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 FASER$\nu$

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.

<table>
<thead>
<tr>
<th></th>
<th>ν_e</th>
<th>ν_μ</th>
<th>ν_τ</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dominant production process</td>
<td>$K \to ν_e eX$</td>
<td>$π \to ν_μ μ$</td>
<td>$D_s \to ν_τ τ$</td>
</tr>
<tr>
<td>Number of $ν$ traversing FASERν</td>
<td>$3 \times 10^{11}$</td>
<td>$2 \times 10^{12}$</td>
<td>$8 \times 10^9$</td>
</tr>
<tr>
<td>Number of $ν$ interacting in FASERν (1.1 tonnes)</td>
<td>830</td>
<td>4400</td>
<td>14</td>
</tr>
<tr>
<td>Average energy of interacting neutrinos (GeV)</td>
<td>820</td>
<td>820</td>
<td>810</td>
</tr>
</tbody>
</table>

Source: 2207.11427 [physics.ins-det]
Building FASER$\nu$

- 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 silicon 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 silicon strips
- Threshold Scan → 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 FASER$\nu$ 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]
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 $v_{t50}$ 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]