



The Scattering and Neutrino Detector at the LHC

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EPFL



Outline

- The SND@LHC detector
- Detector preparation
- Data Acquisition (DAQ) system

SND@LHC

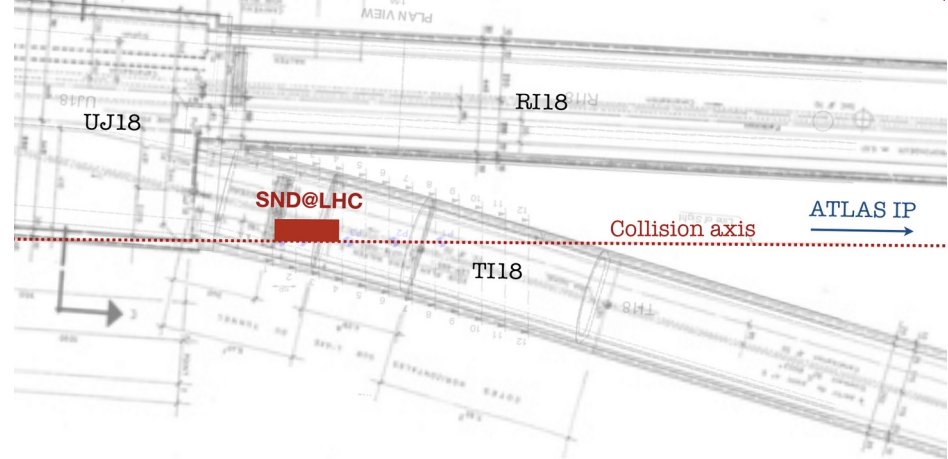
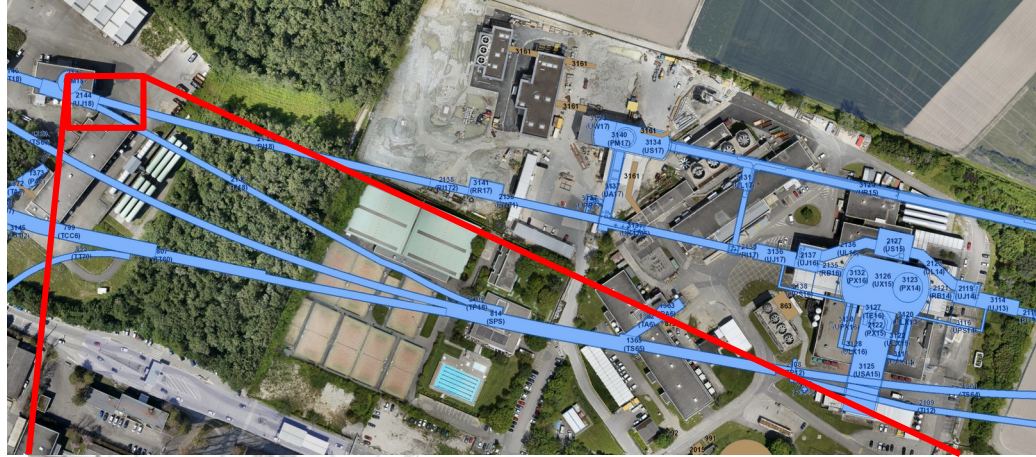


- Scattering and Neutrino Detector at the LHC
 - 24 institutes in 13 countries
- Compact experiment, optimised for detecting the 3 neutrino flavours
- Experiment approved by the research board in March 2021
- Assembly and preparatory works currently ongoing
- Physics programme
 - Measurement of the $pp \rightarrow \nu X$ cross-section
 - Heavy flavour production in pp collisions
 - Lepton flavour universality in neutrino interactions
 - Measurement of the NC/CC ratio
 - Search for non-SM feebly-interacting particles

Location



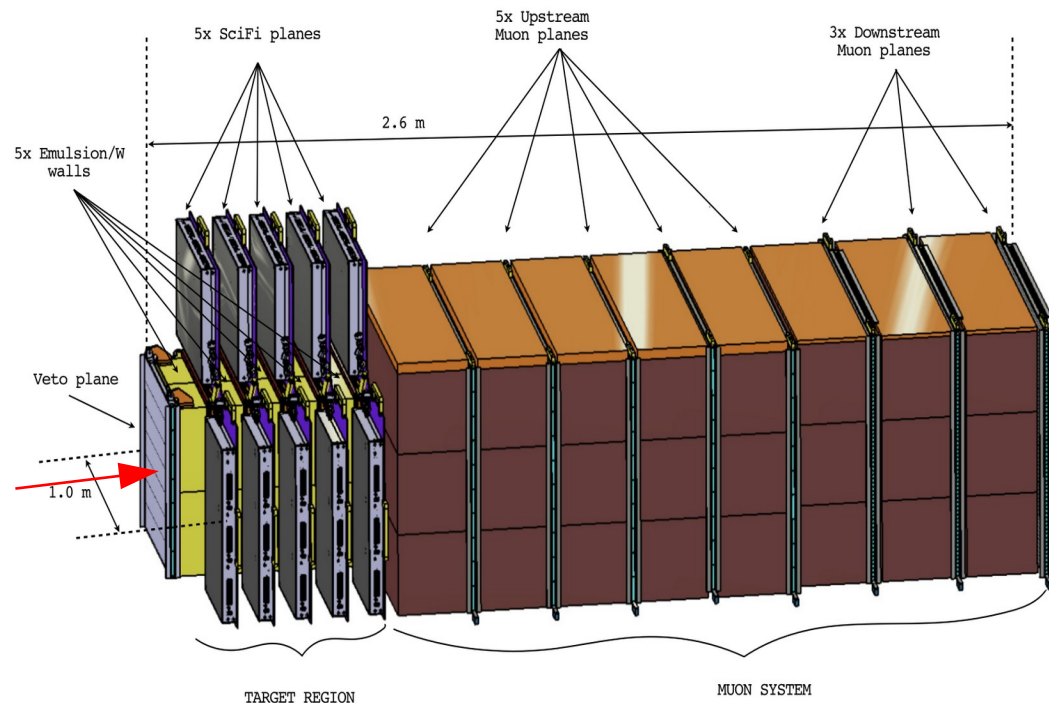
- TI18 tunnel
 - Former service tunnel connecting SPS to LEP
 - Symmetric to TI12, where FASER is located
- ~480 m from ATLAS interaction point
 - Shielded with ~100 m of rock
- Angular acceptance: $7.2 < \eta < 8.6$
 - Offset wrt collision axis



SND@LHC



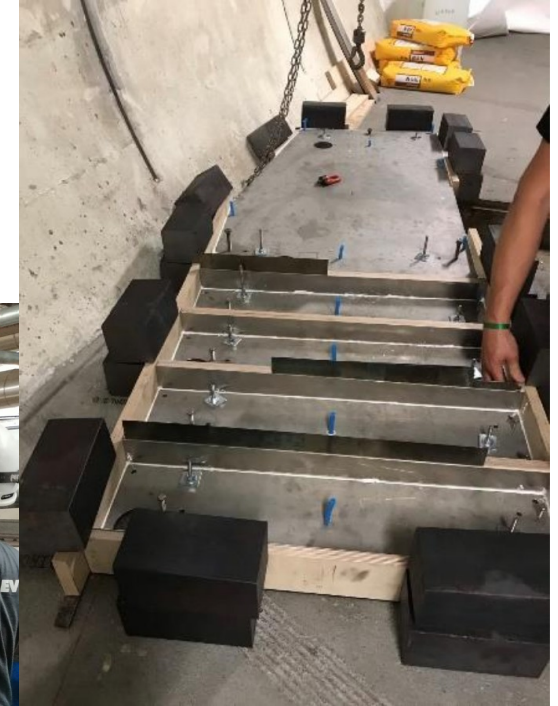
- Veto
 - Scintillators: tag incoming muons
- Target region
 - Emulsion cloud chambers (830 kg): neutrino interaction detection
 - Scintillating fibres tracker/ECAL: timestamp, position and energy measurement
- HCAL/Muon system
 - Iron walls and scintillators: energy measurement and muon detection



Tunnel preparation

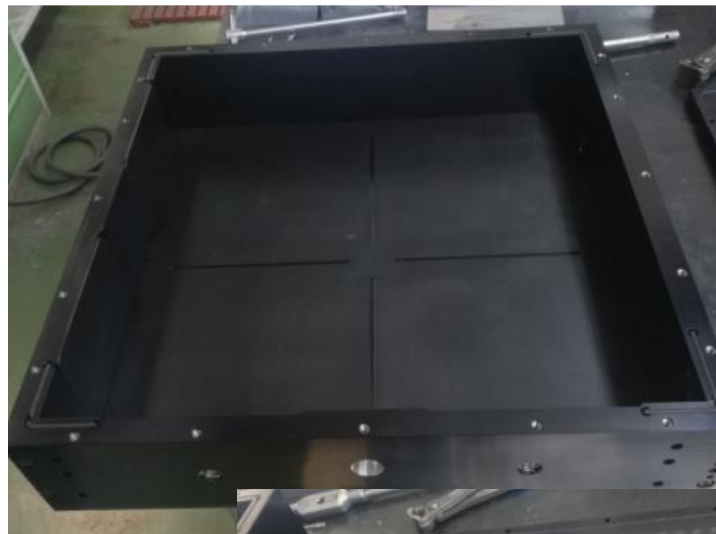


- Ongoing preparatory works
- Services installation
- Cryostat protection



Detector assembly

- Emulsion box prototype assembled
 - Using aluminium instead of emulsions
- Tests are being performed
 - Light tightness
 - Mechanical tests of emulsions
 - Fine tuning of mechanical structure



Detector assembly

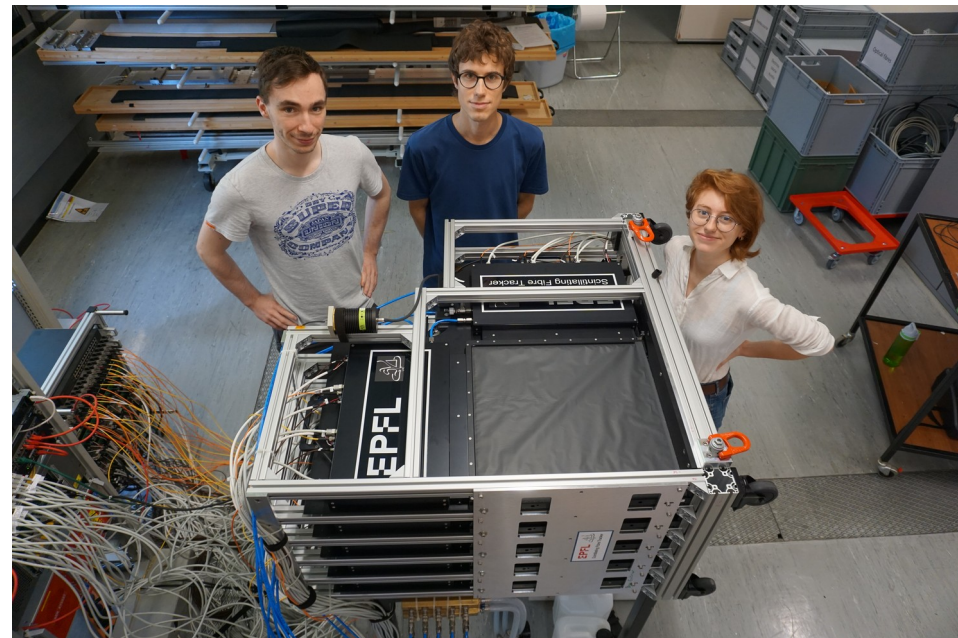
- Veto
 - Fully assembled
- Upstream muon/HCAL
 - Fully assembled
 - Currently at testbeam for energy calibration
- Downstream muon
 - 1 out of 3 planes assembled
 - Currently at testbeam



Detector assembly



- SciFi tracker/ECAL fully assembled at EPFL
- Successful data taking with cosmics
 - Full DAQ, event builder, controls...
- Setup will be moved at CERN mid-September



HCAL energy calibration

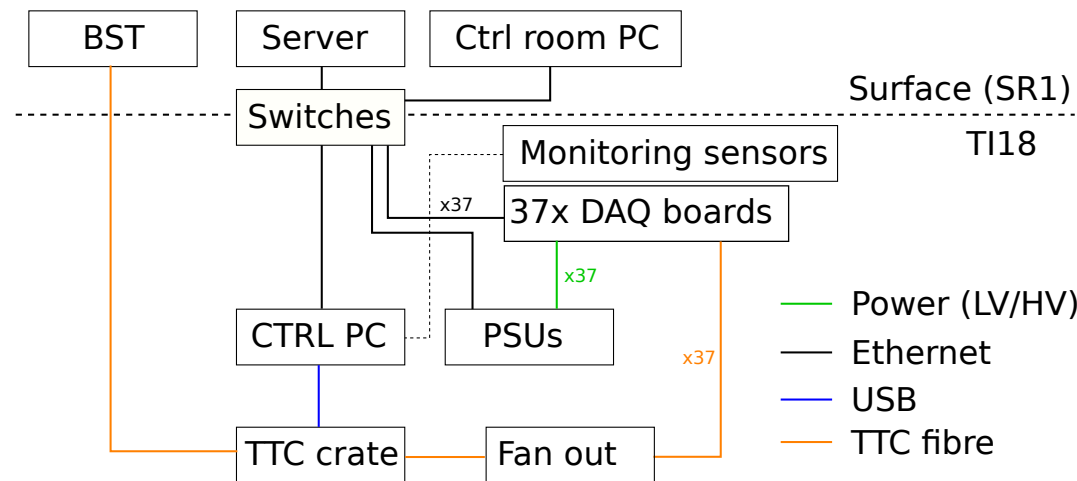


- Testbeam with HCAL/Muon system at CERN SPS
- Data taking with pions (180, 140, 100 GeV)
- Data extremely important to calibrate MC



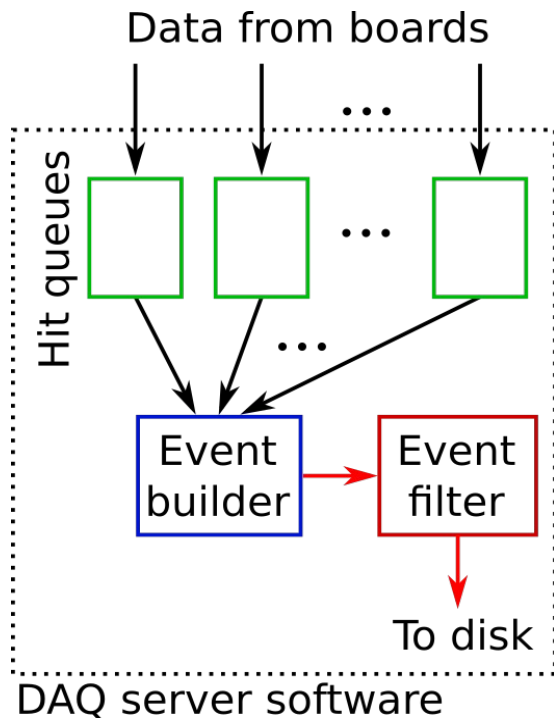
The DAQ system

- Veto, SciFi tracker, muon system read-out with common DAQ board
 - 37 boards used
 - Synchronous to LHC clock
 - Data transmitted to server on the surface
- TTC system receives LHC clock from BST and distributes it to DAQ boards



TTC: Timing, Trigger and Control
 BST: Beam Synchronous Timing

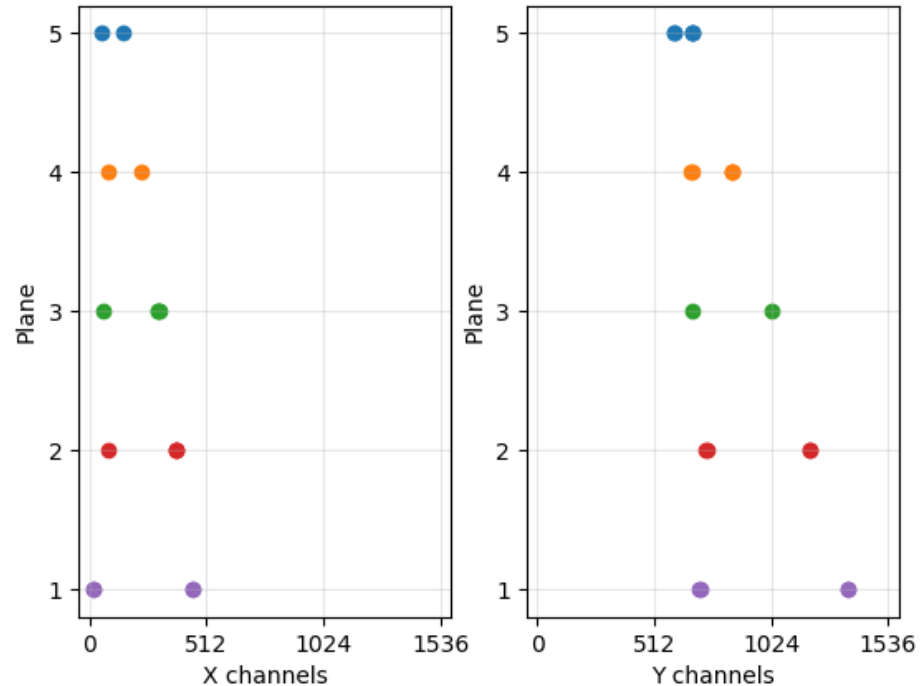
The DAQ system



- Triggerless system
 - All data above threshold is sent to the server
- Event building
 - Hits from all boards are build into events based on timestamp
- Online noise suppression
 - Events required to have signal from a minimum number of boards
- Valid events saved to disk

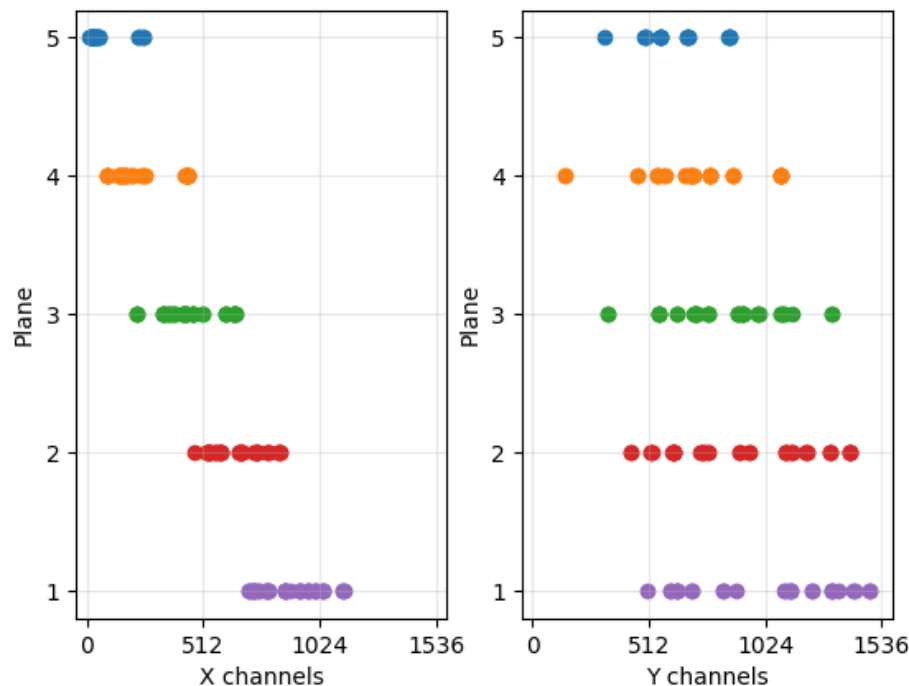
First data

- First test of DAQ system performed on SciFi tracker
- Detector oriented to take cosmic rays data
- First runs
 - Determine event building capabilities (max hit rate ~ 200 kHz)
 - Find best thresholds and parameters



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Conclusions

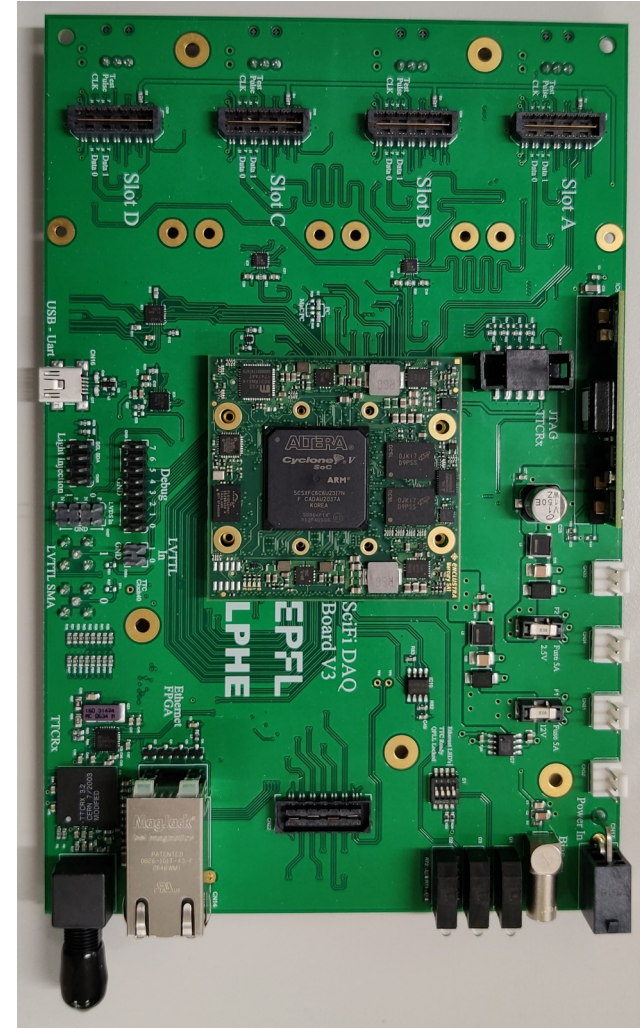
- SND@LHC is a compact detector optimized for the 3 neutrino flavours
- Its construction is underway, expected installation at the end of the year
- DAQ system based on custom DAQ board and front-end
 - Triggerless readout
 - Online event building and noise suppression
- System performance is being evaluated



Backup

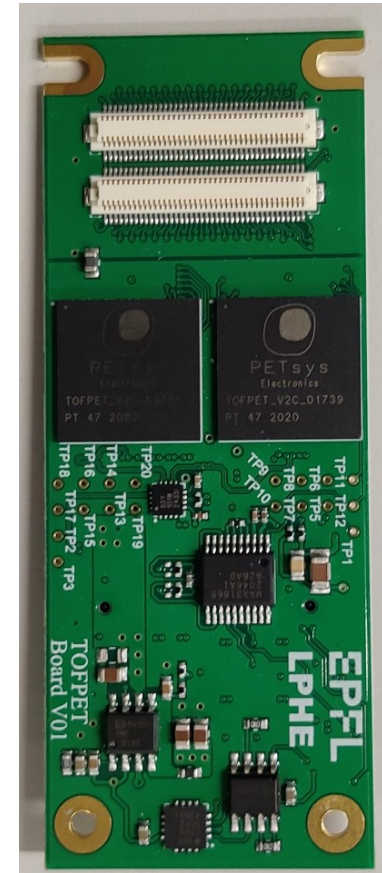
The DAQ boards

- Same DAQ board for all subsystems
- Developed at EPFL, based on Cyclone V processor+FPGA
 - Clock from TTC system, using TTCrx chip
 - Data transmitted over Ethernet to the server
- 4 front-end board slots
 - 512 channels in total



The front-end boards

- Each board contains 2 TOFPET2 chips
 - Analogue front-end and ADCs
 - Data fully digitized
 - 128 channels in total
- Allows for low signal thresholds (1.5 pe)
 - 3-threshold system for best time and amplitude resolution and dark noise reduction
- Good timing (40 ps resolution) and amplitude measurement with charge integration or time-over-threshold





Performance assessment

- Efficiency measurement
 - With tracks reconstruction
- Channels time alignment
 - Using light injection system
- Time/energy resolution evaluation
- Will be performed in the coming weeks