

# Snowmass Planning

## **CF7 Cosmic Probes of Fundamental Physics**

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CMB-S4 Summer Collaboration Meeting  
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# CF7 Cosmic Probes of Fundamental Physics

Using the windows on the universe to learn about fundamental particles and high energy physics

**Science goals:** CF7 covers cosmic probes of fundamental physics topics beyond Dark Matter and Dark Energy using gravitational waves, cosmic rays, gamma rays, and neutrinos, as well as their combined studies to facilitate the multi-messenger science. It also covers various tests of  $\Lambda$ CDM using high and low redshift observations and the potential of standard candle/siren cosmology to address existing tensions in the data.

## Conveners:

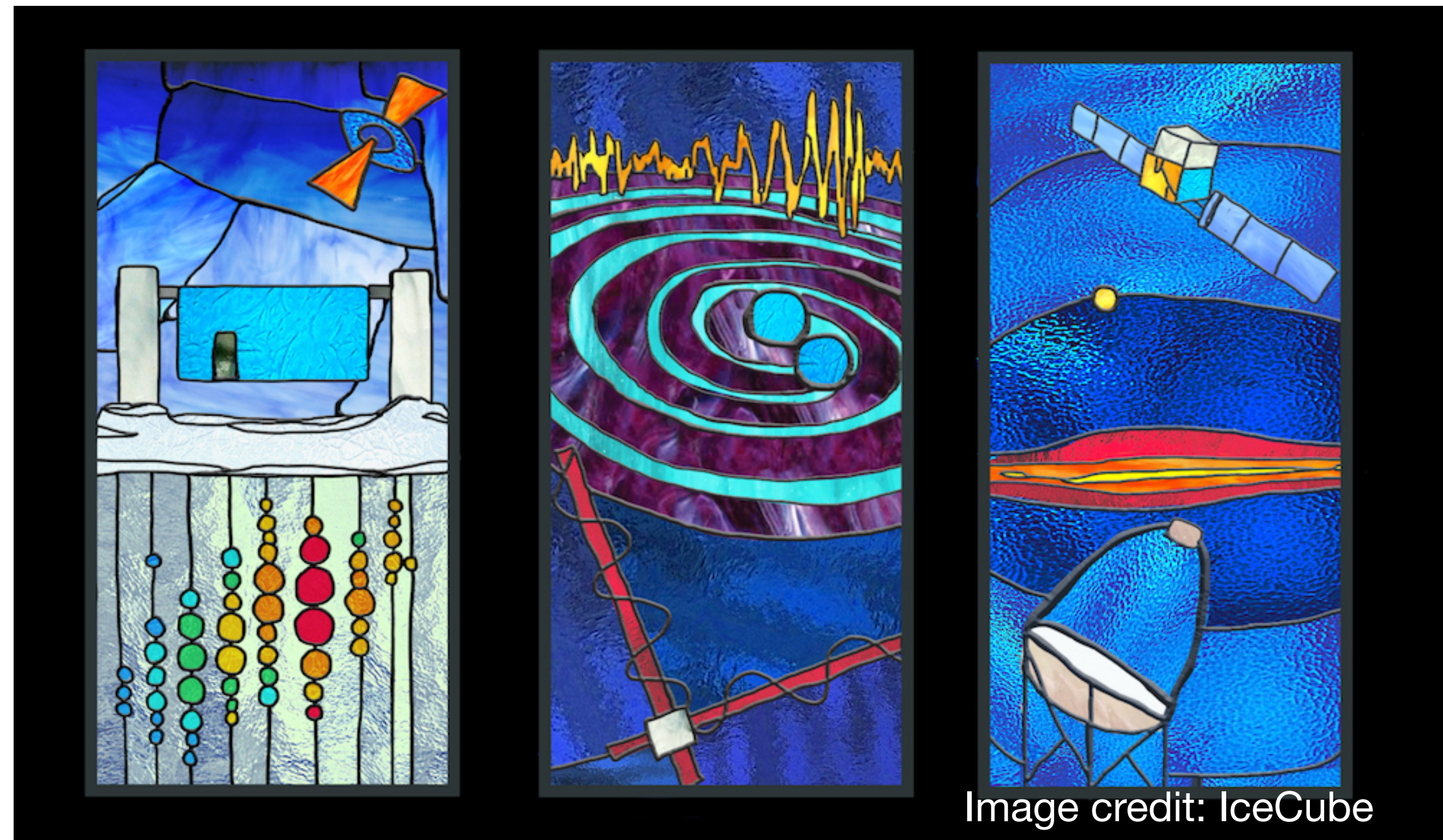
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## Past Activities

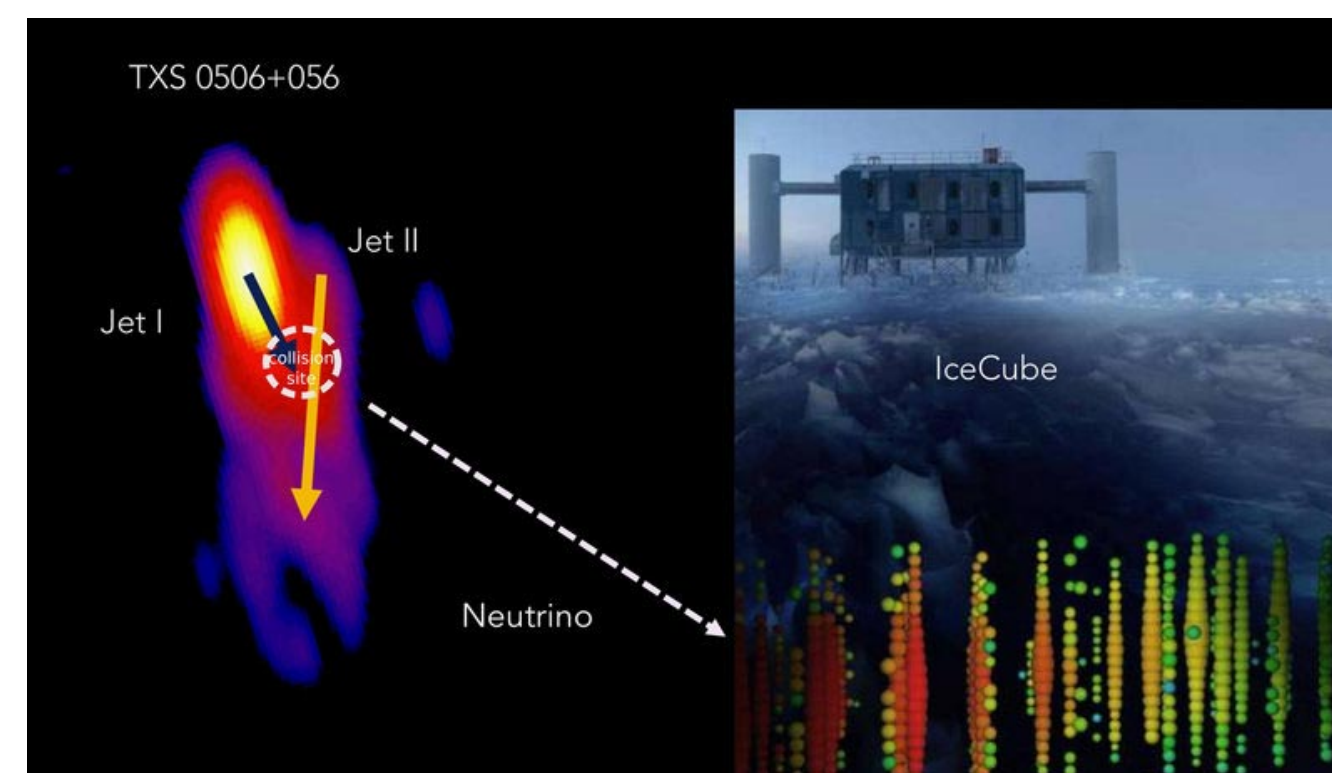
- **Town Halls** [Link to slides and recordings](#)

1. Jul 21, 2020
2. Jul 30, 2020
3. Nov 13, 2020

- **Community planning meetings** Oct 5-9, 2020 [Link to Indico](#)

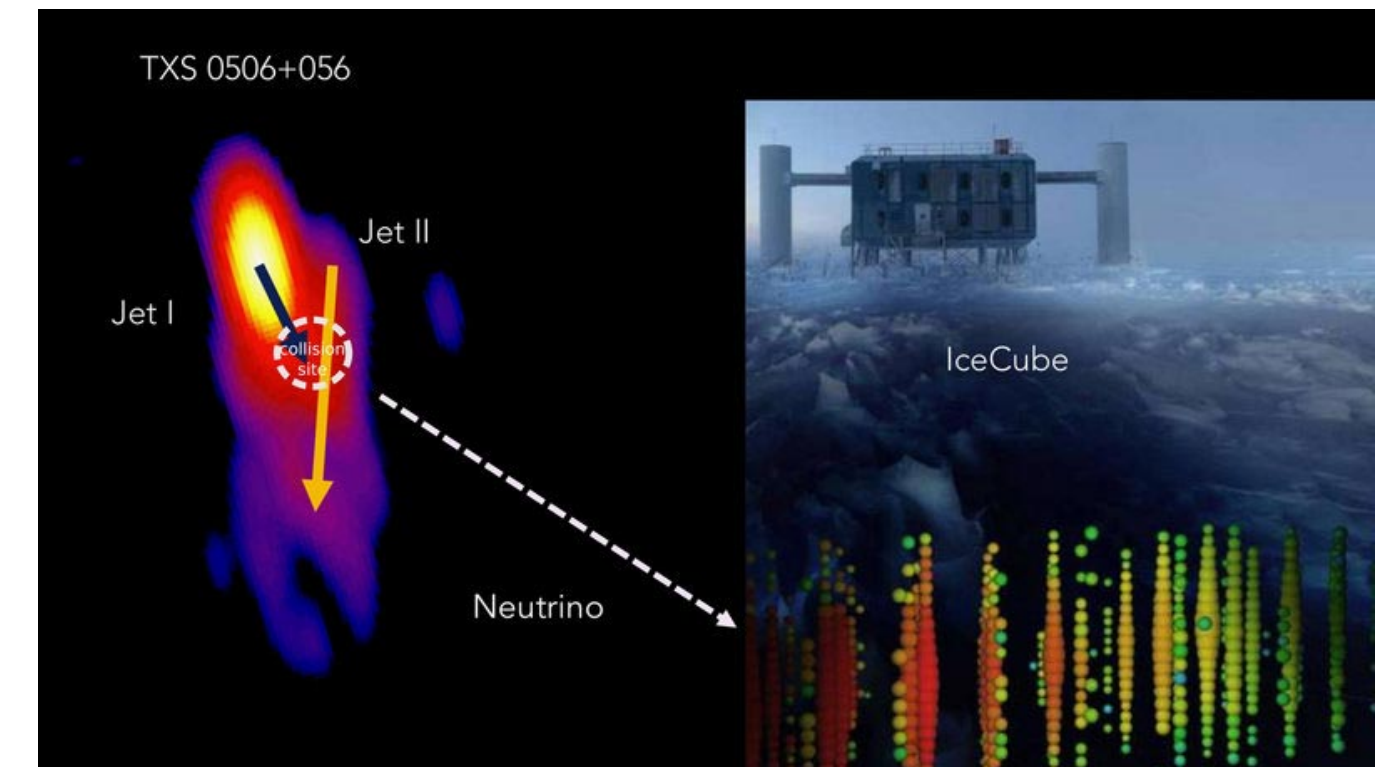
- 74 Primordial black holes
- 137 High and ultrahigh energy neutrino experiments
- 138 Synergy of astro-particle physics and collider physics
- 140 Future medium to ultrahigh energy gamma-ray detectors
- 141 Gravitational wave source modeling
- 148 Future GW facilities

+ other CF/TF-led sessions



# Past Activities-Continued

- **New for Snowmass 2021/2022:**
  - Major Science Accomplishments since the last Snowmass: discovered astrophysical neutrinos and gravitational waves, their electromagnetic counterparts, a large scale anisotropy in ultrahigh energy cosmic ray sky, evidence for a tension between inferred and measured values of Hubble constant
- **LOIs:** received 140 LOIs in total, 71 with CF7 as a main topic (Dec 2020)
  - By messengers: 30, 22, 35, 45 on Gravitational waves, Cosmic rays, Neutrinos, Photons (including ~15 on cosmology, ~25 on gamma-rays)
  - By type of work: 32 focusing on theory, the rest on experiments and detectors
- To be restarted in Sep 2021



# Proposed Community White Papers

1. **Multi-messenger facilities and experiments** - umbrella paper that incorporates the GW, gamma-ray, cosmic rays and neutrino white papers; joint analysis; multi-messenger follow-up

2. **Equation of state of high-density matter and QCD phase transitions** - led by CF7

3. **Fundamental physics and beyond the Standard Model**: Tests of general relativity, the nature of black holes, exotic objects (gravastars, boson stars, fuzz balls, etc.), Scalar GWs

4. **Cosmology**: (joint with CF3, CF1 & ?) - 3 papers

(A) Paper 1 - probing the dark sector multi-messengers: dark matter, dark energy

(B) Paper 2 - beyond the standard model: dark photons, ultra-light bosons, axions, primordial black holes, sterile neutrinos, etc.

(C) Paper 3 - Phase transitions in the early Universe

I. Complementarity between collider and GW signatures of first order electroweak phase transitions

II. Probing Fundamental Physics using the Stochastic Gravitational Wave Background from the Early Universe

III. Correlating Stochastic Gravitational Wave Background with Electromagnetic Observations

## Proposed Community White Papers - Continued

5. **Gamma-ray experiments** (joint with CF6, CF1-3, IF, TF?) - umbrella paper of different techniques, science, come up with some benchmarks across experiments
6. **High-energy and ultrahigh energy neutrinos** ( joint with NF4, NF10, TF11, IF10?) - umbrella paper of different experiments + theory
7. **GW facilities paper** - umbrella paper across all techniques - benchmarks
8. **Ultrahigh-energy Cosmic Rays** - umbrella paper
9. Synergy between astroparticle and collider physics (led by EF)
10. **Modeling gravitational wave sources** (jointly with TF4)

More information (related LOIs, contacts, etc) can be found in [this link](#)

**Your participation is welcome!**