Guillermo Haro Workshop 2018
Synergy between the GTC and GTM/LMT

A 345-GHz Heterodyne Receiver for the GTM-LMT

Edgar Colín-Beltrán (Conacyt-INAOE), Gary Fuller and Danielle George (UoM), Brian Ellison, Fiachra Cahill, Nart Daghestani and Olivier Auriacombe (RAL), Laurent Loinard and Stan Kurtz (IRYA-UNAM)

Tonantzintla, September 11th, 2018

Content

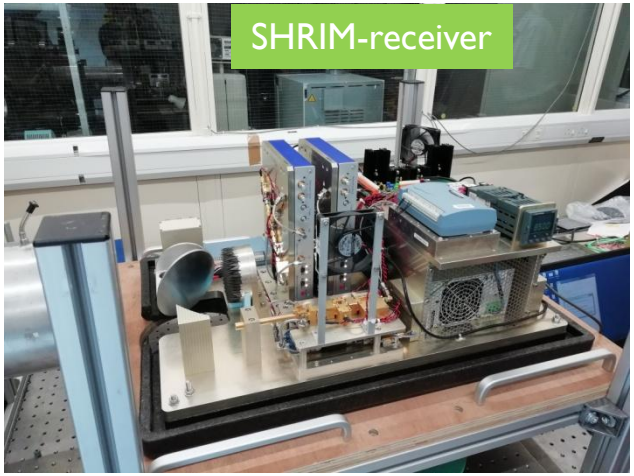
- Introduction
- Receiver concept (SHRIM-WBS II)
- Plan for LMT
- Work on Progress
- Future plan

Introduction

ASTEC: **A**stronomical **S**ystem **T**raining, **E**ngineering and **C**ollaboration
(14 months project)

- particle physics
- space science
- materials
- astronomy
- photon science
- computational and e-science
- biology
- biomedicine
- chemistry

https://stfc.ukri.org/about-us/where-we-work/rutherford-appleton-laboratory/



Original aim: spaceborne instrument detecting atmospheric gases emission between 0.32-0.35 THz

Receiver concept (SHRIM-WBS II)

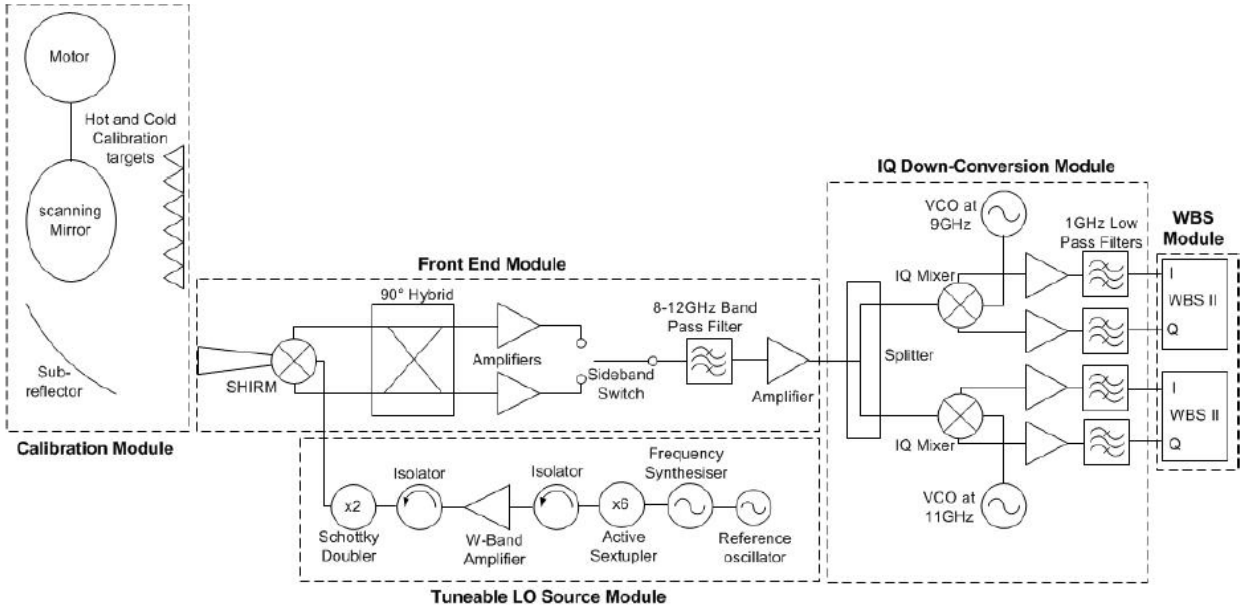


Figure 3: Instrument Block Diagram.

Rackauskas. B, Internal Report RAL, 2014

Characteristic	Value
RF Band	Switchable tested bands: 1) 322-326 GHz 2) 342-346 GHz
IF Band	4 GHz (1 GHz each)
Trec	~4000 K
Polarization	one
BW/WBS	2 GHz
No. Channels	2048
Resolution	~1MHz, 0.87 km/s @ 345 GHz
Angular resolution	4.35"
Integration time	Up to 60s

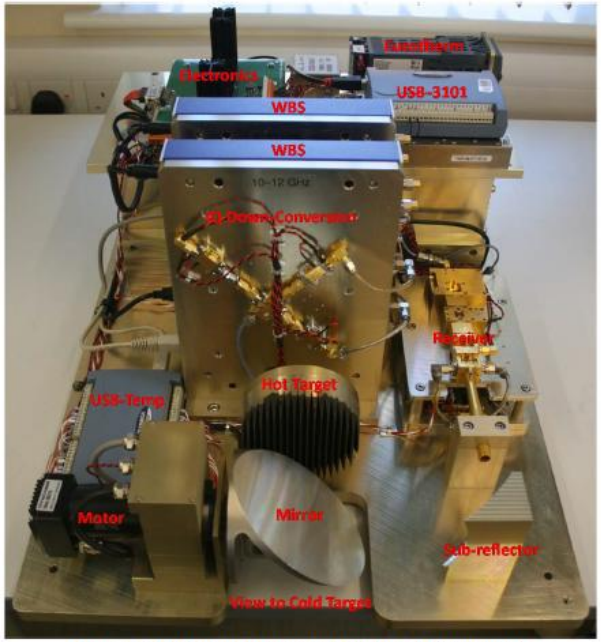


Figure 4-2 SHIRM-WBS II Instrument Breadboard (Front View)

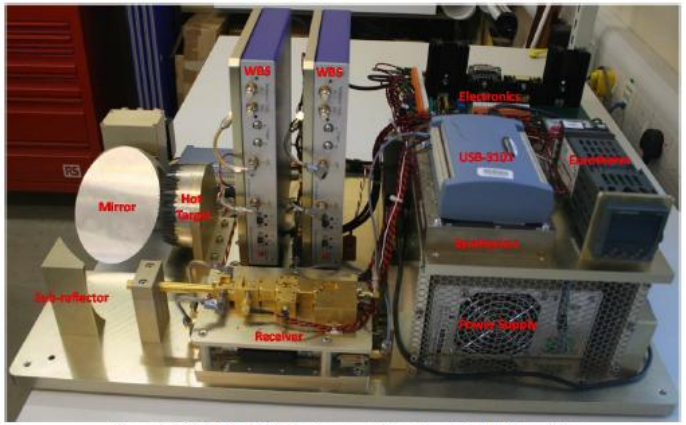
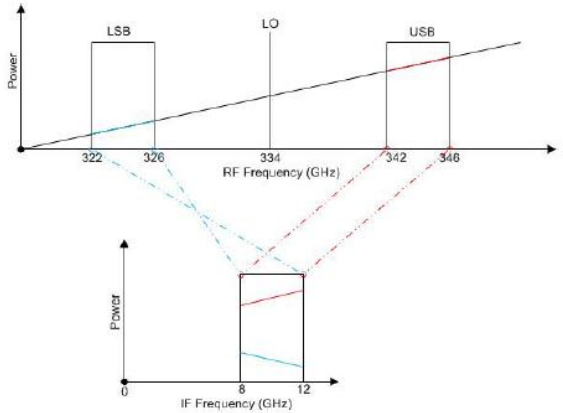


Figure 4-3 SHIRM-WBS II Instrument Breadboard (Side View #1)



CEOI, RAL, Final Report, 2013

Figure 14: The SHIRM breadboard mounted at the Jungfraujoch, Switzerland amid testing.

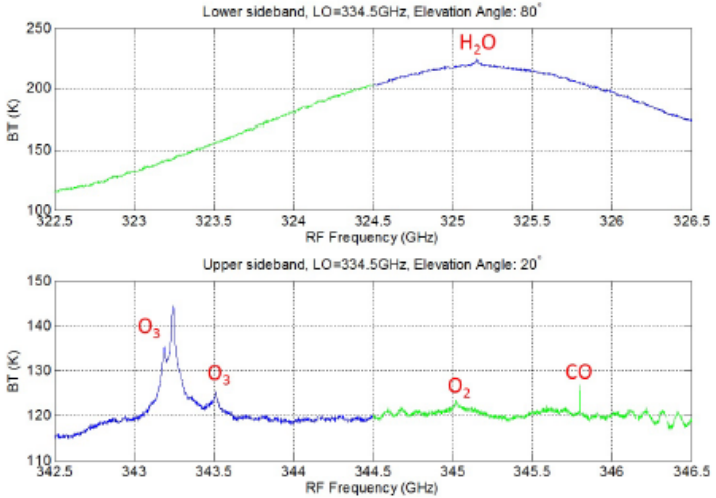


Figure 15: The first results from the Jungfraujoch deployment show exciting spectral features. The two colours represent the two different WBS II units.

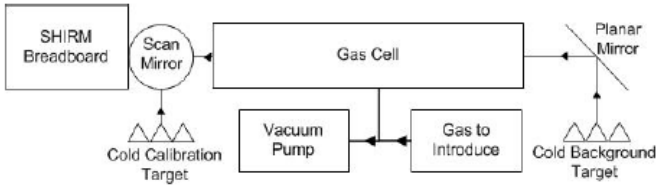


Figure 17: The experimental set-up of the gas cell measurements.

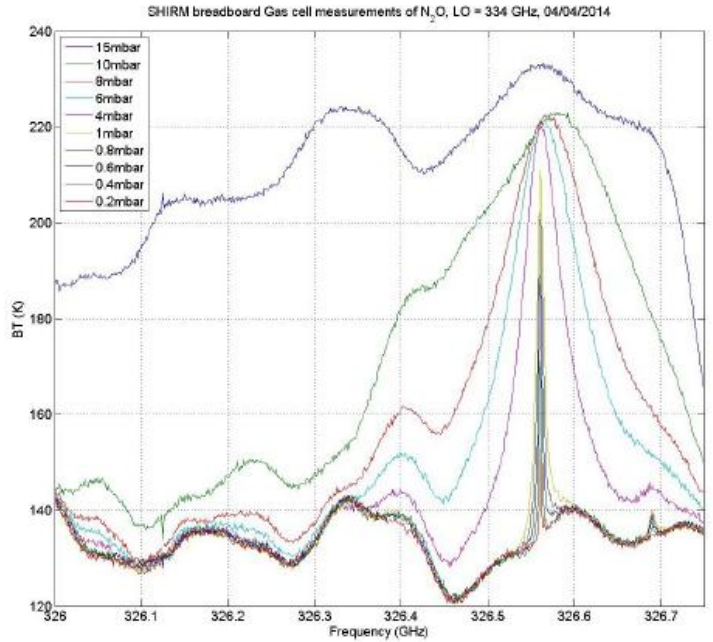


Figure 18: The emission line of Nitrous Oxide as seen by the SHIRM Breadboard from a gas cell.

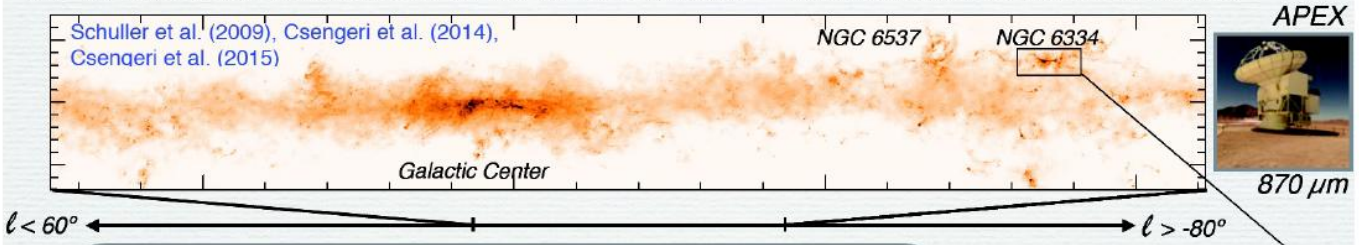
Plan for LMT

Follow up of surveys made with small (12-15m) single-dish telescopes

- ATLASGAL: APEX Telescope Large Area Survey of the Galaxy [and its spectral lines follow ups]
- CHIMPS: The CO Heterodyne Inner Milky Way Plane Survey (JCMT)
- Dynamics of the CMZ
- Kinematics of filaments
- Cloud physical conditions (using also SEQUOIA)
- Fragmentation
- Chemistry (unbiased line surveys of full GMCs)

ATLASGAL: the most sensitive ground based submm survey

APEX Telescope Large Area Survey of the Galaxy: *~ 420 sq. degree of the inner Galaxy*



1. Continuum

Catalogs:

- compact sources, Contreras+2013, Csengeri+ 2014, Urquhart+ 2014
- filaments Li+ *in prep*

Large scale statistics:

- time-scale estimates Csengeri+ 2014,
- dense gas fraction Csengeri, Weiss+ 2015
- evolutionary stage indicators Urquhart+ 2013a,2013b

2. Distances
kinematic
Wienen+ 2012
Wienen+ 2015
Giannetti+ 2015
maser: BesSel
Brunthaler+ 2009

3. Spectroscopy
astro-chemistry
Csengeri+ 2015 (SiO)
Leurini+ 2014 (H_2O)
Giannetti+ 2014 (CO)

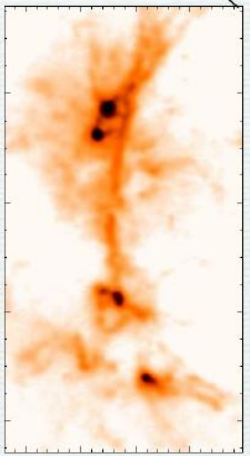
4. Young massive clumps
ALMA follow-up
Csengeri+ *in prep*

~ 40 sources

> 400 sources

> 3000 sources

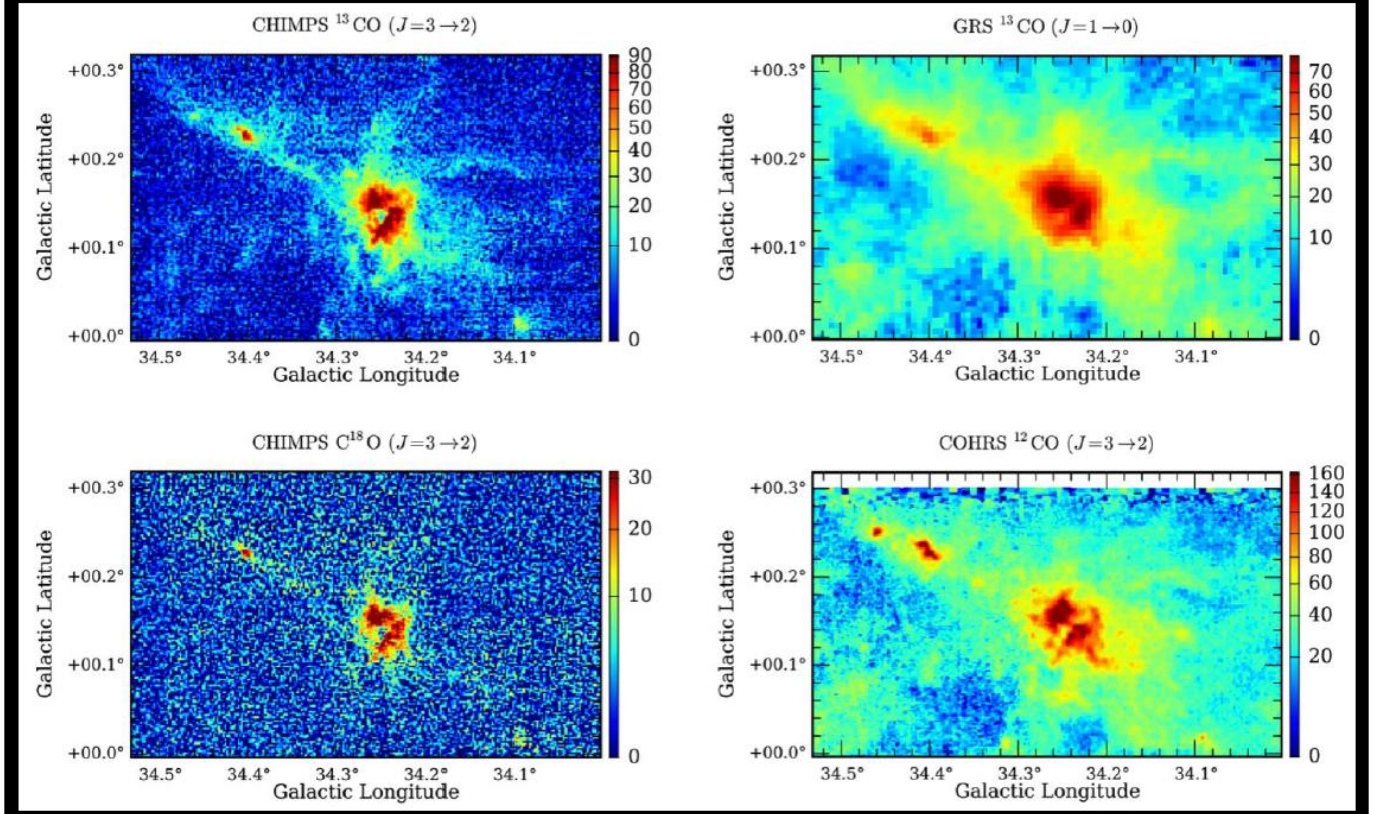
> 10 000 sources



ATLASGAL database: http://atlasgal.mpifr-bonn.mpg.de/

F. Wyrowski

CHIMPS, COHRS, GRS



Rigby et al. (2016)

from Kee-Tae Kim

Spectral advantages with 6 GHz IF band

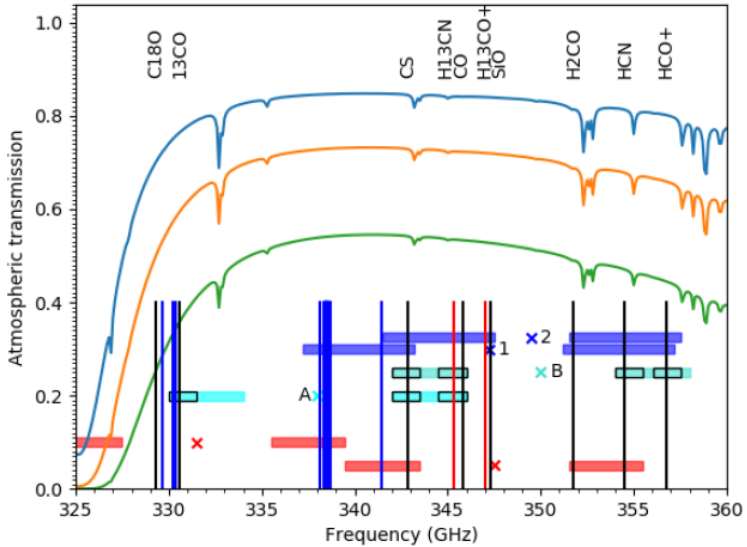
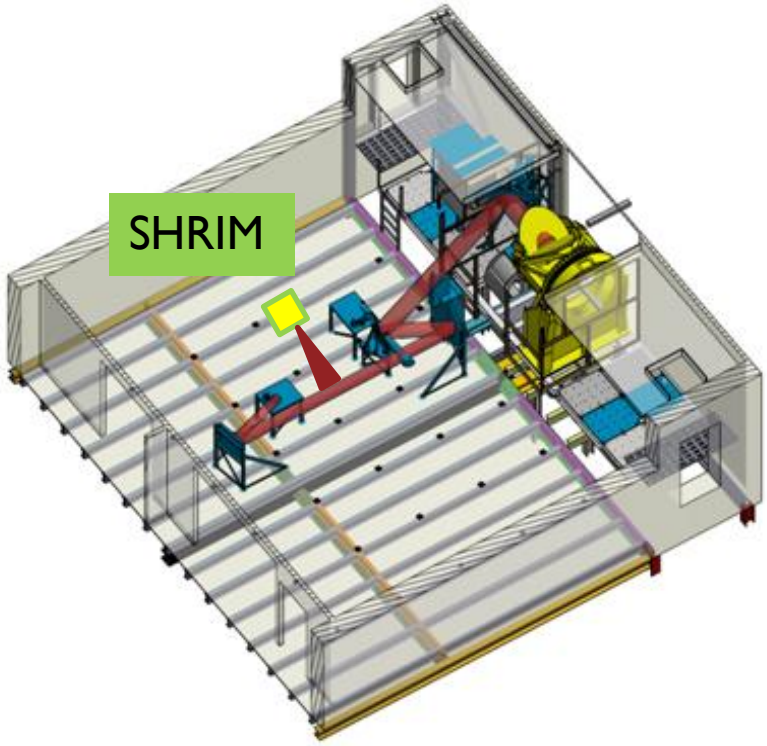


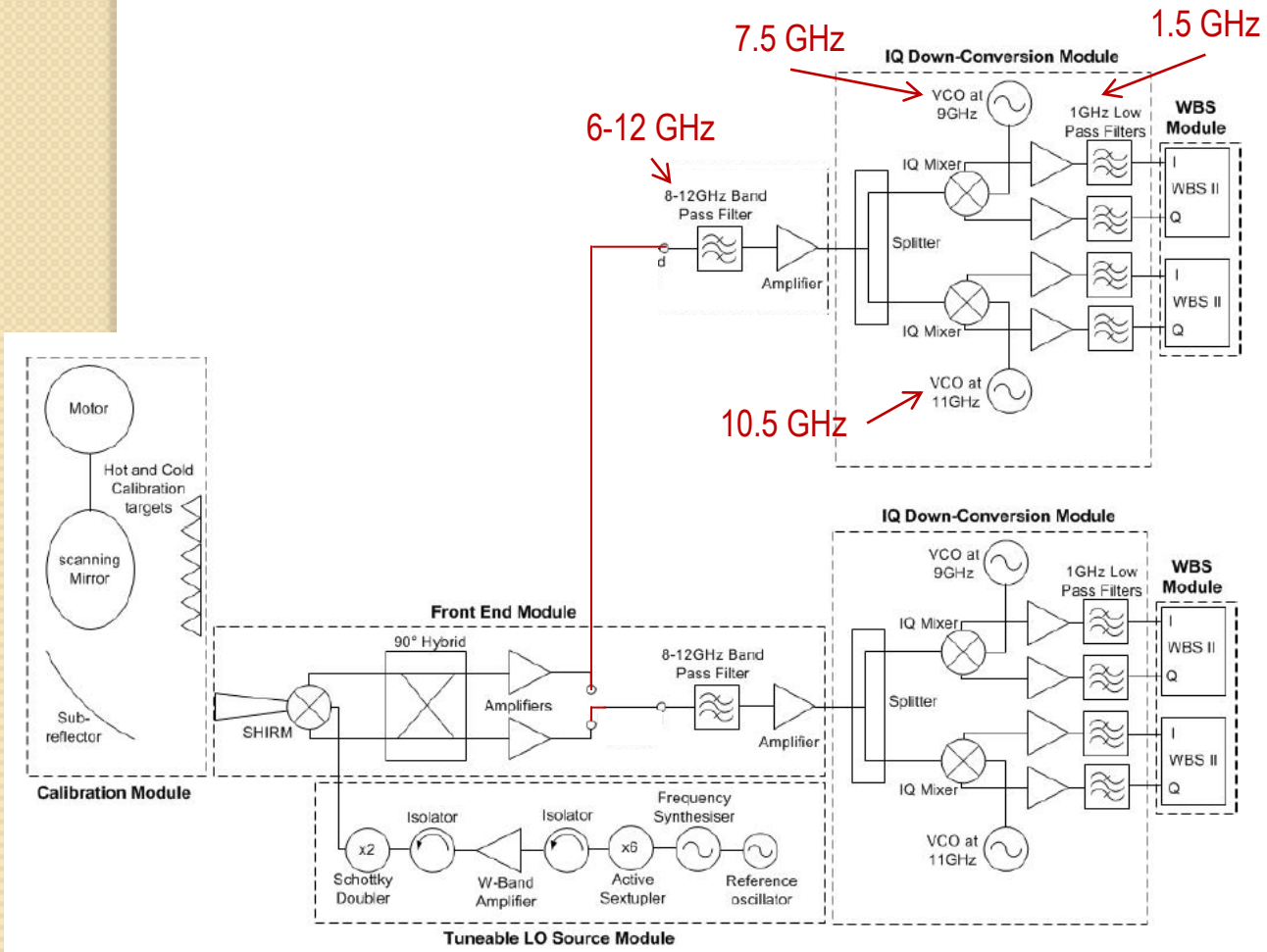
Figure 1: Plot of the atmospheric transmission for 1mm, 2mm and 4mm of precipitable water vapour. The vertical bars indicate the location of important spectral lines. The species are indicated at the top of the plot, except for those lines from methanol (CH_3OH) which are shown as blue lines. Weaker lines are shown in red. The horizontal bars show possible positioning of the USB and LSB for a 4-8 GHz IF frequency. The black boxes show possible positions for 1.5 GHz wide spectrometers. The two pairs of cyan boxes show two configurations to observe interesting sets of lines. The two pairs of red bars show the two extremes of the LO range fo SHIRM. The coloured cross between each pair of coloured bars indicate the LO frequency of the setting. The LO settings shown in blue correspond to possible new 6 GHz bandwidth configurations for SHIRM.

Work on Progress



•Optical Design: Gaussian beam theory for quasi-optics devices along GRASP simulations.

* Edgar, Fiachra, Nart on RAL next two months.



- Defining IF bands and their receiver chains depend on instant BW and noise (budget constrained).
- New WBS with better resolution.

Future plan

✓UK people visiting LMT- October 15-20th

✓Optics manufacture: perhaps by a Company in Mexico, taking advantage of MUSCAT experience (~Nov. 2018)

✓Testing and integration with fully SHRIM system (~Dec, 2018) [RAL].

✓Packaging and shipping of receiver to LMT (~May 2019) [RAL-INAOE].

✓Integration to LMT (~Jul-Sep 2019) [INAOE- help UMass].

✓Cryogenic upgrade study and design plan (~Oct. 2019).

Acknowledgements

Drawings: Gopal and Ron from UMass, and Edgar Castillo and Manuel Tarango from INAOE.

Astronomical information: Arturo Gomez and Gary Fuller.