



# Design and Implementation of an Online Beam Current and Stability Monitor for the UMCG-PARTREC AECR Ion Source

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#### 1. Introduction

Maintaining beam stability and intensity is a core challenge for accelerator operators. Traditional measurement methods are often destructive, making real-time monitoring difficult. To address this, the EUROLABS-ERIBS collaboration has developed a novel, non-intercepting online beam monitor with feedback capabilities. At UMCG-PARTREC, a miniferanday cup has been integrated near the main collimator to capture unused ions, enabling continuous signal sampling and ripple analysis without disrupting beam transport. This poster presents the design, implementation, and operator interface of this innovative system, offering a new tool for beam development and stability control.

#### 2. UMCG-PARTREC



Fig.1.: AGOR cyclotron at UMCG-PARTREC Groningen NL

In 2019 the KVI-CART facility was merged with the University Medical Center in Groningen (UMCG) and became a Particle Research Center (UMCG-PARTREC) [1]. PARTREC promotes multidisciplinary research and aims for better physics and biology, imaging, bigdata analysis, and clinical research to improve the quality of proton therapy treatment and explore potential benefits of other particles used for cancer treatment.

## 3. The AECR Ion Source

The UMCG-PARTREC accelerator facility is equipped with an AECR-U type ion source [2]. To enable dual-frequency microwave injection, the system utilizes two radiofrequency (RF) generators: a 500 W traveling wave tube (TWT) amplifier operating in the 11–12.5 GHz range, and a 1.1 kW dual TWT amplifier covering the 12.75–14.5 GHz frequency band. The gas delivery system comprises three independently controlled gas valves, allowing precise regulation of the plasma composition during production. This configuration facilitates the fine-tuning of ion beam cocktails by adjusting the relative fractions of injected gases.

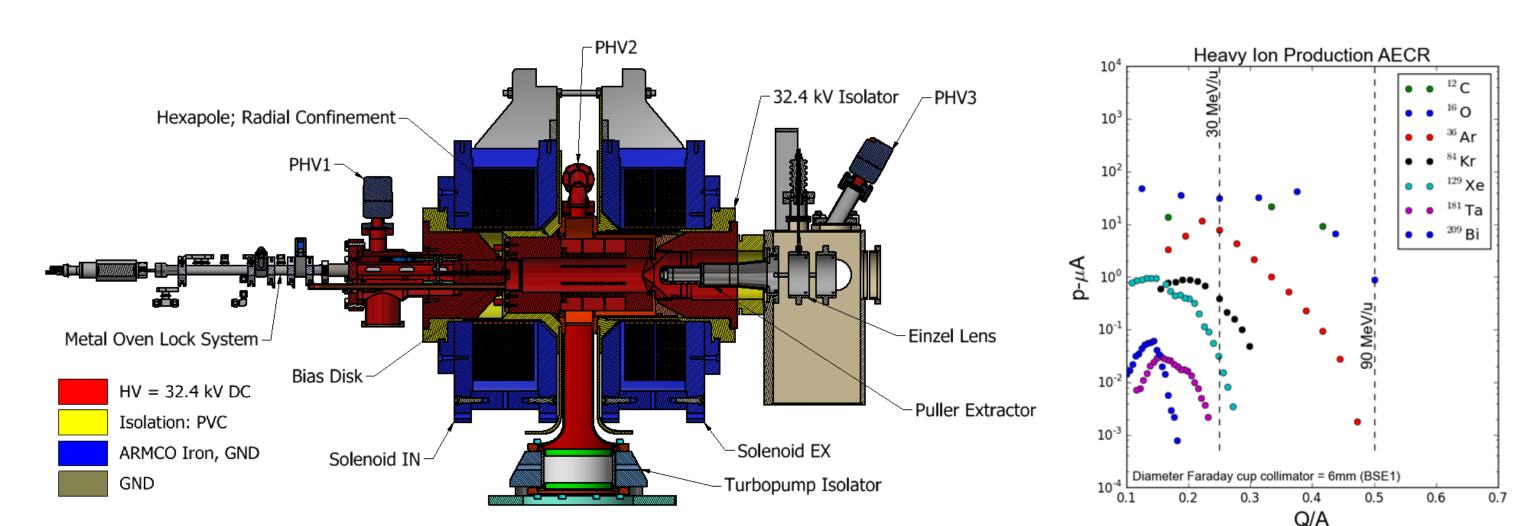


Figure 2: Cross section CAD drawing of the AECR on source from oven to extraction

Figure 3: Performance overview of several ion species in the beam in a) emicroA and b) in particle microamp.

#### 4. The the mini-Faraday cup



Figure 4: Back side photo of the mini-Faraday cup

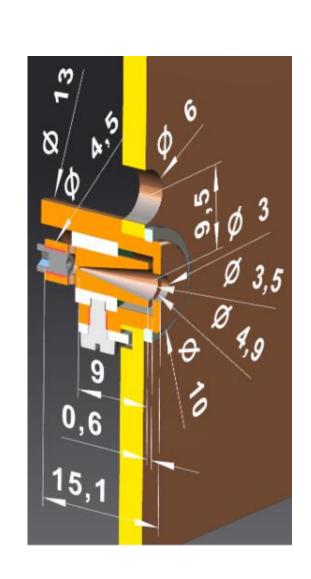


Figure 5: Mechanical design with dimensions of the mini-Farady cup

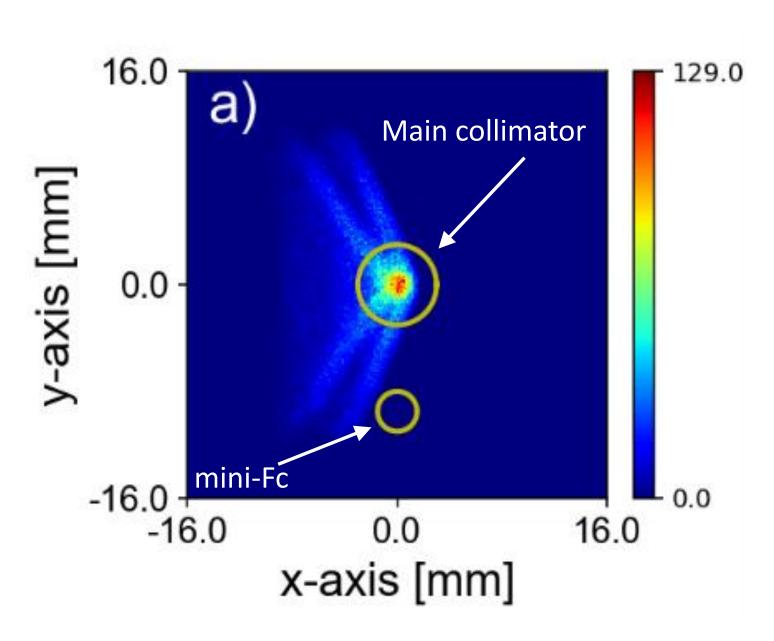
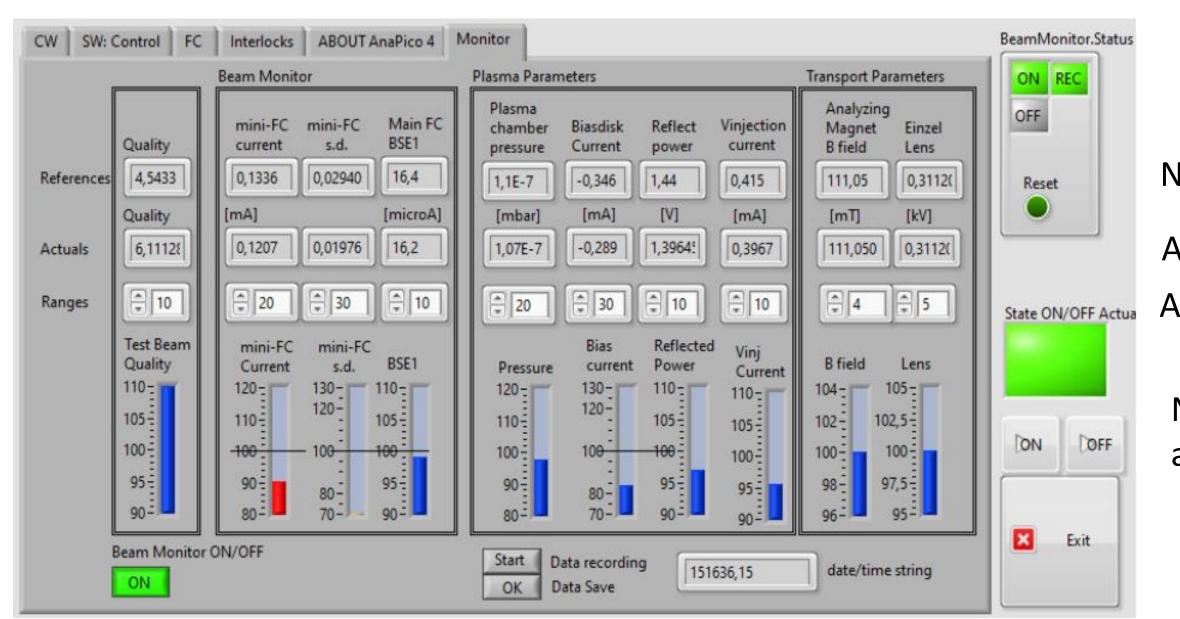


Figure 6: Position of the mini-Faraday cup with respect to the ion optical aberrations [3]

#### 5. The semi-automated feedback loop



Beam Monit Quality

Monitor F

Plasma parameters

Transport

Normalization value

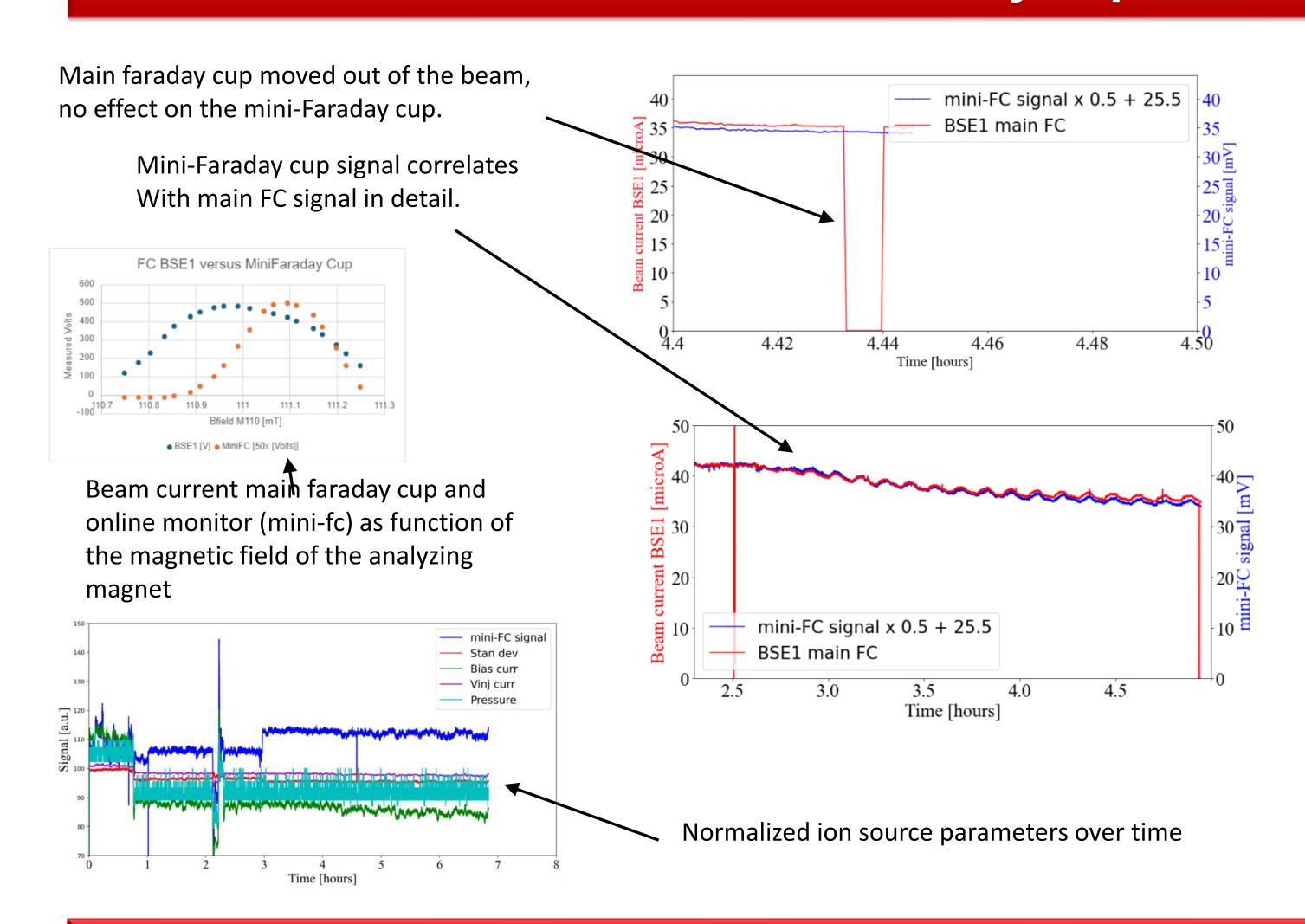
Actuals

Acceptable range

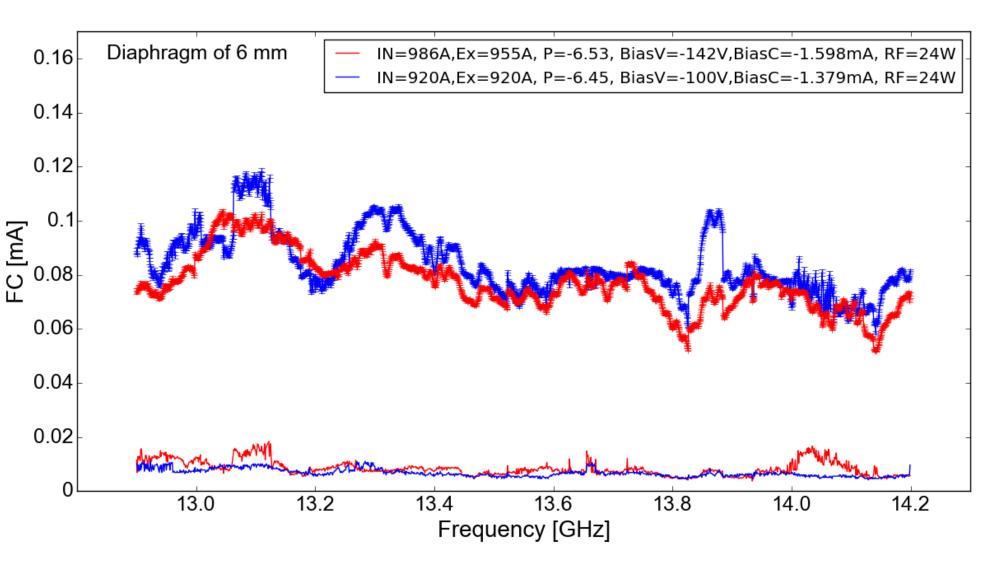
Normalized range

Normalized range and actuals

## 6. Measurements with the mini-faraday cup



#### 7. Intensity and stability sweep



Measured beam current of a 23kV He<sup>1+</sup> and stability (s.d.) as function of the plasma heating frequency. Each measurement point is a one second measurement of 1000 samples to determine the beam current as well as the ripple on the beam current by determining the standard deviation (s.d) [4]

## 8. Preliminary conclusions

- The mini-Faraday cup operates as an online beam current monitor and its signal correlates within 1% with the main Faraday Cup.
- The measurement obtained from the primary Faraday cup, located directly downstream of the mini-Faraday cup, is not influenced by the operation of the online beam current monitor (mini-FC).
- The frequency scan indicates areas with maximal intensity as well as minimal noise on the beam.

## 9. Summary

In the framework of the EUROLAB collaboration a mini-Faraday cup has been developed, used as an online beam current monitor, in combination with a semi-automated feedback loop. The system is operational and used by operators. Signal correlates within 1% with the main faraday cup. Stability regions in beam current can be observed when the frequency of the rf plasma heating is scanned.

## 10. References

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