



Fred Young Submillimeter Telescope @ SA3CC

Mike Nolta, FYST Software Lead
CITA & SciNet, University of Toronto
2022 April 19

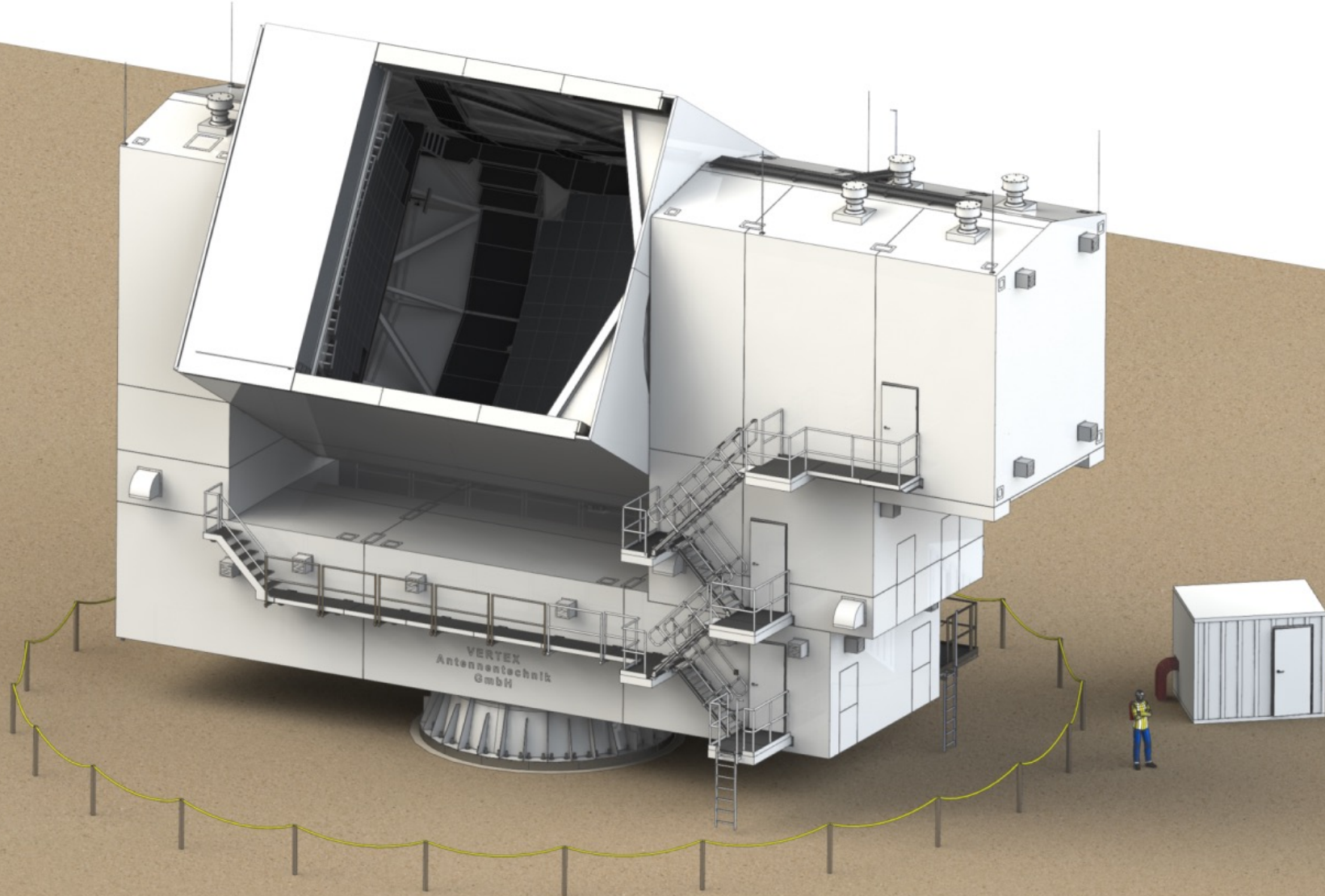
Who we are

- Formerly known as CCAT-prime.
- Led by Cornell University, with Arizona State University, Cardiff University, NIST, University of Chicago, University of Pennsylvania help on Prime-Cam
- German consortium led by University of Cologne:
 - Cologne, Bonn, Max Planck Inst. for Astrophysics
- CATC (Canadian Atacama Telescope Corp.)
 - Canadian consortium led by University of Waterloo
 - Waterloo, Toronto, British Columbia, Calgary, Dalhousie, McGill, McMaster, Western Ontario
 - CATC “observers”/partners: St. Mary’s, Manitoba, Lethbridge, Alberta, National Research Council
- Chilean Universities: Universidad de Chile, UCSC, PUC

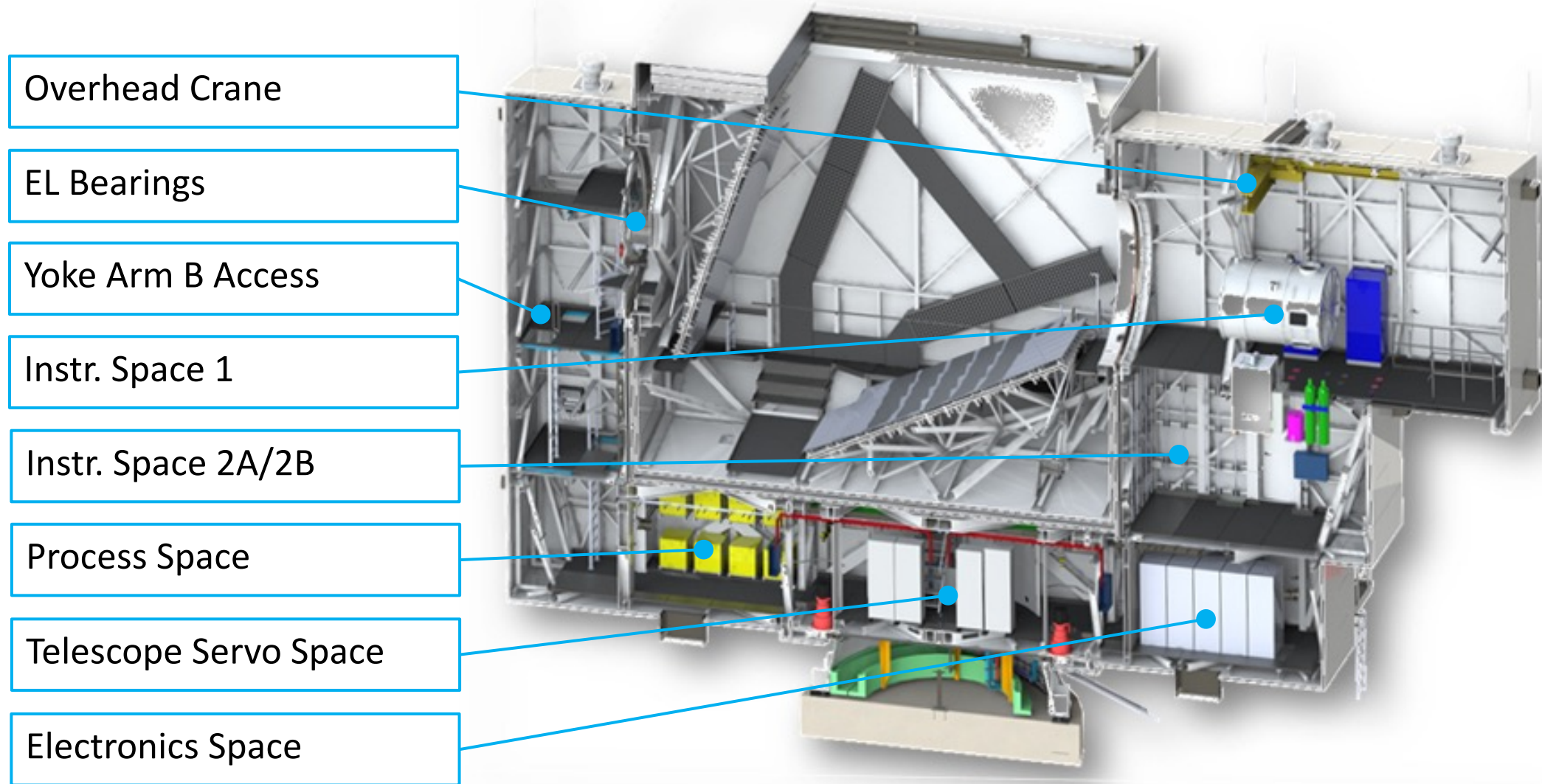
What we're up to

- FYST will be the highest throughput sub-mm telescope ever built:
 - Frequency range 210-850 GHz (350 μm)
 - 6m diameter mirrors, cross-Dragone design
 - High surface accuracy ($\sim 8 \mu\text{m}$)
 - Large field of view (8 deg at 3 mm)
 - Precise pointing (error $< 1.4''$)
- Located on Cerro Chajnantor, near ALMA. Best site for 350 μm in the world.
- Expected first-light mid 2024.
- $\sim 3\text{-}8$ TB/day.

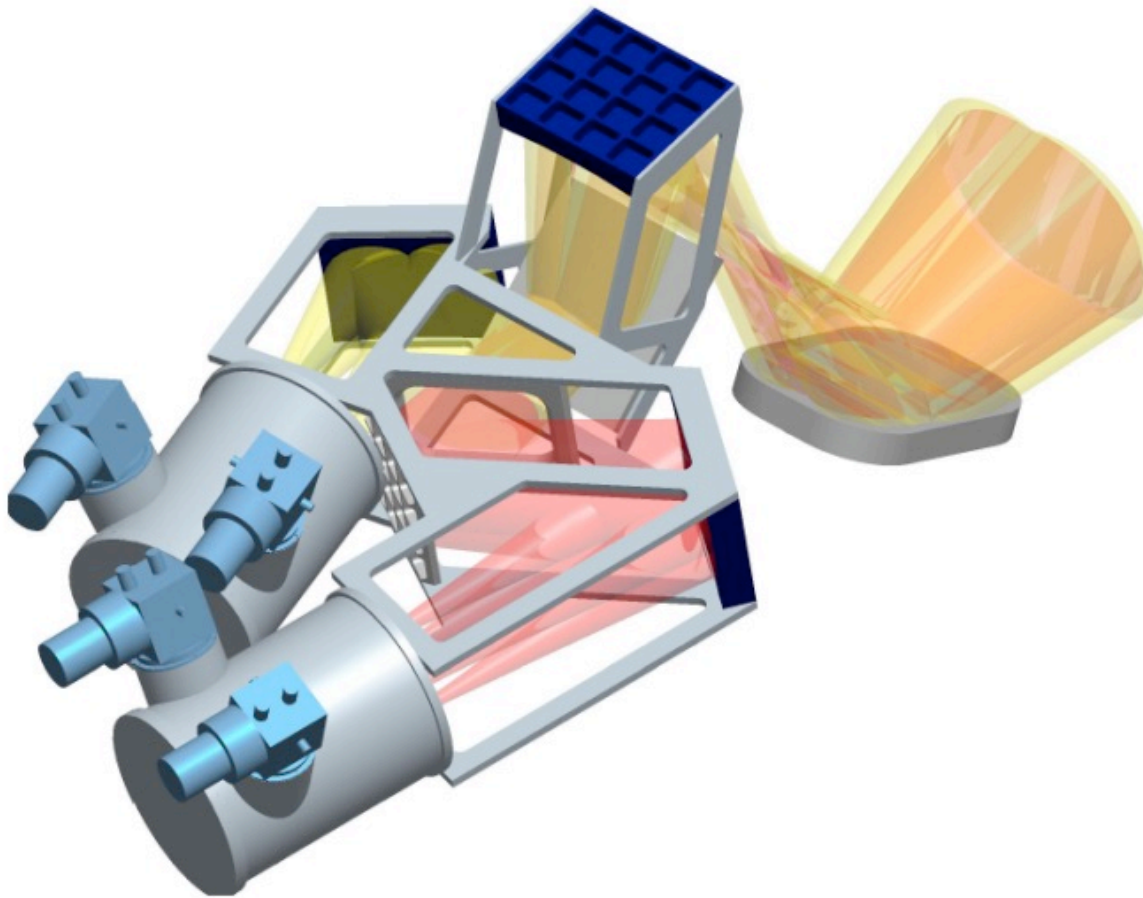




Telescope cross-section



First-light instrument: CHAI

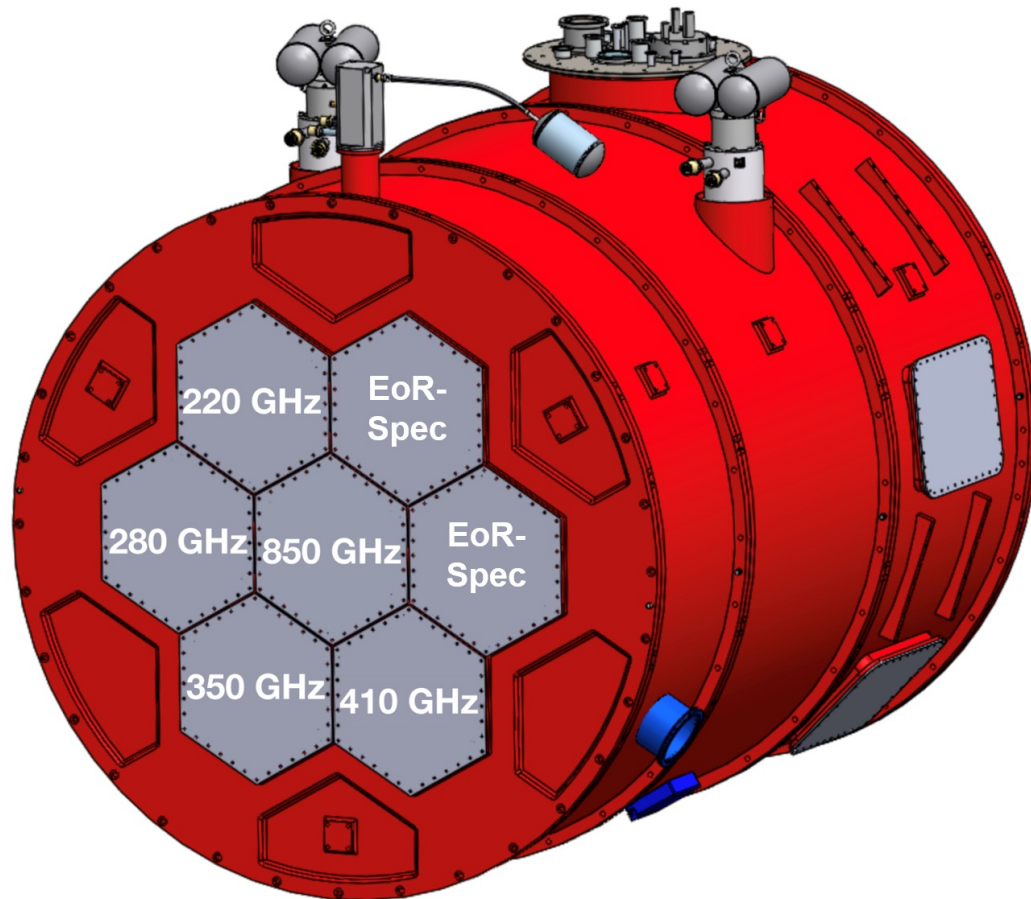


- Multi-pixel heterodyne spectrometer
- 2 frequency bands, 455-495/800-820 GHz
- 128 pixels each band
- Angular resolution 26/15 arcsec (FWHM)
- Spectral resolution 0.06/0.04 km/s
- [CI], [NII], CO line mapping

CHAI Surveys

- Galactic Ecology project (GEco):
 - Galactic mid-plane
 - Nearby molecular clouds (typically out of plane)
 - Magellanic clouds & nearby galaxies
- Science:
 - Cloud structure formation
 - Star formation
 - Microphysics & chemistry of the interstellar medium

First-light instrument: Prime-Cam

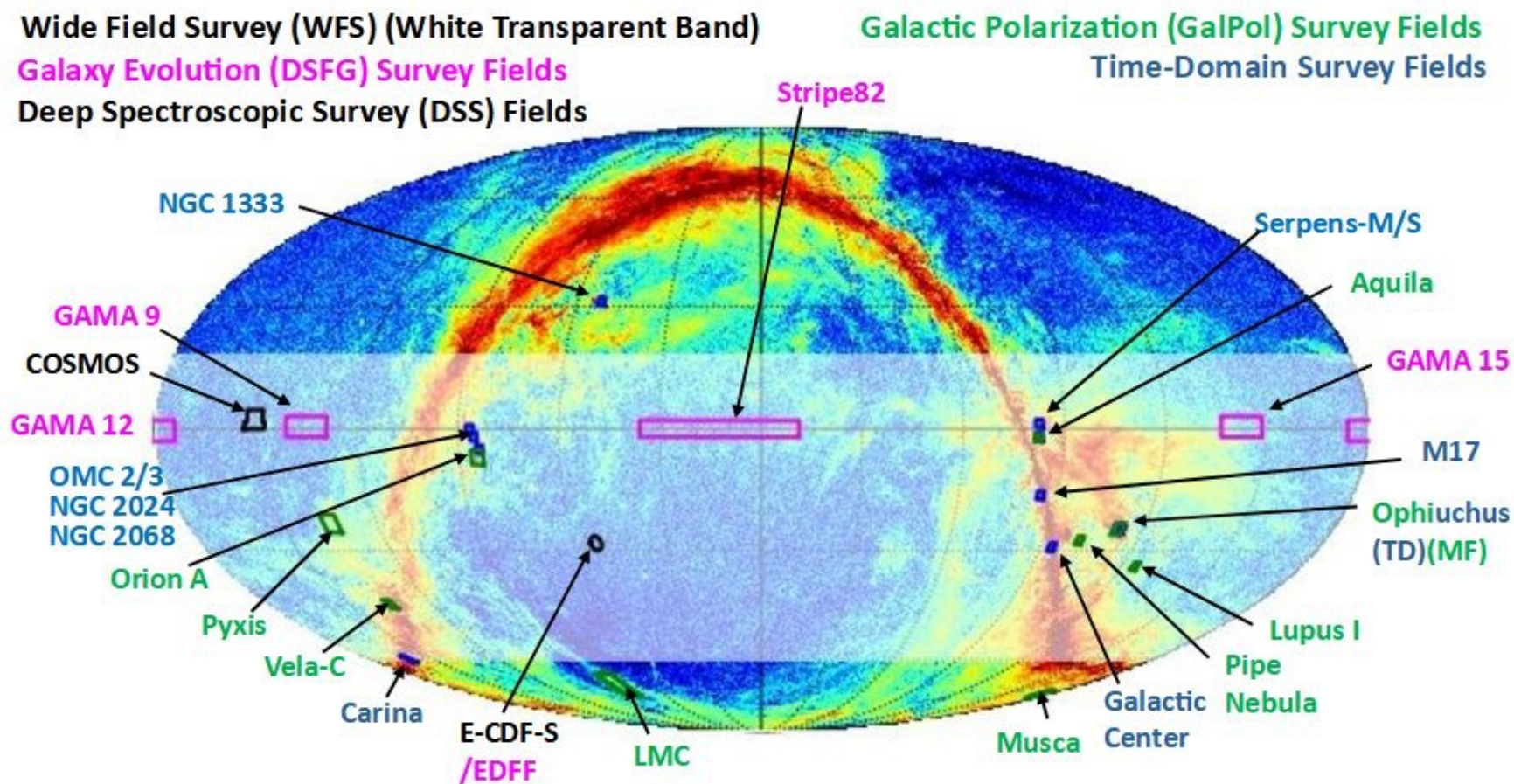


- 7 optics tubes, each tube with a field of view of ~ 1.3 deg
- Cooled to 100mK in a 1.8m diameter cryostat
- 5 broadband polarimeter camera modules: 220-850 GHz, 59-15 arcsec beam, 7-20k pixels
- 2 spectrometers: 220-410 GHz, 58-33 arcsec beam, 6k pixels each

Prime-Cam science goals

- Epoch of reionization (first stars)
- Tracing galaxy evolution
- Characterizing CMB foregrounds
- Galactic magnetic fields
- Galaxy clusters (SZ)
- Rayleigh scattering
- Time-domain phenomena

Prime-Cam surveys



First light instrument: Mod-Cam

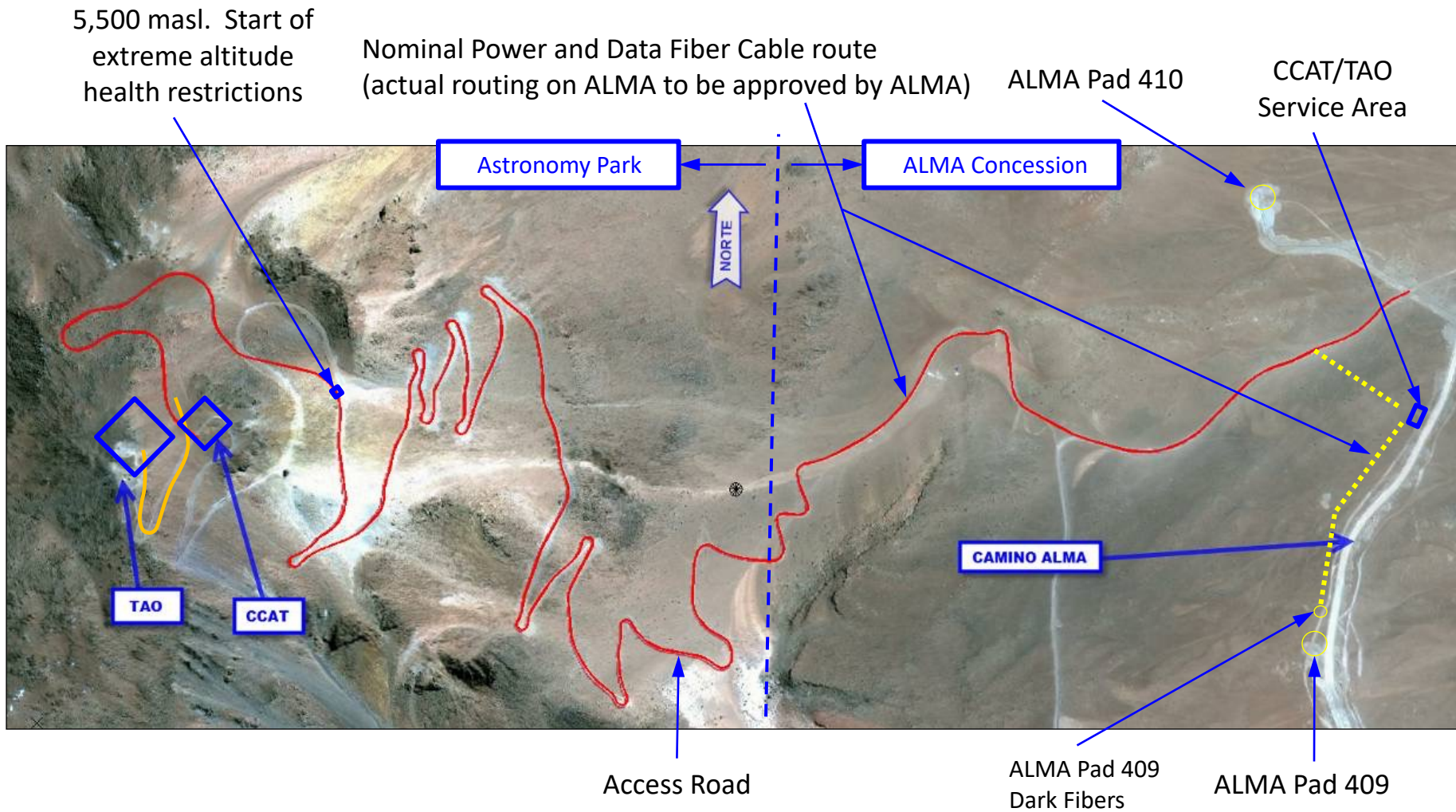


- Scaled down version of Prime-Cam, holding a single optics tube.
- First cooldowns completed, $>400\mu\text{W}$ cooling at 100mK.
- Will ship to Chile w/ 280Ghz module if Prime-Cam not ready in 2023.

FYST is at extreme altitude

- FYST is located on the eastern slope of Cerro Chajnantor, at 5612m.
- 36% lower PWV than the plateau, and up to 80% lower (inversion layer).
- Twice as good as the plateau or South Pole at 350 μ m.
- Chilean law changes at 5500m. Increased scrutiny and requirements above this height:
 - Hypobarica and extra medical tests required annually.
 - Region II Health SEREMI approves every company and receives reports on every individual worker.
- Fuel companies won't make regular deliveries at this altitude.
- So need to site our generators at a more accessible site, and trench power lines.

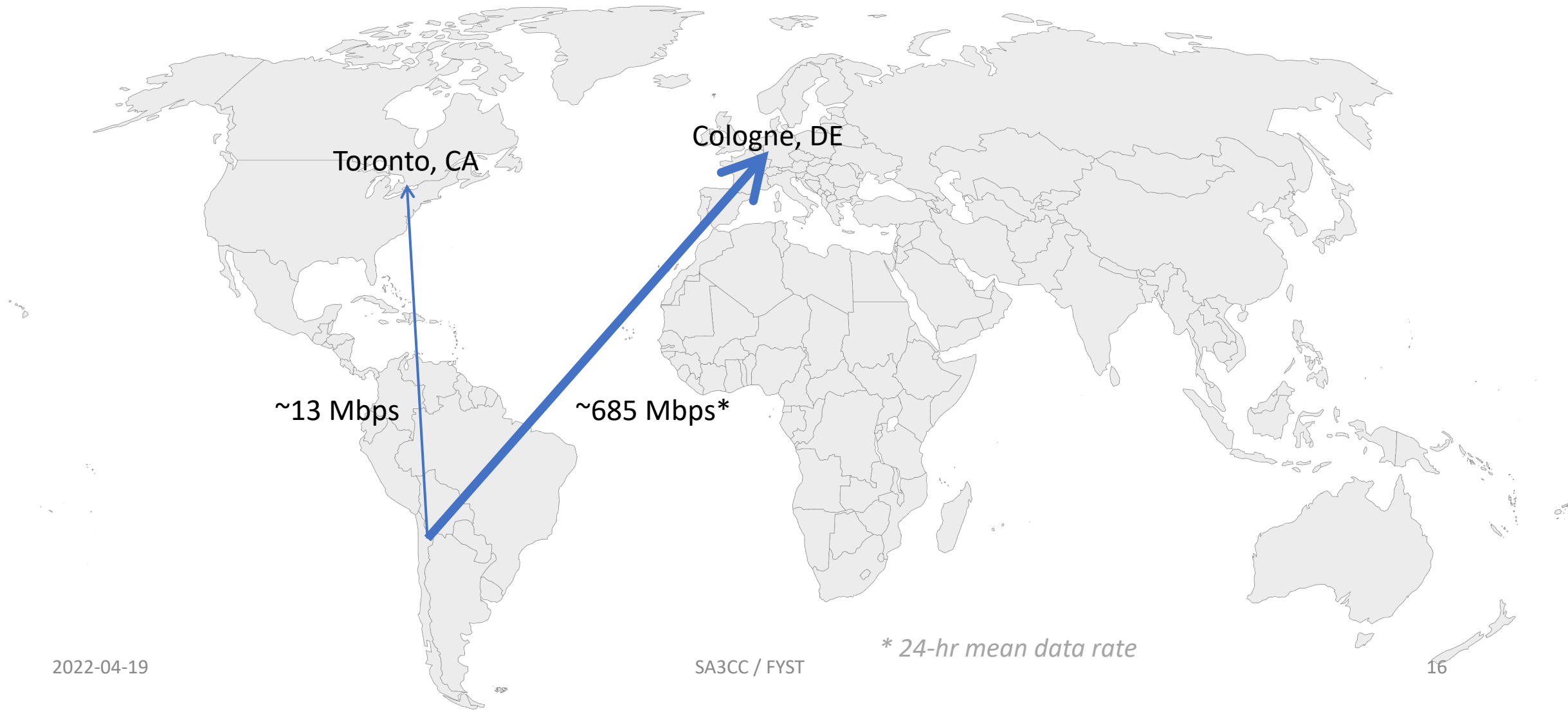
Site layout



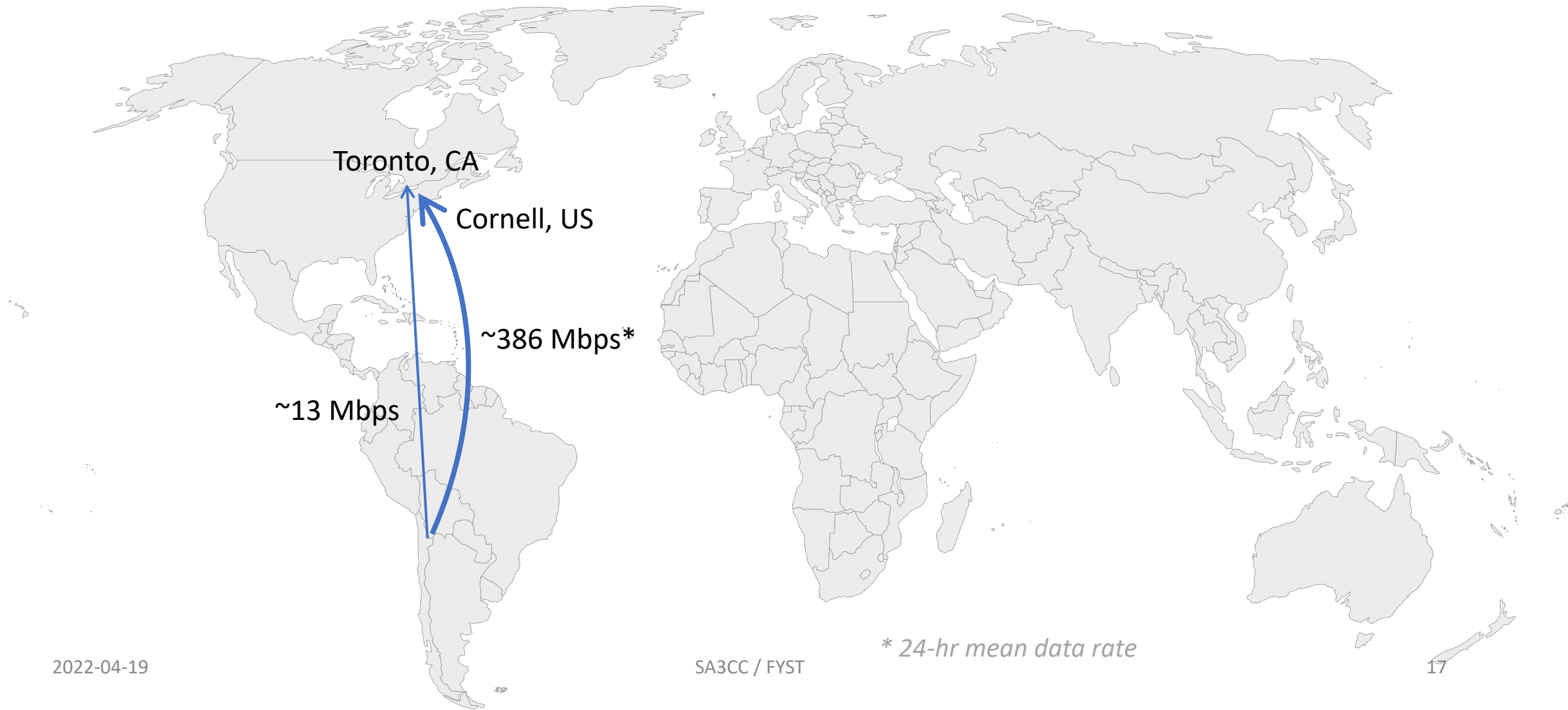
Fiber network plan

- Trenching power, so obviously install fiber at the same time.
- Service area is on ALMA property, near Pad 409.
- Signed agreement with ALMA to lend us a pair of their dark fibers to the AOS, connecting at Pad 409.
- Connect to REUNA PoP at ALMA.

Data rates during CHAI observing



Data rates during Prime-Cam observing



ALMA \leftrightarrow Toronto network bandwidth test

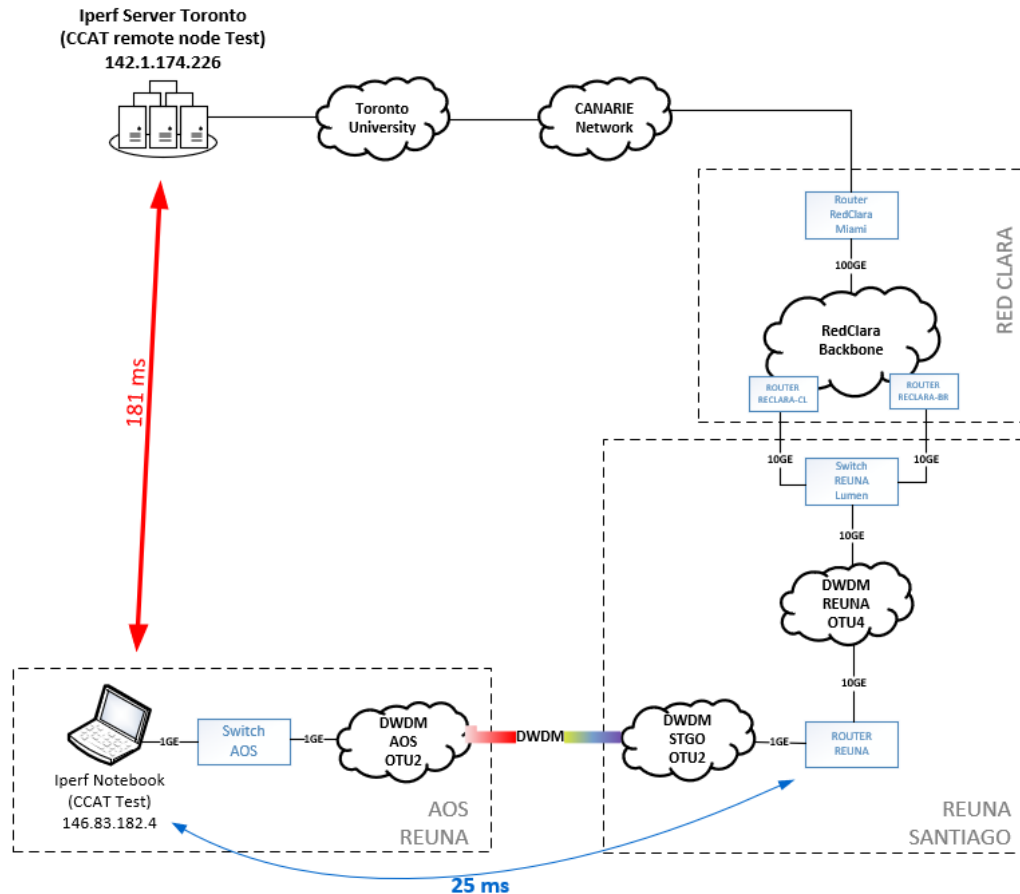
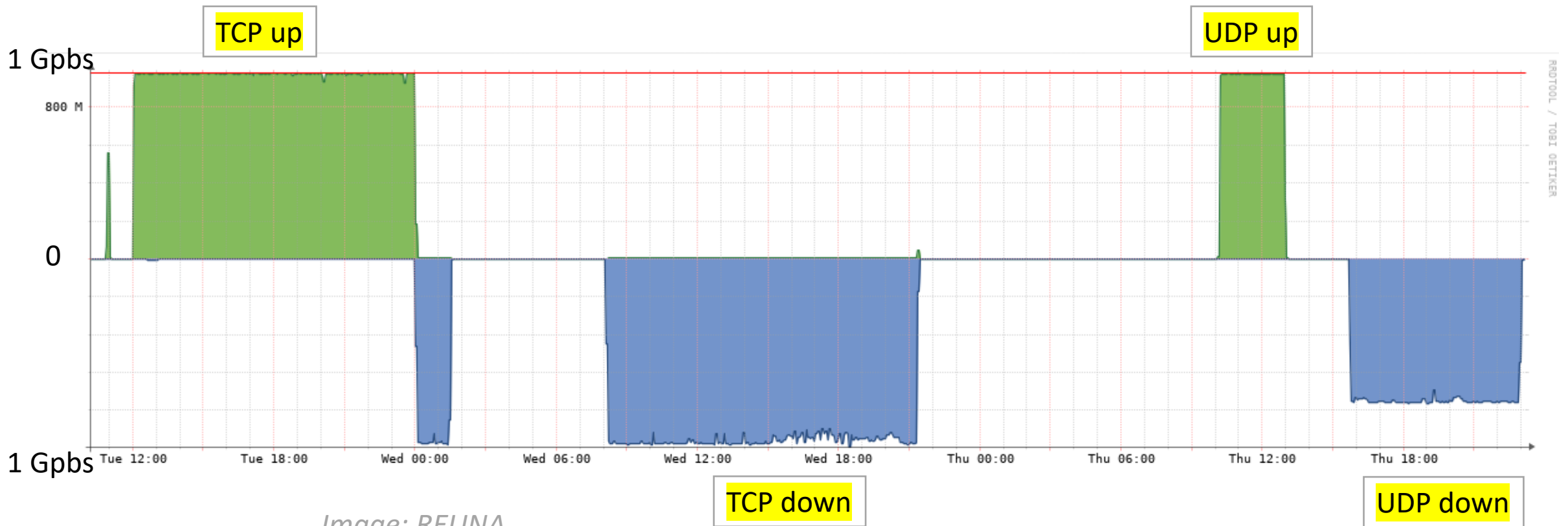


Image: REUNA

- ~12 hour iperf3 tests, Feb 22-24, by Sergio Cofre & Albert Astudillo (REUNA)
- AOS to SciNet:
 - 933 Mbps TCP
 - 951 Mbps UDP
- SciNet to AOS:
 - 917 Mbps TCP
 - 749 Mbps UDP
- UDP down test saw high packet loss.

ALMA↔Toronto network bandwidth test (2)



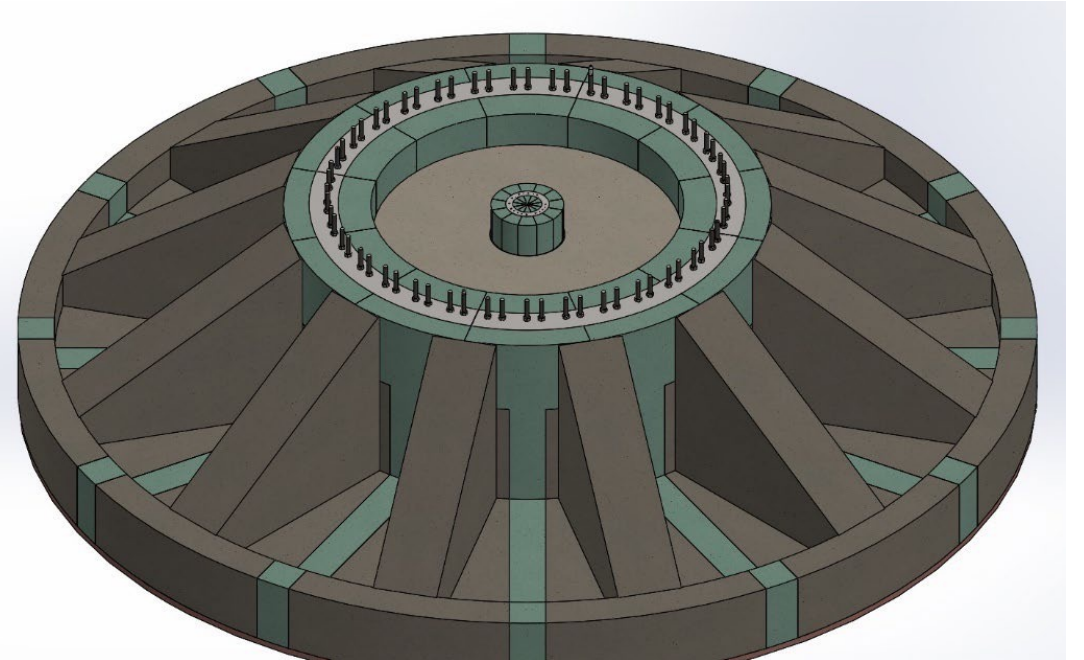
Summit has been leveled



Foundation hole dug



Foundation ready to be installed in May

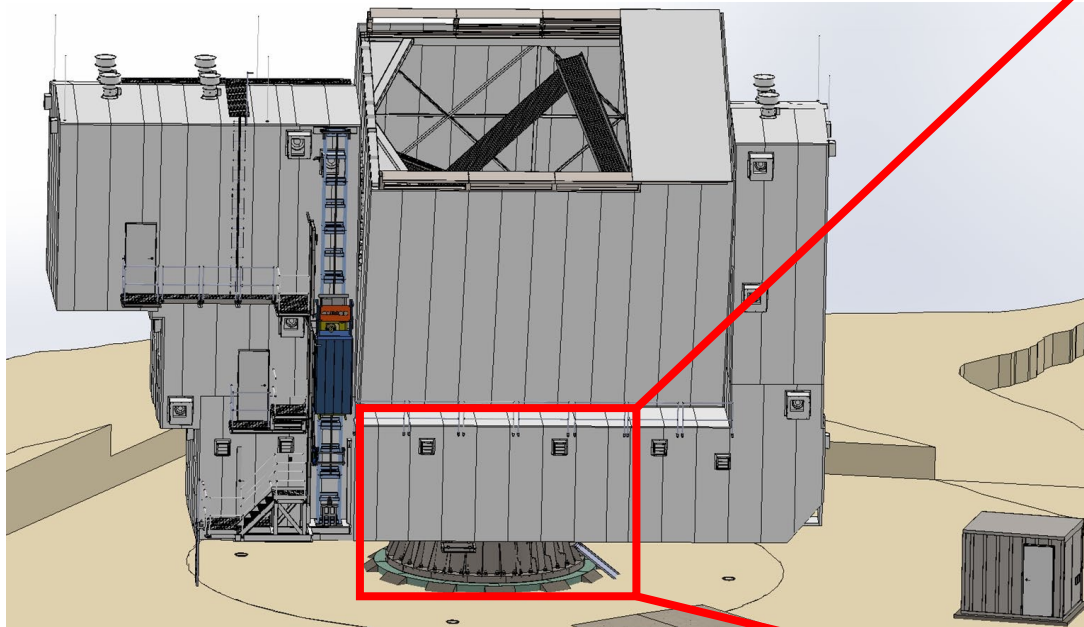


Trenching in progress



- ~9km trench from Pad 409 to summit, ~20% complete.
- First reels of 23kVA power line & optical fiber installed.
- Expect to finish by July.

Telescope being constructed in Germany



Schedule

- Telescope:
 - Assembled in Germany by November this year.
 - Ships to Chile 2023Q2.
 - Final acceptance 2024Q1.
- Instruments ship 2023Q4 (CHAI & likely Mod-Cam). Prime-Cam likely to ship in 2024.
- Science observations start late 2024Q3

