Calibration, test, and General Configuration

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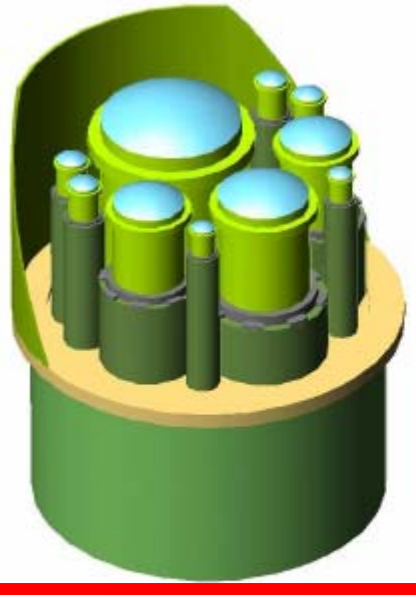
Calibration / Test

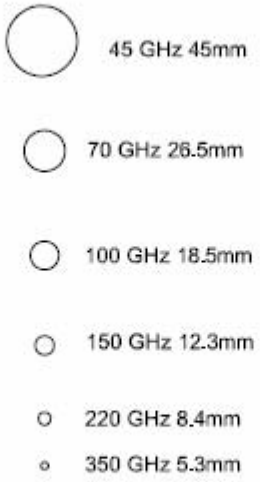
- System level calibration is a big issue (cfr. Planck…).
- The naive solution is to trade the ground calibration for a system validation/test, and rely on subsystem-level calibrations.
- In-Flight calibration:
  - Easier for a pointed satellite with polarization modulator
  - More difficult, but duable, for a scanning system (see e.g. EPIC proposal)

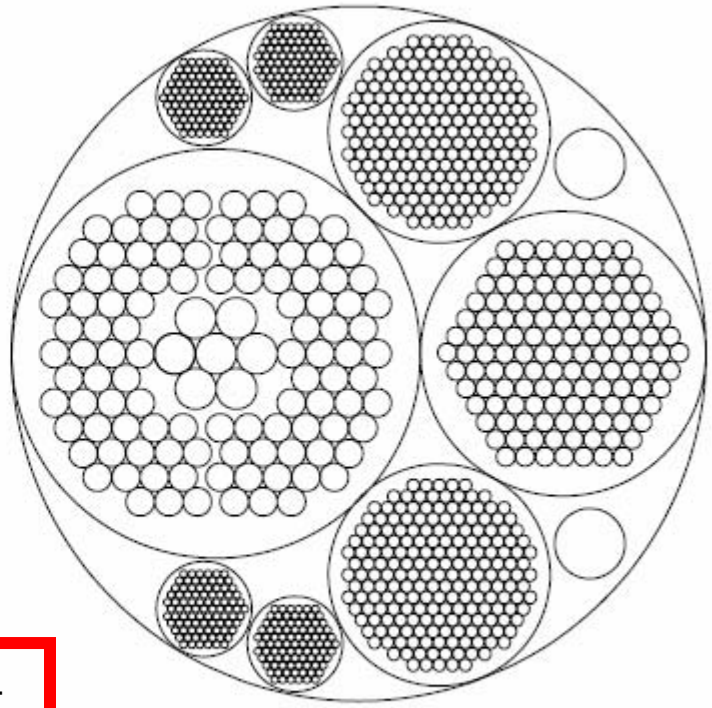
- Now let’s focus on the General Configuration, given the situation.

Configuration 0 - Scaling-up the B-pol proposal :

Freq. band (GHz)	45	70	100	143	217	353
$\Delta\nu$	30%	30%	30%	30%	30%	30%
ang. res.	15deg	68'	47'	47'	40'	59'
# horns	2	7	108	127	398	364
det. noise ($\mu K \cdot \sqrt{s}$)	57	33	53	53	61	119
Q & U sens. ($\mu K \cdot$ arcmin)	33	23	8	7	5	10
Tel. diam. (mm)	45	265	265	185	143	60







Optimize Distribution of Detectors in Bands –
Increase size of 100 GHz telescope ?
Stress improvement in TRL wrt 2007 proposal

Not the option I prefer because

- We need to widen the science case and avoid the null-result possibility
- We need to show the achievements of the community and, consequently, its increased ambitions
- We need to minimize the scooping risk
- We need to maximize the thrill-factor of this proposal

The quest for angular resolution

- Necessary to convert B-pol into the “Fundamental Physics Probe” and to achieve more Galactic science.
- It is more generally a quest for angular resolution *and* sensitivity
- A good improvement can be obtained by increasing both the aperture and the number of detectors (wrt 2007 proposal).
- My proposal: 1.2 m ap. (7.0’ FWHM @ 150 GHz), N (TBD) detectors (naked/horns, multi-f … need a focal-plane focused team)
- In the coming months we need to carry out a quick/honest investigation to decide if this can fit the tight cost-mass-size constraints of an ESA M mission.

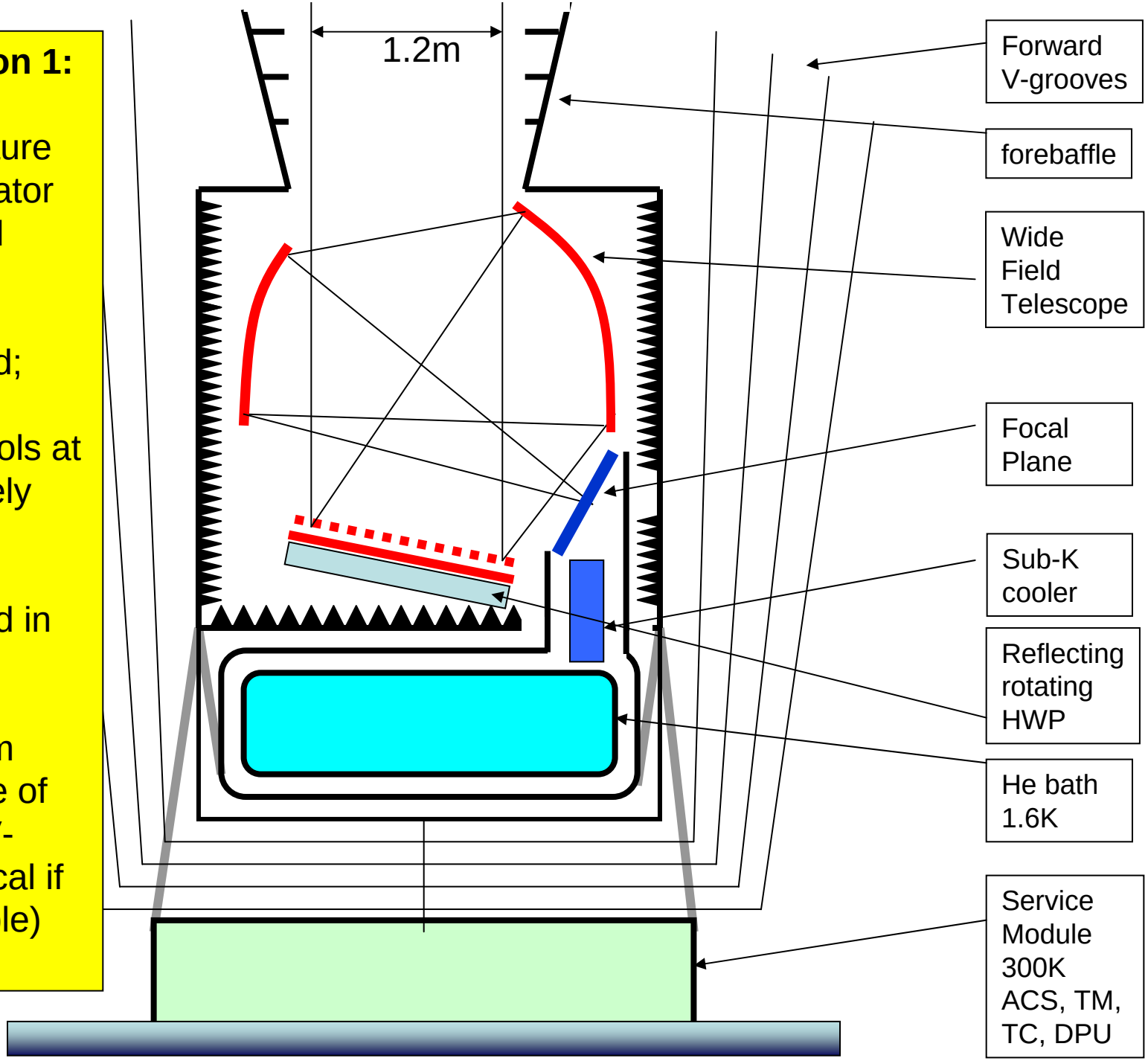
Configuration 1:

- 1.2 m aperture
- cold modulator is first optical element

- Launch cold; Telescope assembly cools at 30K radiatively

- focal plane cover opened in space

- fits the 3.9m diameter fare of the Soyuz (V-grooves critical if not deployable)



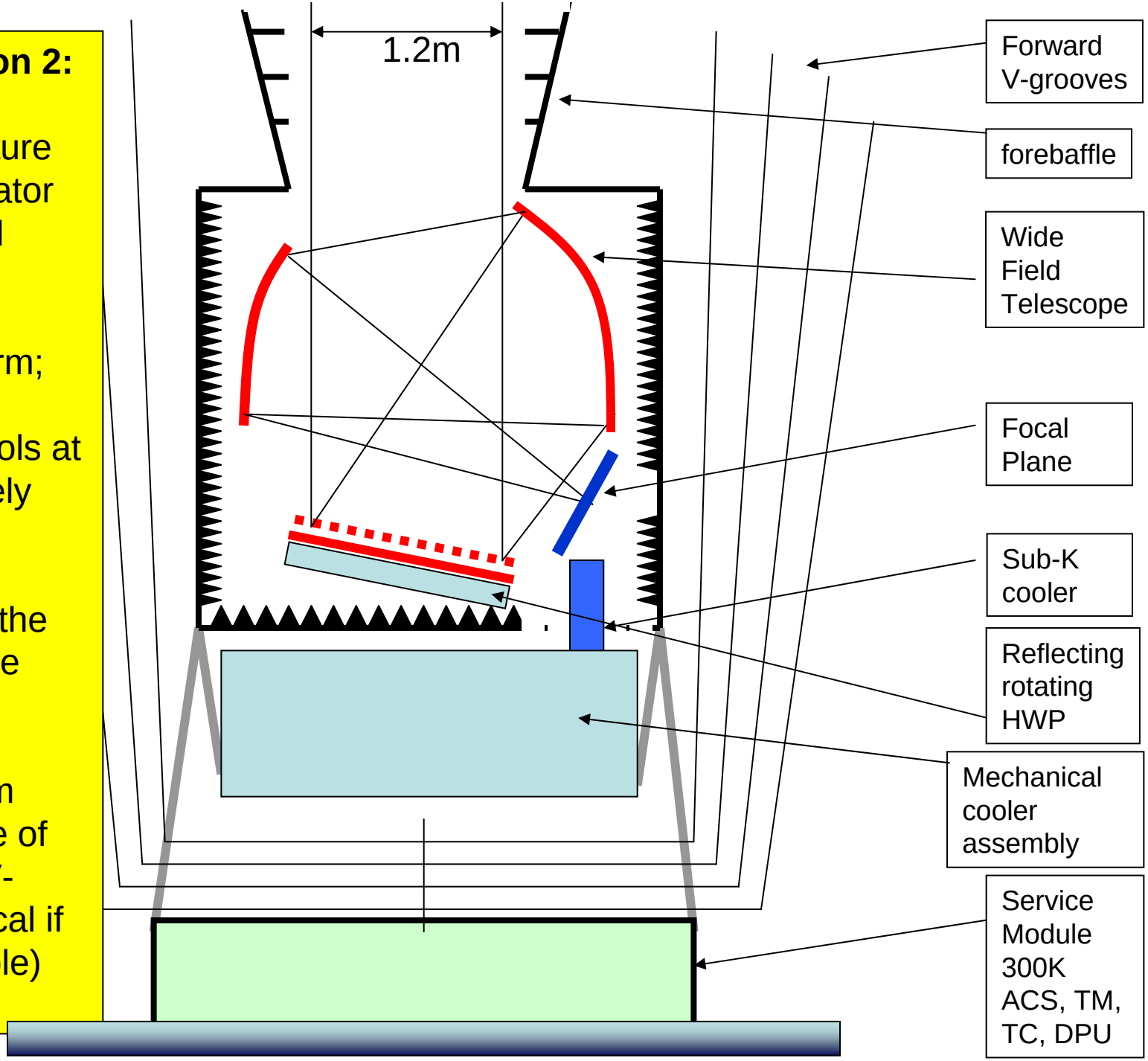
Configuration 2:

- 1.2 m aperture
- cold modulator is first optical element

- Launch warm; Telescope assembly cools at 30K radiatively

- Mechanical cooler cools the system on the way.

- fits the 3.9m diameter fare of the Soyuz (V-grooves critical if not deployable)

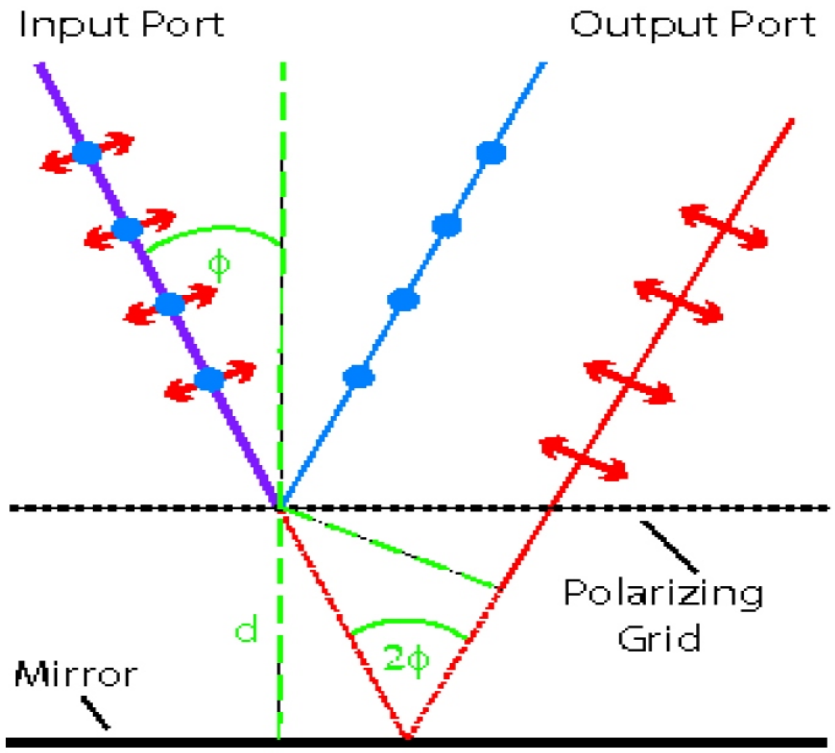


Reflective HWP

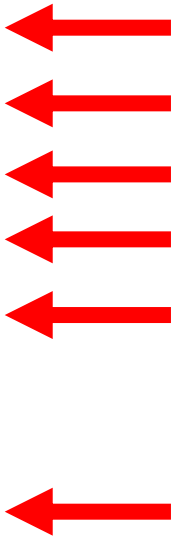
- See Siringo et al. 2004 for a description
- Works as a HWP at all frequencies

$$\nu_n = \frac{2n+1}{4\cos\varphi}\frac{c}{d}$$

- For a given incidence, one can adjust *d* so that



n	$\nu_n(GHz)$
1	60
2	100
3	140
4	180
5	220
6	260
7	300
8	340



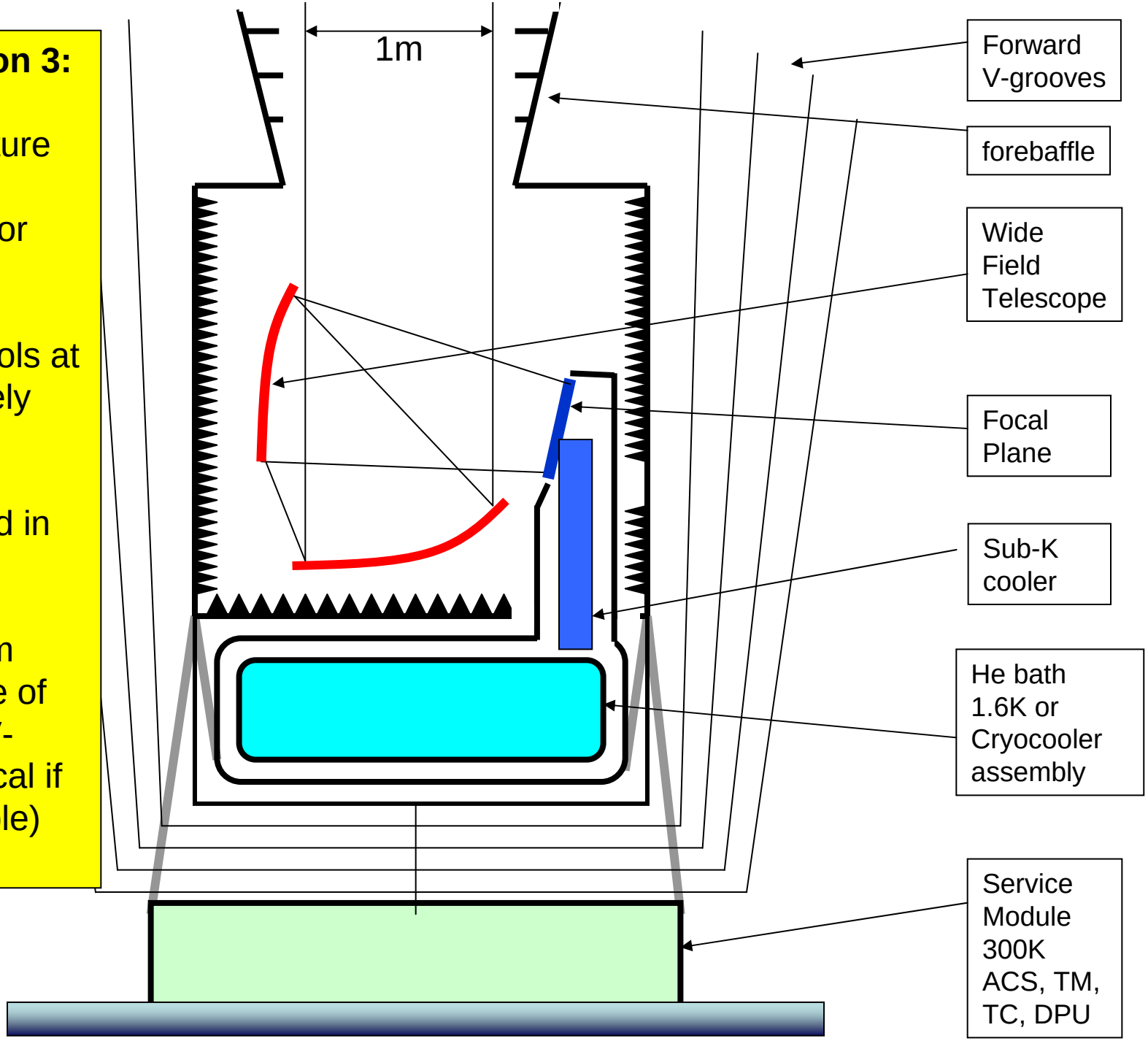
- Usable bandwidth 10-15% **TBC**

General comments

- 3-axis stabilized platform
- Can perform any needed scan
- Can point to a calibration source integrating the modulated signal for the time needed for an accurate calibration
- Criticalities:
  - Large modulator: flatness of wires, movement (step vs continuous) power dissipation, bandwidth, cleaninless requirements
  - Mass of cryostat / TRL of mechanical cooler
  - Size of V-grooves
  - Cost

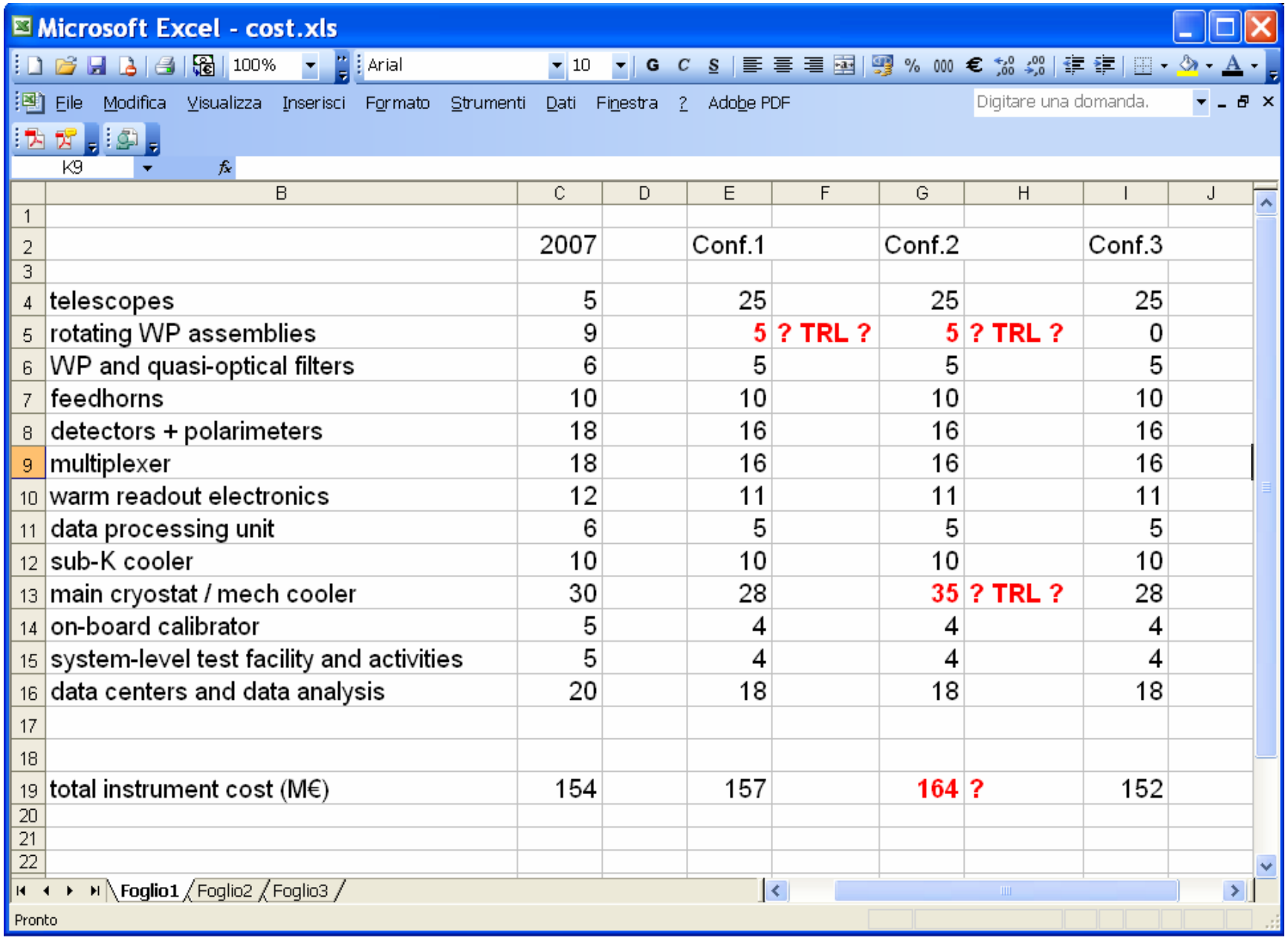
Configuration 3:

- 1.2 m aperture
- no modulator
- Telescope assembly cools at 30K radiatively
- focal plane cover opened in space
- fits the 3.9m diameter fare of the Soyuz (V-grooves critical if not deployable)



General comments

- 3-axis stabilized platform
- Need to scan the sky fast enough to modulate polarization signal and obtain sufficient angles coverage at short timescales (spin 1 rpm + precession 1 rph + …)
- Criticalities:
  - Mixing of beam effects and polarization signals ?
  - Stability at hour timescales ?
  - Calibration more difficult
  - Mass of cryostat / TRL of mechanical cooler
  - Size of V-grooves



	B	C	D	E	F	G	H	I	J
1									
2		2007		Conf.1		Conf.2		Conf.3	
3									
4	telescopes	5		25		25		25	
5	rotating WP assemblies	9		5	? TRL ?	5	? TRL ?	0	
6	WP and quasi-optical filters	6		5		5		5	
7	feedhorns	10		10		10		10	
8	detectors + polarimeters	18		16		16		16	
9	multiplexer	18		16		16		16	
10	warm readout electronics	12		11		11		11	
11	data processing unit	6		5		5		5	
12	sub-K cooler	10		10		10		10	
13	main cryostat / mech cooler	30		28		35	? TRL ?	28	
14	on-board calibrator	5		4		4		4	
15	system-level test facility and activities	5		4		4		4	
16	data centers and data analysis	20		18		18		18	
17									
18									
19	total instrument cost (M€)	154		157		164	?	152	
20									
21									
22									

Time to discuss