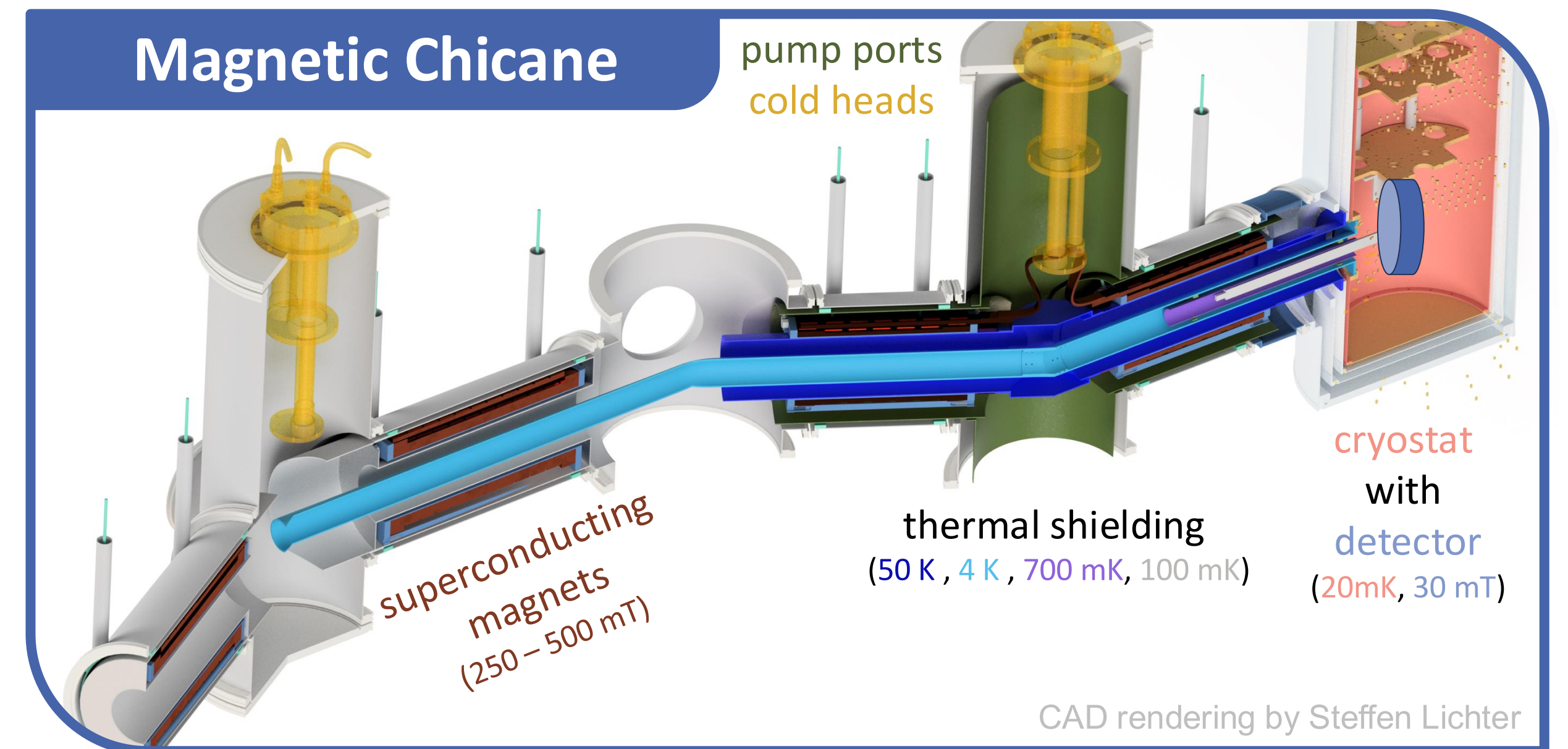
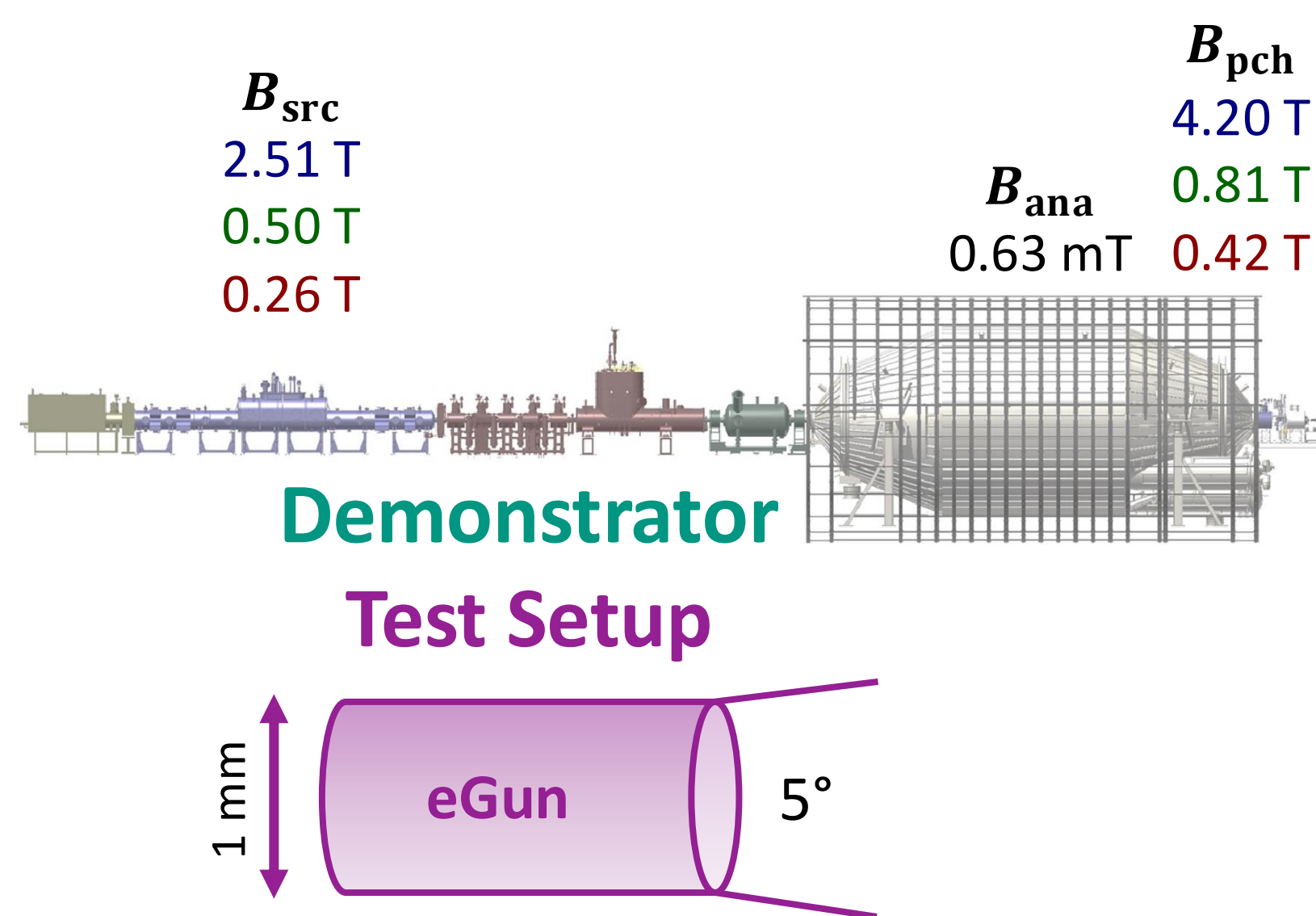
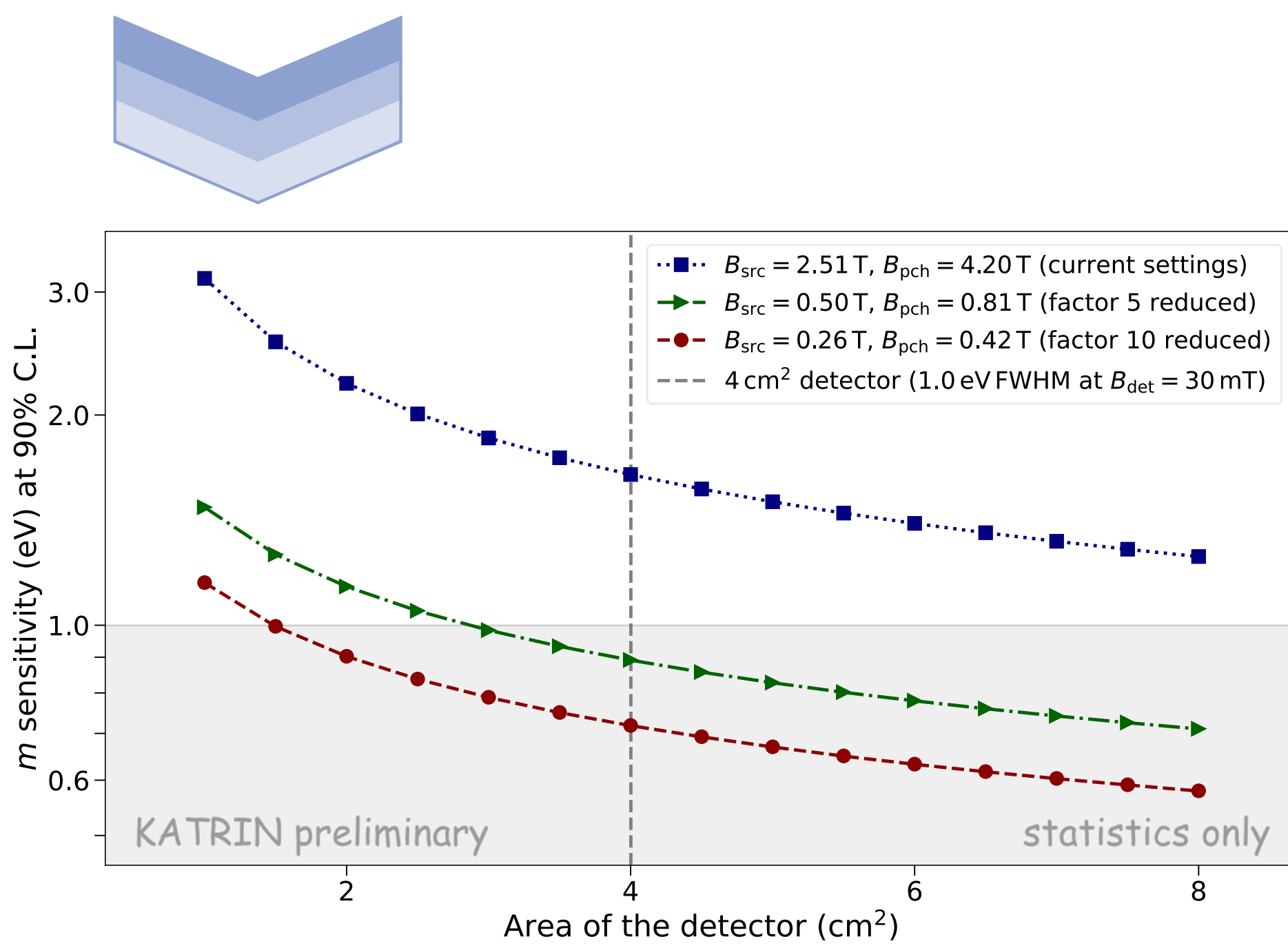


# Magnetic Field Simulations for the Next-Generation MMC-Based KATRIN Experiment

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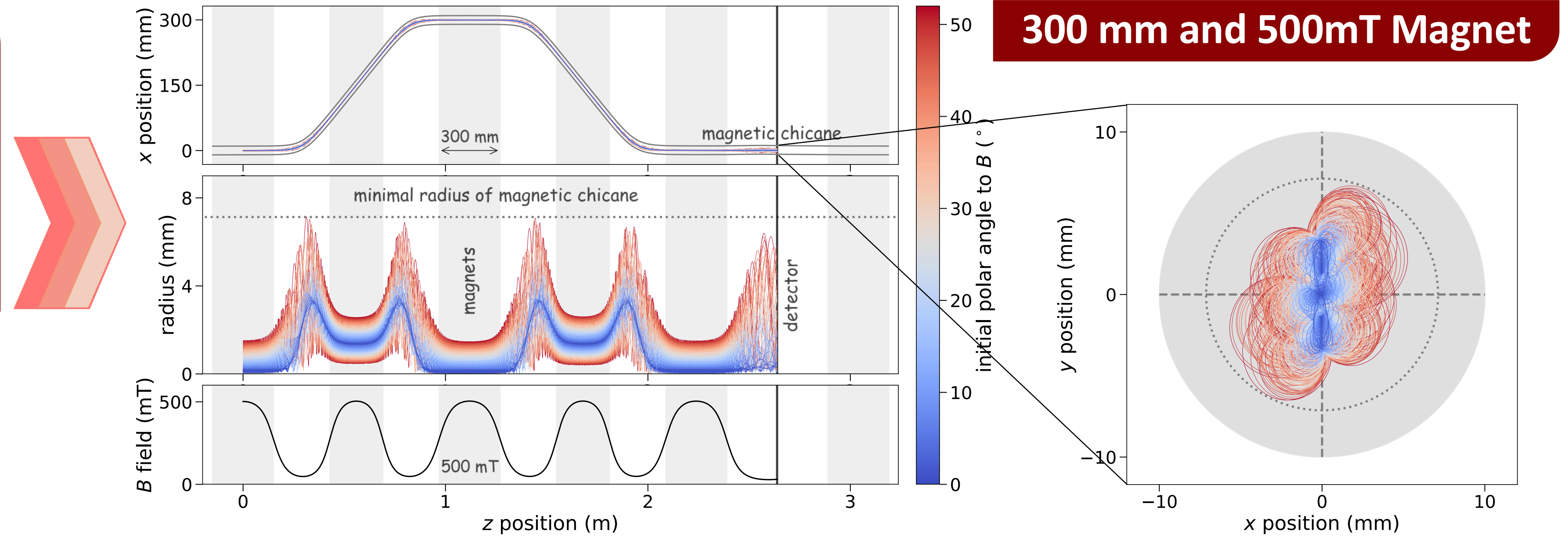
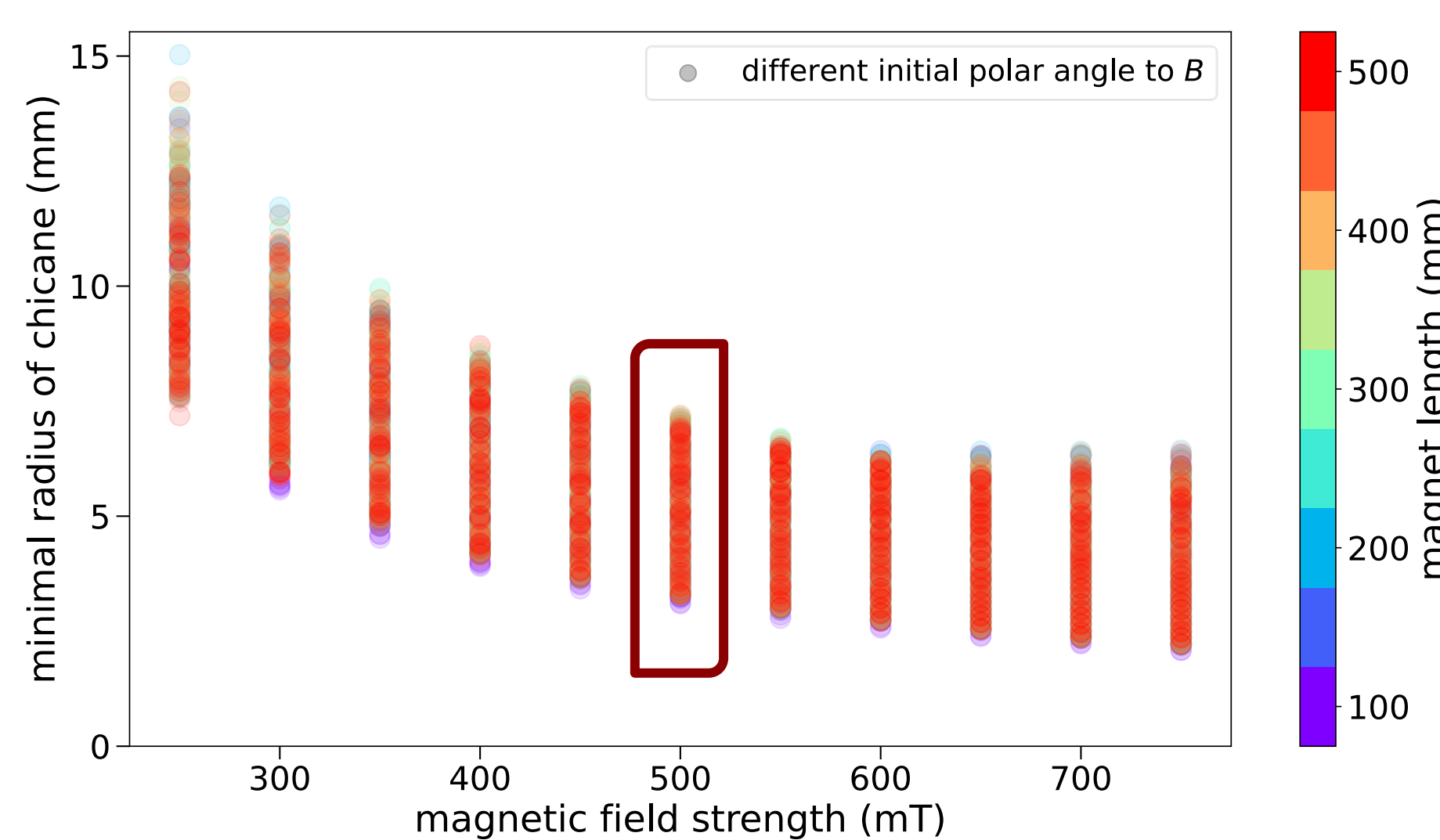
## Introduction

- The **next-generation** tritium-based neutrino mass **experiment** aims to achieve sensitivity to the **inverted neutrino mass ordering**
- Concept: Use novel **metallic microcalorimeters** (MMCs) as quantum detectors
- ➔ **Demonstrator**: A **4 cm<sup>2</sup>** MMC-based detector array (1 eV FWHM) in the **KATRIN** beamline ➔ **sub-eV** sensitivity within **30 days**
- ➔ **Design a magnetic chicane** for a **test setup** to guide electrons from an **eGun** at room-temperature to MMC-based detectors at mK temperatures



## Magnetic Field Simulations

- Simulate trajectories** of single electrons with physically realistic initial **polar angles to B** ( $\theta_{max} = \sqrt{B_{chk}/B_{pch}}$ )
- ➔ Determine **minimal chicane radius**

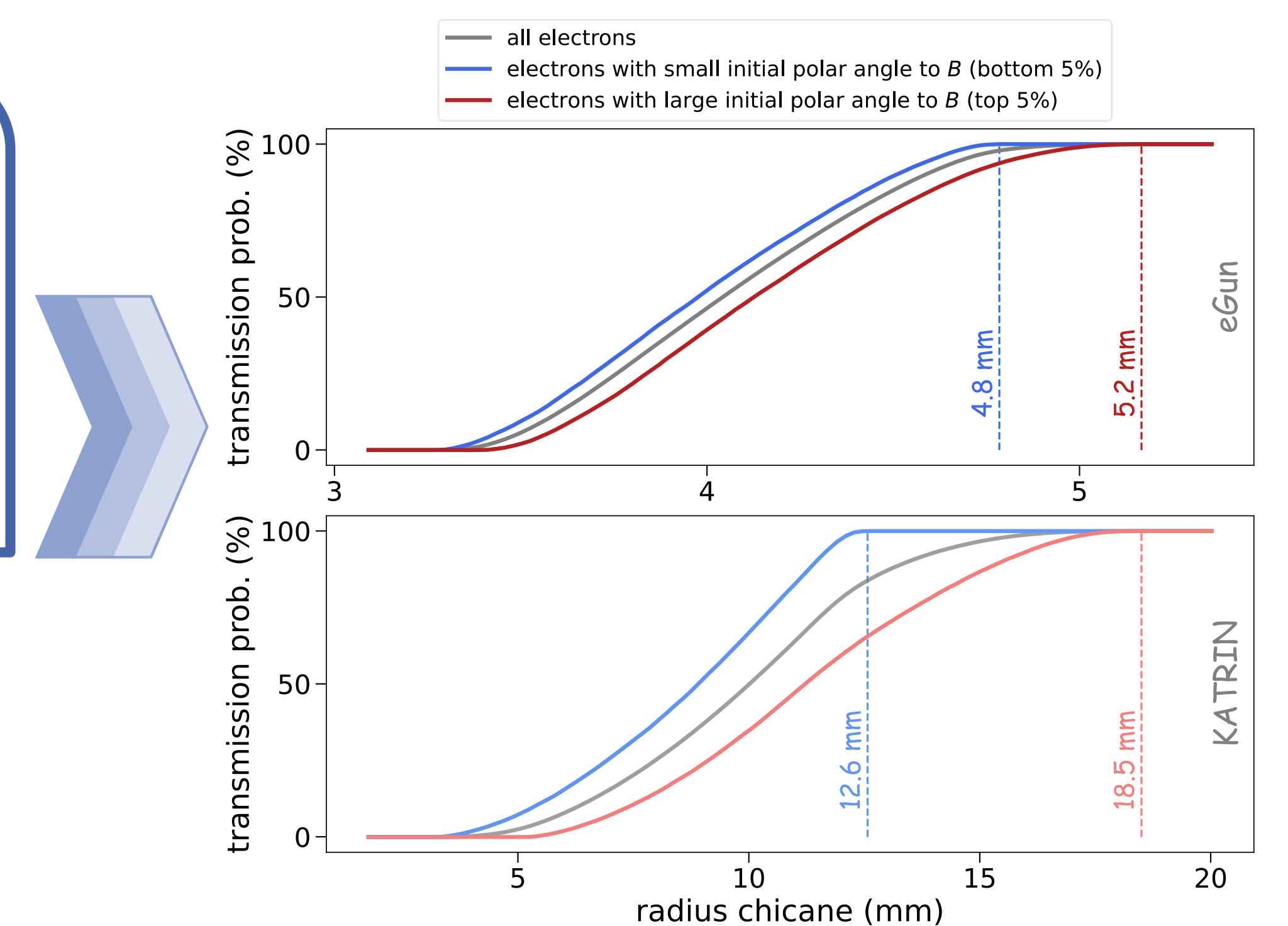


## Find Magnetic Field Settings

- Vary **magnet length** (100 to 500 mm) and **magnetic field strength** (250 to 750 mT)
- ➔ Optimal configuration: **300 mm magnet length with 500 mT field strength**

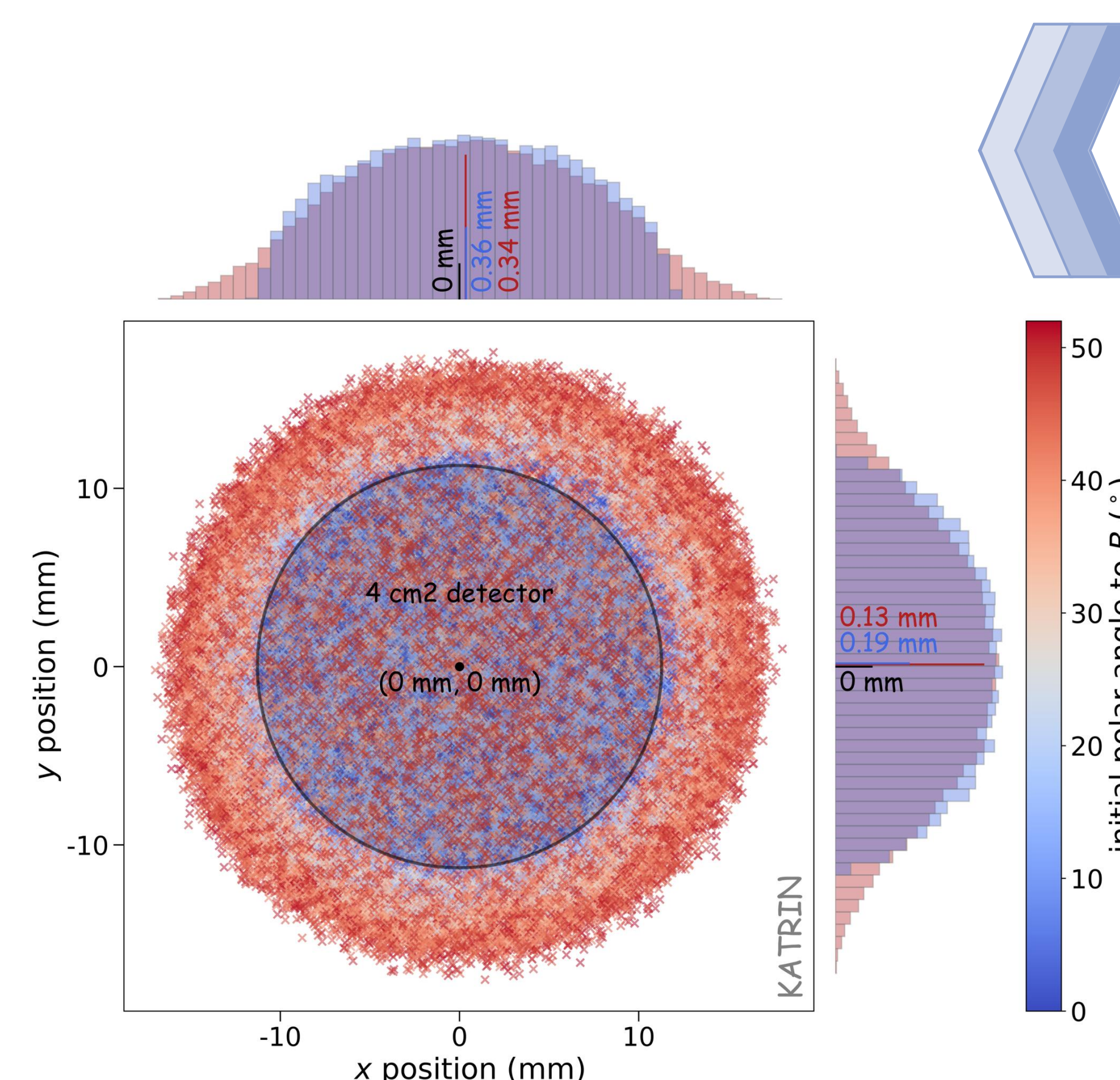
## eGun vs KATRIN (1 Mio Electron Tracks)

- eGun**: 1 mm beam diameter, up to 5° initial **polar angles to B**
- KATRIN**: Flux corresponding to a 4 cm<sup>2</sup> detector, up to 52° initial **polar angles to B**
- ➔ Full **transmission** achieved with **chicane radii** of **5.2 mm** for the **eGun** and **18.5 mm** for the **KATRIN** source ➔ build a **magnetic chicane** with an **inner radius of 20 mm**



## Final Distribution – KATRIN

- Final positions at detector** for different initial **polar angles to B**
- Comparison** of electrons with **small/large** initial **polar angles to B**
  - ➔ **85% (93%/76%)** of the electrons **hit the detector**
  - ➔ **Larger initial polar angles to B** lead to **broader final spatial distribution**
  - ➔ **Mean deviates** from expected value
    - Effect due to cyclotron motion?
    - Effect due to non-adiabaticity?



## Outlook

- Investigate **non-adiabatic effects**
- Study **energy losses** (synchrotron radiation, gas scattering or wall interactions)
- Evaluate impact on neutrino mass **sensitivity**
- Develop a geometry suitable for the full KATRIN source with a larger detector