GroundBIRD

Mike Peel, on behalf of the GroundBIRD collaboration

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GroundBIRD Collaboration (Japan, Korea, Spain, Netherlands)

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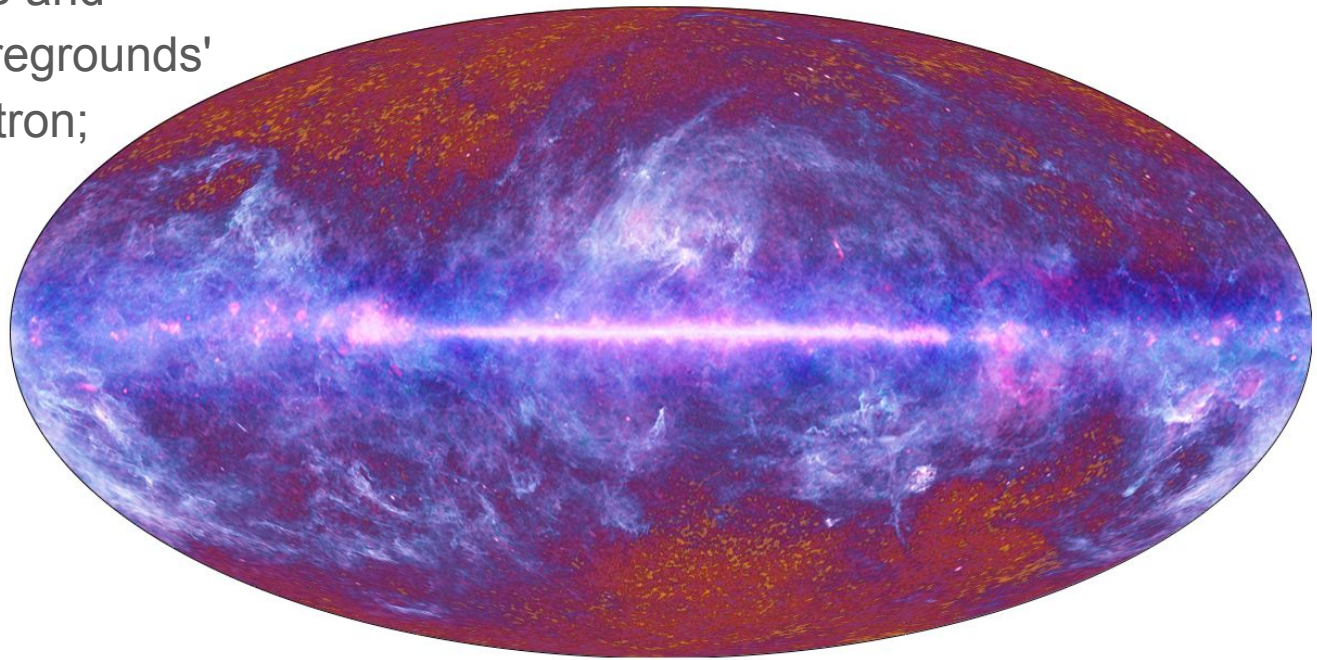
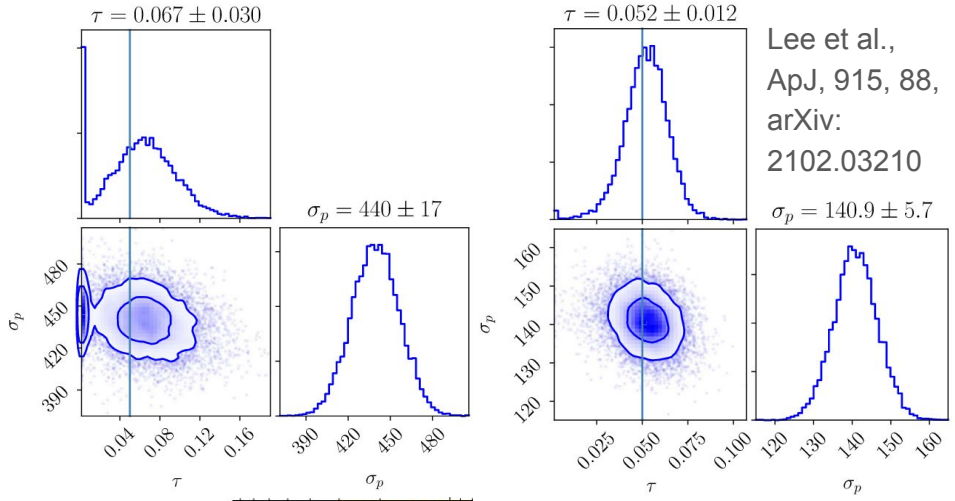
Context

- Single dish ~mm telescopes have long Cosmic Microwave Background history
- e.g., Planck satellite: best all-sky map at e.g., 353, 545, 857GHz
- Measure both the CMB and large angular scale 'foregrounds' (thermal dust; synchrotron; free-free; anomalous microwave emission; CO; ...)
- Small (~10cm) up to large (~2-6m, even ~30m for CMB-HD)

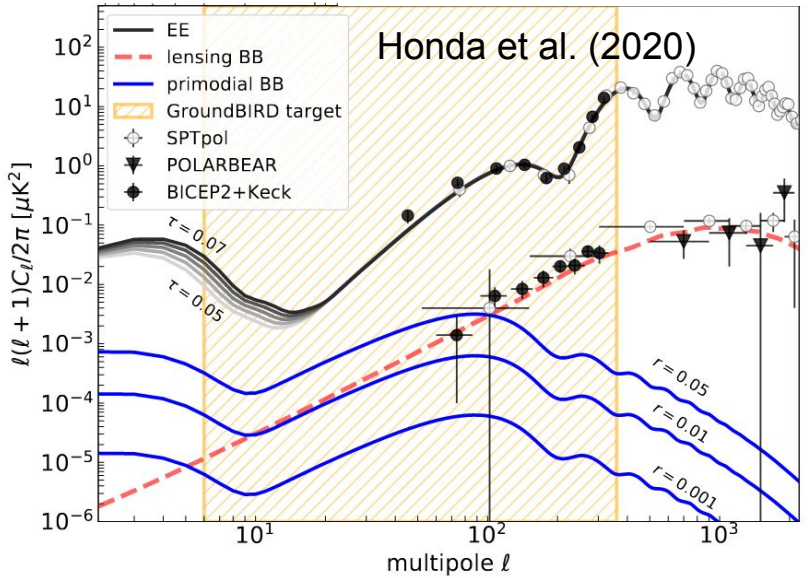


Science goals

- High sensitivity measurements of largest angular scales from ground (ℓ = 6–300)
- B-modes: tensor-to-scalar ratio, *r, to* σ_r < 0.01
  Current best limit from BICEP <0.036 2σ
- E-modes: optical depth to reionisation, τ, to σ_τ < 0.03 (GB only) or <0.012 (with QUIJOTE)
  Gives the epoch at which the universe became ionised: higher value = earlier - known to 0.0073 from Planck but systematics? See Lee et al. (2021)
- Polarised thermal dust emission amplitude + spectral properties
- Northern hemisphere observations
  Complementary to South observations
  Understanding full sky foregrounds is important for satellite observations
- First CMB experiment & wide sky survey using MKIDs!

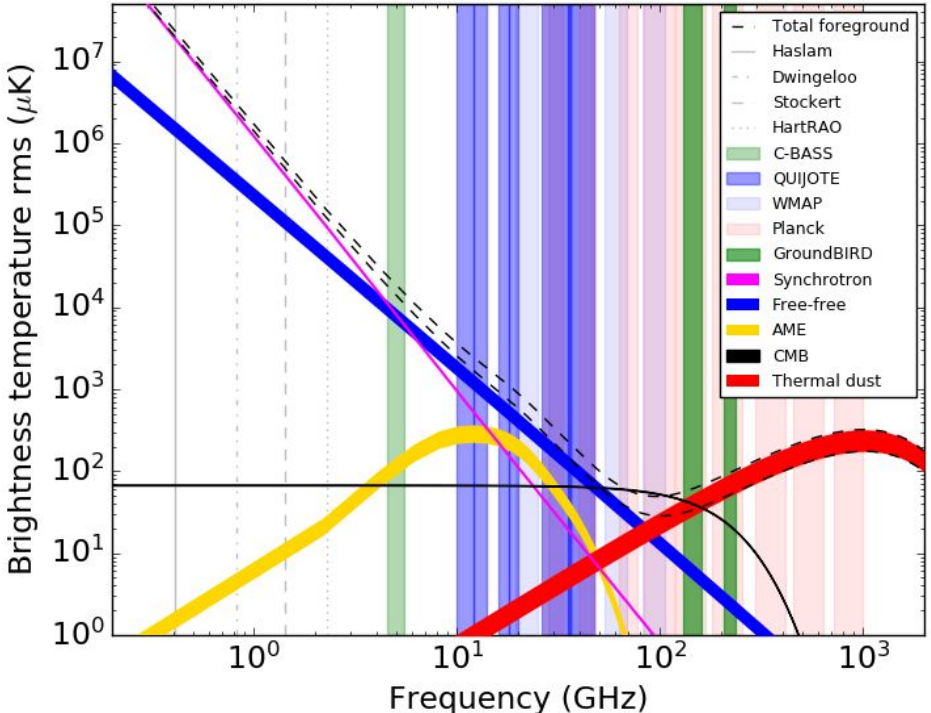


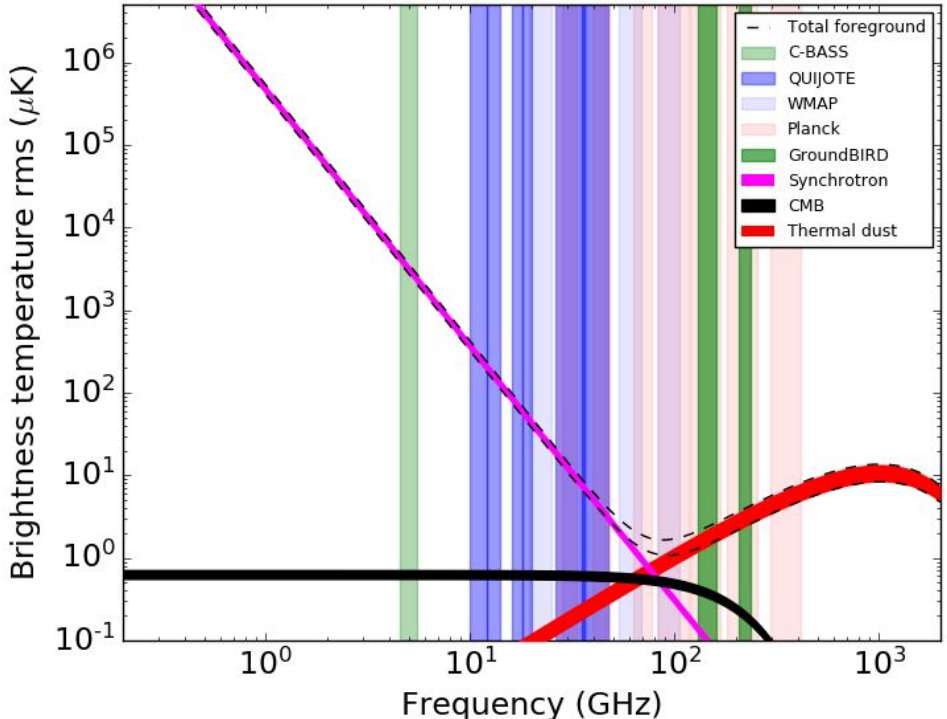
Lee et al., ApJ, 915, 88, arXiv: 2102.03210



Foregrounds

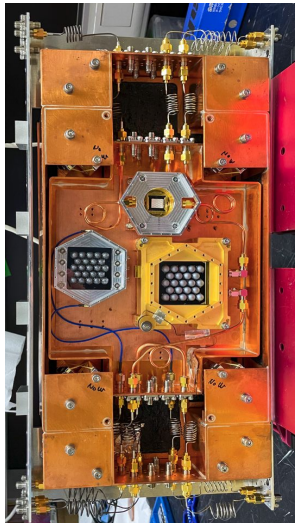
- GroundBIRD sees CMB + thermal dust (intensity + polarisation)
- cf. QUIJOTE seeing CMB + synchrotron (I+P) + free-free + AME
- Need multi-frequency analysis to accurately remove foregrounds + extract CMB

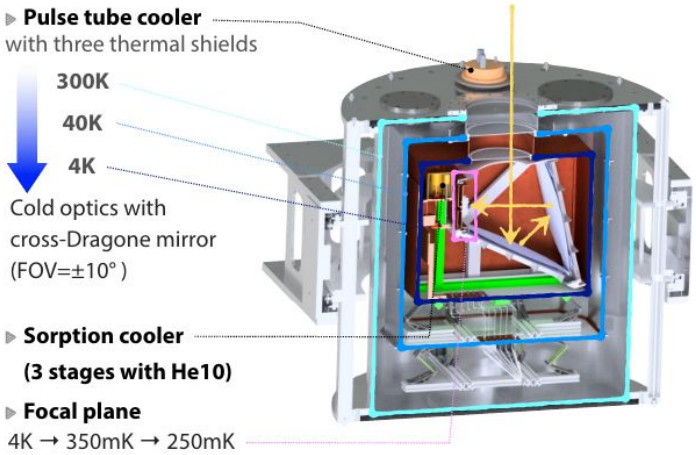


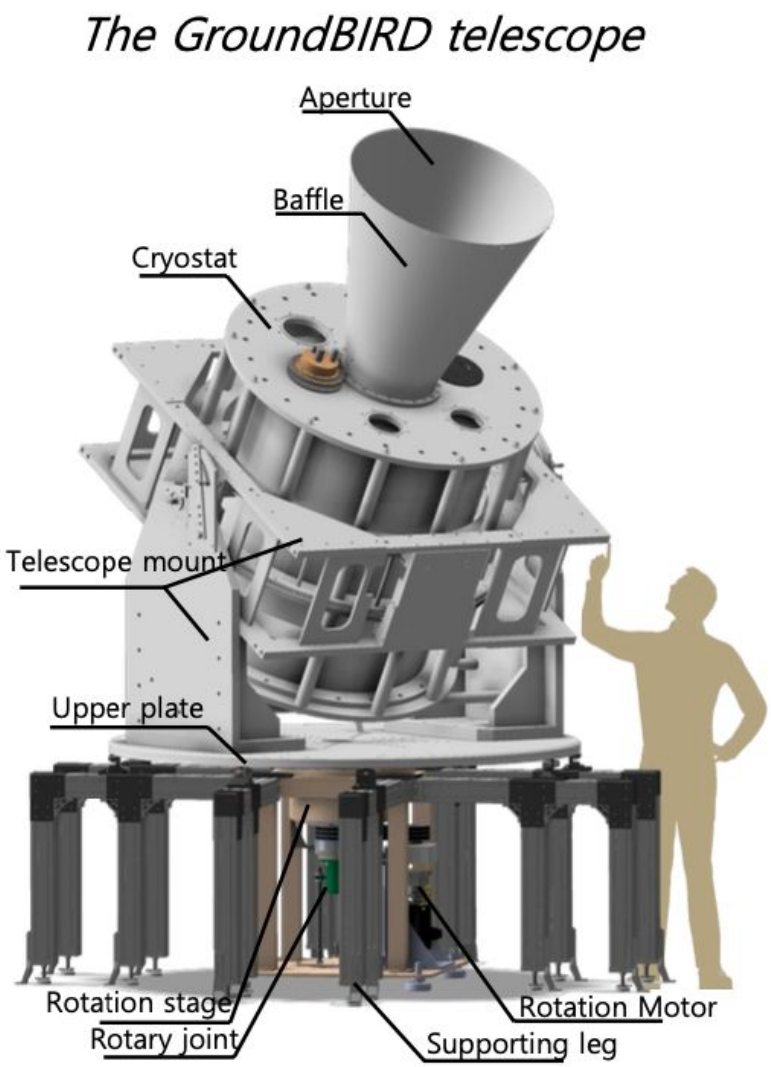


Specifications

- Focal plane at <0.3 K (sorption cooler, PTC)
- KIDS detectors at 145 GHz, 220 GHz
  - 7 x 23 pixel array: 161 total
  - 6 x 150 GHz arrays, 1 x 220 GHz array
- 40 cm cooled (4 K) cross-dragone mirrors
- Resolution around 0.5°/0.3° (145/220 GHz)
- 20 rpm rotation (120°/sec) to minimise 1/f

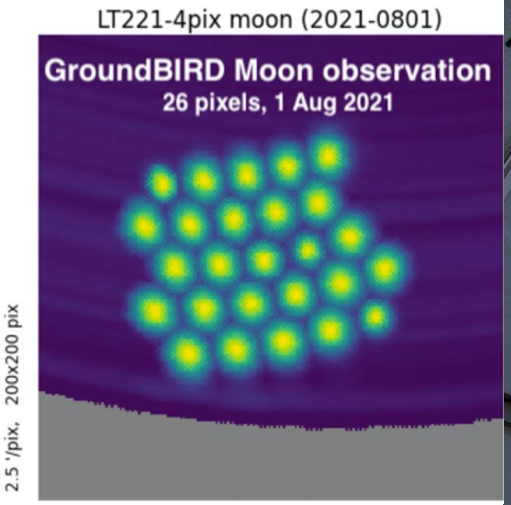


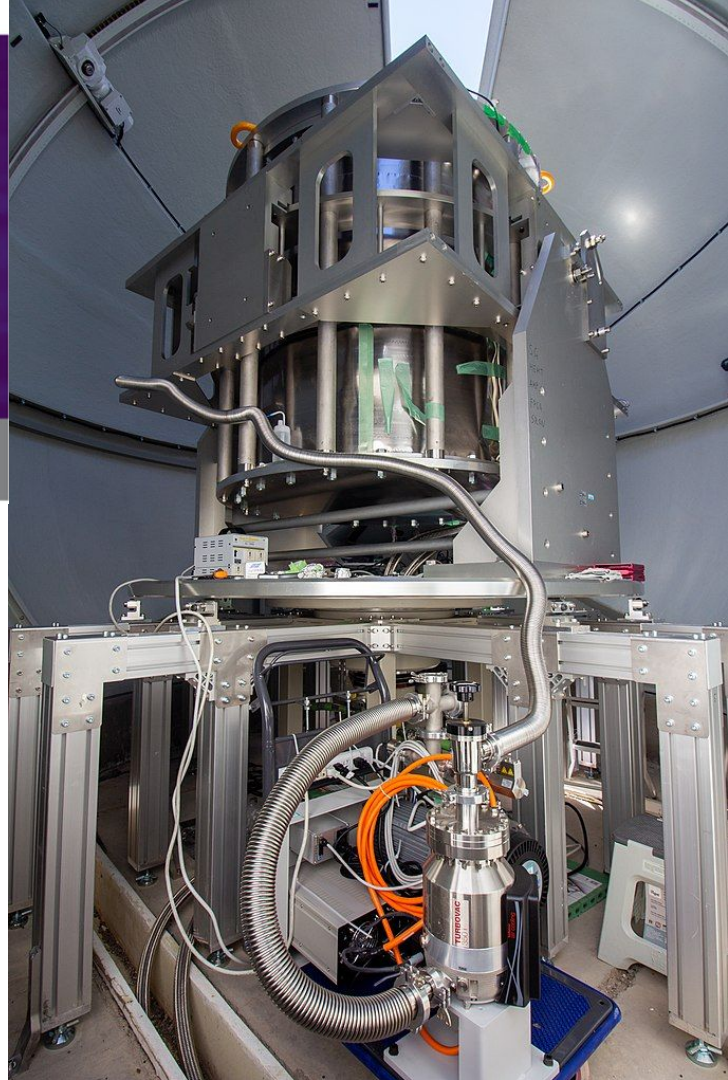




Timeline

- 2018: dome installed
- 2019: instrument installation first light (on moon)
- 2020-2021: covid slowdown...
- 2021: resume observations (Example: Moon w/ 26 KIDs, only 4 lenslets)
- 2022: 2x23 pixel wafers installed, remote observations prepared
- August 2022: start of remote science observations with two wafers
- March 2023: upgrade to full set of 7 wafers
- Continuous survey observations until ~2025





Conclusions

- GroundBIRD is fully installed and prepared for remote observations
- Starting routine science observations shortly!
- 40cm mirror, 120°/s
- Aim is ~110 uK arcmin at 150 GHz in the Northern hemisphere - complementary to Southern obs!
- Will constrain τ with an uncertainty < 0.03, r with an uncertainty < 0.01