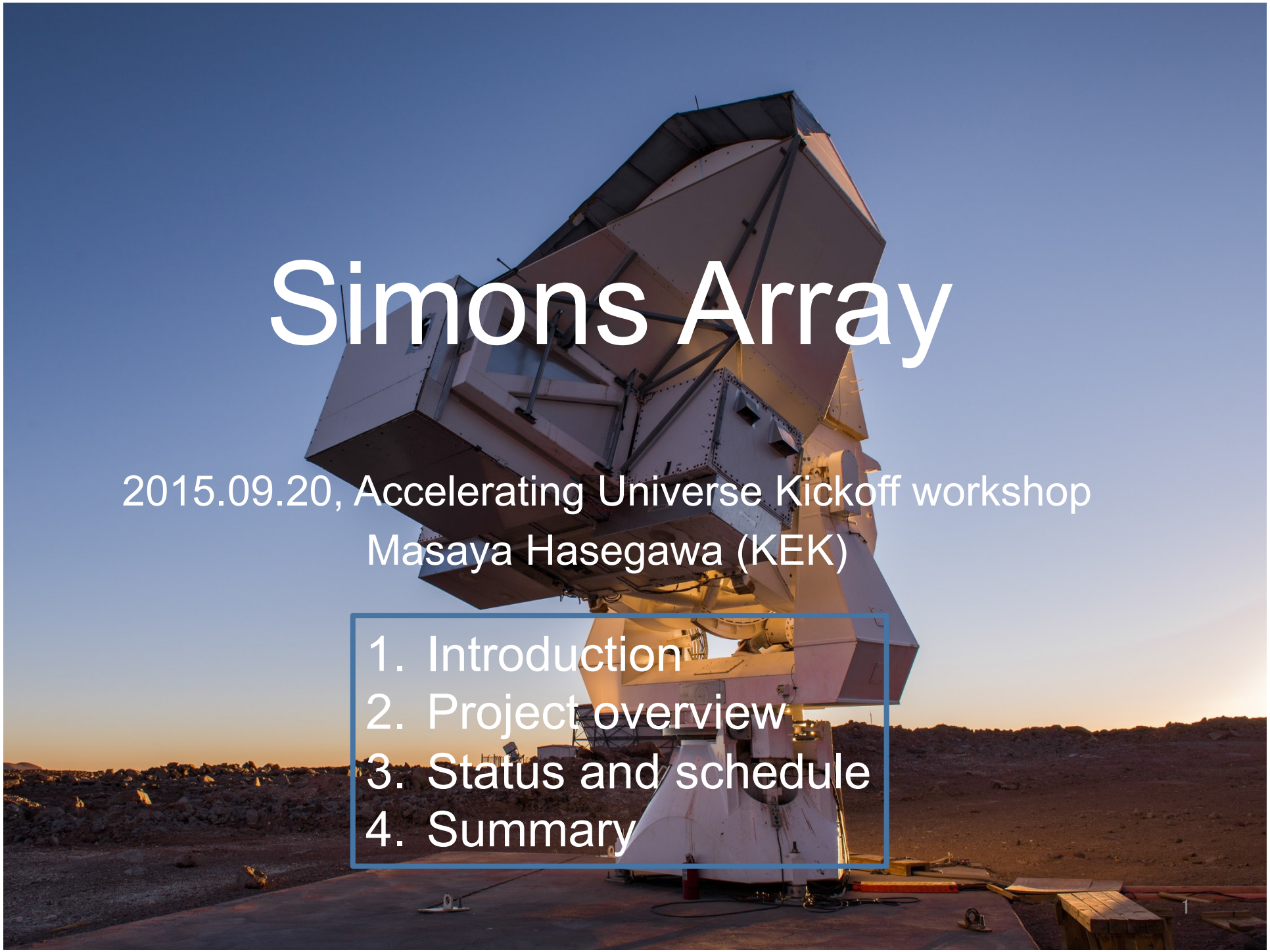


Simons Array

2015.09.20, Accelerating Universe Kickoff workshop

Masaya Hasegawa (KEK)

1. Introduction
2. Project overview
3. Status and schedule
4. Summary

What's Simons Array ?

- Simons Array is
  - Next generation (Stage-III) ground-based CMB polarization experiment
  - Aiming the detection/characterization of 'B-mode' polarization pattern for both small and large angular scales

Target sensitivity

Tensor-to-scalar ratio : $\sigma(r) < 0.01$

Neutrino mass : $\sigma(\Sigma m_\nu) \sim O(10\ \mathrm{meV})$

What's Simons Array ? –cont'd

- Three distinctive features among stage-III experiments.

1) Fast mapping speed

   - World largest array w/ > 20000 detectors

2) Good systematic error control

   - Leverage POLARBEAR experience,

   (σ_{sys} (r) < 0.01 is promising)

3) Cost efficient scalability

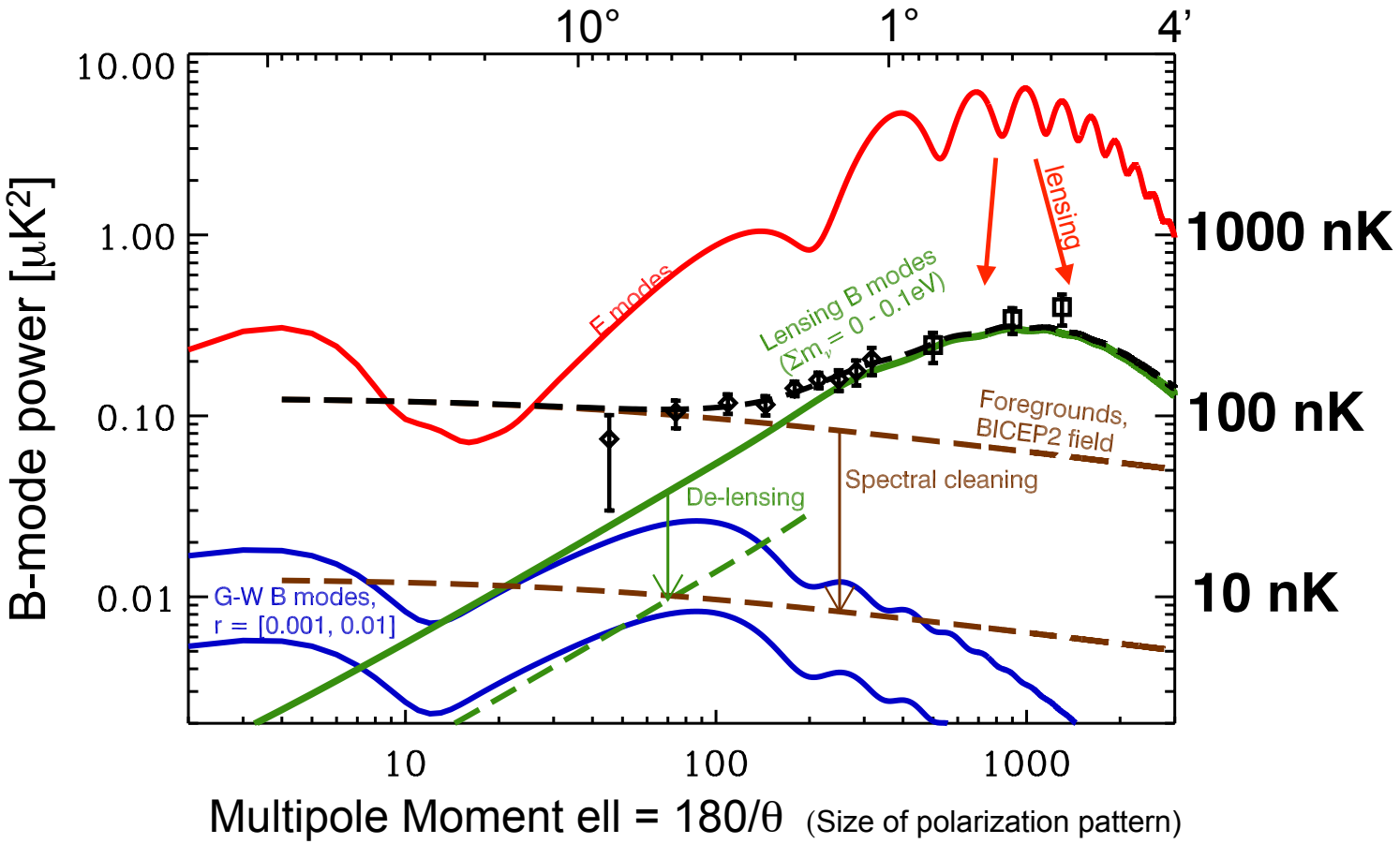
Realization of the Simons Array in Sin-gakujutsu is

- important step towards stage-IV (N_{det} ~ 500,000!),
- good pathfinder for LiteBIRD.

Outline

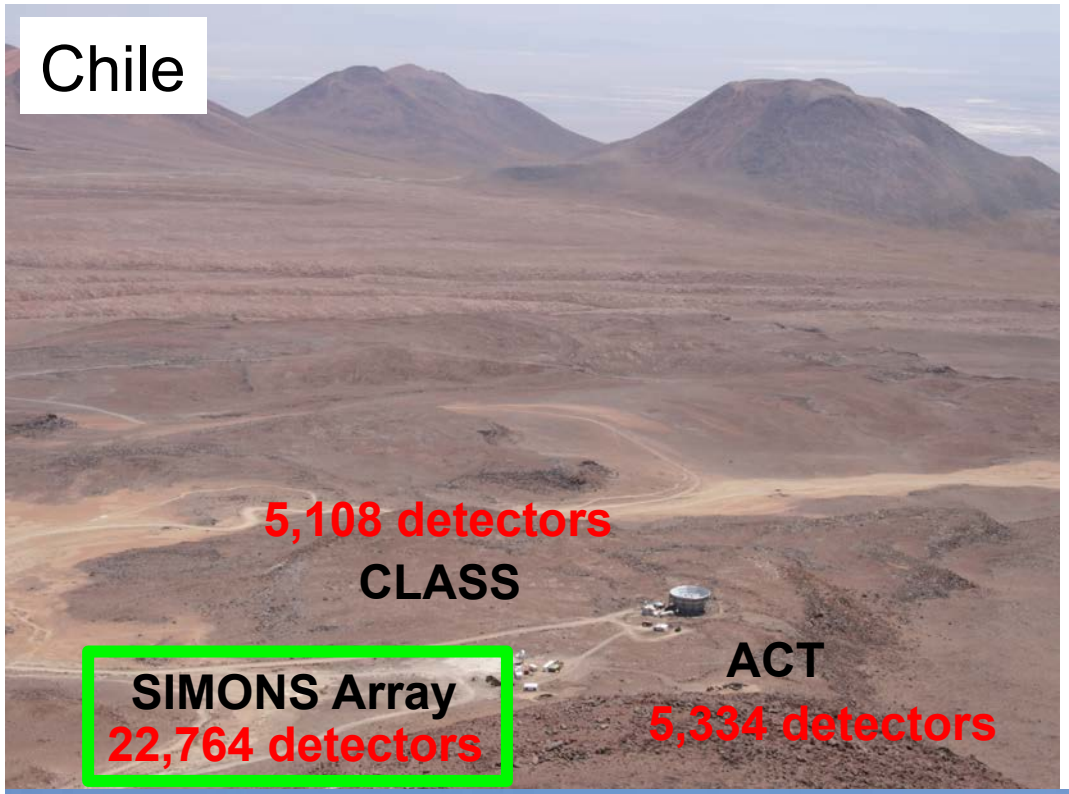
- Project overview
- Status and schedule
- Summary

Chasing inflationary B-modes



For deeper survey (beyond the TT limit), new receiver with

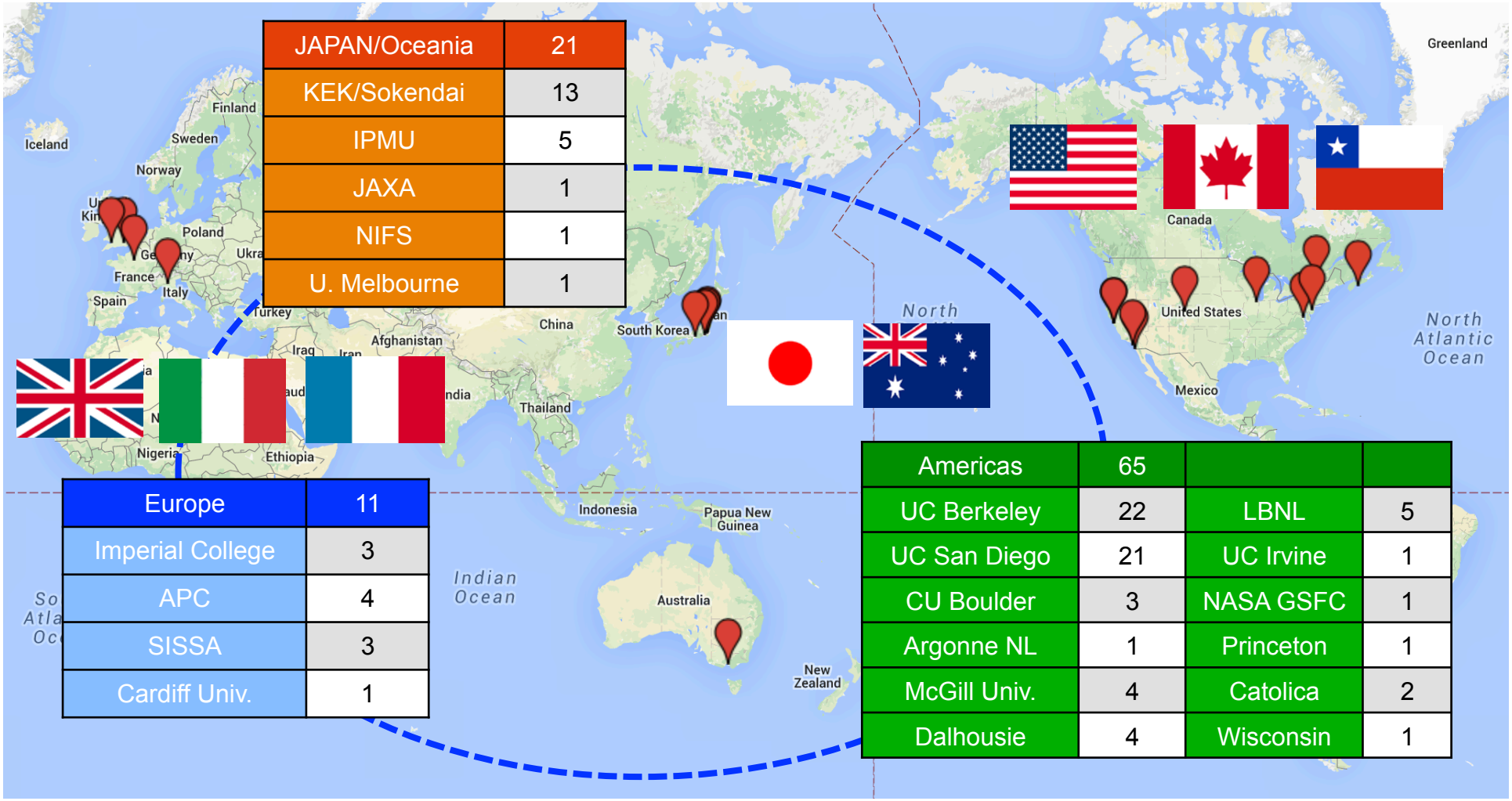
- Multi-color detector to clean foregrounds
- High angular resolution (< 4’) to remove lensing is indispensable.



Stage-III CMB experiments

(ground-based only)

Simons Array Collaboration



JAPAN/Oceania	21
KEK/Sokendai	13
IPMU	5
JAXA	1
NIFS	1
U. Melbourne	1

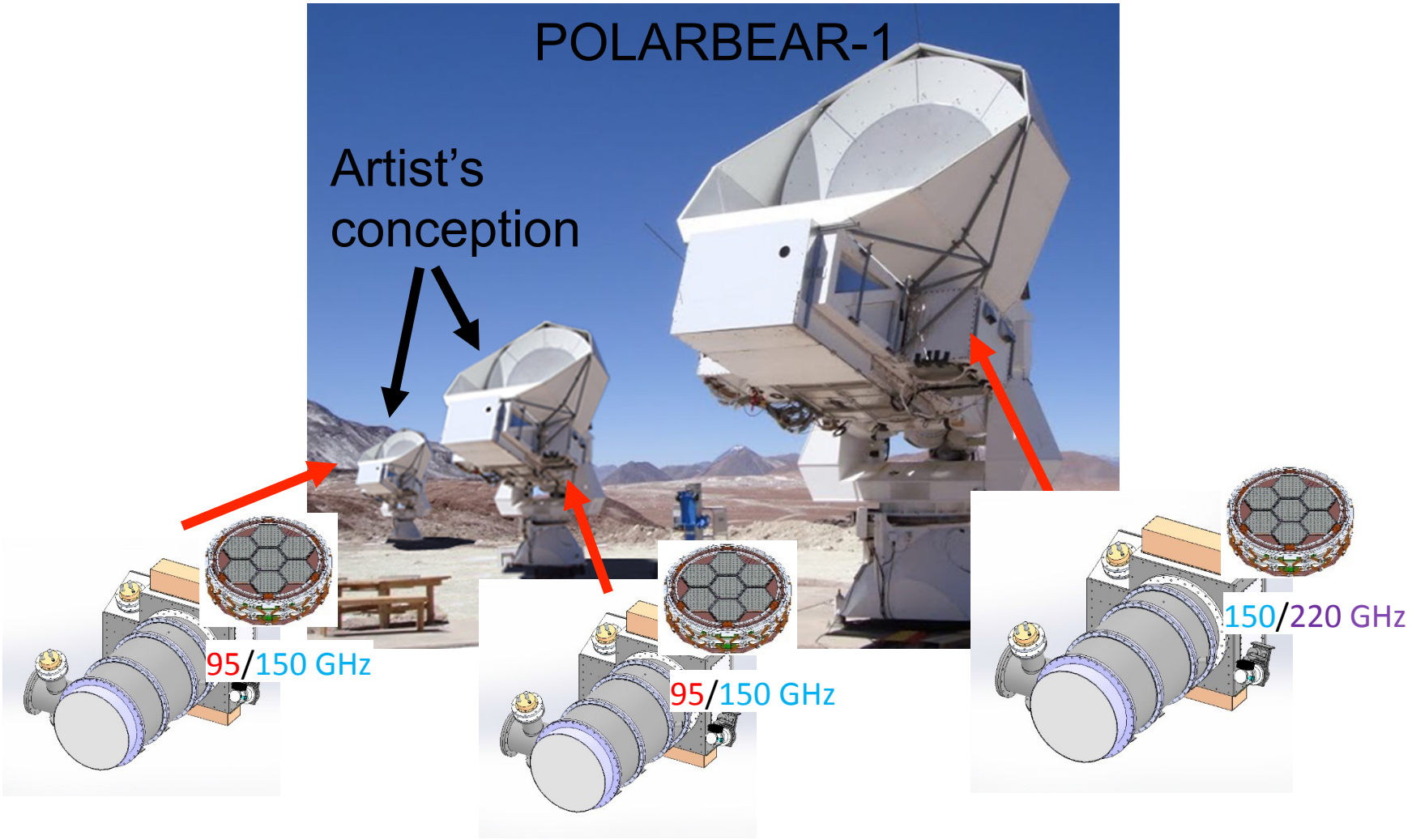
Europe	11
Imperial College	3
APC	4
SISSA	3
Cardiff Univ.	1

Americas	65		
UC Berkeley	22	LBNL	5
UC San Diego	21	UC Irvine	1
CU Boulder	3	NASA GSFC	1
Argonne NL	1	Princeton	1
McGill Univ.	4	Catolica	2
Dalhousie	4	Wisconsin	1

8 countries, 21 institutes, ~97 people

The Simons Array

Expanding POLARBEAR to three multi-chroic telescopes

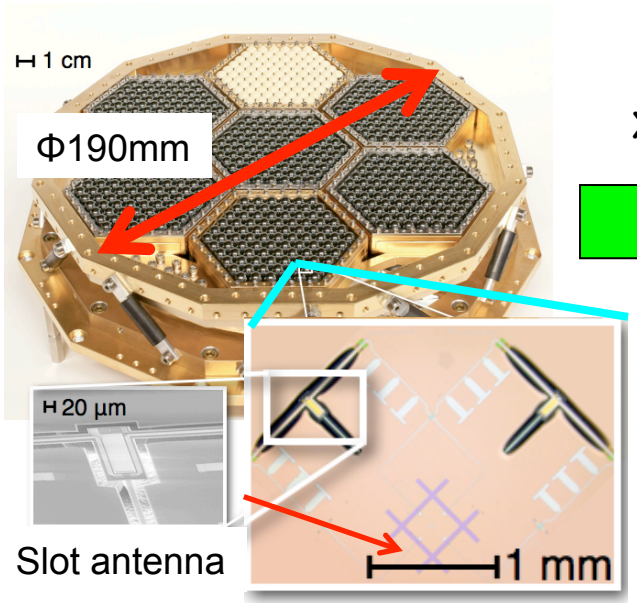


Three upgraded receivers, observing at 95, 150, 220 GHz

POLARBEAR to Simons Array

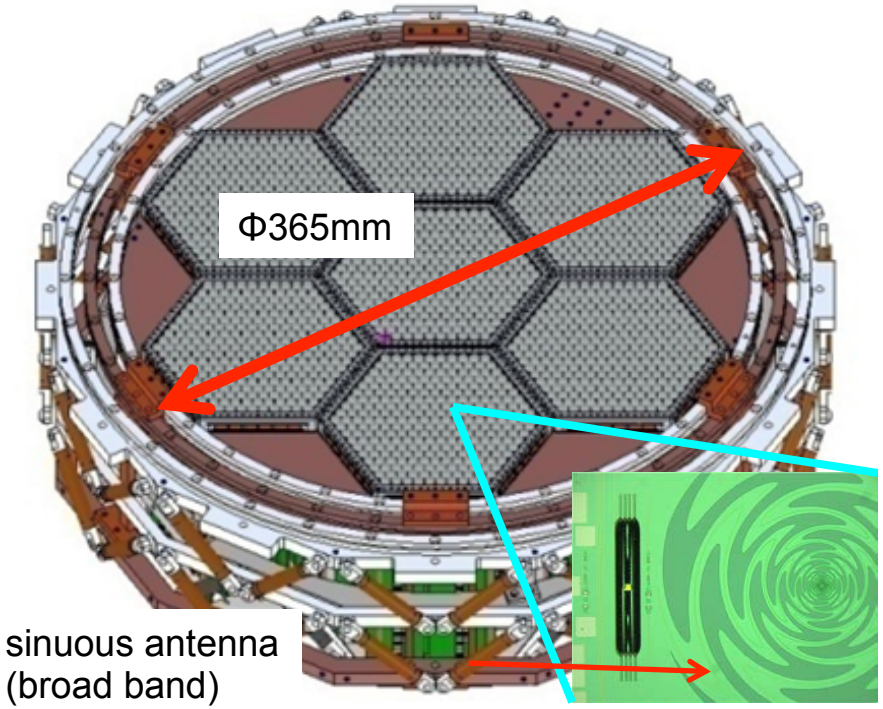
20x leap with multi-chroic pixels

POLARBEAR-1
1274 detector array



x6

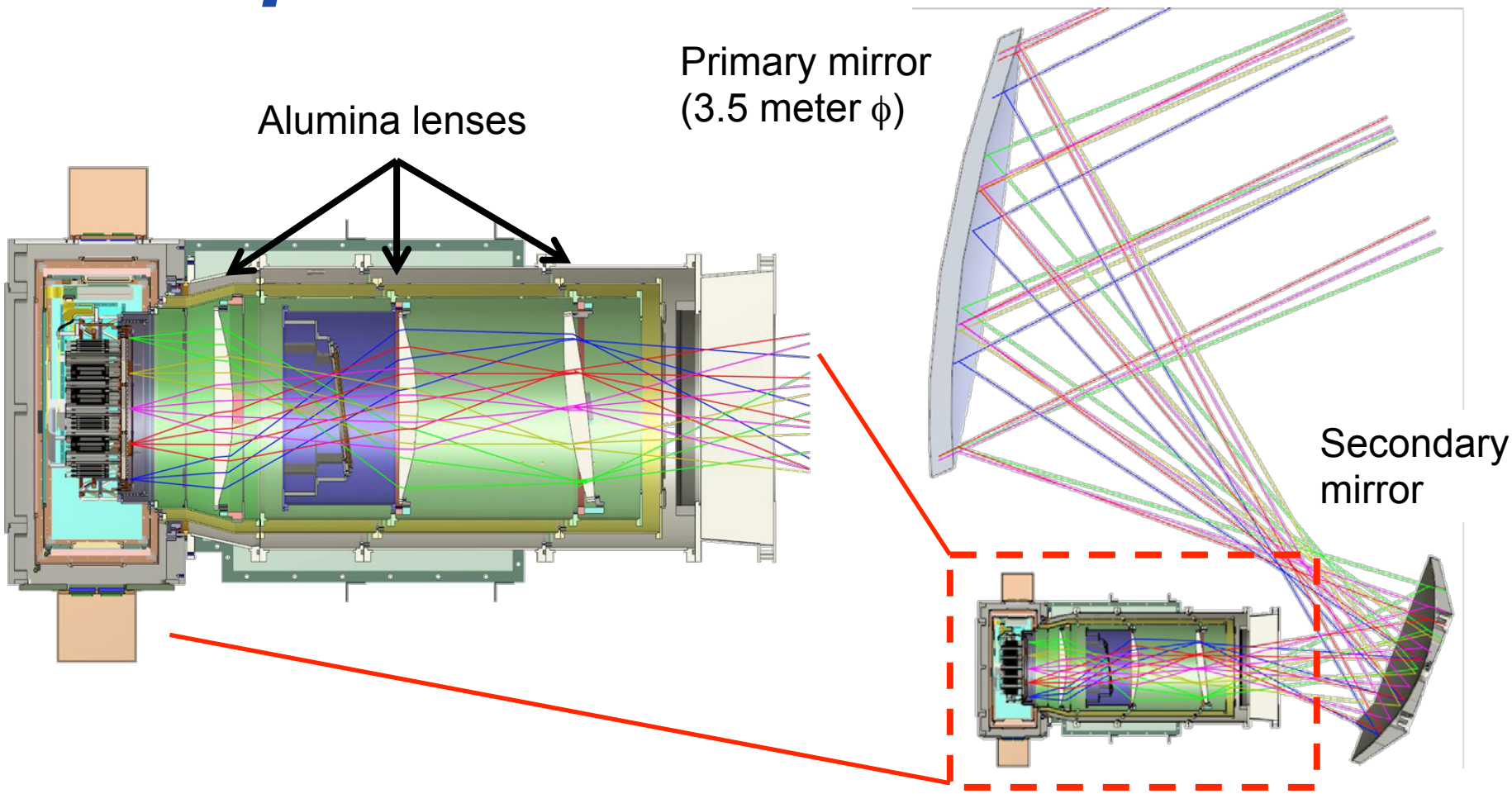
Simons Array focal plane



- Three large focal planes (7588 TES bolometers / focal plane)
- Multi-chroic pixels with 95/150,150/220GHz frequency coverage.

☑ Multi-color detector to clean foregrounds

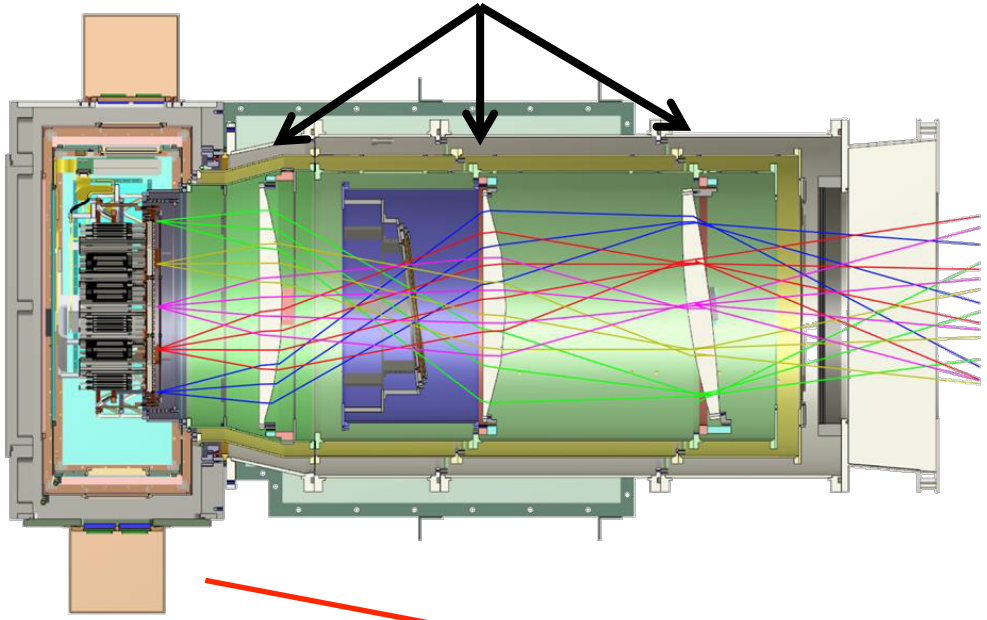
New optics & receiver



- Designed diffraction-limited optics, matching with ϕ3.5m mirror.
  - Angular resolution (~λ/D) : 3.5 arcmin @150GHz

☑ High angular resolution (<4') to remove lensing

New optics & receiver



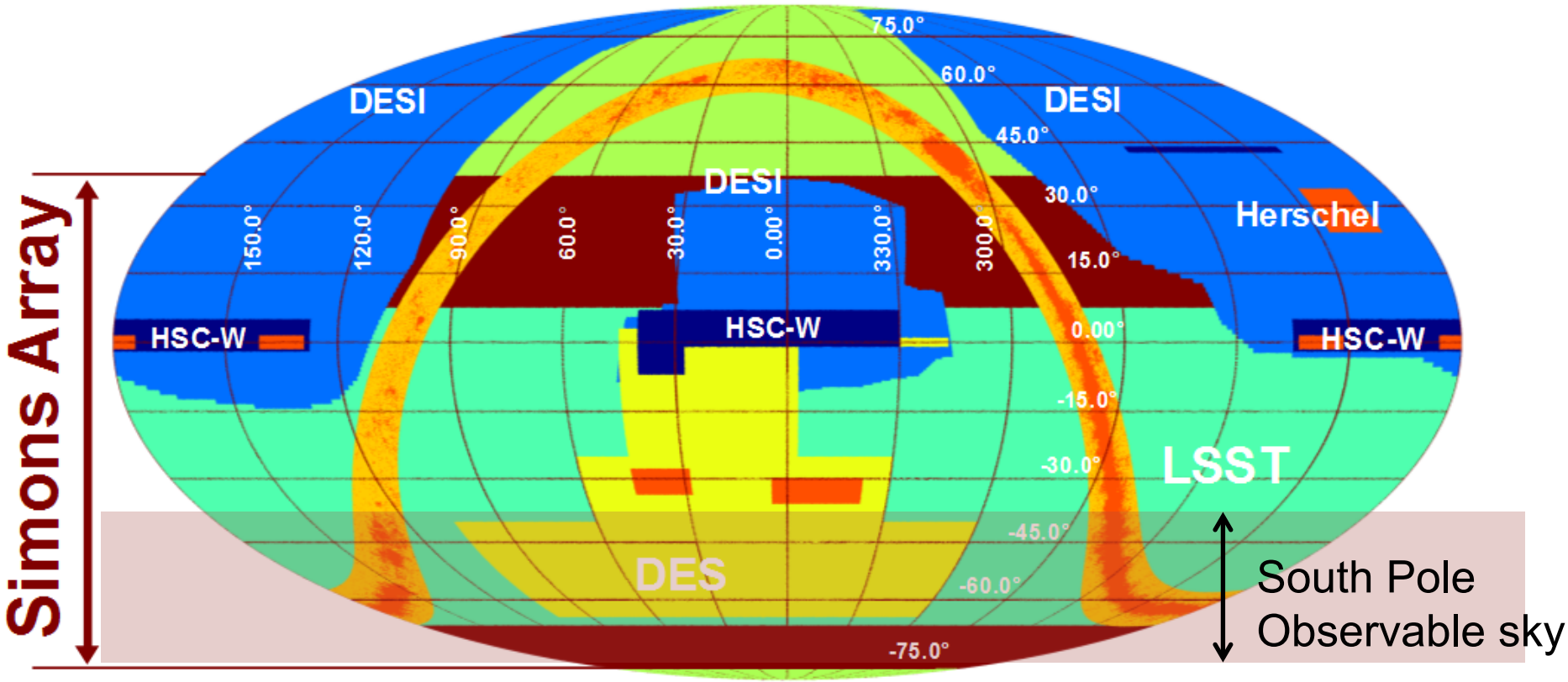
Primary mirror
(3.5 meter ϕ)

ary

- Designed diffraction-limited optics, matching with ϕ3.5m mirror.
  - Angular resolution (~λ/D) : 3.5 arcmin @150GHz

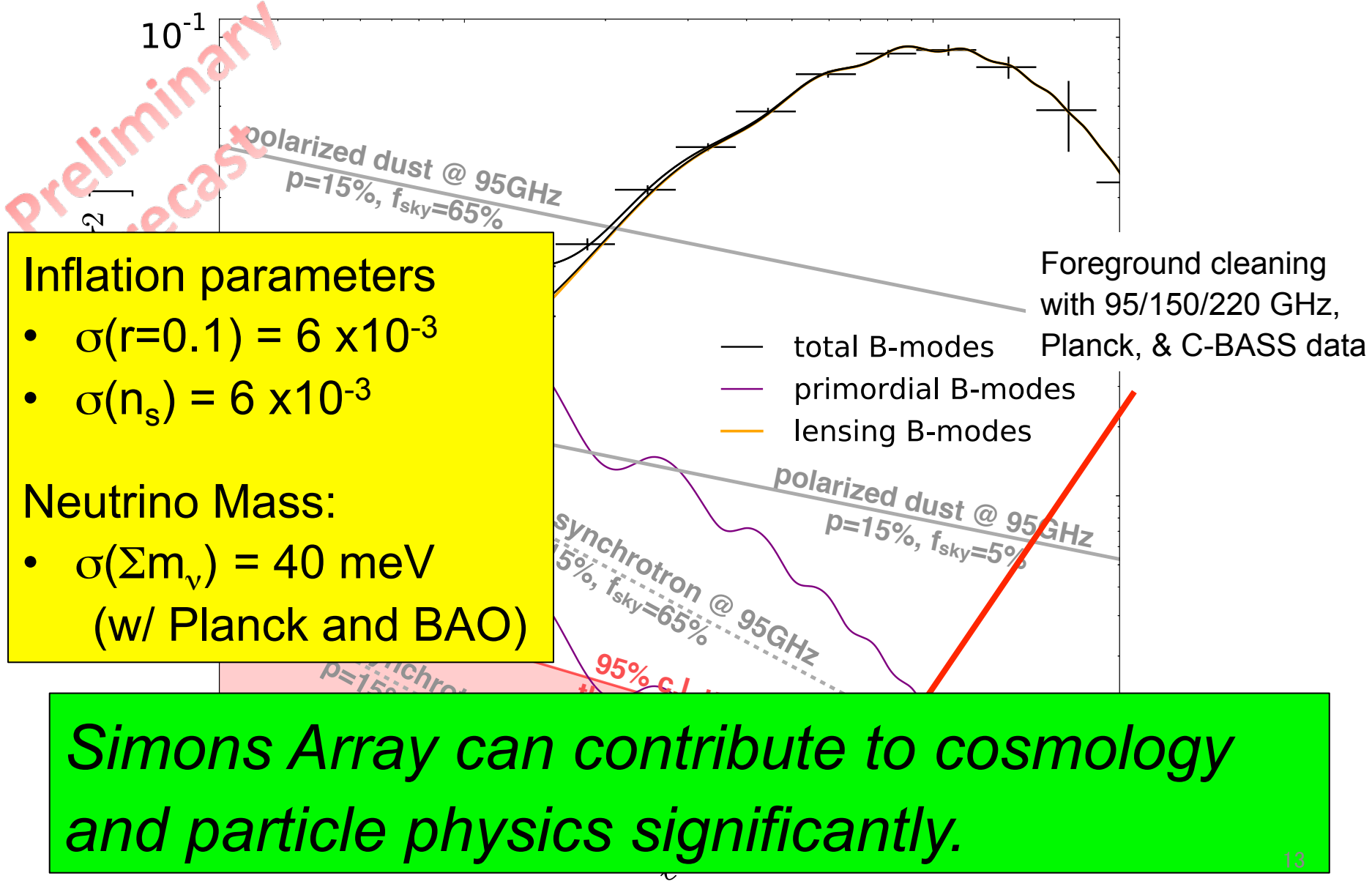
☑ High angular resolution (<4') to remove lensing

(Plus) good location



- SA can access to > 80% of the sky ($\sigma(r) \propto 1/\sqrt{fsky}$)
- Baseline : map ~65% of the sky.
  - Cross-correlated with other observation types.

Simons Array (projected) sensitivity



Inflation parameters

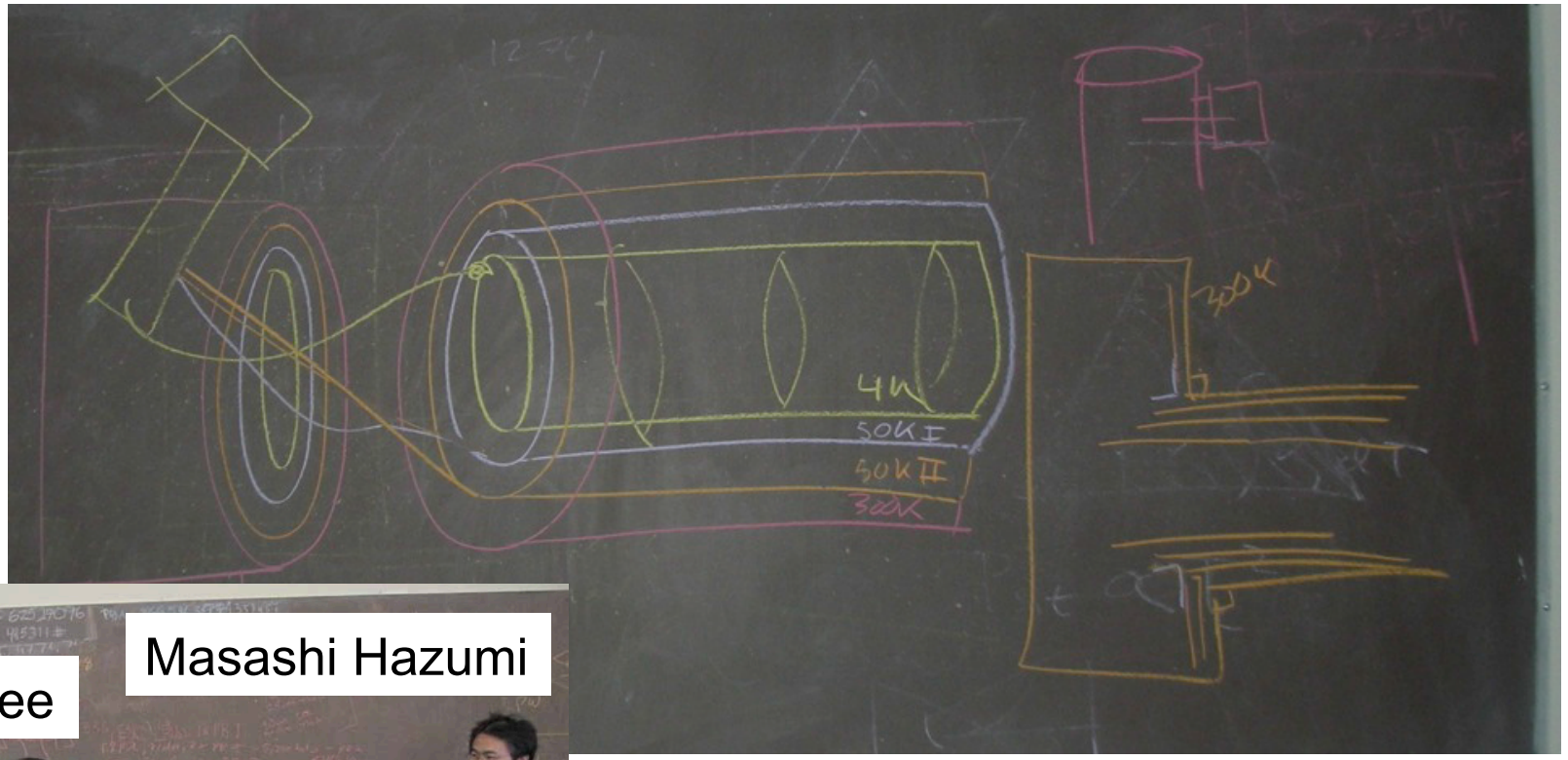
- $\sigma(r=0.1) = 6 \times 10^{-3}$
- $\sigma(n_s) = 6 \times 10^{-3}$

Neutrino Mass:

- $\sigma(\Sigma m_\nu)$ = 40 meV
  (w/ Planck and BAO)

Simons Array can contribute to cosmology and particle physics significantly.

Conceptual drawing of Simons Array receiver

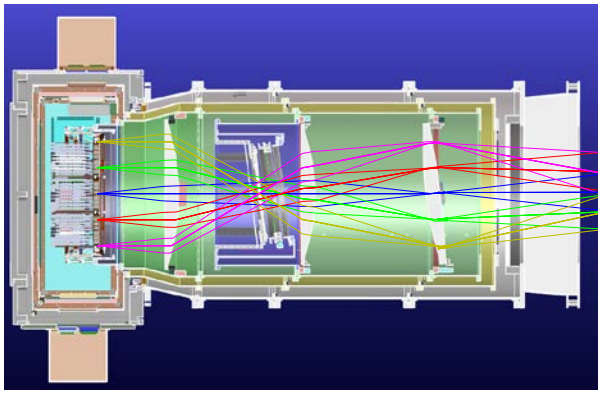


New receiver design kickoff meeting, September 29, 2009

Realization is important.

Activities of B01 members

Receiver



MH (B01 Bun-tan)
+ grad. students
with helps from cryogenic experts
- Takayuki Tomaru (KEK)
- Suguru Takada (NIFS)

Readout

Kaori Hattori (IPMU)

Data management

Haruki Nishino (KEK)
B01 Renkei

Calibration

Osamu Tajima (KEK)
B01 Renkei

Analysis

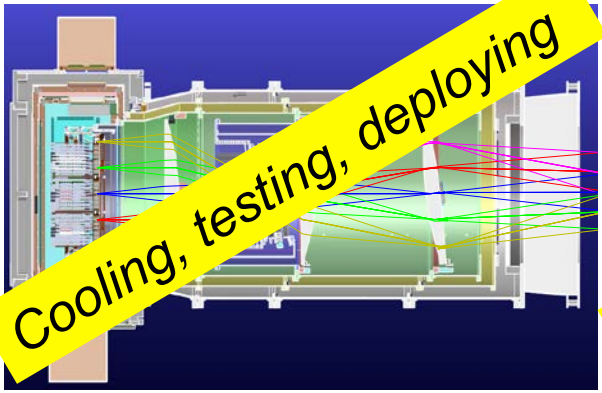
Yuji Chinone (UCB)
B01 Renkei

Organization/Management …

Masashi Hazumi (KEK/IPMU)

Activities of B01 members

Receiver



Cooling, testing, deploying

MH (B01 Bun-tan)

+ grad. students

with helps from cryogenic experts

- Takayuki Tomaru (KEK)
- Suguru Takada (NIFS)

Readout

Multiplexing (8→40MUX)

Kaori Hattori (IPMU)

Data management

Handling 180TB/year data (=1500xPlanck)

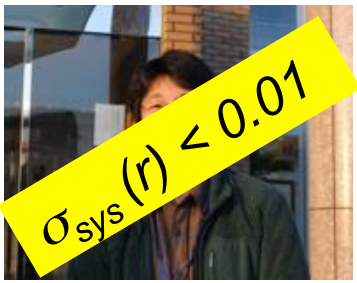
Nishino (KEK)

B01 Renkei

Organization/Management …

Masashi Hazumi (KEK/IPMU)

Calibration



$\sigma_{sys}(r) < 0.01$

Osamu Tajima (KEK)

B01 Renkei

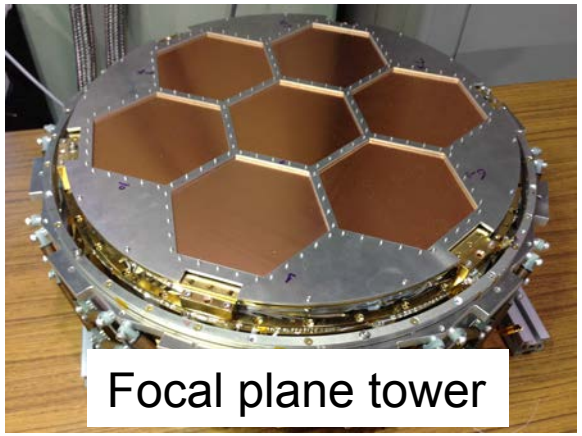
Analysis

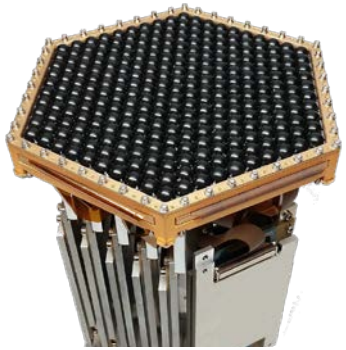
Rapid & reliable Analysis frame

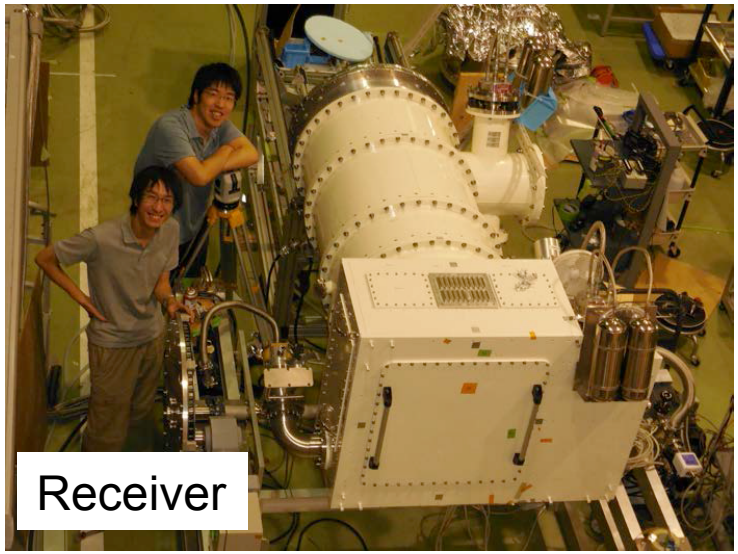
Yuji Chinone (UCB)

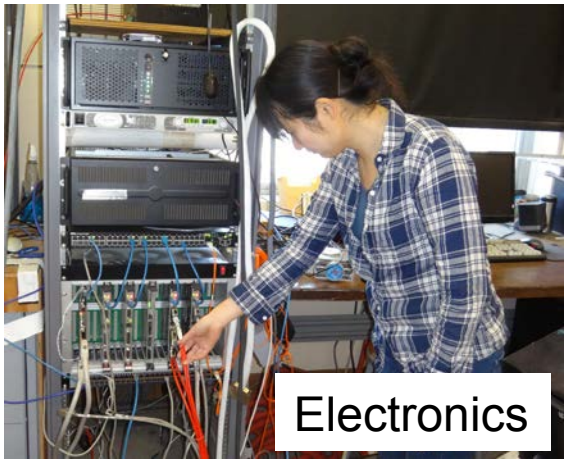
B01 Renkei

1st receiver assembly at KEK


Focal plane tower

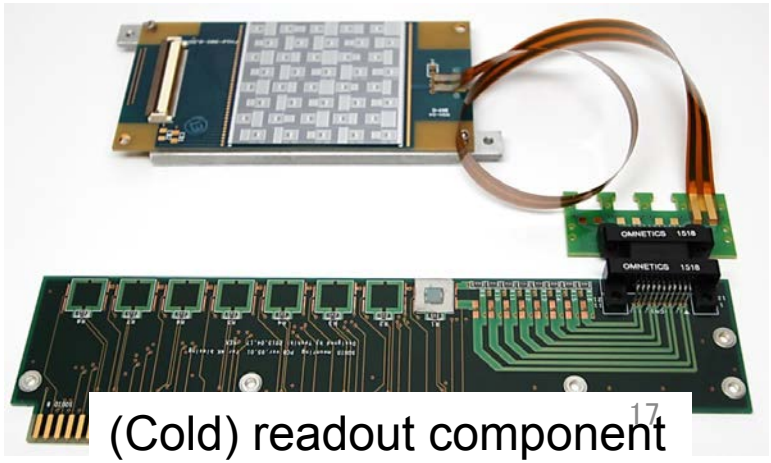

Detector module


Receiver


Electronics

Lab. testing with full equipment will be started soon.

1st receiver will be deployed in 2016.


(Cold) readout component

New telescopes

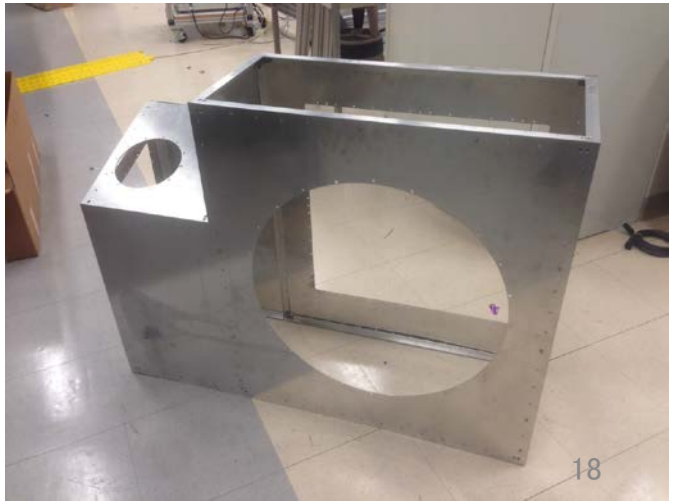
Telescope parts

Primary mirror

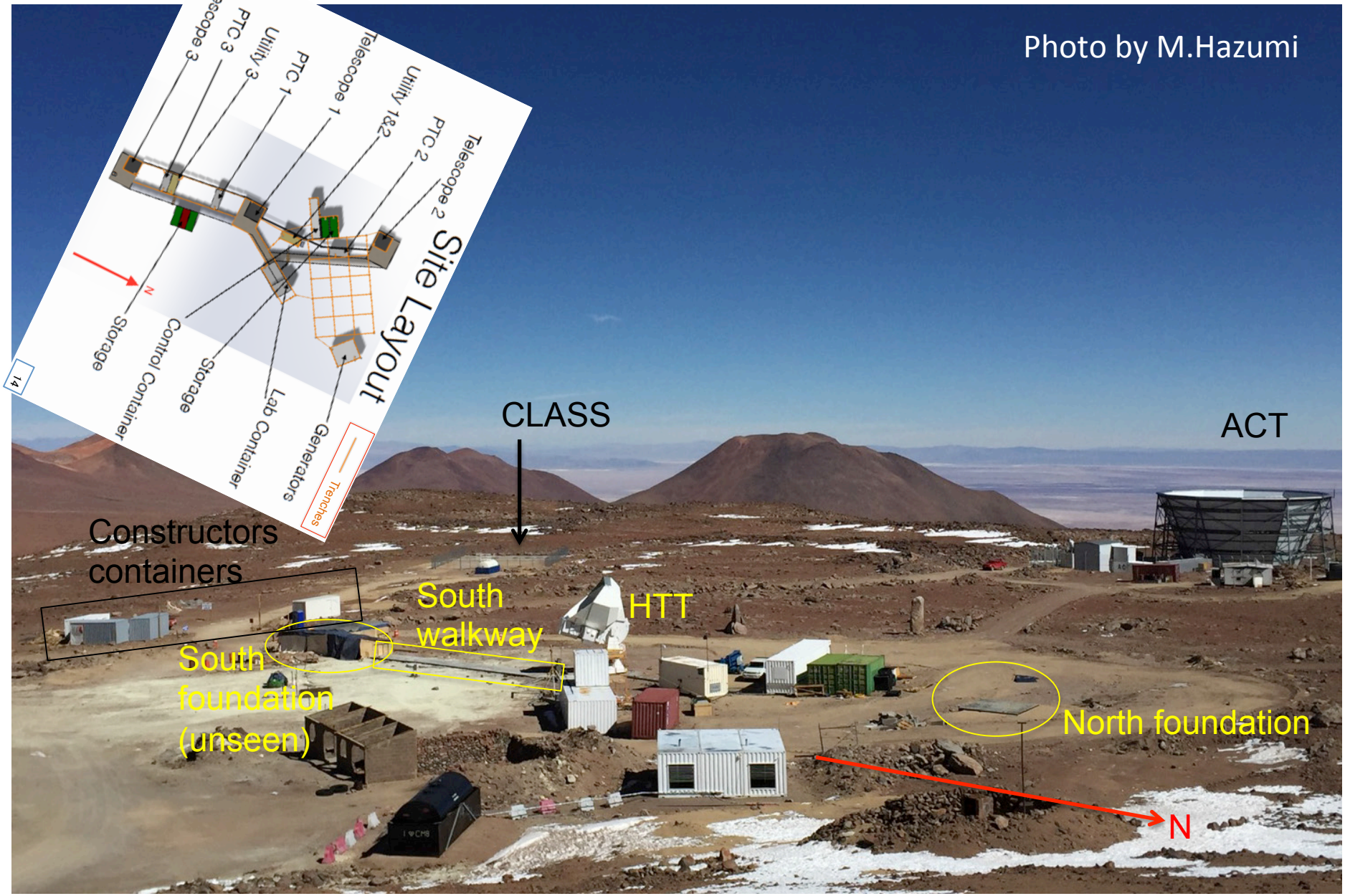
Secondary mirror

- New telescopes will come to chile in mid. next year.
- 2nd & 3rd receivers started to be fabricated.

Cryostat shield for 2nd receiver

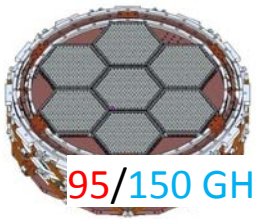


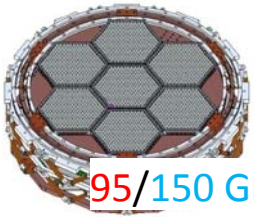
Site preparation

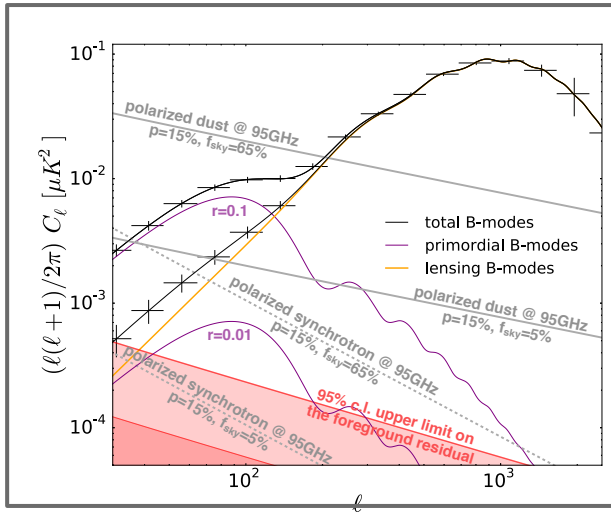


Simons Array Timeline

Deploy 2nd receiver
2 x 7588 det. (95+150 GHz)



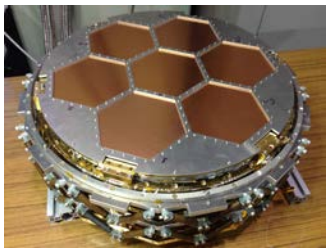


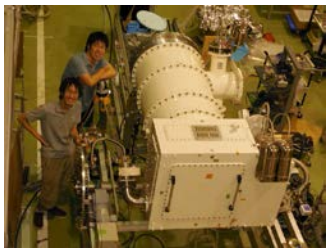


First observation of
- Inflationary B-mode and/or
- Finite neutrino mass effect !

2016 2017 2018 2019 2020

Deploy 1st receiver
7588 det. (95+150 GHz)





Deploy 3rd receiver

Observation w/ full Array will be started.
- 95+150+220 GHz
- > 22,000 detectors

Last words

- Real competition of (inflationary) B-mode hunting is coming in next 5 years.

- The Simons Array is a next generation (Stage-III) ground-based CMB polarization experiment.

- By 2020, the Simons Array will:
  - Constrain (or measure) inflation parameters
    - Tensor-to-scalar ratio : $\sigma(r=0.1) = 6 \times 10^{-3}$
    - Scalar index : $\sigma(n_s) = 6 \times 10^{-3}$
  - Produce a map of projected gravitational potential
    - Neutrino Mass : $\sigma(\Sigma m_\nu) = 40$ meV