Program

14:00 F. Bertoldi:
CCAT-prime project overview

14:15 J. Stutzki:
CCAT-p first light instrumentation

14:35 R. Simon:
CCAT-p: The Galactic ECology (GEco) Project

14:55 B. Magnelli:
High-redshift galaxy surveys with CCAT-p

15:15-15:30 Break

15:30 D. Riechers:
Tomography of Cosmic Reionization Through [CII] Intensity Mapping at Redshifts 5-9 with CCAT-p

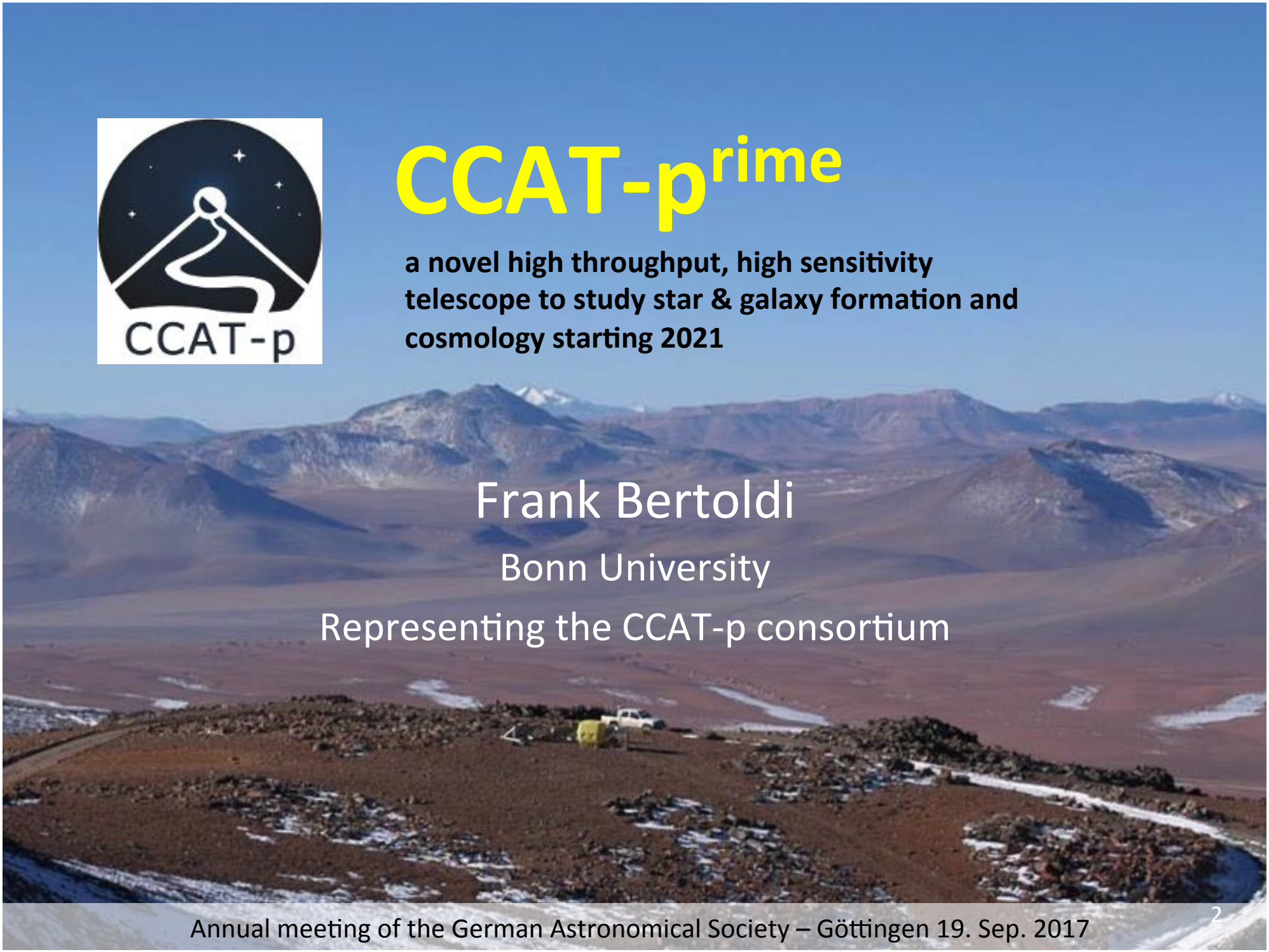
15:50 K. Basu:
Cluster cosmology with CCAT-p

16:05 J. Erler:
Observations of the relativistic SZ effect: from Planck to CCAT-p

Presentation	Title
Bruckmann	Simulation of Galactic disk PDRs line emission
Karoumpis	Predictions for the redshift 5-9 [CII] intensity distribution
Ziebart	Mapping the ISM in nearby galaxies with CCAT-p: the case of M51

CCAT-p

2017
Astronomische Gesellschaft
German Astronomical Society



CCAT-p^{rime}

a novel high throughput, high sensitivity telescope to study star & galaxy formation and cosmology starting 2021

Frank Bertoldi

Bonn University

Representing the CCAT-p consortium

Who is CCAT-p ?

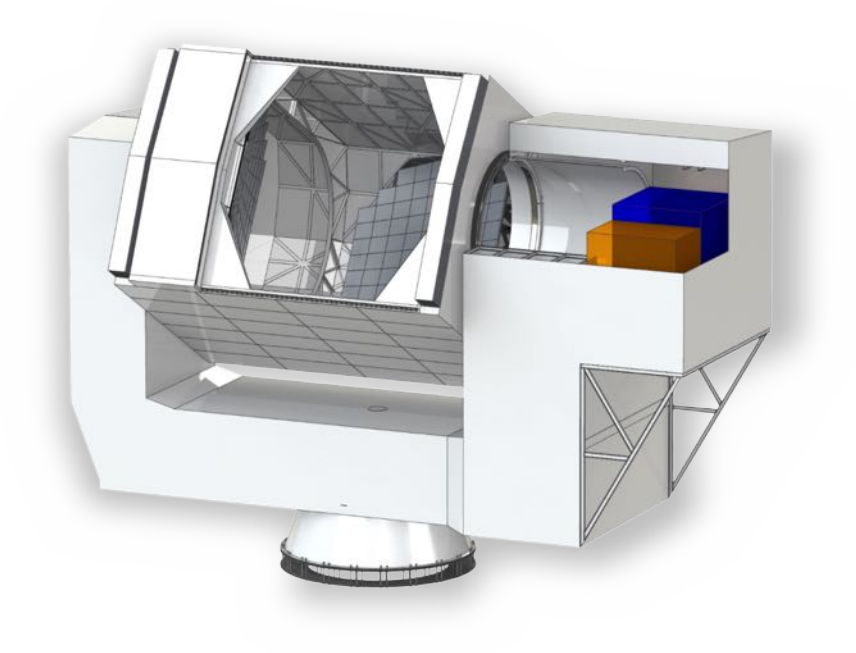
University consortium with strong emphasis on training & development

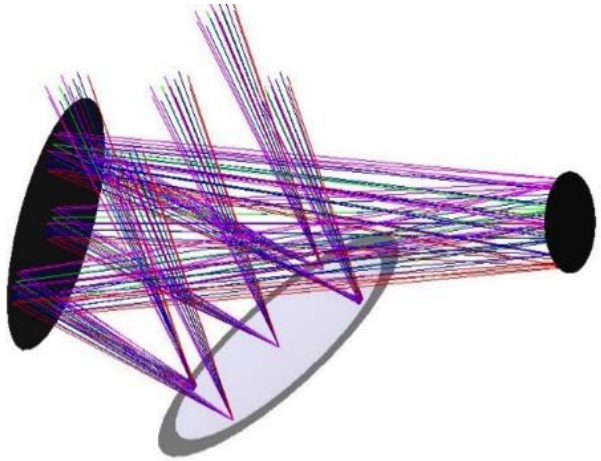
- **Cornell University**
- **German consortium Univ. Cologne & Univ. Bonn**
  - joining: LMU (Mohr), MPA (Komatsu, White)
- **Canadian university consortium**
  - **Waterloo**, Toronto, British Columbia, Calgary, Dalhousie, McGill, McMaster, Western Ontario

- **Funding:**
  - private donor and Cornell university
  - DFG Grossgeräte, Univ. Köln & Bonn, SFB956 (CHAI)

What is CCAT-p?

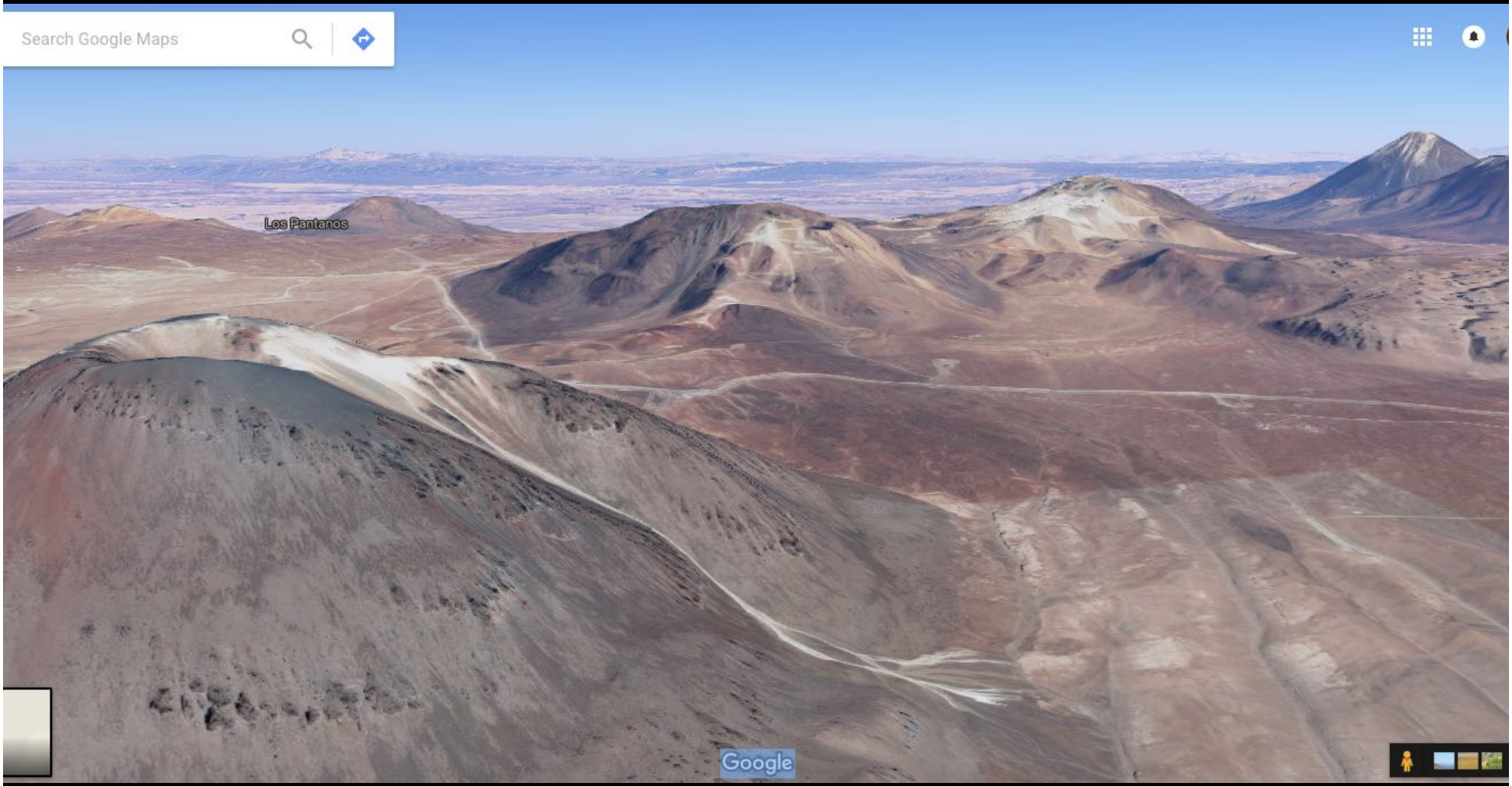
A high surface accuracy, high throughput
6 m aperture, submm (0.3-3mm) telescope for
dedicated surveys





Moonrise over NRAO test equipment on the 5000m altitude Chajnantor plateau, Chile.
Photo: S. Radford 1995

Licancabur 5920m
Toco 5604m
Chajnantor 5639m
El Chascon 5703m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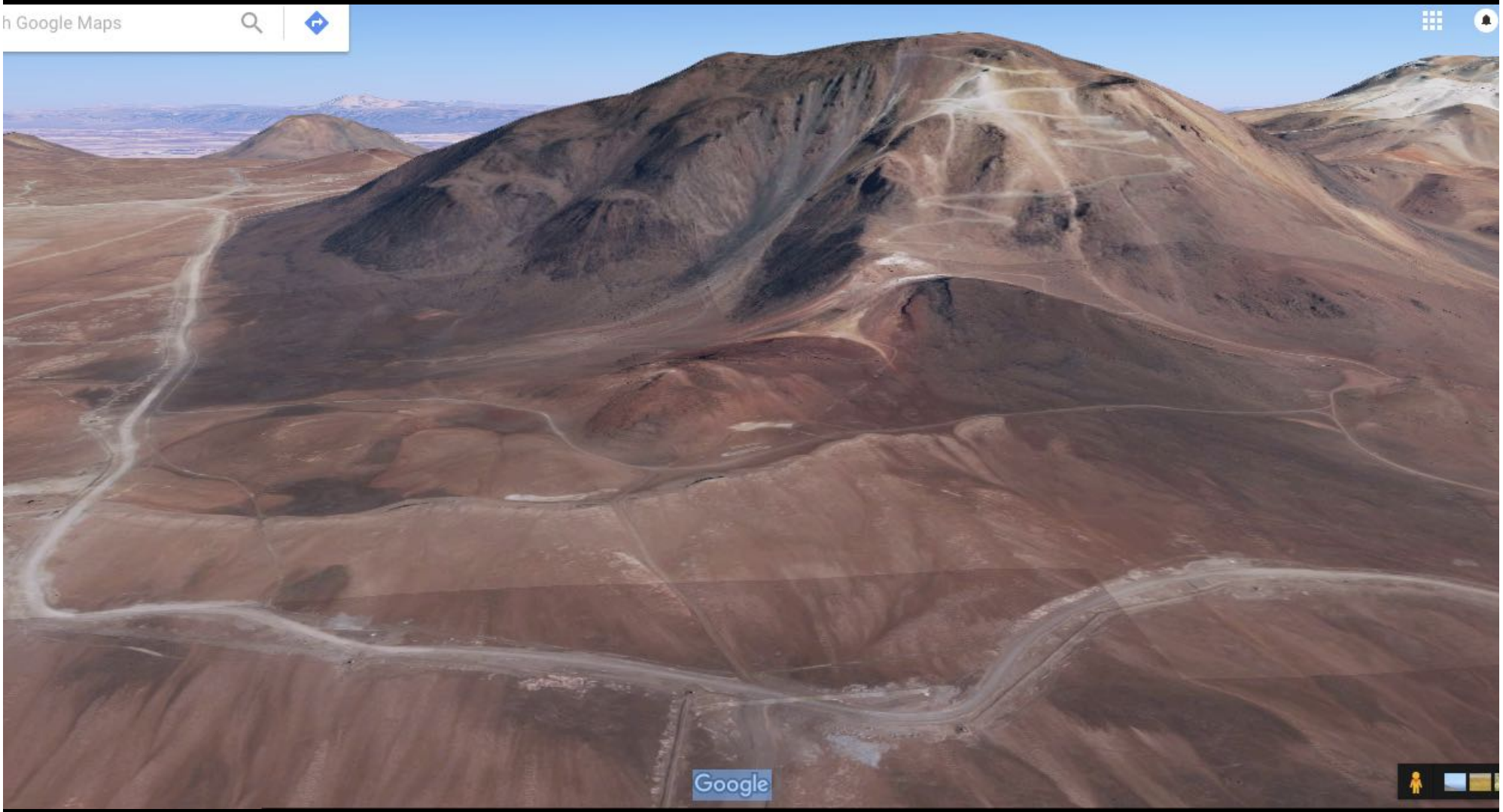
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P-HD66

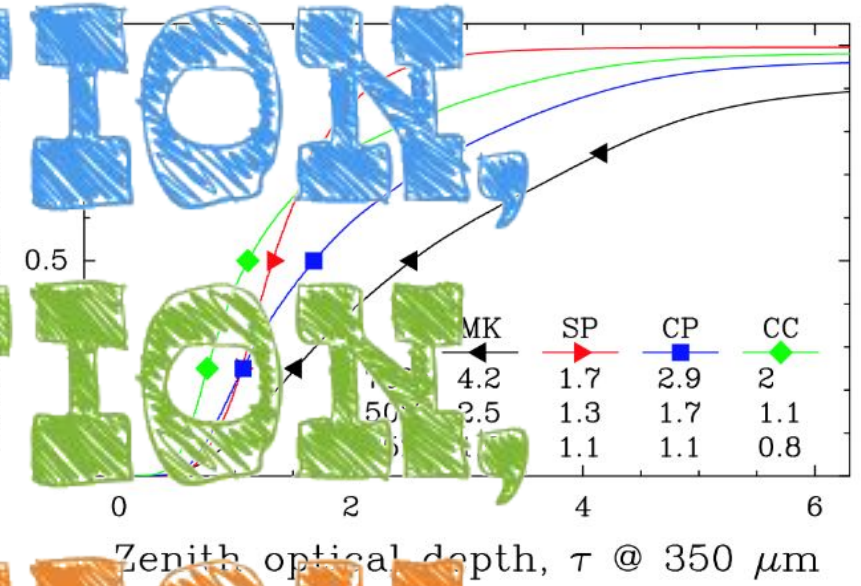
Cerro Chajnantor at 5600 m (below TAO)

5000 meter is good, but 5600 meters is better

- Submillimeter sensitivity is set by telluric transmission
- Simon Radford has been tipping radiometers at primary sites for more than a decade (Radford & Peterson, arXiv:1603.07979)
- Simultaneous for CCAT & ALMA sites: median is 1 mm H_2O

  ⇒ *factor of 1.7 in sensitivity*

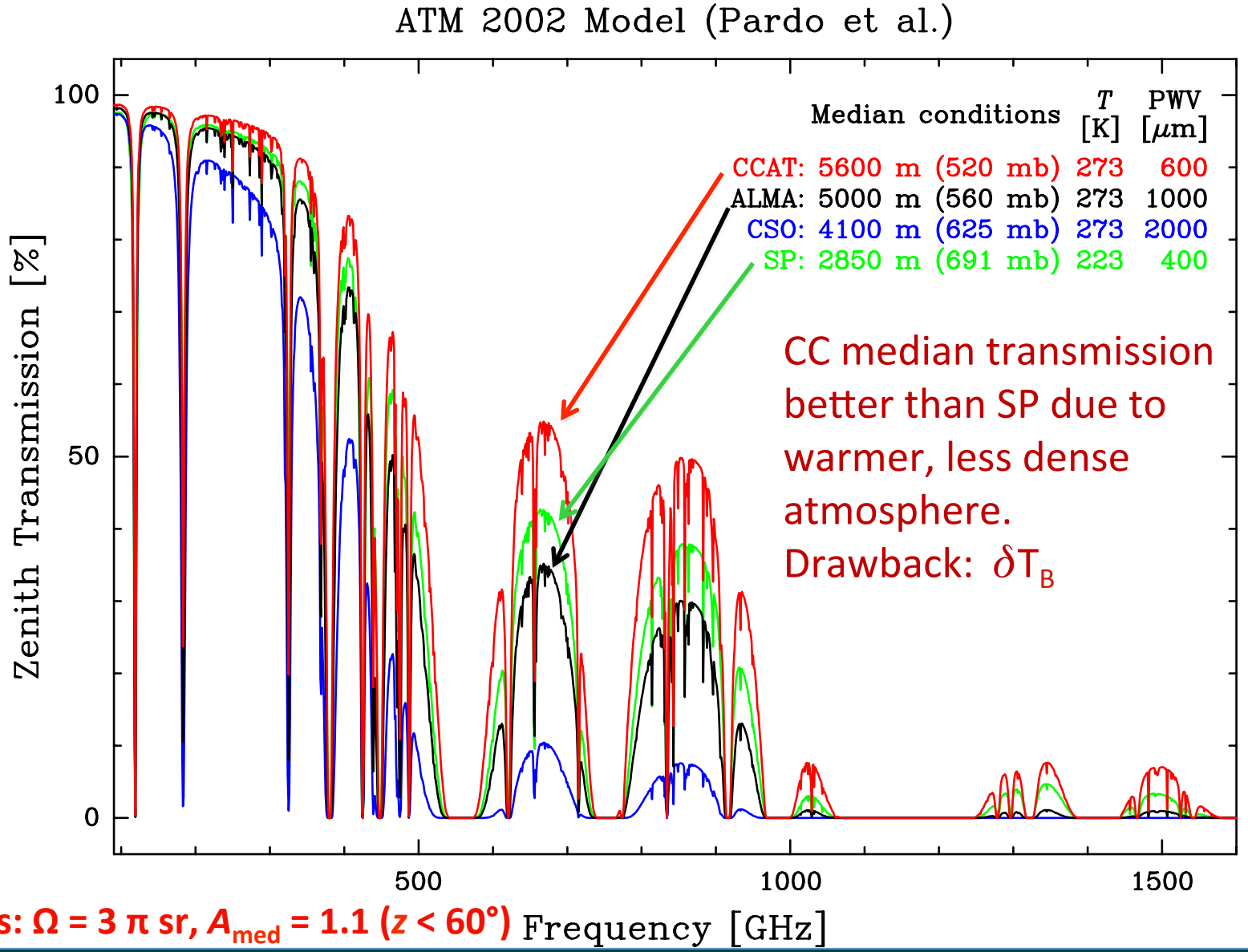
LOCATION, LOCATION, LOCATION



	$\tau(350\,\mu m)$ Chaj. plateau	$\tau(350\,\mu m)$ Cerro Chaj.	PWV [mm] Chaj. plateau	PWV [mm] Cerro Chaj.	WV scl. ht. [m] *
75 %	2.7	1.9	2.0	1.3	1280
50 %	1.5	1.1	1.0	0.6	1080
25 %	1.0	0.7	0.53	0.28	860

* WV scale height = 550 m/ ln(PWV$_{cp}$/PWV$_{cc}$)

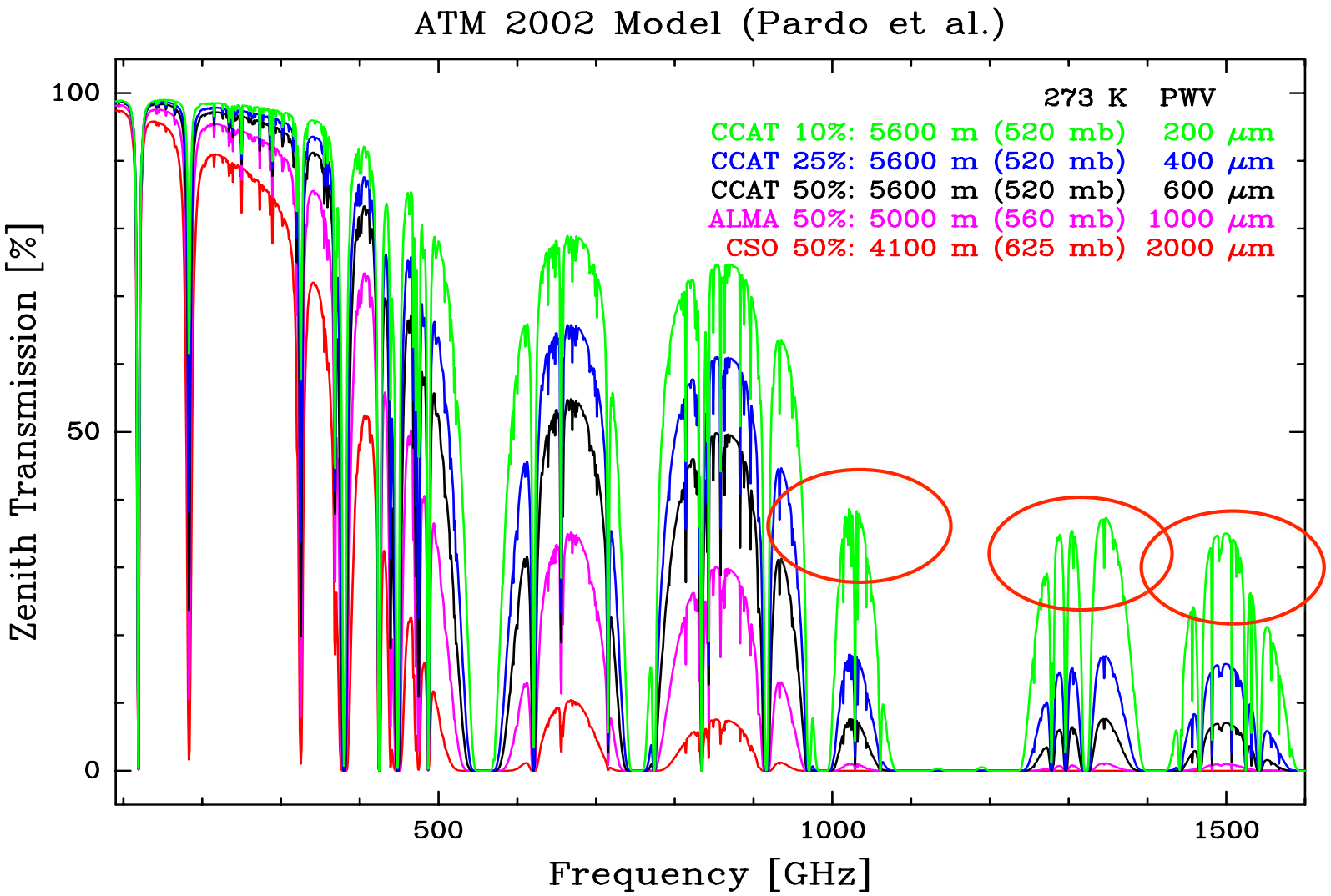
Median *Zenith* Transmission



Tropics: Ω = 3 π sr, A_{med} = 1.1 (z < 60°)

Pole: Ω = 1 π sr, A_{med} = 1.4 (z < 60°)

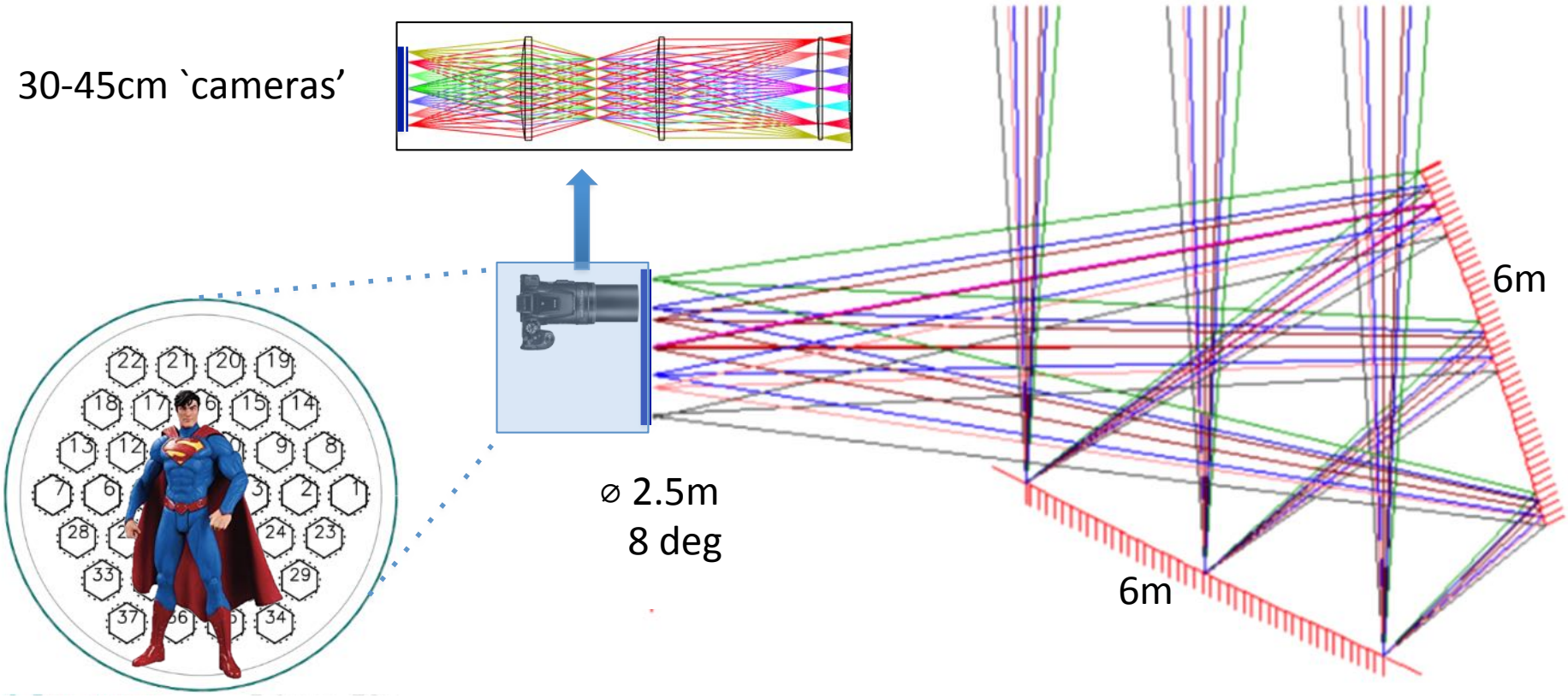
Chajnantor Site opens up THz Windows



Crossed-Dragone Telescope

high throughput, wide field-of-view, flat focal plane, low blockage / emissivity

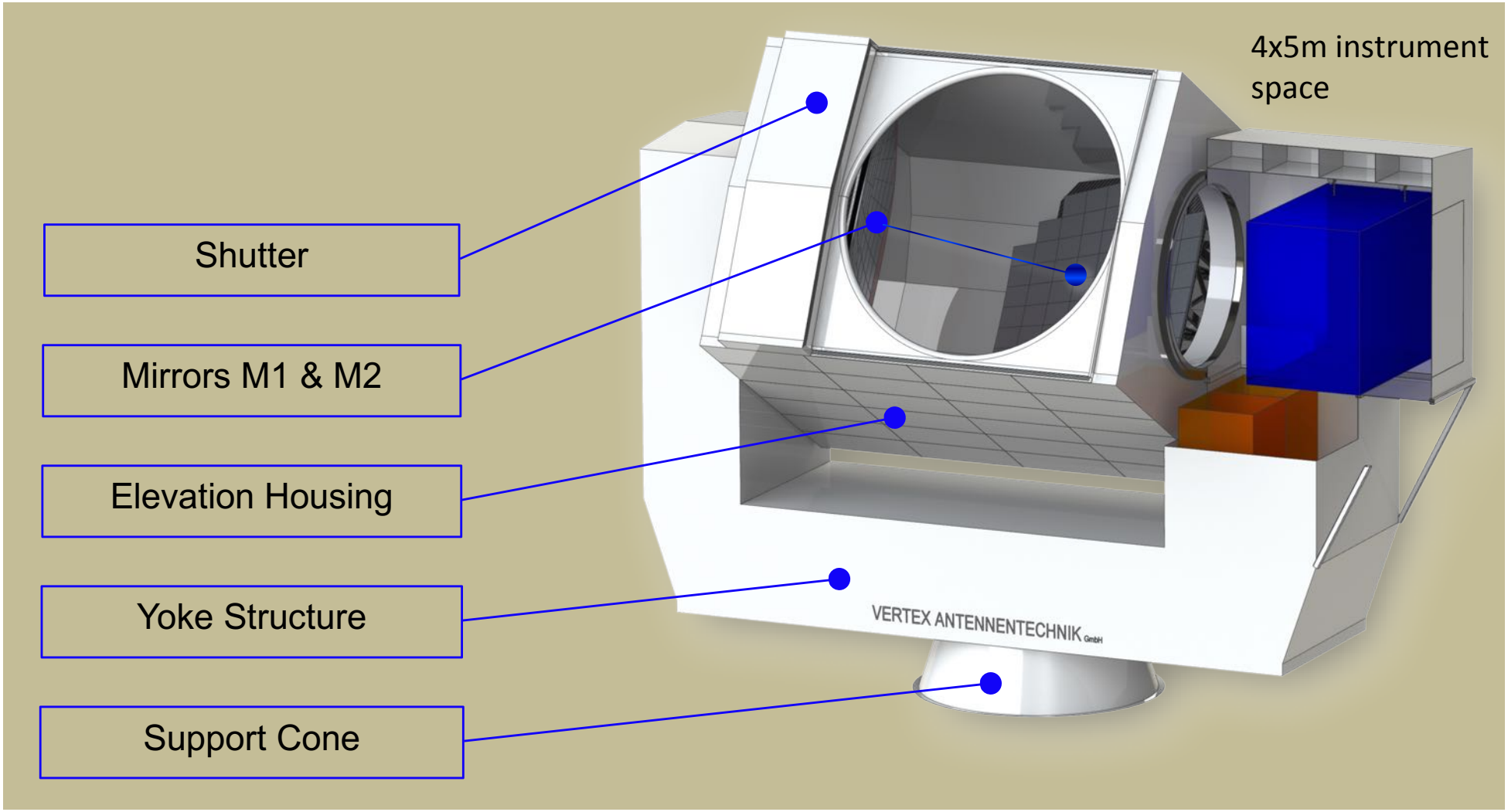
- Original concept published in 1978 by Corrado Dragone AT&T Tech. Mem. 57, 2663
- Used in <2 m CMB experiments (QUIET, C. Bischoff. et al. 2013), Atacama B-Mode Search (Essinger-Hileman et al. 2009)

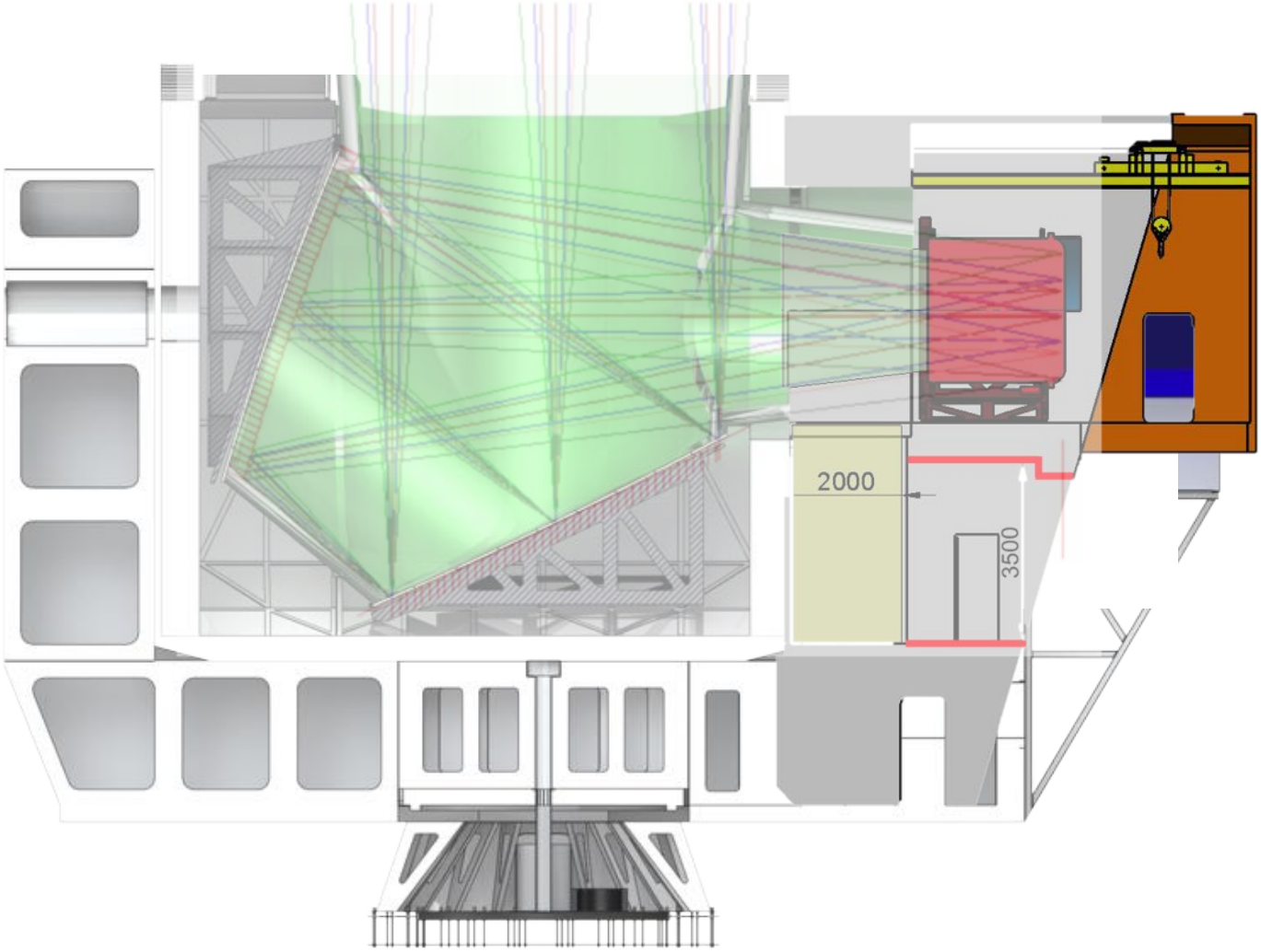


M. Niemack, Applied Optics 2016

CCAT-prime

designed and built by Vertex Antennentechnik GmbH, Duisburg





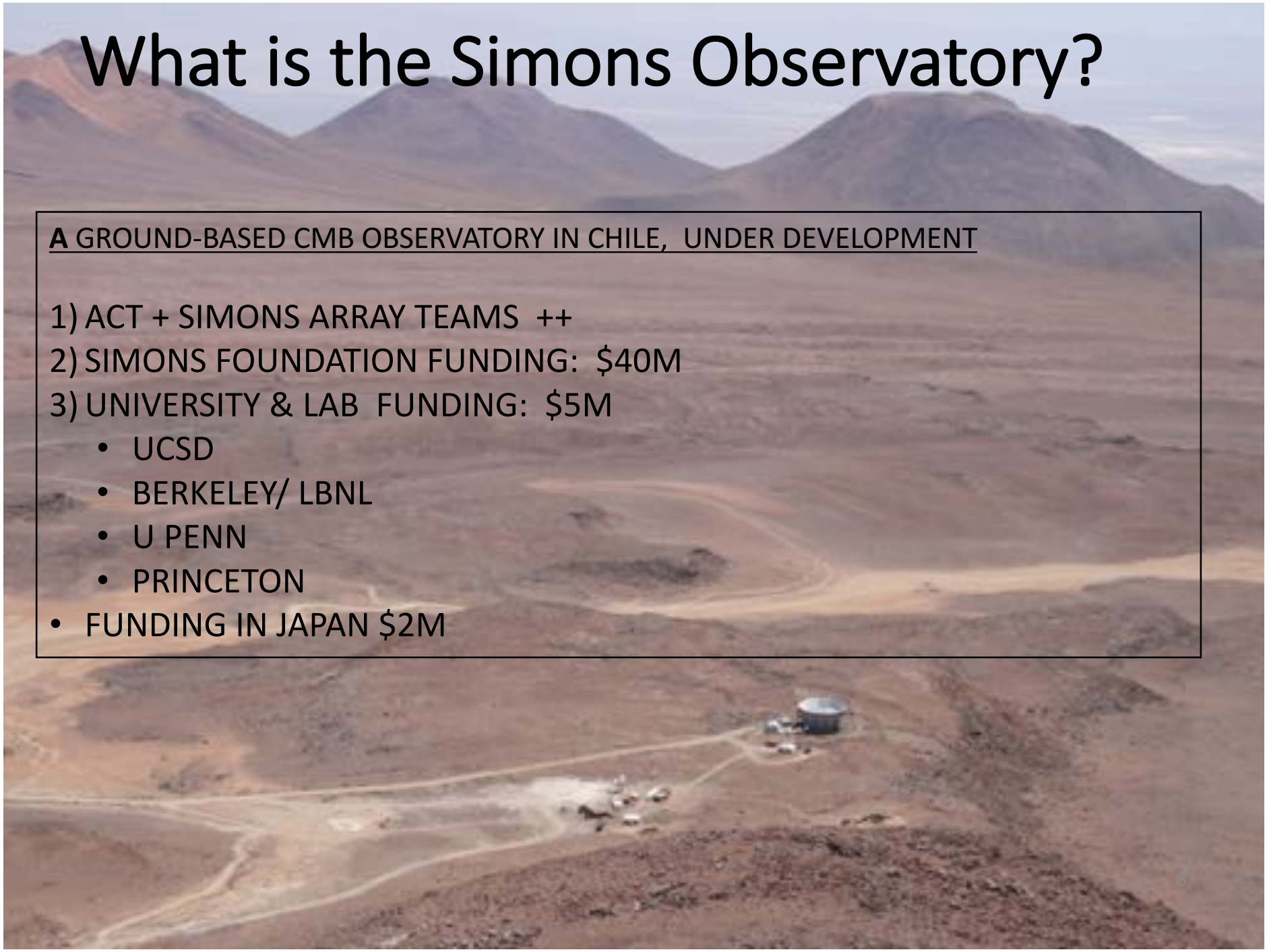
coma-corrected f/2.6 with 5.5m free aperture

Simons Observatory adopting similar design

What is the Simons Observatory?

A GROUND-BASED CMB OBSERVATORY IN CHILE, UNDER DEVELOPMENT

1) ACT + SIMONS ARRAY TEAMS ++
2) SIMONS FOUNDATION FUNDING: $40M
3) UNIVERSITY & LAB FUNDING: $5M
   - UCSD
   - BERKELEY/ LBNL
   - U PENN
   - PRINCETON
- FUNDING IN JAPAN $2M



Schedule

Telescope: 4 year construction (6/2017 to 6/2021)

- 20 months detailed design
- 13 months fabrication incl. trial assembly in Duisburg
- 3 months shipping & receiving
- 12 months assembly/checkout

Cameras under design & construction, $€ still being raised (NSF: MSIP, MRI, DFG: SFB, ...)

Project has started, but still welcomes new partners.

CCAT-p Science

- Star formation in the **Milky Way,** the **Magellanic clouds** and other **nearby galaxies** through submm spectroscopy and photometry. (talk by R. Simon)
- Evolution of **DSFG** through submm-mm wave surveys. (B. Magnelli)
- EoR **intensity mapping in [CII]** at redshifts from 5 to 9. (D. Riechers)
- Measurement of **the velocities, temperatures and optical depth of galaxy clusters** via the SZ effects to place new constraints on models of dark energy and modified gravity and the sum of the neutrino masses. (K. Basu)
- CMB Stage 4: **CMB polarization** at 10 times the speed of current facilities $\Rightarrow$ inflationary gravity waves and the sum of the neutrino masses.
  - **Polarization foregrounds**: Galactic dust science

CCAT-p

- Unique **site** enables unique science
- Novel **telescope design**: high accuracy (< 11 μm rms), low blockage (< 1%), low emissivity (< 2%), maximizes surface brightness sensitivity. Extraordinary **throughput** optimal for large-area survey science
- **Paving the road** & lowering risk for a large-aperture submm telescope (at the same site?)

Atacama Large-Aperture Submm/mm Telescope (AtLAST)

https://www.eso.org/sci/meetings/2018/AtLAST2018.html

T-p

A workshop to discuss science/technical aspects of

the **At**acama **L**arge-**A**perture **S**ubmm/mm **T**elescope (AtLAST)

ESO-HQ, Garching b. München, Germany

January 17-19, 2018

The Atacama Large Millimeter/Submillimeter Array (ALMA) is currently the world's most sensitive telescope operating at 0.3 to 3 mm (and will soon be extended to 10 mm). However, as an interferometer, its mapping speed for large areas is limited, while the largest angular scales it can access are limited to < 1 arcminute at 3 mm. This limit is even more stringent at shorter wavelengths. Further, existing submm/mm single dish facilities are not expected to remain competitive beyond 2030.[1]

We have therefore begun a two-year effort concerning the scientific merit for – and technical implementation of – an **At**acama **L**arge **A**perture **S**ubmm/mm **T**elescope (AtLAST). We now invite to community to join in establishing working groups on science and technology aspects of AtLAST, and are holding a 3-day workshop at ESO Headquarters in Garching on January 17-19, 2018. The science and technology working groups will conclude the study in early 2019 with a public report including recommendations for organisational and financial paths to building an international collaboration. The workshop will be a crucial forum to collect insights and feedback, and commit to a single vision for producing a single dish facility.

The science case, role and prospects for a large single dish submm/mm telescope will also be discussed in the context of existing and planned major single dish (sub)mm observatories. As an outcome of the workshop, our study will collect and critically review the existing science cases, identify possible technical designs and their instrument / development options, assess operational and technological ties with ALMA and explore science synergies with both ALMA and future survey missions at other wavelengths, such as Athena, the ELT, Subaru, eROSITA, the Origins Space Telescope, SPICA, and the SKA, to name a few. One possible synergy for ALMA, in particular, is to use this facility in long baseline and/or VLBI campaigns. Roughly half of the workshop will be dedicated for discussion and planning of study reports.

The workshop will take place at the ESO Headquarters in Garching (Germany) January 17-19, 2018, and is supported and coordinated by ESO, the University of Bonn, and RadioNet. This event has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 730562 [RadioNet].

Workshop email: AtLAST@eso.org