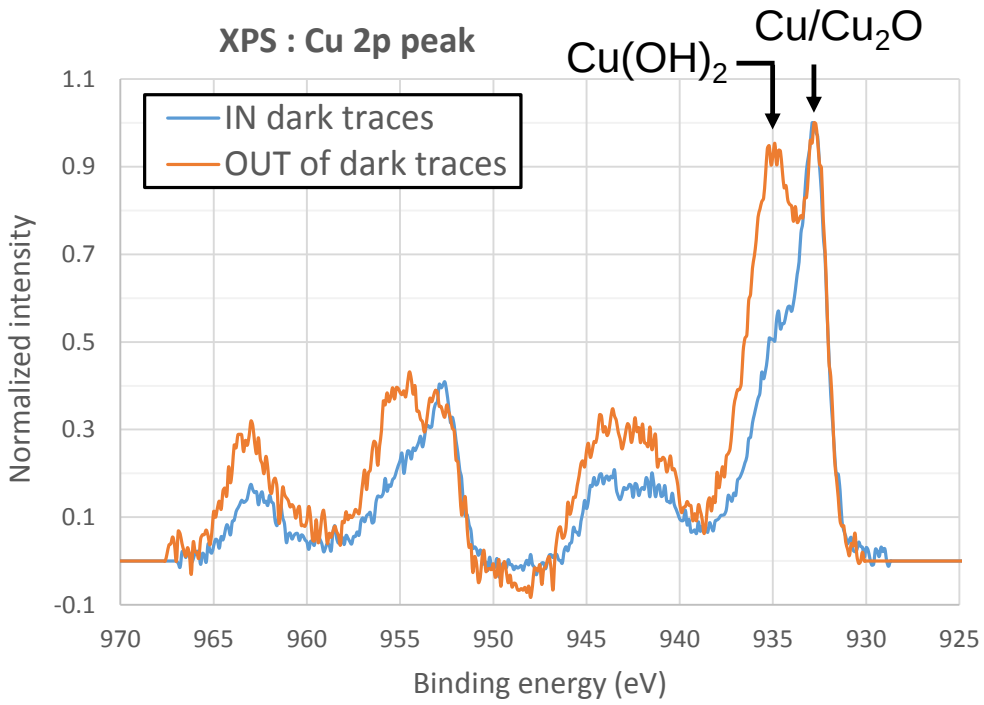
Baked to enhance colour contrast

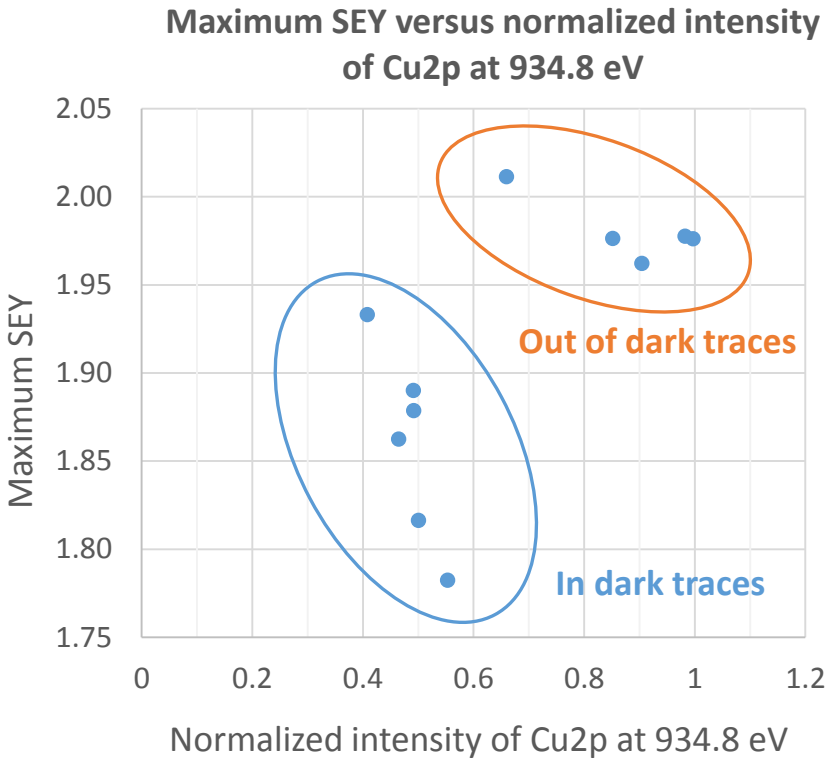




- Dark traces
  - Low SEY regions
  - Compatible with “deconditioned” state
- Out of dark traces
  - High SEY regions
  - same δ_{max} as “clean” material

Pumping Slot Shield





- δ_{max} : low SEY regions versus high SEY regions
- Cu 2p peak : high $Cu(OH)_2$ versus low $Cu(OH)_2$ peak

→ Parts exposed to e-cloud : conditioned

Conclusions

- Transition tube
  - Uniform SEY in azimuth
- Beam screen :
  - Uniform SEY in azimuth
  - Maximum SEY globally lower than “not installed” beam screen
    → compatible with a partial conditioning state in the machine
- Pumping slot shield
  - zones presenting the memory of conditioning

Perspectives

- Influence of the conditioning level reached on the SEY value observed after air exposure (deconditioning)
- Analysis of V2 beam screen
- More statistics on the sawtooth extracted from the A31L2 magnet
- Long-term : conditioning at low temperature

Acknowledgments

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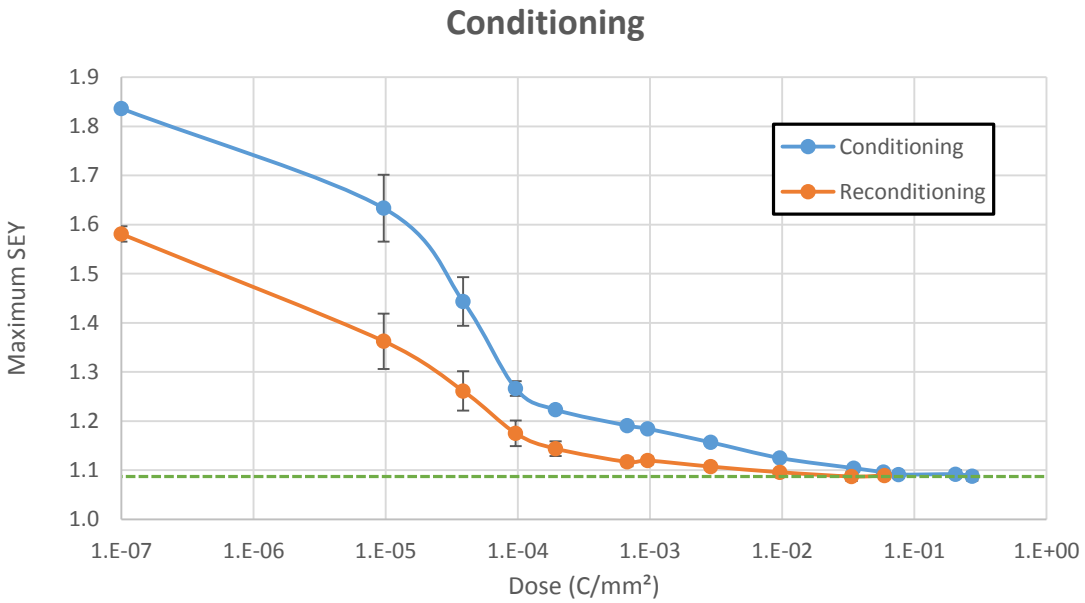
Thank you

Spares

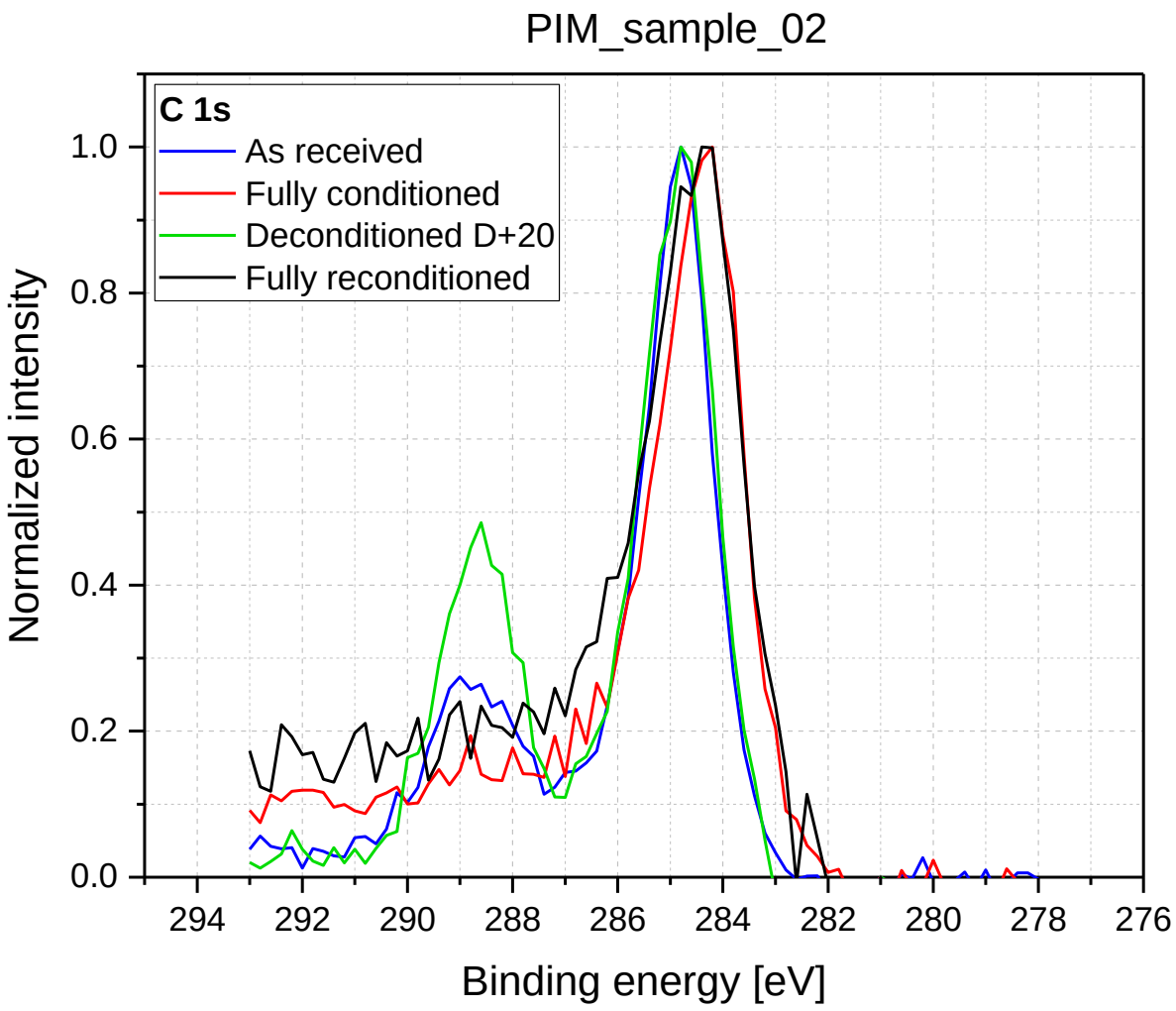
Transition tube

- Conditioning at E_p = 250 eV
- Base pressure P = 2.10^{-9} mbar
- Error bars : dispersion over 4 measurement points



- As received : δ_{max} = 1.84
- Fully conditioned : δ_{max} = 1.09
- Deconditioned 3 weeks : δ_{max} = 1.58
- Fully reconditioned : δ_{max} = 1.09

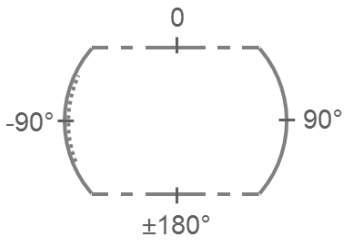
Transition tube

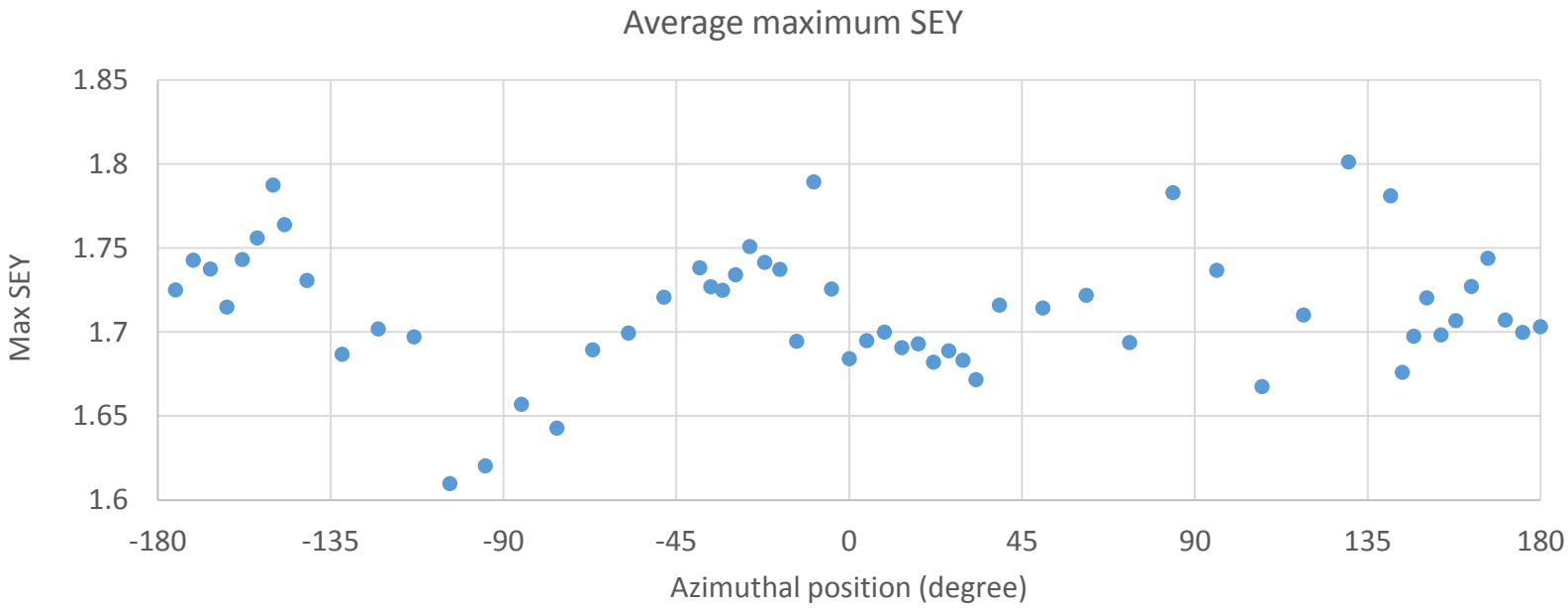


Conditioning :

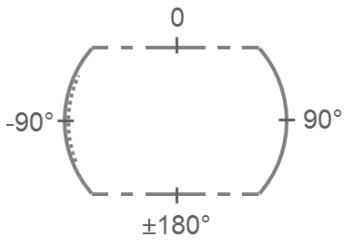
- Shift to lower binding energy
- Remove bump at 288.5 eV

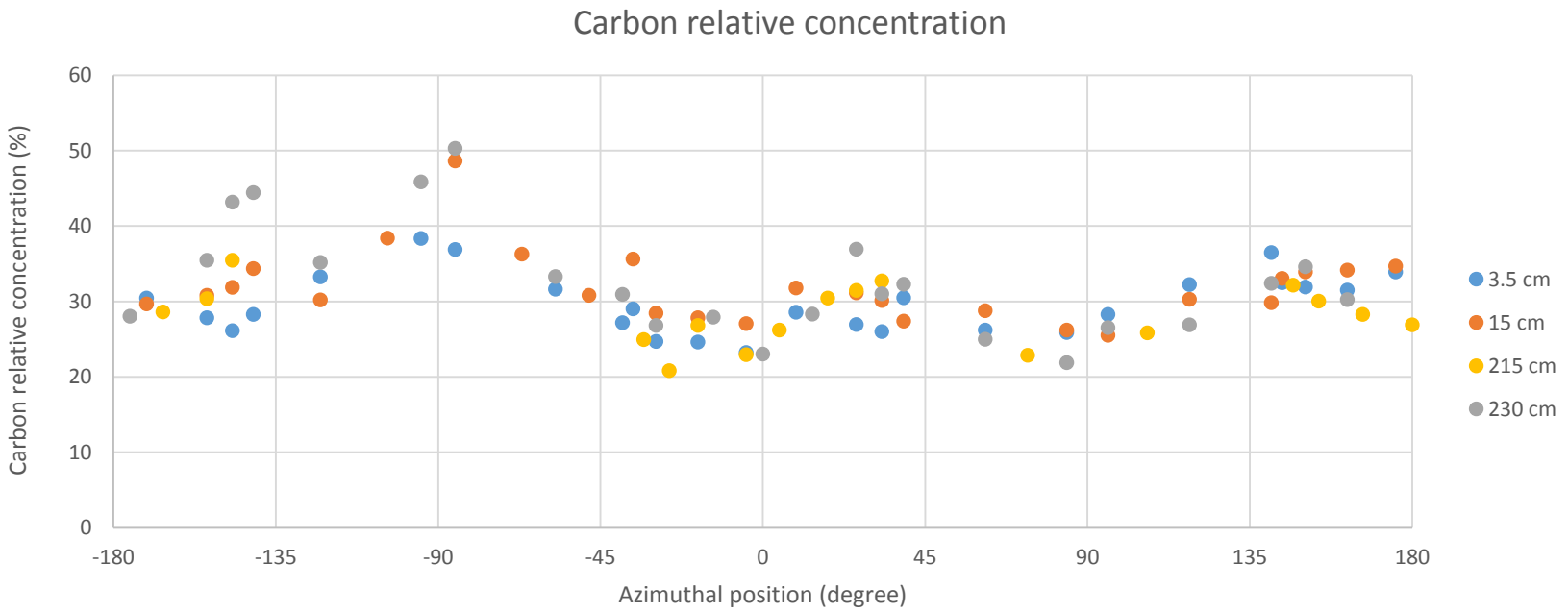
Beam Screen : A31L2 magnet





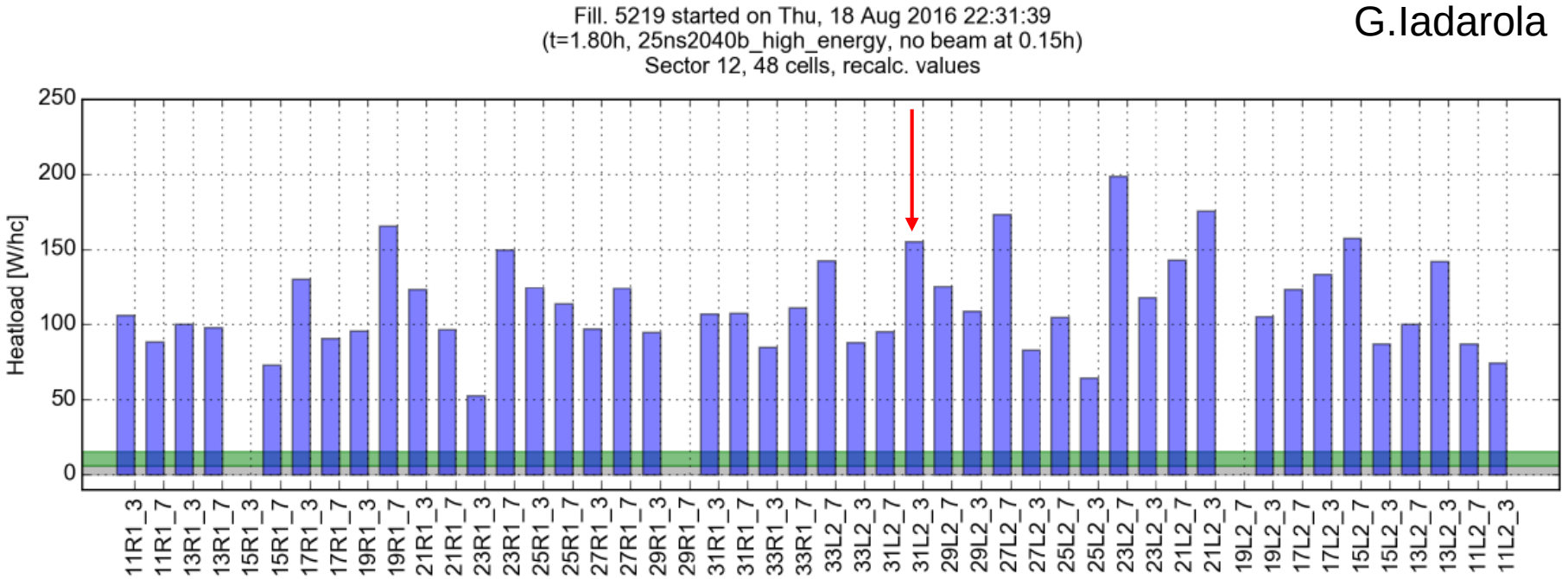
Beam Screen : A31L2 magnet



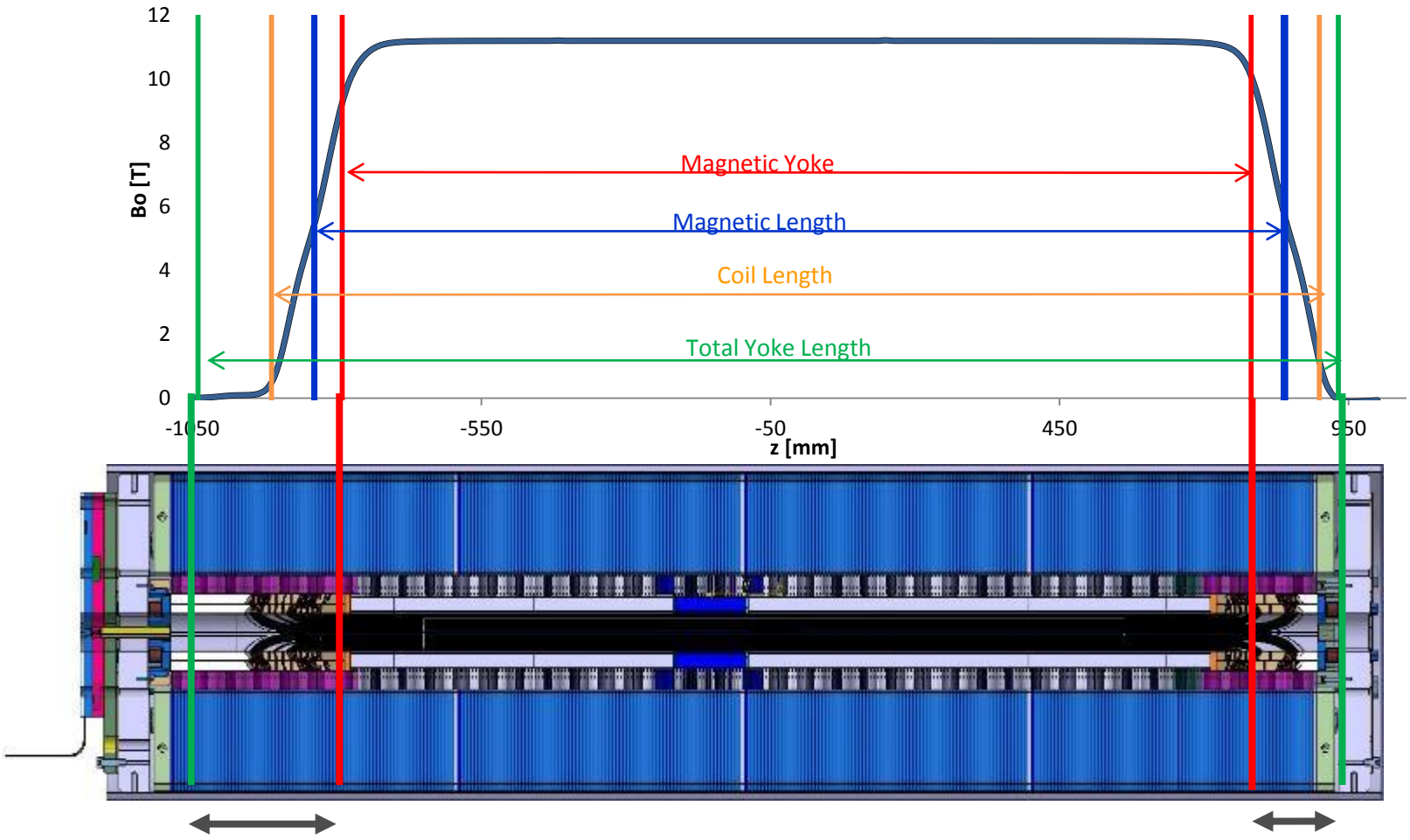


Heat load

G.Iadarola



Magnetic field



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