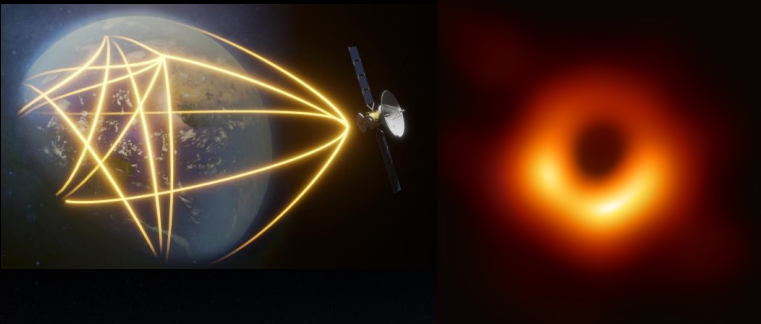




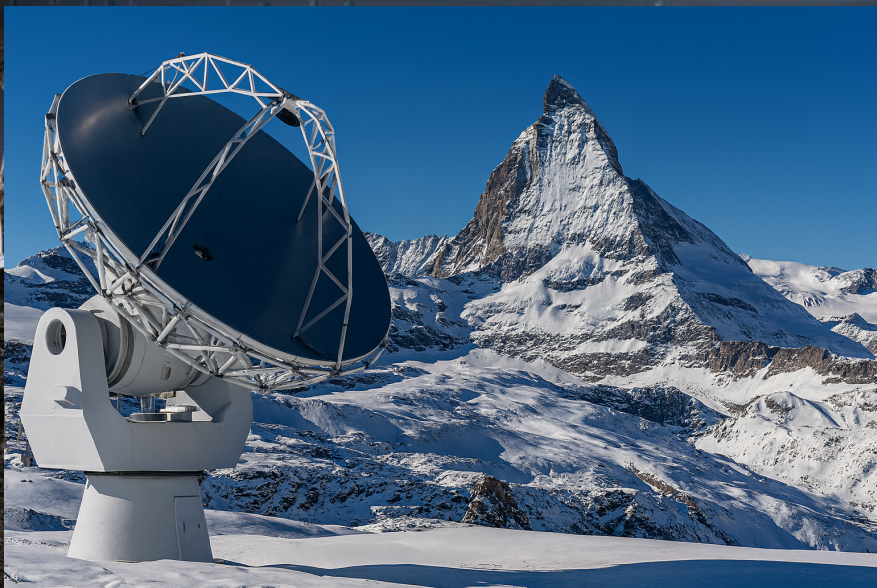
Synchronizing the Universe

Global Future Projects in Radio Astronomy

Chin-Shin Chang

Data Manager, Event Horizon Telescope Collaboration
Science Delivery Coordinator, SKAO/SRCNet

Swiss SKA days, Neuchatel, 2026-09-01



UNIVERSITÉ
DE GENÈVE

SKACH





Precision timing transforms telescopes separated by continents and space into one large instrument



Making this possible depends on our ability to preserve the amplitude and phase of extraordinarily faint signals while maintaining frequency stability and time precision across vast distances.

- e.g. SKA, ALMA, VLA
- A central reference (e.g. hydrogen maser) generates a highly stable frequency, which is distributed to every antenna via optical fiber
- Maintain coherence with all other antennas



- e.g. EHT, GMVA, EVN, VLBA
- Frequency reference is independent at every station
- Data recorded locally
- Hydrogen maser needed at each site

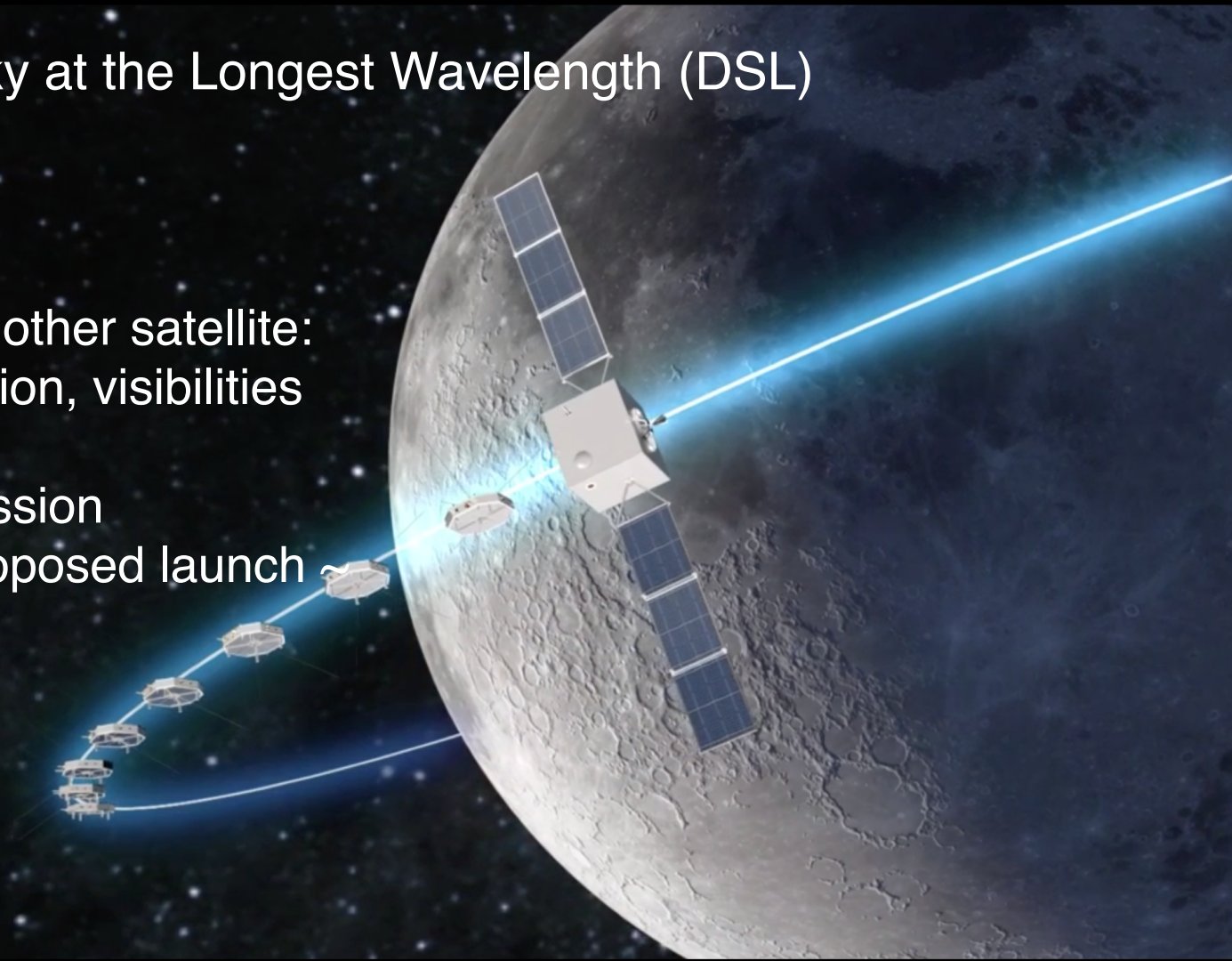


Future Radio Projects

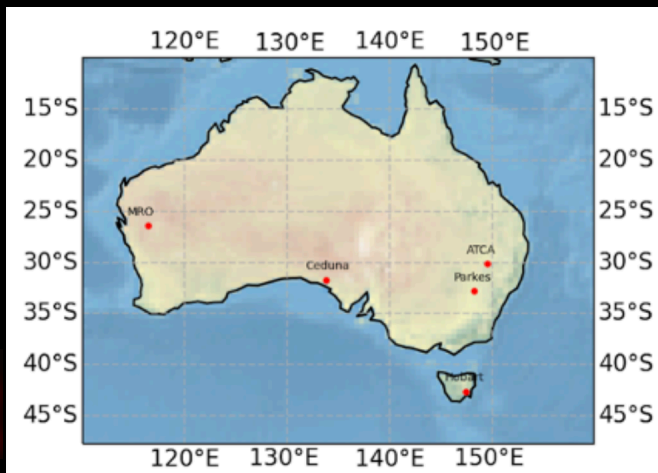


Discovering the Sky at the Longest Wavelength (DSL)

- 0.1 - 30 MHz
- Moon orbit
- 8 daughter + 1 mother satellite:
real-time correlation, visibilities
sent to earth
- Status: under mission
development, proposed launch
2030



- Same antennas & station layout as SKA-Low
- 4-6 stations @ LBA sites
- 2024-2025: System demonstrator & deployment
- 2026+: Consortium funding, science case



SKA^{CH} Hydrogen Intensity and Real-time Analysis eXperiment (HIRAX)



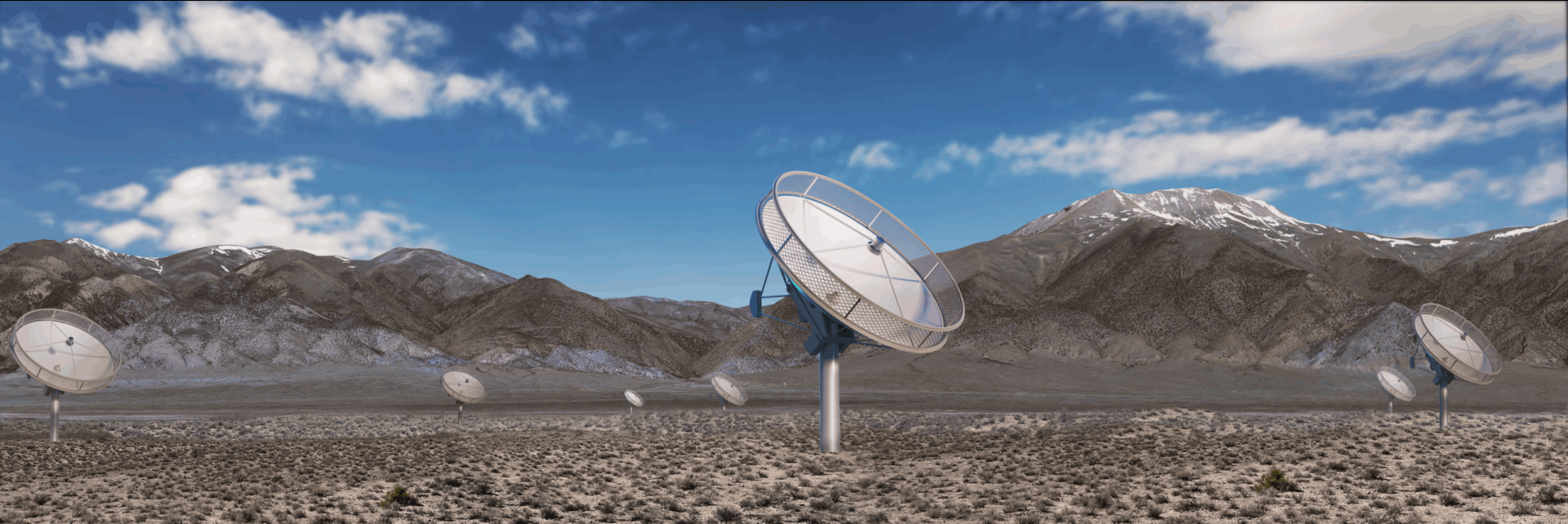
- South Africa
- 1026 6m dish
- 400 - 800 MHz (2.5-6.5 byr old Universe)
- 2026: first light
- Continue to build toward 256 dishes





Deep Synoptic Array (DSP)

- Nevada, USA
- 0.7 - 2 GHz, 1650 x 6.15 m dishes
- Full construction authorized June 2026
- Target completion: 2029



FAST Core Array



SKACH FAST Core Array

- Guizhou, China
- 24 x 40m antenna extending within 5km
- 0.35 - 10 GHz
- 2027: Early science

FAST



Event Horizon Telescope



UNIVERSITÉ
DE GENÈVE

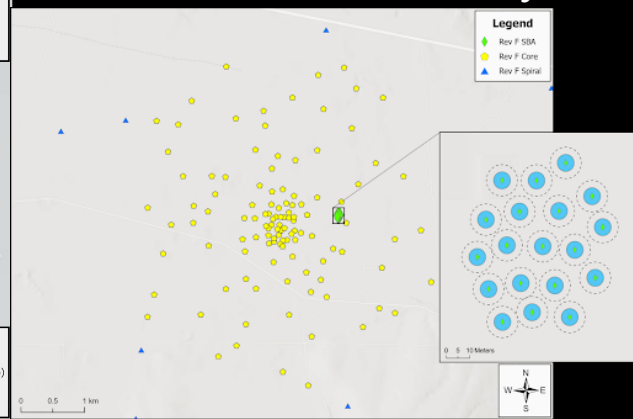
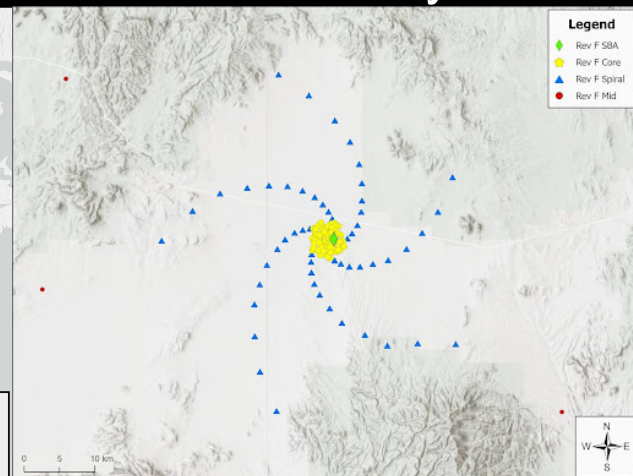
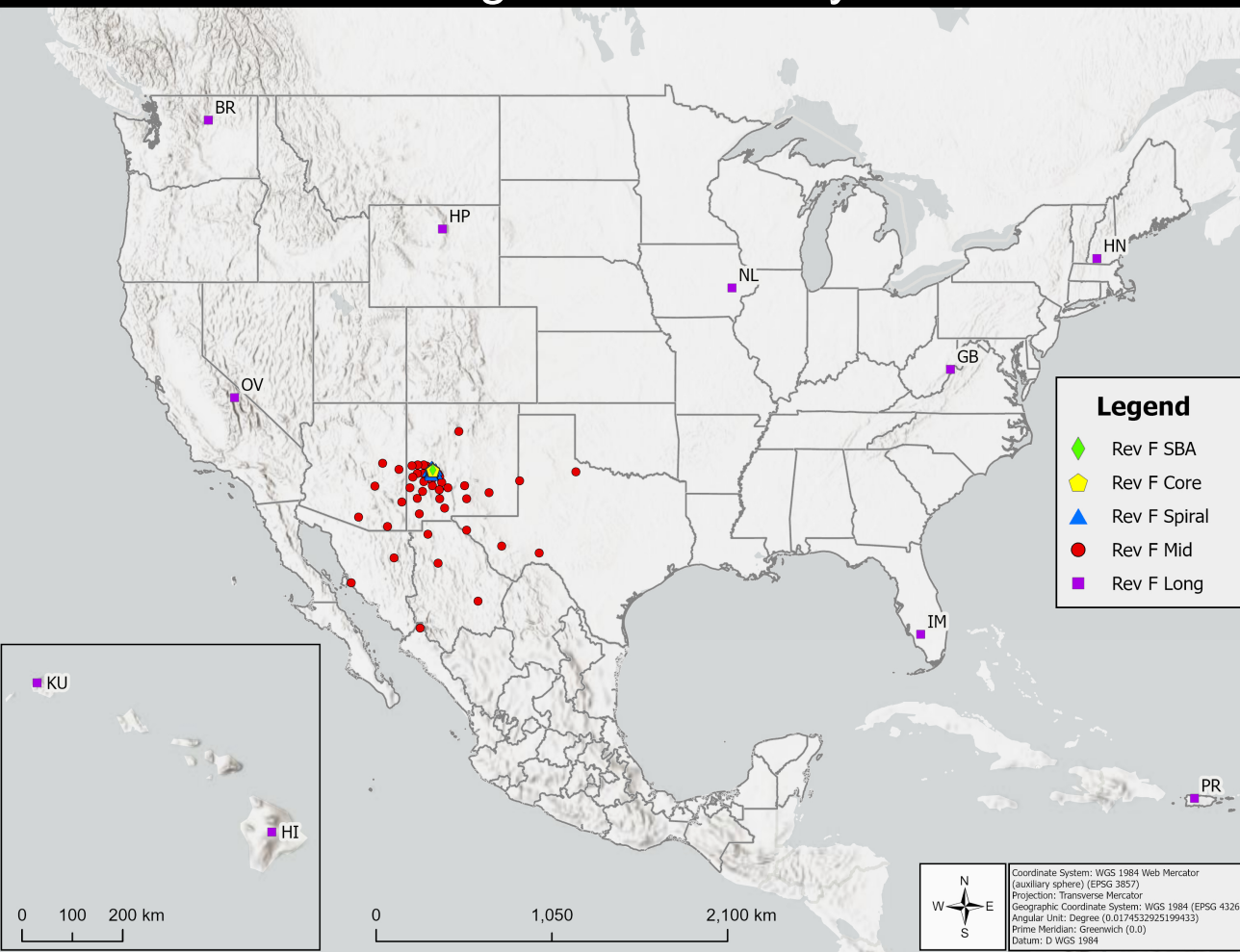
Qitai Radio Telescope (QTT)

- Xinjiang, China
- Steerable 110m dish
- 1.5 - 115 GHz



- 244 x 18m + 19 x 6m antennas
- 1.2 - 116 GHz
- 10 x sensitivity/resolution of the VLA
- Late 2020s:
 - ngVLA pathfinder (Long baseline elements)
 - possible start of array construction







- German Alps near Schneefernerhaus
- 18m dish, 1.2 - 120 GHz
- ngVLA antenna design
- Construction: 2027-2029
- Early VLBI science: 2030~



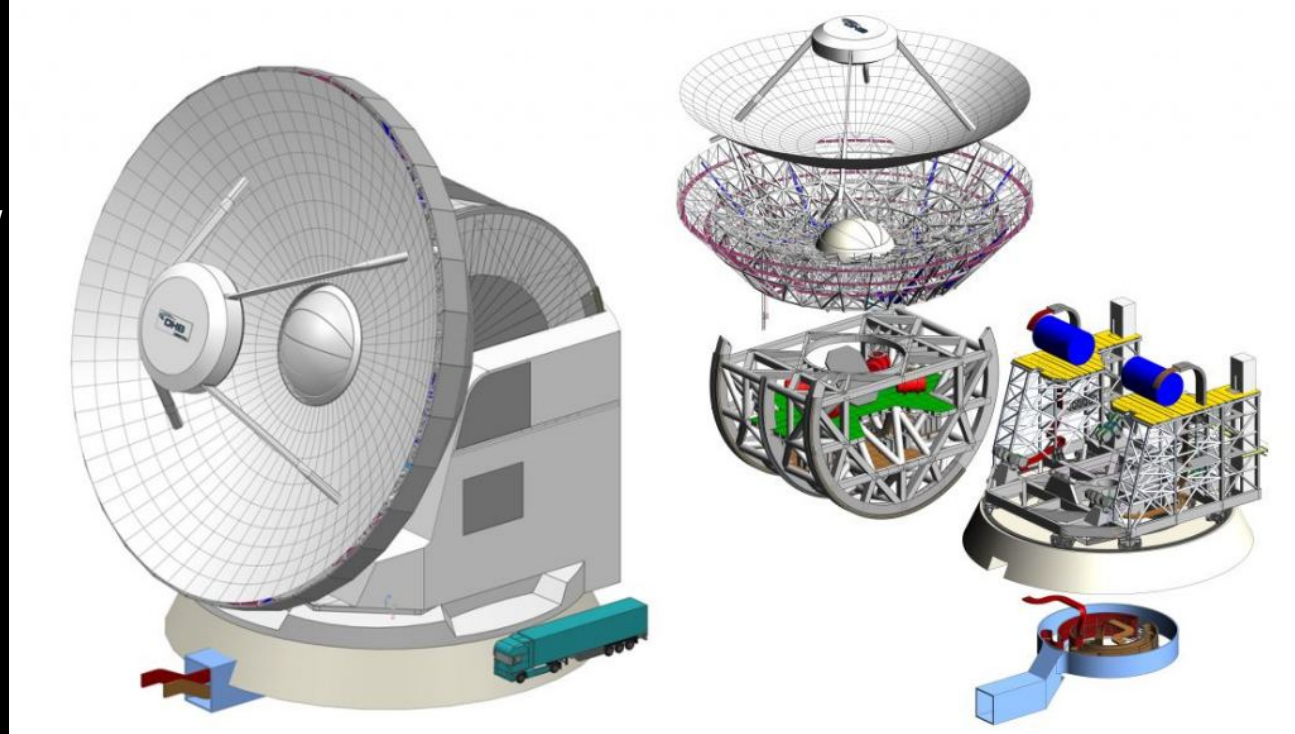
- Probing the cold Universe (35-950 GHz)
- 4 x wider bandwidth, 2 x sensitivity
- Detecting fainter, more distant galaxies
- Detecting many molecules simultaneously
- Accelerating studies of the first dusty galaxies and the gas/chemistry where planets form



- Design the next generation mm observatory
- White paper deadline Sep. 20, 2026
- Possibility: many new antennas, baseline extension, etc.
- Challenges: distribute an extremely stable frequency reference over much longer fiber length (16km $\rightarrow$ 50+km)

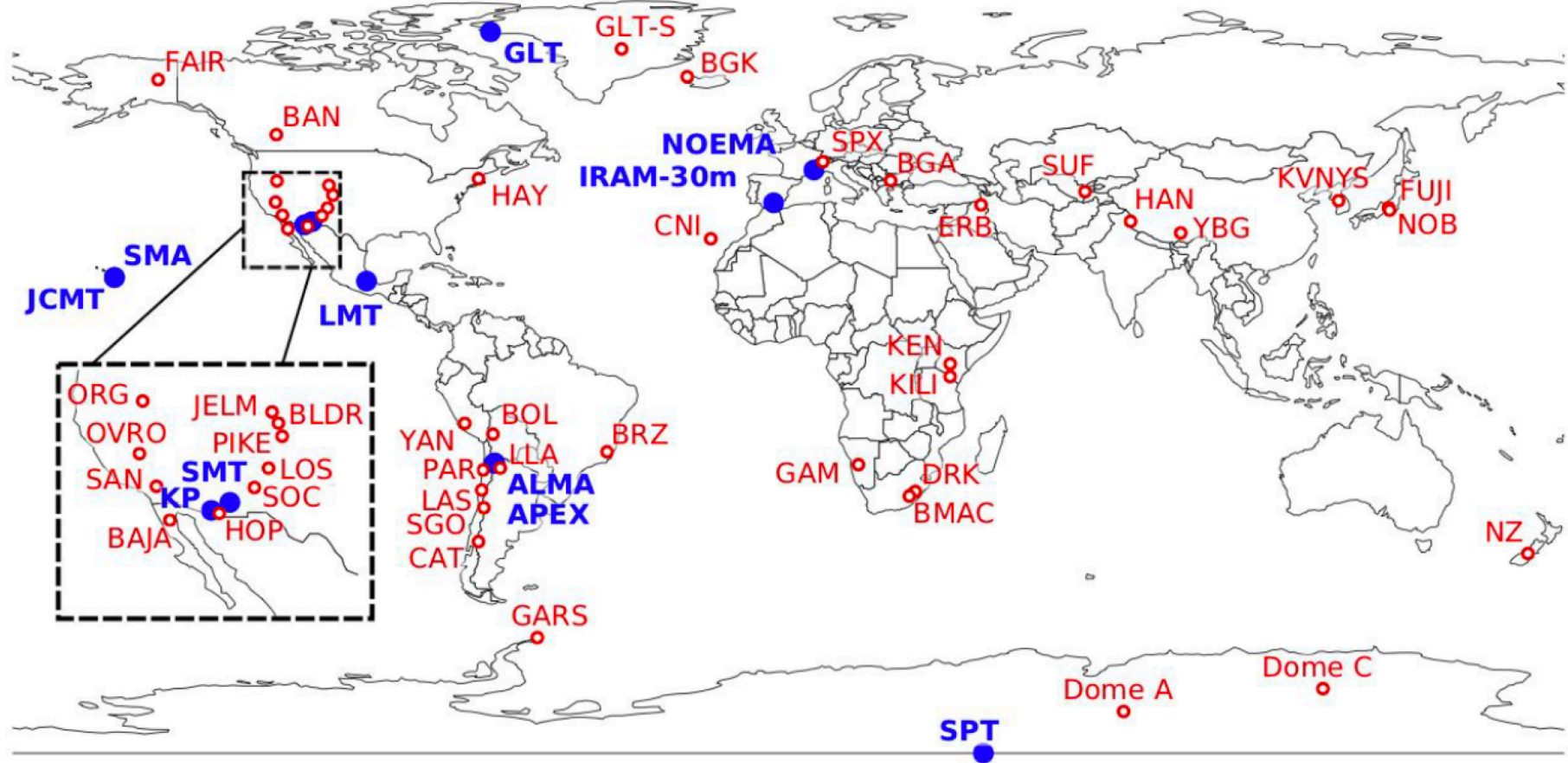


- 30 - 950 GHz
- 10kms from ALMA
- 50m dish
- Preliminary design review by mid-2028 (target)
- 2030: potential construction subject to funding status





- 15m, 86 - 500 GHz
- Located at 5000m plateau in Western China
- Target completion: 2027
- Long term vision: ALMA-like millimeter array

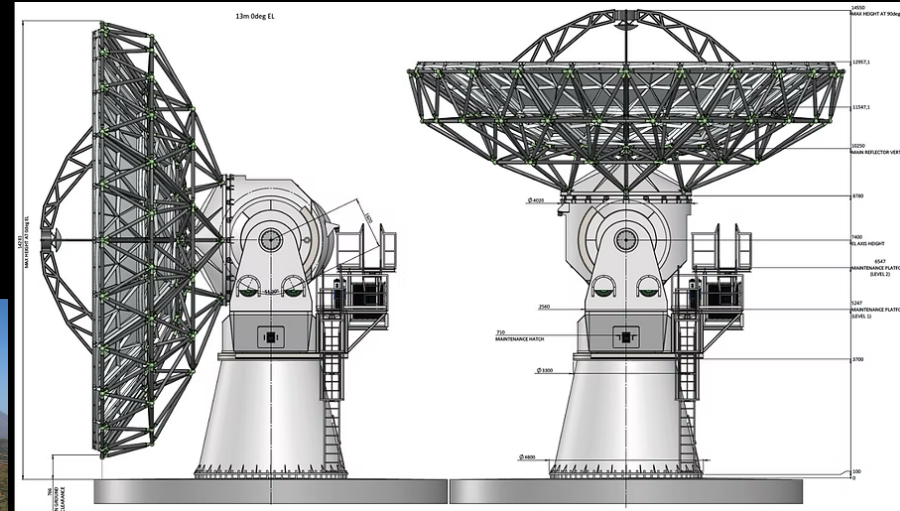


- ngEHT project
- Kilimanjaro Saddle, Tanzania
- 2026: site monitoring and preliminary study



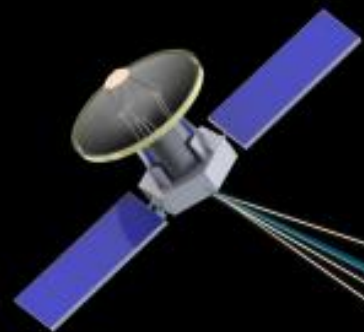


- 86, 230, 345 GHz, 13m dish
- Funding secured, ready to build



- Khomas Highlands, Namibia
- 35 - 373 GHz, 14m
- 2026-2027: construction
- 2028: first light





Ground Only

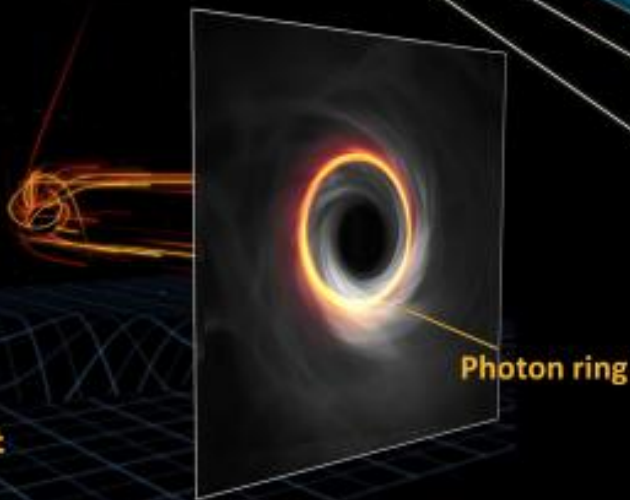


Ground + Space

Black Hole Explorer (BHEX)

Proposal under
submission to NASA

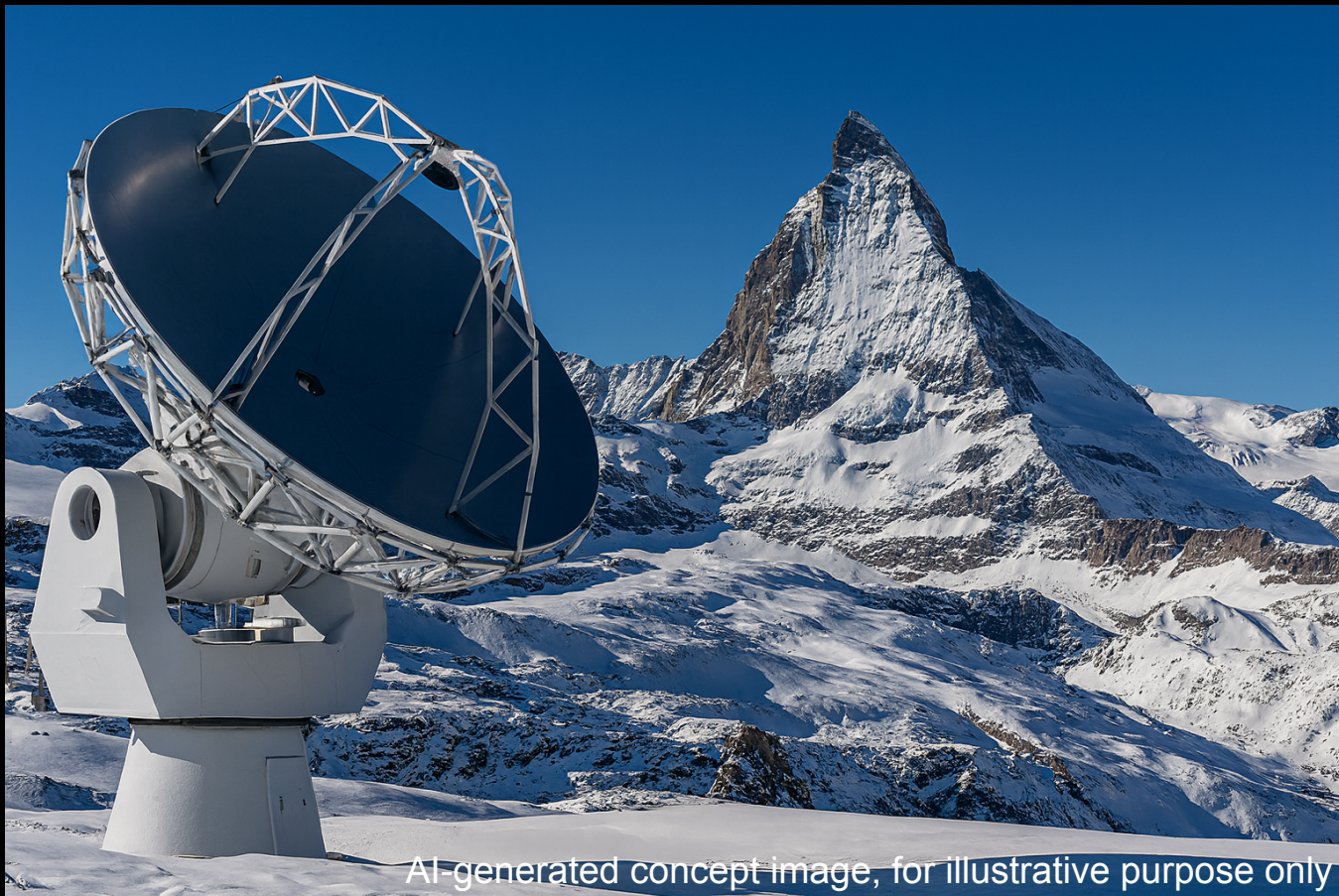
Space-Ground Baselines (3x Longer than EHT)
High-Speed Laser Downlink (100 Gb/s)



Orbiting Light
Direct Light



UNIVERSITÉ
DE GENÈVE



AI-generated concept image, for illustrative purpose only

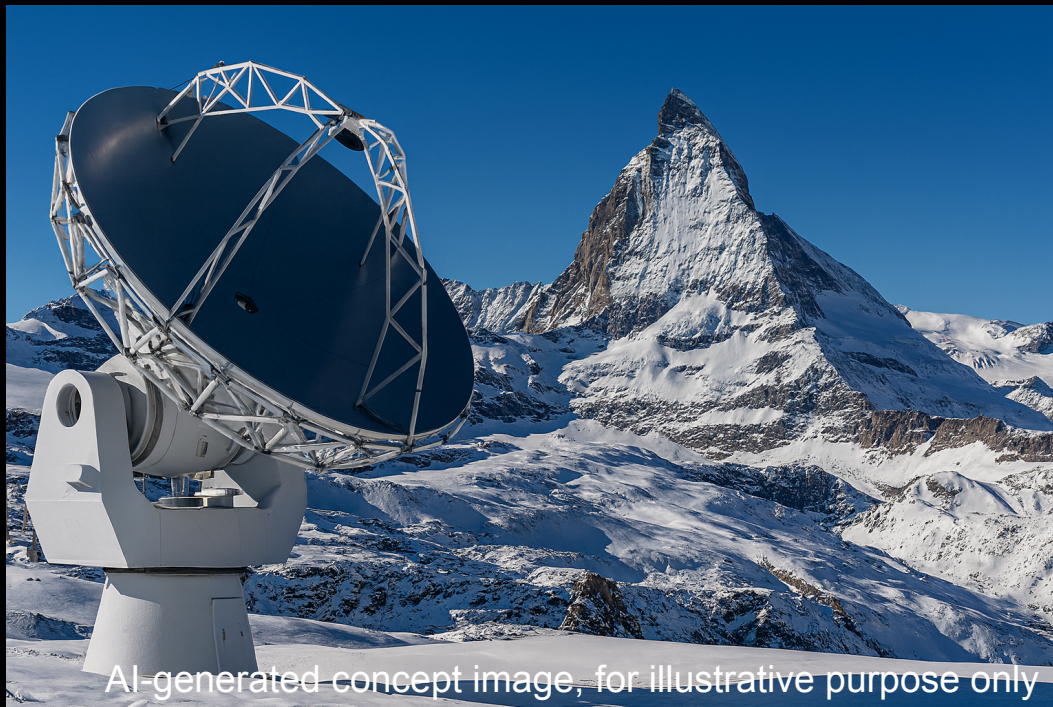


Final phase of land permission, looking for funding and collaboration to built

Candidate site next to the Gornergrat railway station



Swiss Millimeter Telescope workshop: Oct. 12-13, Sion



Thank you!

Chin-Shin.Chang@unige.ch

