ETH
Eidgenössische Technische Hochschule Zürich
Swiss Federal Institute of Technology Zurich

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„The e-Callisto network“

e-CALLISTO

Solar Radio Astronomy, Space Weather, Education, Radio monitoring

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Topics

- General information about project and instrument
- Coverage aspects and interference issues
- Presentation of 3 (out of 35) observation sites
- Network structure
- Science aspects, papers
- Students projects
- Conclusions

Callisto as Swiss - contribution to IHY2007 and ISWI

C ompound
A stronomical
L ow cost
L ow frequency
I nstrument for
S pectroscopy and
T ransportable
O bservatory

11th anniversary of Callisto since 1st light of the prototype receiver in 2002

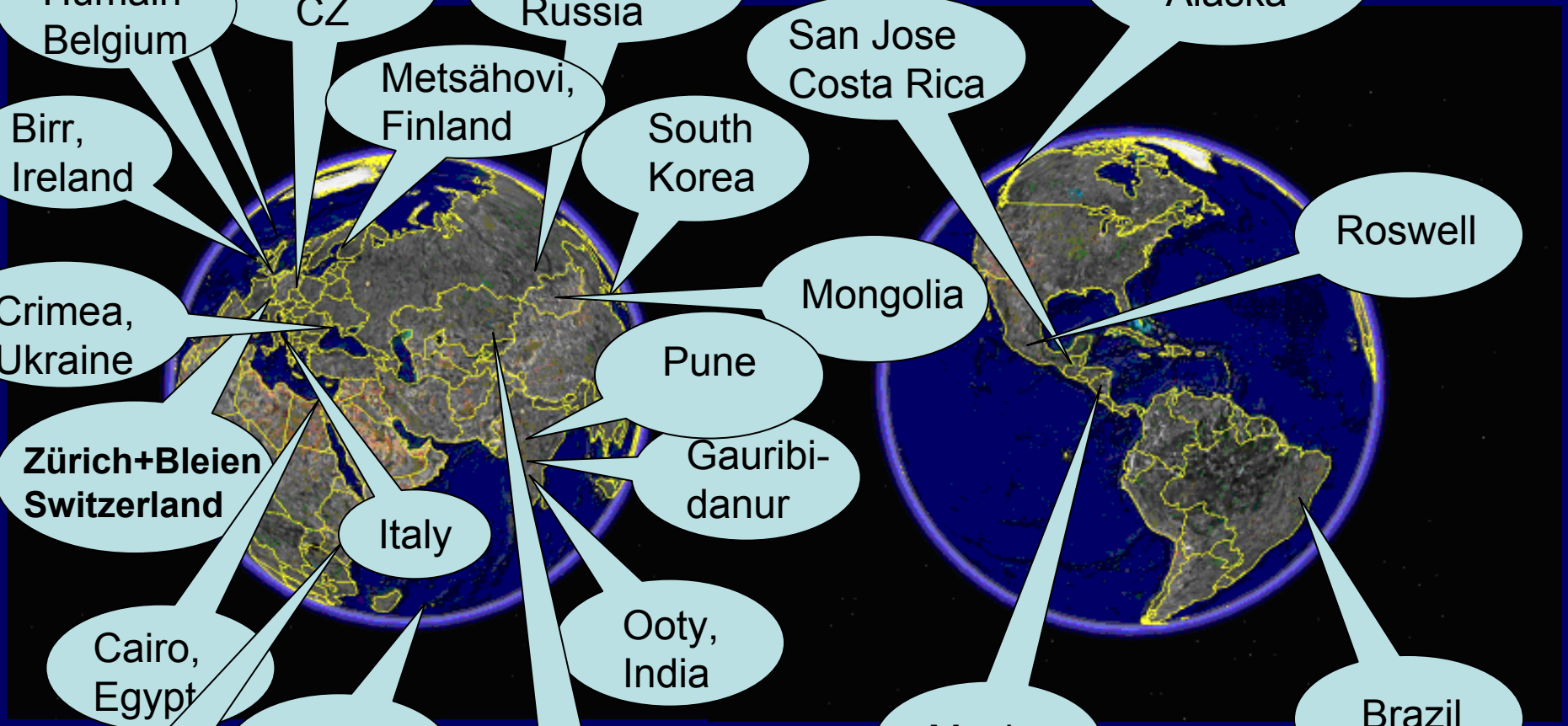
What is Callisto good for?

- Real-time observation of dynamic, electromagnetic solar radio bursts
- Radio-monitoring, site evaluation for other radio-telescopes
- Environmental studies
- Animal tracking system (e.g. baboon tracking in SA)
- Education & outreach
- Electronics training for physics apprentices and students

Specification Callisto

Parameter	Specification
Frequency range	45.0 MHz … 870.0 MHz (34 cm < λ < 6.7 m) any other range, using heterodyne/homodyne converters
Frequency step size	62.5 KHz (13'200 channels)
Radiometric bandwidth	300 KHz @ -3dB
Integration time	1 msec
Dynamic range	> 50 dB
Noise figure	< 10 dB
Measuring rate	800 pixels/sec maximum
Sweep length	1…400, nominal 200 frequencies per sweep
Power consumption	12 V +/- 2 V / ~225 mA (2.7 Watt)
Weight	~ 1 kg
Dimensions	110 mm x 80 mm x 205 mm
Cost	Hardware ~400$, labour 1 week (soldering, testing etc.)
Inputs	4 files (configuration, frequency, scheduler, calibration)
Outputs	4 files (FITS-files, logfile, light curve file, spectral overview)

24h/7day of observation



Glasgow UK

Humain Belgium

Ondrejov CZ

Badary, Russia

Anchorage Alaska

San Jose Costa Rica

Metsähovi, Finland

Birr, Ireland

South Korea

Roswell

Mongolia

Crimea, Ukraine

Pune

Zürich+Bleien Switzerland

Gauribi-danur

Italy

Ooty, India

Cairo, Egypt

Mauritius

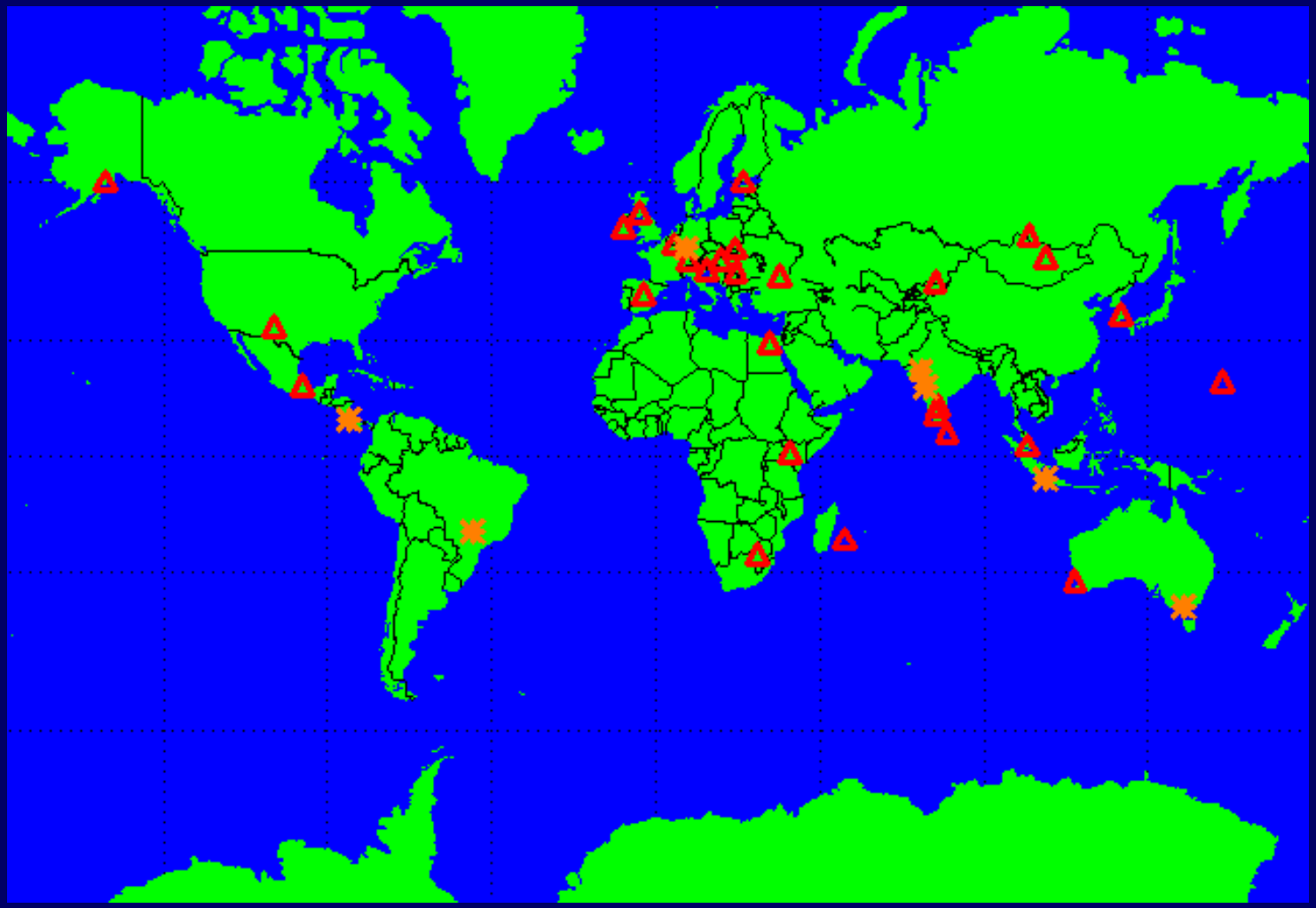
Almaty

Nairobi, Kenya

Mexico

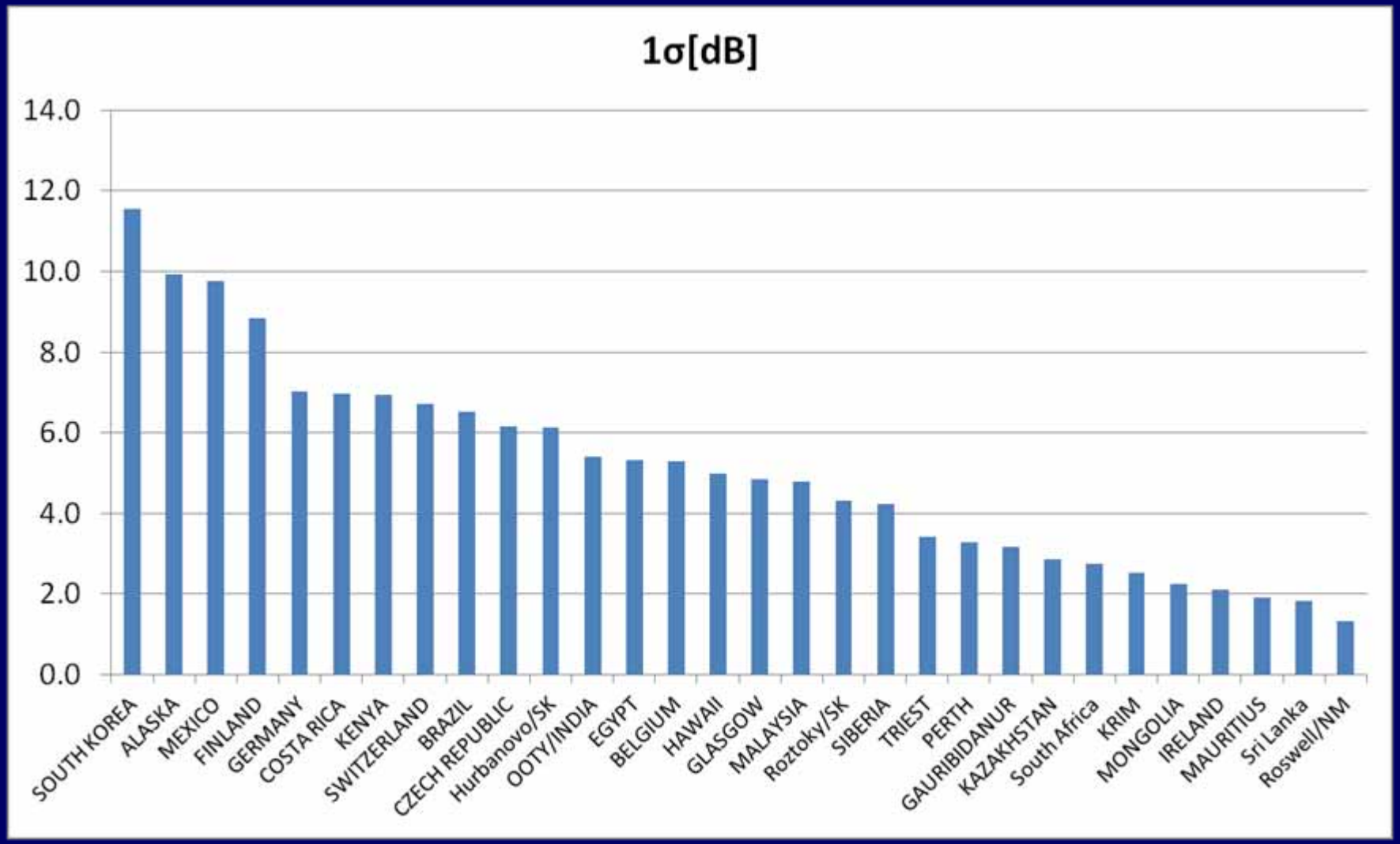
Brazil

Coverage

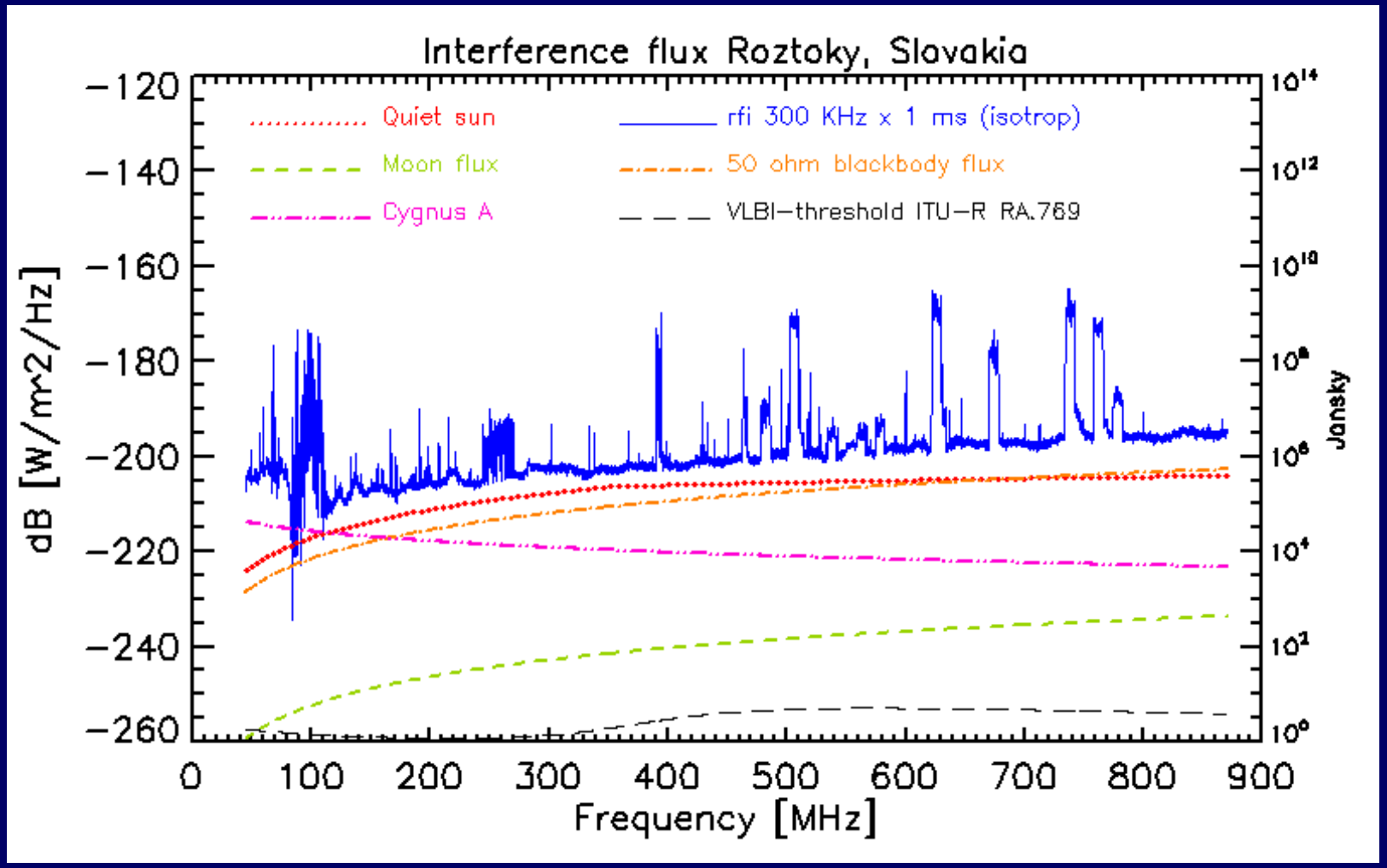


Status August 2013: 65 instruments at 35 different locations worldwide
Reached 100 % coverage all over the years in March 2013

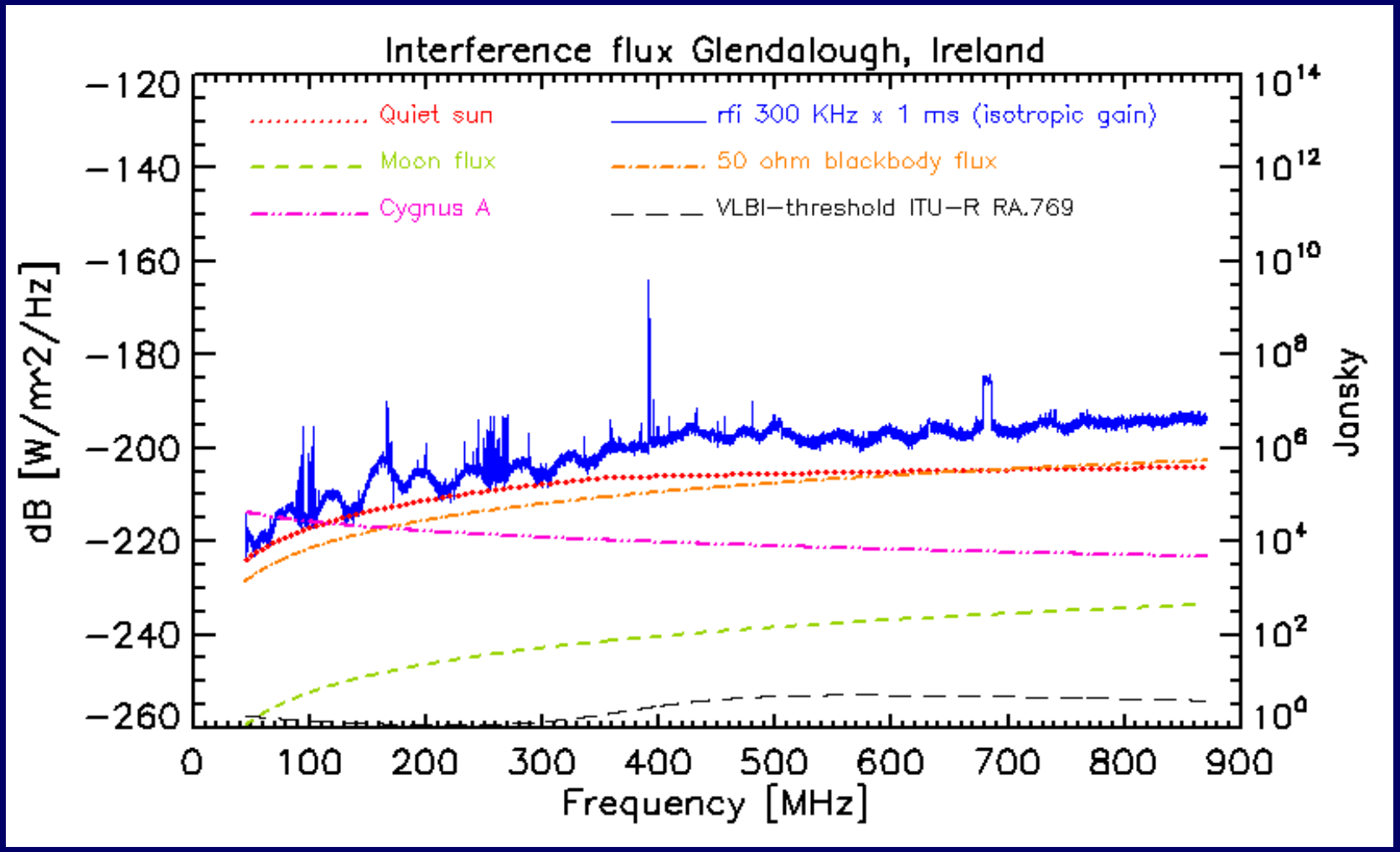
Interference situation per location



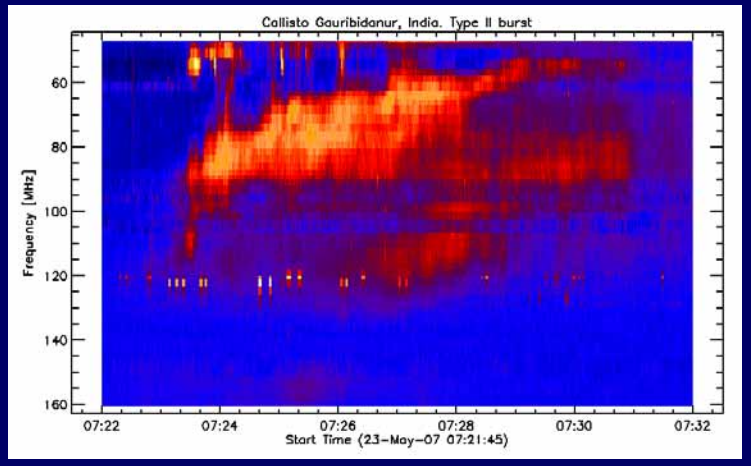
Interference situation



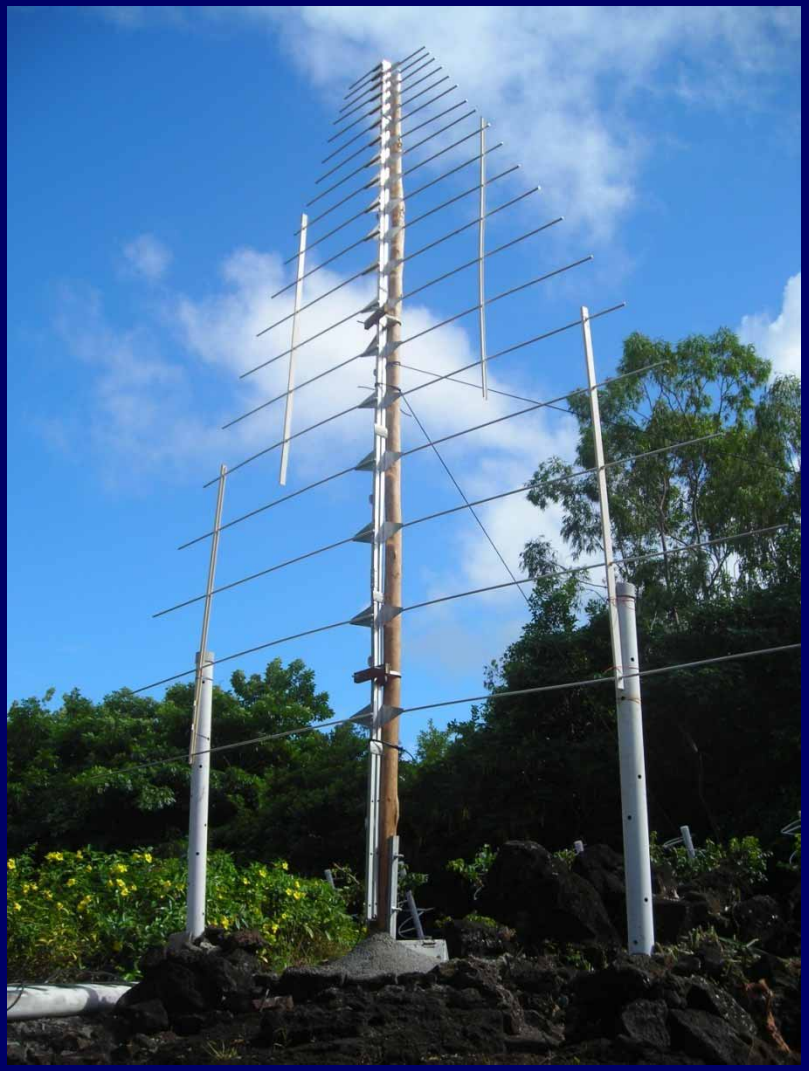
Interference situation

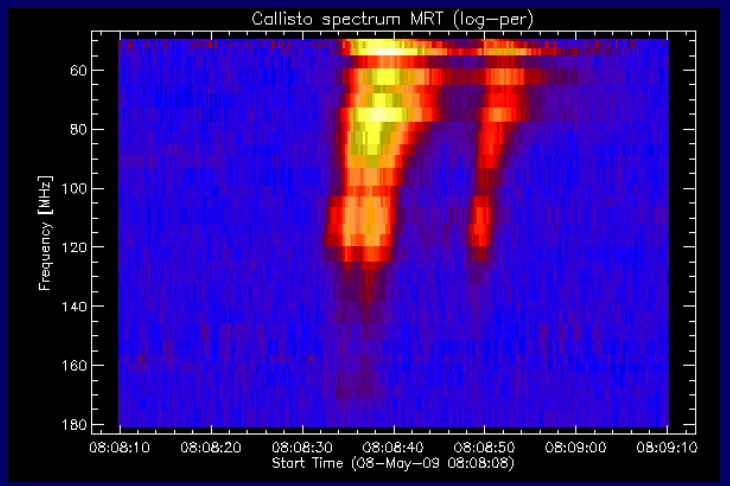


Callisto at IIA in Gauribidanur, India

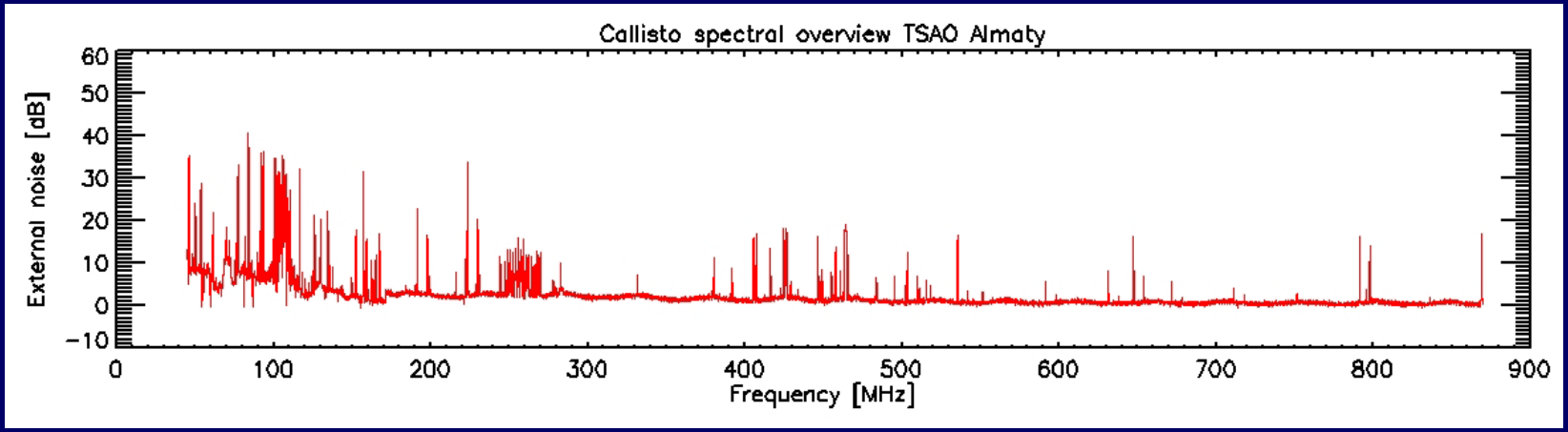


Callisto in Bras d'Eau Flacq, University of Mauritius



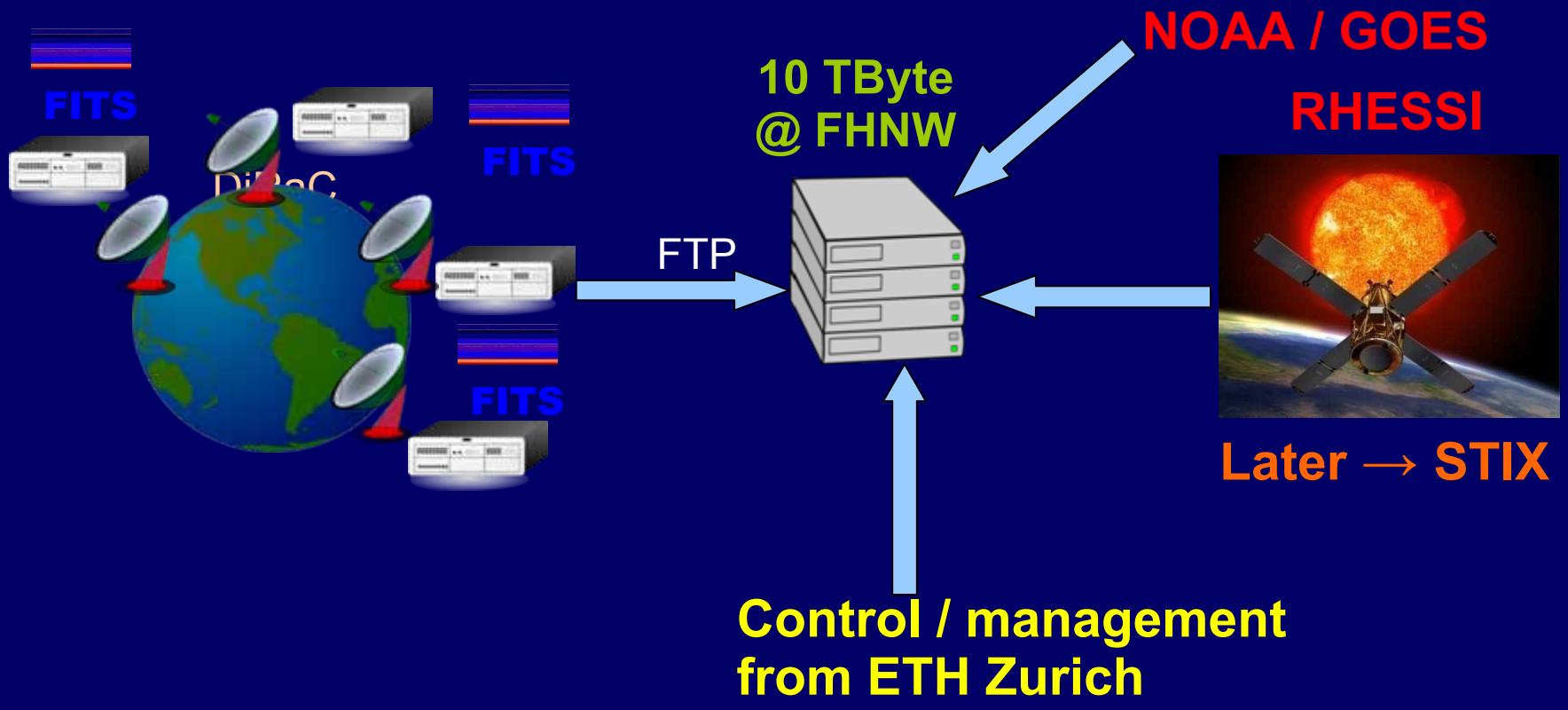


Callisto at Institute of Ionosphere Almaty, Kazakhstan



e-Callisto network

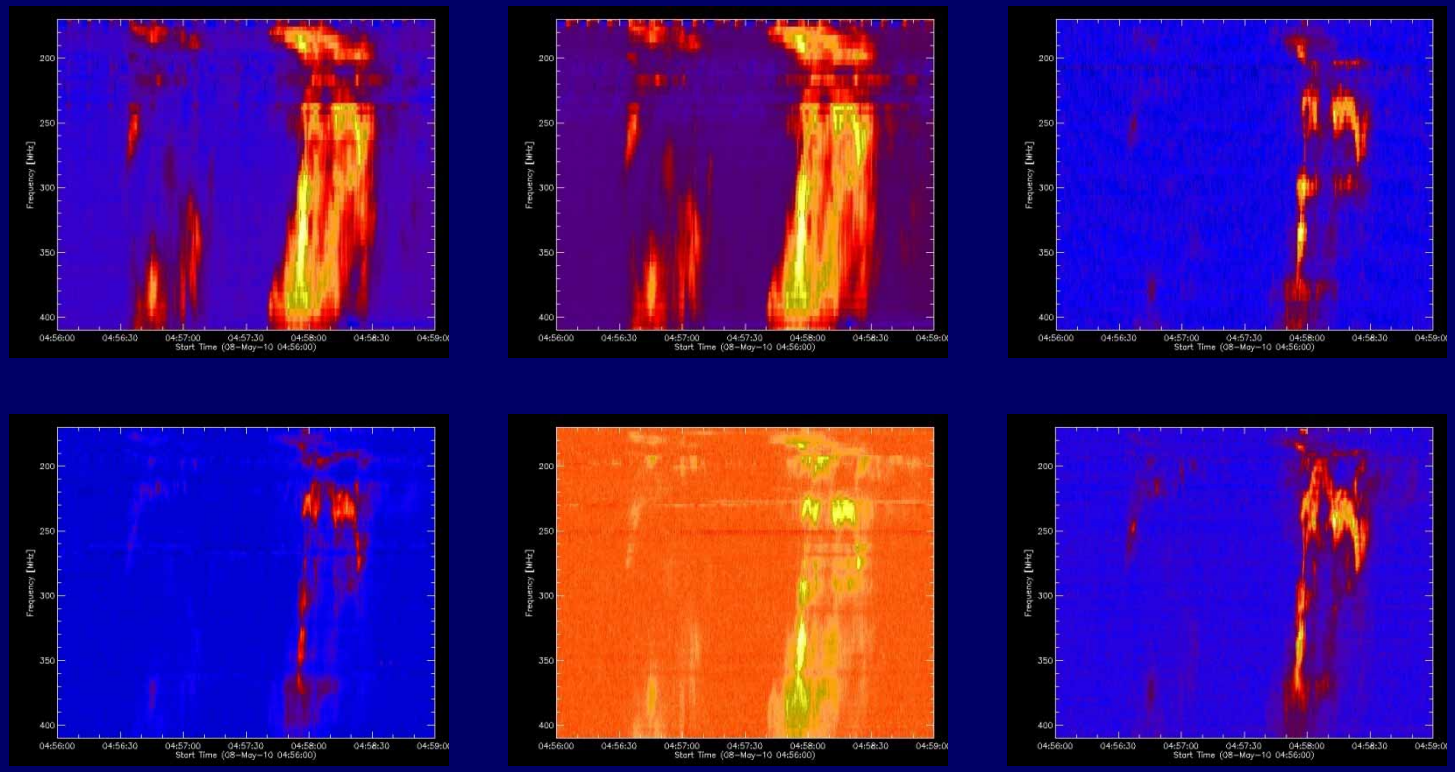
http://soleil.i4ds.ch/solarradio/



Current User Statistics

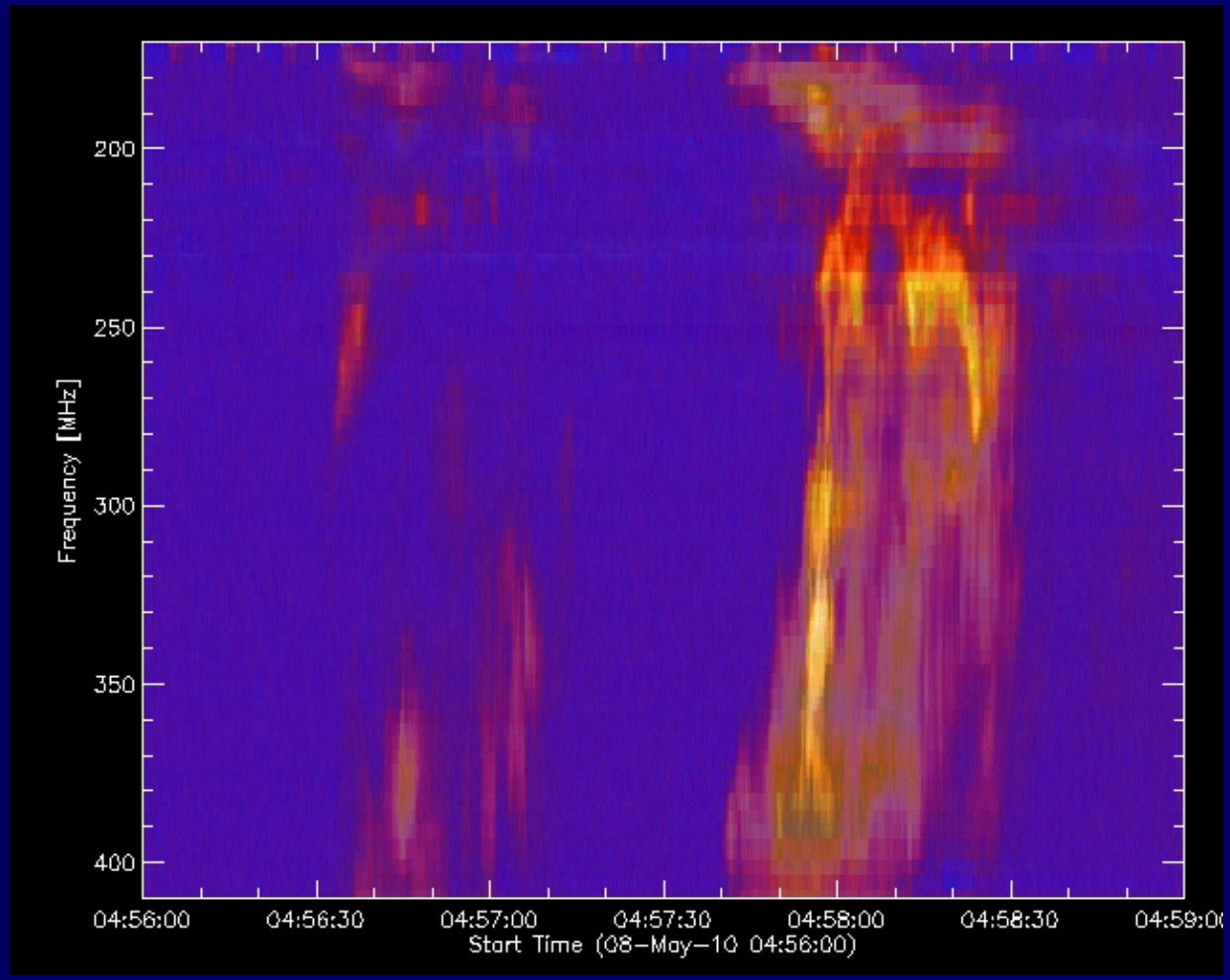
~ 500 worldwide visits per month from > 90 countries
~ 60 GByte solar radio data per year (FITS-files)
10 Tera Byte data archive available at FHNW

Geographical Redundancy



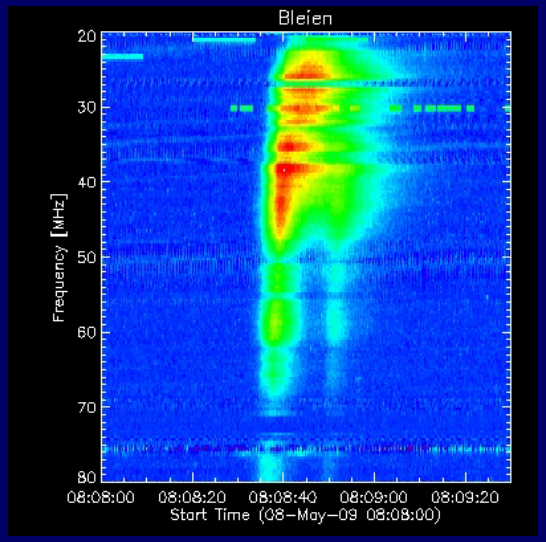
2 x Switzerland (LHCP, RHCP) + Mauritius + Ooty + Gauribidanur + Siberia

6 integrated locations



6 different locations integrated into one plot improves SNR (→ correlated)
Radio frequency interference goes down (→ not correlated)

Append in frequency range



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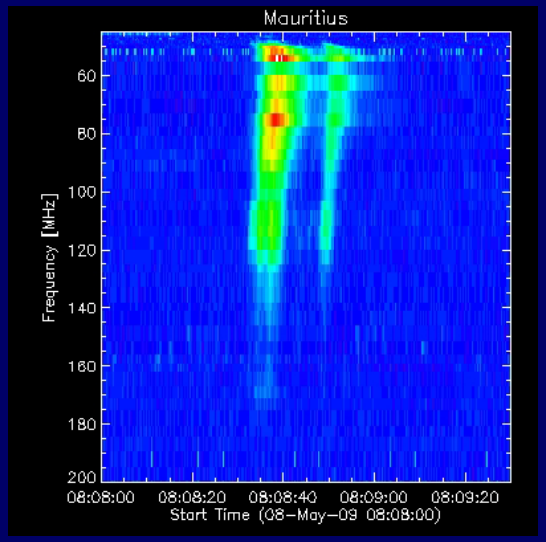

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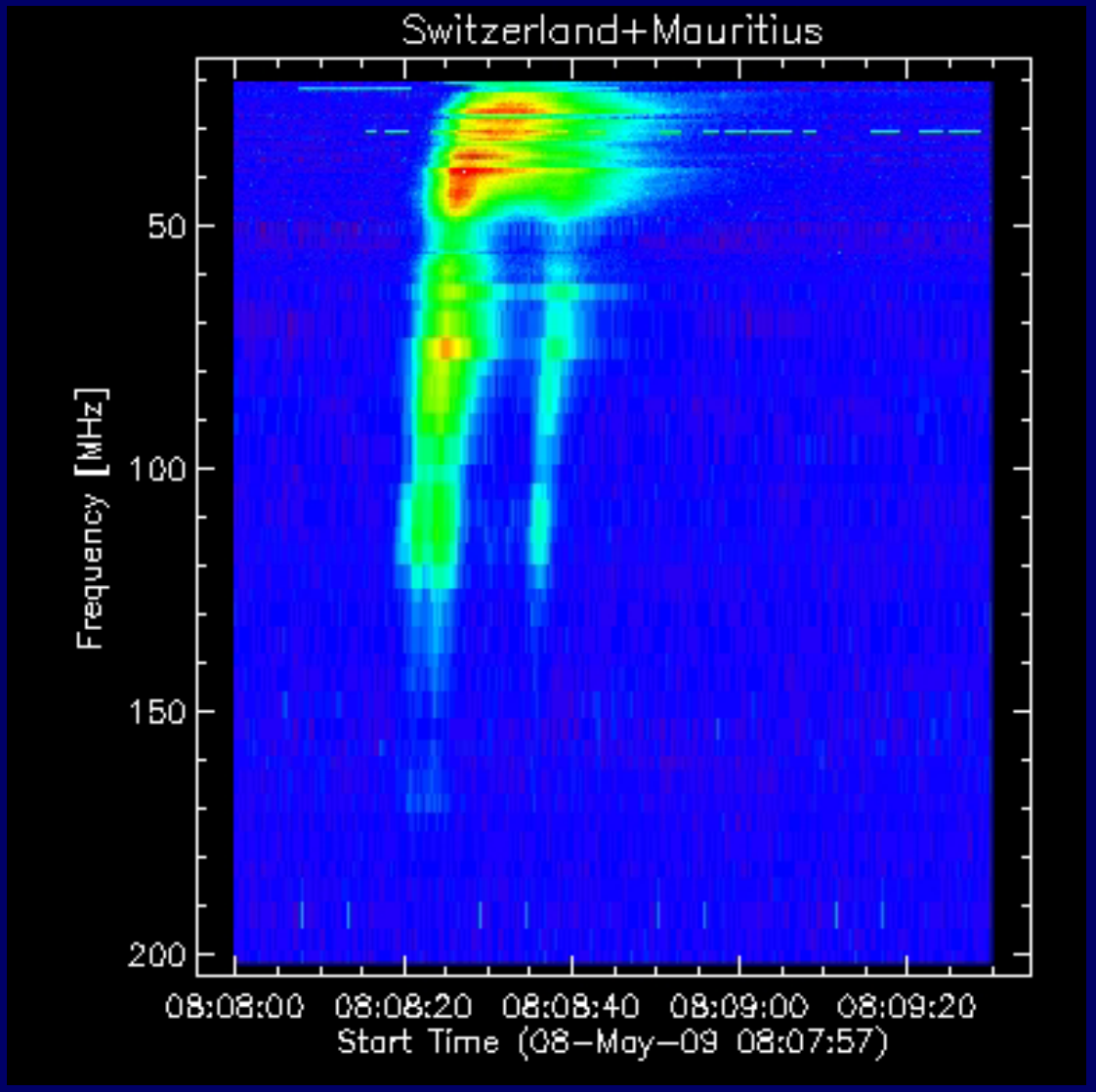
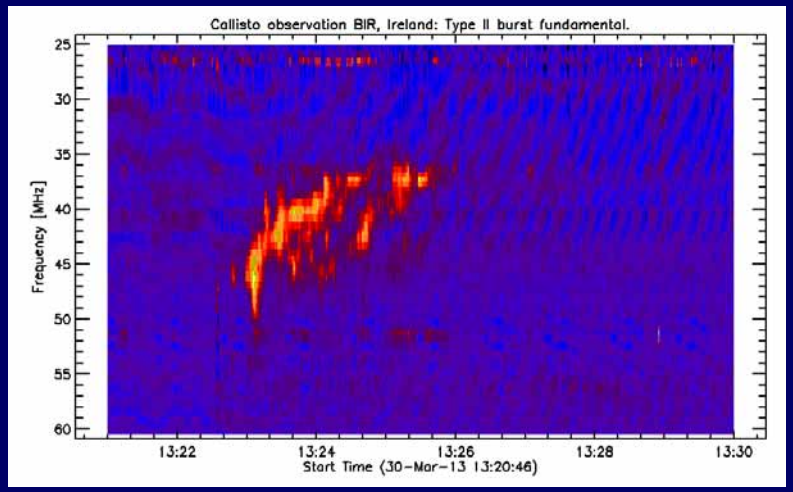


Switzerland 20…60 MHz + Mauritius 63…200 MHz

Append in frequency range



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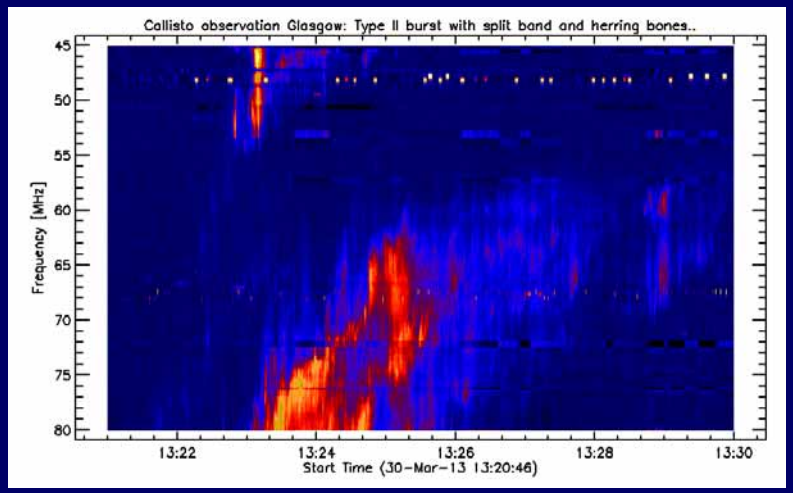

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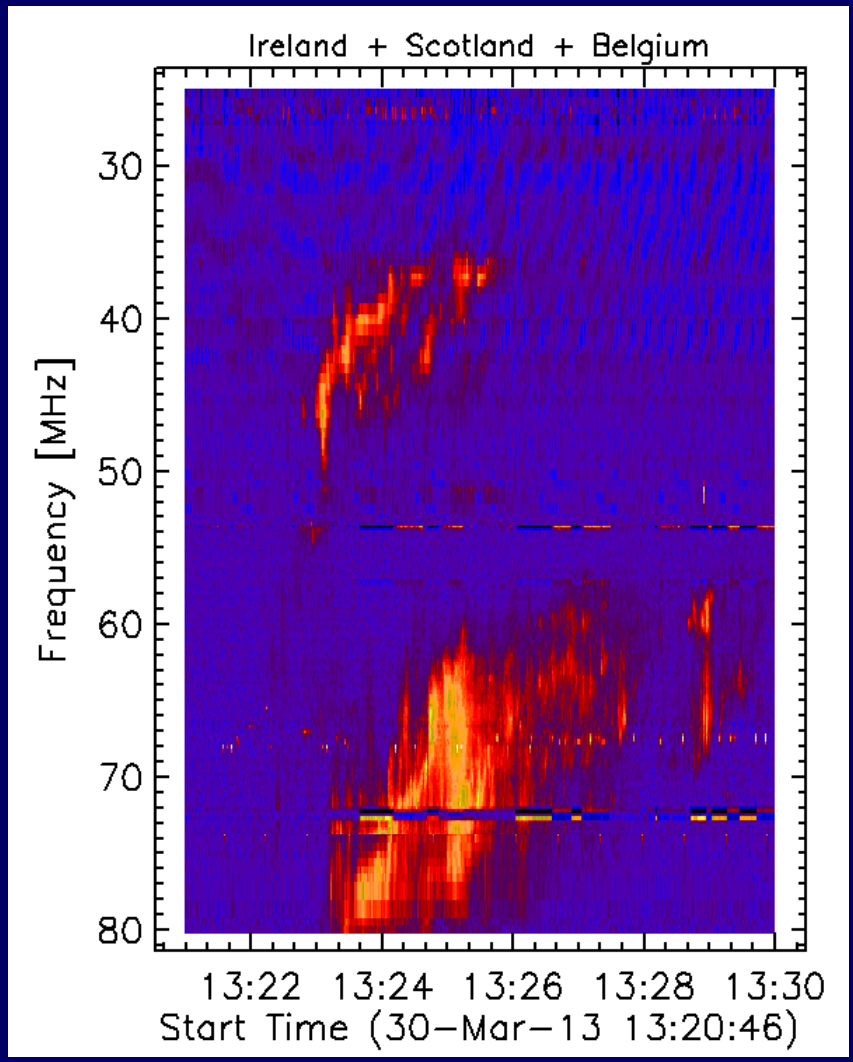

Ireland 10…60 MHz + Scotland 45…80 MHz + Belgium 45…80 MHz

Publications

14 reviewed and published papers over a period of ~10 years

Arnold O. Benz, Christian Monstein, Hansueli Meyer ETH Zurich, Solar Physics, 226, 143 - 151 (2004)

Benz, A. O.; Perret, H.; Saint-Hilaire, P.; Zlobec, P. Advances in Space Research, Volume 38, Issue 5, p. 951-955. (2005)

Pick, Monique; Malherbe, Jean-Marie; Kerdraon, Alain; Maia, Dalmiro Jorge Filipe
The Astrophysical Journal, Volume 631, Issue 1, pp. L97-L100. (2005)

Monstein, C.; Ramesh, R.; Kathiravan, C. Bulletin of the Astronomical Society of India, Vol. 35, p. 473-480 (2007)

Benz, A. O.; Monstein, C.; Meyer, H.; Manoharan, P. K.; Ramesh, R.; Altyntsev, A.; Lara, A.; Paez, J.; Cho, K.-S.
Earth, Moon, and Planets, Volume 104, Issue 1-4, pp. 277-285 (2008)

Monstein, Ch. A.; Lesovoy, S. V.; Maslov, A. I. Geomagnetism and Aeronomy, Volume 49, Issue 7, pp.856-859 (2009)

Bong, S.-C., Kim, Y.-H., Roh, H., Cho, K.-S., Park, Y.-D., Choi, S., ,
Journal of the Korean Astronomical Society, vol. 42, no. 1, pp. 1-7 (2009)

Ramesh, R.; Kathiravan, C.; Barve, Indrajit V.; Beeharry, G. K.; Rajasekara, G. N.
The Astrophysical Journal Letters, Volume 719, Issue 1, pp. L41-L44 (2010)

Shibasaki, K.; Alissandrakis, C. E.; Pohjolainen, S. Solar Physics, Volume 273, Issue 2, pp.309-337 (2011)

Nicola Nosengo, Nature News, 17 February 2011 | Nature | doi:10.1038/news.2011.97

P. Zucca, E. Carley, J. McCauley, P. Gallagher, C. Monstein, Solar Physics (2012)

H. M. Bain, Säm Krucker, L. Glesener, and R. P. Lin, The Astrophysical Journal, Volume 750, Number 1, 2012

R. Ramesh, M. Anna Lakshmi, C. Kathiravan, et. Al., The Astrophysical Journal, 752:107 (6pp), 2012 June 2013

J. Kallunki, M. Uunila, C. Monstein, IEEE Aerospace and Electronic Systems Magazine , V28, Nr. 8 August 2013

Possible students projects

- Variability of VHF/UHF satellite transponders -> calibration source?
- Occupancy of spectrum over a longer period of time -> free channels?
- Far field calibration with rf-generator/noise source -> calibration through the air
- Invent a method to qualify Callisto observatories regarding rfi and regarding burst sensitivity as a measure for data quality
- Measurement campaign per country -> find a radio quiet zone
- Setup interferometer to determine the diameter of the solar corona
- Build a down- or an up-converter for other frequency ranges

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Conclusions

- Network still growing, some new requests

- Geographical coverage to be improved, especially American/Pacific region

- Data quality improving (learning process)

- Apprentice of Physics dept. very much like Callisto production

- More science could be done (education?)

- Only little funding in Switzerland and neither UN nor NASA have funding left to further support instruments in developing countries.

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International Space Weather Initiative
ISWI

Additional information:

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http://e-callisto.org

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