QRFH Wideband Cryogenic Receivers

Callisto

www.callisto-space.com

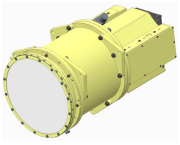
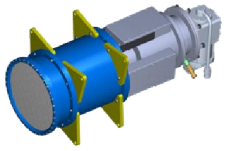
Introduction

Callisto has over 20 years experience producing cryogenic Low Noise Amplifiers for satellite ground stations. Callisto has produced more than 50 cryogenic receivers for worldwide renowned customers such as the European Space Agency (ESA), the Indian Space Agency (ISRO), the French Space Agency (CNES), the BKG (Wettzell Observatory) and several other institutional or private operators.

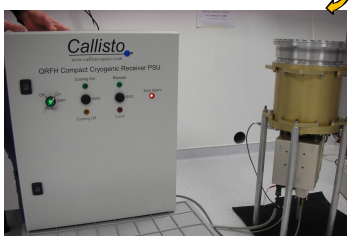
Callisto has two wideband cryogenic receivers optimized for VLBI applications and using the Caltech designed QRFH feed:

- one "Compact" cryogenic receiver,
- one "Ultra" cryogenic receiver.

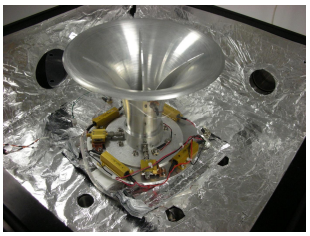
Wideband Cryogenic Receivers – Overview & Comparison

	Compact	Ultra
Receiver Model:		
Frequency Band	2-14GHz	
Noise Temperature (at receiver input flange)	**<40K**	**<20K**
Gain	>33dB	
Other RF features	. Phase & Noise calibration (standard or optional) . Polarization Conversion (linear to circular receiver ouput)	
Operation Type	Continuous	
Cryocooler type	Stirling	Gifford-McMahon (GM)
Receiver Dimensions	L. 612 mm x φ. 311 mm	L. <1 m x φ. 311 mm
Receiver Weight	<25kg (all included:receiver, cryocooler, compressor, heat exchanger)	<50kg (includes receiver, cryocooler, sleeve system); exludes compressor, gas lines, heat exchanger)
Mean time **between services**	**No Service required**	10,000 hours (~14 months)
Mean time **to failure (MTTF)**	200,000 hours	Non Specified
Power Consumption (max)	**400W**	8000W
Unique Features	**No vacuum pump** required for operations (not required for cooldown)	**Sleeve system**: cold head removal for service without dismounting receiver from the antenna
Monitoring & Control	Drawer + Software (running on industrial PC) for local and remote M&C	
Other Options	Installation support, training course, warranty extension	

The Quad-Ridge Flared Horn (QRFH) is a Caltech designed wideband feed. With a **compact design** made from **aluminium**, it is **robust to cryogenic** cooling and requires **only two LNAs** for a linear polarization output. The standard QRFH feed delivered by Callisto fits on Patriot and MT Mechatronics antennas optics. However it is possible to adapt the feed design to various antennas optics such as Vertex 12m antenna for instance. The following figure illustrates the QRFH feed and an example of its normalized pattern (Co-Pol).



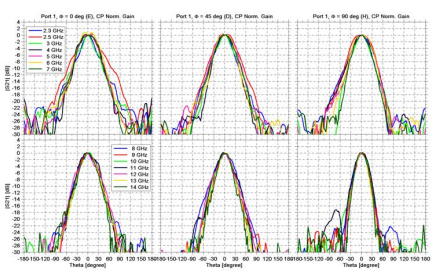
↑ Prototype Compact Receiver with M&C Drawer



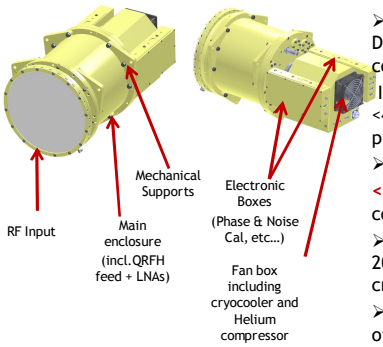
↑ QRFH feed inside Callisto cryogenic test Dewar

Port 1 Normalized Patterns – Co-pol

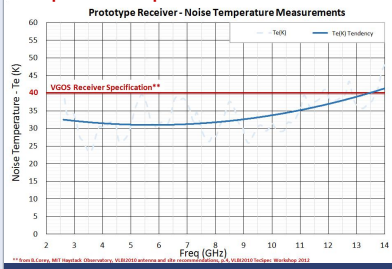
E-plane D-plane H-plane



« Compact » Wideband Cryogenic Receiver



➢ This is a state-of-the-art piece of equipment for telescopes all over the world but with **particular interest** for those **operated in remote locations where energy costs are high** and **maintenance logistics** is particularly **complex and expensive**.



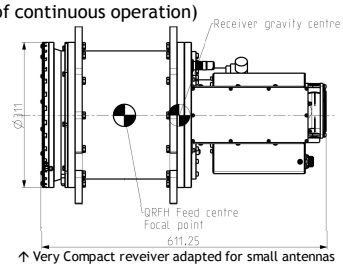
➢ **<40K Noise Temperature (NT)** (At Dewar window, excluding external noise contributions (Tsky, Tg, Tant).

It is anticipated that NT can be reduced <40K for 100% of the band for the production units.

➢ **Very compact**: L. 612 mm x ϕ. 311 mm **<25kg** (all included! receiver, cold head, compressor, heat exchanger)

➢ **Very low power consumption** (<400W, 20 times less than a conventional cryogenic receiver)

➢ **No maintenance** (for at least 5 years of continuous operation)

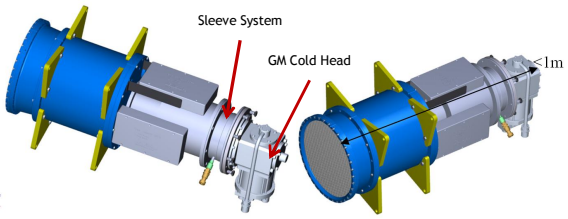


↑ Very Compact reveiver adapted for small antennas

← **Noise Temperature Measurements** at cryogenic temperature on prototype receiver (including large vacuum window, QRFH feed and LNAs)

Optimizations have been identified and will be implemented for prototype testing on VLBI 12m Patriot antenna in July 2015.

« Ultra » Wideband Cryogenic Receiver



➢ **<20K NT** (At Dewar window, excluding external noise contributions (Tsky, Tg, Tant))

➢ **Simplified cold head service**: Patented Sleeve System allowing the removal of the cold head **without dismounting the receiver from the antenna**. Once at room temperature, the cold head is simply slipped-off of the receiver by a single operator and, with a spare cold head available the receiver is ready for cooldown within 30 minutes after the beginning of the cold head removal. As the receiver is not dismounted from the antenna, **it does not require realignment of the telescope optics**!

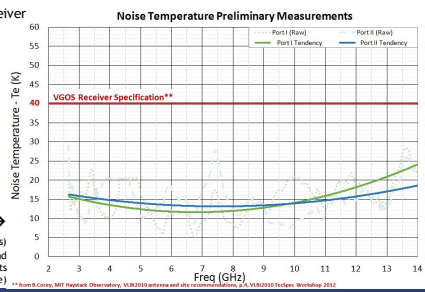
➢ This wideband receiver "Ultra" model, based on a GM cryocooler, is intended for users **with no constraints on electrical consumption and regular maintenance aspects** looking for **the very best NT performance**.

↓ Sleeve cold head removal from a cryogenic receiver

Measurements done at cryogenic temperature →

(including large vacuum window, QRFH feed and LNAs)

(~ Ultra ~ receiver physical temperature will be lower and performance will be better than these preliminary measurements done in a laboratory test enclosure)



Contact

Callisto

Rémi RAYET
Business Unit Manager
12 Av. de Borde Blanche
31290 VILLEFRANCHE DE LAURAGAIS
FRANCE

www.callisto-space.com
remi.rayet@callisto-space.com
Phone: 0033 5 61 800 807