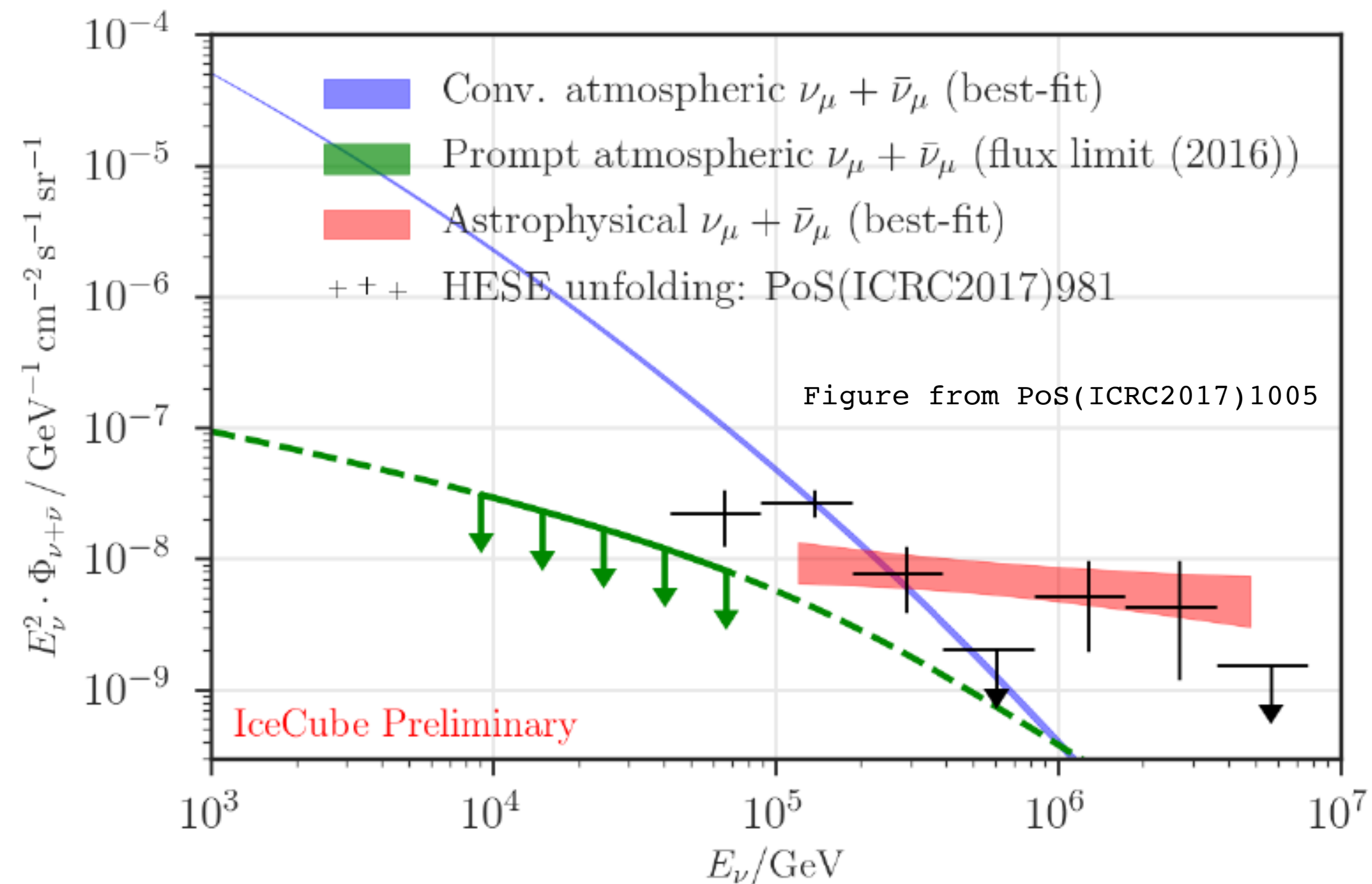


Neutrinos from charm: Forward production at the LHC and in the atmosphere

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Atmospheric neutrinos



■ Conventional neutrino flux

- produced from the π and K decays
- mean lifetime of π/K : $\tau \sim 10^{-8} s$
- dominates at relatively low energies.

■ Prompt neutrino flux

- originated mostly from charm meson decays
- mean lifetime D/B: $\tau \sim 10^{-12} s$
- dominates over the conventional flux at high energies
- main background of astrophysical neutrinos

- The cross-over energy is not known since the prompt atmospheric neutrinos have not been detected and the theoretical prediction of their fluxes have large uncertainties mainly due to uncertainties in charm hadron production.

Forward experiments at the LHC

- RUN 3 (2022 - 2024): $\sqrt{s} = 14 \text{ TeV}$, $\mathcal{L} = 150 \text{ fb}^{-1}$
 - FASER/ FASER ν ($\eta \gtrsim 9.2 / 8.8$)
 - SND@LHC ($7.2 < \eta < 8.6$)
- HL-LHC (2027 - 2036): $\sqrt{s} = 14 \text{ TeV}$, $\mathcal{L} = 3000 \text{ fb}^{-1}$
 - Forward physics facility (FPF) - a set of forward experiments
 - Under discussion for upgrade with additional experiments

Forward experiments at the LHC can measure prompt neutrinos and heavy flavor production

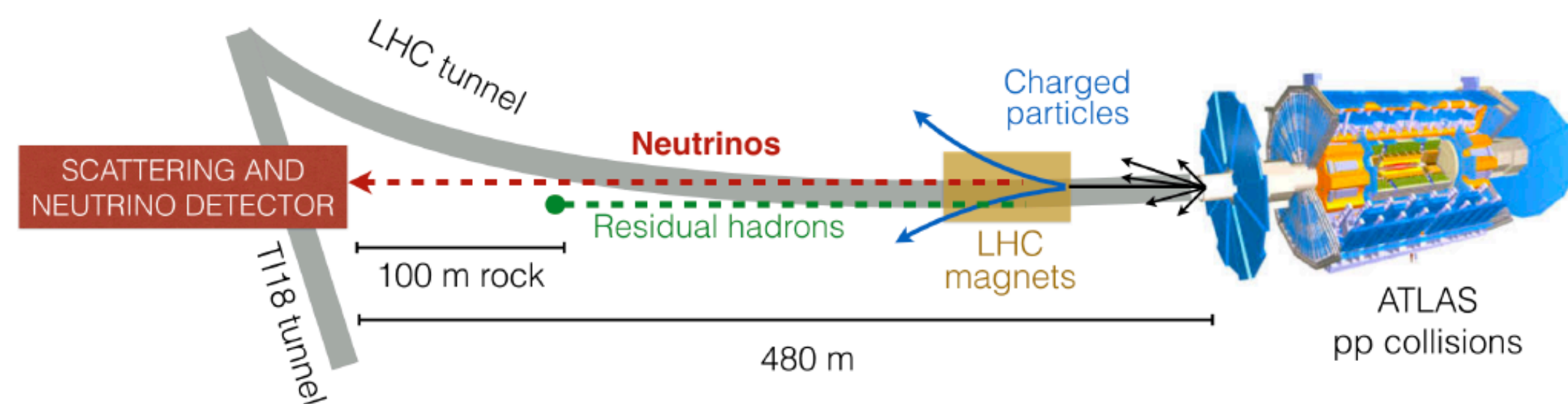
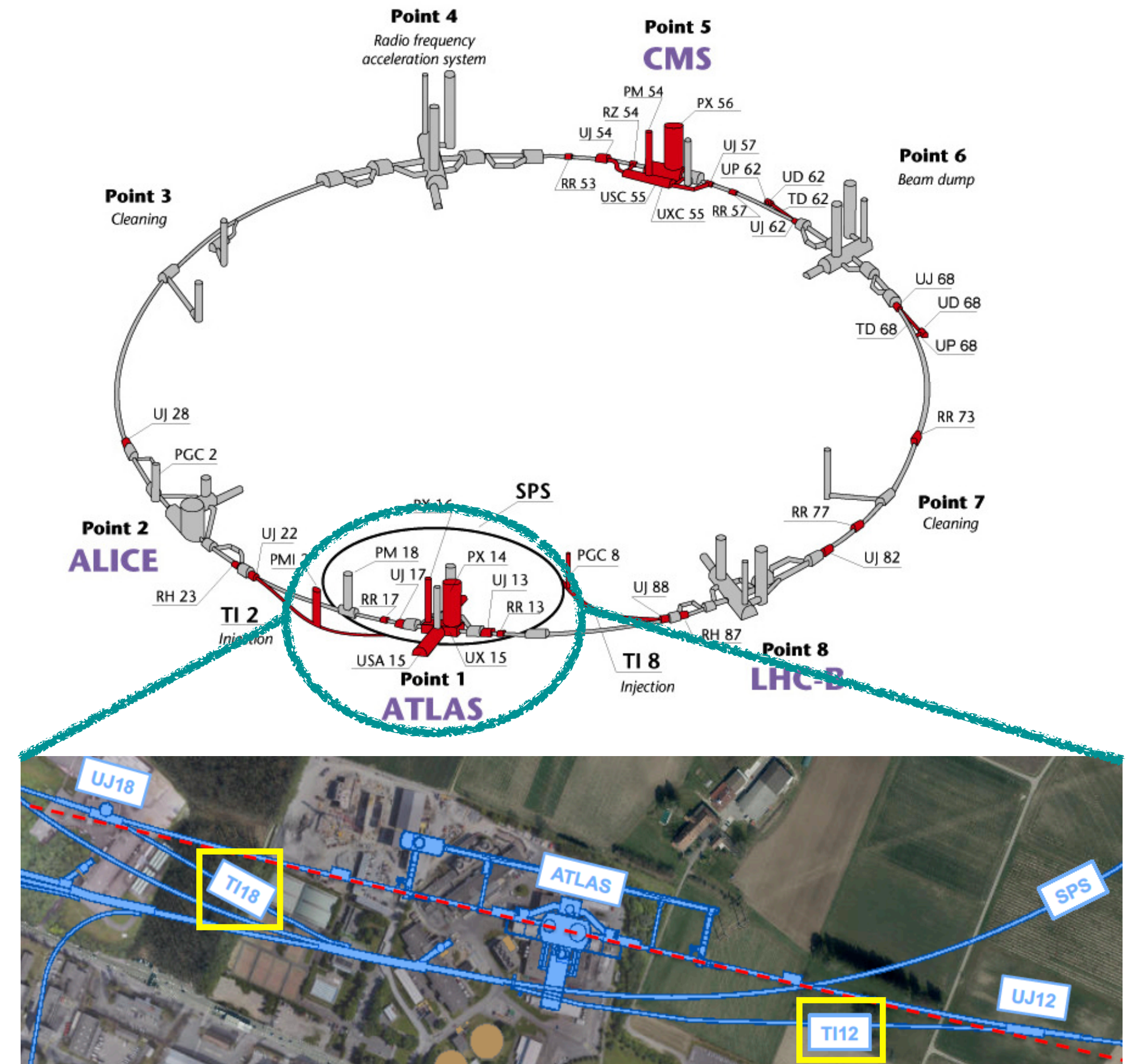
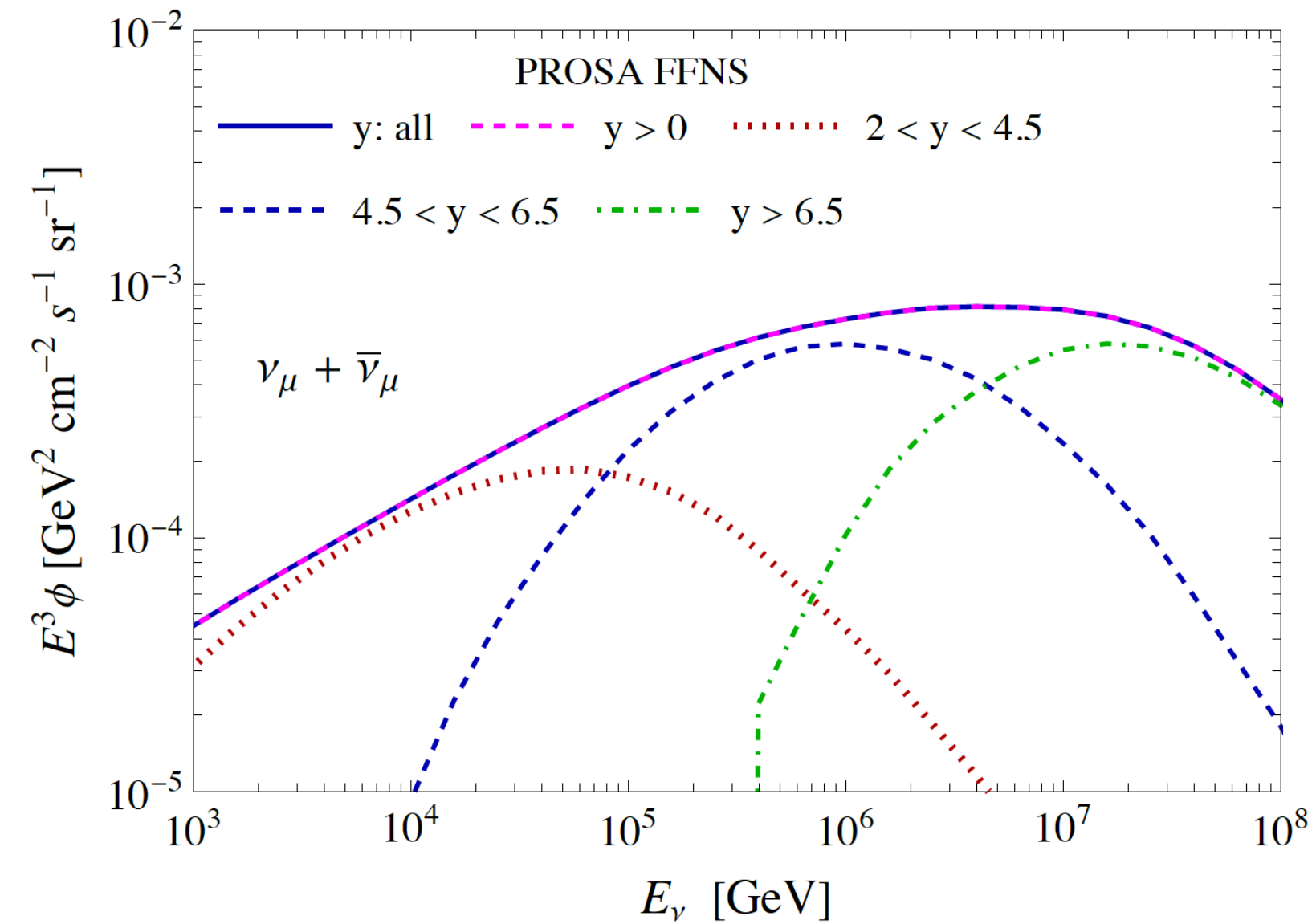
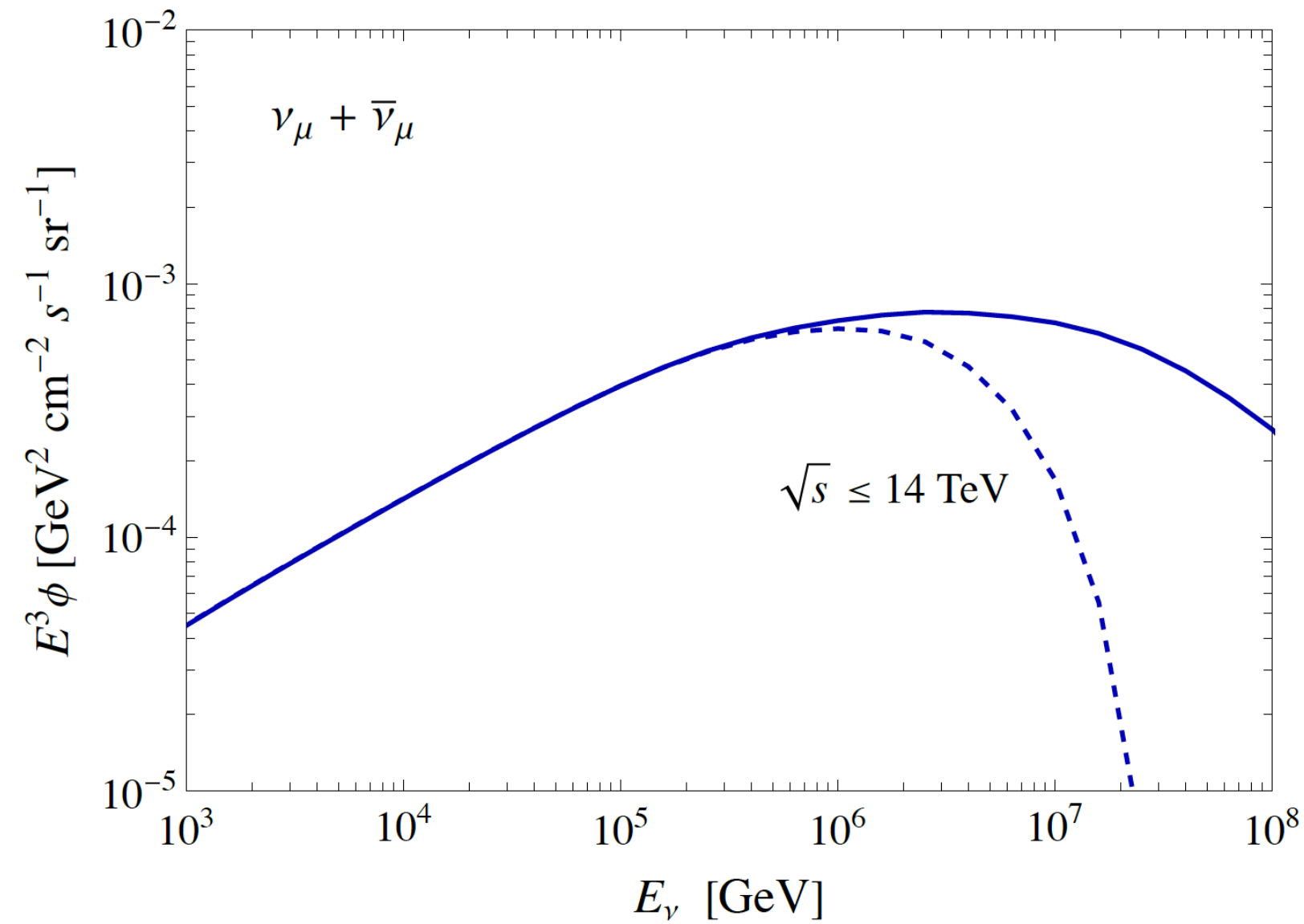


Figure taken from A. Di Crescenzo's slides for SND@LHC from the 2nd FPF meeting



Ref: 1903.06564, 1908.02310, 2002.08722

Prompt atmospheric neutrino fluxes



- Charm meson production at the energy of the LHC has contribution to the high energy atmospheric neutrino flux, the main component of which is prompt neutrinos.
- The most important contribution to the prompt atmospheric neutrinos are from the charm meson produced in $4.5 \lesssim y \lesssim 6.5$.
- Measurement of the heavy flavor production and prompt neutrinos at the LHC at this rapidity range would provide important data for essential input and help to develop the theoretical prediction on the prompt atmospheric neutrino flux.