UNIVERSIDAD CATOLICA
DE LA SANTISIMA CONCEPCION

ucsc.cl

Astro-Engineering and Microwaves Laboratory (LAIM) at UCSC

Ricardo Bustos

November 10, 2016

Universidad Católica de la Santísima Concepción (UCSC), is one of the 3 traditional universities in the city of Concepción, with ~11,500 students.

Faculty of Engineering:

- Informatics
- Industrial
- Logistics
- Geological
- Civil
- Electrical

Electrical Engineering program

- Started in 2012. No graduates yet. Young group…
- 7 academics ⟶ 8 next year. A position-call soon…
- ~ 60 students per year
- Areas:
  - Electrical Power and Energy Systems
  - Control Engineering
  - Signals and Telecommunications
    - Analog and digital communications
    - Signal processing
    - Astro-Engineering

Astro-Engineering at UCSC

LAIM UCSC
LABORATORIO DE ASTRO-INGENIERIA Y MICROONDAS

2012: nothing….
2013: LAIM was planned.
2015: Official inauguration.

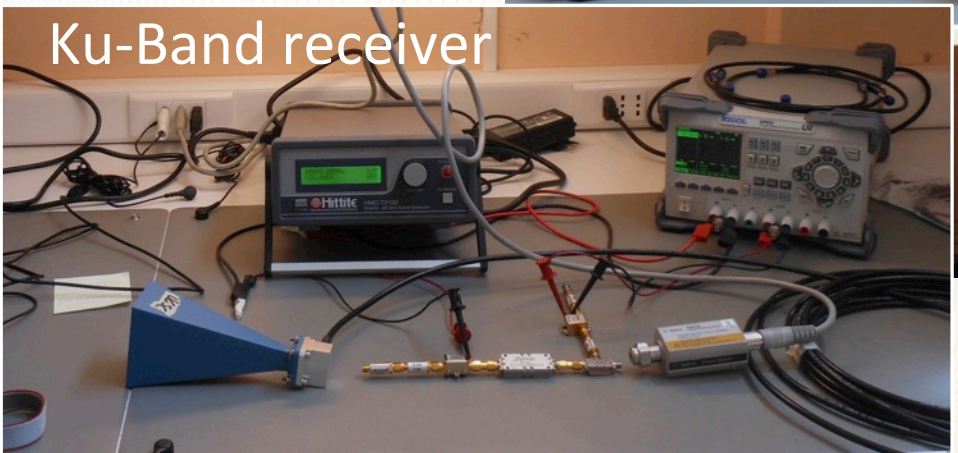
UNIVERSIDAD CATOLICA DE LA SANTISIMA CONCEPCION

ucsc.cl

Laboratorio de Astro-Ingeniería y Microondas

Funding sources:

UCSC
ESO-CM
Quimal/Conicyt



Equipped up to 26.5 GHz!

LAIM:

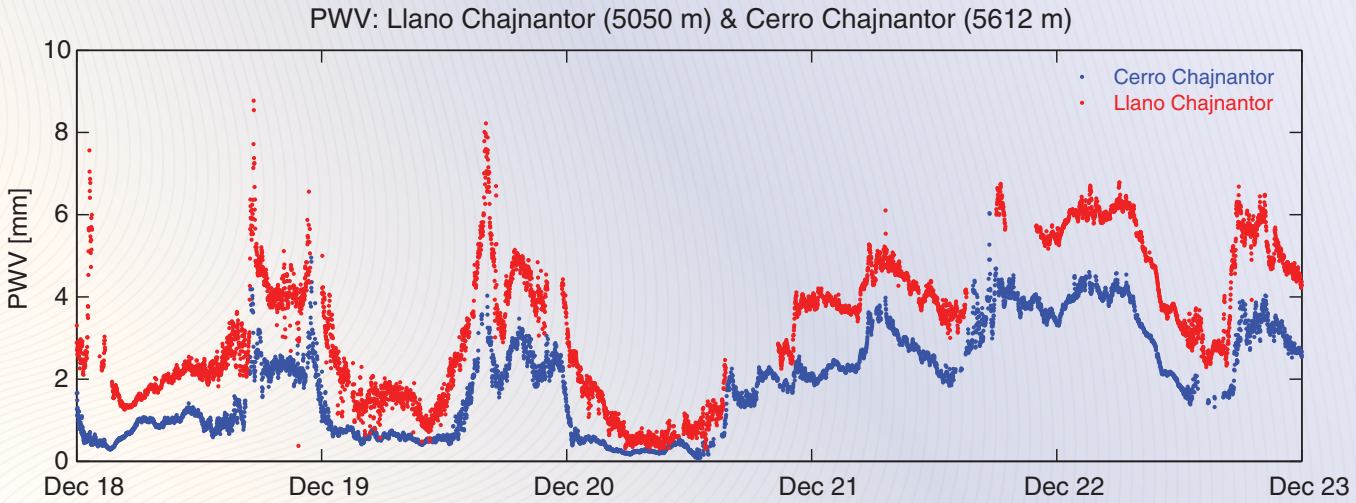
- Training EE students in astronomical instrumentation
  ➔ RF engineers.
- Support installation and operations of telescopes.
  More than 15 yrs. of experience in the Chajnantor area.
- PWV understanding of the Chajnantor area:

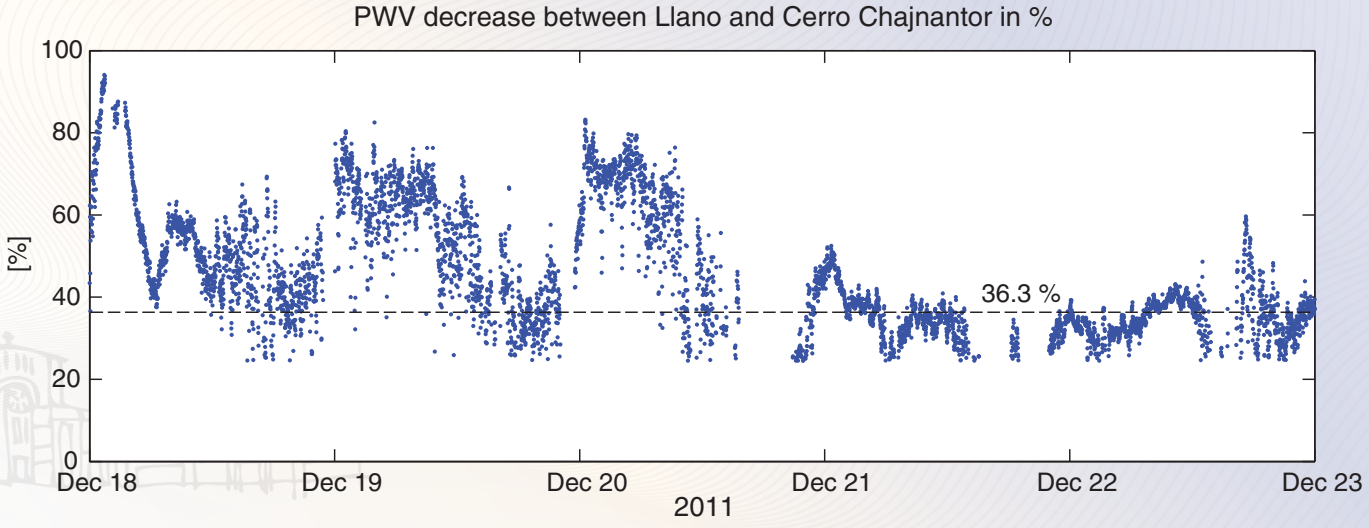
  - *Bustos et al. 2014, PASP,* **126**, 1126-1132.
  - *Cortés et al. 2016, Radio Science*, **51**, 1166-1177.

- Radio lab available for testing/calibration.
- Science with HI observations during EoR.

PWV understanding of the Chajnantor area:

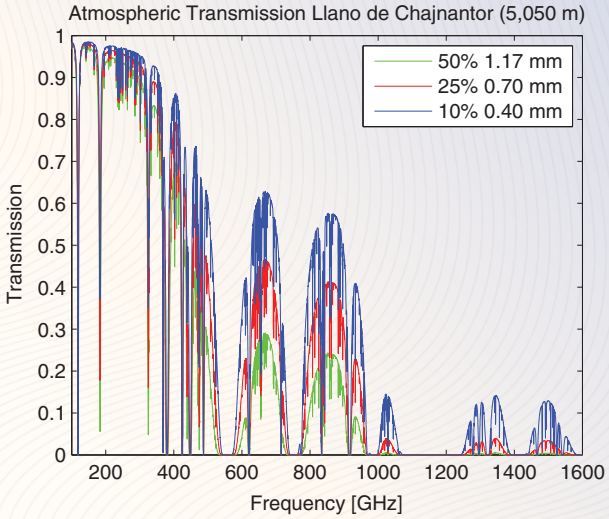
Bustos et al. 2014, *PASP*, **126**, 1126-1132.

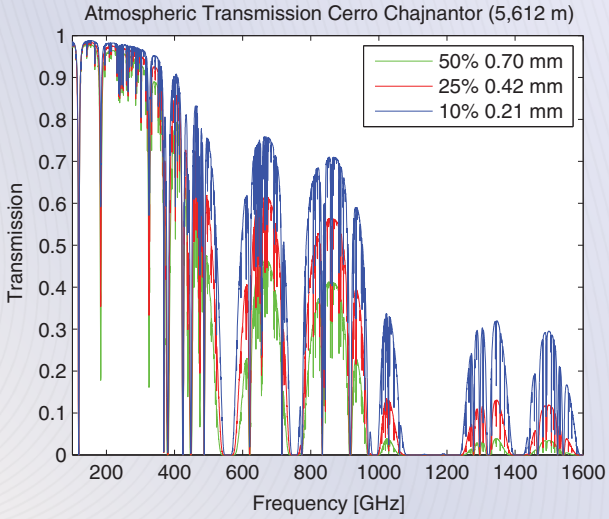




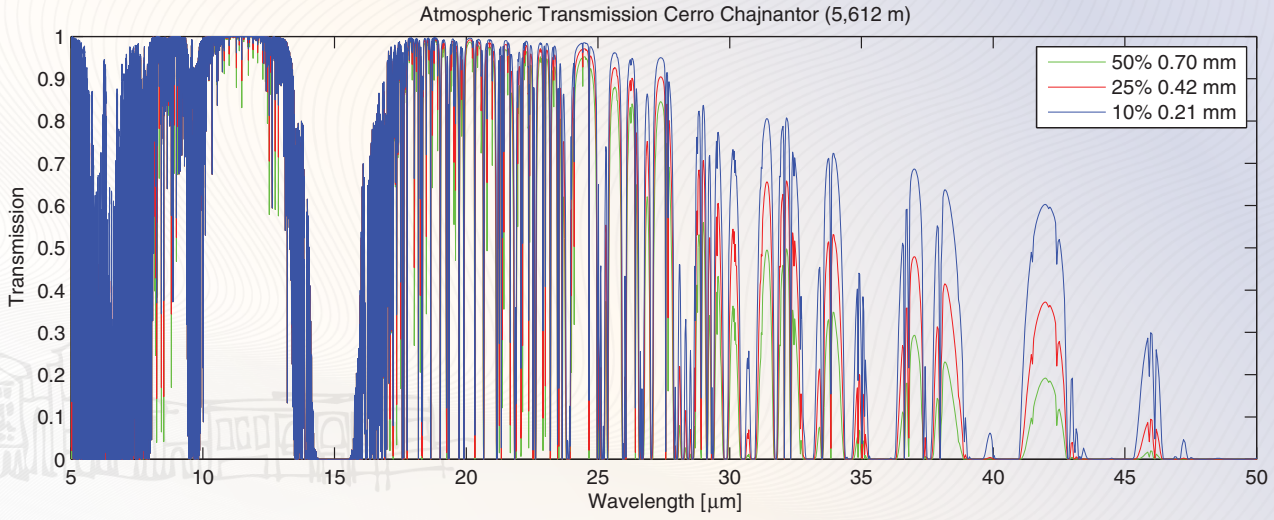
PWV understanding of the Chajnantor area:

Bustos et al. 2014, *PASP*, **126**, 1126-1132.





mm to sub-mm



mid-IR to far-IR

PWV understanding of the Chajnantor area:

Cortés et al. 2016, *Radio Science*, ***51***, 1166-1175.

Table 4. Summary With the Results of PWV Slopes Between Different Sites, Time Span of Measurements, and Altitude Difference Between Sites

Instrument Pairs	Period of Years	Slope	Altitude Difference (m)
TA-2/APEX	2006–2010	**1.07**	–27
TB-2/TA-2	2005–2009	**1.00**	0
TA-3/APEX	2011–2014	**1.00**	0
TOCO/APEX	2009	**0.89**	213
TB-3/APEX	2009–2012	**0.68**	505
TB-3/TA-2	2009–2010	**0.68**	532

Consistent with TAO results: 0.5-0.6 slope at night.

Table 5. Atmospheric Scale Heights Calculated From the PWV Ratios and Altitude Differences Shown Above

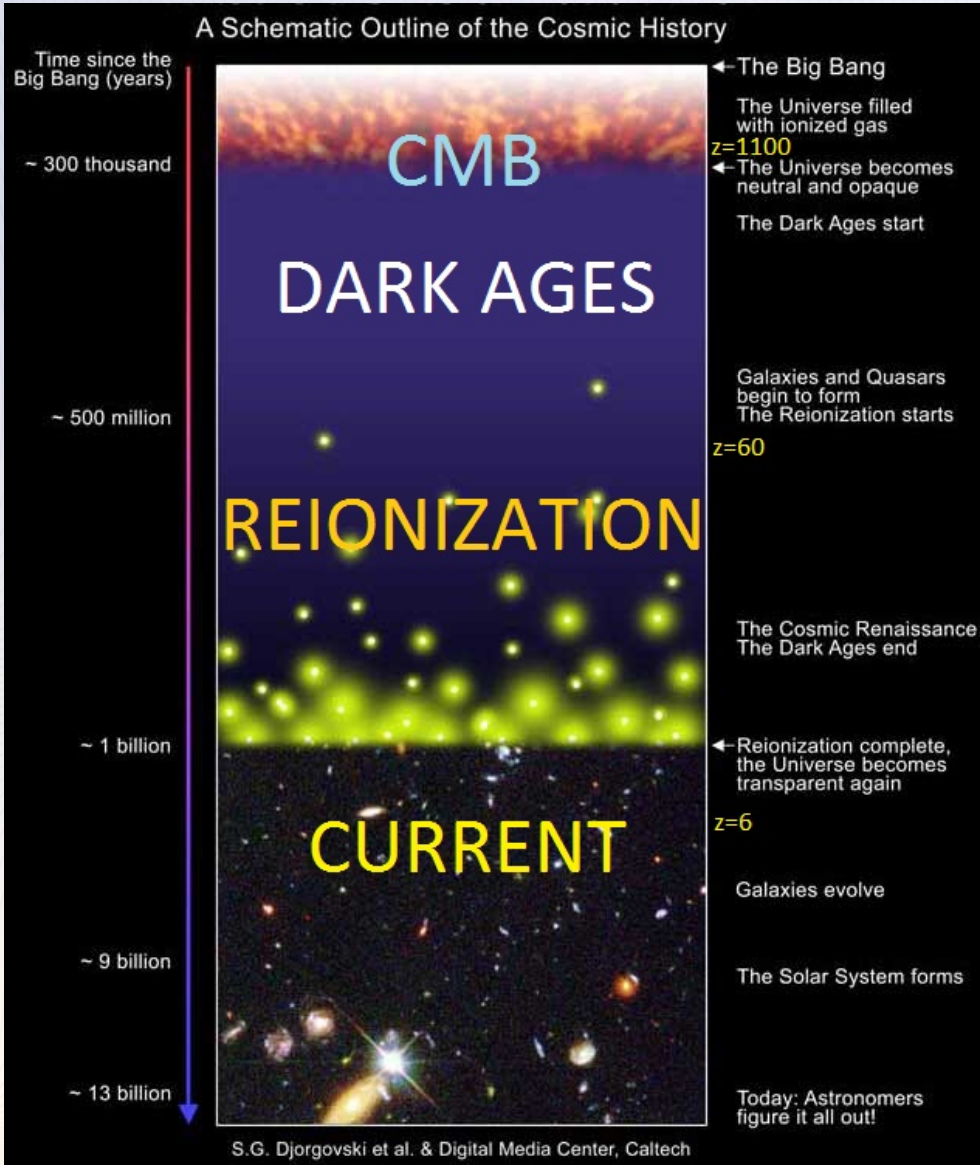
Involved Sites	Scale Height
APEX site: Cerro Chajnantor	1309 (m)
CBI site: Cerro Chajnantor	1379 (m)

Scientific case:

Detect emission line of neutral Hydrogen during EoR.

At rest, HI emits at 1.42 GHz (21-cm).

During the dark ages and EoR of the Universe ($6 < z < 35$), HI emission lies between 200 and 40 MHz.

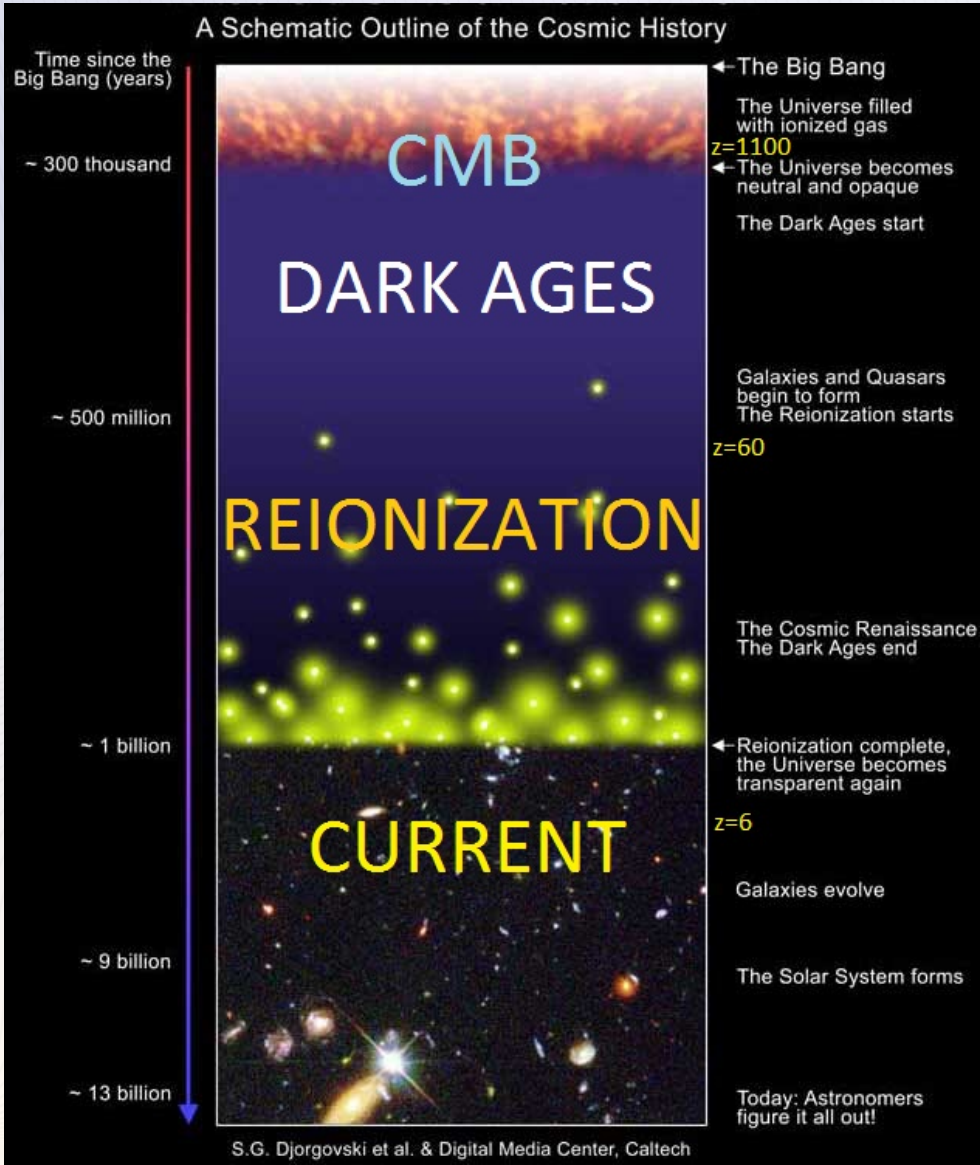


A site with low RFI is needed. At these frequencies, a very dry site is not a requirement.

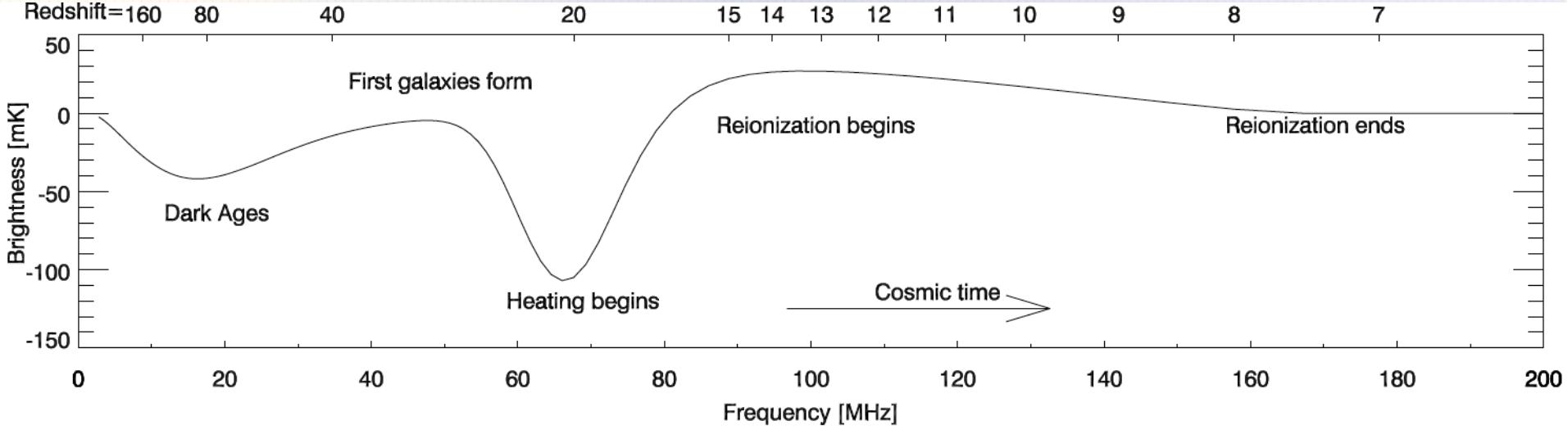
Possibility for Chajnantor: “radio-quiet zone”

HI from EoR is a very weak signal, not yet detected.

2nd generation to EDGES, LOFAR, PAPER, MWA, DARE, Sci-HI, and others.



Fiducial model of the global 21 cm signal

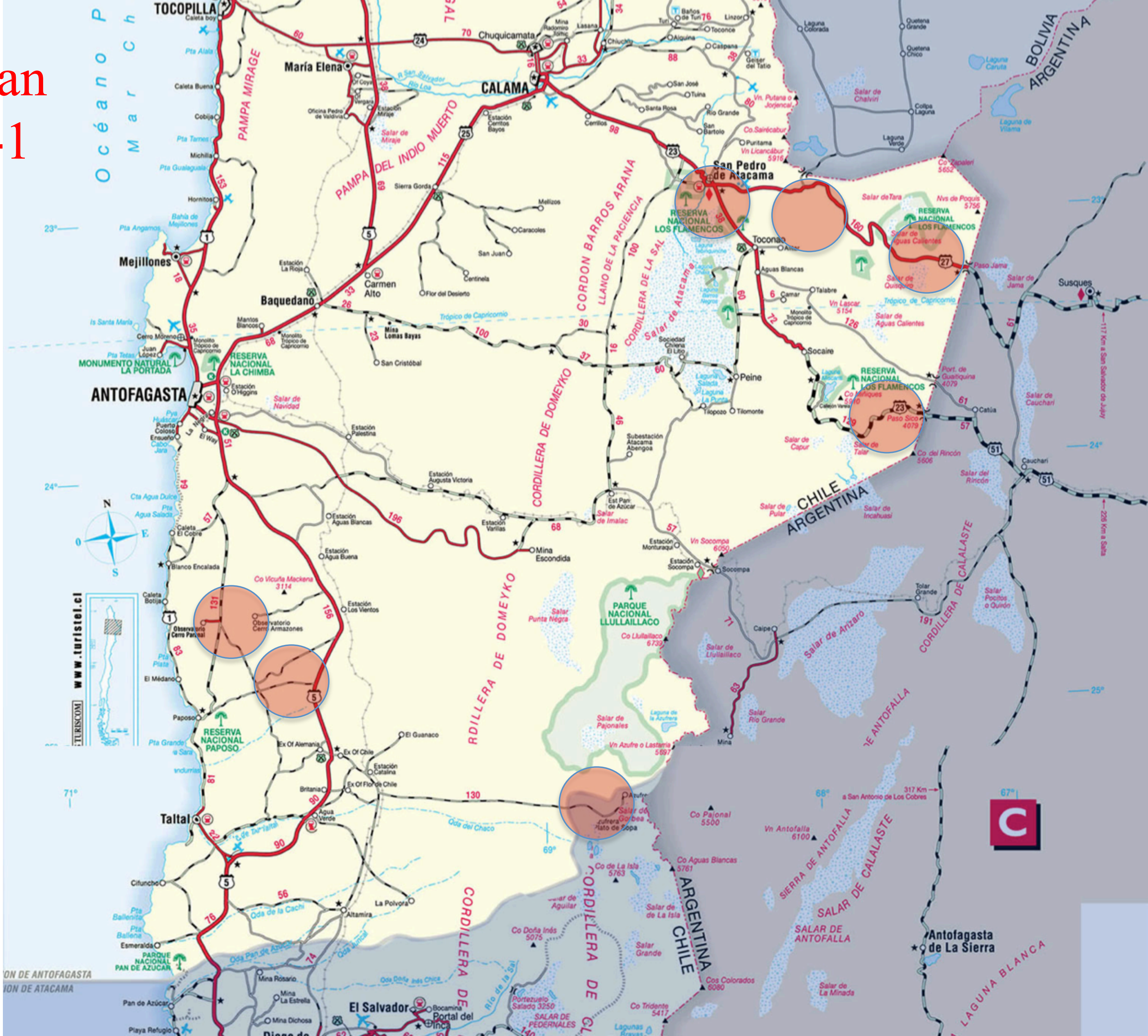


Pritchard & Loeb (2010)

MARI-UCSC

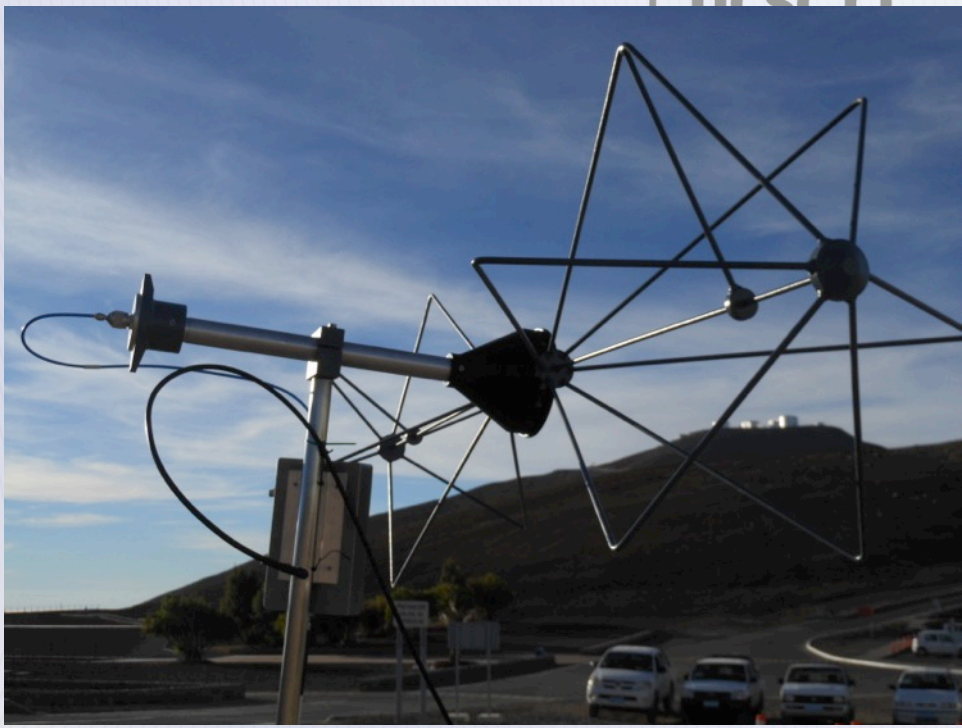
- MARI: **M**edidor **A**utónomo de **R**adio-**I**nterferencia.
- 2-year project funded by QUIMAL/Conicyt 2013.
- Measure RFI (Radio Frequency Interference) levels between 50 y 250 MHz.
- Collaboration between UCSC, ASU, UdeC.
- Team:
  - Ricardo Bustos (PI, UCSC)
  - Raúl Monsalve (Co-PI, ASU now at Colorado-Boulder)
  - Judd Bowman (ASU)
  - Alexandra Suárez (Student, UdeC)

Final plan MARI-1



UNIVERSIDAD CATOLICA
DE LA SANTISIMA CONCEPCION

MARI - Phase I, Dec. 2014

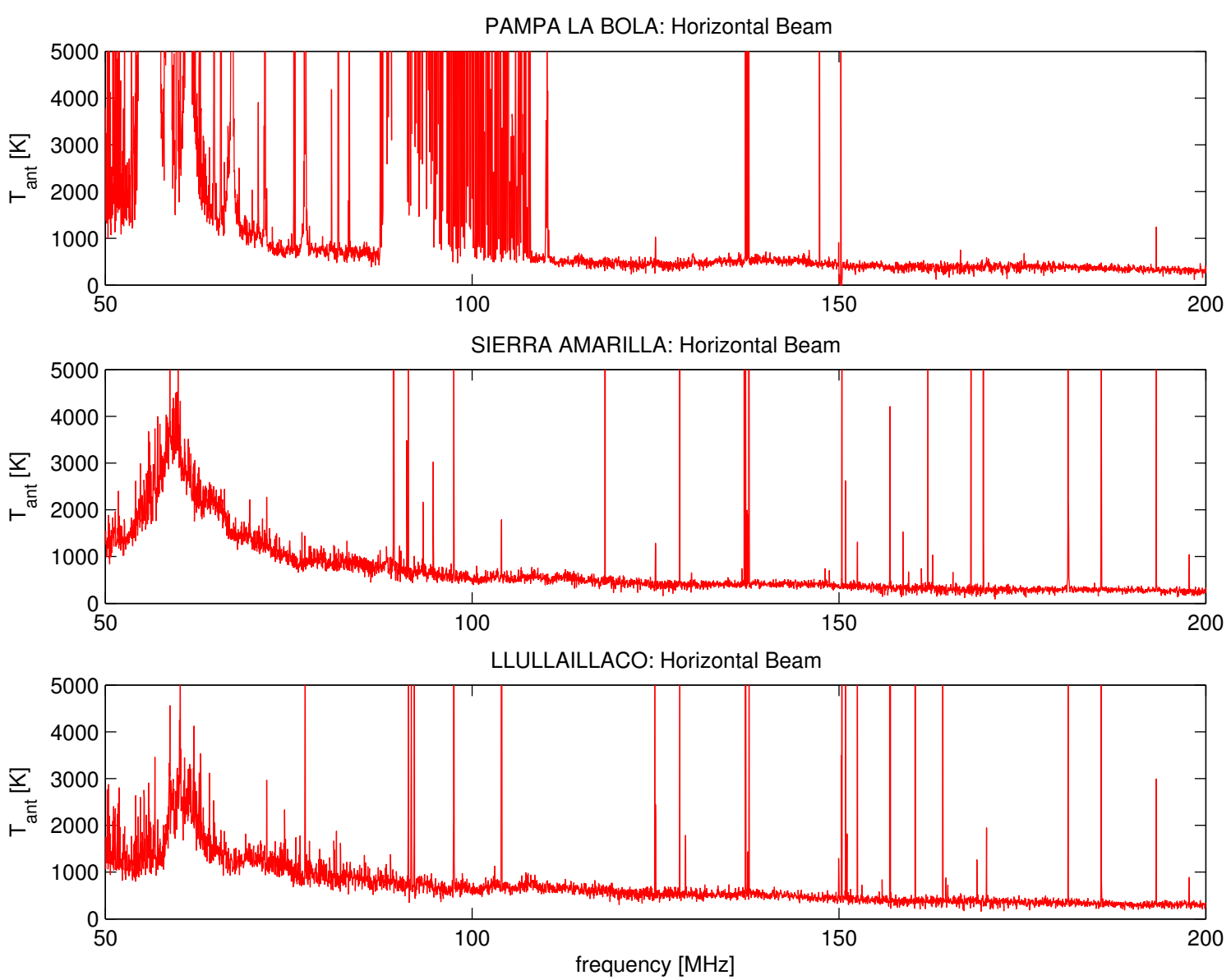


MARI - Phase II

- Participation of UCSC Electrical Eng. students
- Gained experience working on site

MARI-I

Pampa La Bola, Paranal & Llullaillaco – 1hr



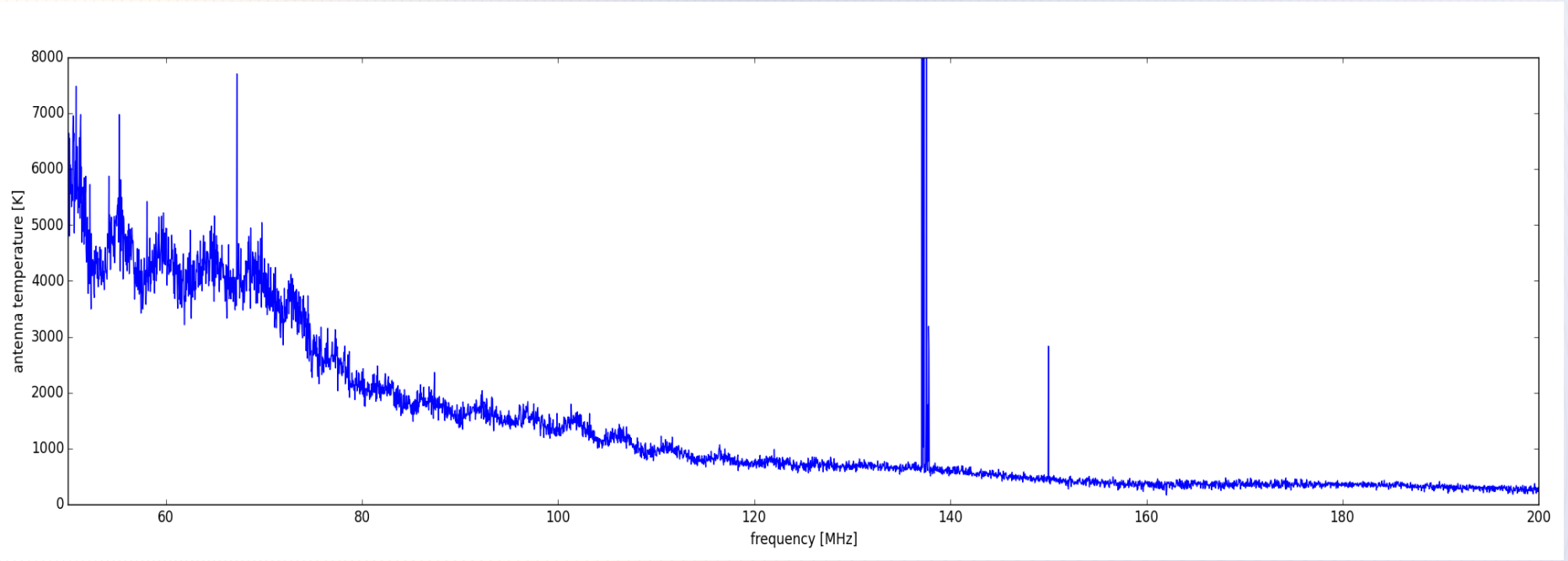
MARI-II

- Continuous 1-week RFI measurement campaigns.
- MARI-II campaigns (6): March, May, July, September, November & December 2015.

5-day continuous observations
4126 channels of 36.3 kHz bandwidth each.
Data obtained in 20 MHz sequences.
It takes 3 minutes to obtain one complete spectrum in the 50-250 MHz range.

MARI-II

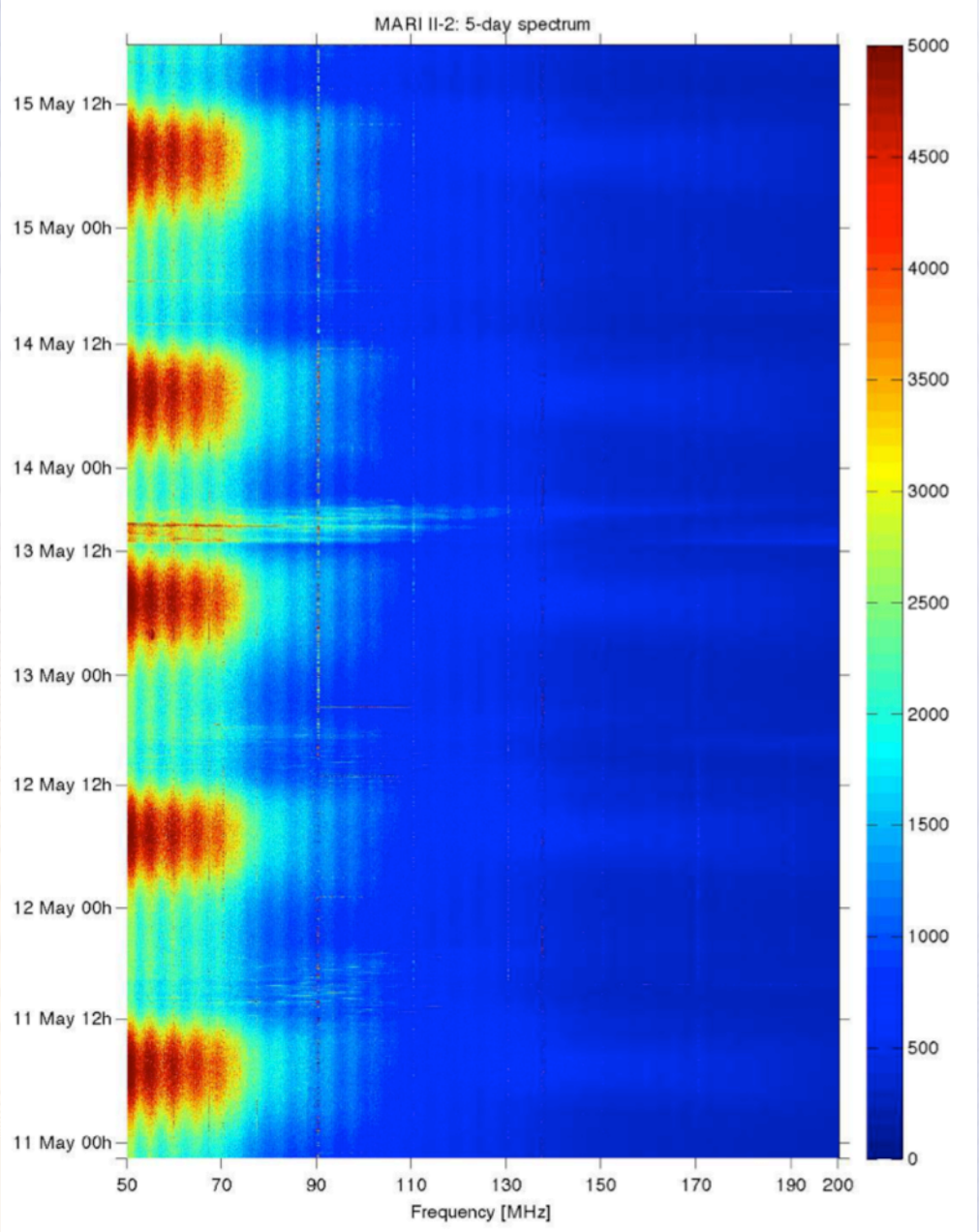
MARI II-3 July 2015: 12-hr average spectrum



UNIVERSIDAD CATOLICA
DE LA SANTISIMA CONCEPCION

MARI-II May 2015

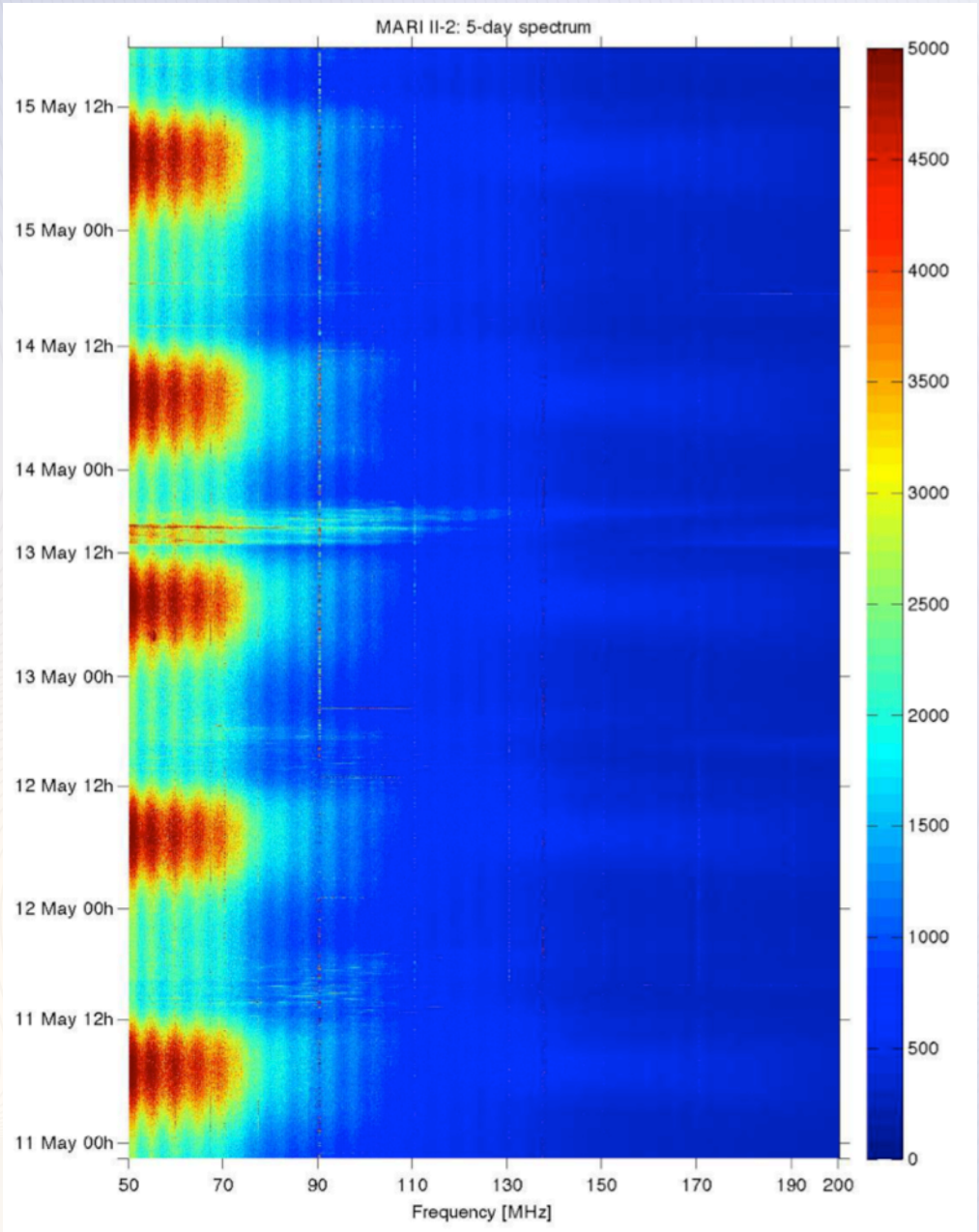
ucsc.cl



Galaxy emission

Orbcomm satellite

High solar activity



MARI - Future

1- Confirm that the new site found is appropriate for low frequency observations → site testing!

2- Permission request in progress to the Ministry of National Assets, II Region.

3- Design, construction and tests of a low-frequency telescope?
➔ a Chilean astronomical instrument!

4- Possibility for international instruments to deploy at this site.

5- Expand frequency coverage for astronomy over Chilean skies….


http://mari-ucsc.blogspot.cl
@Lab_Astro_UCSC
Thank you!