USING MULTIFEED SYSTEMS for MULTIFREQUENCY mm-VLBI OBSERVATIONS from 18 to 100 GHz and ABOVE

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SCIENTIFIC NEEDS

a. Observe at 3mm but adding lower frequencies is welcome (mm-VLBI)

b. With as high sensitivity as possible (↑ η_a; ↓ T_{sys}; ↑ t; ↑ B; dual pol.)

c. Solve phase fluctuation problem at 3mm (WVR; PR; FFS; SFPR; Simultaneous ν)

The last one appears to be the most promising and efficient

d. Observe with as high resolution as possible (many mm-antenna throughout the world)

Upgrade the cm-antenna and/or a new receiving system at mm-VLBI observatories

SOME PAPERS

Alef, 2003
Sasao, 2003
Middelberg, 2005
Roy, 2006
Jung, 2010
Sawada-Satoh, 2012
Rioja, Dodson, 2011

MULTIFREQUENCY SYSTEMS

A. Coaxial frequencies receiver

Two well separated bands only, many compromises on performance, particularly for secondary focus mounting.
Simultaneity

B. Frequency agility systems

Need specific receiver arrangement and long and fast stroke of secondary mirror.
Slow semi-simultaneity

C. Dichroic filters and mirrors (Quasi-optical systems)

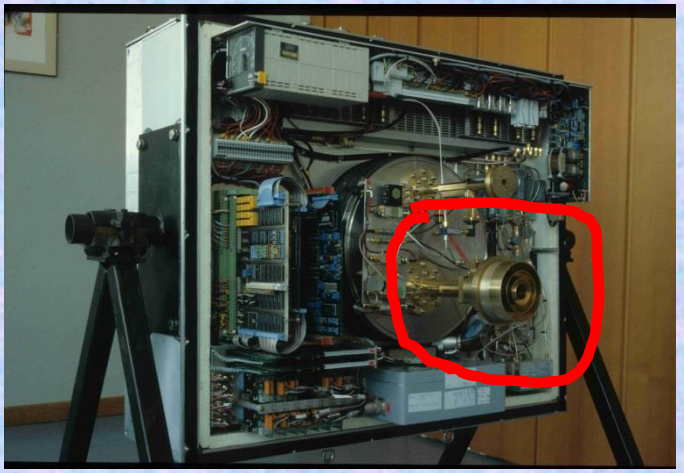
Change the mechanical arrangement in the secondary focus cabin.
Simultaneity

D. Multifeed with different frequency bands

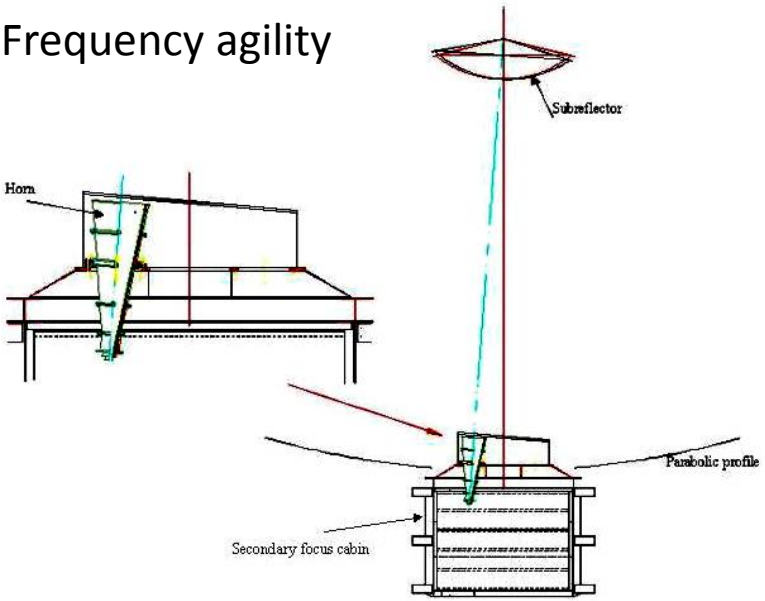
No change in the mechanical arrangement of the receivers at the antenna.
As many bands as needed into usual receiver dimension.
Fast semi-simultaneity or…….simultaneity (?)

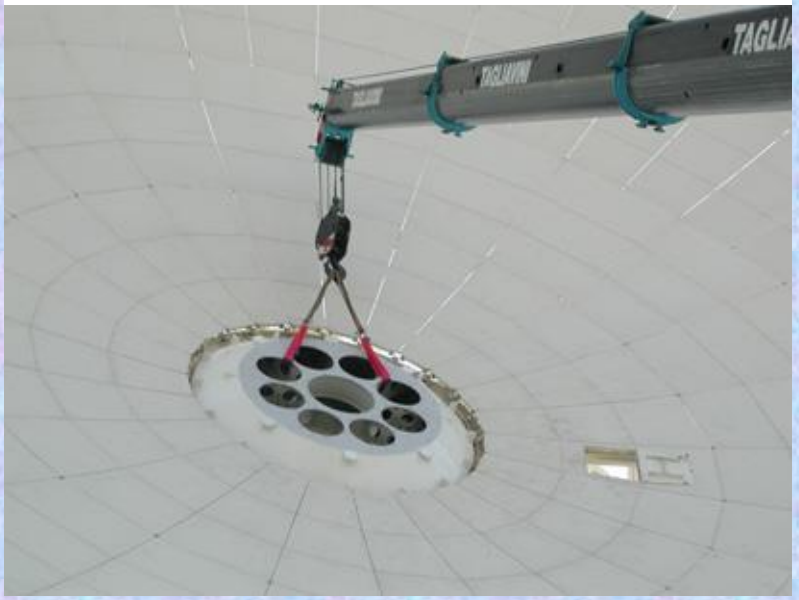
MULTIFREQUENCY SYSTEMS: EXAMPLES

COAXIAL, v2/v1≈4

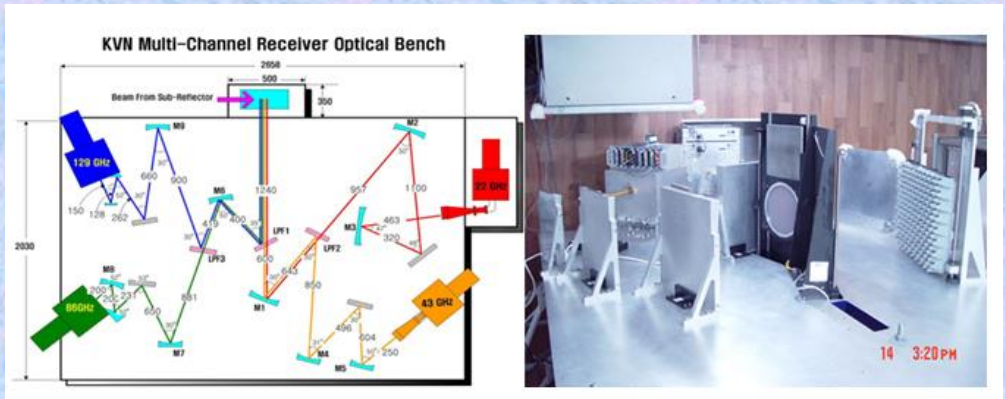


Frequency agility





QUASI-OPTICAL SYSTEMS



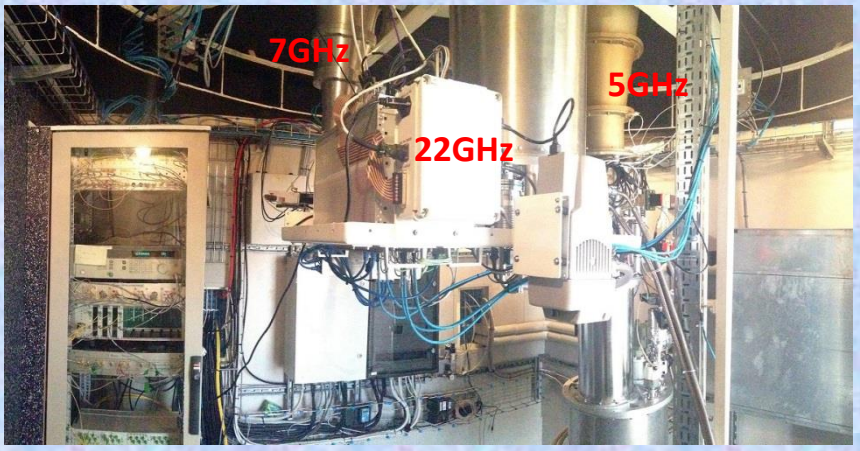
ARRANGING A SYSTEM ON THE ANTENNA

SRT configuration
D=64m; F/D=2.34

- Coaxial OK from mech. point of view
  NOK from e.m. point of view
- Frequency agility NOK
- Dichroic NOK
- Multifeed OK

FREQUENCY AGILITY	
Antenna	Switching time for secondary RX (*s*)
MED/NOTO	≤ 3
SRT	≥ 11
VLBA	7

Med/Noto configuration
D=32m; F/D=3.04



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  NOK from e.m. point of view
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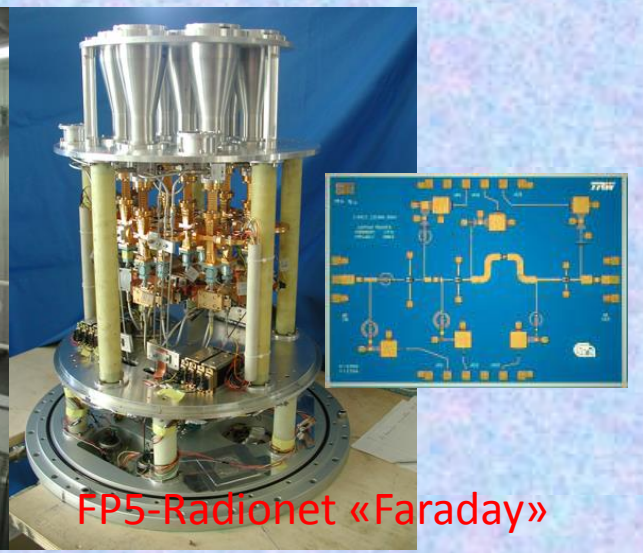
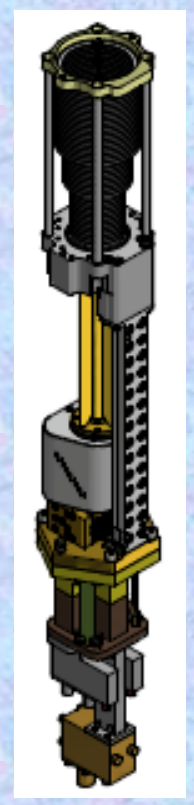
MULTIFEED SYSTEMS

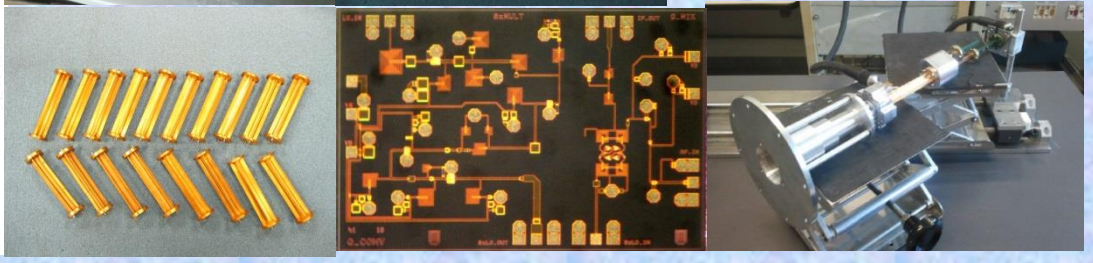


FP5-Radionet «Faraday»



80-100 GHz
in the future?

19-beam double pol
33-50GHz
(Q-band)

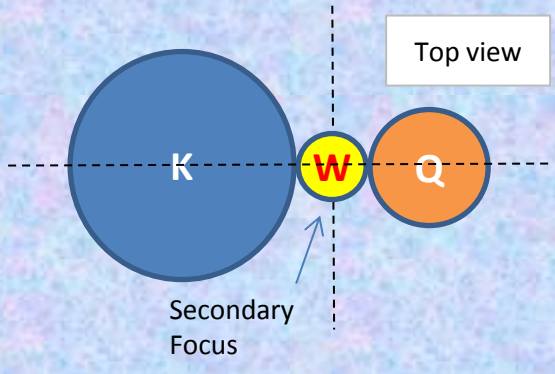


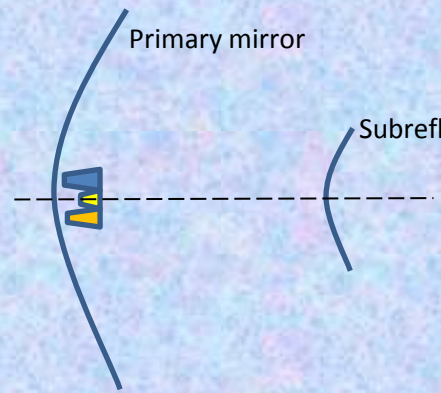
FP7-Radionet «Apricot»

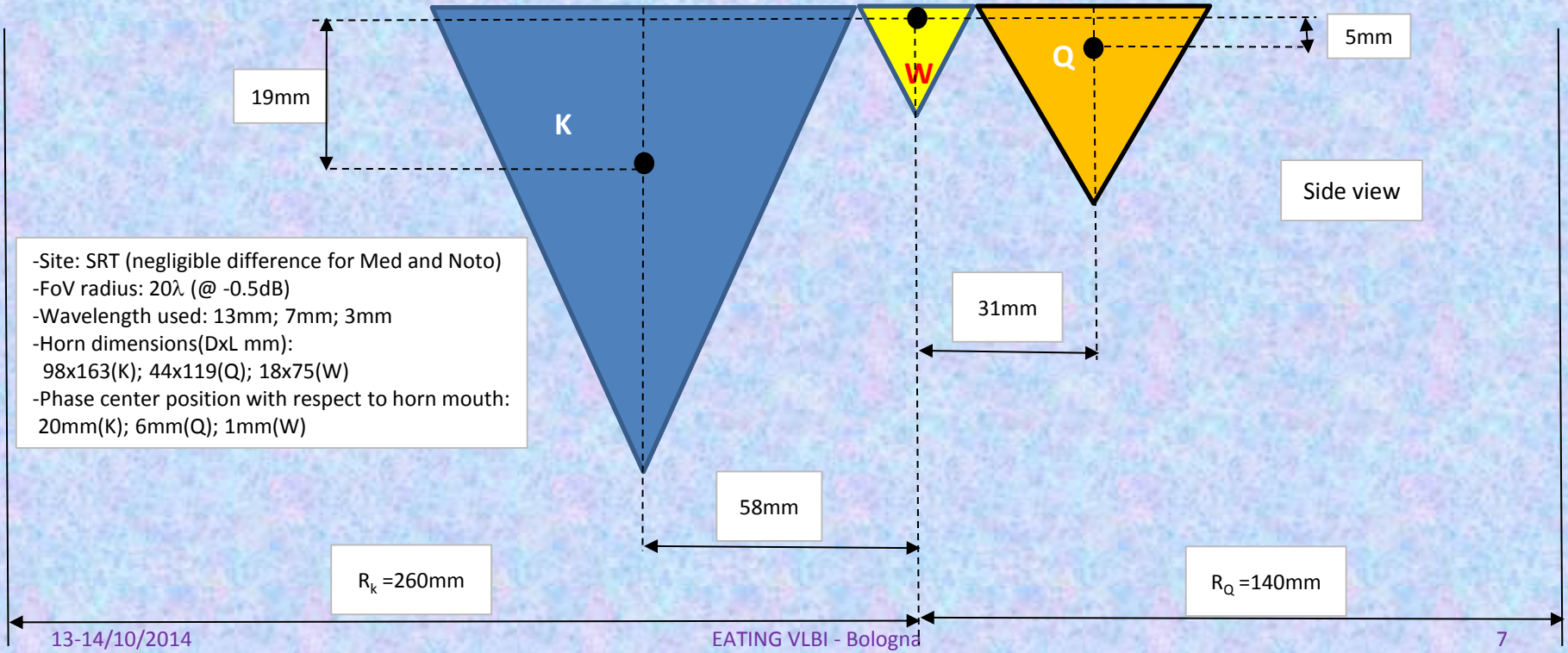
A MULTIFEED-MULTIFREQUENCY CONFIGURATION

MULTIFEED CONFIGURATION WITH 2 or 3 or 4 ***DIFFERENT*** FREQUENCY BANDS

K= 18-26 GHz
Q= 33-50 GHz
W= 80-100 GHz



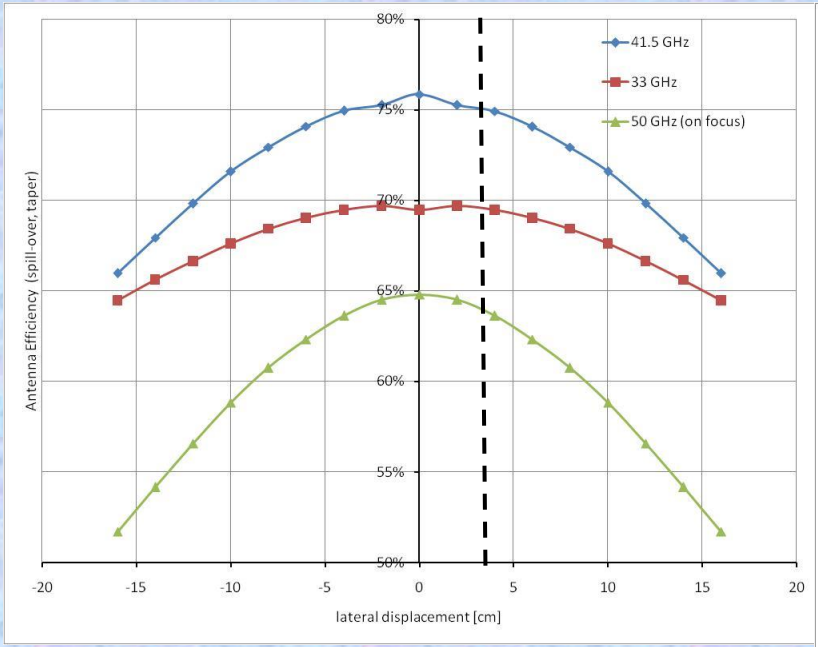




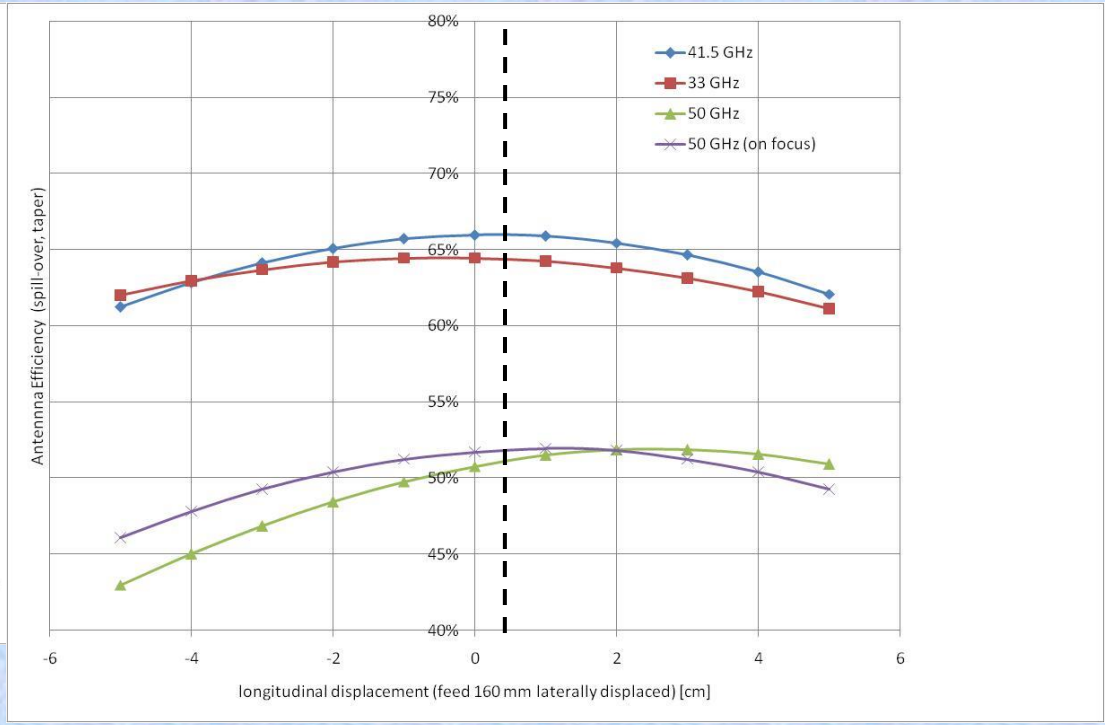
-Site: SRT (negligible difference for Med and Noto)
-FoV radius: 20λ (@ -0.5dB)
-Wavelength used: 13mm; 7mm; 3mm
-Horn dimensions(DxL mm):
98x163(K); 44x119(Q); 18x75(W)
-Phase center position with respect to horn mouth:
20mm(K); 6mm(Q); 1mm(W)

NO LOSS IN PERFORMANCE

LATERAL AND LONGITUDINAL DISPLACEMENT SENSITIVITY: Q-band on SRT



Courtesy: P. Bolli, INAF-OAA

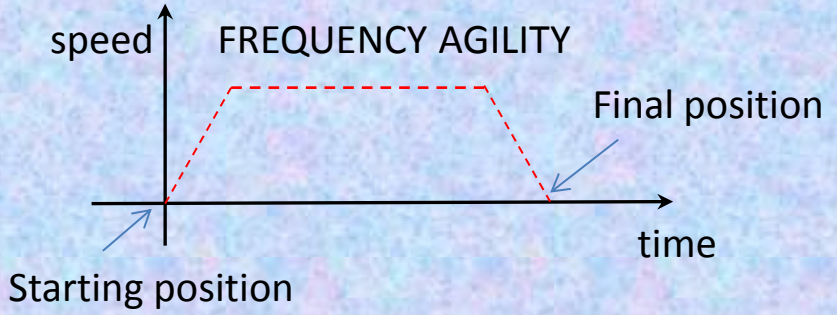


For Med and Noto the situation is better because parabolic in shape

NOISE: MEASURES SHOW THAT Tsys DON'T CHANGE AMONG RECEIVERS OF THE MFEED

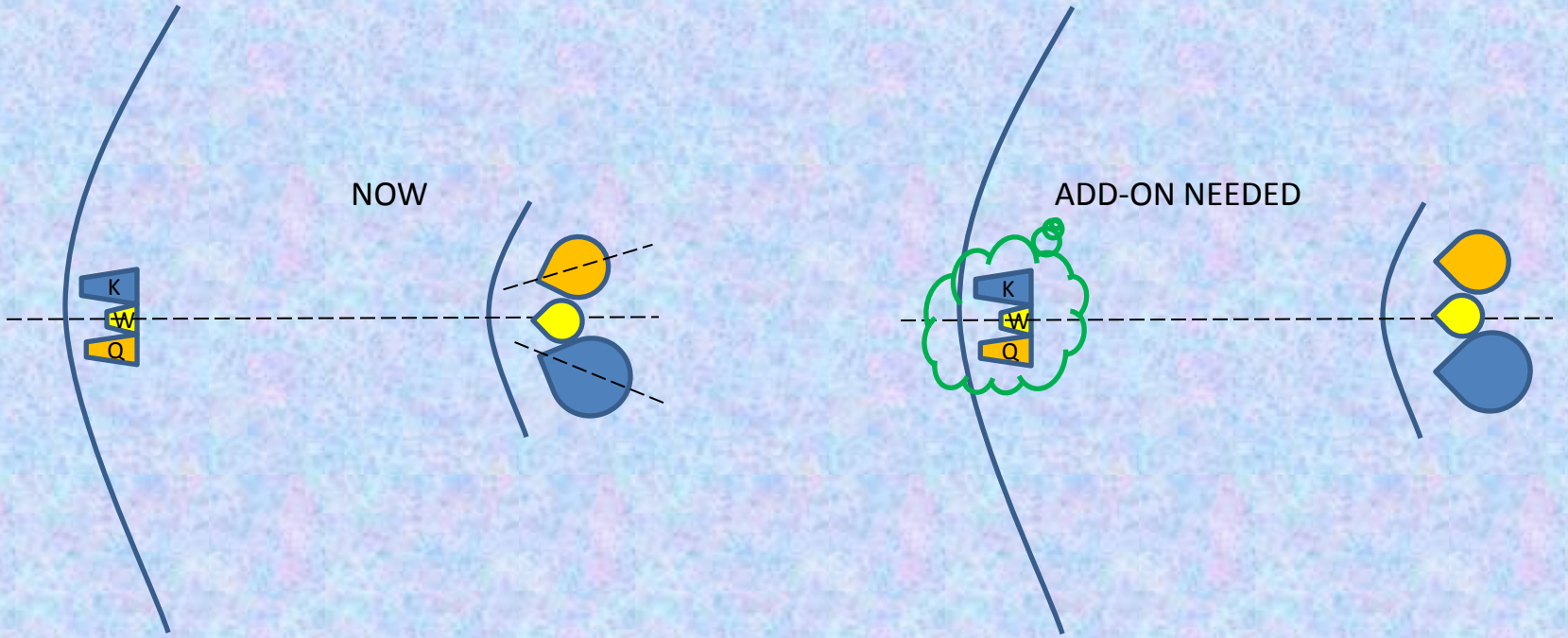
MULTIFEED-MULTIFREQUENCY PROS

MULTIFEED vs FREQUENCY AGILITY				
Antenna	Switching time with agility (*s*)	HPBW (*arcmin*)	Beam separation (*arcmin*)	Switching time with Mfeed (*s*)
MEDICINA NOTO	≤ 3	1.7 (K band) 0.4 (W band) 0.85 (Q band)	2 (K band) 0 (W band) 1 (Q band)	< 1
SRT	≥ 11	0.83 (K band) 0.2 (W band) 0.45 (Q band)	1.3 (K band) 0 (W band) 0.7 (Q band)	< 1



1. NO ANTENNA GAIN AND NOISE PERFORMANCE DEGRADATION
2. RECEIVER LIKE ANY OTHER AT THE OBSERVATORY (< 500mm in diameter)
3. ALLOWS FAST FREQUENCY SWITCHING, MUCH BETTER THAN FREQUENCY AGILITY
4. MAKES 'UNNECESSARY' THE FREQUENCY AGILITY

NEXT STEP: MULTIFEED AND SIMULTANEITY



HOW COULD SIMULTANEITY BE OBTAINED ?

- BEAMFORMING NOT POSSIBLE BECAUSE OF THE DIFFERENT FREQUENCY BANDS
- QUASI-OPTICAL SYSTEMS ONLY IF OF VERY SMALL SPACE OCCUPATION
- OTHER

NEED INVESTIGATION

THANKS