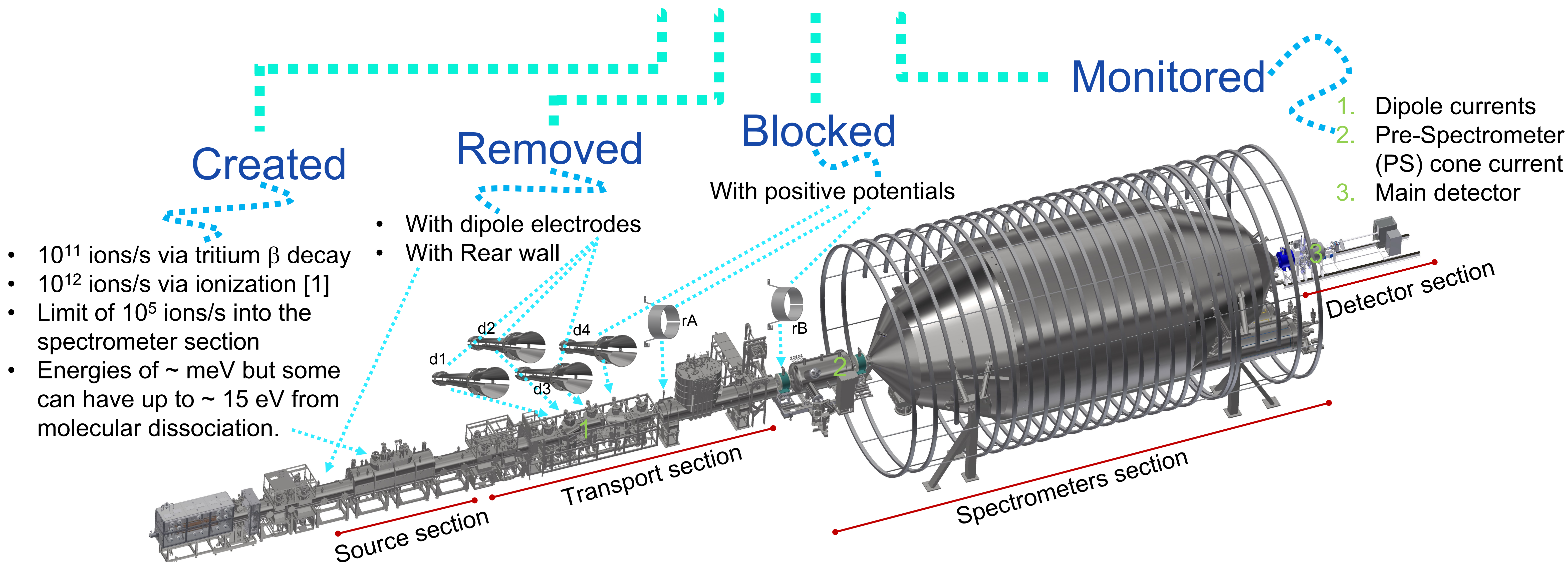


Ion retention, blocking and monitoring within the KATRIN experiment

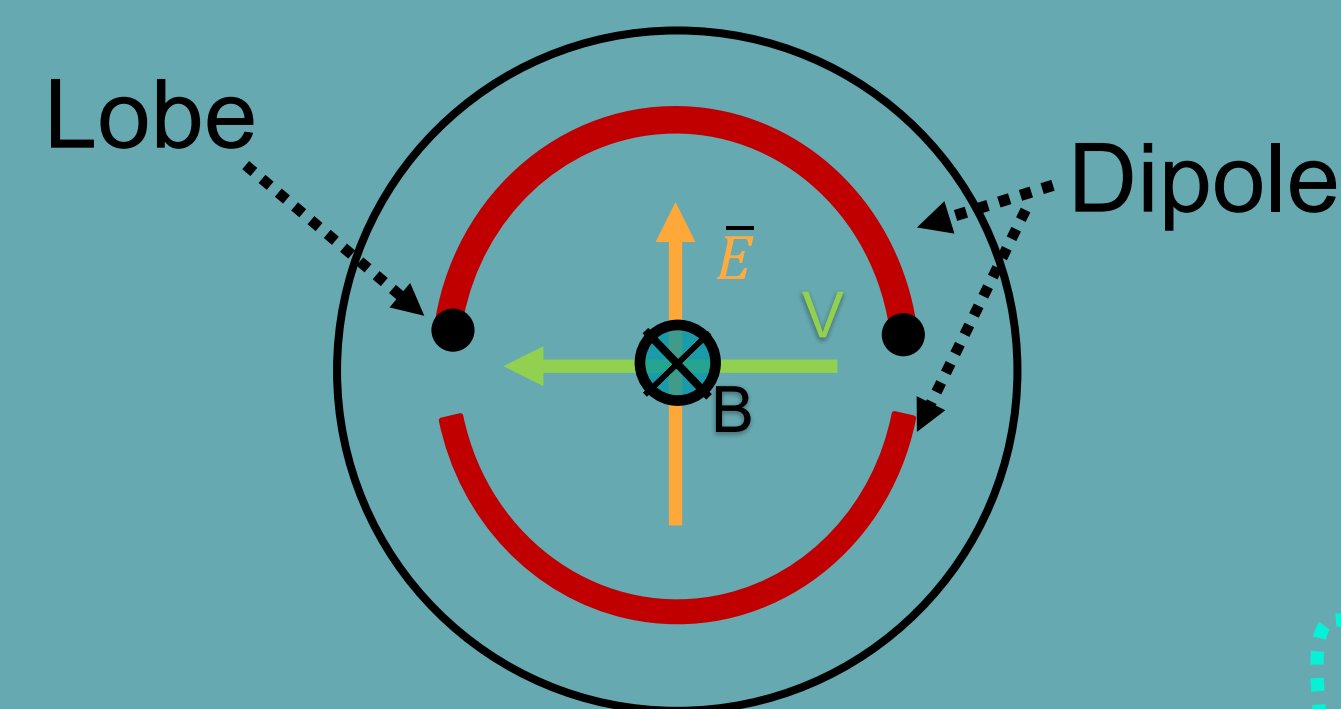
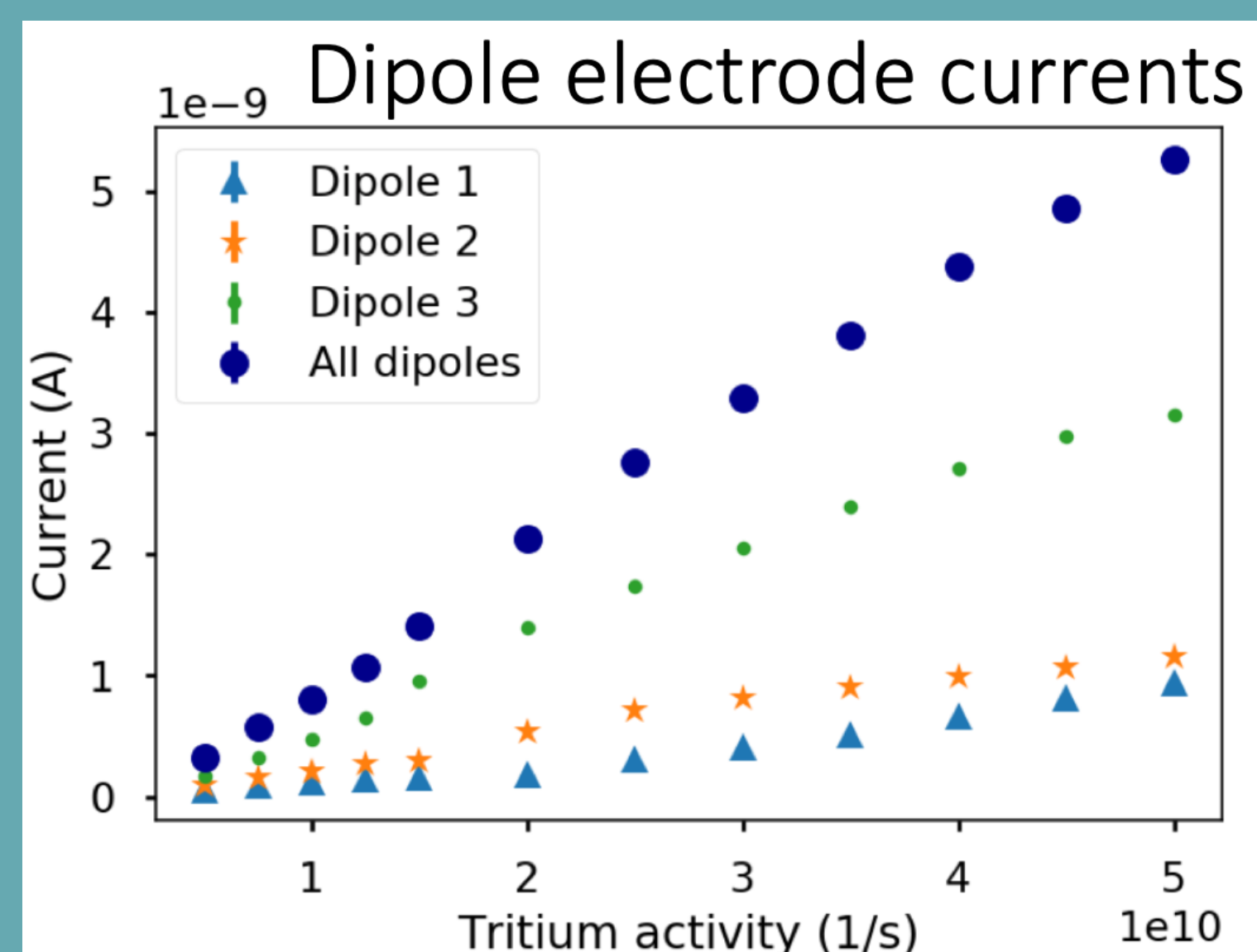
Ana P. Vizcaya Hernández, Fabian Friedel, Ferenc Glück,
Manuel Klein, Magnus Schlösser for the KATRIN collaboration



Ions in KATRIN



Removing ions

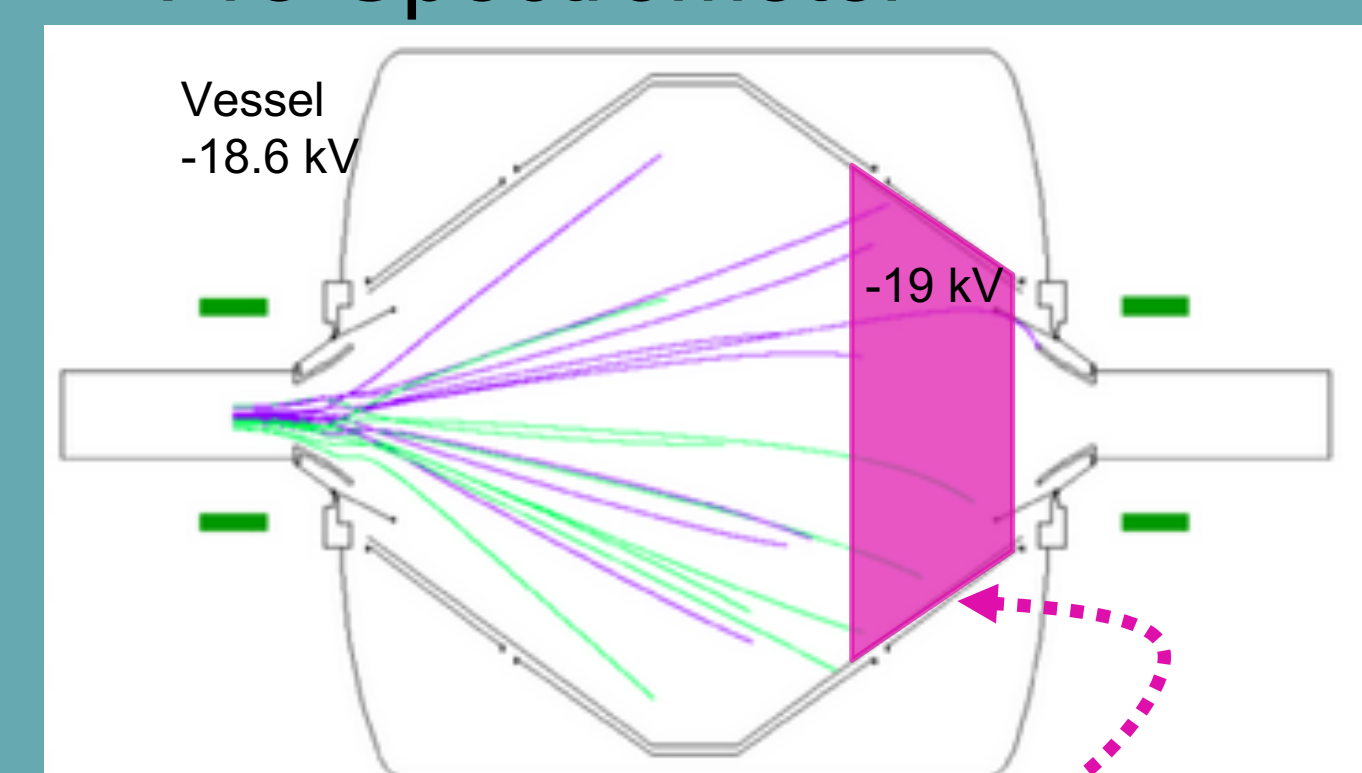


- Ions drift in $\vec{E} \times \vec{B}$ direction and are removed, some hit the lobes and are detected.
- The total current ~2/3 of the removed ions in the transport section.

Monitoring ions

1. Dipole currents
 2. PS downstream cone current $\rightarrow 10^4$ ions/s sensitivity for 2h measurement [1]
 3. Main detector, ion conversion to electron* (ICE)
- *see poster: Detecting ions with KATRIN: performance and results of the ICE method by Fabian Friedel

Simulation of ions inside the Pre-Spectrometer



20% of ions reach the downstream cone

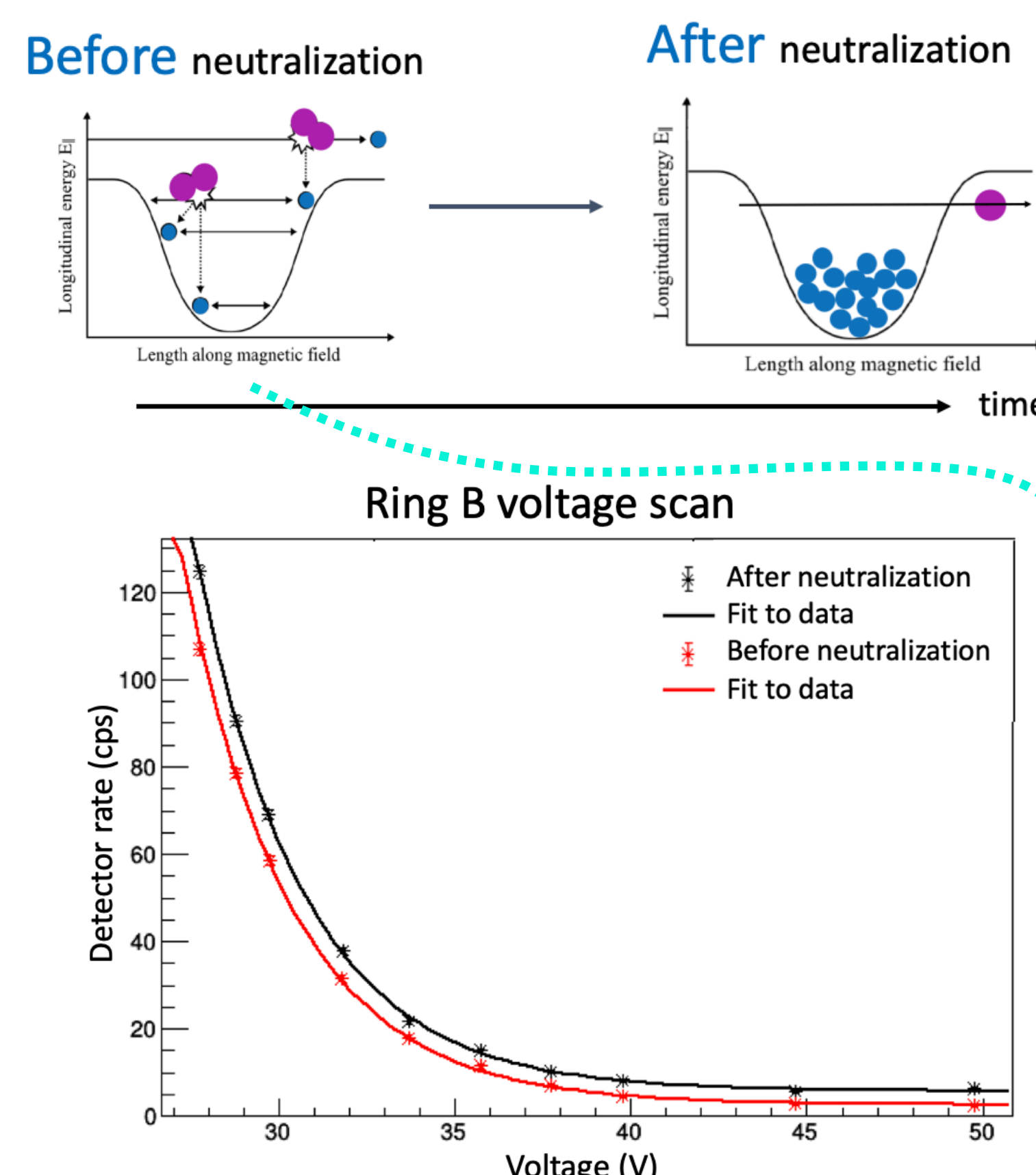
Blocking ions

Neutralization

The blocking potentials will decrease with time as more electrons are captured in the potential.

Voltage shift comparing to nominal value

- Dipole 4: < 1.5% in 5 days
- Ring A: < 0.5% in 7 days
- Ring B: < 1.0% in 12 days

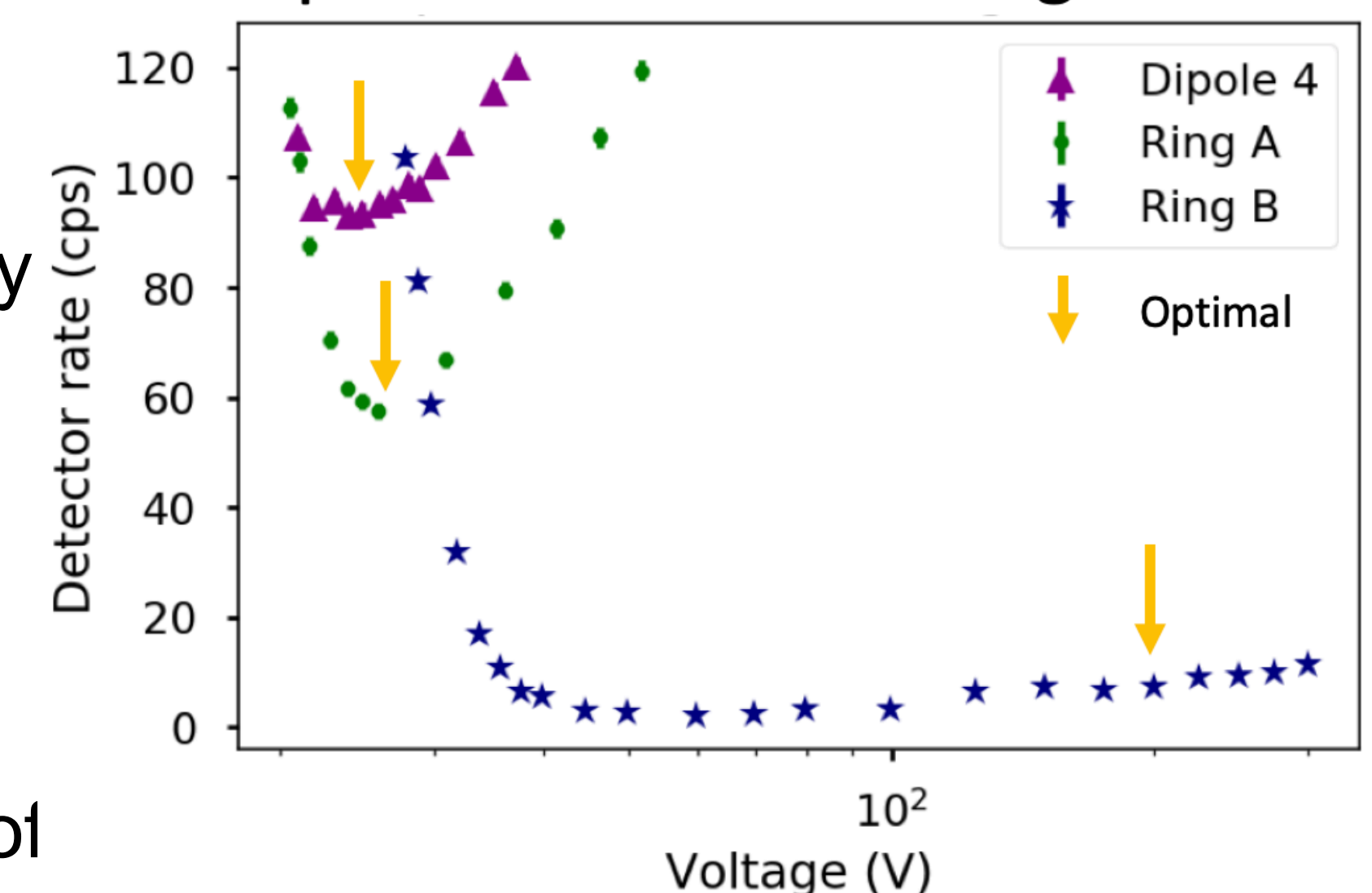


Results using a 25% tritium column density setting [2]

Optimal setting

- Penning ions are created inside positive potentials by electrons colliding with residual gas.
- Dipole 4 \rightarrow 25 V
- Ring A \rightarrow 26 V
- Ring B \rightarrow 200 V because of low Penning ion rate

Optimization of blocking devices



Conclusions

- Source ions are blocked by the ring electrodes and dipole 4 before they reach the spectrometer section and are removed by dipoles 1, 2 and 3.
- An optimal setting was found for the ring electrodes and dipole 4. It depends on neutralization time and Penning ion rate.
- Long times for complete neutralization \rightarrow it is possible to run the experiment for a week before emptying (inverting polarity) the blocking potential traps.

Acknowledgments and References

This work is partially supported by the US DOE Office of Science under Award Number #DE-SC0019304.

- [1] Manuel Klein. Tritium ions in KATRIN: blocking, removal and detection. PhD thesis from Karlsruhe Institute of Technology, 2018.
- [2] J. Angrik, et al. KATRIN design report 2004.