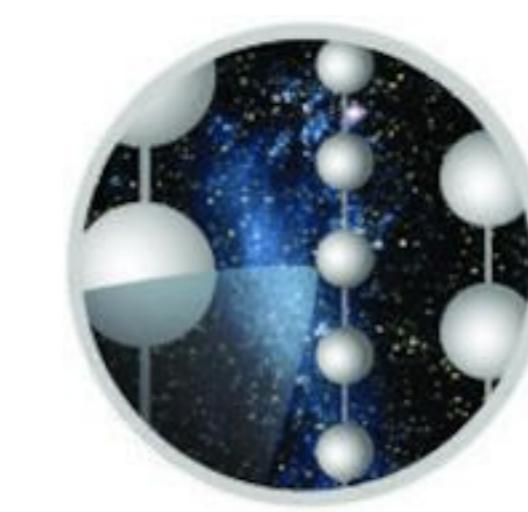


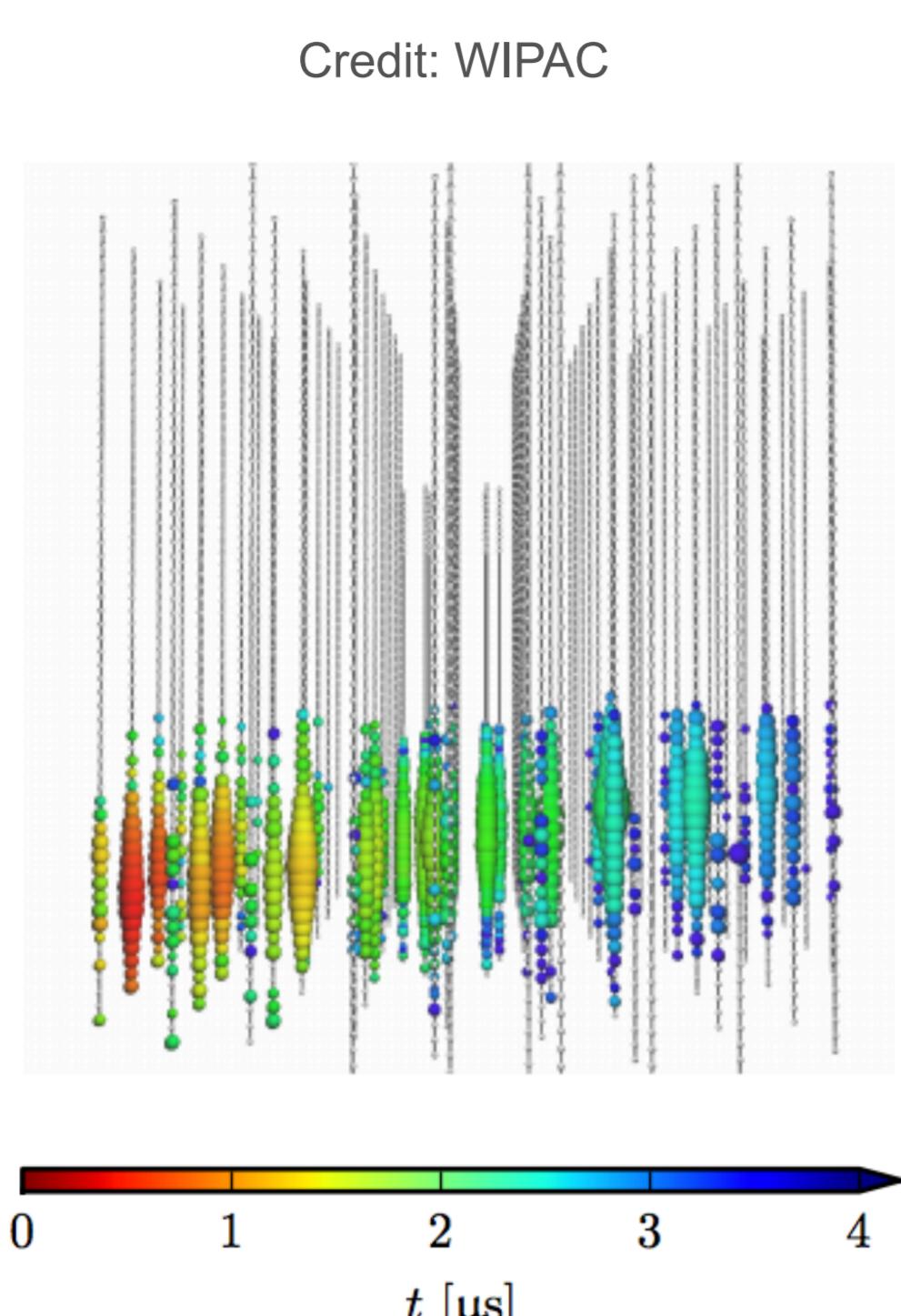
# Probing the Tidal Disruption of Stars by Supermassive Black Holes with the IceCube Neutrino Observatory



**ICECUBE**  
SOUTH POLE NEUTRINO OBSERVATORY

Robert Stein, DESY

## IceCube Neutrino Observatory



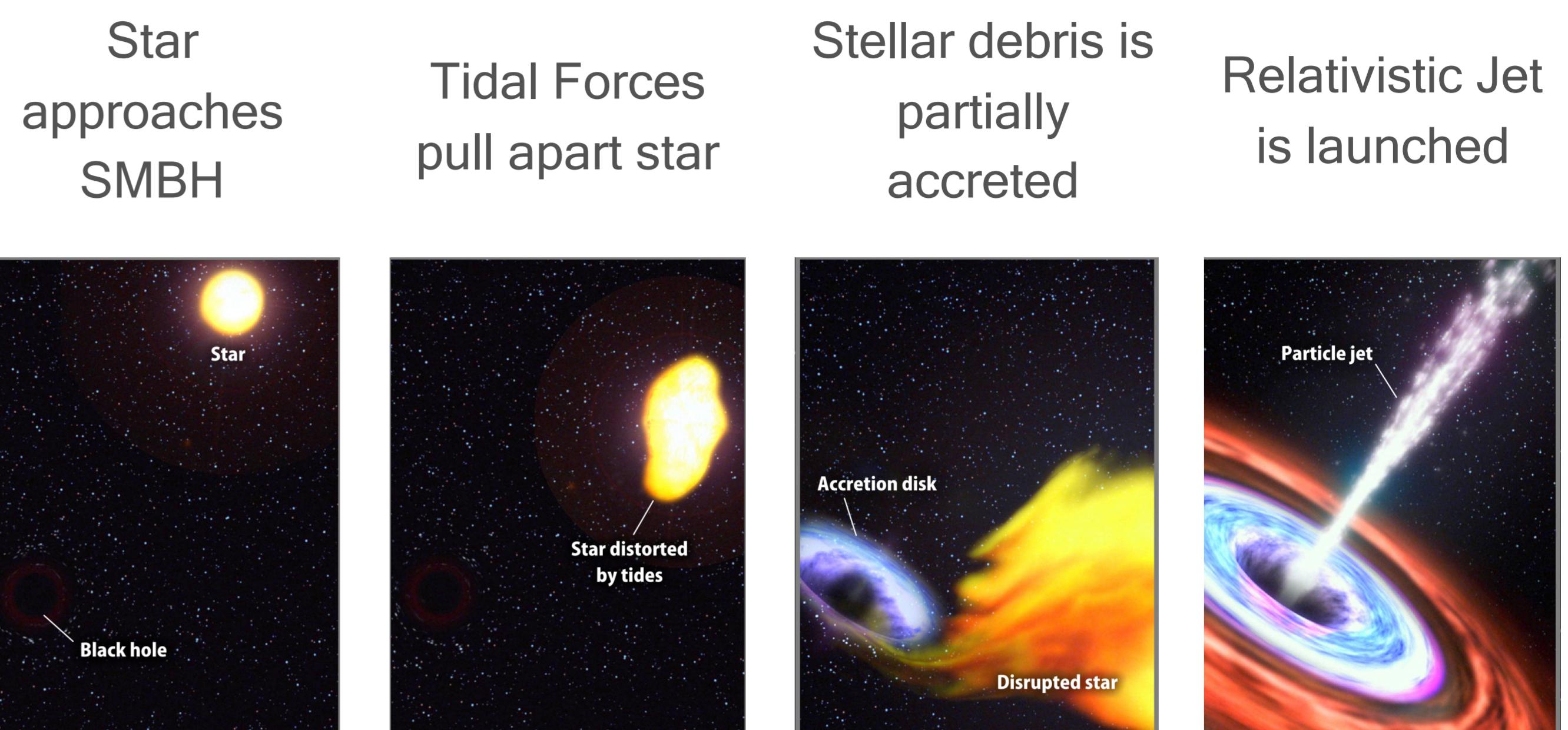
**IceCube searches for astrophysical neutrinos**

IceCube discovered an astrophysical neutrino flux in 2013.

The sources of these neutrinos remain as yet undiscovered, but consistency of flux with an isotropic distribution suggests a predominantly extra-galactic origin.

The neutrino sources must be capable of accelerating cosmic rays to high energies.

## Tidal Disruption Events (TDEs)



Credit: NASA/Goddard Space Flight Centre/Swift

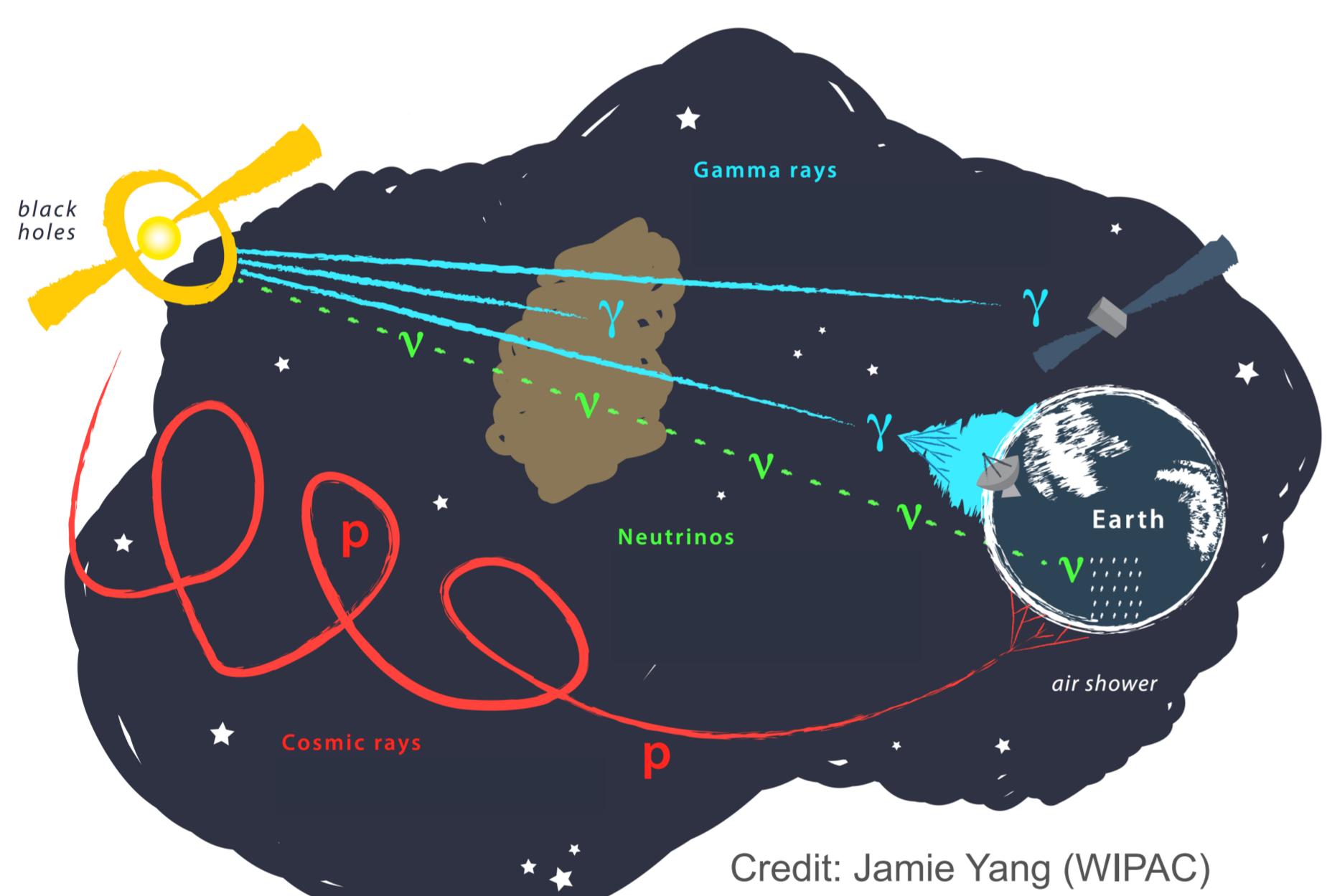
**TDEs are extreme cosmic accelerators**

TDEs are rare EM-bright transients lasting hundreds of days.

Some TDEs are observed to have highly-relativistic jets. Jetted TDEs are like transient blazars. They can be highly super-Eddington, which means they are extremely bright.

They are detected in IR, optical, UV, X-ray and radio bands, with typical unbeamed radiated energy of  $\sim 10^{50}\text{-}10^{52}$  erg.

## Probing Acceleration in Particle Jets



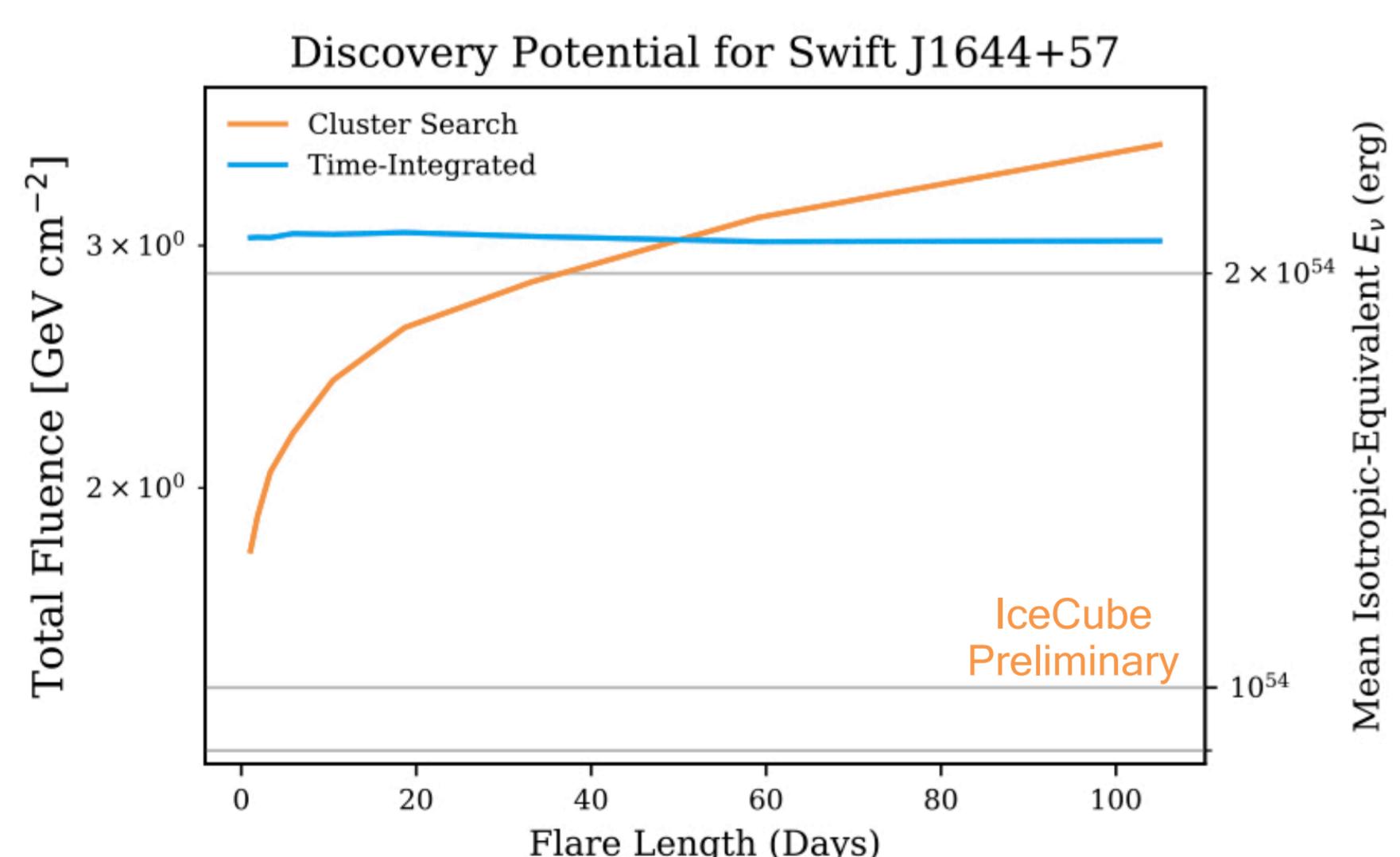
**Only neutrinos carry information about particle acceleration in TDE jets**

TDEs may produce UHECRs, but these would be deflected by magnetic fields, and jet is opaque for high-energy gamma rays.

⇒ Cannot directly measure the cosmic ray luminosity of TDEs.

Neutrino fluence uniquely constrains jet parameters.

## Testing Neutrino Emission Models

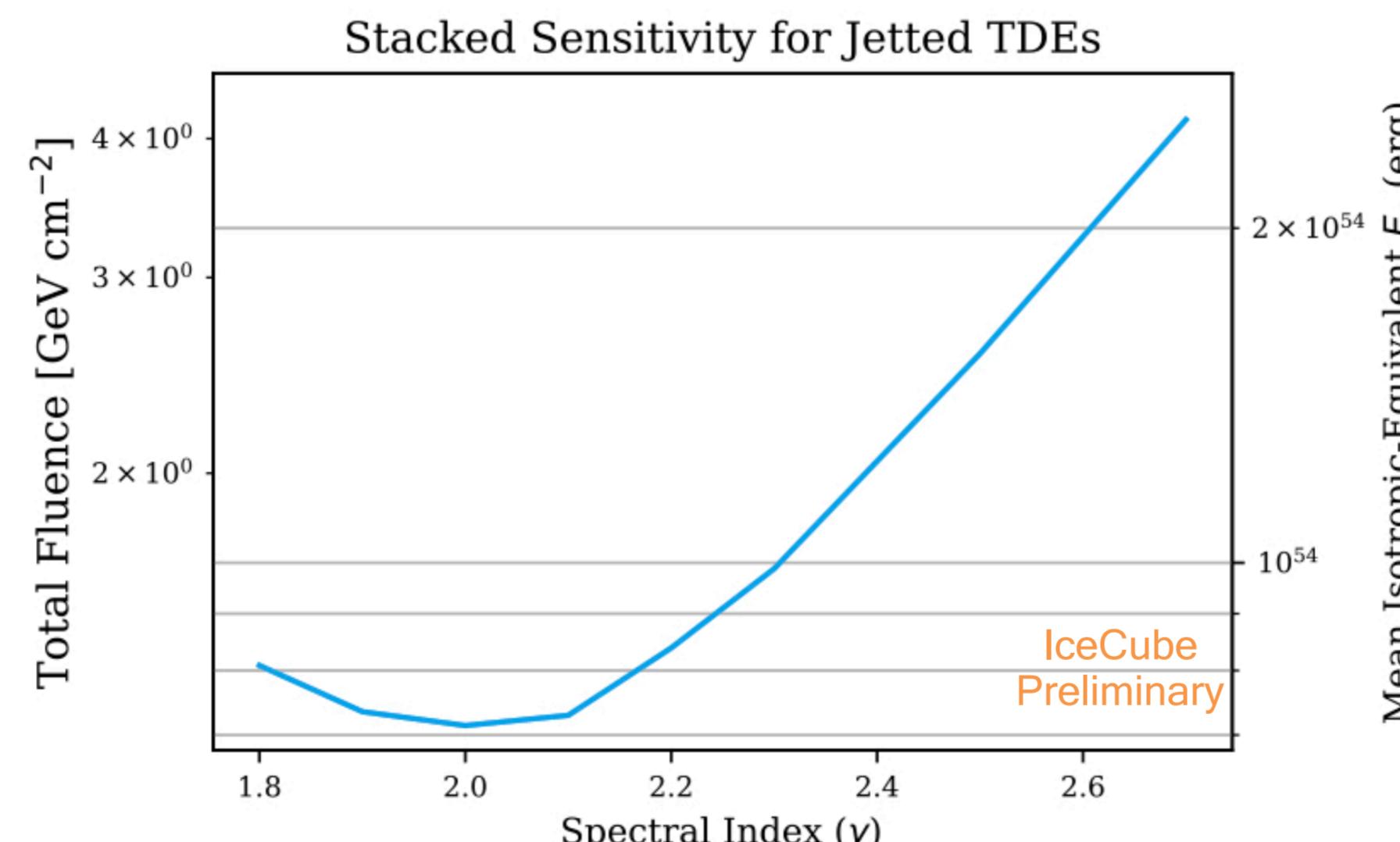


**Individual Neutrino Fluences**

Promising TDEs will be tested individually

Search for neutrino clustering in space and time, for short neutrino burst discovery

Constrains Baryonic Loading Factor of each source

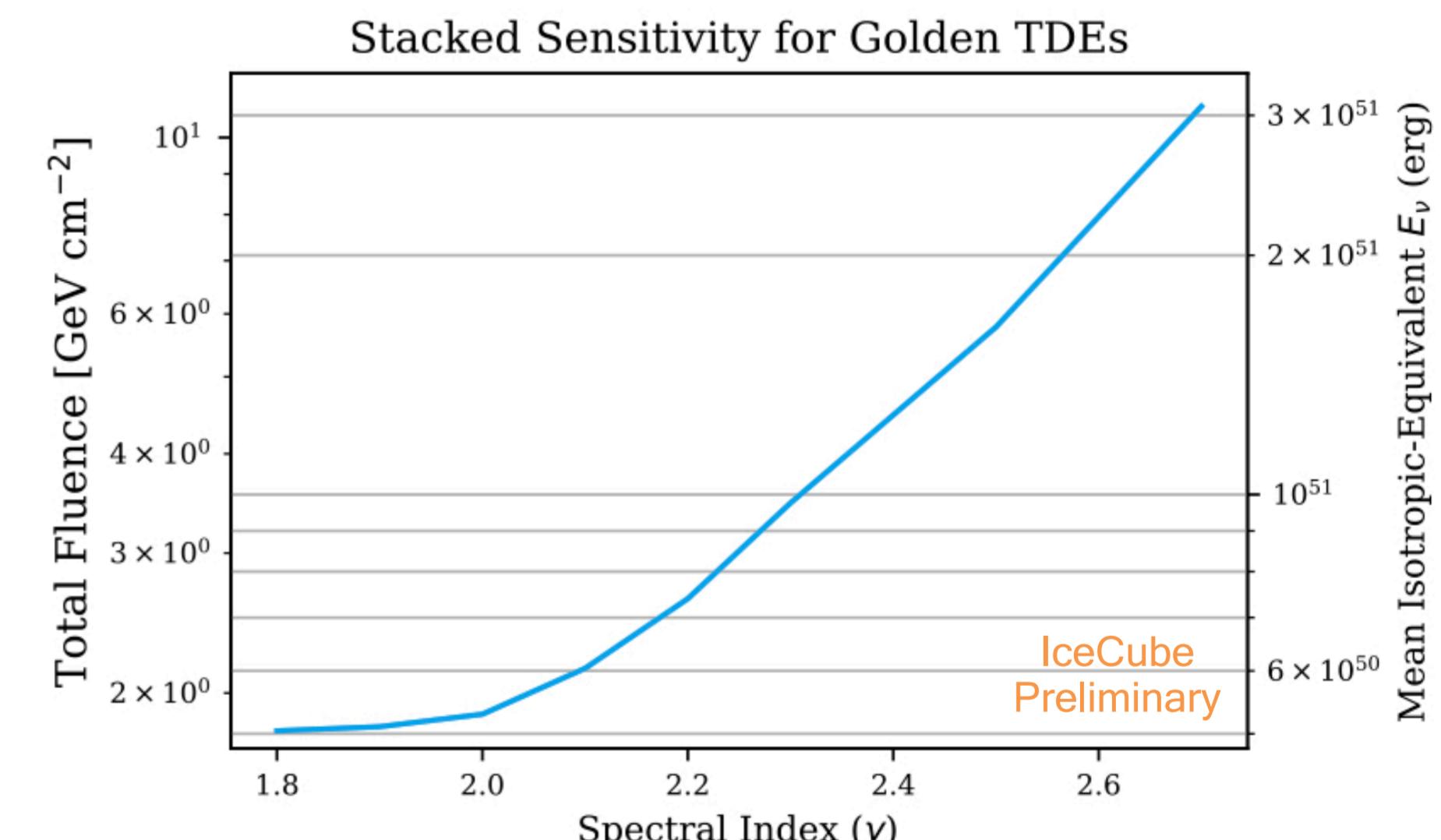


**Stacking Jetted TDEs**

Combining sources improves sensitivity

Search for time-integrated emission in window matching  $\sim 100$  day EM emission, fitting the individual source luminosities

Typical beaming factor of  $\sim 100$



**Stacking Non-jetted TDEs**

Non-jetted TDEs could also produce neutrinos, and are more numerous

TDEs will be categorised based on observational data

Additional time-integrated searches, with same stacking method

## References

- “Evidence for High-Energy Extraterrestrial Neutrinos at the IceCube Detector”, IceCube Collaboration, Science, 342 (2013)
- “Tidal disruption of stars by supermassive black holes: Status of observations”, S. Komossa, JHEAp 7 (2015) 148-157
- “High Energy Neutrinos from the Tidal Disruption of Stars”, C. Lunardini and W. Winter, Phys. Rev. D, 95 (2017)