FASERν: very-forward neutrinos

June 23rd 2020

CORSIKA Cosmic Ray Simulation Workshop

Felix Kling

send feedback to
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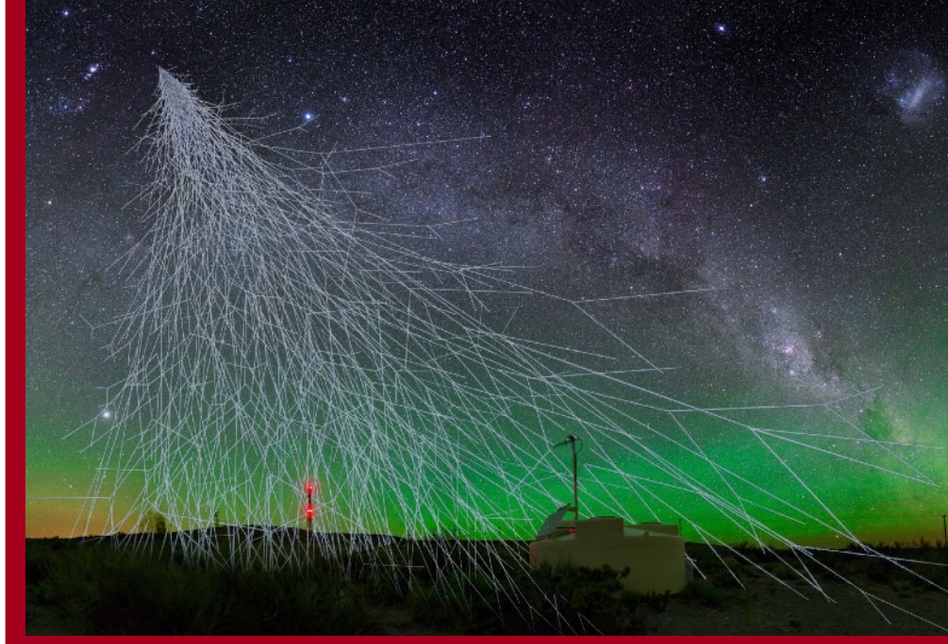

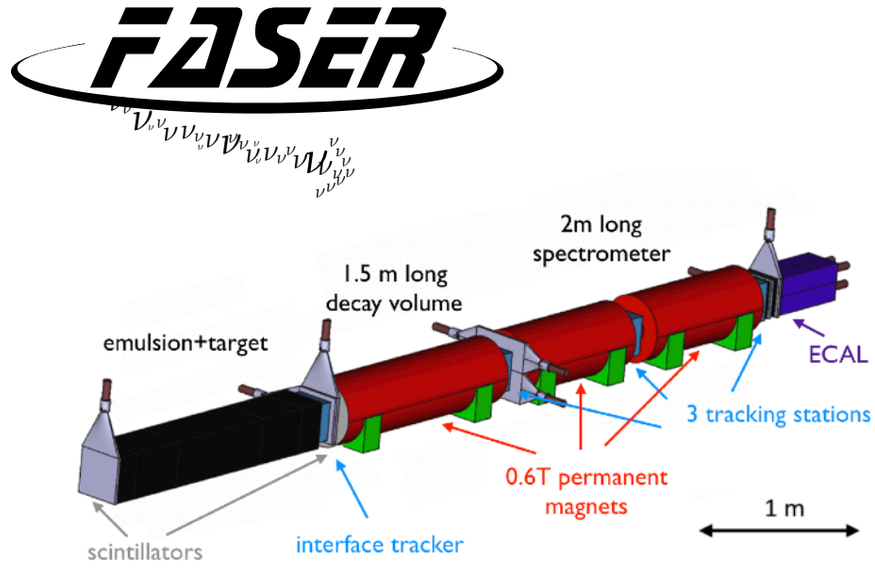

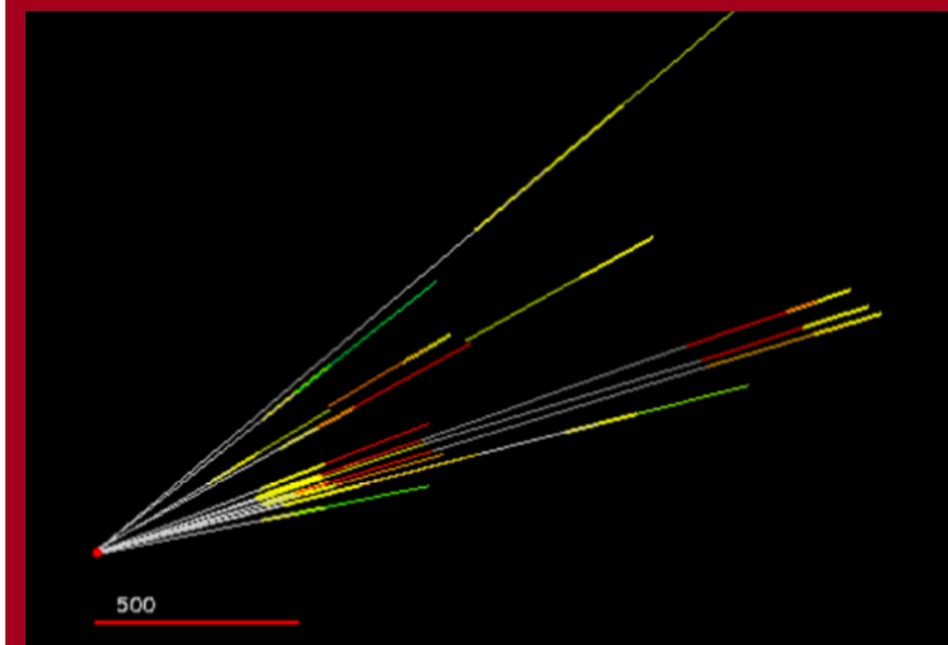

SLAC NATIONAL ACCELERATOR LABORATORY

SIMONS FOUNDATION

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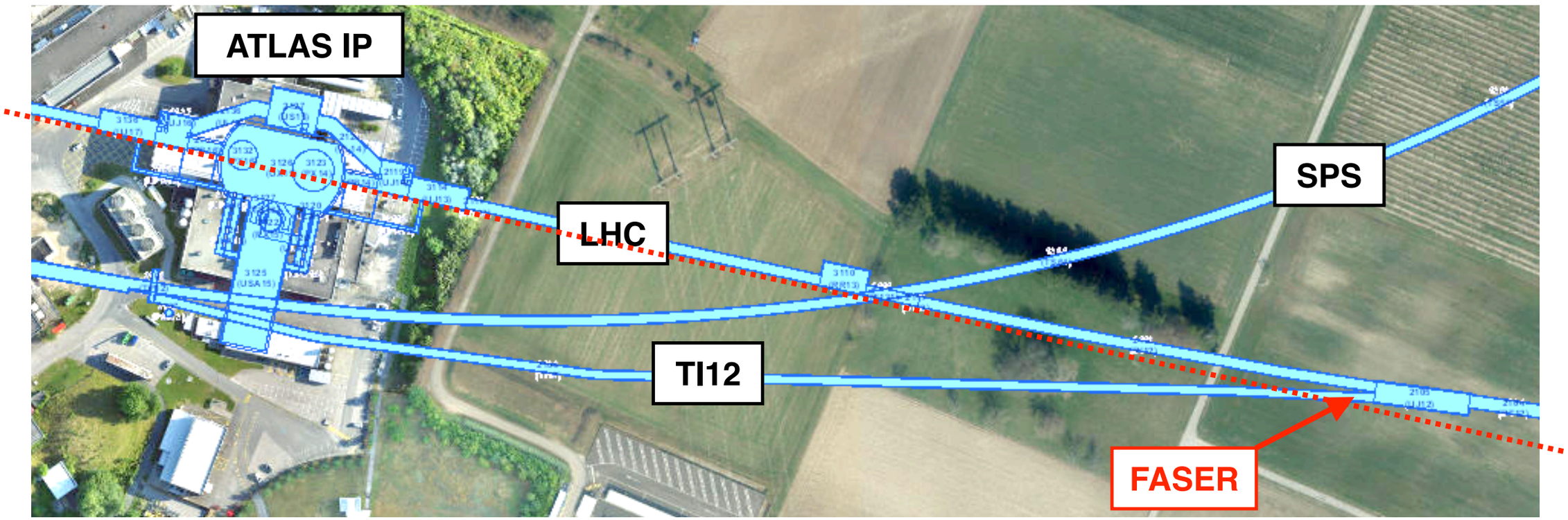
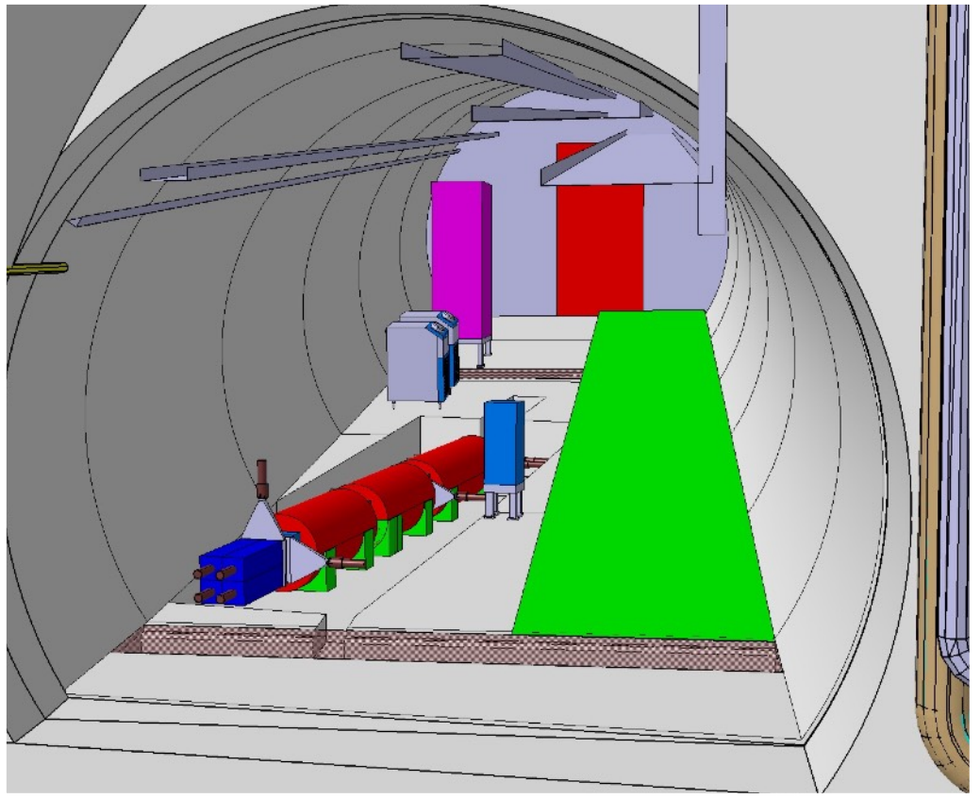
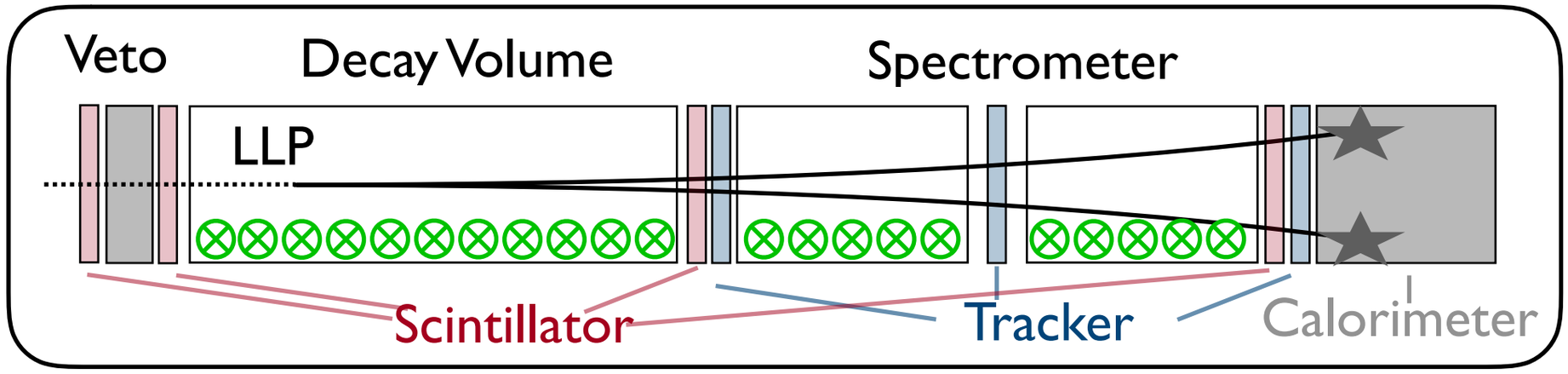
The FASER Experiment



- FASER = ForwArd Search ExpeRiment:
  * newest experiment at the LHC
  * approved, funded,
  * will operate during LHC Run 3 (2021-2024)
  * 60 collaboration members
  * placed along the beam collision axis
  * 500m downstream from ATLAS IP
  * located in unused service tunnel TI12
  * very forward: covers pseudo rapidity $\eta>9$
  * shielded from IP by 100m rock



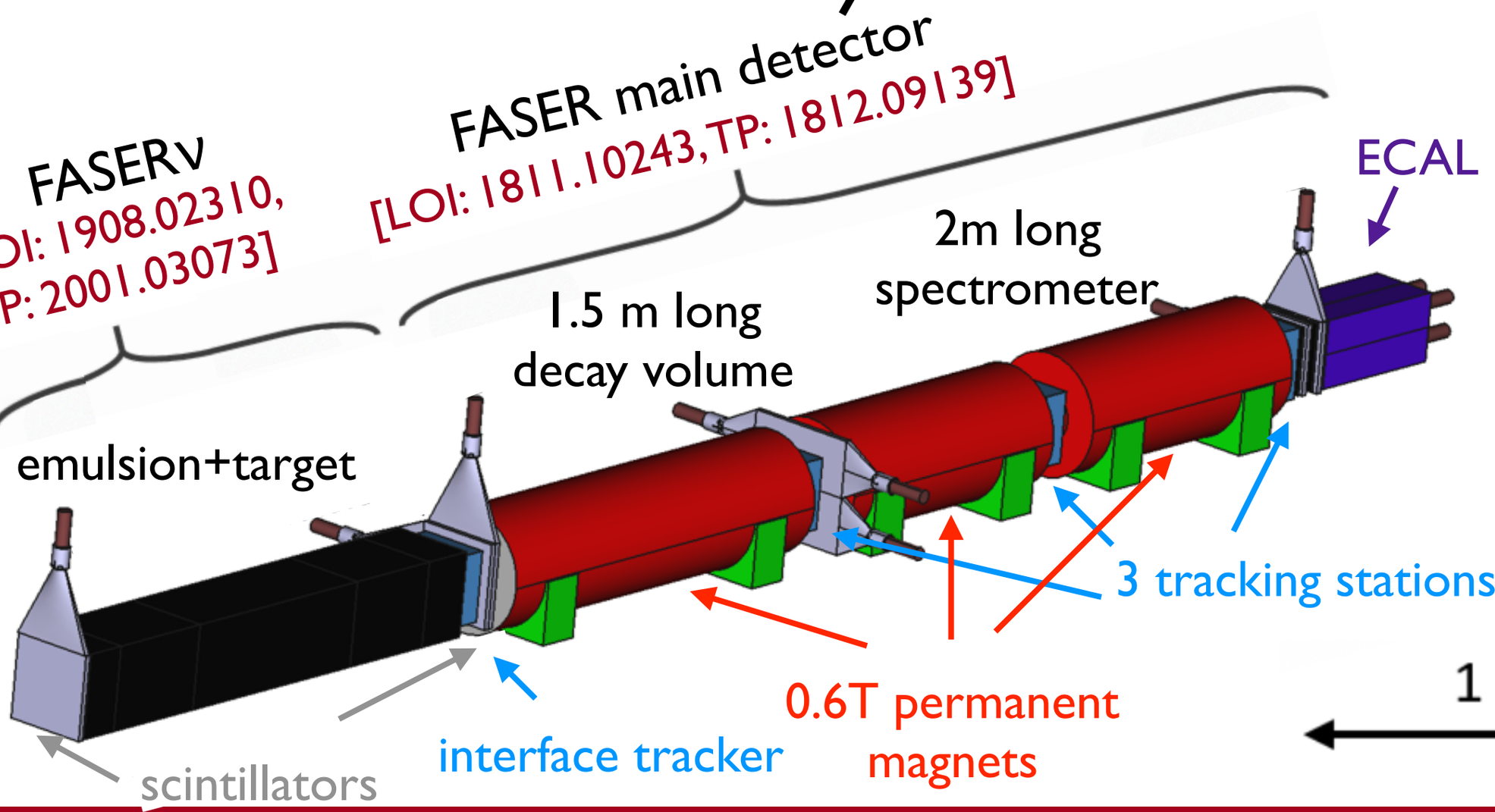
The FASER Detector



main goal: long-lived particle searches

FASERν
[LOI: 1908.02310,
TP: 2001.03073]

FASER main detector
[LOI: 1811.10243, TP: 1812.09139]



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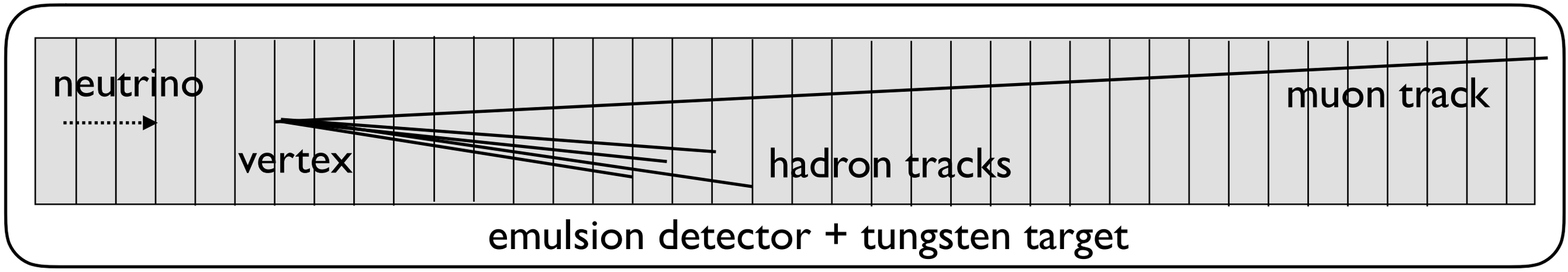

main goal: neutrino physics at the LHC

30% energy resolution
lepton ID
interface to spectrometer

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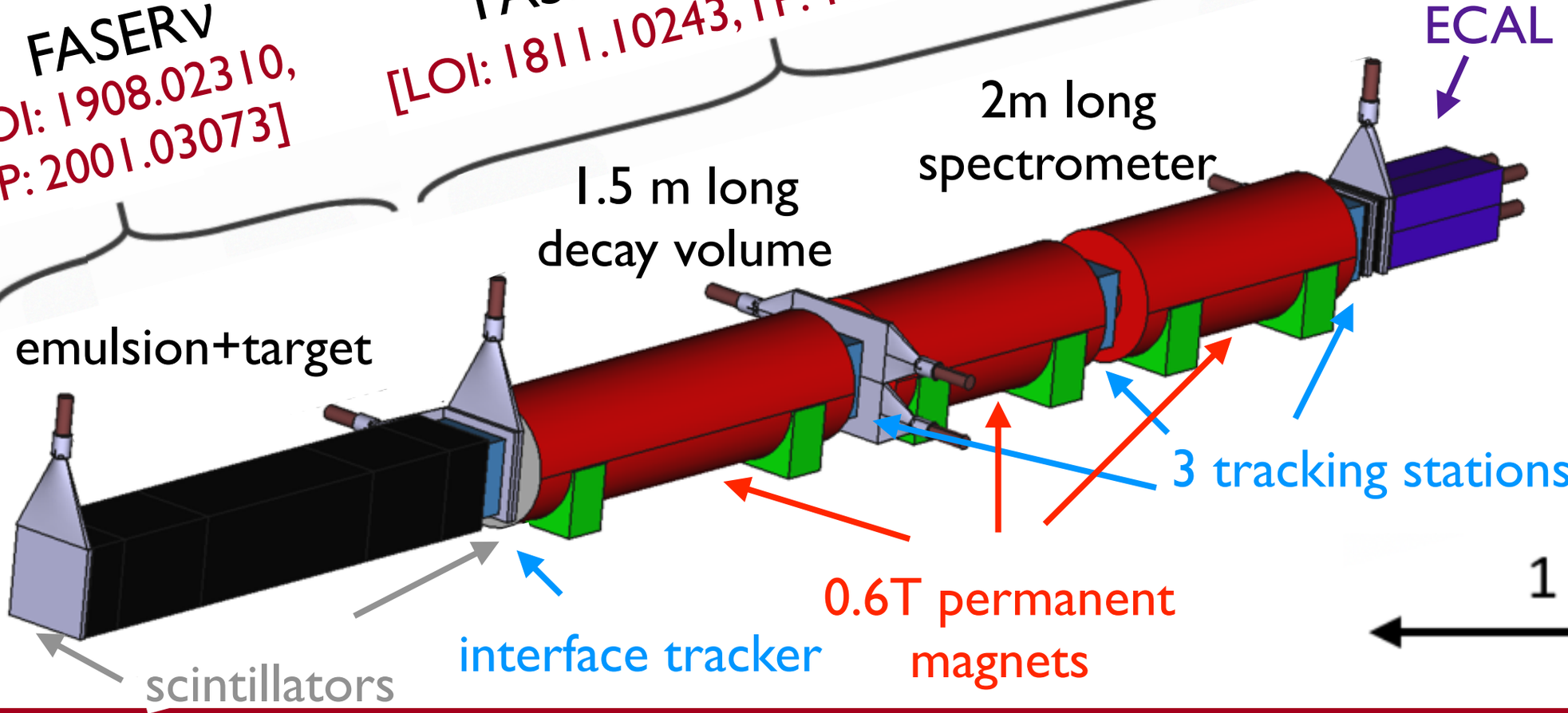
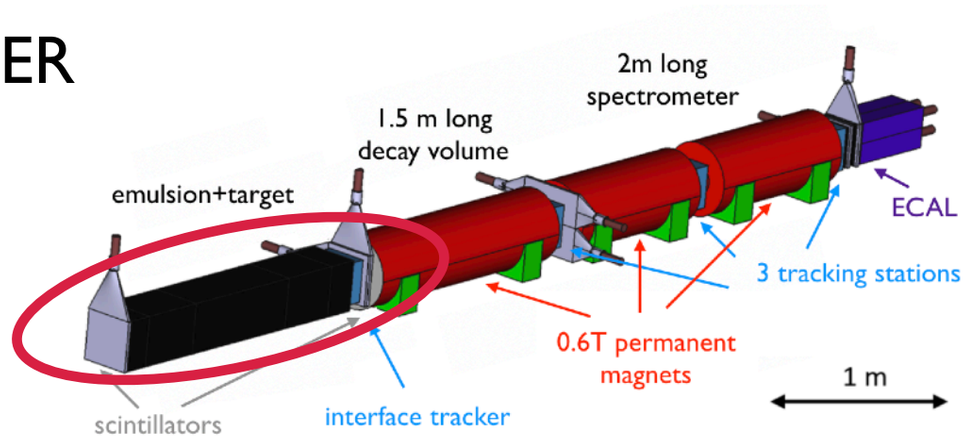


Neutrinos at the LHC

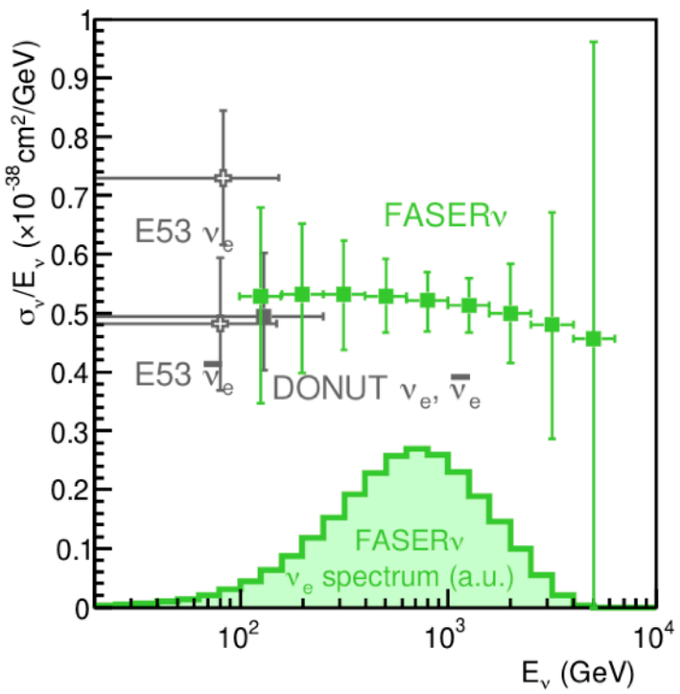
- neutrinos detected from many sources, but not from colliders

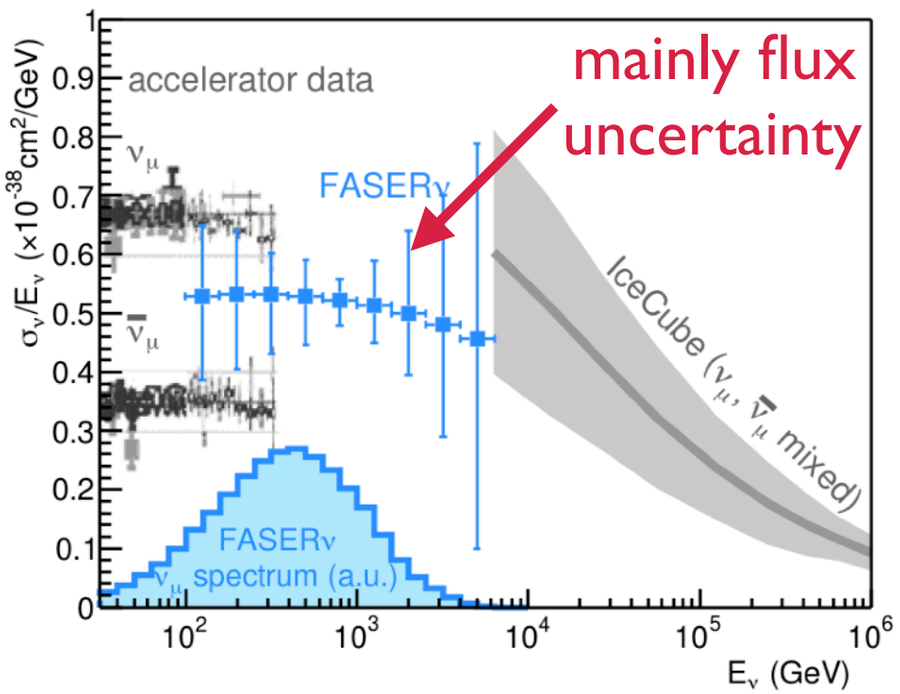
- many neutrinos at LHC produced in π, K, D meson decay
  → ATLAS provides intense energetic collimated neutrino beam towards FASER
  * ~10^{12} neutrino in LHC Run 3 * E~TeV. * θ ~ mrad

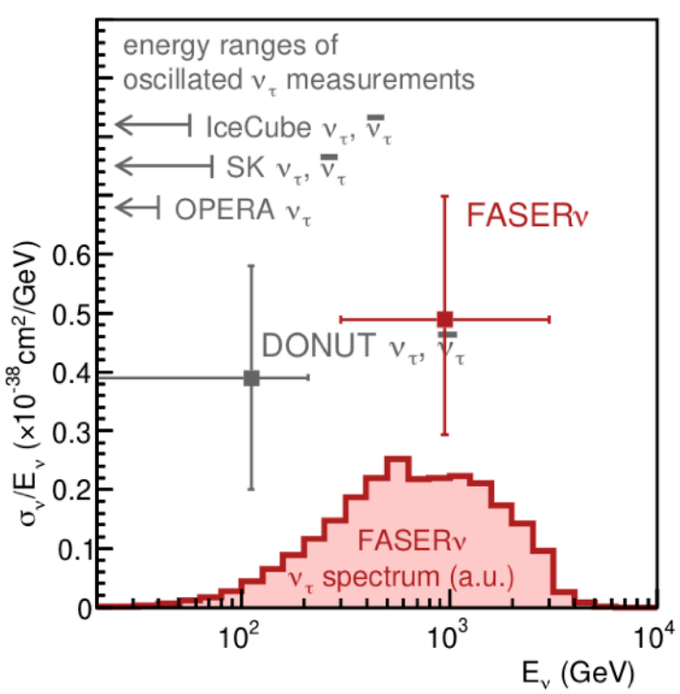
- dedicated FASERν neutrino detector in front of FASER
  * 25cm x 25cm x 1.3m emulsion detector
  * tungsten target with 1.2 ton mass
  * ~ 20000 ν_μ, ~ 2000 ν_e, ~ 20 ν_τ



- TeV energy range currently unconstrained
  * this allows to probe neutrino cross sections at TeV for all 3 flavors







Forward Flux Estimates

- neutrino cross section measurements are limited by neutrino flux uncertainty
  * we need to quantify and reduce these uncertainties
  * currently, we use spread of generator prediction as uncertainty estimate …
- neutrino flux sensitive to forward pion, kaon and charm production

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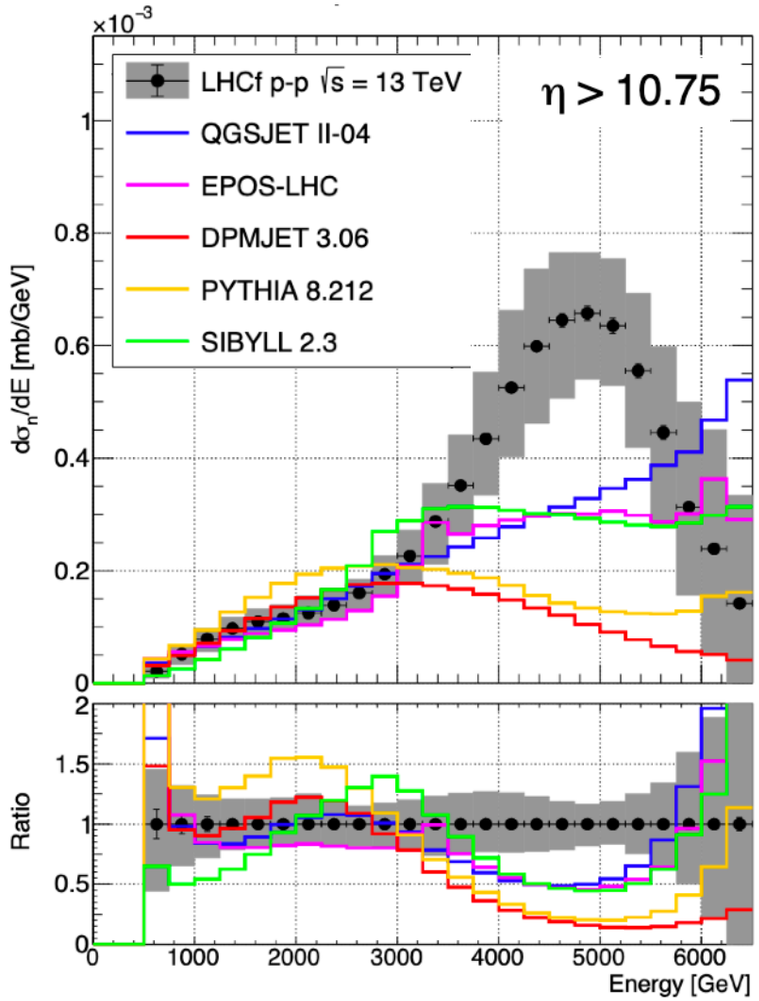
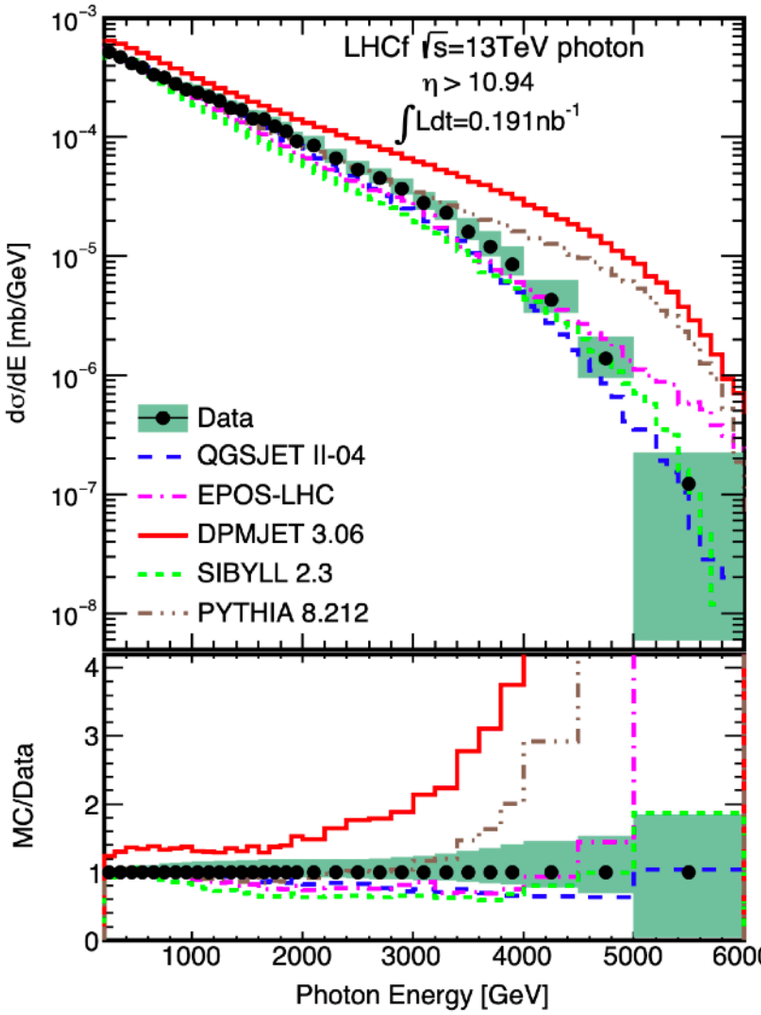
  * use hadronic interaction models
  * not all of them work well …
  * simulators don't provide systematic uncertainties
  * diffractive physics is important but not always modeled well
  * we are currently developing a dedicated forward physics tune in Pythia8 using forward data
  * include tuning uncertainties (similar to PDFs) to estimate flux uncertainties



[LHCf: 2003.02192]



[LHCf: 1703.07678]

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* can be calculated using pQCD: g g → c c
* allows to use PDF and scale uncertainties
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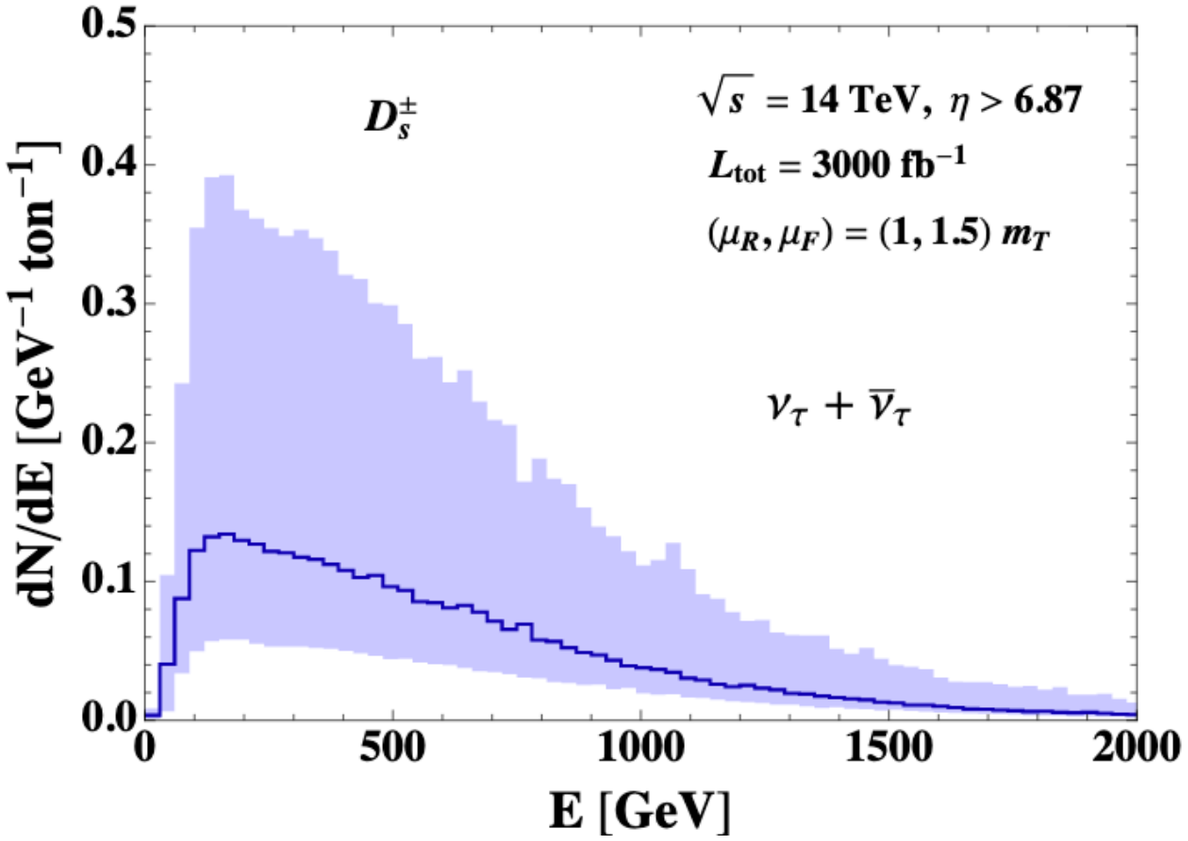

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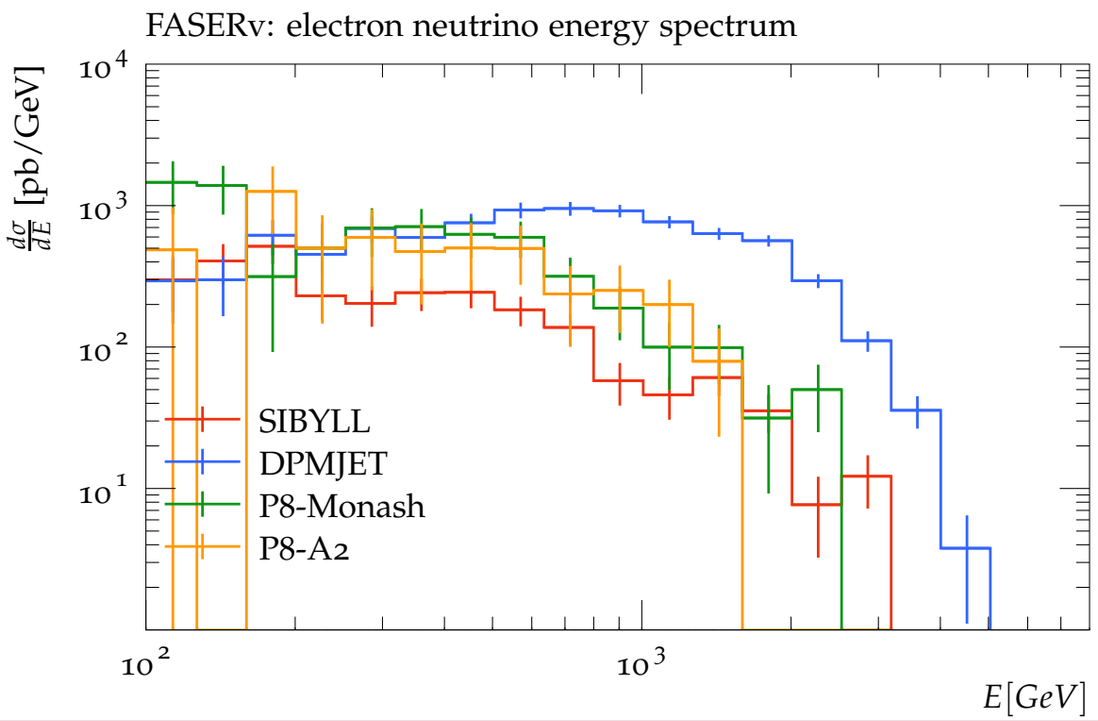

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You are the experts.

Please let me know what you think.

Summary, Questions and Outlook

FASER/FASERv

- new LHC experiment: funded and approved
- sensitive to $\eta>9$
- FASERv: forward neutrino
- FASER: forward muons and LLP searches

Many thanks to the Heising-Simons Foundation, the Simons Foundation, and to CERN for invaluable support

SIMONS FOUNDATION HEISING-SIMONS FOUNDATION

- improved experiments at HL-LHC under consideration (Snowmass 2021)

FASERv and Hadronic Interaction Models

- Hadronic interaction model are crucial for FASERv's neutrino measurements.
- FASER/FASERv might also provide valuable input to probe these models.

- FASERv and CRMCs can benefit from each other
- In the future, we would be happy to work more closely together with you.
- You are the experts, so your expertise is invaluable!
- Let us know, if you have any criticism, ideas or wishes.

We look forward to feedback and suggestions.

send feedback to felixk@slac.stanford.edu