



Contribution ID: 123

Type: Poster

## Designing a TPC for the HIBEAM Experiment at the European Spallation Source: Tracking Code Development and Concept Validation

The HIBEAM/NNBAR program at the European Spallation Source is designed to search for baryon number-violating processes through high-sensitivity studies of neutron oscillations, such as neutron-antineutron transitions. This search requires the development of an annihilation detector since the annihilation signal will be composed of multiple secondary particles, primarily charged and neutral pions. The annihilation detector will consist of a time projection chamber (TPC), an electromagnetic calorimeter and a cosmic veto system. The TPC will be a key component in reconstructing charged pion tracks to identify the signature of such transitions.

We present the current status of the tracking and analysis code development, which serves as a foundation for testing and validating the TPC concept using data from a small prototype originally built for linear collider applications. For this purpose, we have conducted cosmic muon measurements with the prototype, allowing us to assess the detector concept, including the shape and evaluate the performance of the reconstruction algorithms. While the current focus is on estimating track residuals, our long-term goal is to optimize the pointing resolution towards potential annihilation vertices. The prototype also enables validation of particle identification capabilities through measurements of energy loss ( $dE/dx$ ) along the drift path.

Although some design aspects, such as pad shape optimization, are relevant for both the linear collider and HIBEAM experiment, the HIBEAM TPC presents unique challenges due to its short drift lengths (approximately 10 cm), where boundary effects and electric field distortions play a more significant role. Therefore, we are developing a dedicated HIBEAM TPC prototype that will provide more realistic boundary geometry and, hence, electric field distribution.

### Significance

Unlike large TPCs such as the one used in ALICE, the HIBEAM TPC has a much shorter drift length, which makes track reconstruction more challenging and demands new design and analysis strategies.

### References

Santoro, Valentina, et al. "The HIBEAM Instrument at the European Spallation Source." *Journal of Physics G: Nuclear and Particle Physics* (2025).  
DOI 10.1088/1361-6471/adc8c2

### Experiment context, if any

**Author:** RATAJ, Blahoslav (Lund University)

**Presenter:** RATAJ, Blahoslav (Lund University)

**Session Classification:** Poster session with coffee break

**Track Classification:** Track 1: Computing Technology for Physics Research