Smart-1 and radio astronomy

jive

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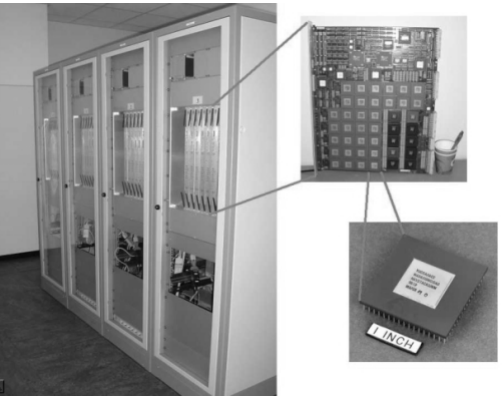
SMART-1 IMPACT ON THE MOON

Courtesy of Mark R Rosiek USGS Astrogeology Team, Planetary Geomatics Group and Dr Anthony C.Cook, School of Computer Science and IT,University of Nottingham,

Medicina 32-m VLBI antenna

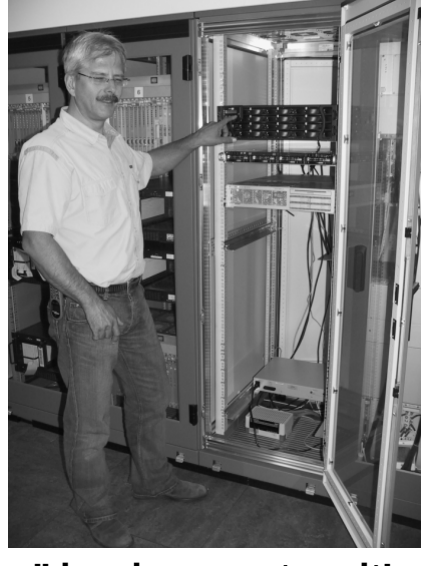
Metsähovi 14-m VLBI antenna

Westerbork synthesis radio telescope, single 25-m antenna is used for tracking experiments



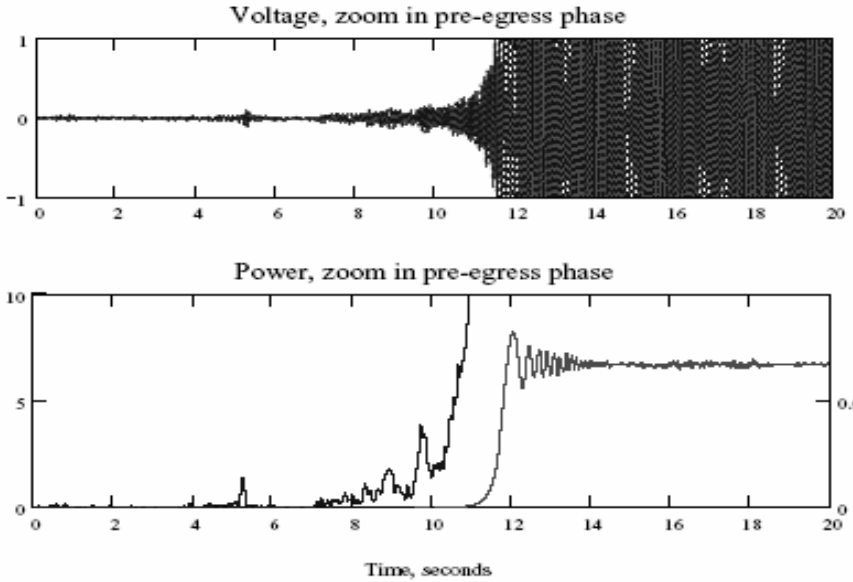
Computational core, oard and chip of the 50 Tflops EVN Mk5 Correlator at JIVE

“Old” hardware setup on which JIVE/Huygens software correlator was developed

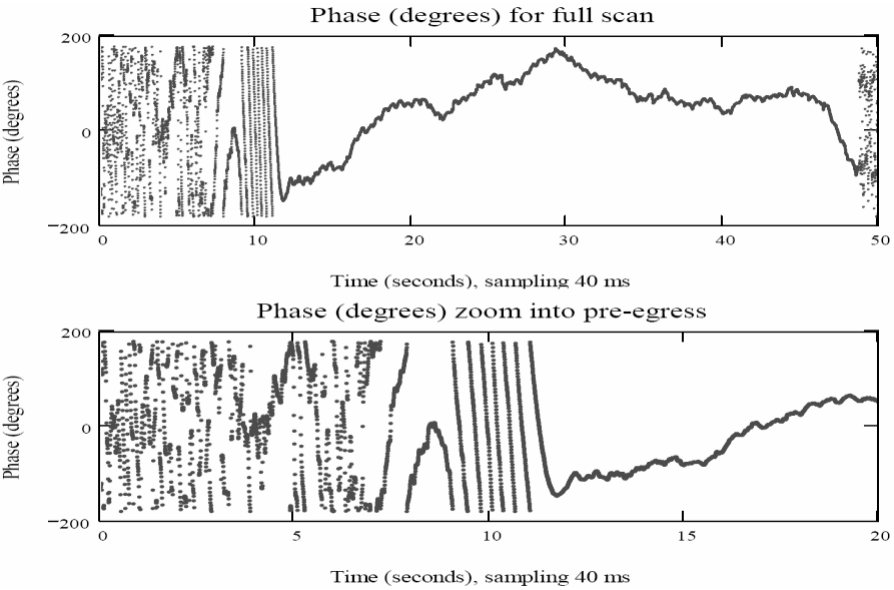


“New” hardware setup; it’s also a development platform for a general purpose broad band EVN Software Correlator at JIVE

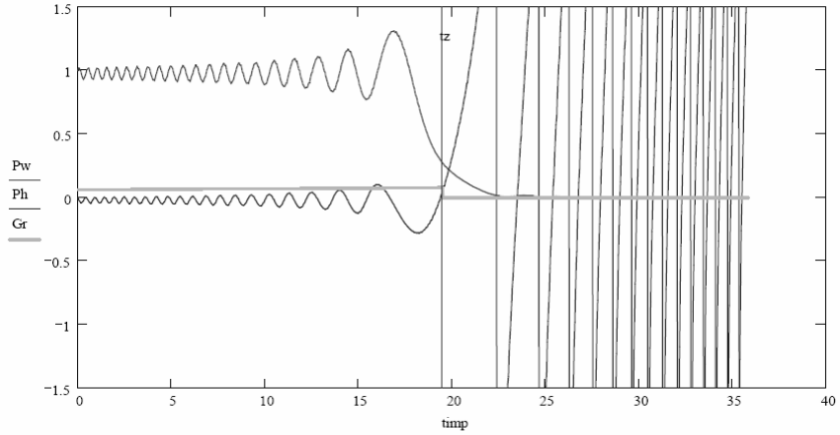
Smart-1 as a text-book demo for classical op



Post-egress “classical” diffraction pattern and zoom on pre-egress high beamed features, like these seen around seconds 5 and 8-10



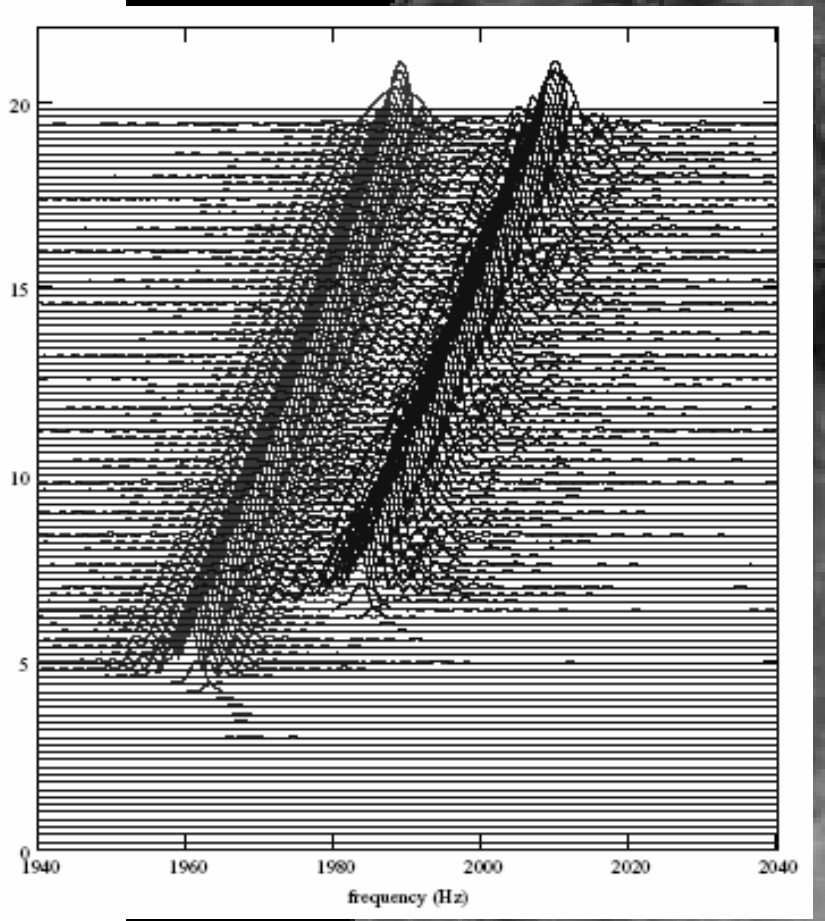
For comparison: power (red) and phase (blue) patterns for diffraction on a flat circular screen



signal as obse

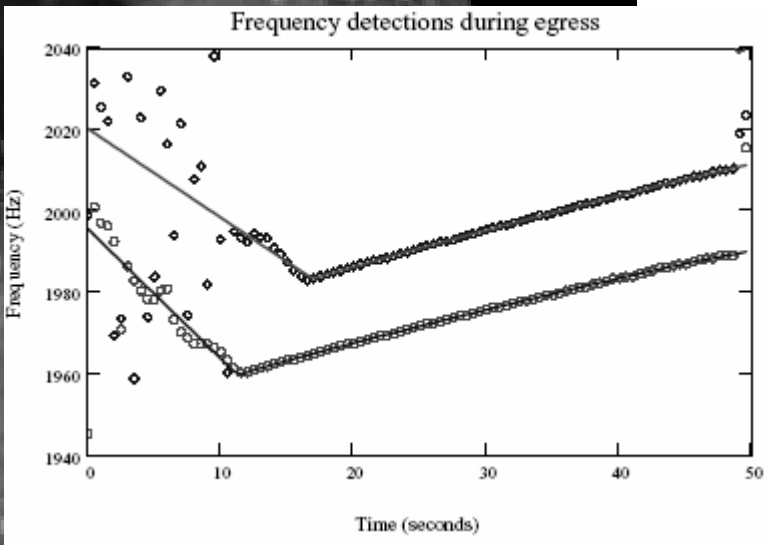
(right) during the spacecr

from an occultation



Frequency de

Medicina – circles, Mets amonds



Frequency scales for both s s are cross-calibrated to sub-milli el with "clock-search" data on ca ource

"Mouse

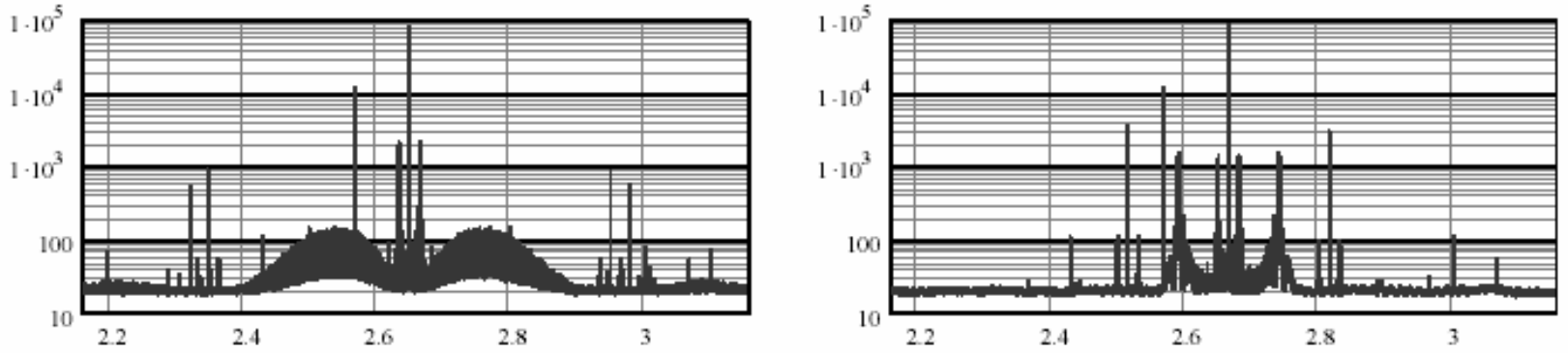
bottom

signal which appears

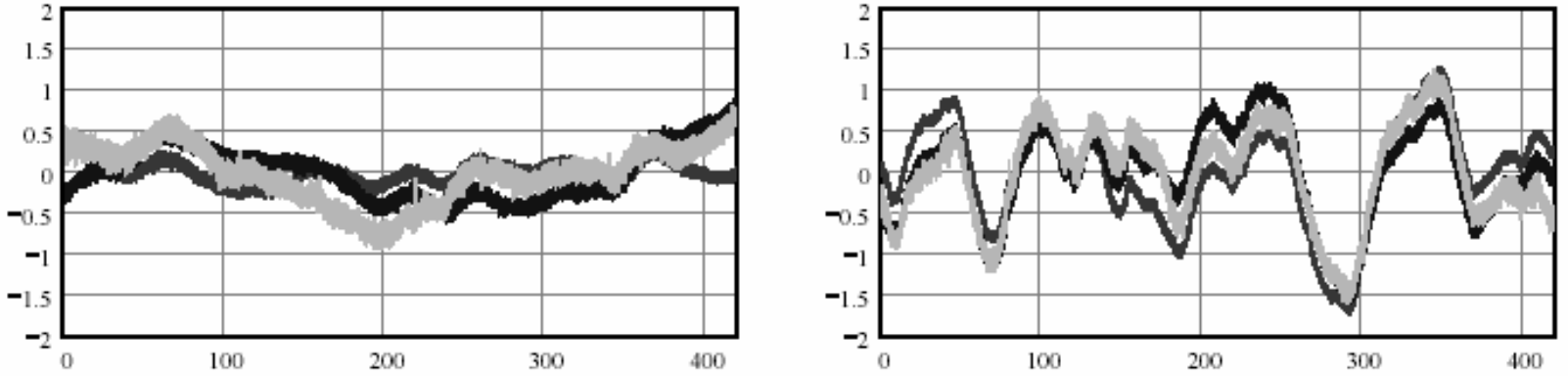
many se signal

beams i

Smart-1 signal seen by “analytical VLBI correla

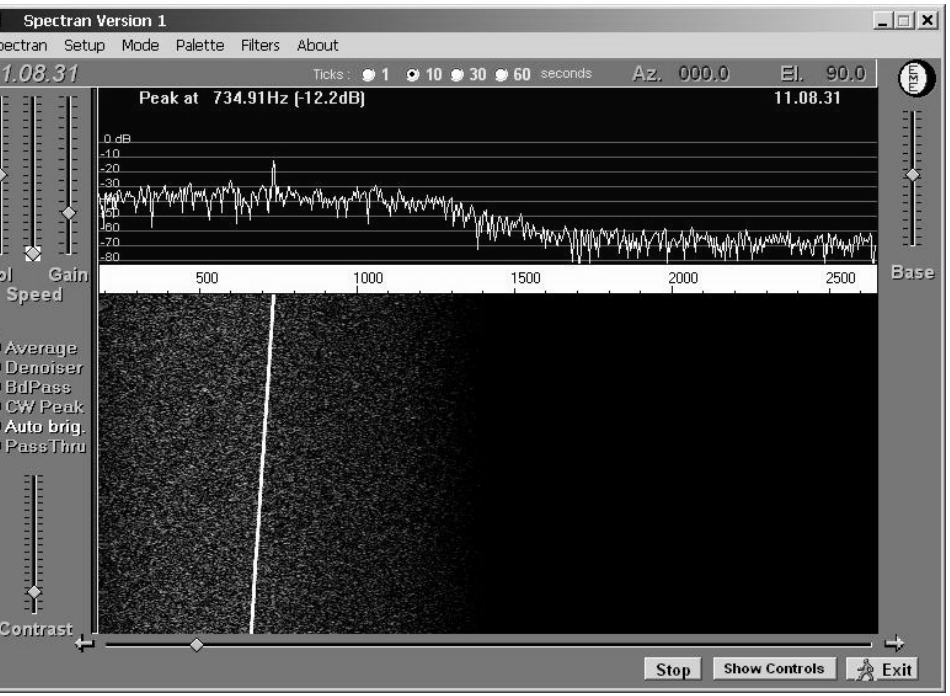


Examples of spacecraft signal spectra as seen by Medicina when S/C was in a data transmission mode with Ground Locked LO (left panel) and in beacon mode with Free Running LO (right panel). Horizontal axis - frequency in video band (MHz), vertical axis - signal spectral power density (r.u.). Spectra taken with 31.25 Hz resolution, 10 s averaging and Hanning smoothing.



Examples of residual phases as seen by Medicina (red), Metsahovi (blue), and Westerbork (green) for Ground Locked Spacecraft LO (left, scan No0001) and Free Running LO (right, scan No0006). Horizontal axis - time (seconds), vertical axis - phase (radians)

Radio astronomy “amateurs” listen for Sma



Dynamic S-band radio spectra of SMART-1. Courtesy G.Tomassetti, Italy (Aug 2006).

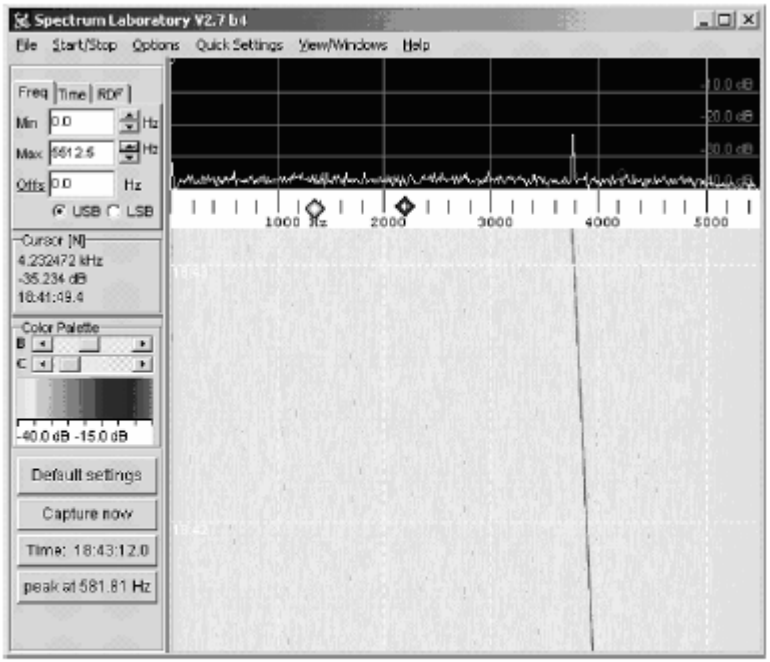


Fig. 4. Screen shot of continuous observation of SMART-1 beacon spectrum at 2235.112000MHz using SpectrumLab at 18:43:12UT. The actual SNR is about 15dB.

Dynamic S-band radio spectra of SMART-1. Courtesy Ch.A. Monstein, Switzerland (02 Sept 2006)

Smart-1 “swan song” VLBI netw

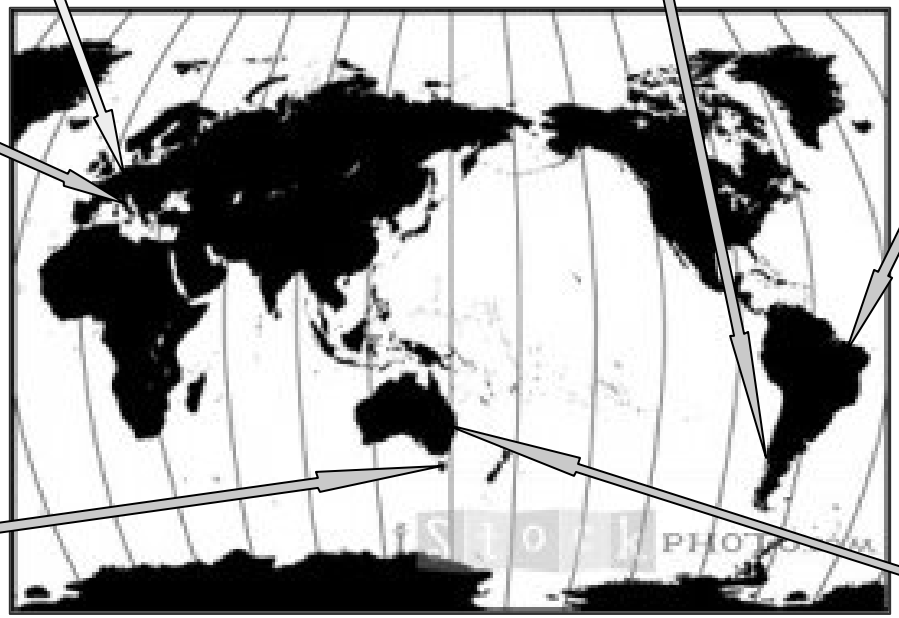
JIVE, NL

TIGO, 6 m, Concepcio
Chile

Fortaleza, 14 m, Brazi

Medicina, 32 m

Italy

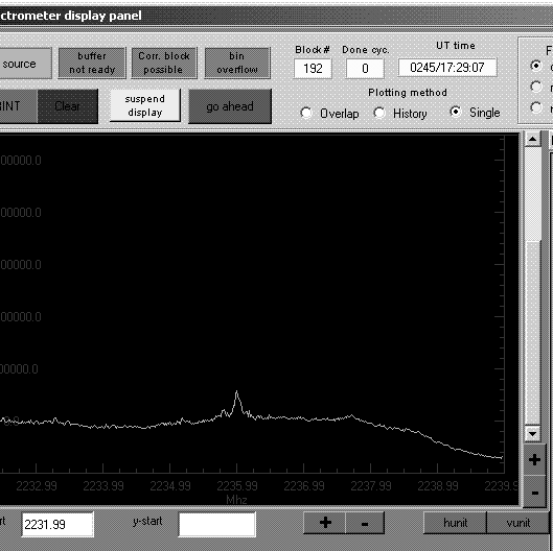


Hobart, 26 m, Australia

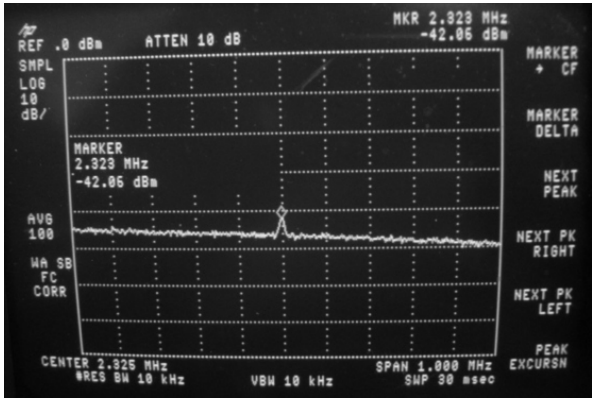
ATCA, 22 m, Narrabri, Australia

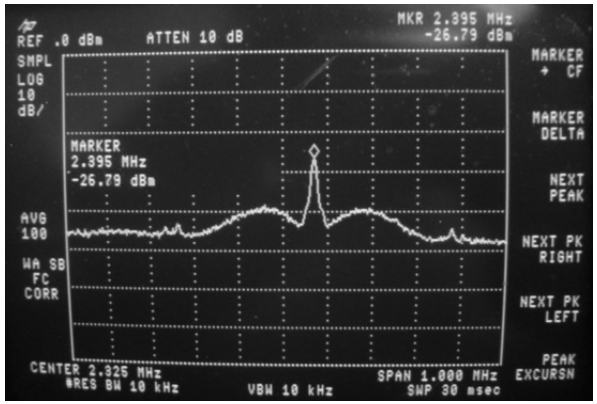
Scenes from the Mission Control, ESOC, 03.09.2

Various tunes of the "so

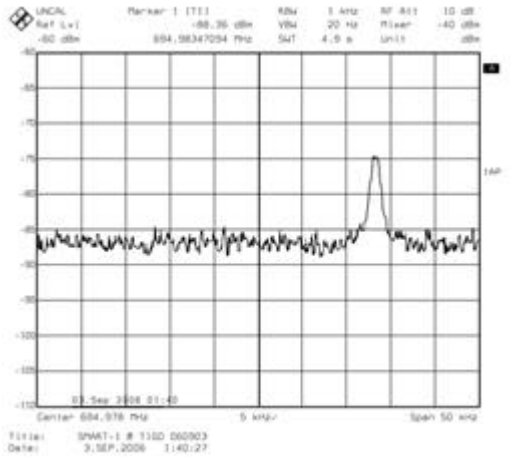


Medicina

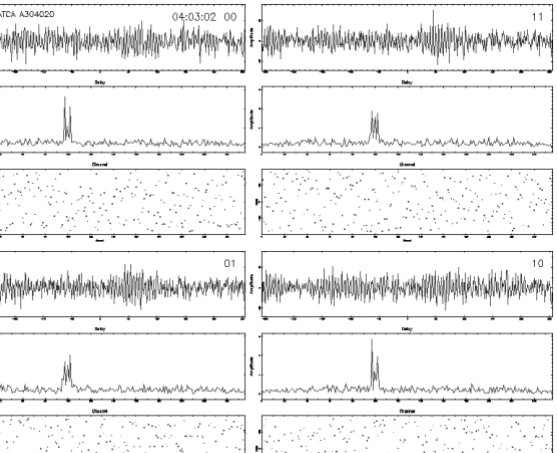




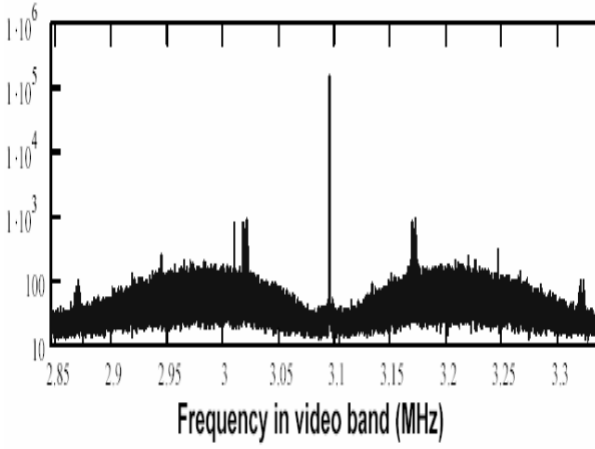
Fortaleza



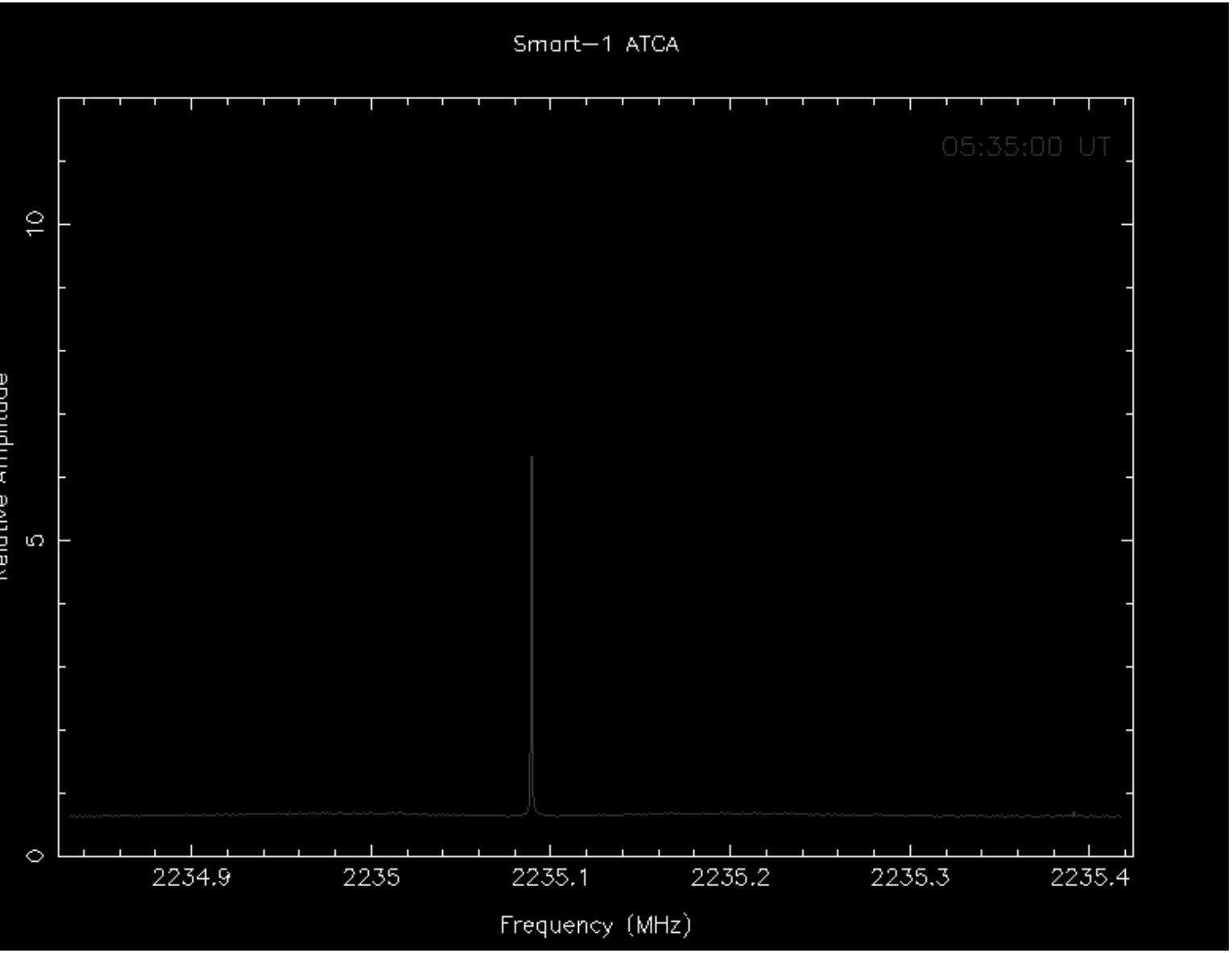
TIGO



ATCA-Hobart baseline (near-real-time)



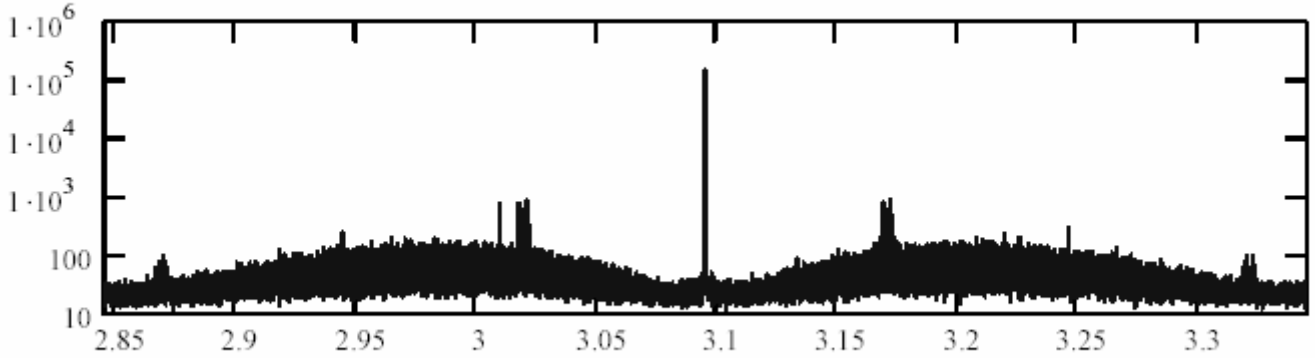
Hobart



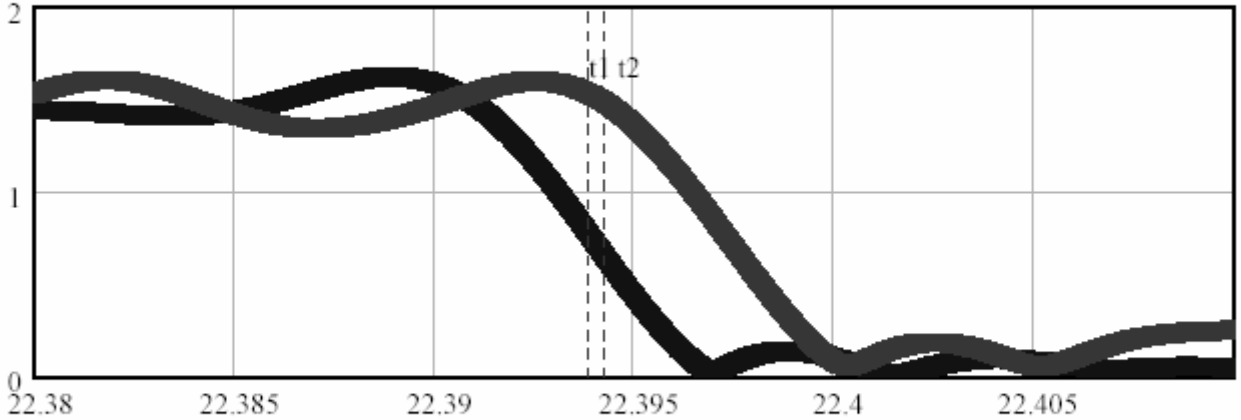
Smart-1
over Narrabr
ATCA single
dish at 2.3 GH

Courtesy
Chris Phillips
Phil Edwards
ATNF

Last 1 second spectrum acquired by Hobart



Power of the carrier line as seen by TIGO (red) and Hobart (blue)
during last 20 milliseconds of the Smart-1 mission



When did it happen (on 03 September 200

- **Last word from Smart-1 pronounced clearly:**

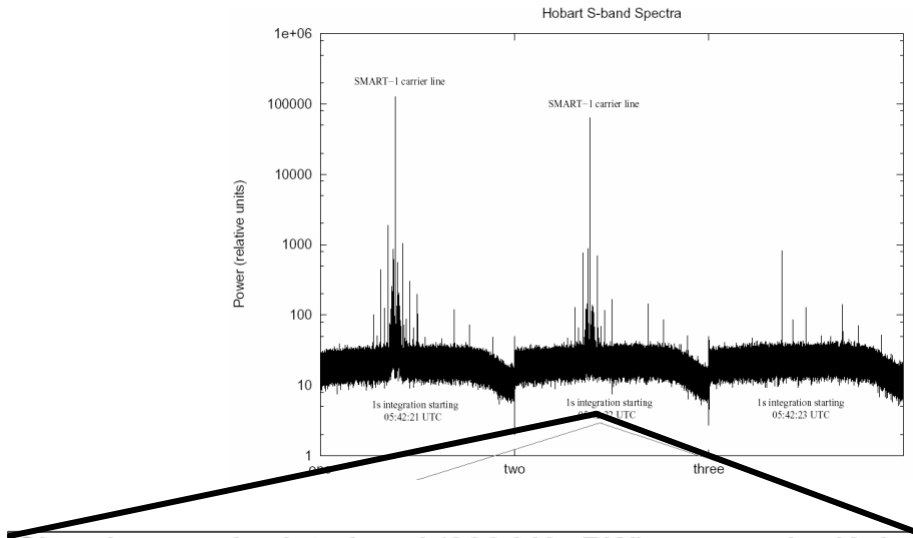
  05:42:21.759

- **Last "gasp":**
  - ***Hobart (Australia):***

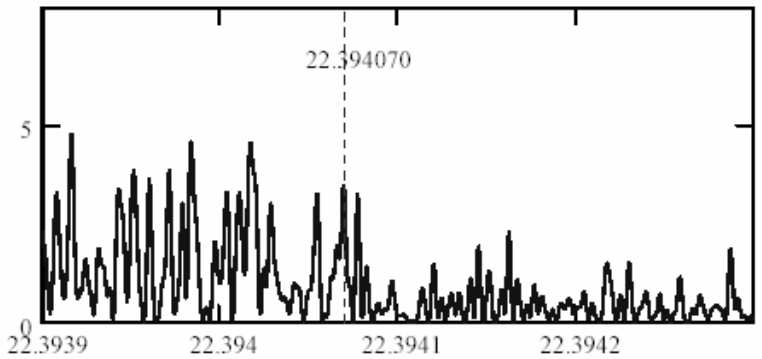
  05:42:22.394076 ±0.000010 s
  - ***TIGO (Chile):***

  05:42:22.380 ±0.010 s

10 µs ← → 2 cm along the trajectory



Signal power in data band (300 kHz BW) as seen by Hoba during last 300 microseconds of the mission



Where to go from h

- **Moon exploration community is MUCH bigger than this audience – we need to be VERY aggressive in getting the community support**
- **VLWA (aka VLF) is not yet a common knowledge – see e.g the debate in *Physics Today* (Nov 2006)**
- **Demonstrators are important – can be suitable for “light” landers of the coming decade (e.g. Chang’E-2)**
- **Play-up synergies with major Earth-based and orbital astronomy facilities (e.g. LOFAR, ALMA, e-VLBI, SVLBI, SKA, JWST, ELT, etc.)**