# MultI-messenger probe of Cosmic Ray Origins: the MICRO project

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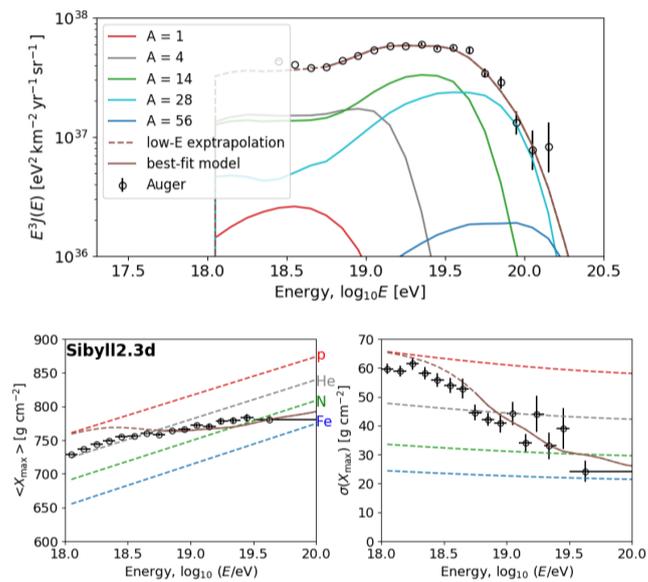condorelli@ijclab.in2p3.fr

## Open questions

✳ How do burst-like signatures (GRBs, AGN-flares) fit the cosmic-ray data?

✳ Can current UHECR observables constrain the 3D distribution of sources?

✳ Do astrophysical high-energy $\nu$, high-energy $\gamma$-rays, and UHECRs come from the same sources?
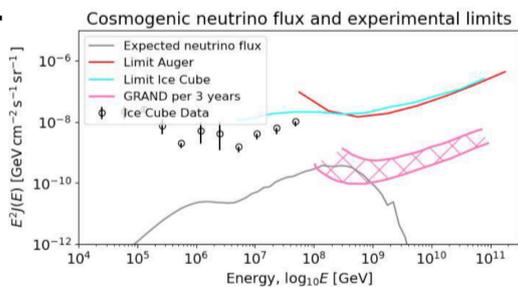
## How to answer?

### Public softwares to fit simultaneously UHECR observables



A diffuse flux from identical sources of UHECRs is propagated and then compared to the data at Earth: spectrum and composition.
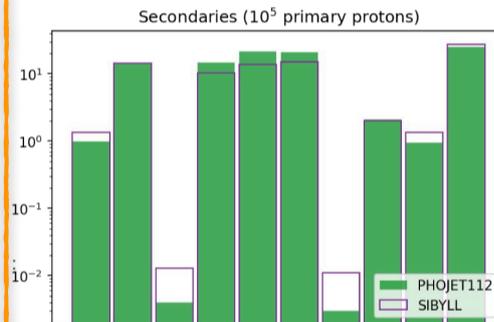


Computation of neutrino fluxes produced along the propagation could help to constrain the parameter space.

### Modelling the source

#### Hadronic interactions in UHECR simulations code



Study of hadronic interactions in CRPropa for different hadronic interaction models.



Comparison of hadronic interactions implemented in CRPropa and SimProp.

#### Source-propagation models



Study of UHECR productions with in-source interactions.

#### Multi-messenger signatures



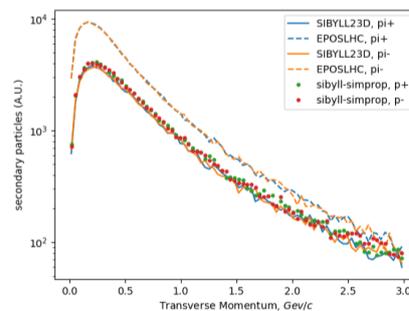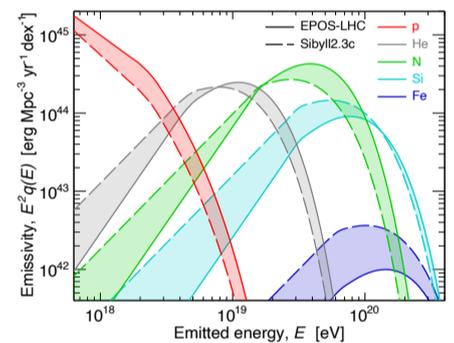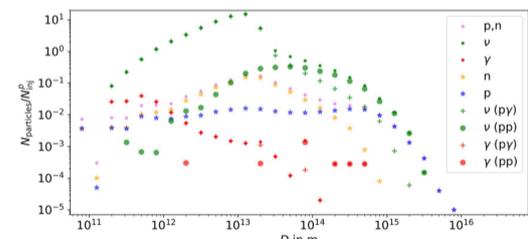Multi-messenger emission by a proton Flares of $10^8$ GeV from blazar.

## Future steps

✳ Combine simulations and data to investigate if/how transient scenarios fit the observables.

✳ Joint accounting for composition, anisotropy, and spectral data to triangulate possible sources.

✳ Predict neutral fluxes from cosmic-ray propagation and interaction, including in-source propagation and comparison to current or future constraints.

Check our website!