



# CCAT/FYST @ SA3CC

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2023 Aug 01

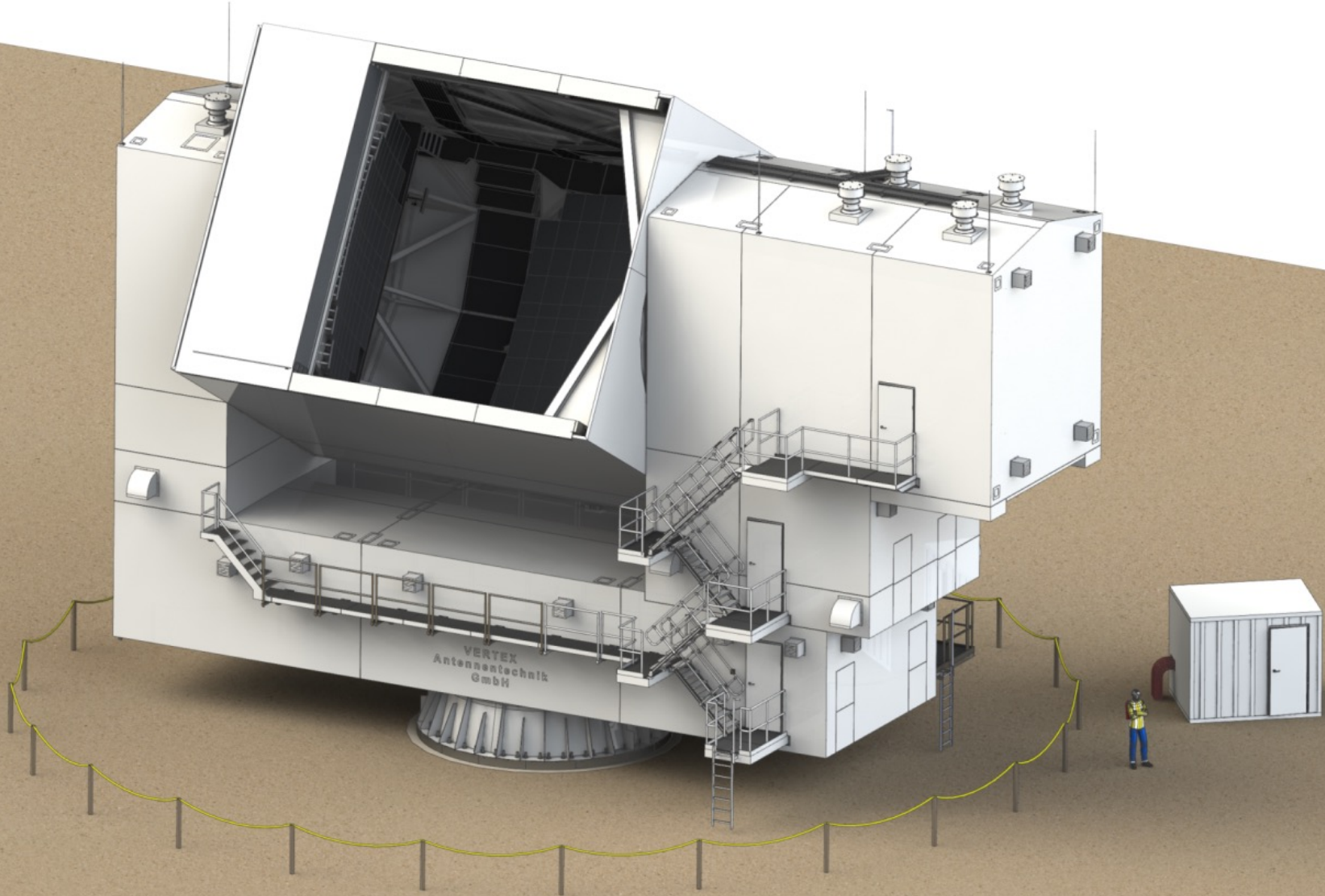
# Who we are

- 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, Queen's
  - CATC “observers”/partners: St. Mary's, Manitoba, Lethbridge, Alberta, National Research Council
- Chilean Universities: Universidad de Chile, UCSC, PUC

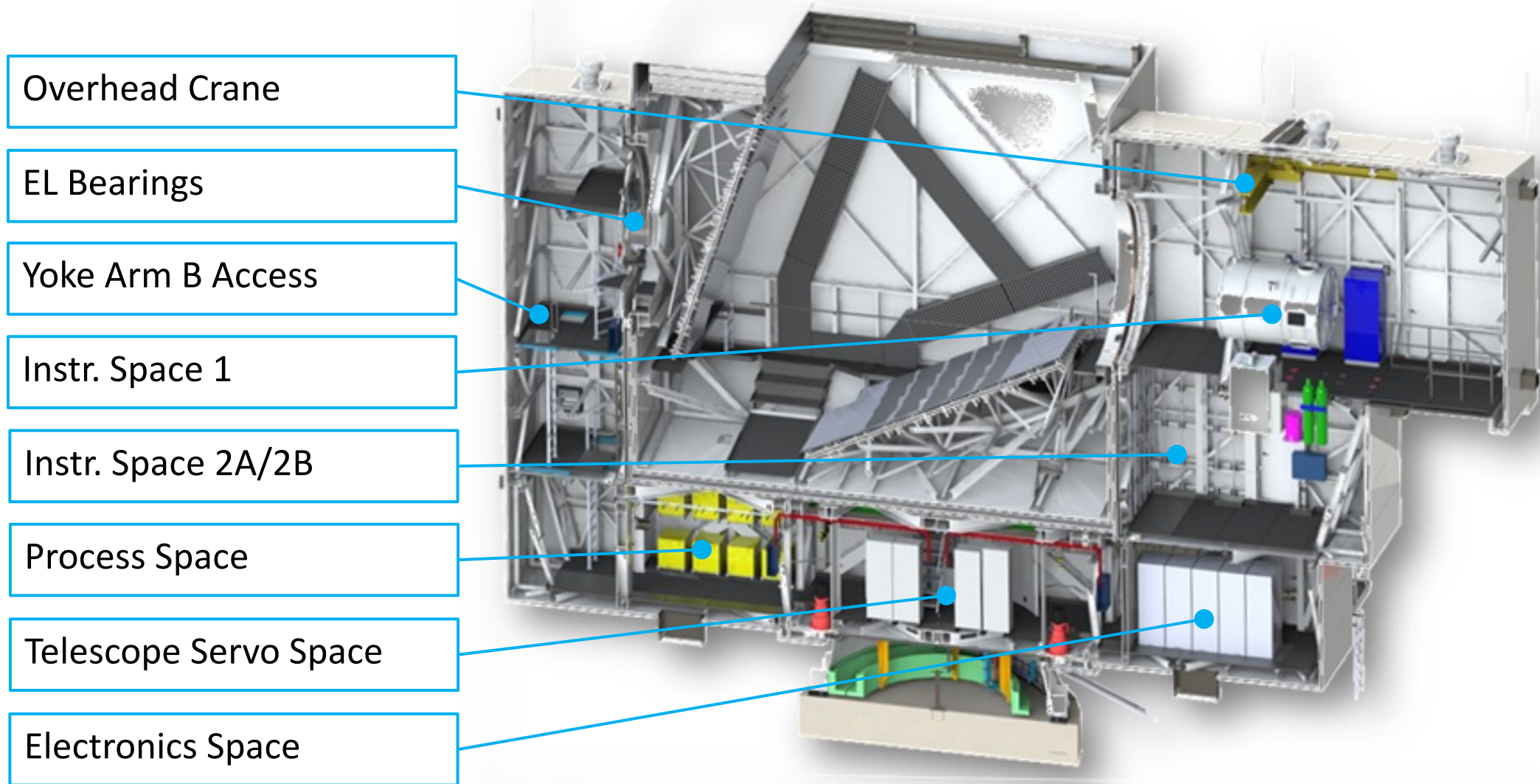
# What we're up to

- FYST will be the highest throughput sub-mm telescope ever built:
  - Frequency range 210-850 GHz (350  $\mu\text{m}$ )
  - 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 $\mu\text{m}$  in the world.
- Expected first-light 2025.
- $\sim 3\text{-}8$  TB/day,  $\sim 1$  PB/year.

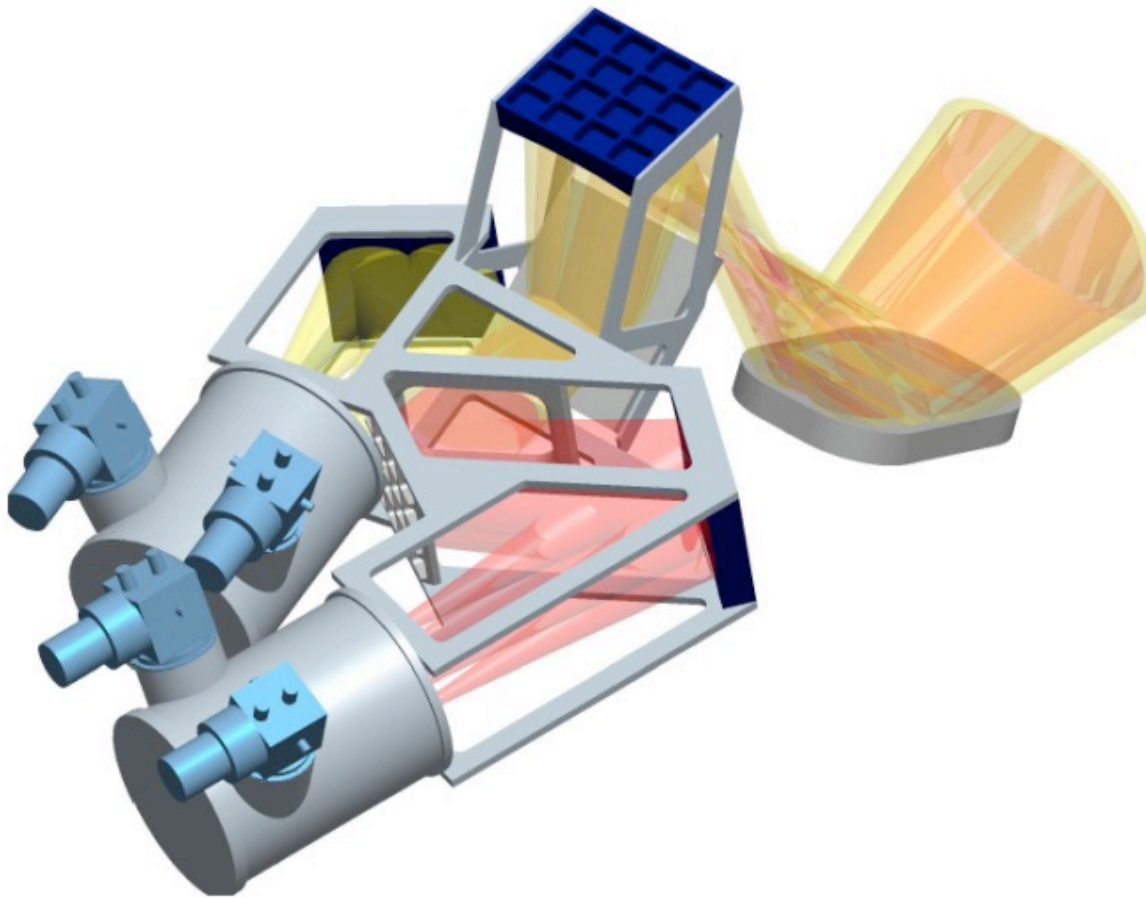




# Telescope cross-section



# First-light instrument: CHAI



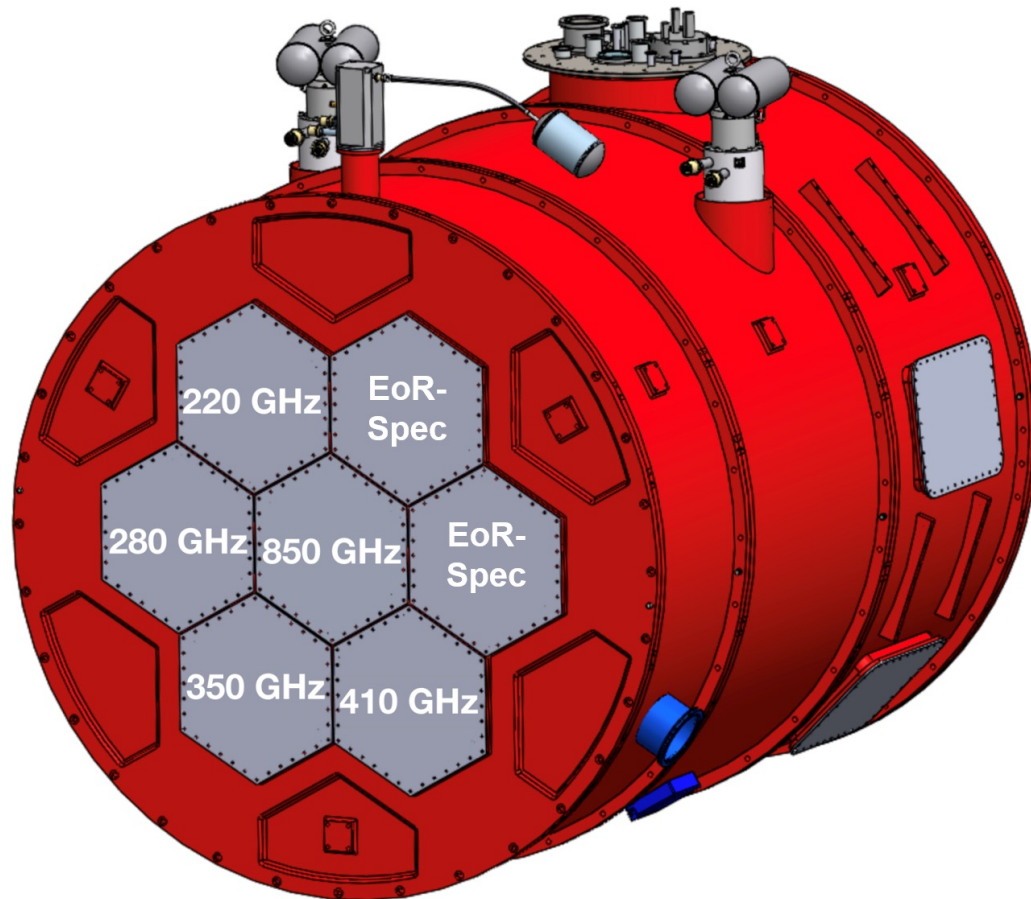
- Multi-pixel heterodyne spectrometer
- 2 frequency bands, 455-495/800-820 GHz
- 128 pixels each band
- Angular resolution 26/15 arcsec (FWHM)
- Spectral resolution 0.06/0.04 km/s
- [CI], [NII], CO line mapping

# 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

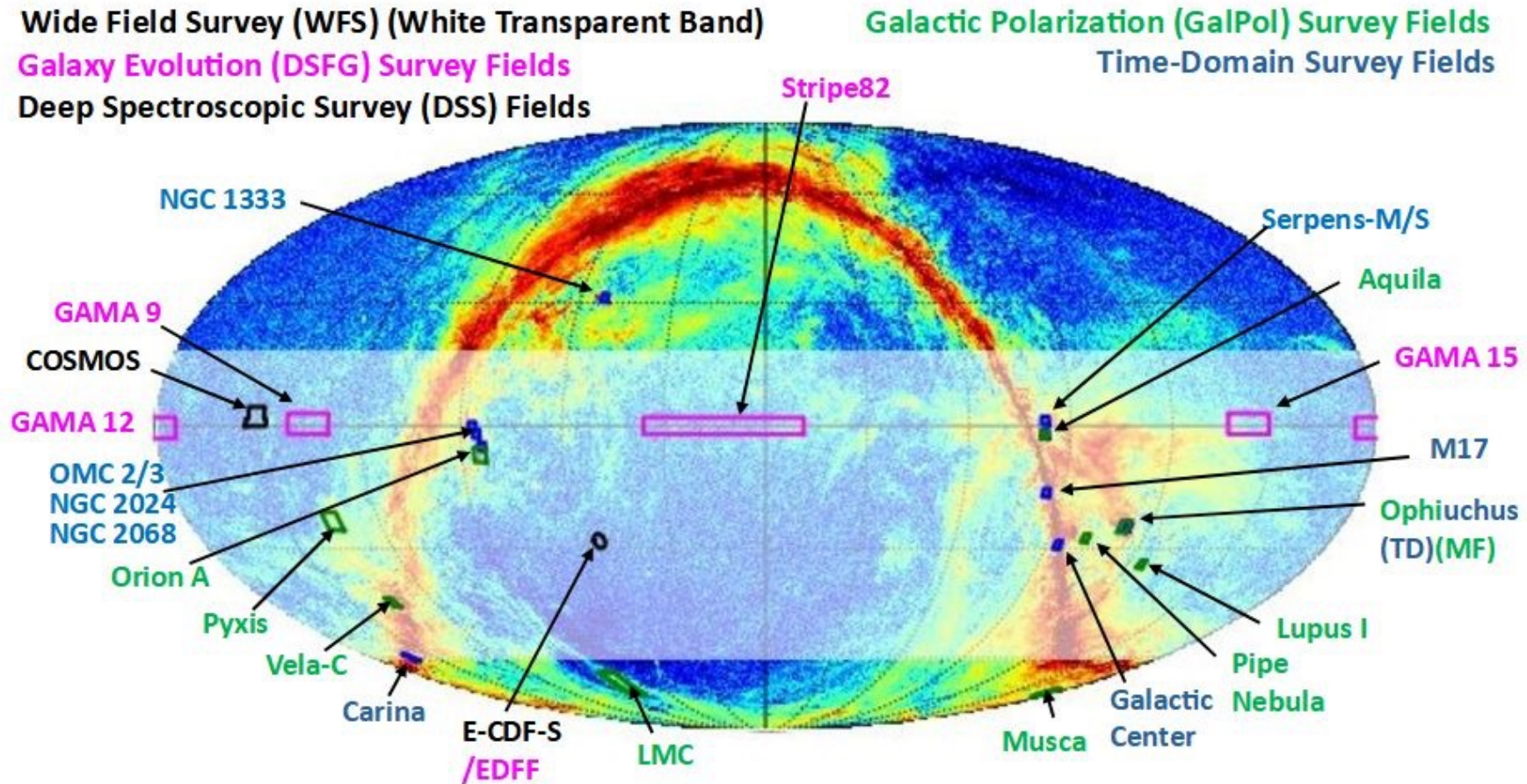


- 1.8m diameter cryostat cooled to 100mK.
- 7 optics tubes, each tube with a field of view of  $\sim 1.3$  deg
- 5 broadband polarimeter camera modules: 220-850 GHz, 59-15 arcsec beam, 7-20k pixels
- 2 spectrometers: 220-410 GHz, 58-33 arcsec beam, 6k pixels each

# Prime-Cam science goals

- Epoch of reionization (first stars)
- Tracing galaxy evolution
- Characterizing CMB foregrounds
- Galactic magnetic fields
- Galaxy clusters (SZ effect)
- Rayleigh scattering of the CMB (improves neutrino #/mass limits)
- 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 year ahead of Prime-Cam.

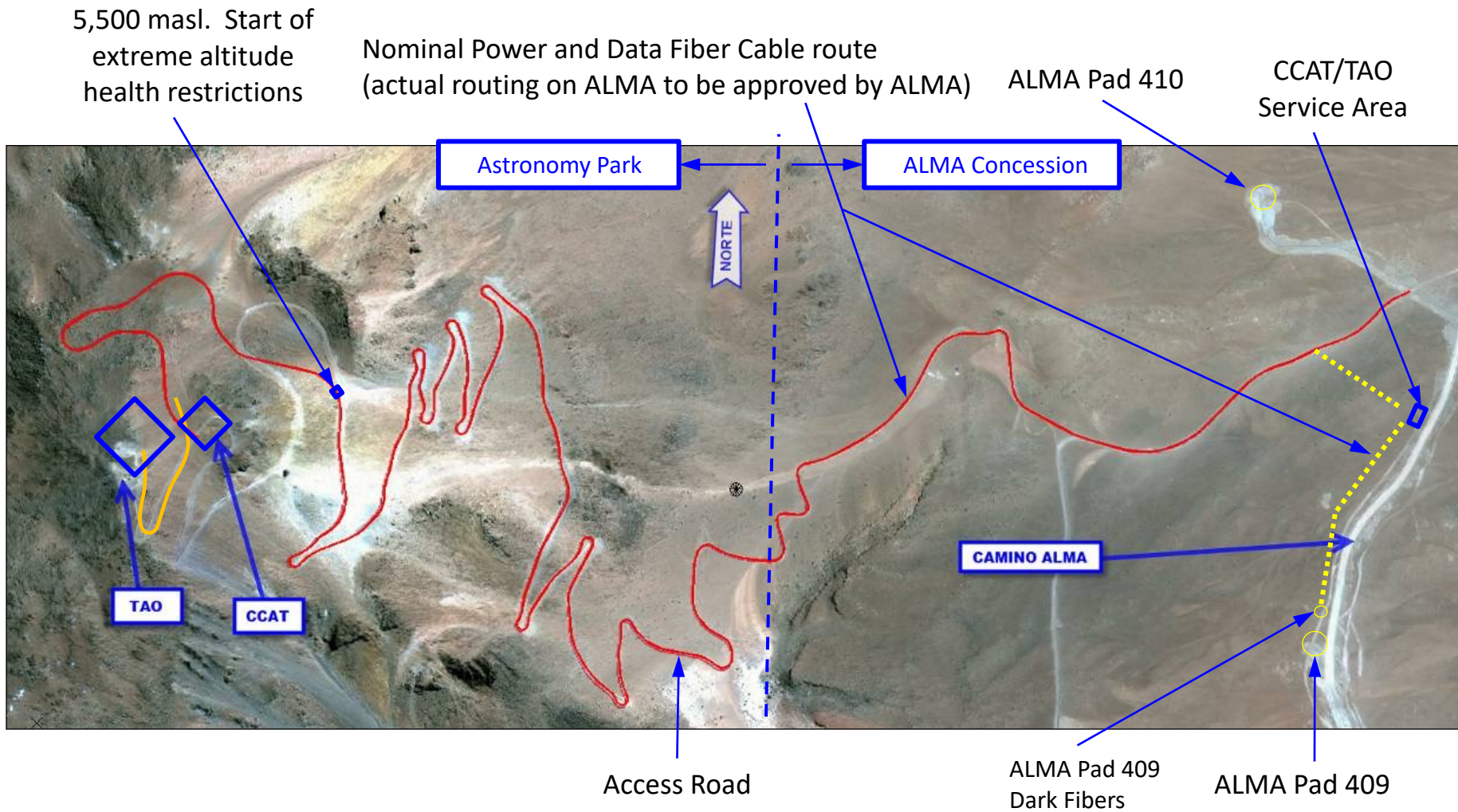
# FYST is at extreme altitude

- FYST is located on the eastern slope of Cerro Chajnantor, at 5612m.
- 36% lower PWV than the ALMA plateau, and up to 80% lower (inversion layer).
- Twice as good as the plateau or South Pole at 350 $\mu$ m.
- However, 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.

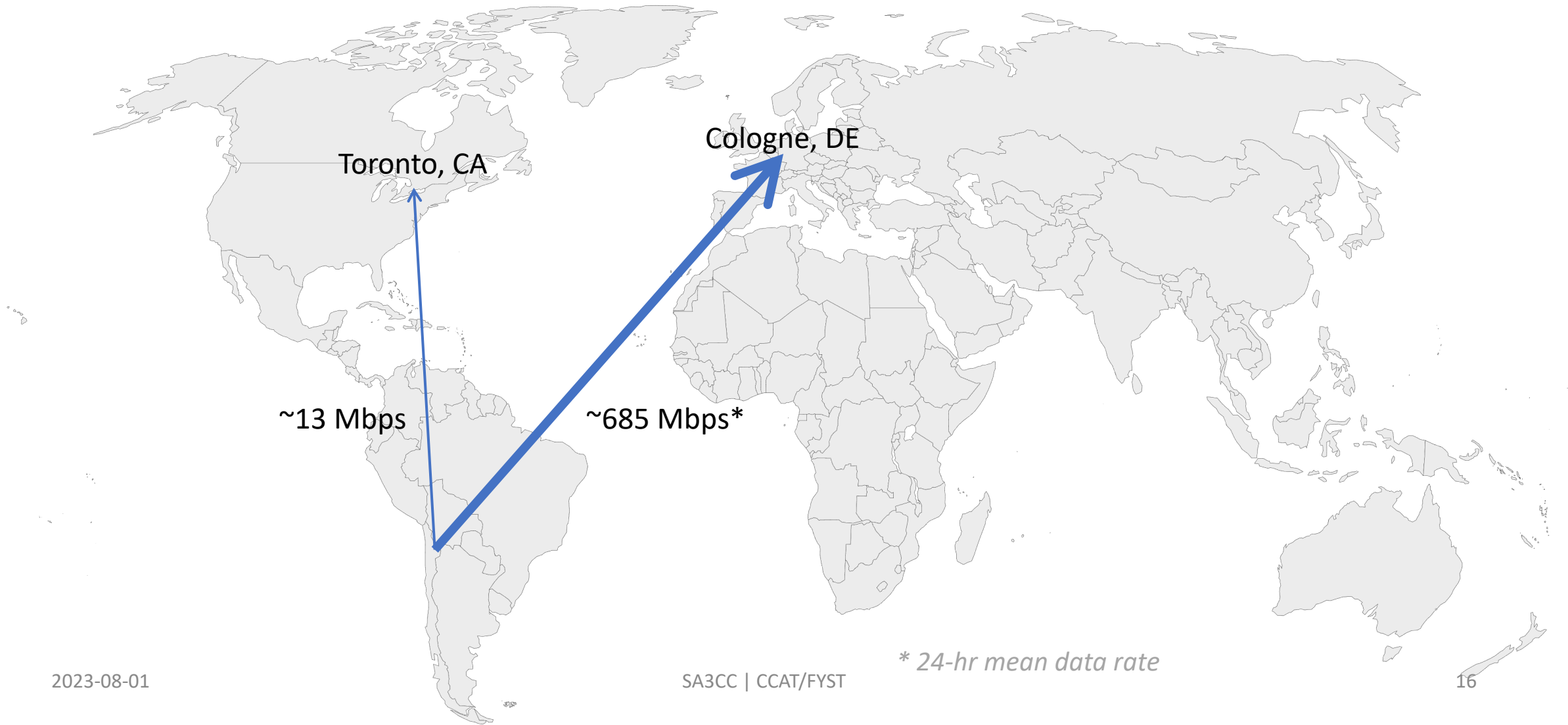
# Fiber network plan

- 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.

# Site layout

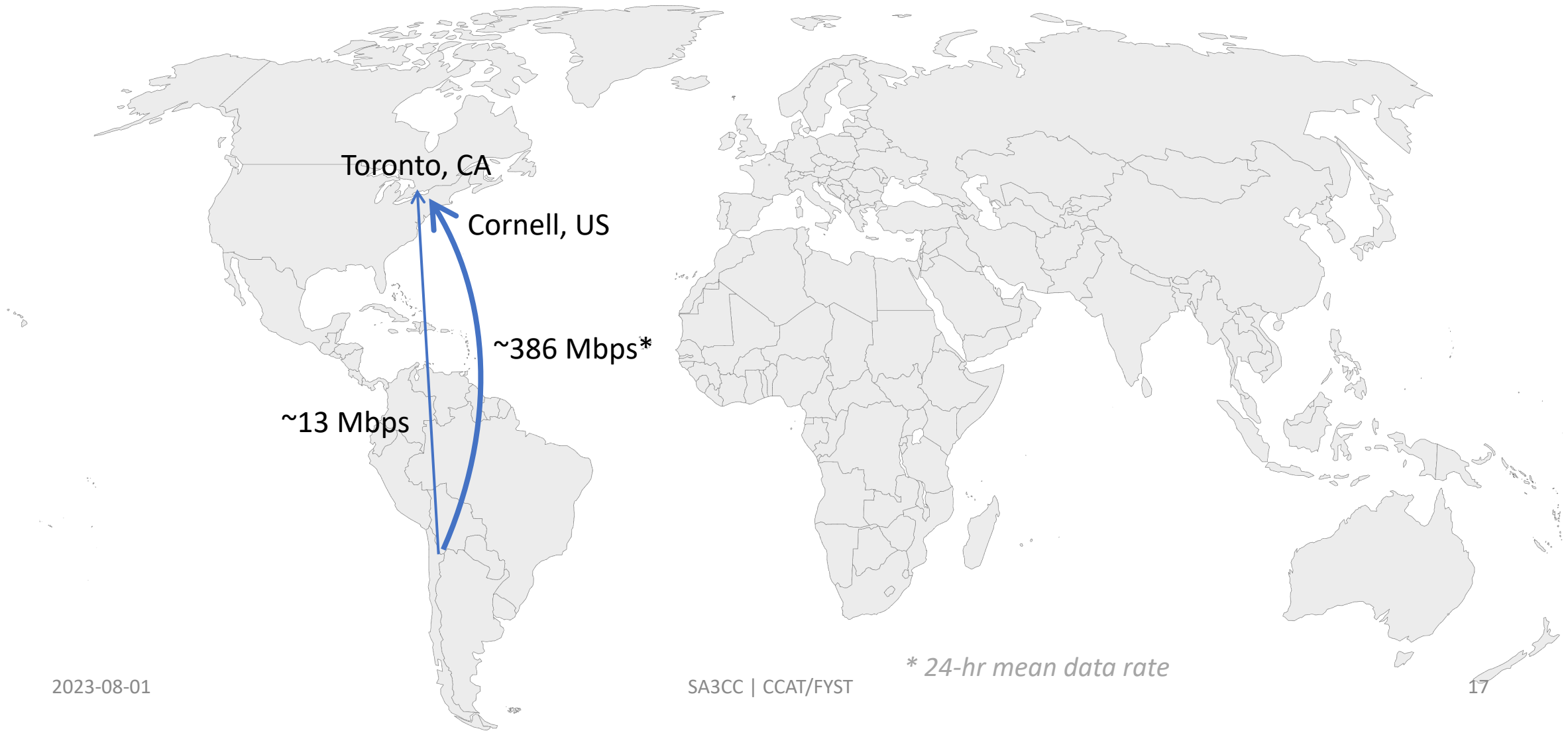


# Data rates during CHAI observing





# Data rates during Prime-Cam observing



# ALMA ↔ Toronto network bandwidth test

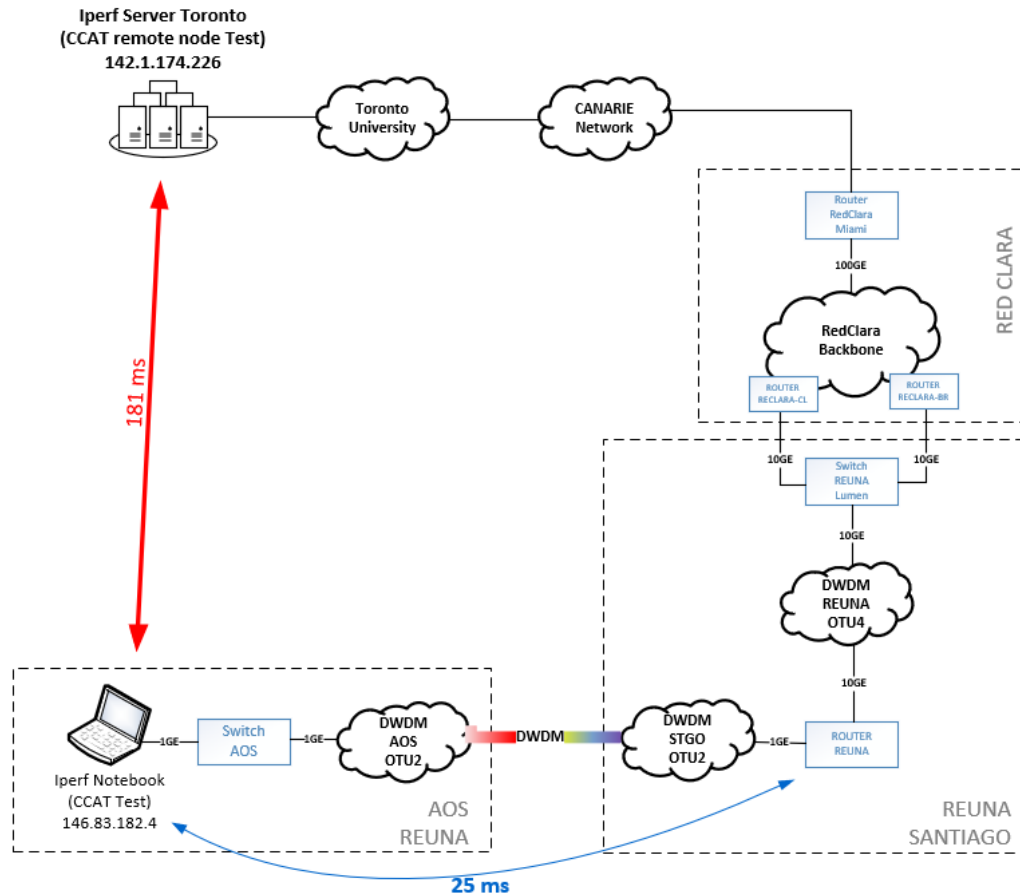


Image: REUNA

- ~12 hour iperf3 tests, 2022 Feb 22-24, by Sergio Cofré & 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)

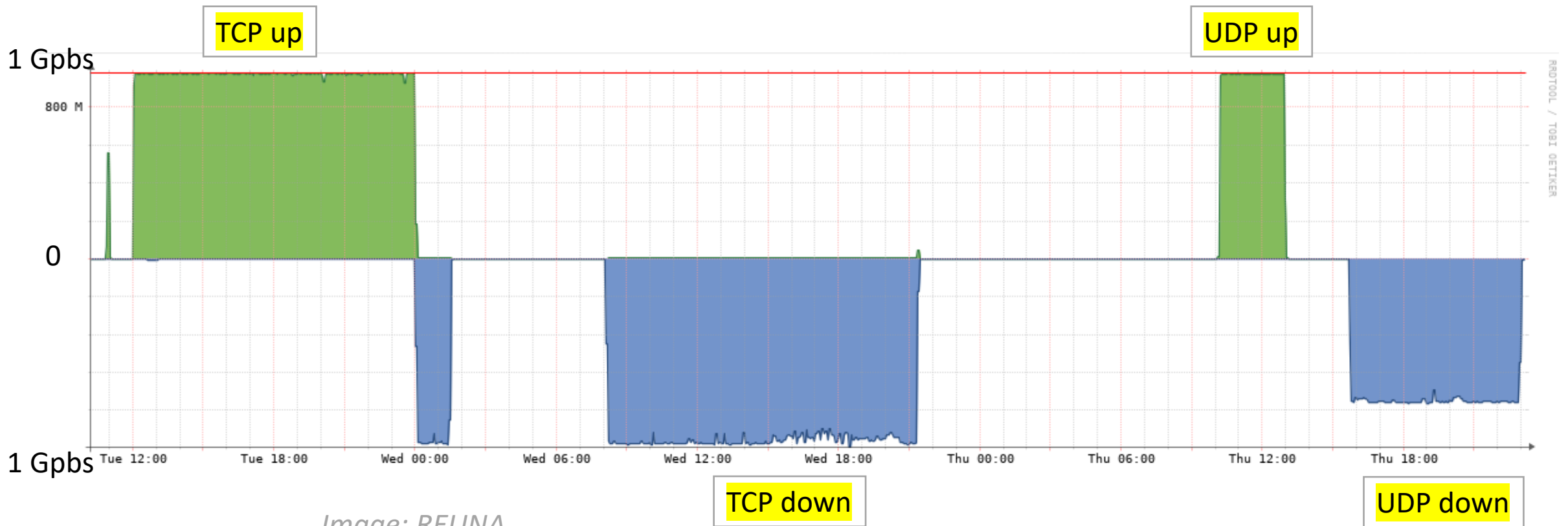
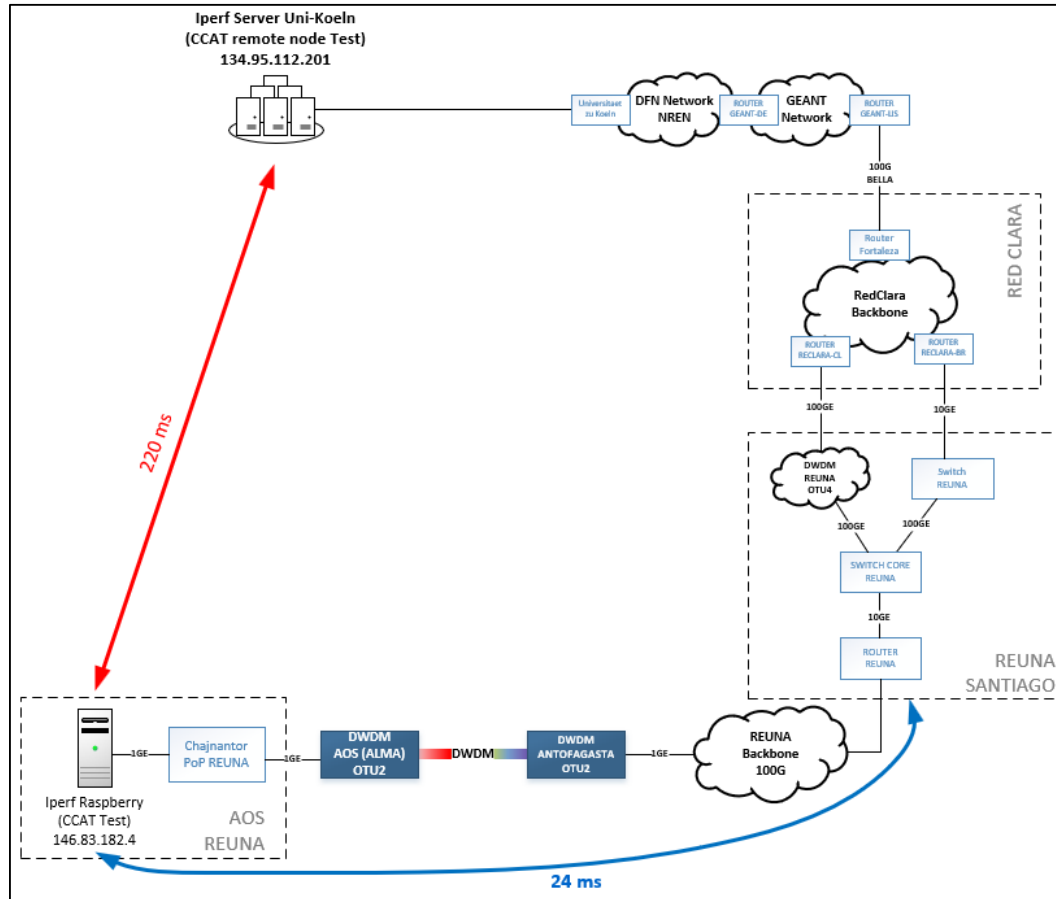


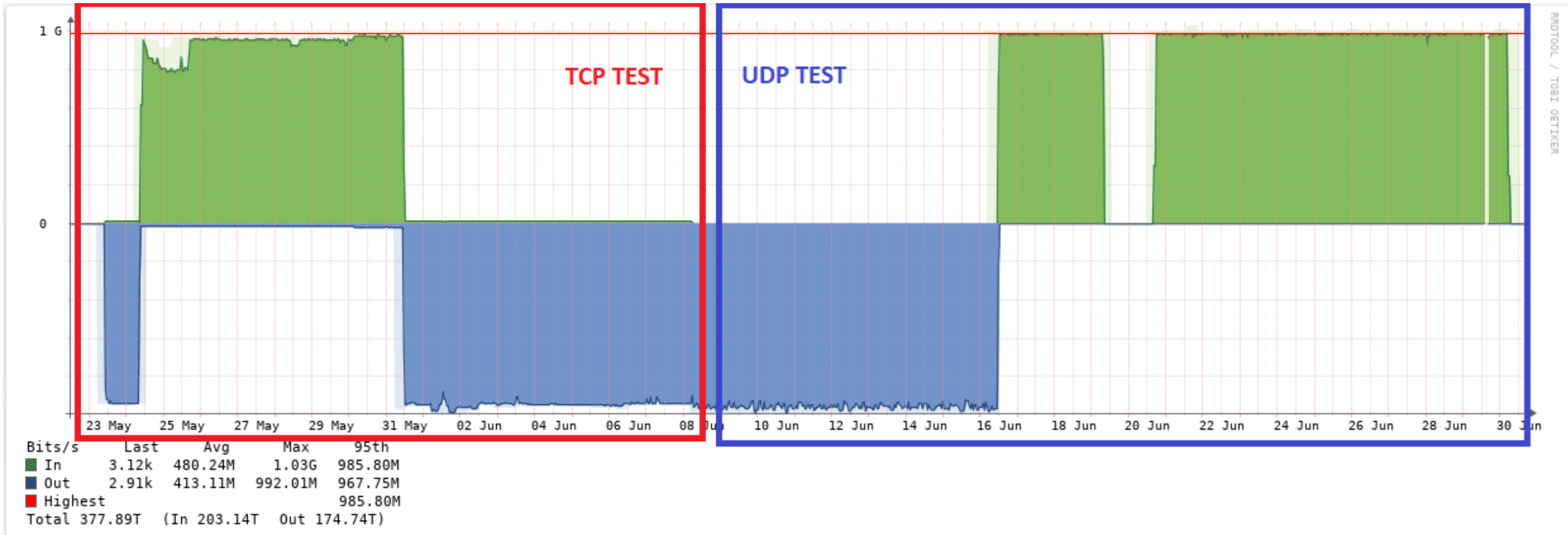
Image: REUNA

# ALMA ↔ Cologne network bandwidth test (2)



- 5 week iperf3 test May 23 to June 30, again by S. Cofré & A. Astudillo (REUNA), and Roland Pabel (UzK).
- AOS to Cologne:
  - 930 Mbps TCP
  - 954 Mbps UDP
- Cologne to AOS:
  - 941 Mbps TCP
  - 981 Mbps UDP

# ALMA ↔ Cologne network bandwidth test (2)



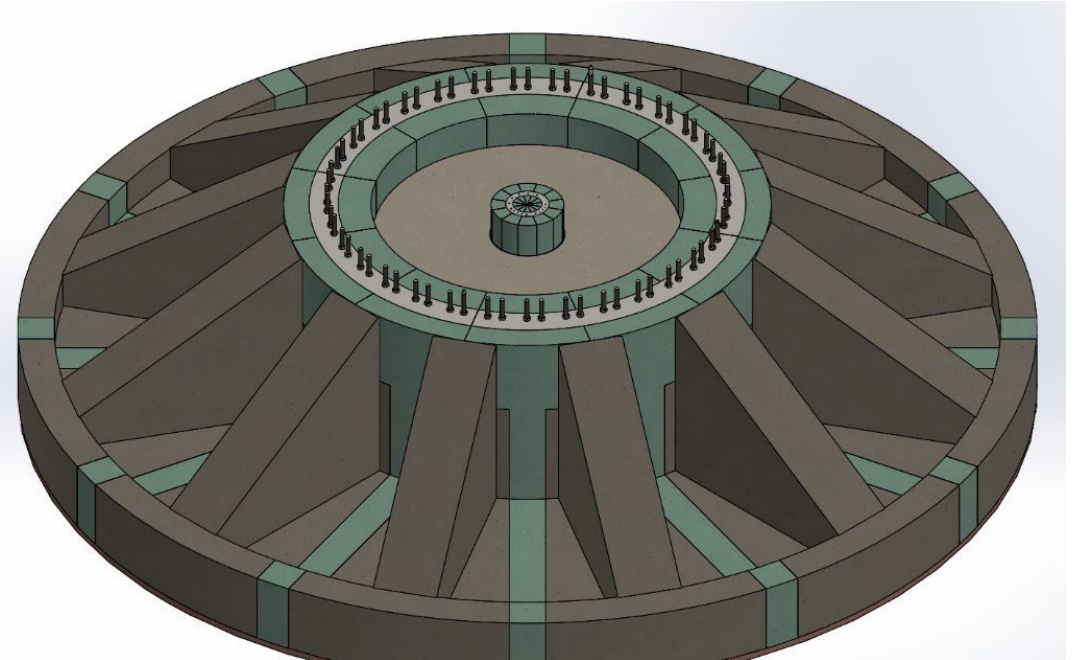
# Summit has been leveled



# Foundation hole dug



# Foundation installed





# Summit finished (leveled, grounded, fenced)



# Trenching in progress



- ~9km trench from Pad 409 to summit, ~98% complete.
- First reels of 23kVA power line & optical fiber installed.

# Trenching fiber/power 98% complete



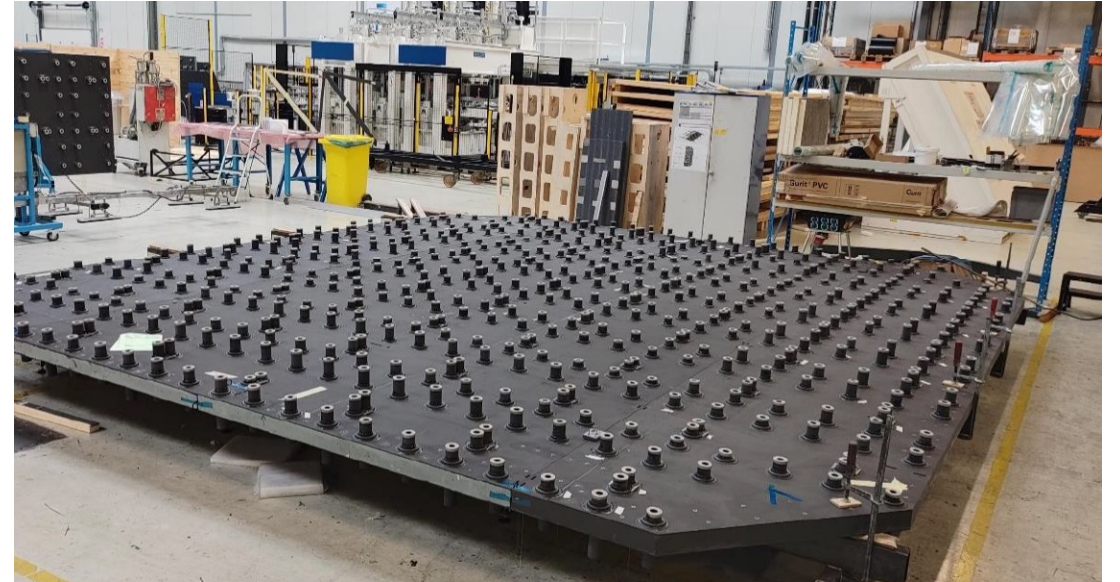
# Service area for generators



# Telescope being constructed in Germany



# Carbon fiber mirror backing structure



# Schedule

- Telescope:
  - Assembled in Germany by November this year.
  - Ships to Chile mid 2024.
  - Final acceptance mid 2025.
- CHAI & Mod-Cam ship late 2024, Prime-Cam ships late 2025.
- Science observations should start late 2025.

