

Non-Invasive Profilers for the cold part of ESS Accelerator



J. Marroncle, P. Abbon, F. Belloni, F. Bénédetti^{*}, B. Bolzon, N. Chauvin, D. Chirpaz-Cerbat, M. Combet, M. Desmons, Y. Gauthier, T. Hamelin, C. Lahonde, P. Legou, O. Leseigneur, Y. Mariette, JP Mols, V. Nadot, M. Oublaid, G. Perreu, F. Popieul, B. Pottin, Y. Sauce, L. Scola, F. Senée, J. Schwindling, G. Tauzin, O. Tuske and S. Tzvetkov, CEA Paris-Saclay, Gif-sur-Yvette, France.

I. Dolenc Kittelmann, A. Gevorgyan, H. Kocevar, R. Tarkeshian and C. Thomas, *ESS Lund, Sweden*.

* Presently at LIPAc Rokkasho, Japan

IPM

Ten Ionization Profile Monitors (IPM) were designed and delivered to ESS to characterize the beam at 100-600 MeV in Linac Warm units, located among cryomodule section.

Electrodes are polarized in symmetric mode, i.e., +15 kV on the electrode and -15 kV on the collection electrode, which means that ions are drawn to an MCP with a phosphorescent screen. Then, the profile is read with a CMOS camera. IPMs will be installed on the beamline in 2024.





NPM (non invasive Profile Monitors)

- FPM (Fluorescence Profile Monitors)
 - used only in hot sections of the accelerator \rightarrow P ~ 10⁻⁷ mbar

FPM

- IPM (Ionization Profile Monitor)
 - used in LWU in cryo-sections of the accelerator \rightarrow P \leq 10⁻⁹ mbar



FPM

IPMs are installed on SPK LWU and are under tests at ESS lab.



- Residual gas composition:
 - \rightarrow H₂ (79%), CO (10%), CO₂ (10%), N₂ (1% mass)
- Bethe's relation + $\langle W_{e/ion} \rangle \sim 35.4$ eV per e/ion pair

| Beam energy (MeV) | 97 | 231 | 279 | 316 | 628 |
|---------------------------|--------|-------|-------|-------|-------|
| E-ion pairs (pairs/cm) | 100210 | 54970 | 49160 | 45850 | 33600 |

Space Charge effect

- ESS design requirement: measuring the beam width with an error on RMS $\leq 10\%$
- SC simulation code developed by F. Belloni & C. Thomas



Calculations performed for electrons and ions with a 300 kV/m EF for 3 different beam energies.



 ΔHV_{MCP} (A.U.)



- **Beam test results conducted at IPHI Saclay (3 MeV proton)**
- Comparing beam width and profile measurements using optical and conductive strips versus MCP read-outs.

– CMOS

Tight space constraints

- 2 IPMs + 2 Wire Scanners
- Risk having interference between both electric fields.
- 2 grounded discs are integrated in the beamline.
- \rightarrow Similar profiles got with tracking for both electric fields calculated with COMSOL





• BPM / IPM correlations 11:00 11:14 11:28 11:43 11:50

beam Camera 2 Beam profile measu-red at **IPHI**

IPHI \rightarrow optical IPM + MCP + phosphorescent screen should fit the requirements

J. Marroncle - IBIC – Saskatoon – Sept. 10-14, 2023 (WEP001)

