Alignment studies for the KATRIN experiment
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- Transmission properties of spectrometer affected by inhomogeneities in electric potential and magnetic guiding fields
- Modeled by simulations which require precise alignment of the detector wafer, beamline and all magnets
- Data from previous measurement campaigns was used for validation of the alignment in the simulation.

### Transmission Function

- Electric potential ($U$) and magnetic field ($B_{min}$) inside of the main-spectrometer can be simulated.
- More details: See J. Behrens and L. Schimpf’s poster (Mo #15)

### Validation of the alignment by measurements

- Asymmetric magnetic field
  - Inner electrode structure mapped on the detector
  - Ring centers give information about the alignment between spectrometer and detector

### Uncertainty on alignment simulations

- Alignment data from FaroArm, LASER tracker and magnetic field measurements go into model
- MC simulation with random alignment of beamline components and magnets within uncertainty range to get uncertainty on tracks

### Results and outlook

- Asymmetric magnetic field measurements and alignment simulation in good agreement
- Sinusoidal structure shown in Krypton line position distribution that could be caused by additional unknown misalignment
- Unknown additional misalignment estimated by finding detector location in simulation with suppressed structure of gaseous Krypton L3 and K line position.
- Further investigation in progress
  - Include further alignment information in model
  - Ring fitter with machine learning algorithm
  - Work function differences (e.g. source systematics)
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Structure of line positions observed during krypton measurement campaign (July 2017)

Structure from discrepancy between simulation and real alignment of main spectrometer and detector.

Magnitude of structure quantified by simple sine function:

\[ f(\theta; A, \varphi, b) = A \cdot \sin(\theta + \varphi) + b \]