Next Generation Sub-millimetre Wave Focal Plane Array Coupling Concepts

ESTEC ITT AO/1-7393/12/NL/MH

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Participants

- 5 Institutes

Science & Telescope Requirements (WP1.1)

- **WP1: Telescope Optics Definition and Requirements Consolidation**
  - **WP1.1: Science and Mission requirements**
    - Detection and characterization of the primordial CMB B modes, Mapping of the CMB lensing, Characterization of non-gaussian signatures in CMB maps, Extragalactic emission from clusters of galaxies, Dust polarization,High redshift dusty galaxies, Low-frequency galactic foreground emission,
  - **Baseline telescope of 1.2m (COrE) or 2.5m (PRISM) to achieve these goals.**

Science & Telescope Requirements (WP1.1)

ν (GHz)	$d\nu/\nu$	resol. arcmin.	phot. noise (μK.s$^{1/2}$)	ΔI_{det} (μK.arcmin)	ΔP_{det} (μK.arcmin)	N_{det}	ΔP_{map} (μK.arcmin)	comment
45	0.33	23.3'	30.47	61	86	6	35.1	synchrotron monitor
75	0.20	14.0'	34.27	69	98	86	10.6	synchrotron monitor
105	0.14	10.0'	38.74	77	109	744	4.0	boundary channel
135	0.11	7.8'	44.60	89	126	996	4.0	CMB channel
165	0.091	6.4'	52.64	103	146	1336	4.0	CMB channel
195	0.077	5.4'	64.03	128	181	1620	4.5	boundary channel
225	0.067	4.7'	80.44	160	226	1350	6.2	dust monitor
285	0.053	3.7'	140.8	280	396	750	14.5	dust monitor
375	0.040	2.8'	403.2	806	1140	470	52.6	dust monitor

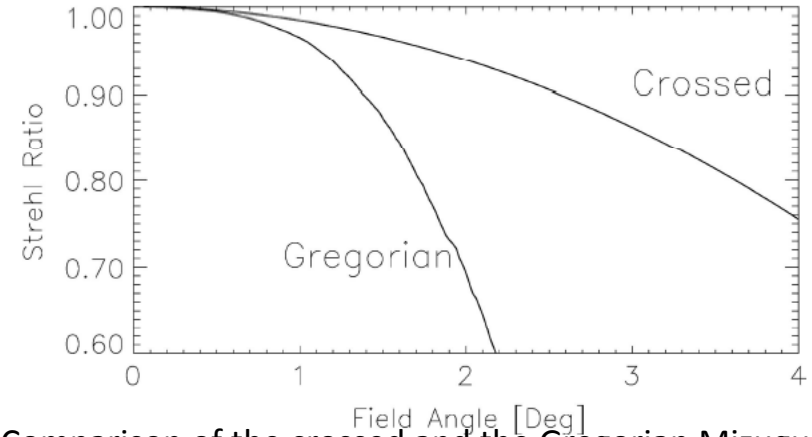
Table 1: Possible set of frequency channels and number of detectors for a COrE-like instrument. The total number of single mode polarised detectors for this configuration is 7358 (i.e. 3679 pairs). This configuration meets requirements for primary B-modes.

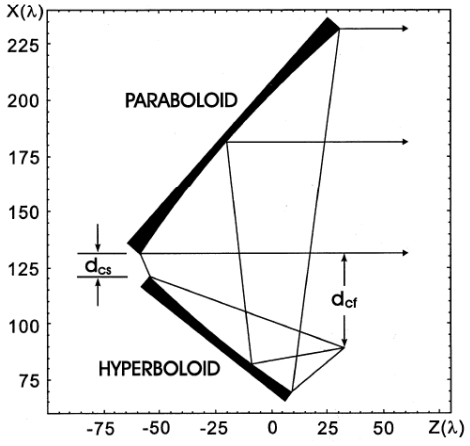
ν (GHz)	$d\nu/\nu$	resol. arcmin.	phot. noise (μK.s$^{1/2}$)	ΔI_{det} (μK.arcmin)	ΔP_{det} (μK.arcmin)	N_{det}	ΔP_{map} (μK.arcmin)	comment
60	0.35	8.4'	27.45	55	78	10	24.7	synchrotron monitor
68	0.35	7.4'	26.59	53	75	18	17.7	synchrotron monitor
90	0.35	5.6'	25.21	50	71	72	8.4	synchrotron monitor
115	0.35	4.4'	24.84	50	71	316	4.0	boundary channel
143	0.33	3.5'	26.30	52	73	336	4.0	CMB channel
185	0.35	2.7'	28.87	57	81	410	4.0	CMB channel
225	0.33	2.2'	36.28	73	103	660	4.0	boundary channel
280	0.33	1.8'	53.92	108	153	306	8.8	dust monitor
340	0.35	1.5'	92.58	185	262	160	20.7	dust monitor
445	0.35	1.1'	316.4	630	891	90	94.0	dust monitor

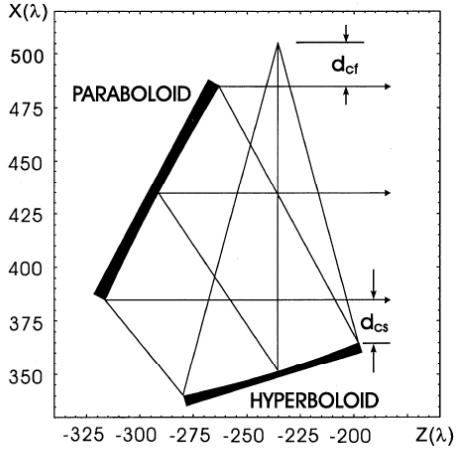
Table 2: Possible set of frequency channels and number of detectors for a PRISM-like instrument. The total number of single mode polarised detectors for this configuration is 2378 (i.e. 1189 pairs). This configuration meets requirements for primary B-modes.

Telescope designs

- Considered off axis reflector designs – Gregonian and crossed Dragone designs considered.
- The Dragonian designs offer a large DLFOV focal plane.
- These can be further broken down into “front fed” and “side fed” designs

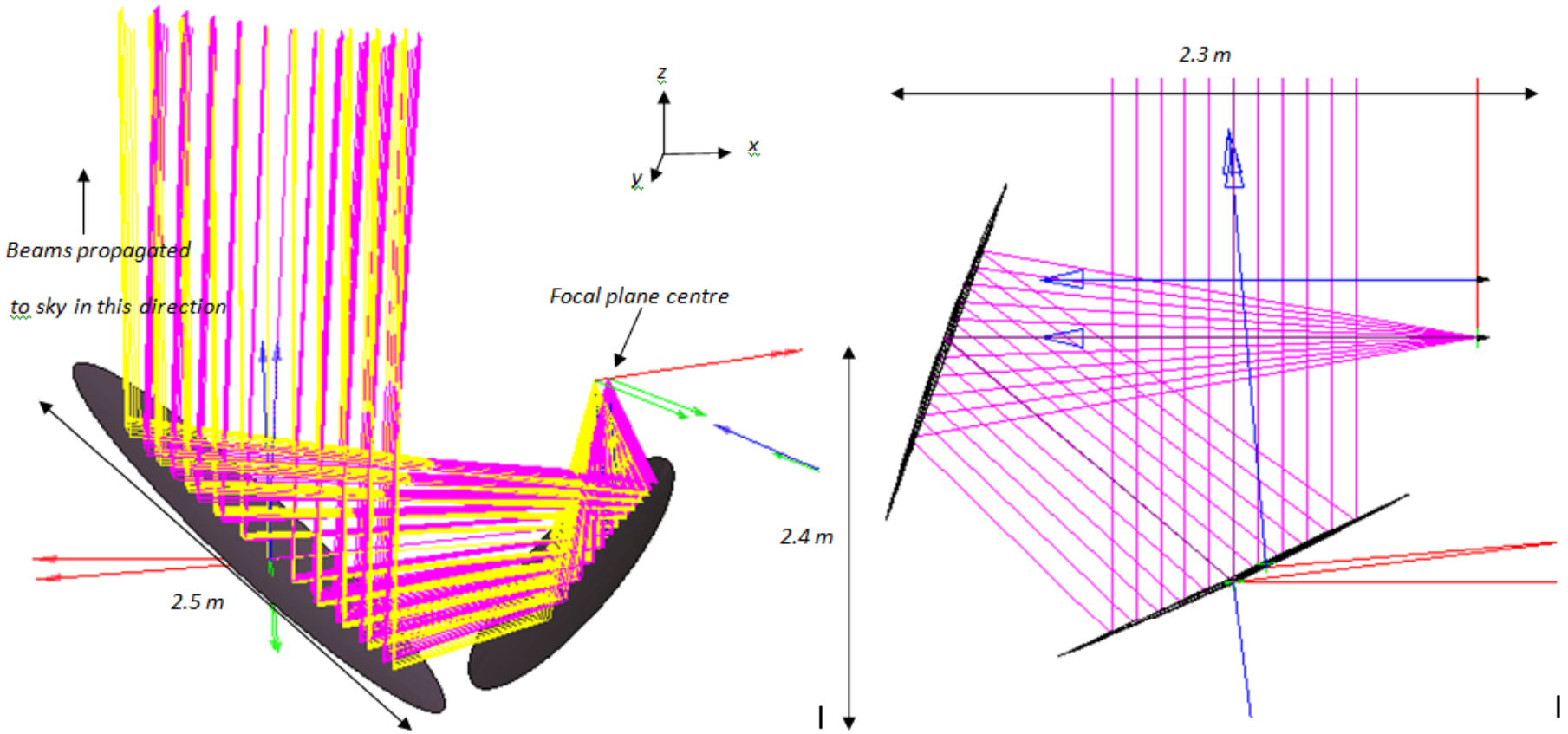






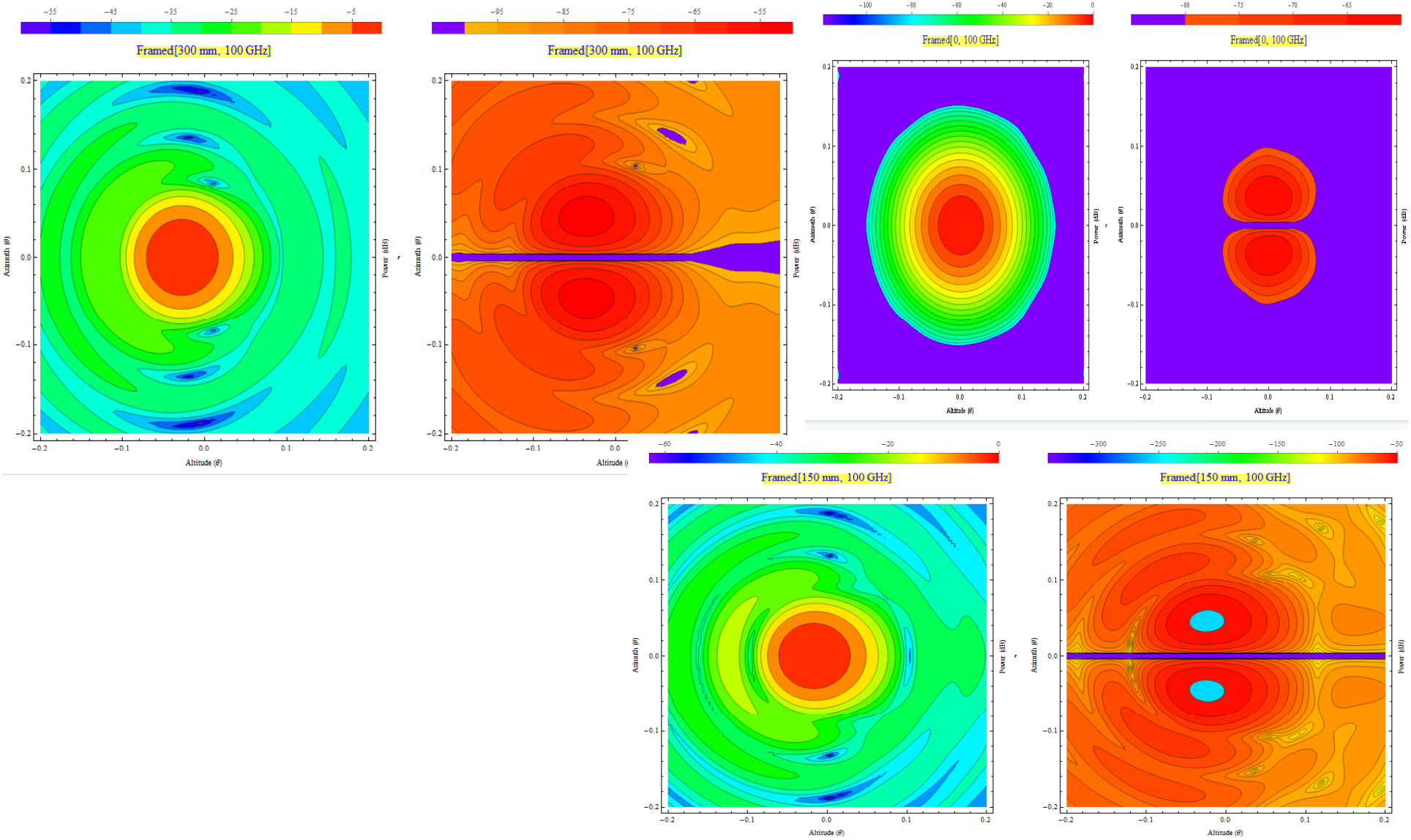
“Comparison of the crossed and the Gregorian Mizuguchi–Dragone for wide-field millimeter wave astronomy,”,Huan Tran et al, 2008 Vol. 47, No. 2 APPLIED OPTICS 103

Science & Telescope Requirements (WP1.2)

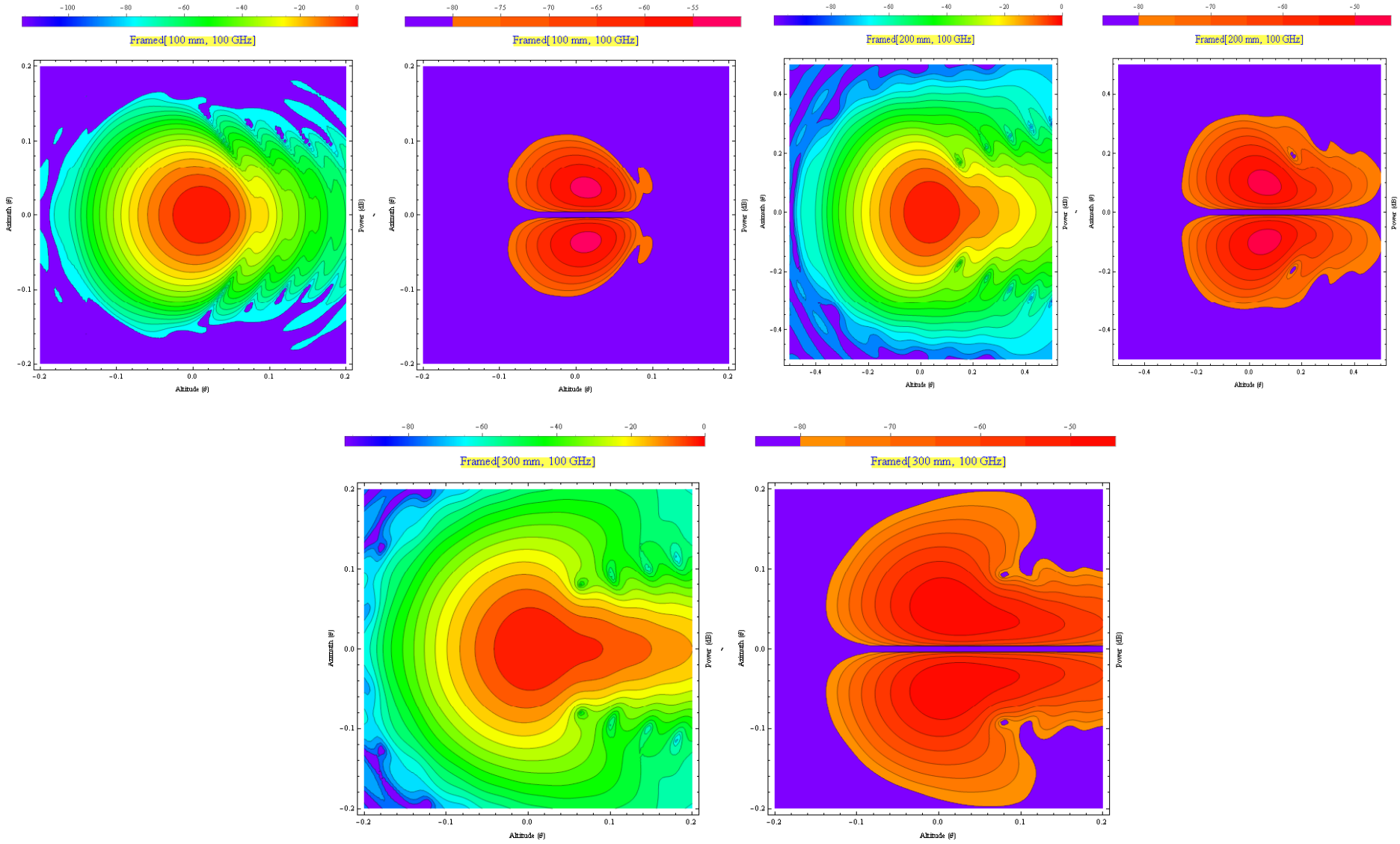


gure 1.1 A schematic diagram of a potential 2.5 m Dragonian telescope design that fits in a Soyuz

Science & Telescope Requirements (1.2 m telescope)



Science & Telescope Requirements ((2.5 m telescope))



Further Work packages

- **WP2: Compact Focal Plane Architecture Concepts (Task 2)**
  - Beam forming technologies
  - Polarisation separation
  - Spectral filtering techniques
  - Review of coupling to detectors

Further Work packages

- **WP3: Focal Plane Coupling Array Design, Trade-off and Baseline Selection (Task 3)**
- RF analysis of focal plane architecture concepts
- Thermal/mechanical analysis of architecture concepts
- Trade off analysis and selection of architecture

Further Work packages

- **Detailed Design and Analysis of Compact Focal Plane Coupling Array Demonstrator (Task 4)**
  - **Potential horn array architectures**
    - **Novel manufacturing techniques**
  - **Potential planar architectures**

Further Work packages

- **WP5: Compact Focal Plane Coupling Array Demonstrator Manufacture (Task 5)**

Further Work packages

- WP6: Compact Focal Plane Coupling Array Demonstrator Test (Task 6)
  - Once chosen, the compact focal plane coupling array Demonstrator shall be manufactured and assembled. The task shall result in a focal plane coupling array Demonstrator ready for test.
  - **Horn array or planar array solutions to be tested optically**

Further Work packages

- **WP7: Design Update and Technology Roadmap Definition (Task 7)**

- All Institutes will review and complete a final report on the design, manufacture and measurement campaigns undertaken
- Knowledge and experience gained will be delivered to ESA including a roadmap to help realise a future B Mode mission