Performance of the Prototype PSI muEDM Entrance Detector Measured with Test Beam Data

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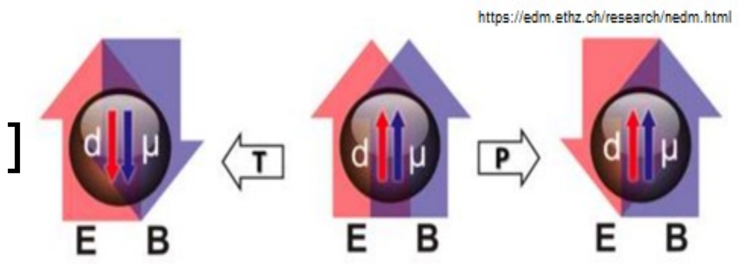
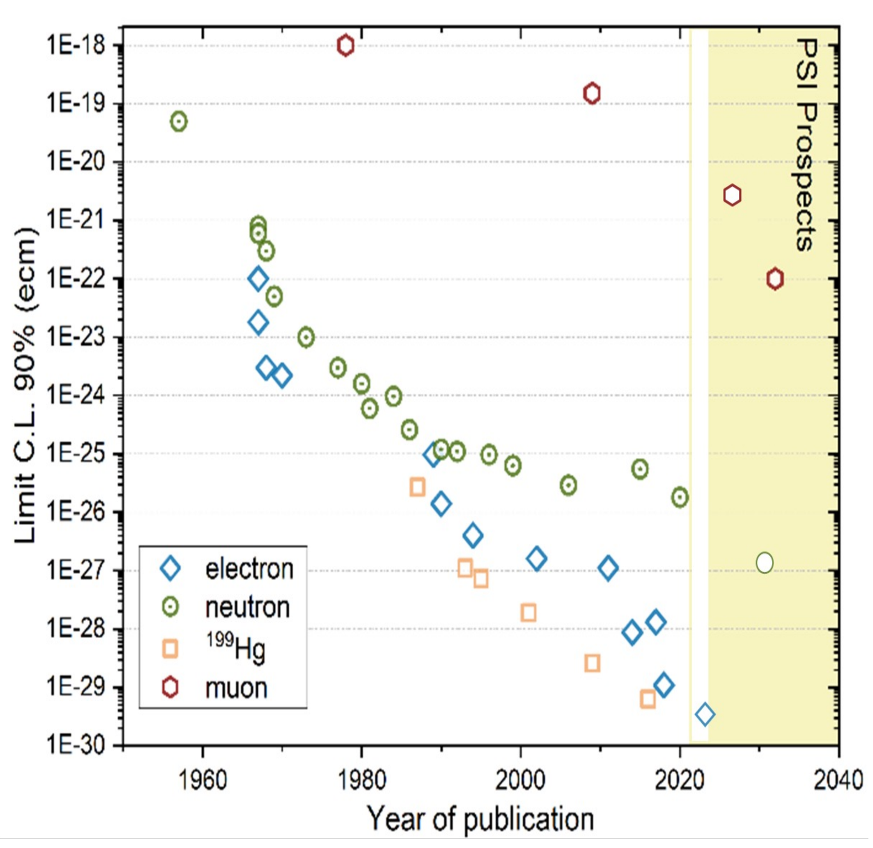
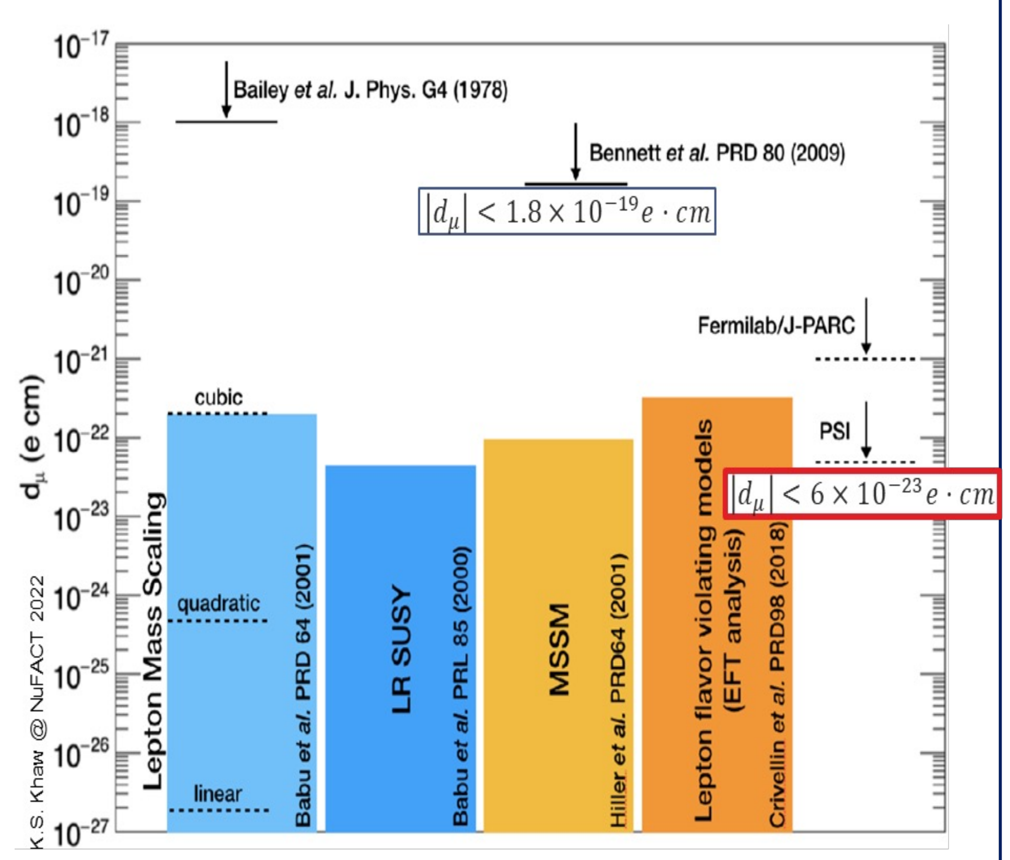
Why search for electric dipole moment (EDM)?

- **EDMs are CPV observables**
  - Small SM prediction ($d_\mu \sim 10^{-38} e \cdot cm$) [1]
  - Background free search for BSM
- **Various BSM models predicts enhanced EDM [2, 3]**
  - Complementary to LHC searches
  - EDMs are good probes for BSM CPV
- **Present landscape of (μ)EDM:**



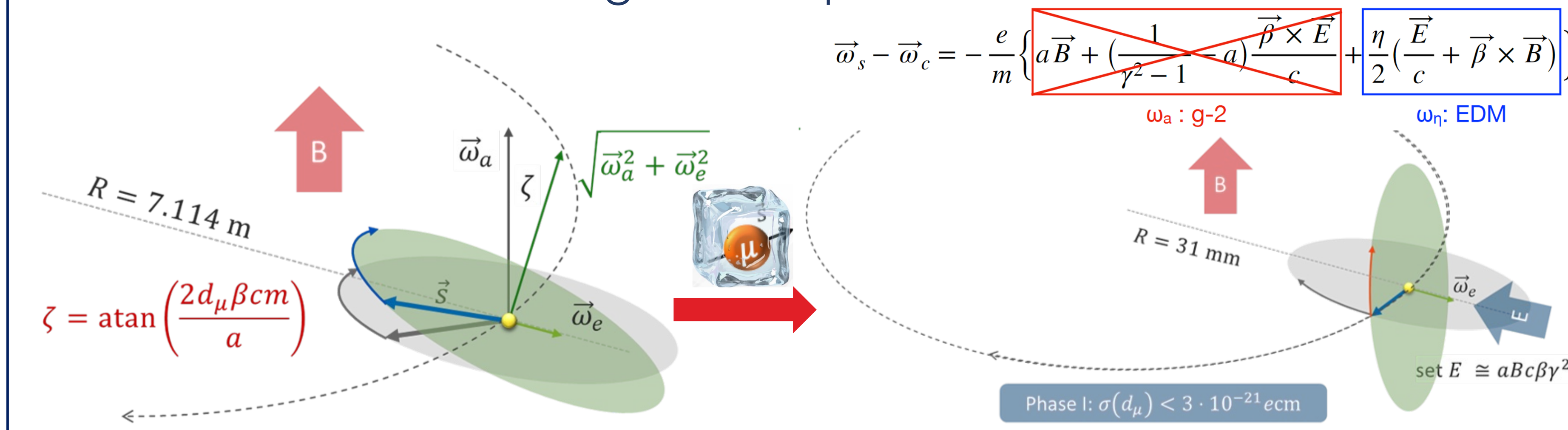




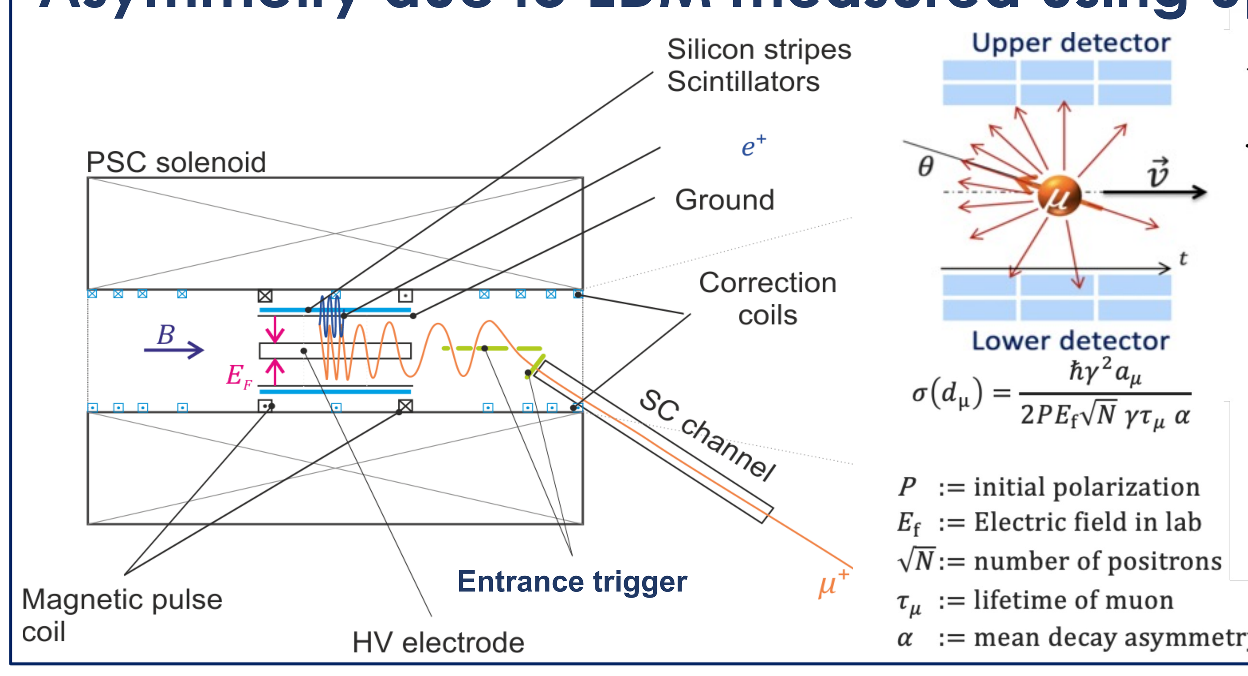
Frozen-spin technique at muEDM

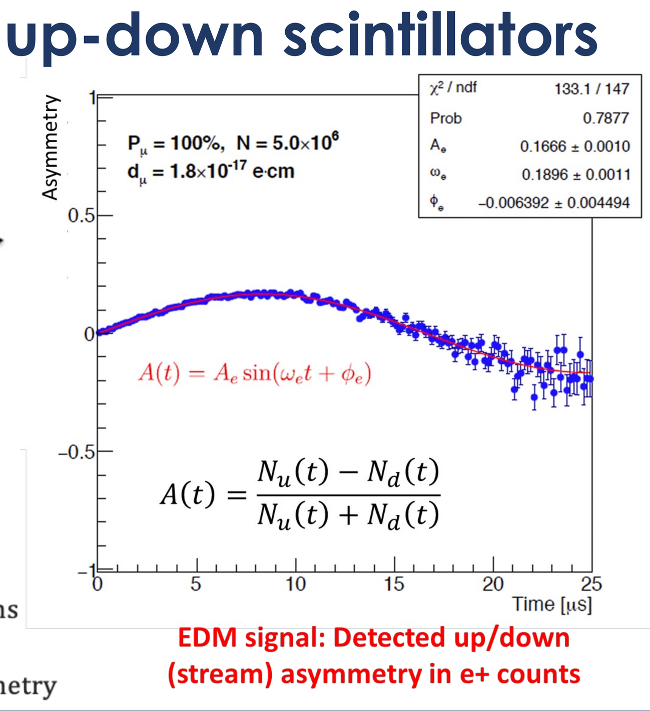
Increase sensitivity by applying a radial E-field, $E_r \approx aBc\beta\gamma^2$

- Removes g-2 anomalous precession in storage plane
- EDM inflicts an increasing vertical polarisation



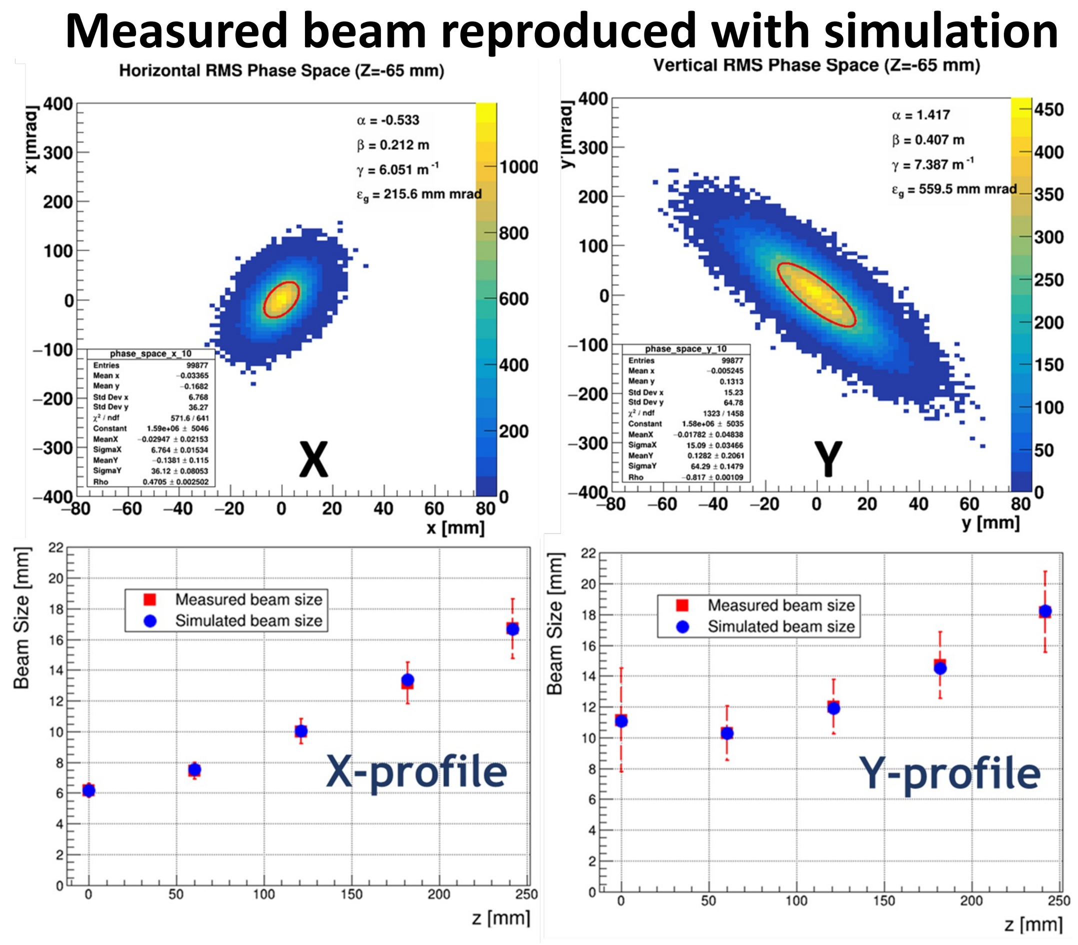
Asymmetry due to EDM measured using up-down scintillators

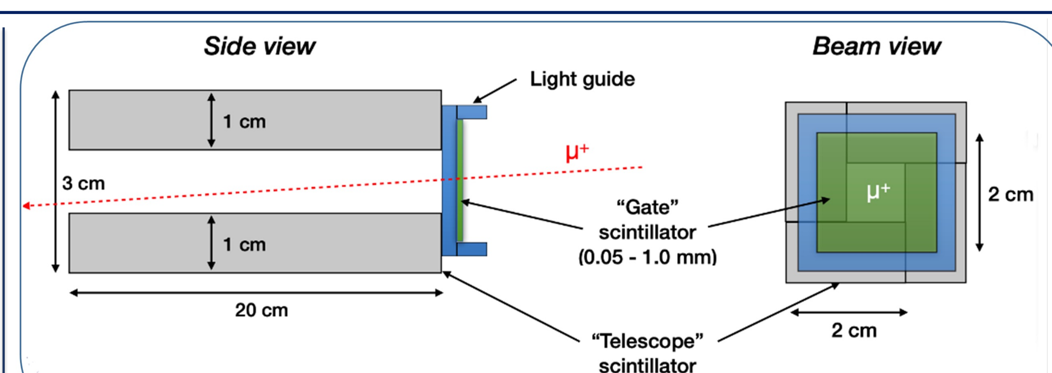




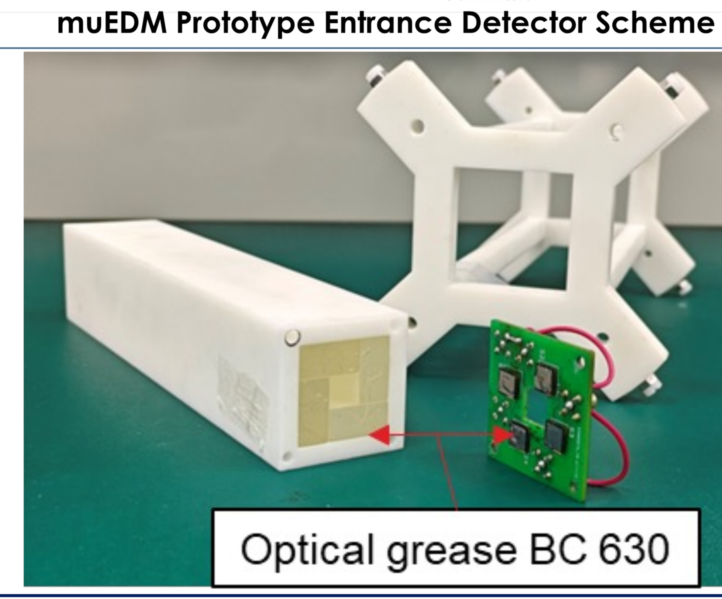
PSI πE1 test beam

Measured beam reproduced with simulation

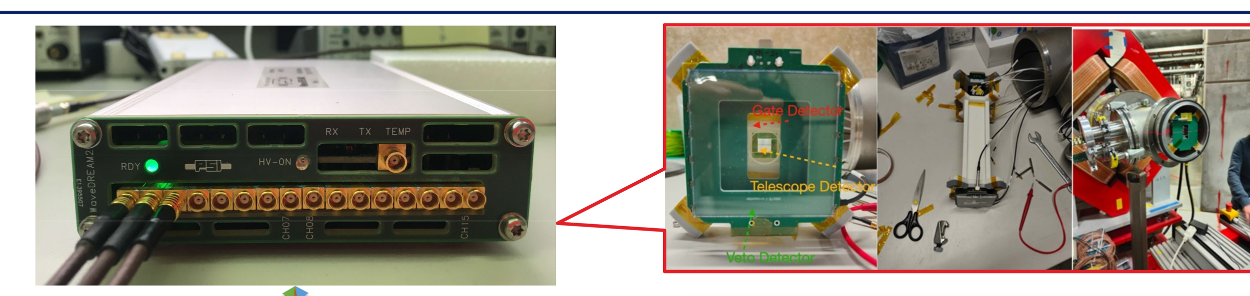


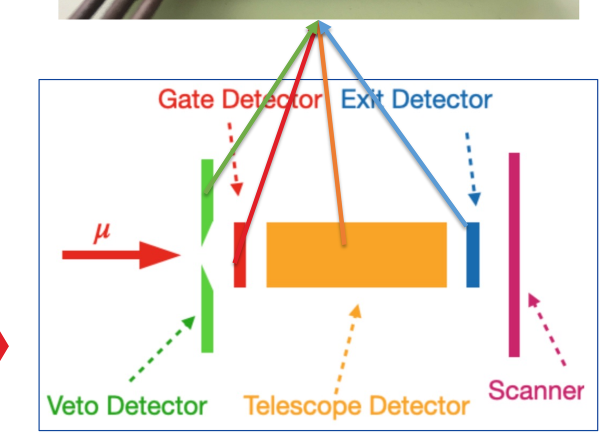


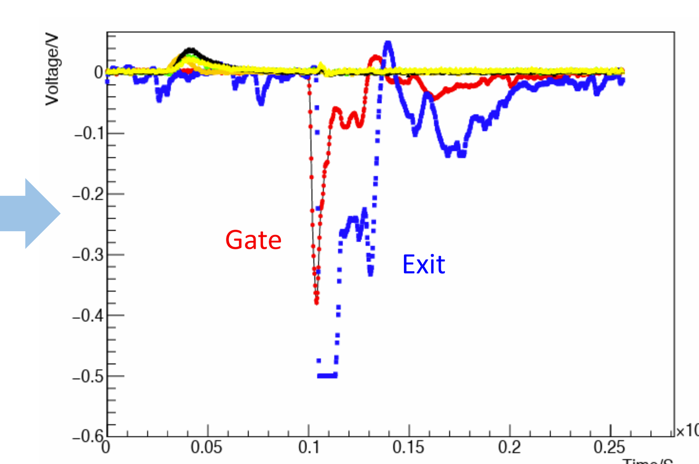
muEDM Prototype Entrance Detector Scheme



Full set-up



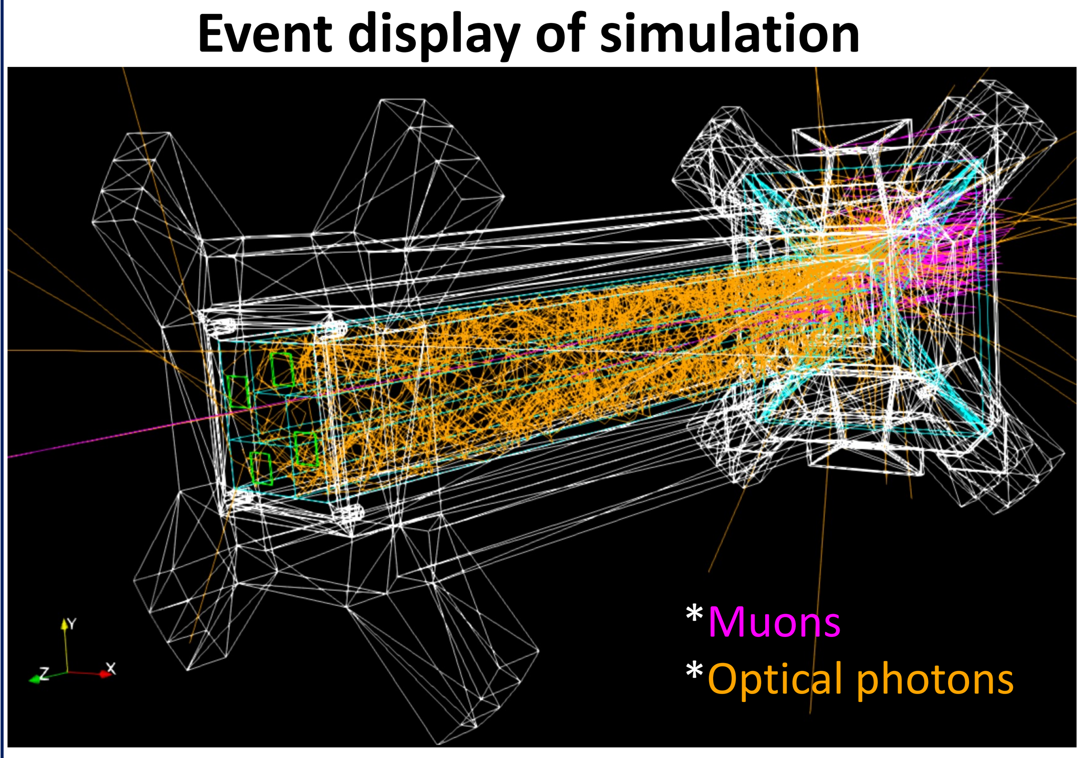




Full set-up with *veto*, *gate* and *exit* scintillators. The measured typical pulse signals of each sub-detectors allowed several trigger modes for better **event characterization**.

Detector Performance

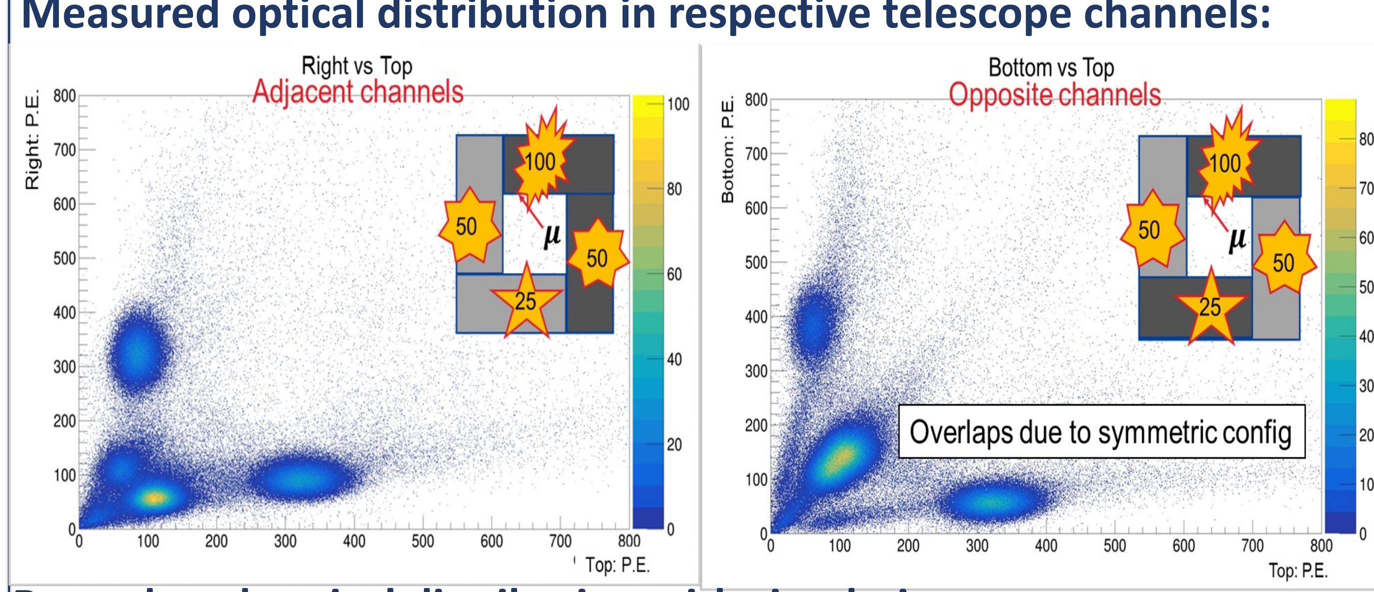
Event display of simulation



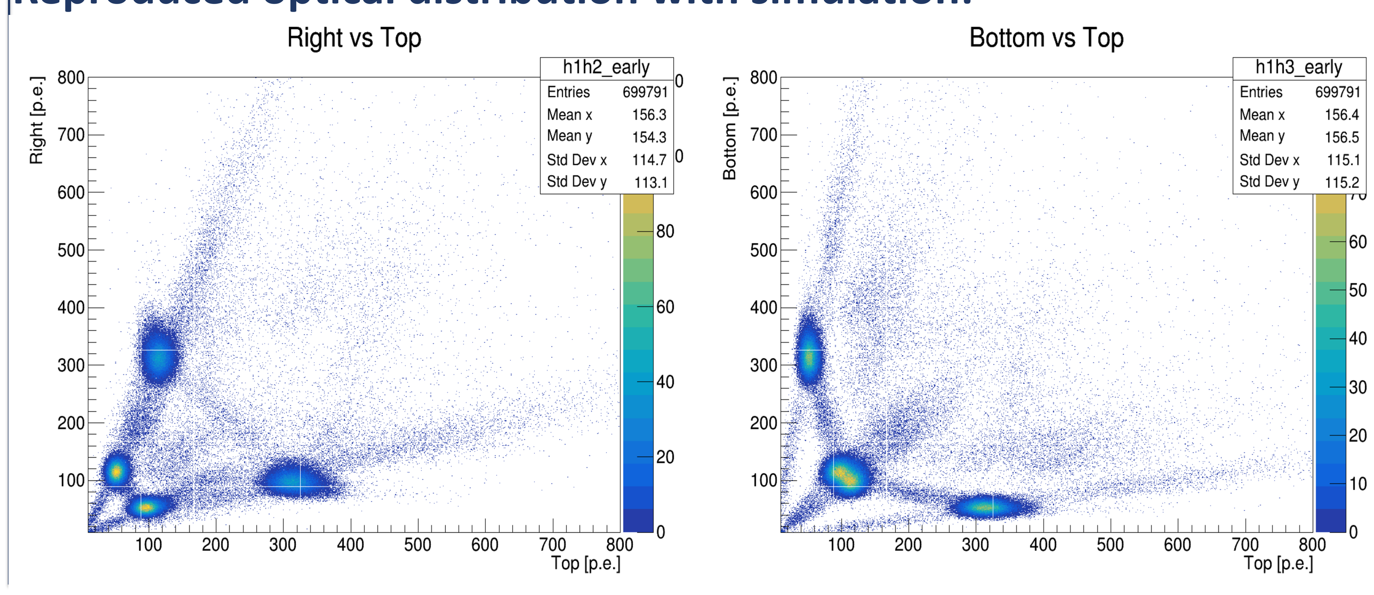
- Detector performance is studied by reproducing event topologies and relative event rates in MC simulation
- Beam model, detector geometry, and detector optical characteristics are implemented

Detector Optical Characteristics

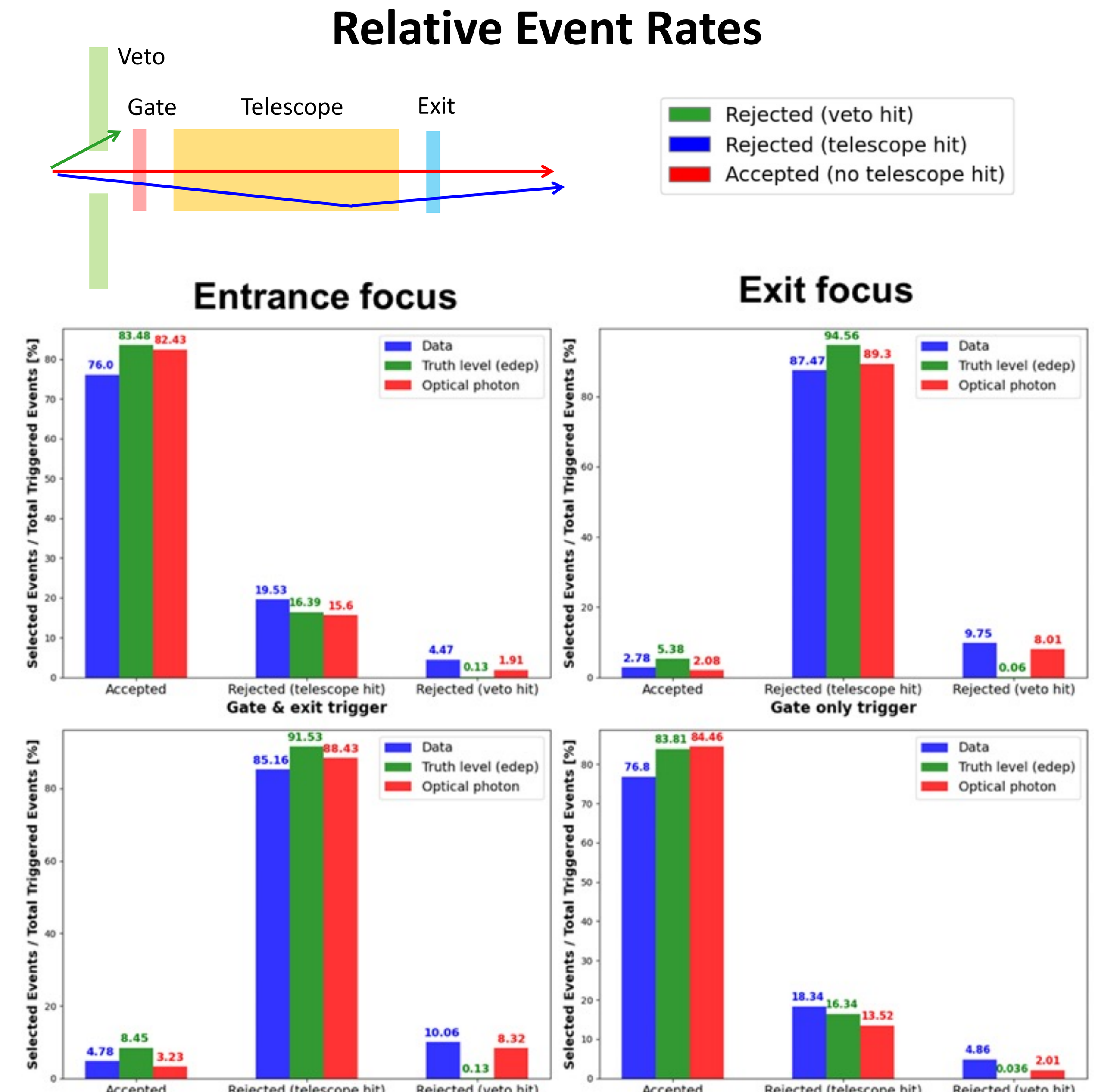
Measured optical distribution in respective telescope channels:



Reproduced optical distribution with simulation:



Relative Event Rates



Summary

- A prototype entrance detector is developed with plastic scintillators and SiPM
- Detector performance evaluated by reproducing event characteristics in simulation with optical characteristics for the telescope detectors
- Event rates reproduced in simulation are of close agreement with the measured results
- Event selection efficiency is at ~4% efficiency with gate-only trigger but improves significantly with gate-exit coincidence trigger to ~70%

References

[1] Y. Yamaguchi, *et al.*, *Phys. Rev.* L**125** (2020), 241802

[2] Y. Shigekami *et al.*, *Phys. Lett.* B **831** (2022 137194

[3] A. Crivellin, *et al.*, *Phys. Rev.* D**98** (2018) no.11, 113002

[4] G. W. Bennett, et al., Phys. Rev. D 80 (2009), 052008

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