STRONG-2020 ANNUAL MEETING (2022)

Polarized Electrons, Positrons and Polarimetry (P3E)

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 824093

WP31 / JRA13 - OBJECTIVES

Pushing further

the **intensity frontier** of polarized electron sources,

the **intensity frontier** of low energy polarized positron sources,

and the **precision frontier** of electron polarimetry.

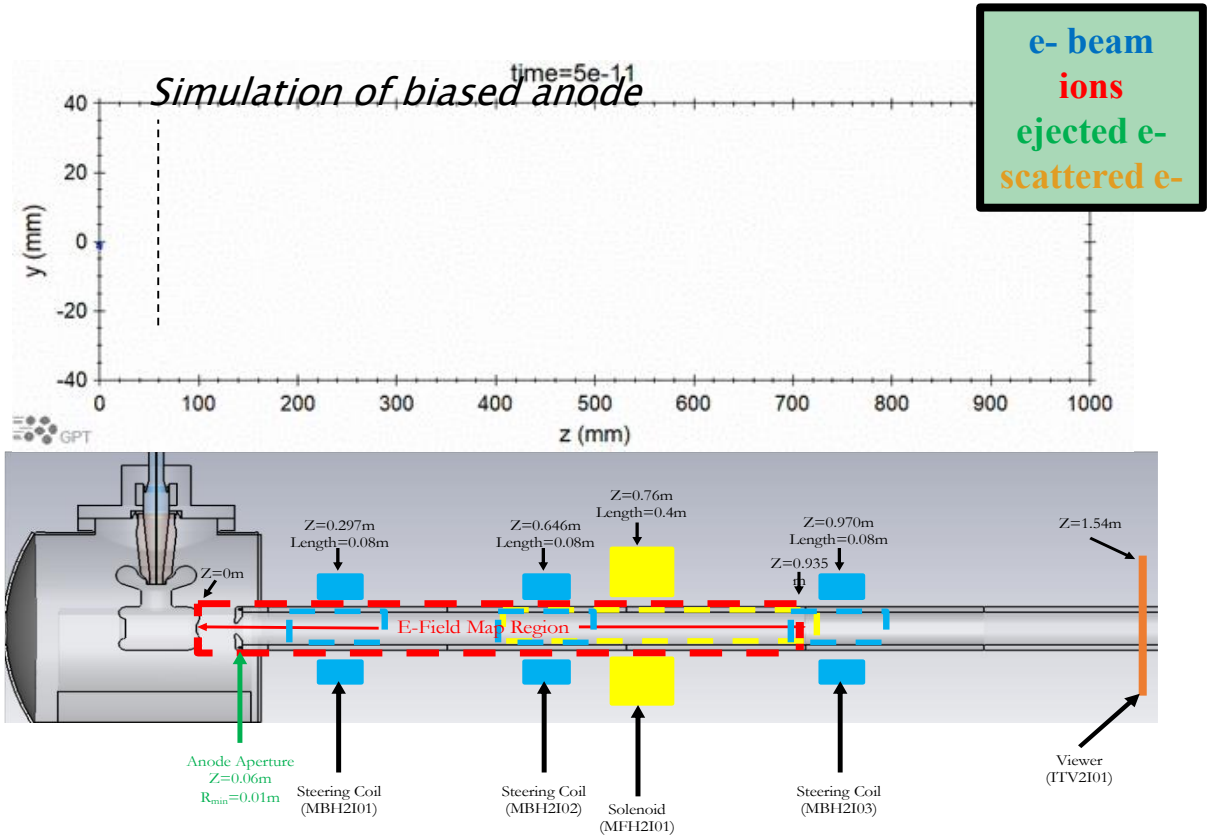
P3E-1: High Intensity Polarized Electron Source

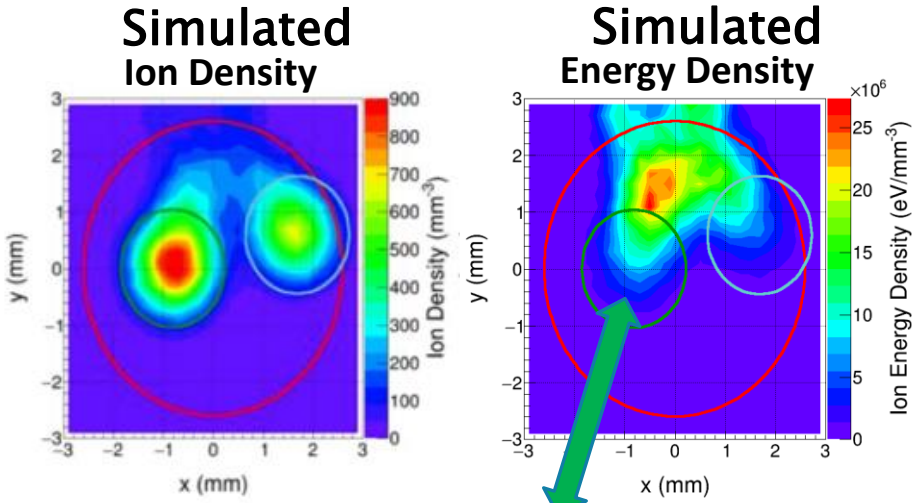
P3E-2: High Intensity Polarized Positron Source

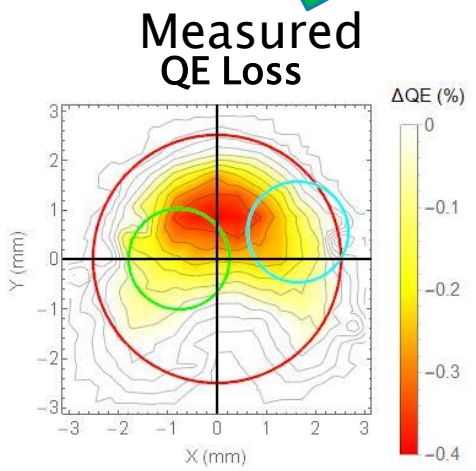
P3E-3: High Precision Electron Polarimetry

P3E-1 – HIGH INTENSITY POLARIZED ELECTRON SOURCES

- Customized GPT software *IONATOR* simulates ion generation in CEBAF polarized electron gun and shows that cathode degradation is strongly correlated with highest energy ions.







Work of J. Yoskowitz

P3E-1 – HIGH INTENSITY POLARIZED ELECTRON SOURCES

- Objectives of this task within STRONG 2020 have been completed : modelling of photocathode quantum efficiency, and proof-of-concept experimentation.

Publications

- JACoW IPAC (2021) WEPAB104
- JACoW IPAC (2021) WEPAB105
- J. Yoskowitz, Ph.D. Thesis, Old Dominion University (2022)

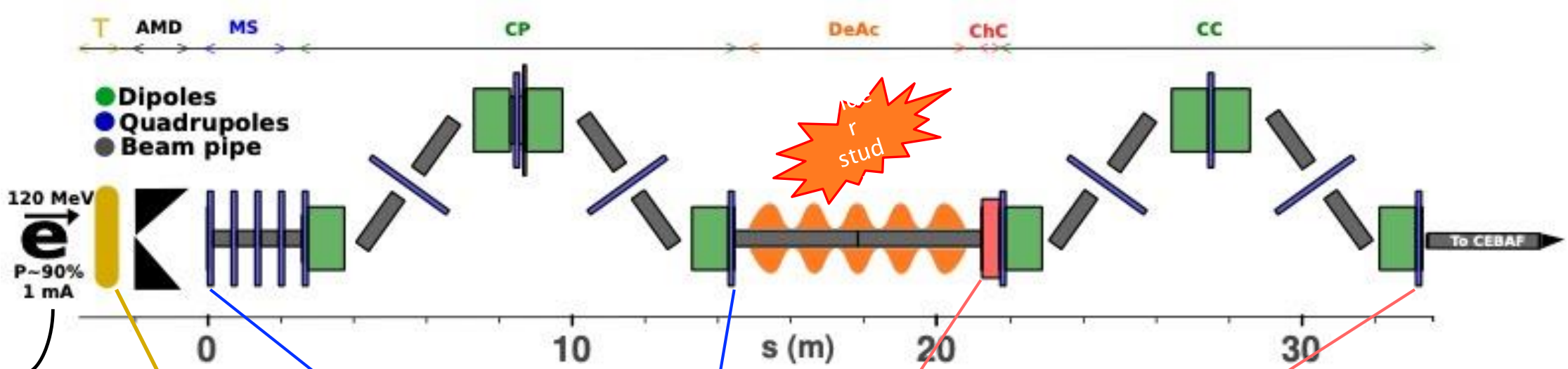
Presentations at Conferences

- IPAC 2021, Campinas (Brazil)

*Current research develops towards the design of a **DC-high voltage photogun** optimized for sustaining high average current (>1 mA) from GaAs photocathodes, directed towards producing **polarized positron beams for CEBAF**.*

P3E-2 – HIGH INTENSITY POLARIZED POSITRON SOURCES

- No modification of the initial Work Plan & Objectives
- The design of the JLab positron source evolved towards a positron injector for CEBAF



$\mathcal{P}$ = 120 kW beam power

Positron Production Target

Momentum Selection Chicane

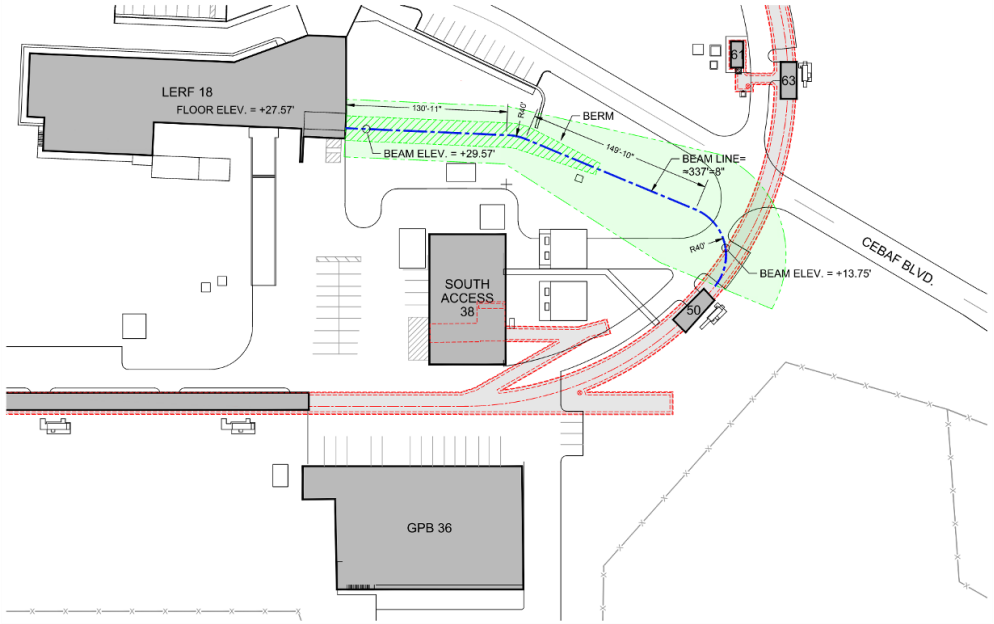
Beam Compression Chicane

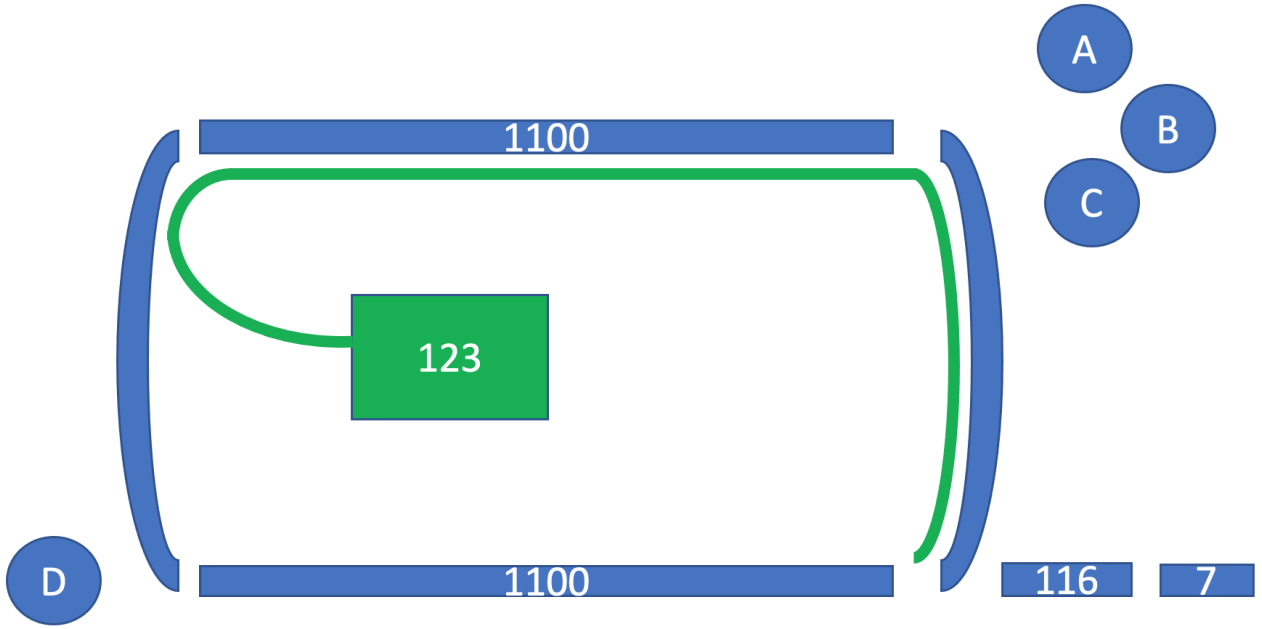
Work of S. Habet

Nominal
I_{e+} > 100 nA @ P_{e+} = 60%
I_{e+} > 3 μA @ P_{e+} = 0%

P3E-2 – HIGH INTENSITY POLARIZED POSITRON SOURCES

- The implementation of positron beams at JLab is currently being addressed, involving the installation of a positron injector in the former FEL (now LERF) building, the civil construction of a new tunnel, the positron beam transport along the accelerator up to the injection point, and the polarity change of the CEBAF arcs.

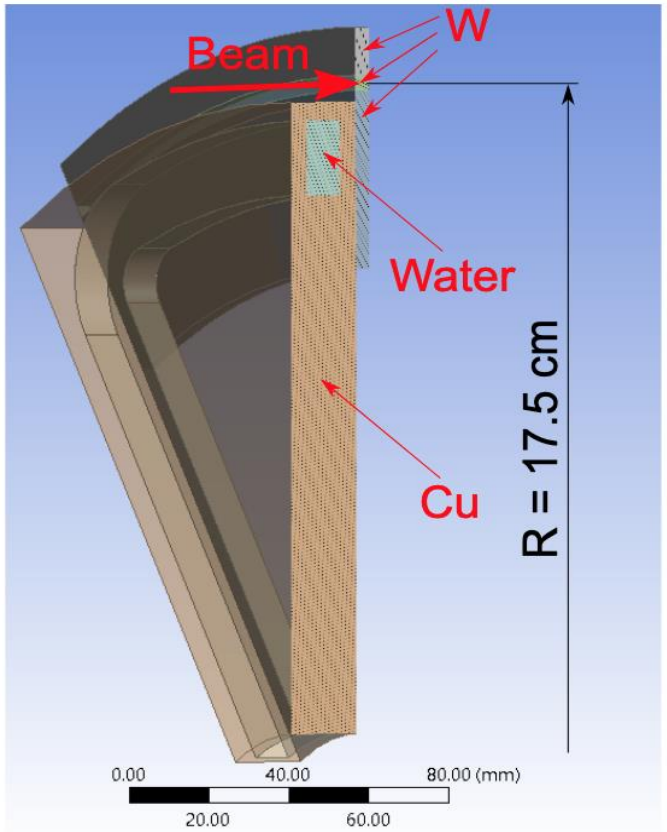




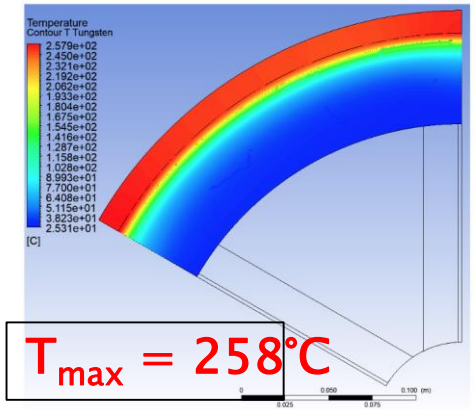
P3E-2 – HIGH INTENSITY POLARIZED POSITRON SOURCES

- The concept of a rotating tungsten target cooled by water was evaluated and validated.

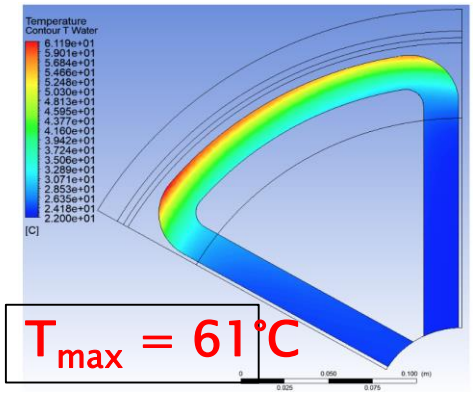
1/8 segment of the e^+ target



Average temperature in W



Average temperature in H_2O

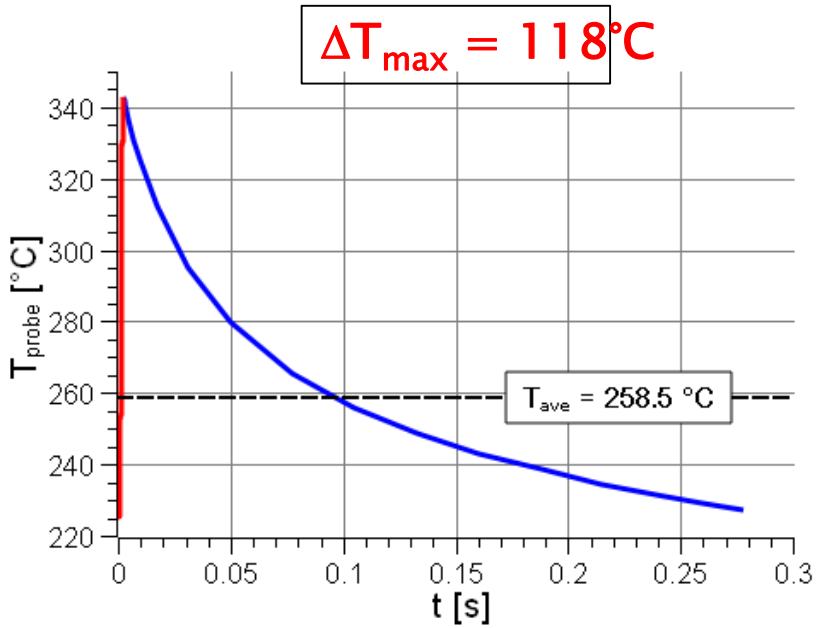


- The electron beam passes through the target at a distance of 17.5 cm from the rotation axis.
- The water channel is 10x20 mm^2 cross section inside which a turbulent water flows at a speed of 2 m/s and a 22°C inlet temperature.
- The beam spot RMS size is 1.5 mm.
- The rotation speed of the target is 4m/s.

Work of A. Ushakov

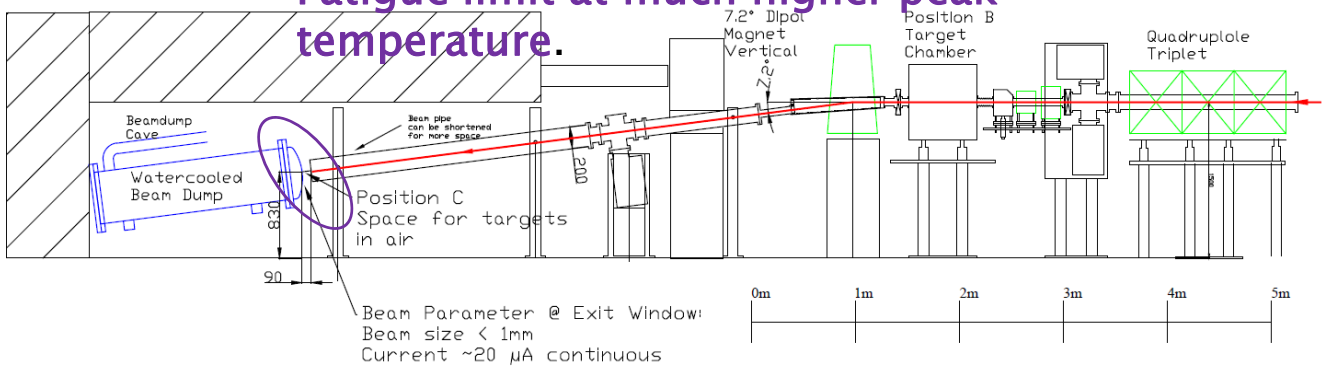
P3E-2 – HIGH INTENSITY POLARIZED POSITRON SOURCES

- The repetition of thermal cycles over 1 year of operation (6048 h ≡ 79. 2 M cycles) weakens materials.
- **Need for experimental benchmarks of material limits.**



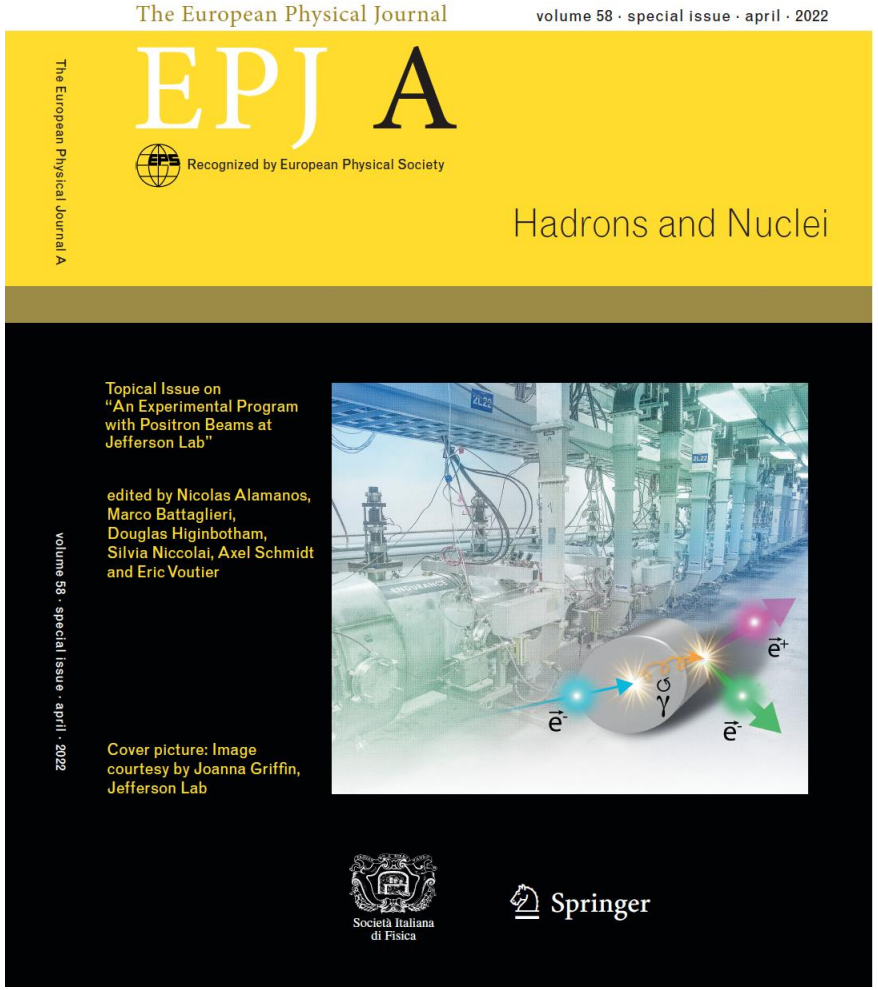
Using the 180 MeV electron beam of MAMI and a 100 µm thick W foil, material irradiation will be conducted to test :

- Radiation damages at operational temperature;
- Thermal cycle effects for ½ life-time;
- Fatigue limit at much higher peak temperature.



Measurements expected in april

P3E-2 – HIGH INTENSITY POLARIZED POSITRON SOURCES



Publications

- EPJA 58 (2022) 45
- JACoW IPAC (2022) 457

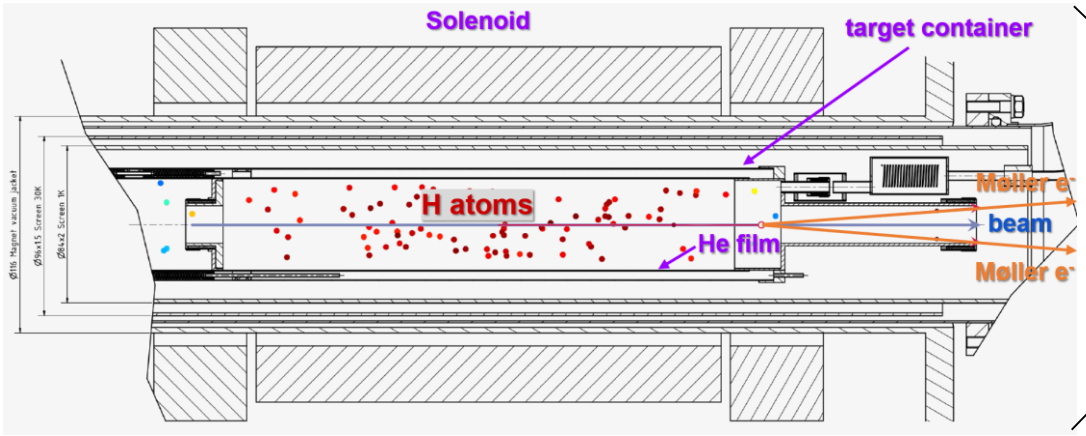
Presentations at Conferences

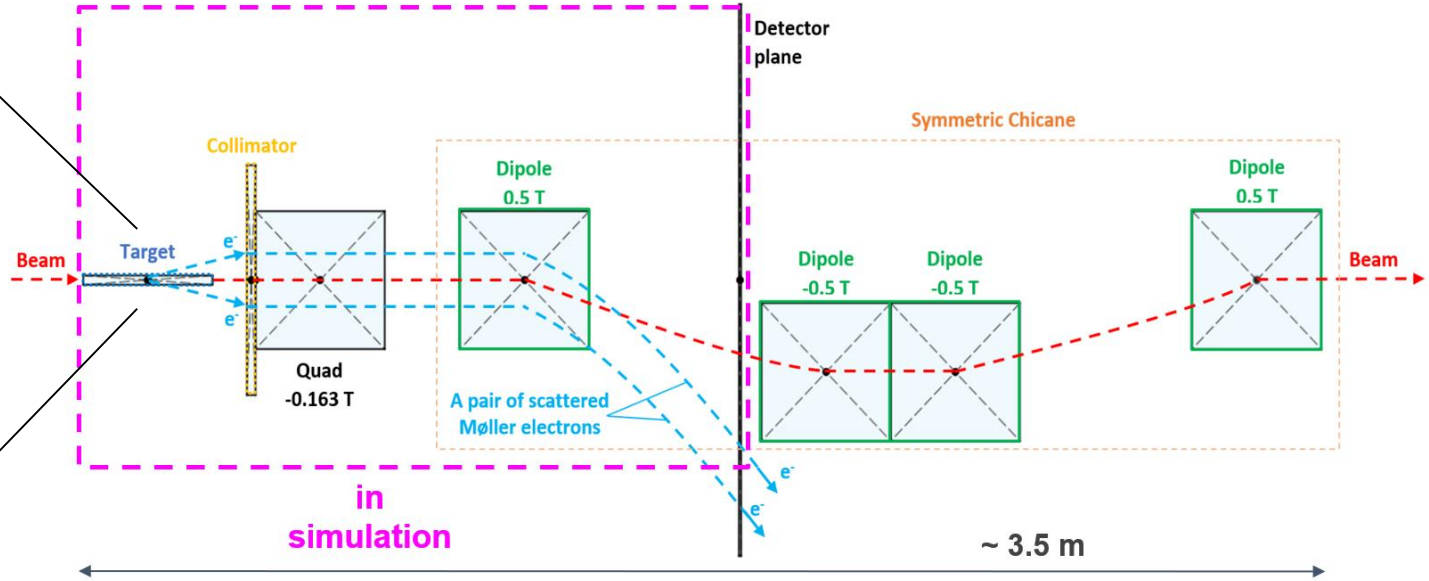
- IPAC 2022, Bangkok (Thailand)
- CLAS Collaboration Meeting, Newport News (VA, USA)
- Parity Violation and other Electroweak Physics at JLab 12 GeV and Beyond, Seattle (WA, USA)
- Towards Improved Hadron Femtography with Hard Exclusive Reactions, Blacksburg (VA, USA)

Jefferson Lab Positron Working Group

P3E-3 – HIGH PRECISION ELECTRON POLARIMETRY

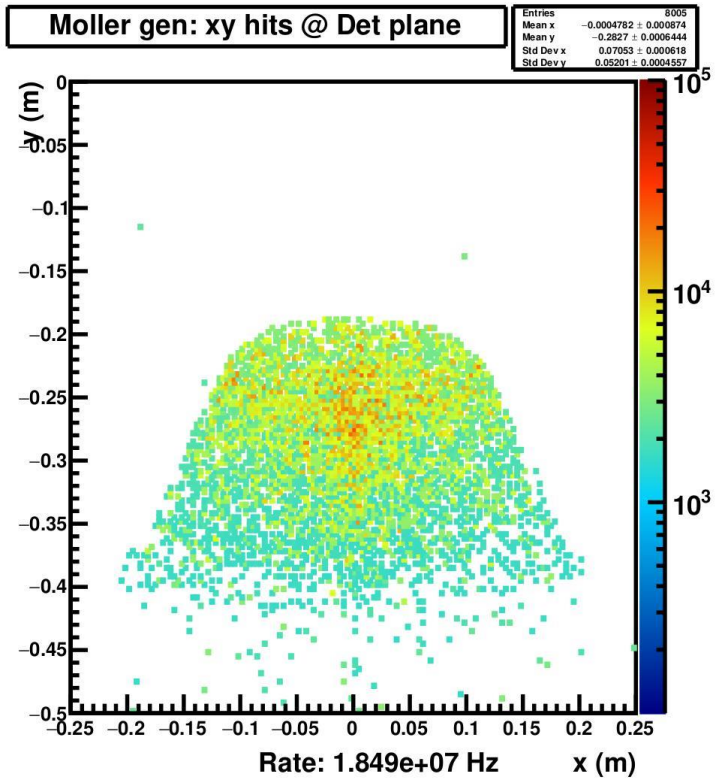
- No modification of the initial Work Plan & Objectives
- Development of the detector system for an atomic hydrogen Møller polarimeter
  (atomic hydrogen can be fully polarized in a strong magnetic field, eliminating the dominating systematics)

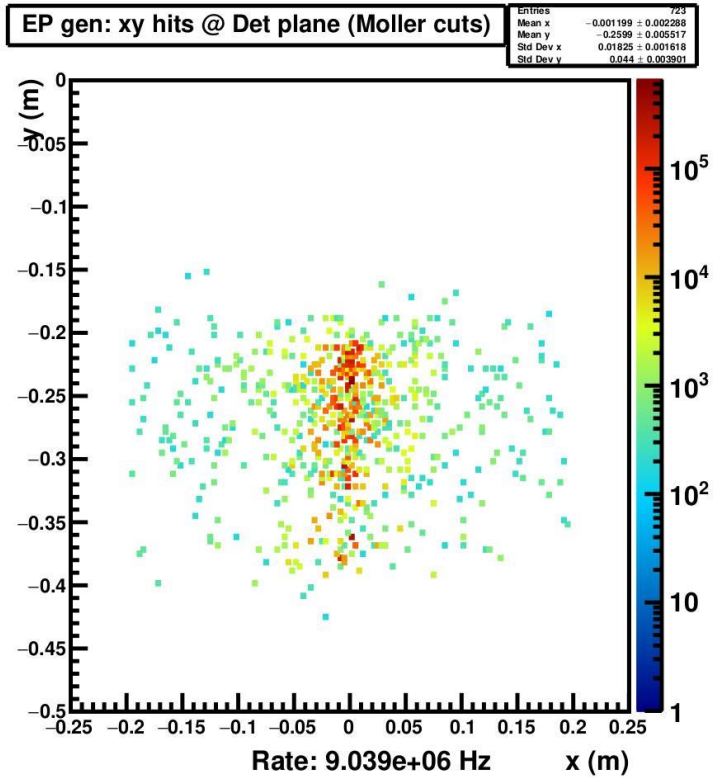




P3E-3 – HIGH PRECISION ELECTRON POLARIMETRY

- Validation of generators in simulation
  - Møller generator
  - (Radiative) Electron-proton background
- Simulation results will guide selection of detectors





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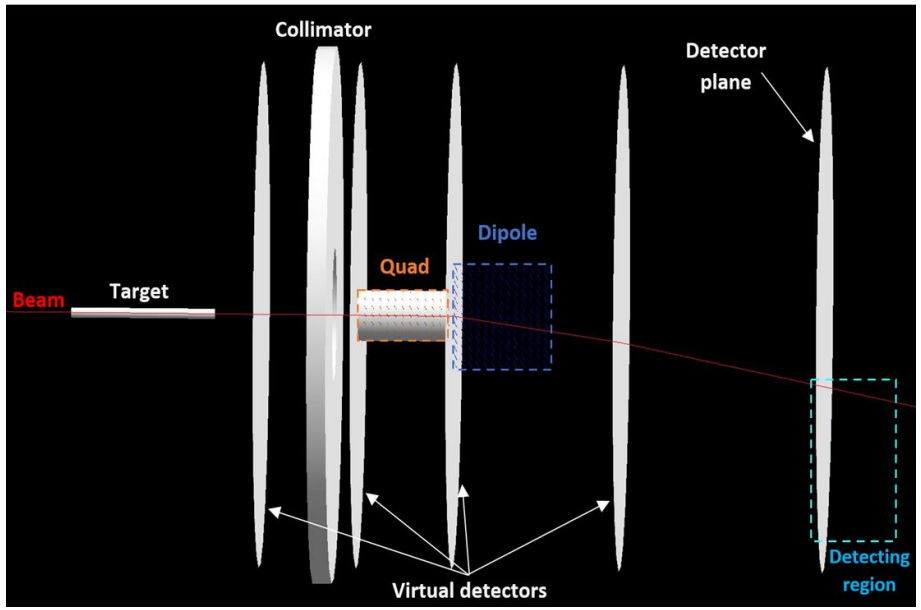
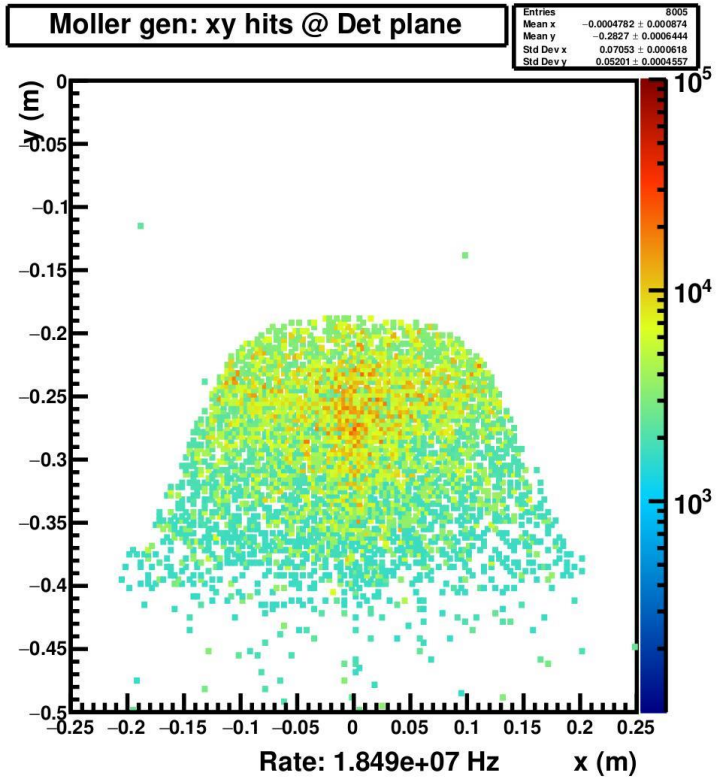
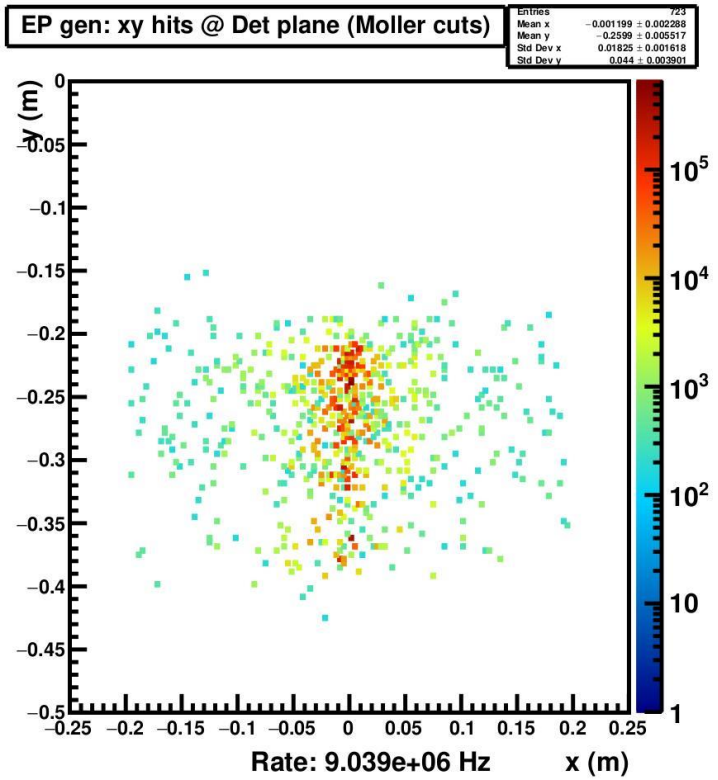
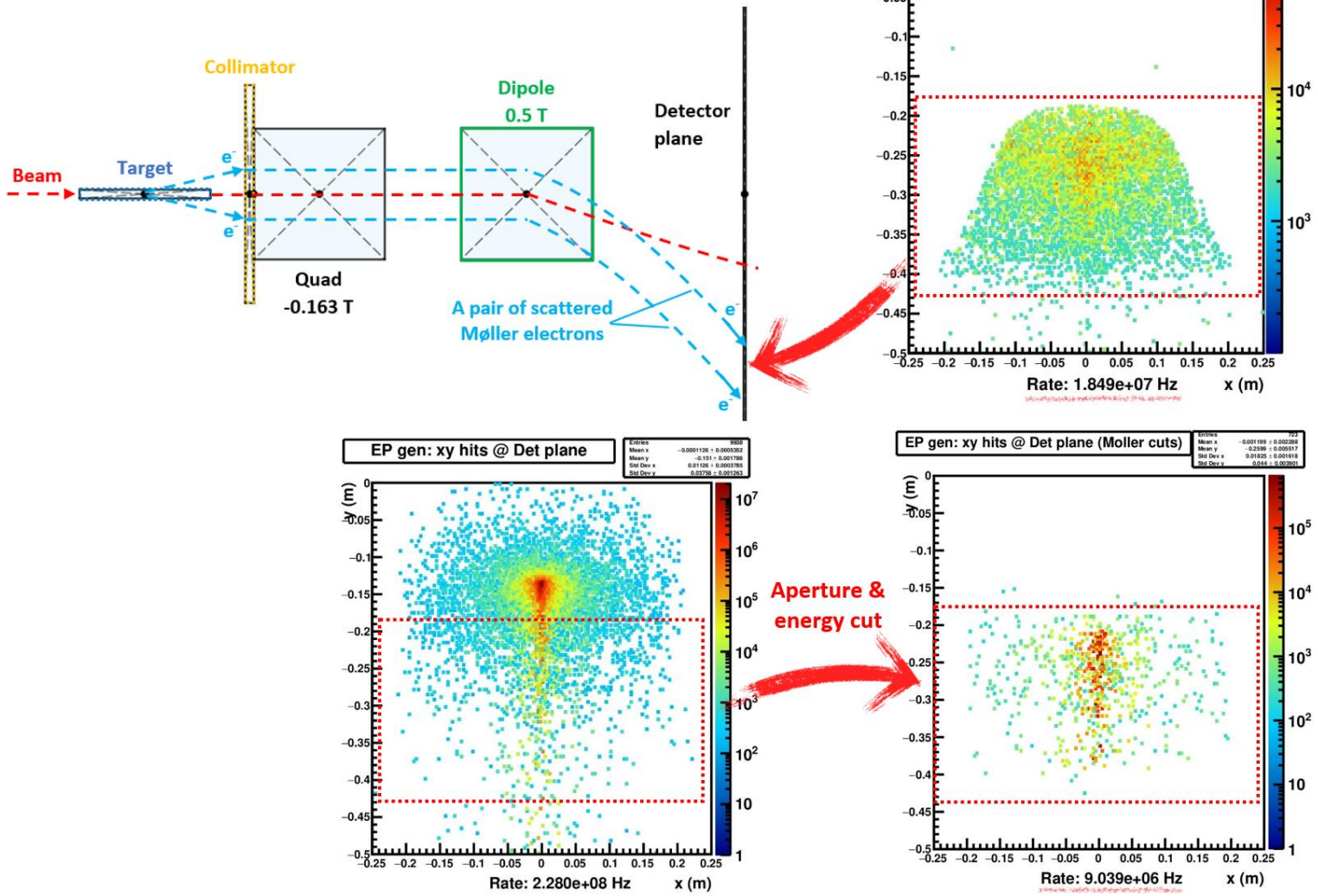






P3E-3 – HIGH PRECISION ELECTRON POLARIMETRY

- Simulation tools ready
- Several detector technologies evaluated:
  - High-Voltage Monolithic Active Pixel sensors
  - GEMs
  - Crystal calorimeters
- Plan:
  - Define detector technology and geometry
  - Write technical design report



P3E - SUMMARY

- **JRA13** is **on track** to achieve in time its scientific objectives.
- The extension of STRONG 2020 till 11/2023 helped to absorb the COVID pandemic induced delays.
- **P3E** completion within STRONG 2020 **do not require further extension**.

The P3E team apologises to the STRONG 2020 Steering Committee for not being able to attend the 2022 A
and gratefully thanks Frank Maas for presenting this report.