Desarrollos en Frontends en el radiotelescopio de 40 m del Observatorio de Yebes.

F. Tercero, O.A. García-Pérez, G. Gómez-Molina.

“Red de Infraestructuras de Astronomía: promoviendo sinergias entre grandes observatorios españoles. I.”
23 de octubre de 2023

- Desarrollos en Frontends.
    - Receptores en RT40m.
    - Óptica.
    - Criostatos + alimentadores + componentes pasivos.
- Mantenimiento de criostatos en RT 40m.

FRONTENDs ≈ antenas + óptica (haces gausianos microondas) + criogenia + alimentadores + elementos pasivos

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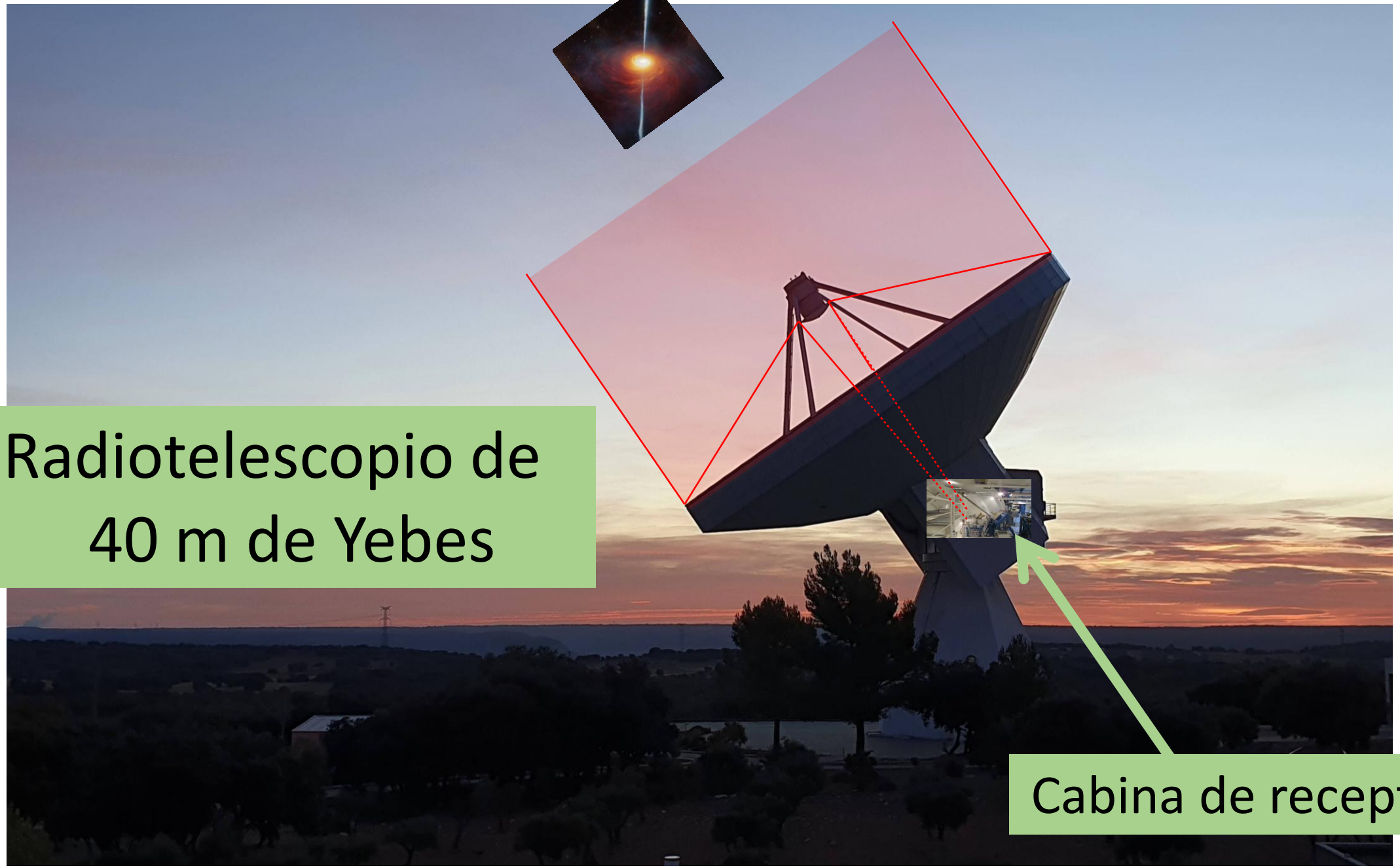
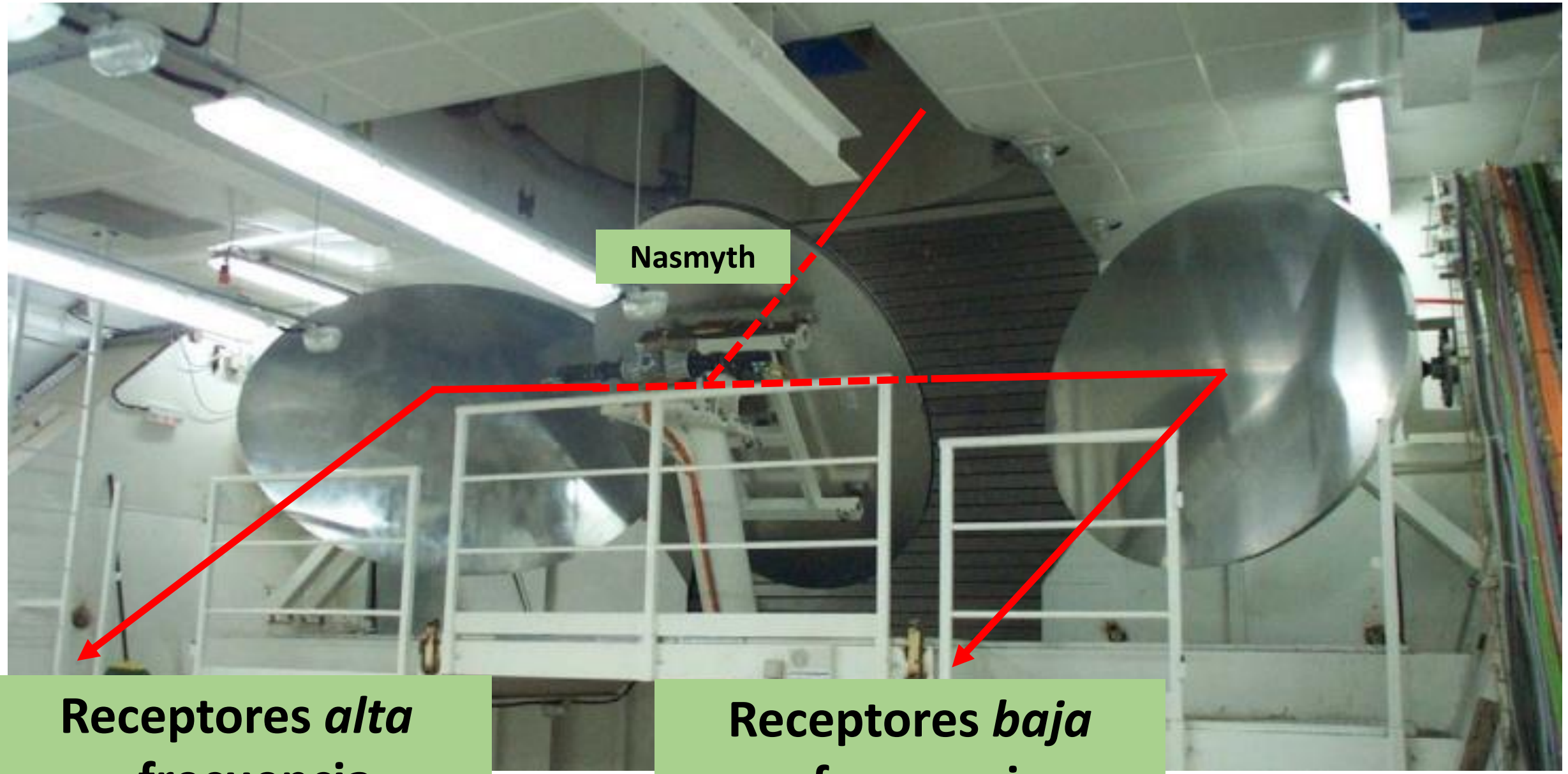
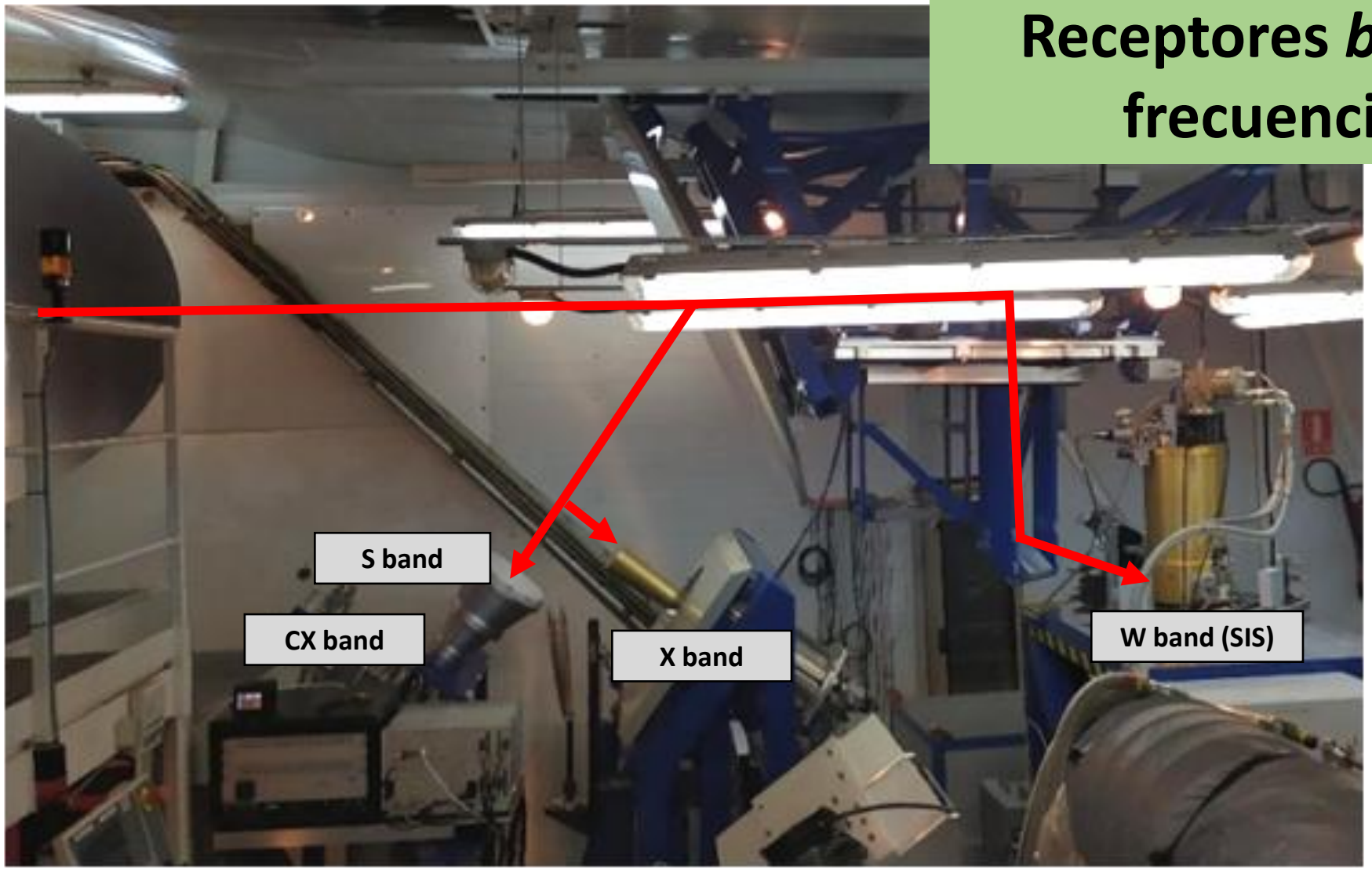
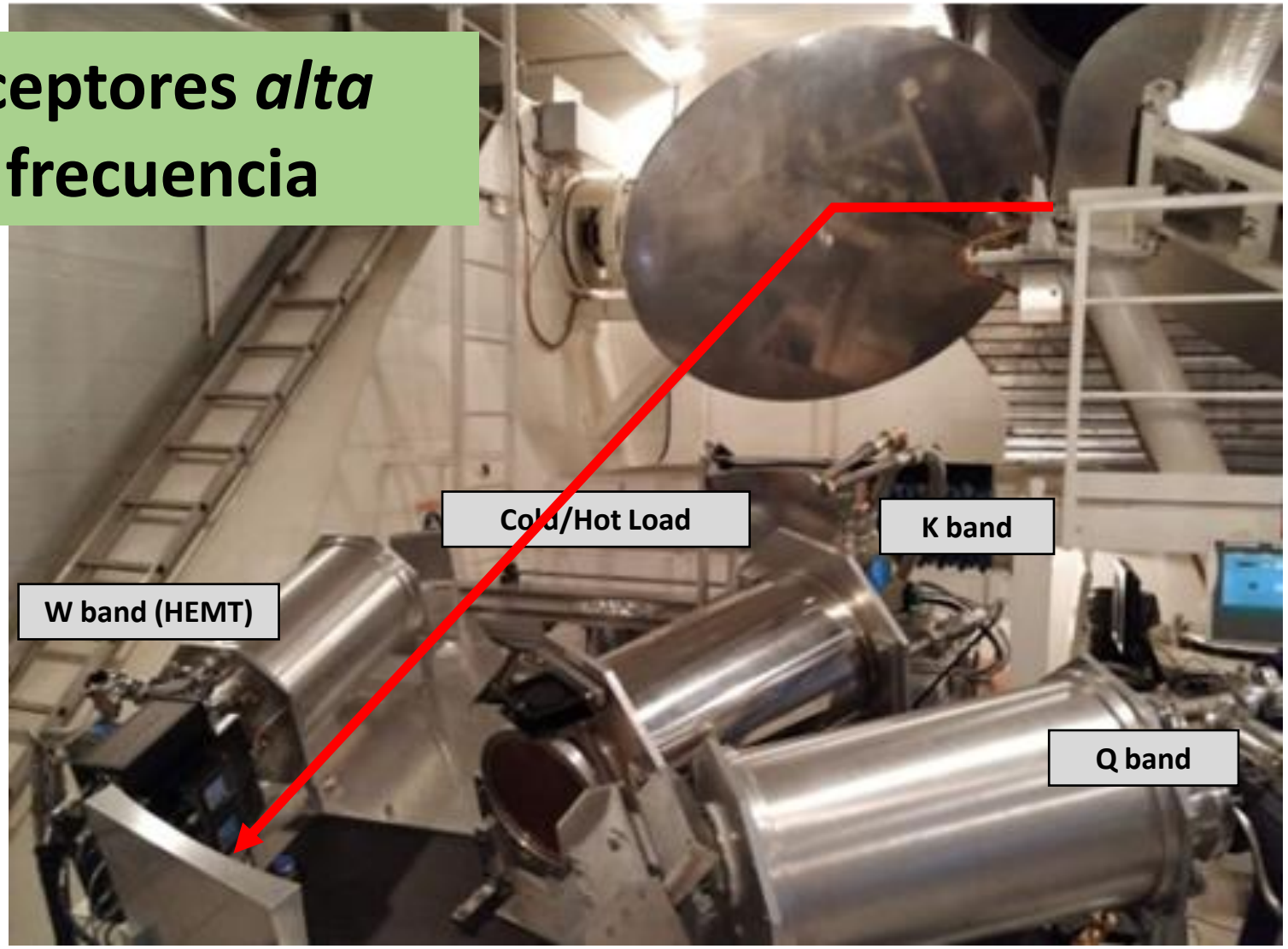

Radiotelescopio de 40 m de Yebes
Cabina de receptores


Nasmyth
Receptores *alta* frecuencia
Receptores *baja* frecuencia

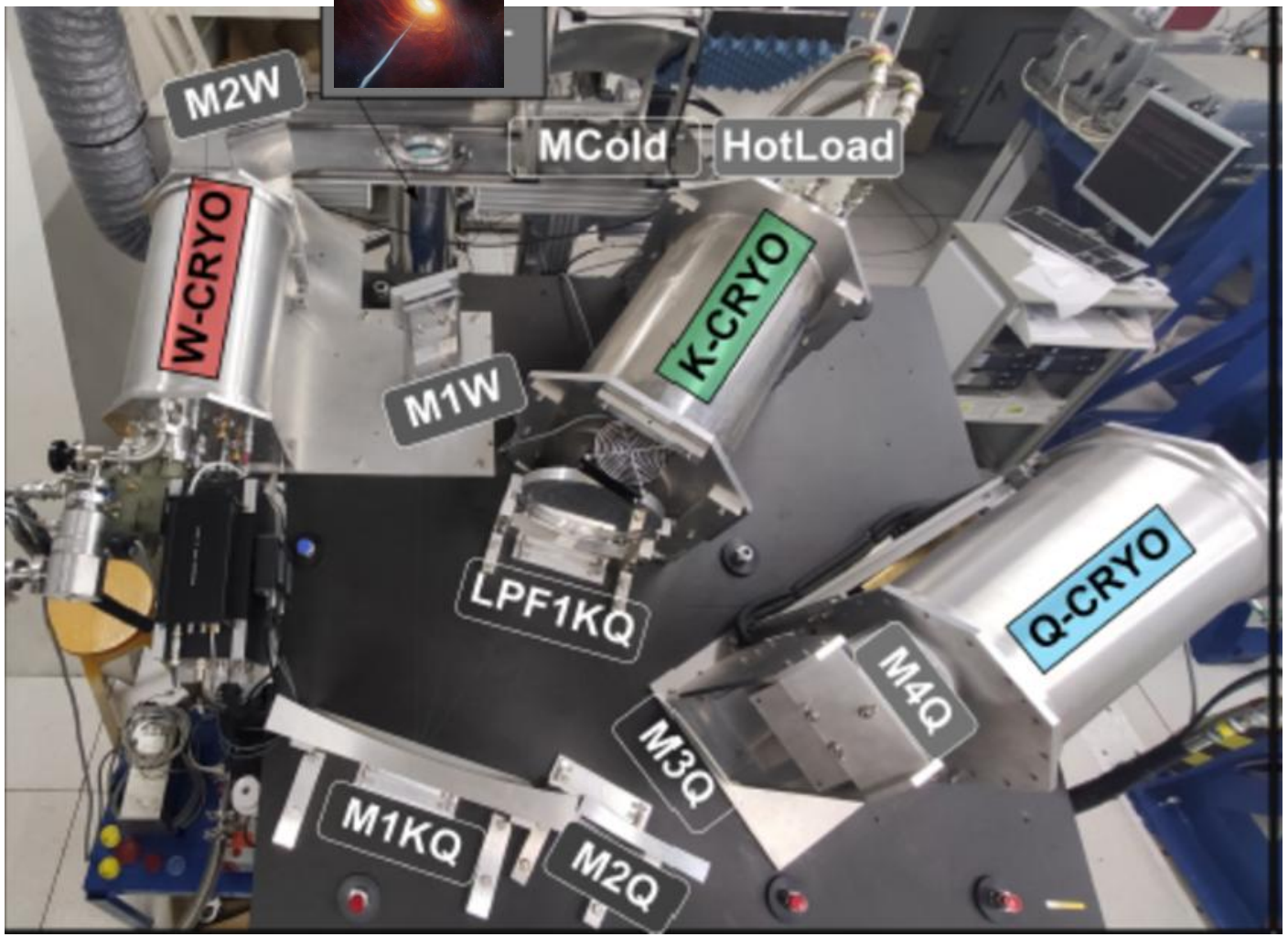
Receptores *baja* frecuencia

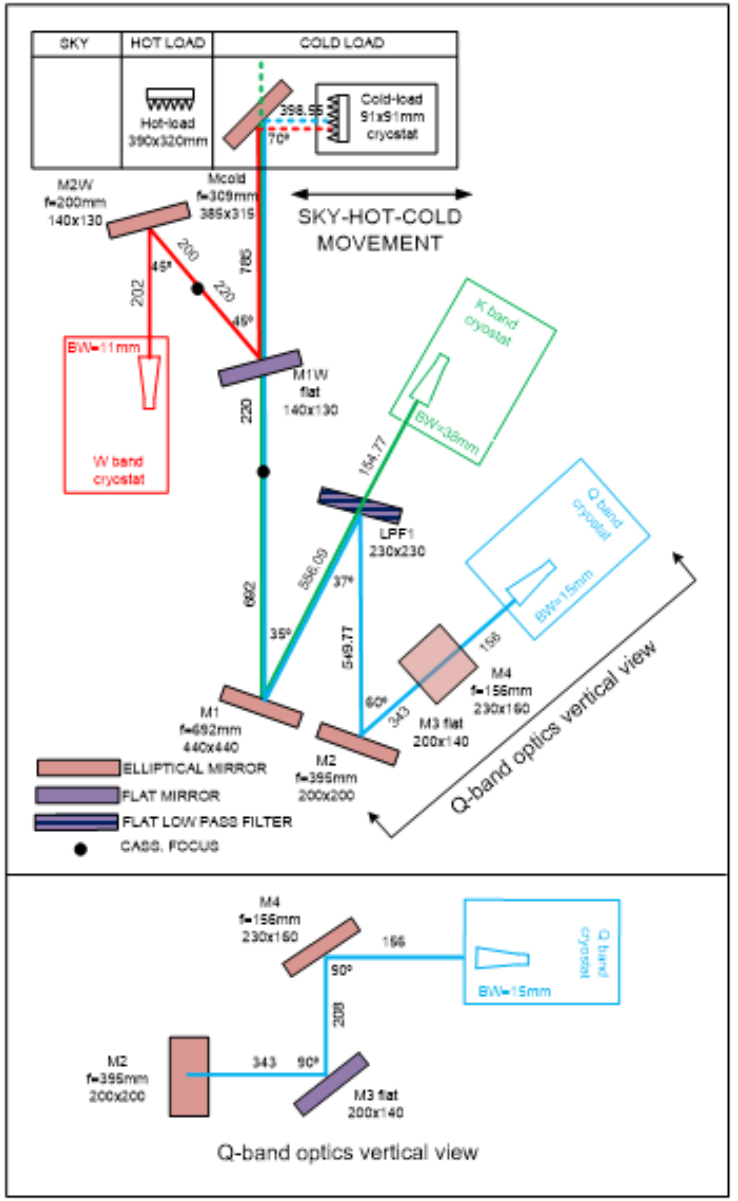


Receptores *alta* frecuencia



Desarrollos en Frontends: Optica.





More info: F. Tercero and O. García-Pérez, "Broadband K-Q-W feed system for the 40 meters Yebes radio telescope," *2019 International Conference on Electromagnetics in Advanced Applications (ICEAA)*, 2019, pp. 0719-0724, doi: 10.1109/ICEAA.2019.8879329.

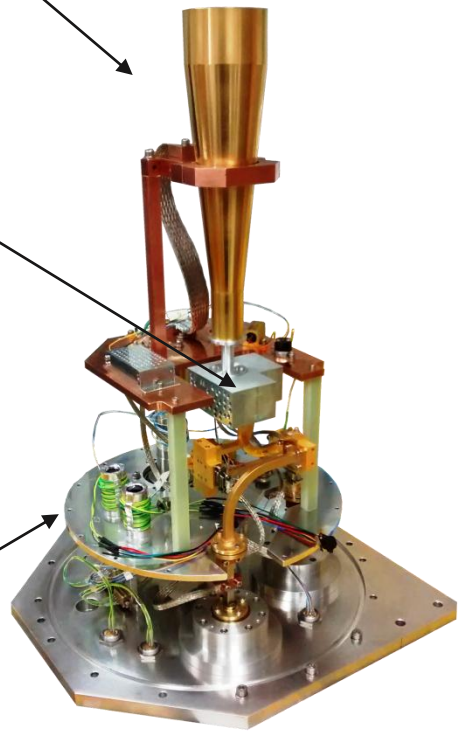
Desarrollos en Frontends: Criostatos + alimentadores + componentes pasivos.

Q-band (31.5 - 50.0 GHz)

Feed type	Corrugated, shaped profile
Return Loss (dB)	< -26
Cross polar (typ.) (dB)	< -55

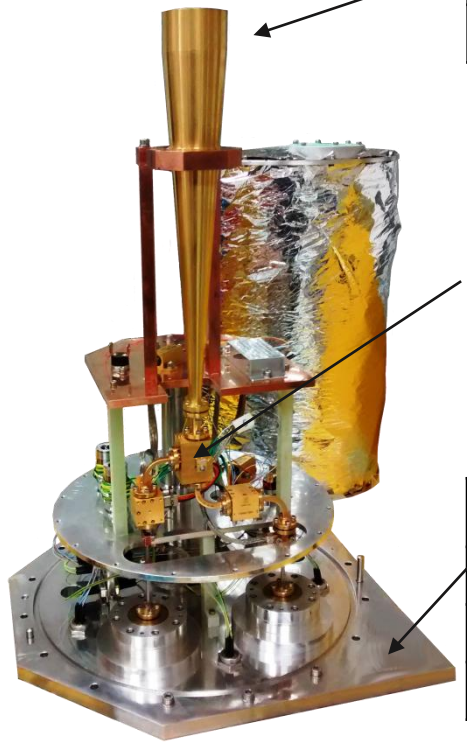
OMT type	Turnstile (4 blocks + scatterer)
Polarizations	Dual linear (circular w/ QWP)
Return Loss (dB)	< -18
Losses (typ.) (dB)	~ 0.4

Refrigerator	Gifford MacMahon CTI 350
Cold Temperature (K)	~ 15
Interm. Temp. (K)	~ 50
Pressure (mbar)	~ 1 x 10^{-8}



W-band (72.0 - 90.5 GHz)

Feed type	Corrugated, shaped profile
Return Loss (dB)	< -20
Cross polar (typ.) (dB)	< -42



OMT type	T-shaped (2 blocks)
Polarizations	Dual linear (circular w/ QWP)
Return Loss (dB)	< -17
Losses (typ.) (dB)	~ 0.6

Refrigerator	Gifford MacMahon CTI 350
Cold Temperature (K)	~ 12
Interm. Temp. (K)	~ 50
Pressure (mbar)	~ 1 x 10^{-8}

*LNAs en charla de **Isaac López-Fernandez**(Desarrollo de componentes criogénicos para receptores de radioastronomía en el Observatorio de Yebes)*

*Criostato en charla de **Gabriel Gómez-Molina** (Receptores VGOS de última generación y **sistema de control criogénico desarrollados en el Observatorio de Yebes**)*

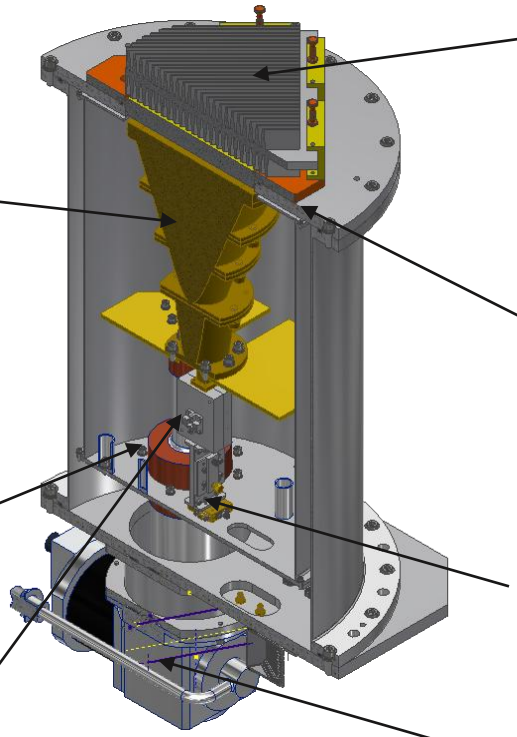
More info: F. Tercero et al., A&A 645 A37 (2021). DOI: https://doi.org/10.1051/0004-6361/202038701

Desarrollos en Frontends: Criostatos + alimentadores + componentes pasivos.

K-band (18.0 - 32.3 GHz)

To be installed in 2023

Feed type	Phased corrected corrugated horn
Aperture Efficiency (mean) (%)	0.74
Return Loss (dB)	< -25
Cross polar (dB)	< -20



QWP type	Triangular corrugated
Frequency (GHz)	20.0-24.00
Return Loss (dB)	< -24
Cross polar (dB)	<-24
AR (dB)	< 0.5

Cryostat window	PTFE triple-corrugated.
Return Loss (max.) (dB)	< -33

Couplers	Multi-hole waveguide coupler
Return Loss (dB)	< -20
Losses (typ.) (dB)	~ 0.05
Coupling (dB)	-29.5 ± 1

OMT type	Double-ridge (2 blocks)
Return Loss (dB)	< -18
Losses (typ.) (dB)	~ 0.05

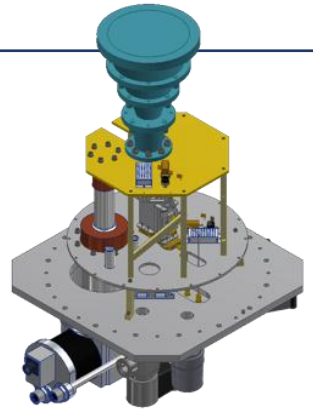
Refrigerator	Gifford MacMahon Sumitomo RDK-408S / S2
Cold Temperature (K)	7
Interm. Temp. (K)	32
Pressure (mbar)	~ 1 x 10^{-8}

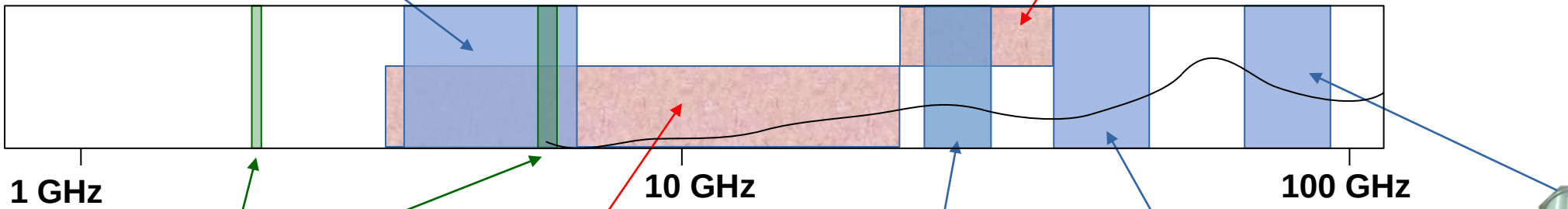
Desarrollos en Frontends: Receptores en RT40m.

4.5 - 9 GHz
(Tr=18 K) VLBI

ASTRONOMIA
GEODESIA
EN DESARROLLO

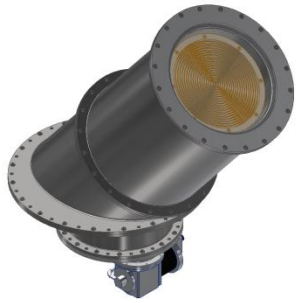
K-band
ASTROREC
18 – 32.3 GHz





2 - 2.3 GHz (Tr=54 K)
8 - 8.8 GHz (Tr=10 K)
VLBI (Geo)

Extended CX-band
4 - 18 GHz



K-band
21 - 25 GHz
(Tr=25 K)
VLBI & SD

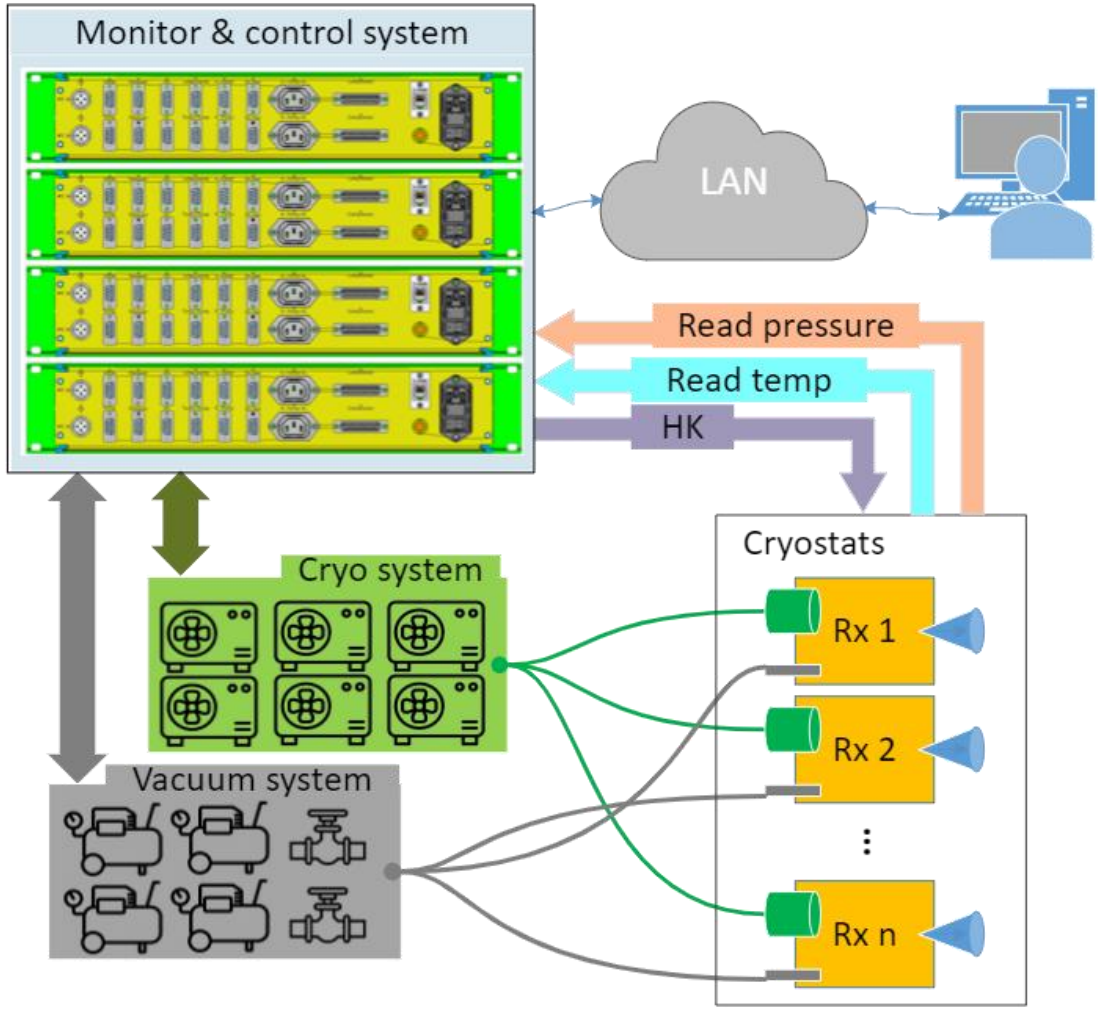
Q-band
31.5 – 50 GHz
(Tr=25 K)
VLBI & SD

W-band
72 – 90.5 GHz
(Tr=40 K)
VLBI & SD

Cryogenic systems are usually stable and **low-maintenance** in the long term

BUT...

- 8 cryostats in the 40m receivers' cabin **(~industrial facility).**
- Heating **problems in the compressors' room.** Systems monitored by the antenna operators and manually re-launched in case of failure.
- Some cryostats require **vacuum cycles (manually) periodically** (e.g. cold load with the 50um mylar window).
- After **a general shutdown** of the systems (e.g., electrical maintenance), the **start-up process** of the receivers is done gradually **(slow)** and requires the presence of an operator/engineer.



- Goal: Development of a **new system to monitor and control the cryostats** remotely
  - Compressors + vacuum systems + temp & pressure & HK in every cryostat.

*Detalles en charla de **Gabriel Gómez-Molina** (Receptores VGOS de última generación y **sistema de control criogénico desarrollados en el Observatorio de Yebes**)*

- **Compressors´ room is not able to exchange heat** (mostly in summer season) for all cryostats working.
  - 3-9 kW per compressor (depends on cold head model and low temperature required)
  - 24 kW (minimum) for a 64 m^3 room.
  - Overtemp protection stops compressor at 35ºC.

- **Water compressors** exchange heat more efficiently but the water (or refrigerant fluid) must be cold down again in a closed cycle. We must manage with...
  - Industrial chillers near of receivers' cabin.
  - Limited room for installation of all required cold down power.

- En el observatorio de Yebes se diseñan, construyen y miden casi la totalidad de compnentes que forman la óptica y los frontends.

- Los dos nuevos receptores, una vez instalados, permitirán que el RT40m observe cualquier frecuencia de desde 4 a 90.5 GHz (exceptuando la ventana del oxígeno 60-72 GHz).

- Se están llevando a cabo acciones para minimizar el tiempo de mantenimiento de los crisotatos instalados en la cabina