FASER experiment

Samuel Zahorec

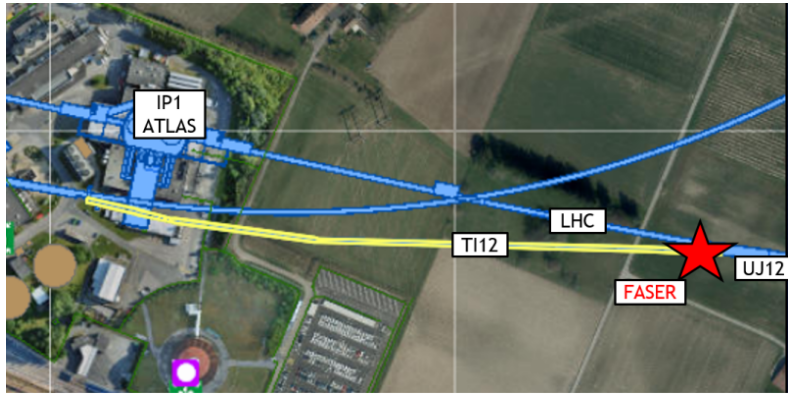
Supervisors:
Tomohiro Inada
Susanne Kuehn

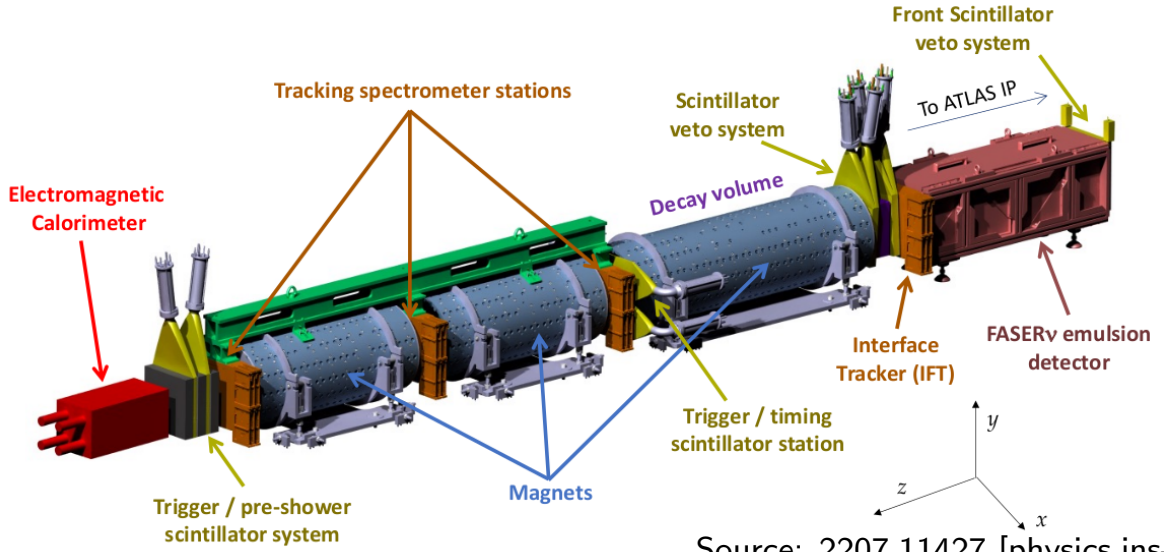
CERN Summer Student

2022

ForwArd Search ExpeRiment (FASER)

- Located 480 m downstream of the ATLAS interaction point.
- Background muons
- Particles we want to observe:
  - new weakly interacting particles
  - neutrinos
- Sub-detector FASERν

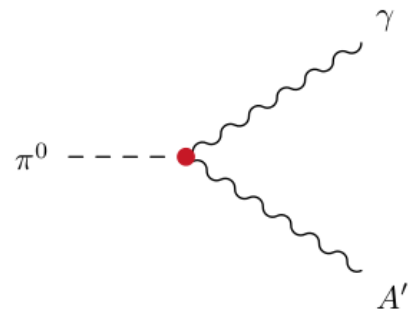


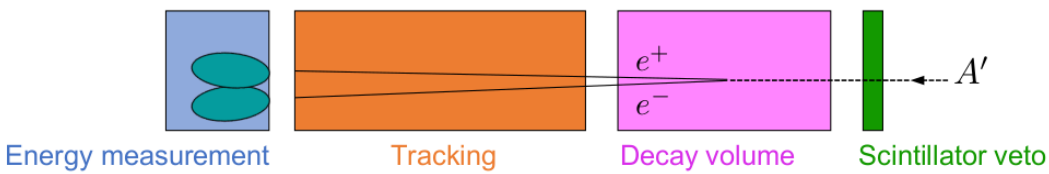


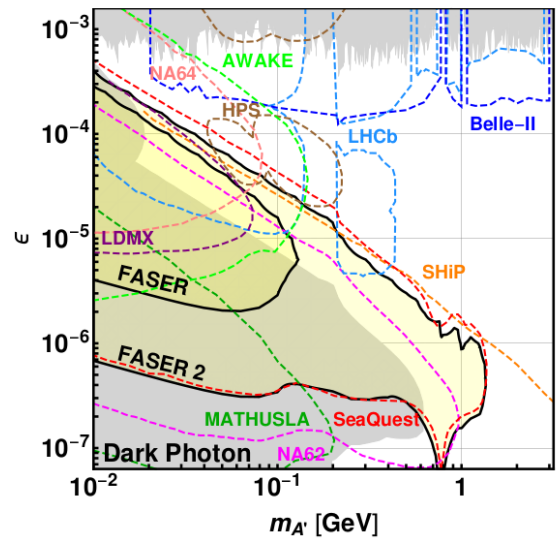
Source: 2207.11427 [physics.ins-det]

Physics objectives - BSM

- Search for light and very weakly interacting particles.
  - Beyond Standard Model theories → long-lived particles:
  - Mainly dark photons A'
  - Other possible models: dark Higgs bosons, heavy neutral leptons, axion-like particles
- Studying the parameter space not covered by previous experiments



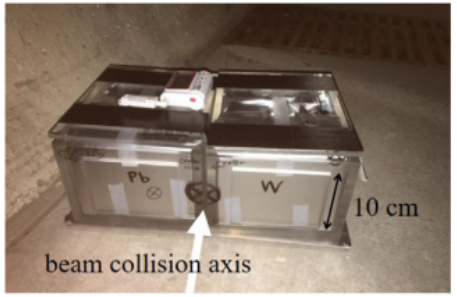


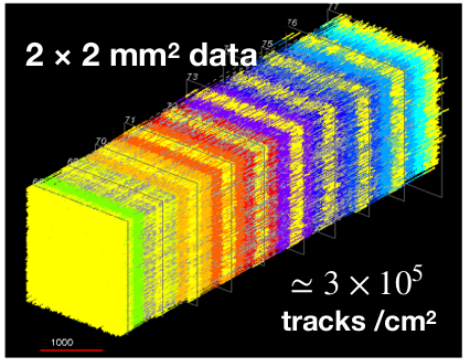


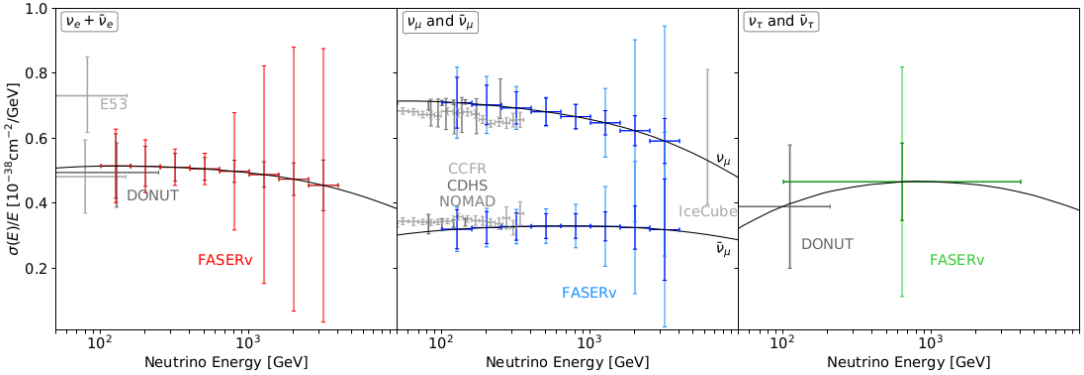
Source: 2207.11427 [physics.ins-det]

Physics objectives - neutrinos

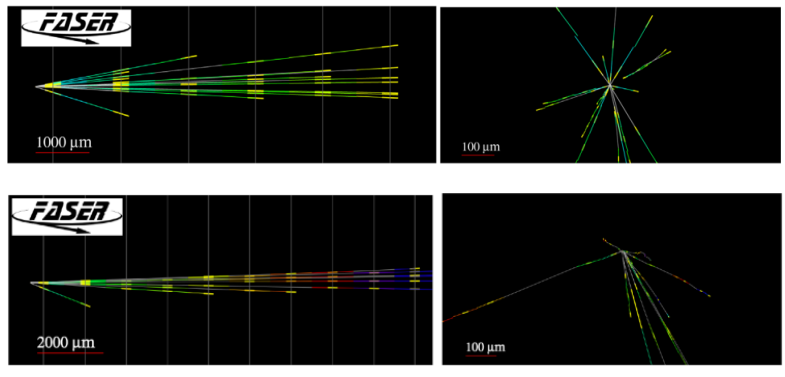
- Observation of collider neutrinos of all flavors (TeV energy scale !)
- Emulsion detector FASERν
- Constraining forward hadron production models.







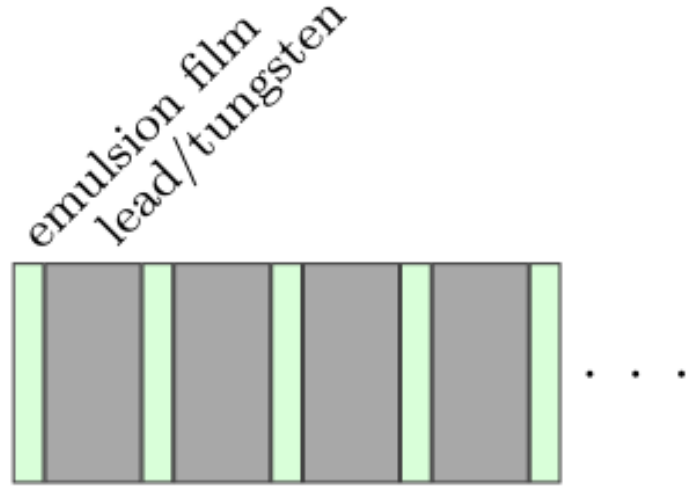
-	ν_e	ν_μ	ν_τ
Dominant production process	$K \to \nu_e eX$	$\pi \to \nu_\mu \mu$	$D_s \to \nu_\tau \tau$
Number of ν traversing FASERν	3×10^{11}	2×10^{12}	8×10^9
Number of ν interacting in FASERν (1.1 tonnes)	830	4400	14
Average energy of interacting neutrinos (GeV)	820	820	810



Source: 2207.11427 [physics.ins-det]

Building FASERν

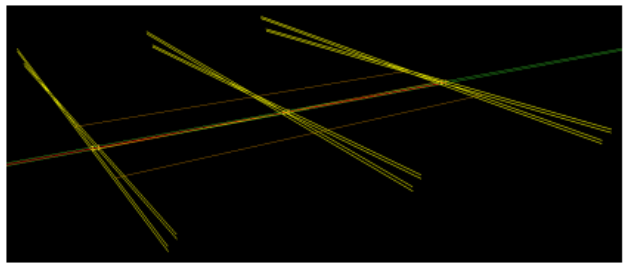
- Construction of an emulsion detector and subsequent replacement of the previous one in TI12 tunnel.
- 730 1-mm-thick tungsten plates interleaved with emulsion films
- Currently the development of emulsion foils is beginning!

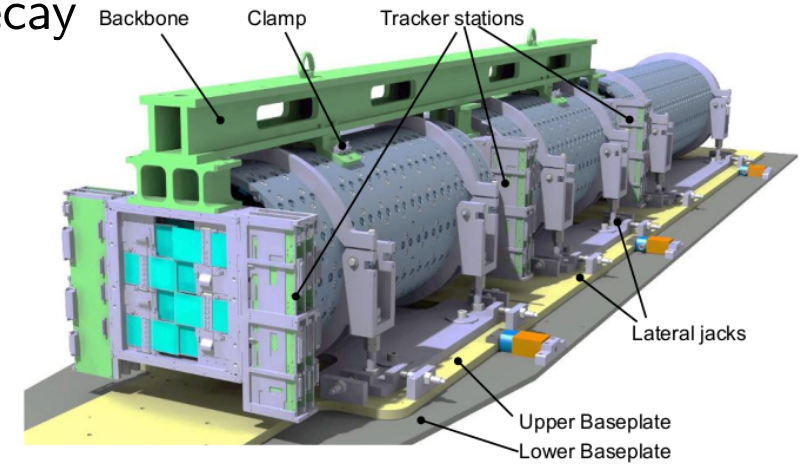


Source: 2207.11427 [physics.ins-det]

Tracking system

- Tracking spectrometer + interface tracker (IFT)
- In total 4 tracker stations, each has 3 layers of sillicon strip modules
- Recovering the trajectories of charged particles
  - leptons from neutrino CC interactions
  - lepton pairs from dark photon decay

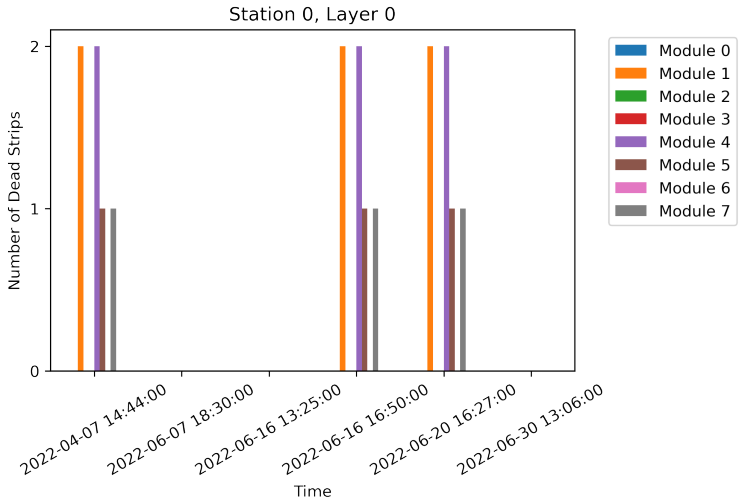


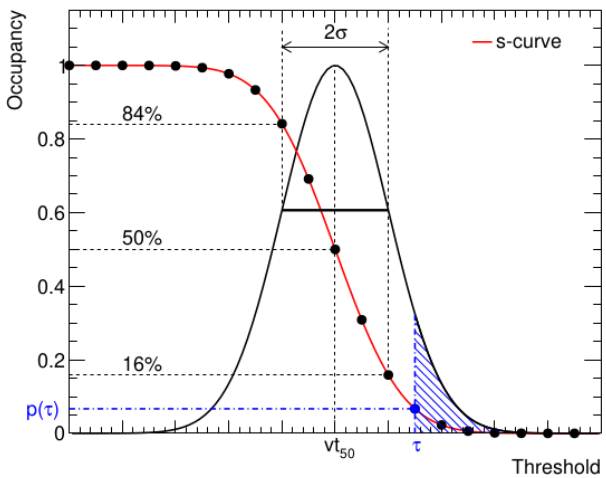


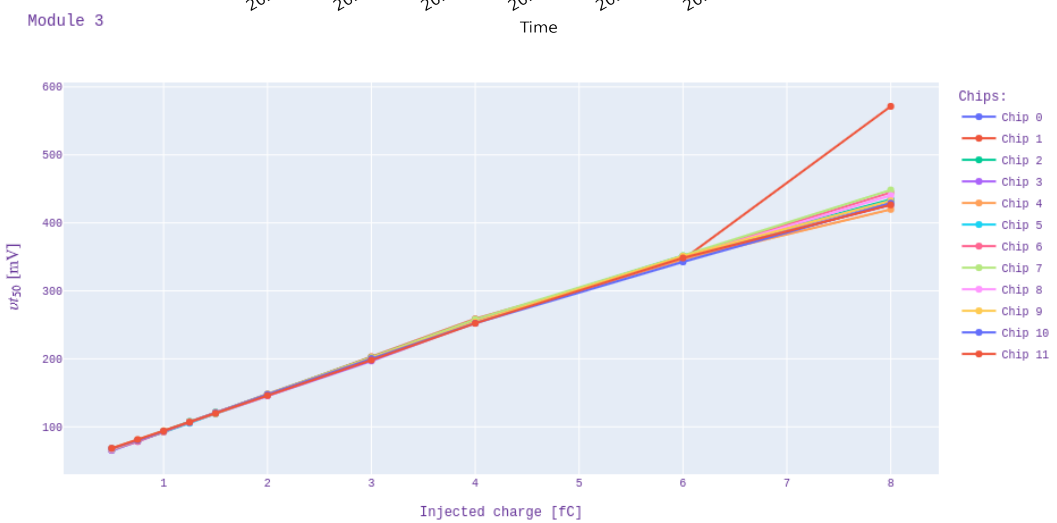
Source: 2207.11427 [physics.ins-det]

Calibration data

- The correct working of the Tracker is essential for all physics analysis.
- Dead and noisy sillicon strips
- Threshold Scan $\rightarrow$ Response curve
- Studying the time evolution of the parameters of calibration tests.



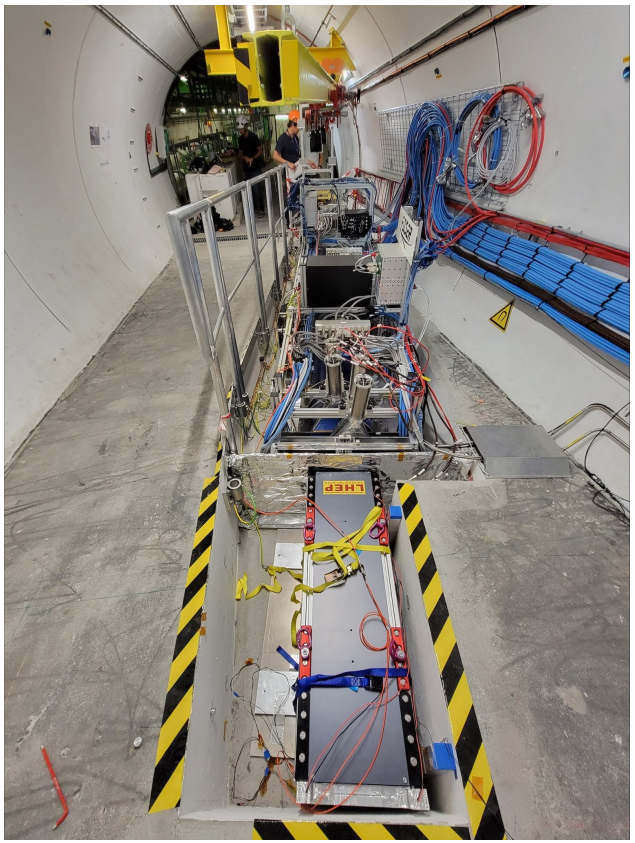


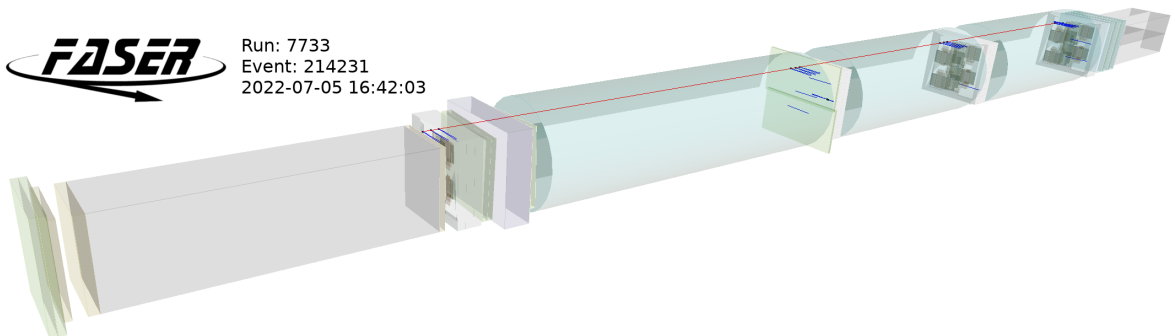


Source: 2207.11427 [physics.ins-det]

Summary and future prospects

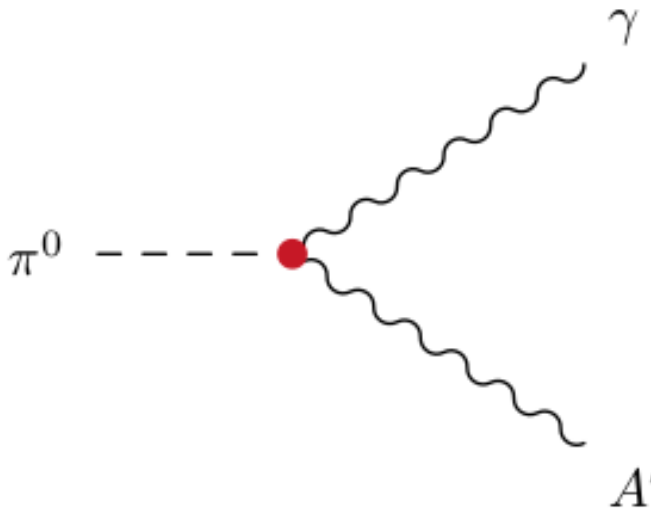
- Construction of the FASERν detector installed in the tunnel during last weeks.
- Processing the calibration data.
- Configuring an online calibration database.
- Analysis of the first data from FASER Tracker.

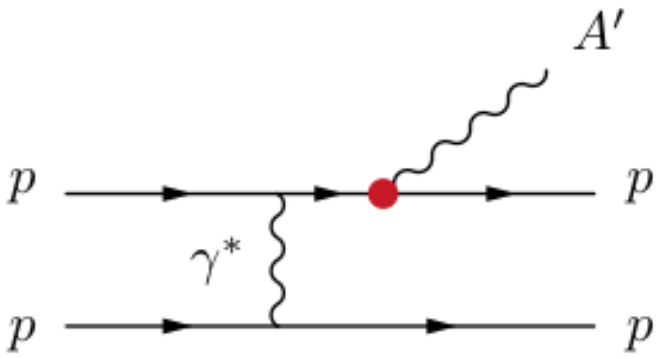


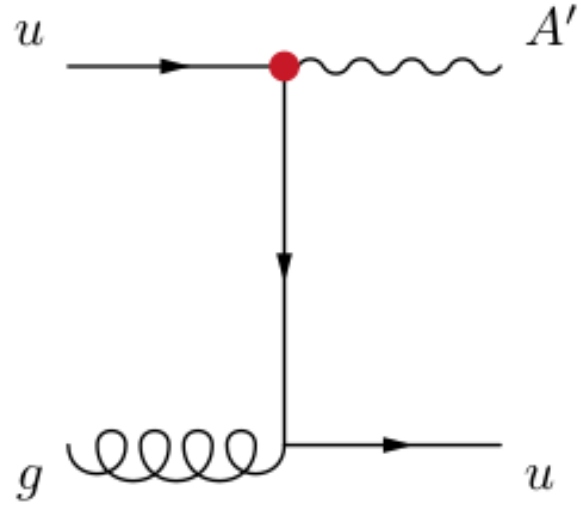


Thank you for your attention!

Backup - production of dark photon



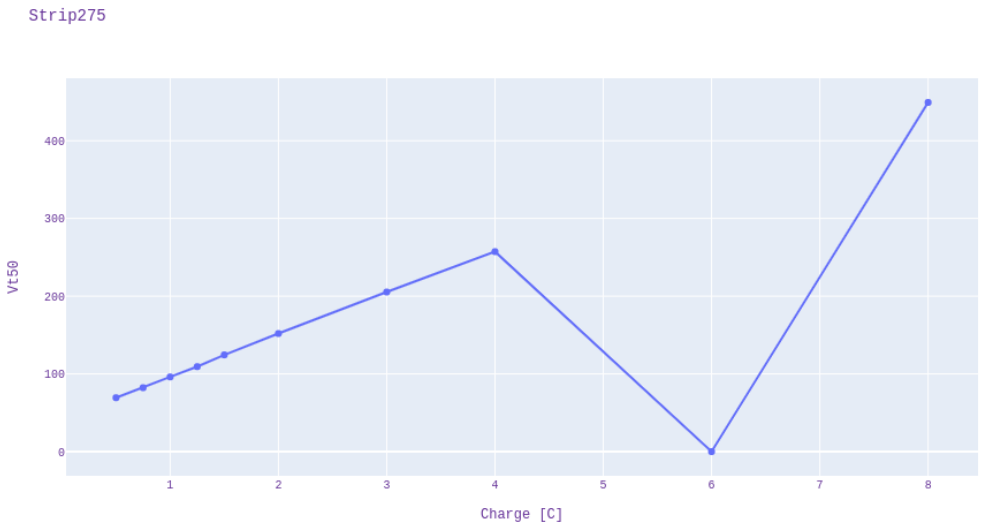


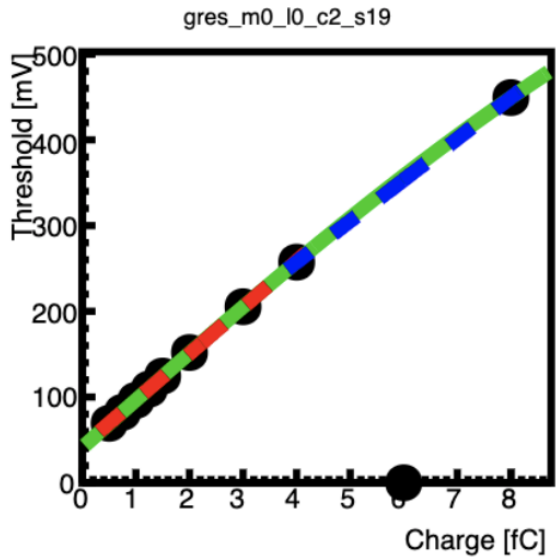


Source: 2207.11427 [physics.ins-det]

Backup - StripSeed

- The idea of qualifying the strips using the Response curve.
  - **Criterion 1**: Low gain is approximately the same as high gain ($\pm$10 mV in this case), i.e. the linearity of the Response curve must be satisfied.
  - **Criterion 2**: The Response curve does not oscillate. A condition was imposed that the value of vt50 can't drop too low (below 20 mV).





Backup - Missing scale of neutrino energies

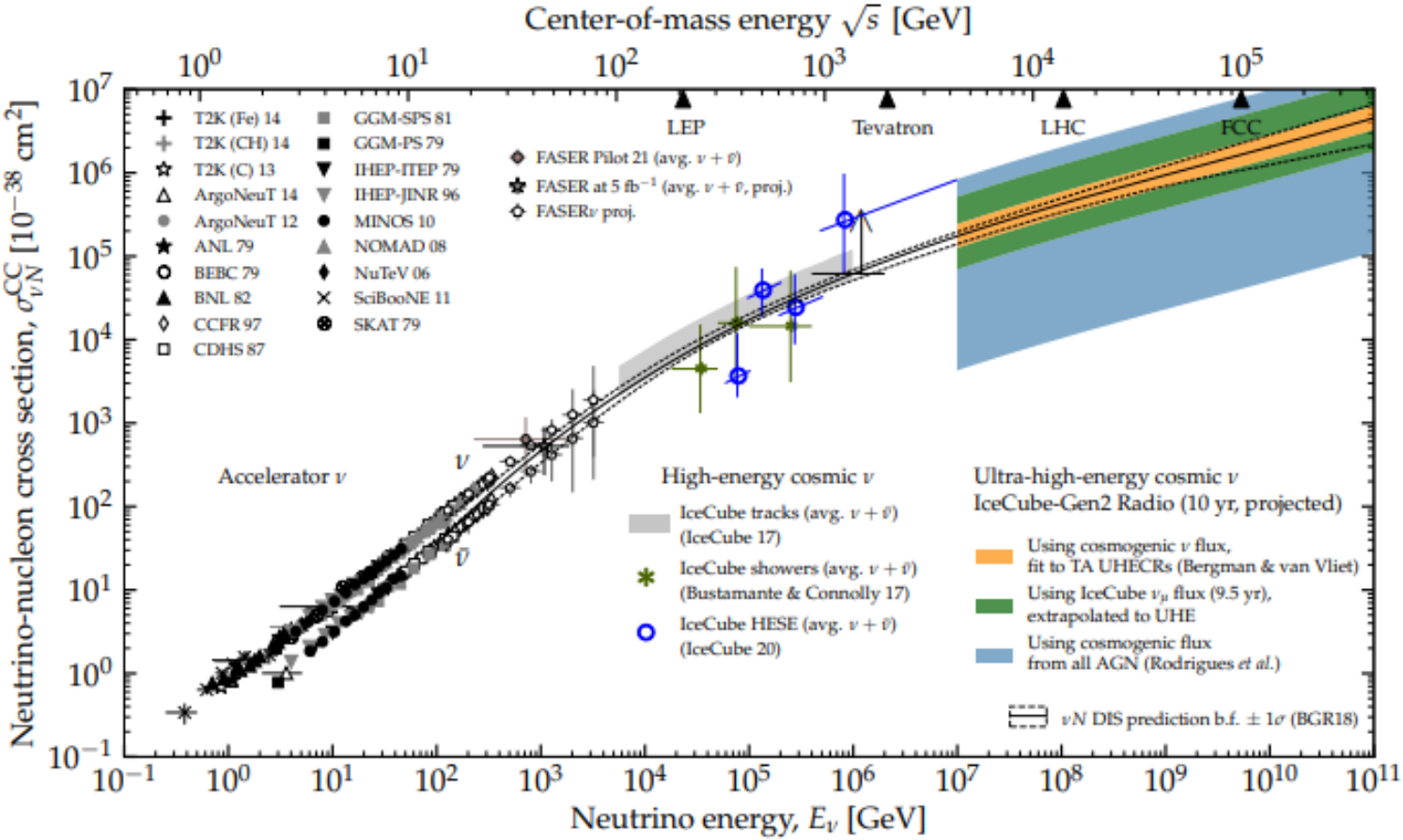


Figure 5. Neutrino-nucleon cross section measurements, compared to deep-inelastic-scattering (DIS) cross section predictions from Ref. [161] (BGR18). In the TeV range, FASER and FASERν have started measurements [219]. Measurements in the TeV–PeV range are based on IceCube showers [18, 122] and tracks [17]. Projected measurements at energies above 100 PeV [106] are based on 10 years of operation of the radio component of IceCube-Gen2, assuming a resolution in energy of 10% and a resolution in zenith angle of 2°. Since the flux at these energies remains undiscovered, projections for the measurement of the cross section are for different flux predictions. Figure adapted from Ref. [106].

Source: 2203.08096 [hep-ph]