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# Neutrino flux calculations for FODO and FFAG nuSTORM rings and NuMAX FODO ring

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# Outline

- Introduction
- Effect of scallop angle on the neutrino flux
  - FODO ring versus FFAG doublet
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- Flux in the near detector of nuMAX
- Conclusions

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# Introduction

- No absolute normalization
- No polarisation included
- Comparison between nuSTORM FODO assumes equal number of stored muons, no DA limitations, etc.
- We are interested in understanding the effect of scallop angle on neutrino spectrum and performance
- Flux at near detector of NuMax is calculated just to see the difference in spectrum
- Effects of dispersion and finite emittances are included.
- Beam is generated and decayed in discrete locations along the decay straight and extrapolated to the detectors.

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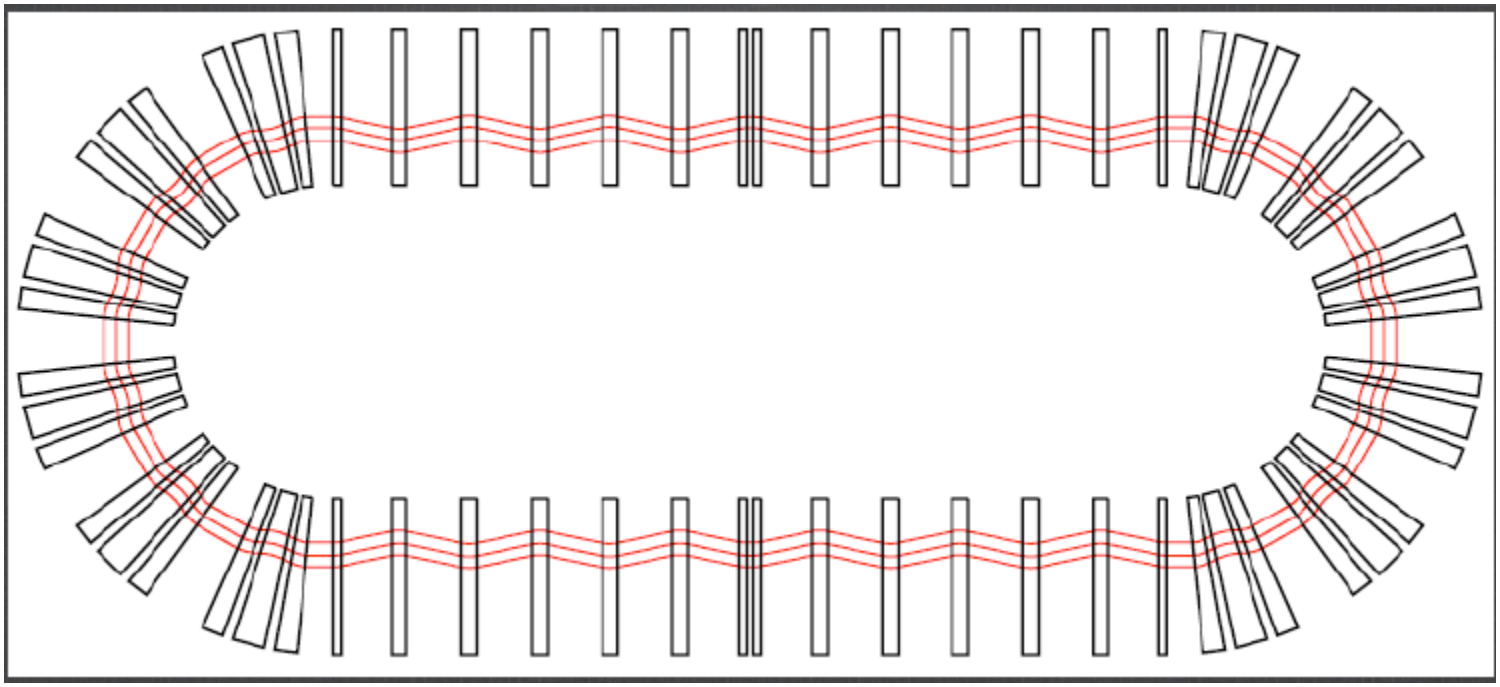
# Scallop angle is present in FFAG production straight



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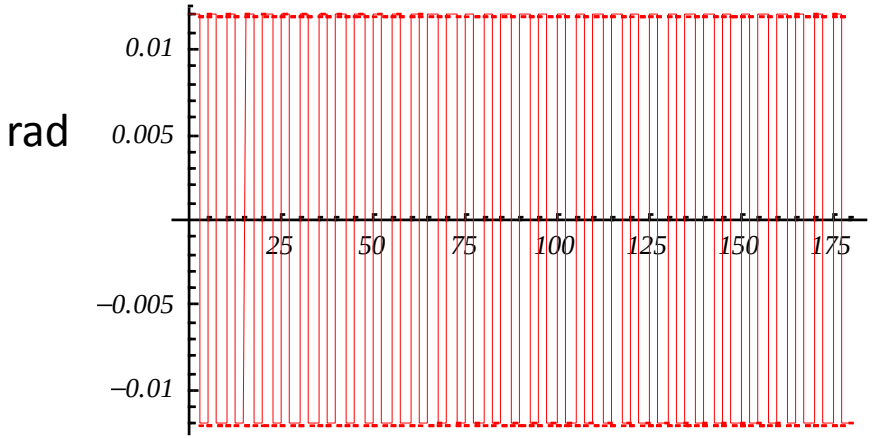
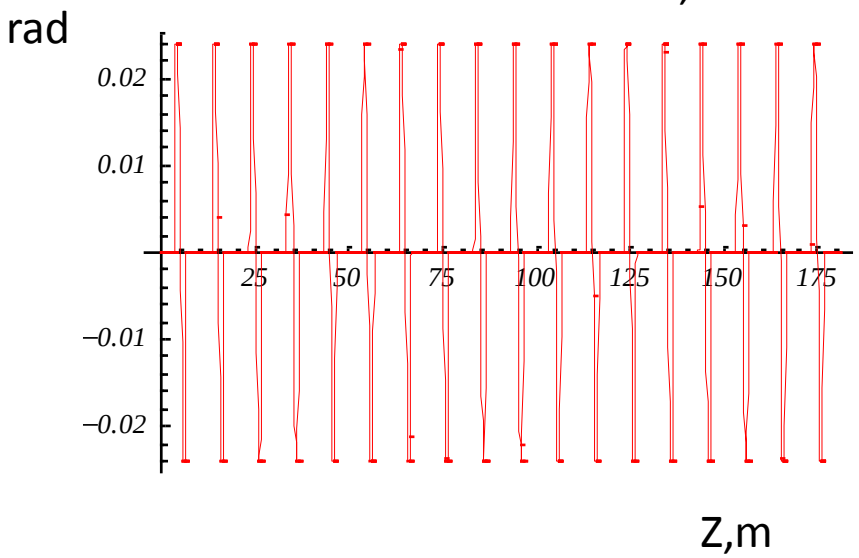
# Model of scallop angle in FFAGs

- For doublet FFAG




- For triplet



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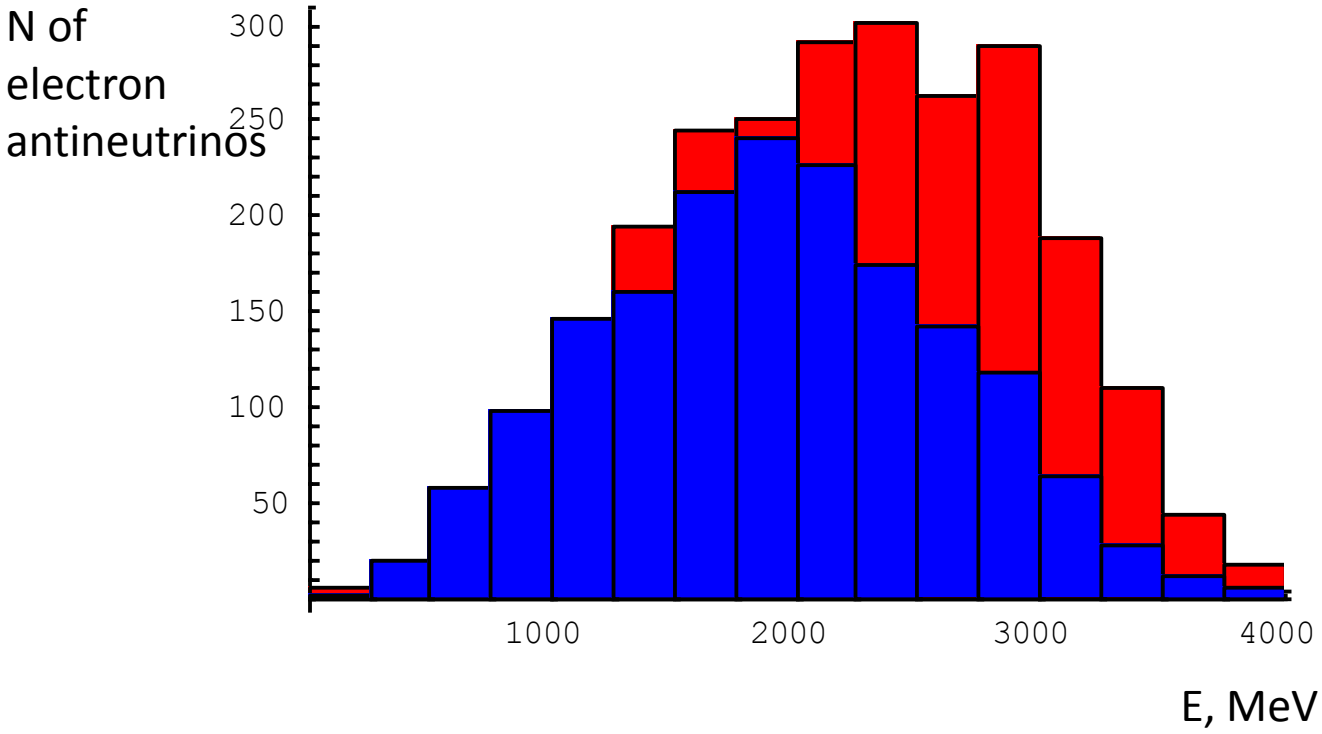
# nuSTORM FODO versus doublet FFAG

- Far detector distance 2km, 5m diameter, simulation for 4000000 stored muons



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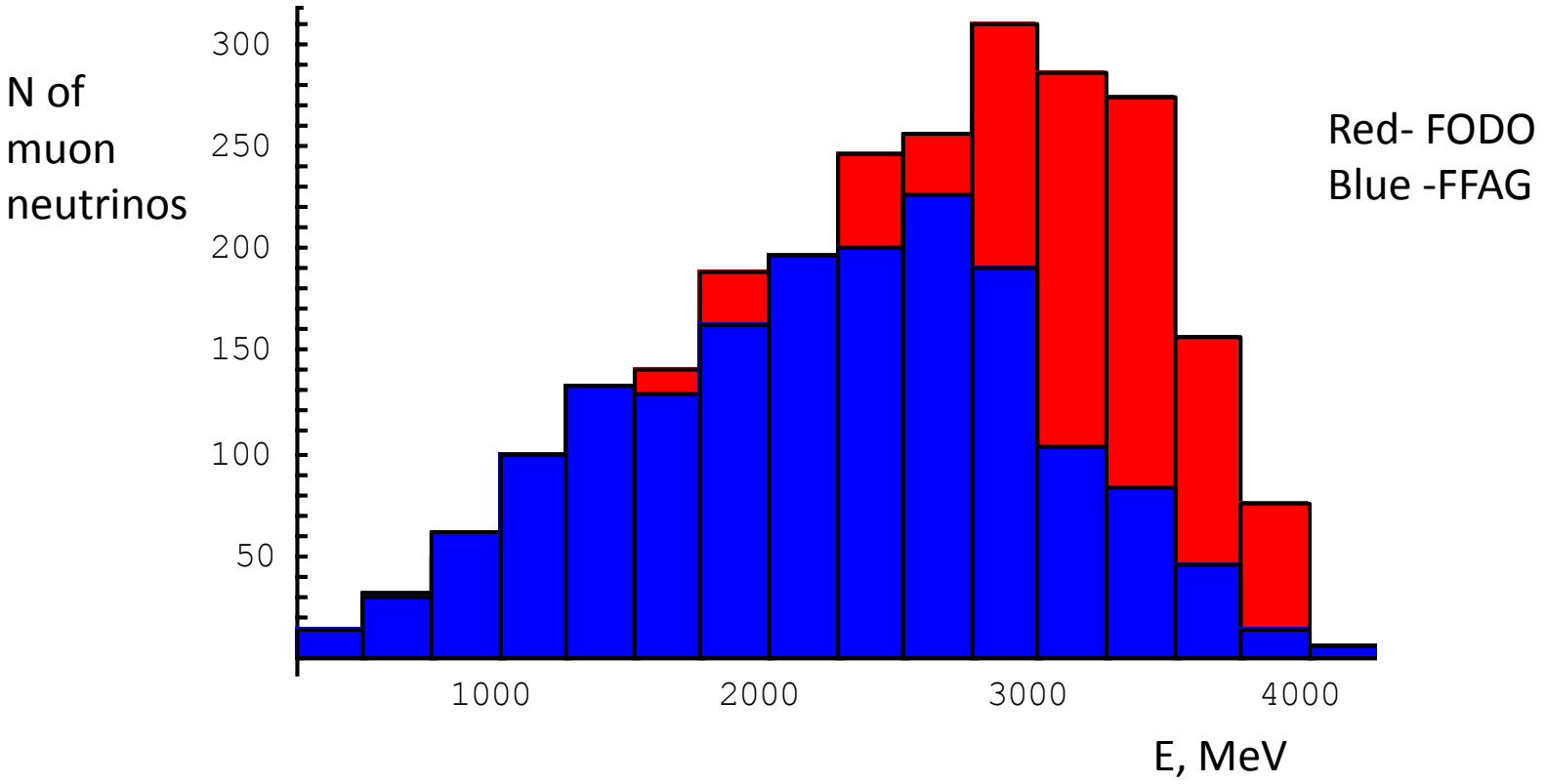

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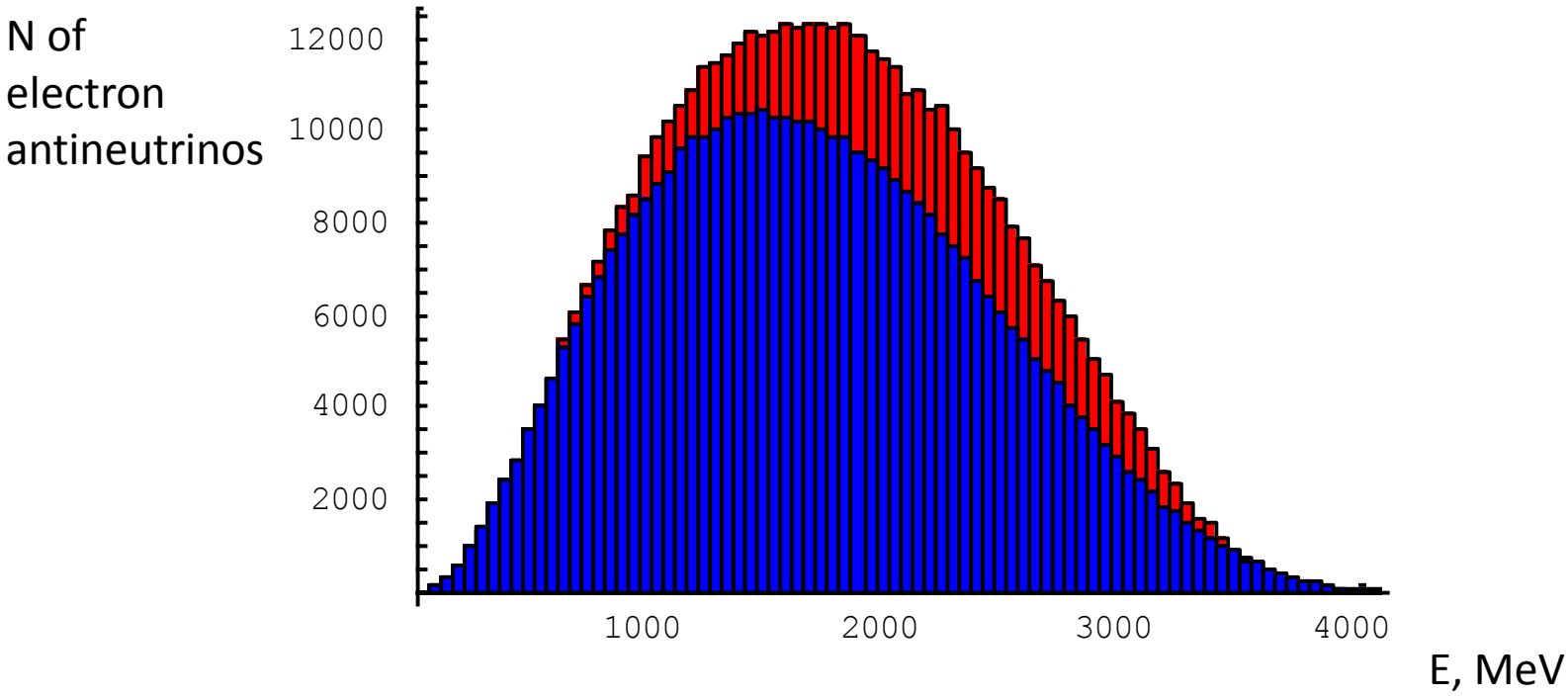
# nuSTORM FODO versus doublet FFAG

- Near detector distance: 50m, 5m diameter, simulation for 4000000 stored muons



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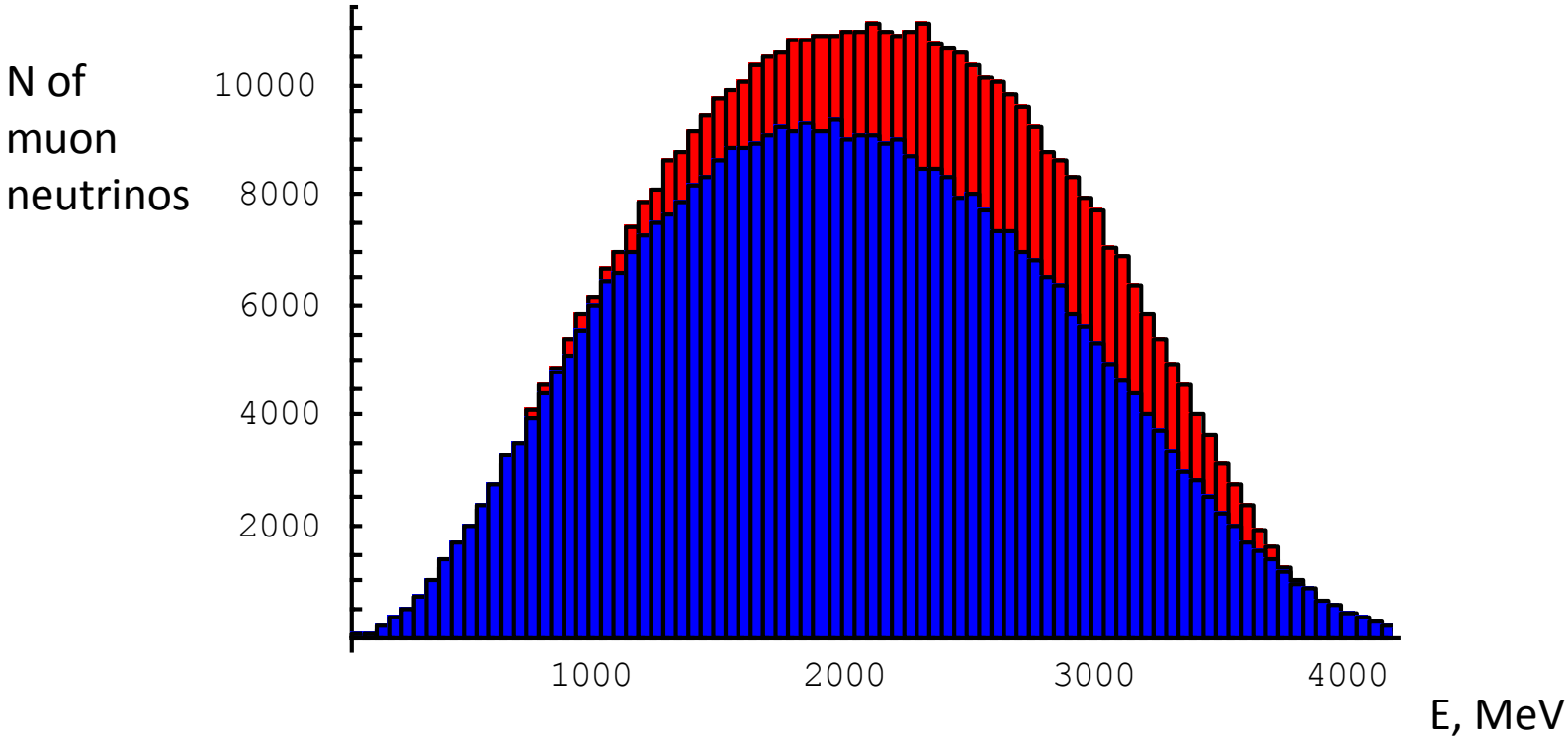
# nuSTORM FODO versus doublet FFAG

- Near detector distance: 50m, 5m diameter, simulation for 4000000 stored muons



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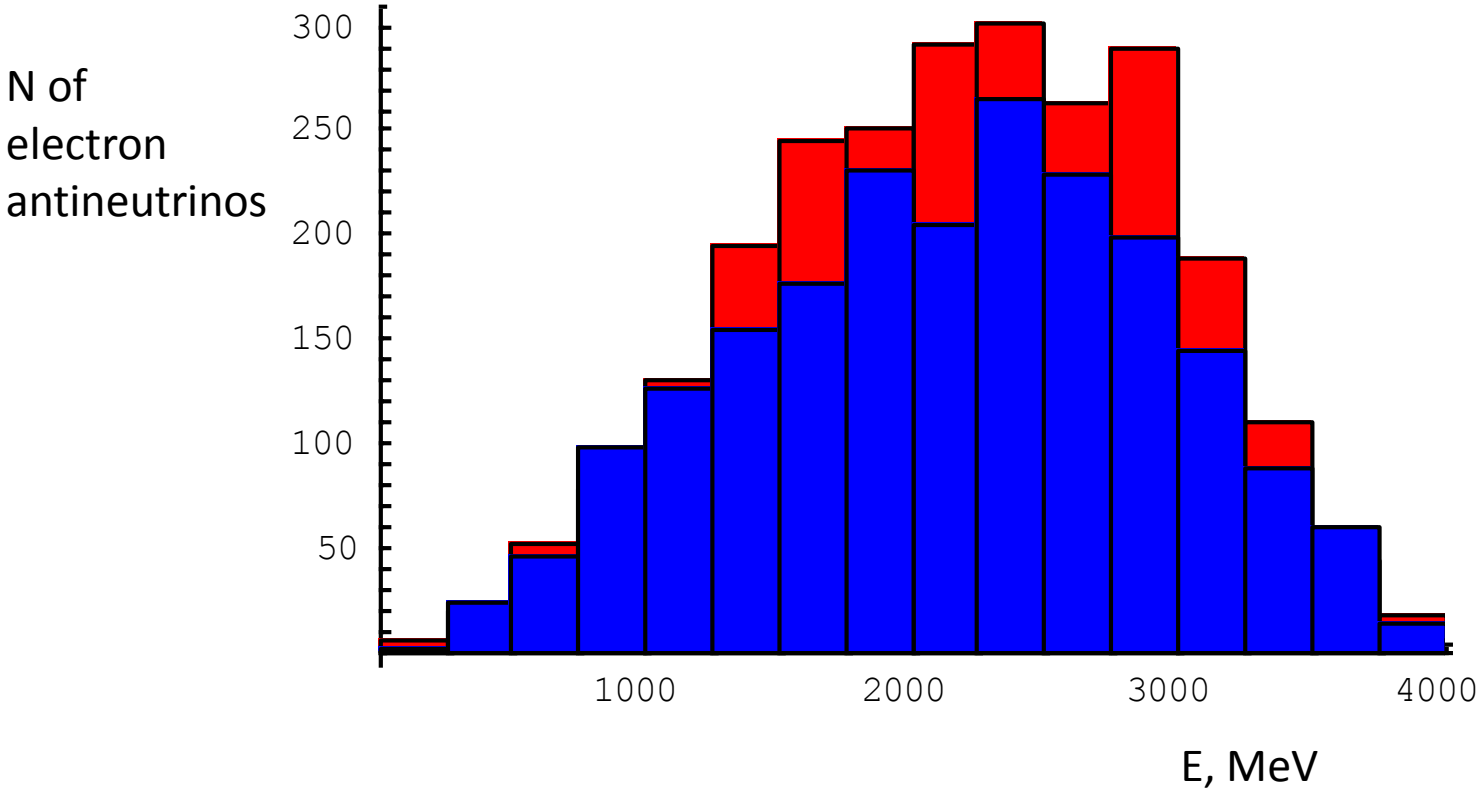
# nuSTORM FODO versus triplet FFAG

- Far detector distance 2km, 5m diameter, simulation for 4000000 stored muons



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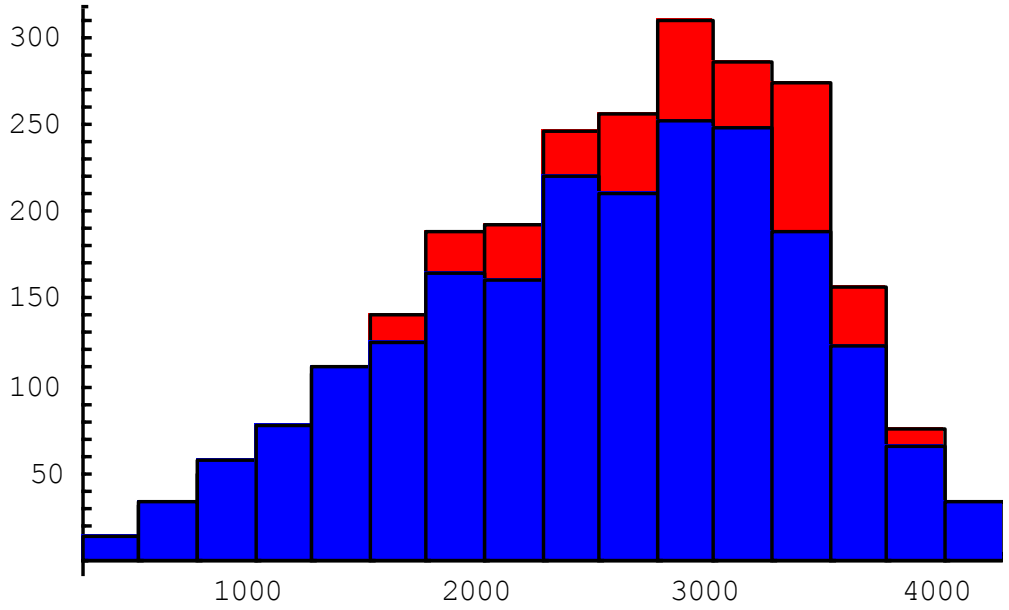
# nuSTORM FODO versus triplet FFAG

- Far detector distance 2km, 5m diameter, simulation for 4000000 stored muons

N of muon neutrinos




Red- FODO
Blue -FFAG

E, MeV

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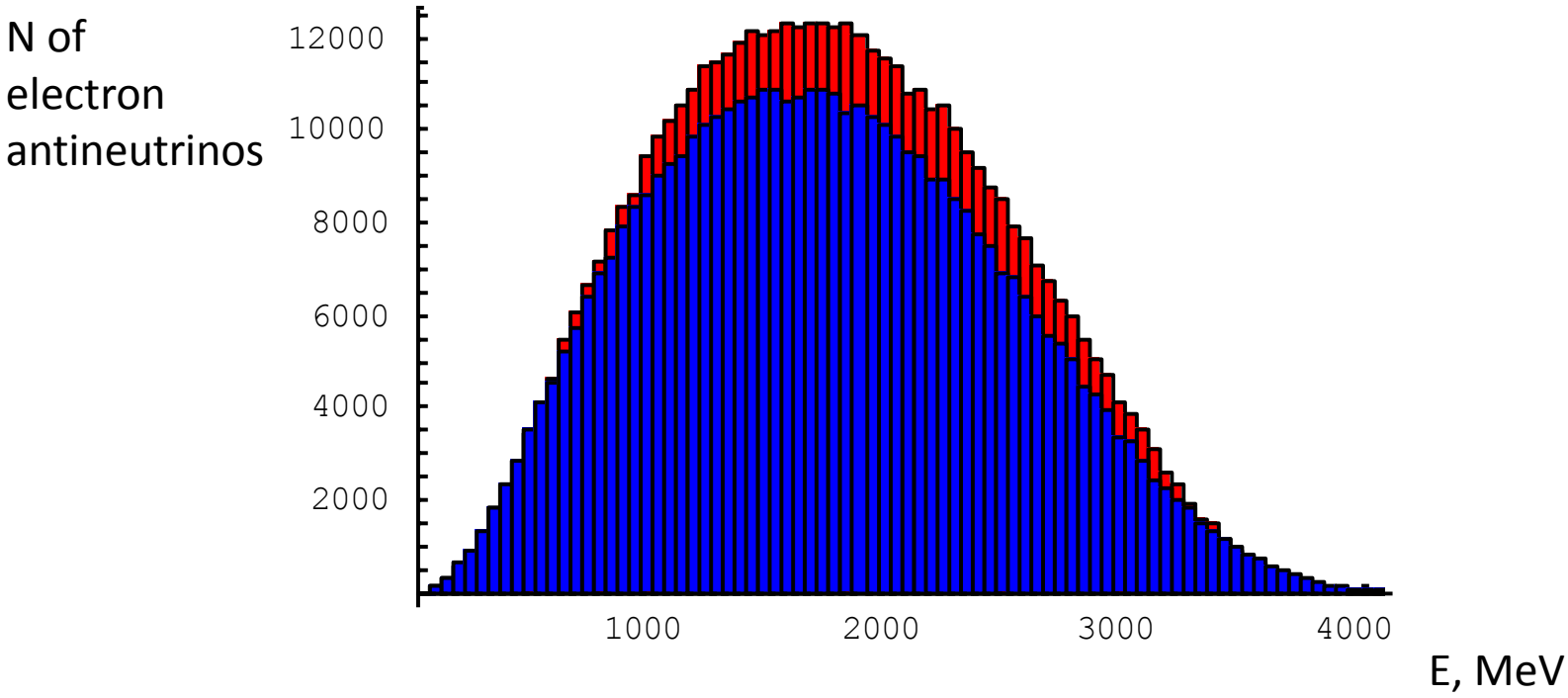
# nuSTORM FODO versus triplet FFAG

- Near detector distance: 50m, 5m diameter, simulation for 4000000 stored muons



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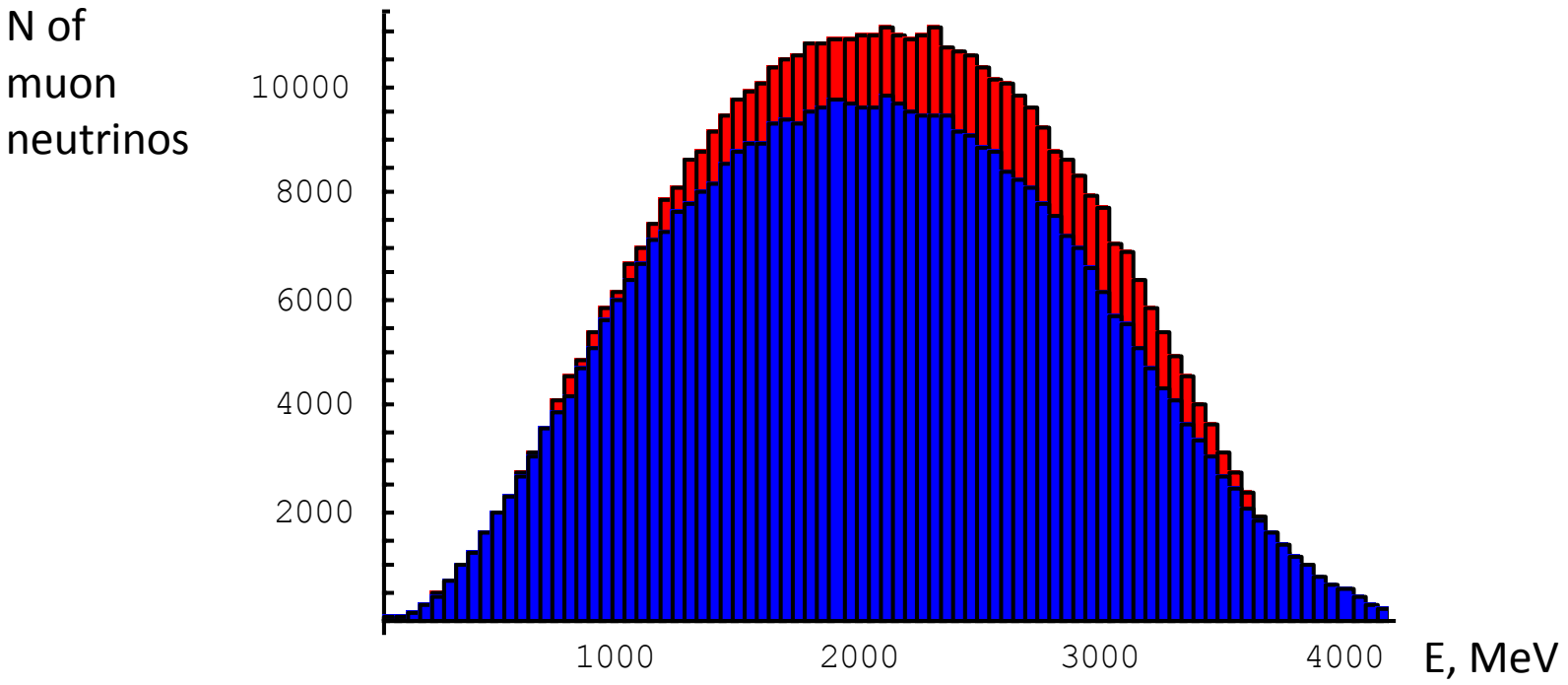
- Near detector distance: 50m, 5m diameter, simulation for 4000000 stored muons



# IDS-NF vs NuMAX

| | IDS-NF | NuMAX |
|---|---|---|
| Muon energy [GeV] | 10 | 5 |
| Number of bunch pairs | 3 | 1 |
| Bunch train [μs] | 250 | ~170 |
| Normalised acceptance [pi mm rad] | 30 | 20 |
| Ring inclination | 10° | 5.8° |

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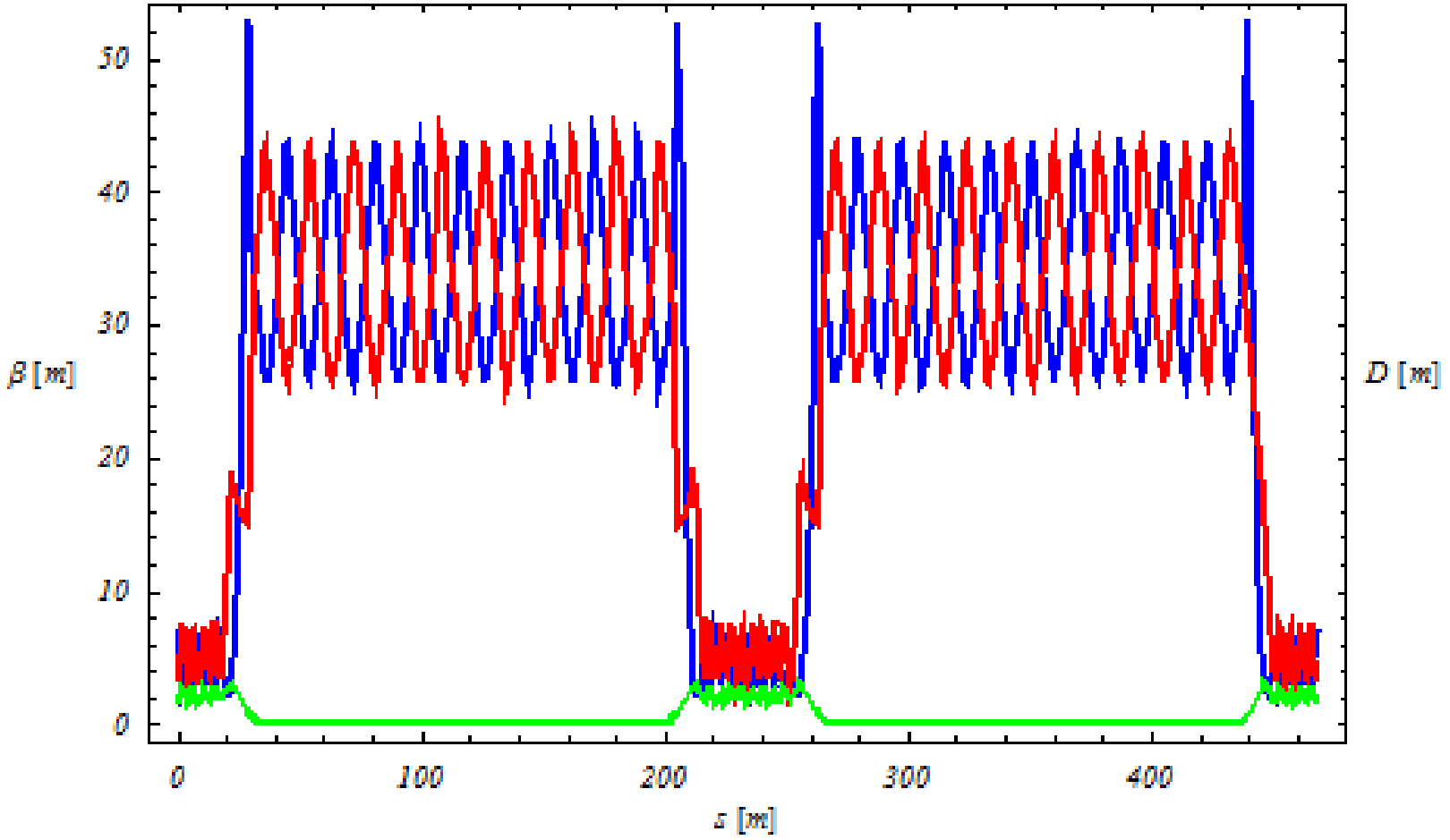
# Preliminary NuMax ring with FODO production straight



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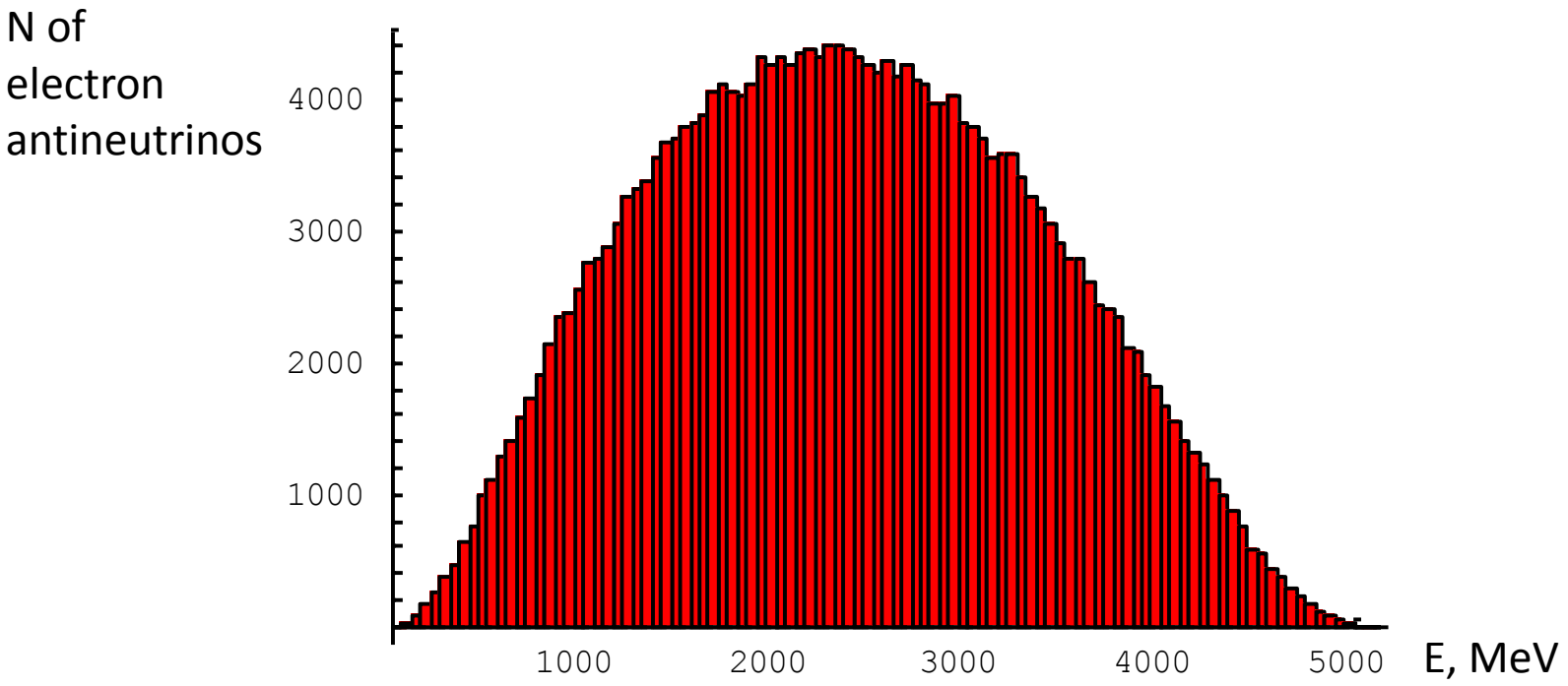
# NuMAX

- Near detector distance: 50m, 5m diameter, simulation for 1000000 stored muons



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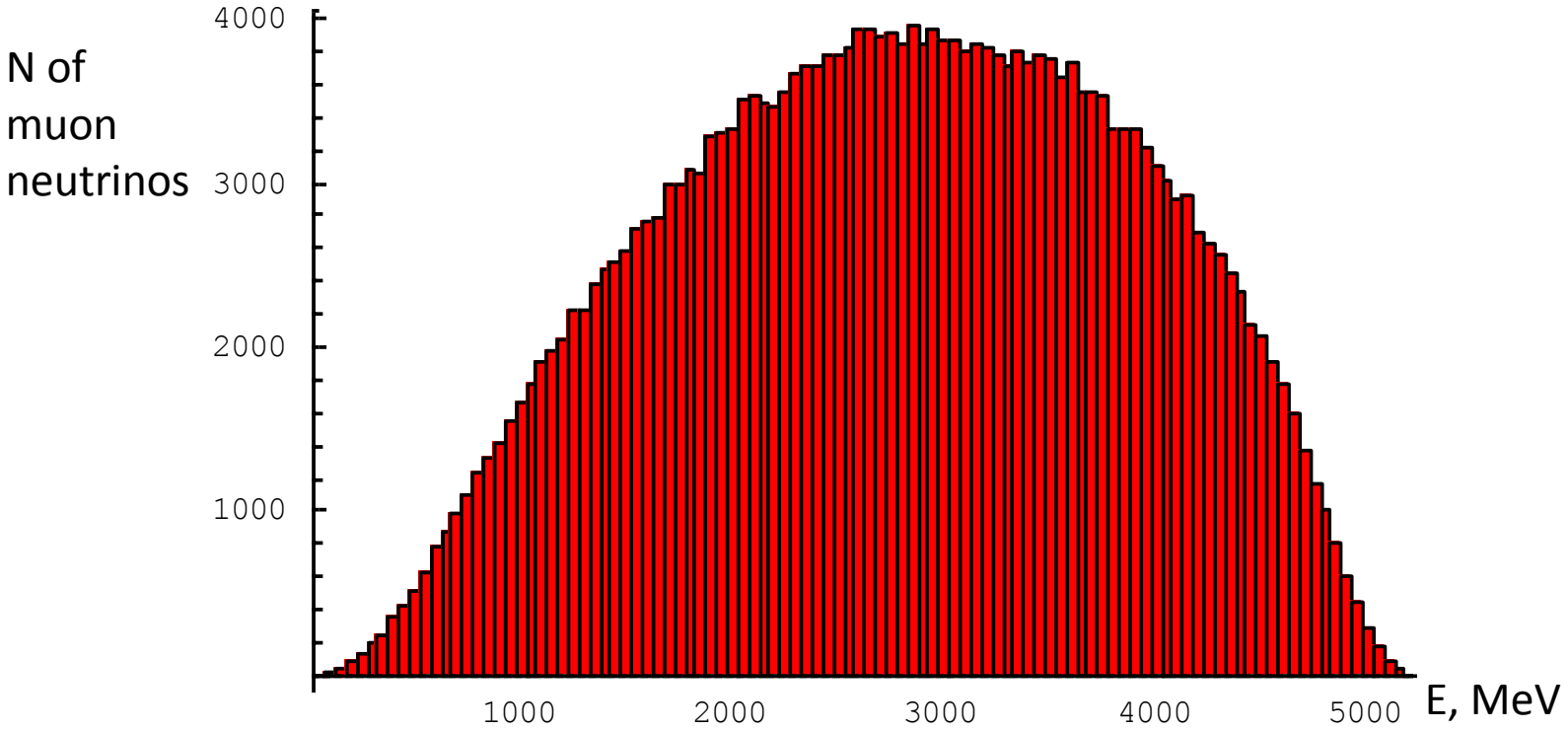
# NuMAX

- Near detector distance: 50m, 5m diameter, simulation for 1000000 stored muons



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# Conclusions

- Effect of scallop angle has been evaluated
  - ❑ Its seems to be acceptable in the near detector for both doublet and triplet
  - ❑ Spectrum in the far detector is affected in case of doublet.
- The triplet seems to be the way forward, however more statistics is needed
- Other effects: injection efficiency, capture efficiency and dynamic losses need to be included in performance evaluation.
- Similar simulation was performed for NuMAX near detector: ~1.75 times higher flux of neutrinos per stored muon are produced in NuMAX compared to nuSTORM.
  - ❑ Absolute normalization will be performed.