DsTau (NA65):
Study of tau neutrino production at CERN-SPS

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Contents

Motivation

Tau neutrino is the least studied elementary particle

The large uncertainty of ν_τ interaction cross section is due to:

- small number of registered ν_τ interaction events
- lack of knowledge about ν_τ production

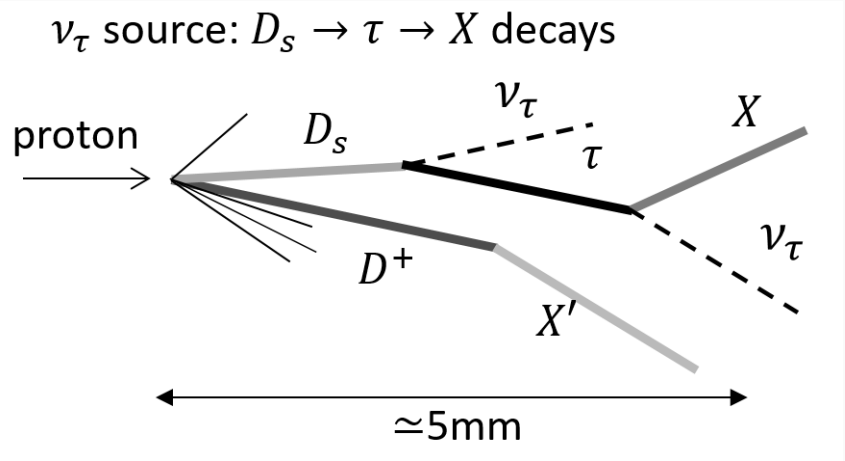
The DsTau experiment is aimed at:

→ Studying ν_τ production:

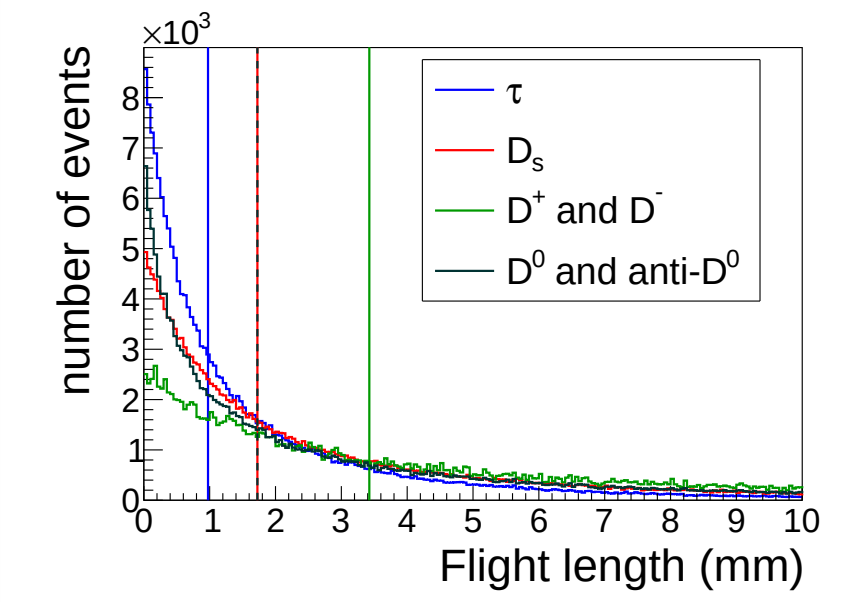
- Reducing the systematic uncertainty of ν_τ flux prediction
- Providing fundamental input for future experiments
  - △ Testing Lepton Universality in neutrino interactions

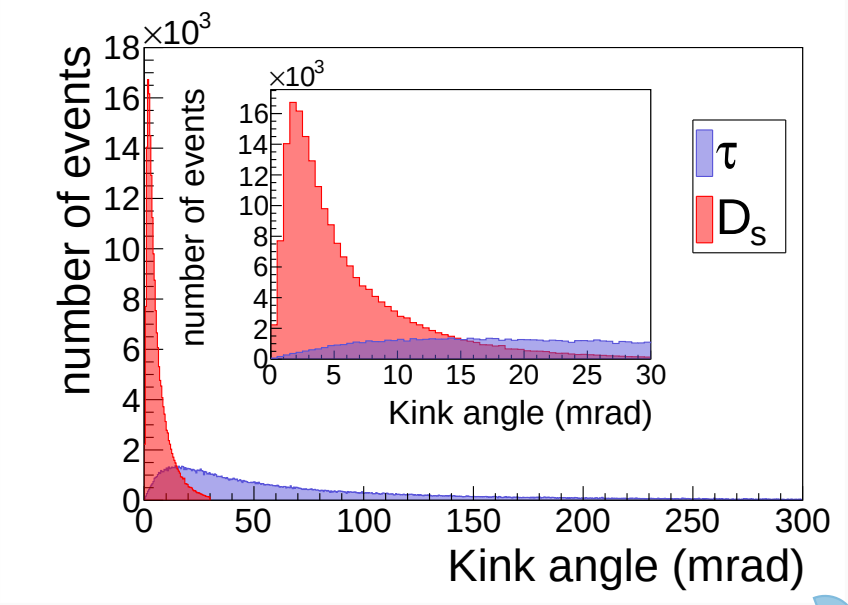
Goals and principles

- → The main source of ν_τ is the decay of D_s mesons, which has a distinct topology
- → In all data ~ 1000 $D_s \to \tau$ decays are expected to be identified



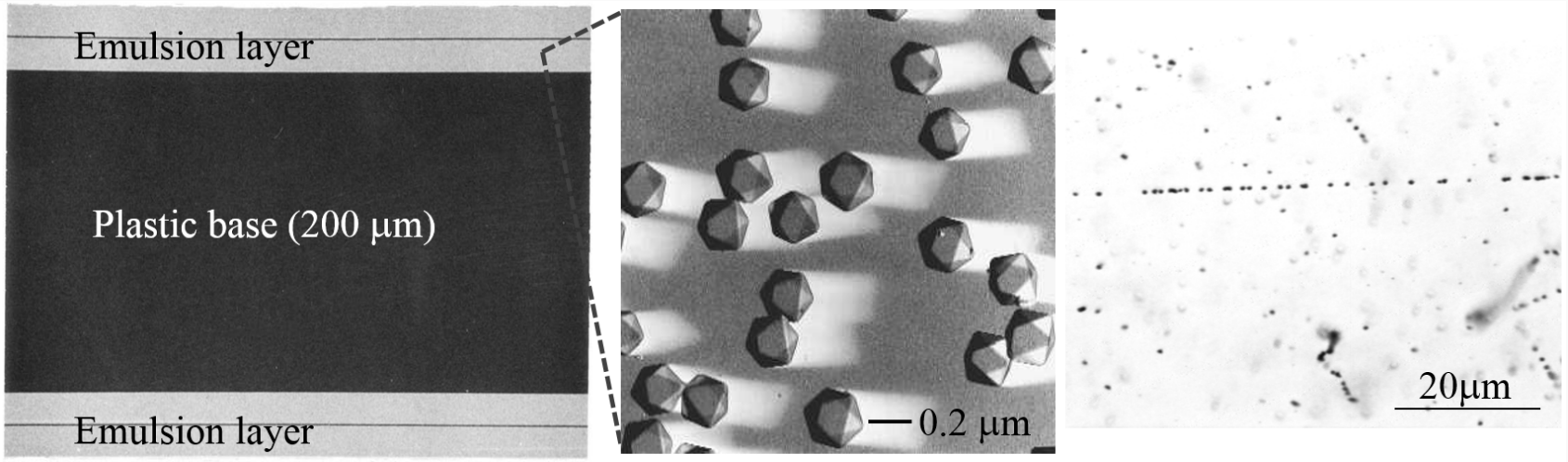
The signal topology



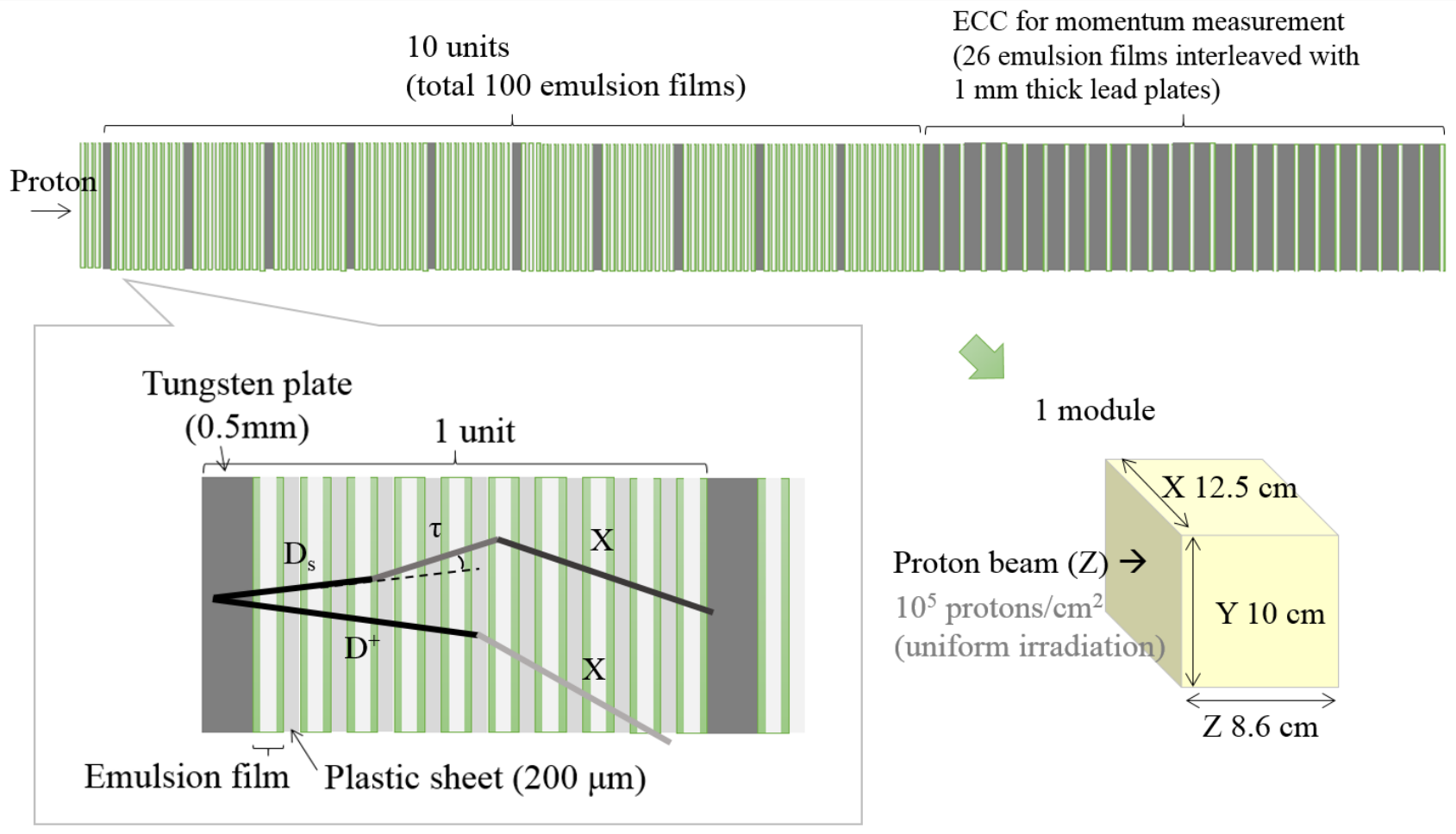


Nuclear emulsion

- → Silver halide crystals in gelatin media
- → 70 μm thick emultion layers on both sides of a 210 μm thick plastic base
- → Track position resolution 50 nm, angular resolution 0.34 mrad

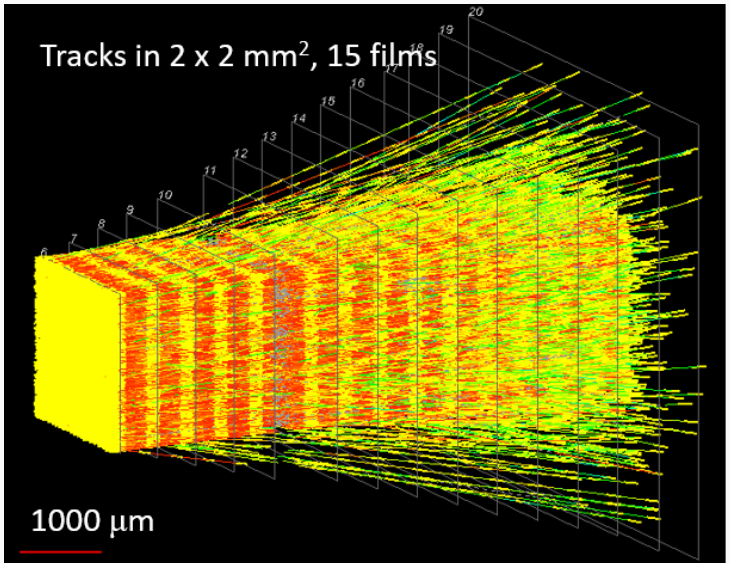


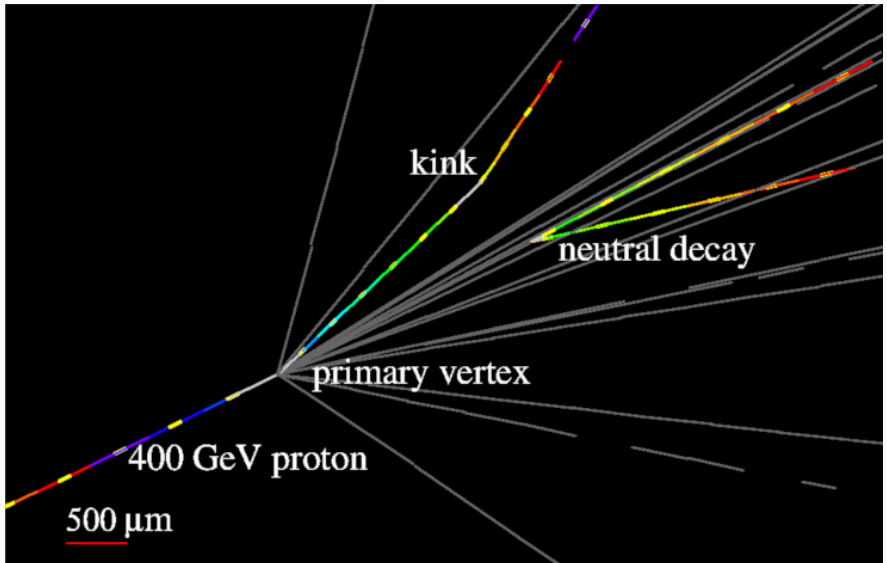
Experimental setup



Scanning and reconstruction

- → Information is extracted with fully automatic scanning stations ~ 5000 cm^2/h
- → Track density $\gtrsim 10^5$ tracks/cm^2
- → Two stages:
  - Fast scanning system with a relatively coarse resolution
  - Scanning of interesting events at slower but more precise scanning systems





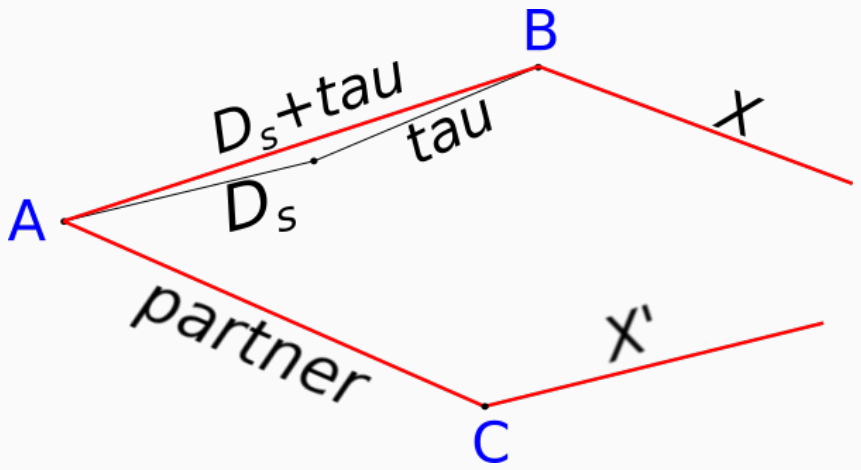
Hadronic interaction background

- → The main background consists of hadronic interaction events with the topology similar to the signal one
- → The signal events are very rare ($\sim 10^3$) and the number of hadronic interactions is extremely high ($\gtrsim 10^8$), therefore it is necessary to significantly suppress background

Hadronic interaction background

Reducing hadronic interaction background on the first scanning stage can be done using kinematic cuts.

Approximately **575** signal (out of ~**2500**) and **27650** background events will pass this selection.



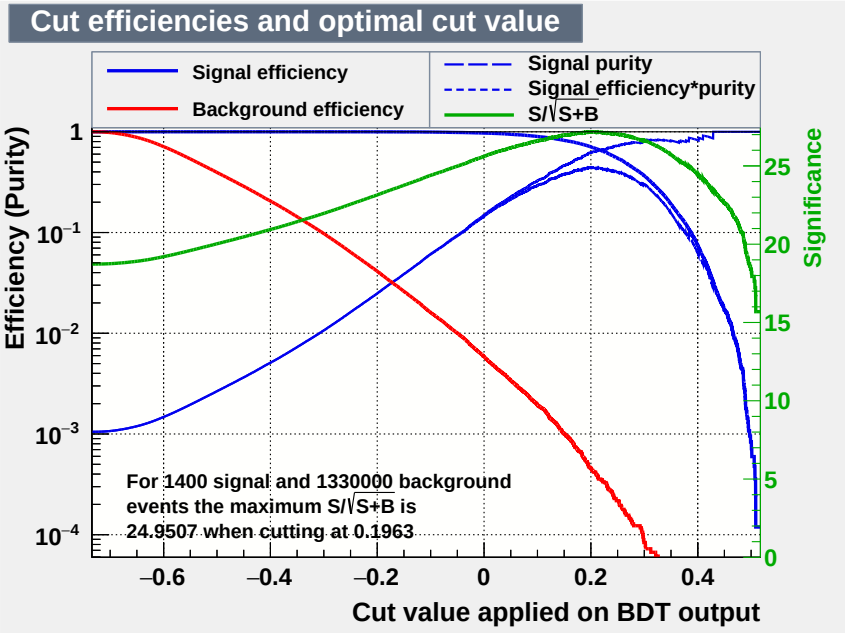
The D_s decay is not visible on the first stage of scanning due to low spacial resolution

Hadronic interaction background

Boosted Decision Tree method was used to improve signal-background separation.

The following variables were chosen for separation:

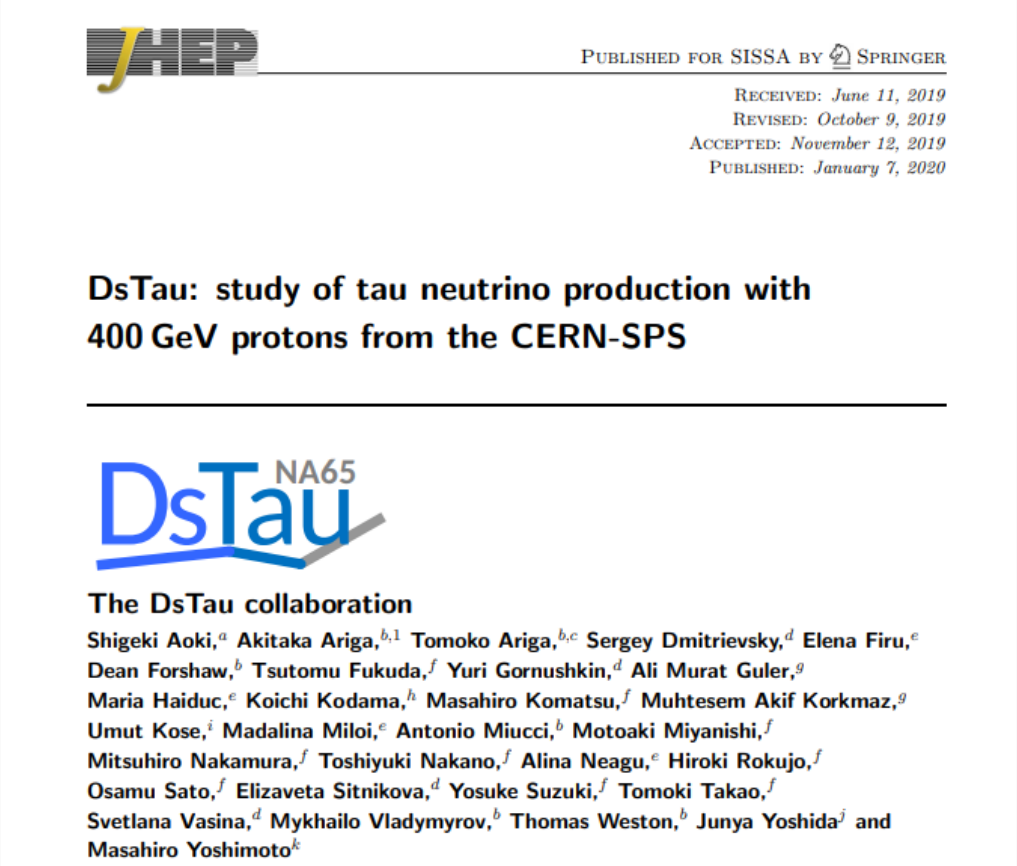
- → Paths of $D_s + \tau$ and partner
- → Kink angles of $\tau \to X$ and partner $\to X'$ decays
- → Longitudinal coordinates of τ and partner's decays
- → Impact parameters of X and X' to primary vertex



Using BDT method expected number of charged channel signal events was increased from **575** to **1 398** events with the same level of background (∼**28 000** events)

Thank you for your attension

More information can be found in the paper



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NA65 DsTau

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BACKUP

Hadronic interaction background

Selection
(1) Flight length of $D_s + \tau \geq 4$ emulsion layers
(2) Flight length of $D_s + \tau < 10$ mm
(3) $\Delta\theta_{\tau \to X} \geq 15$ mrad
(4) Pair charm: 0.1 mm $\leq$ flight length $<$ 5 mm (charged decays with $\Delta\theta \geq 15$ mrad or neutral decays)

Cross sections