

CALLISTO

Compound
Astronomical
Low frequency
Low cost
Instrument for
Spectroscopy and
Transportable
Observatory

Double - Heterodyne -
Frequency Agile - Radio - Spectrometer

IHY workshop Bangalore Nov/Dec 2006
Christian Monstein ETH Zürich

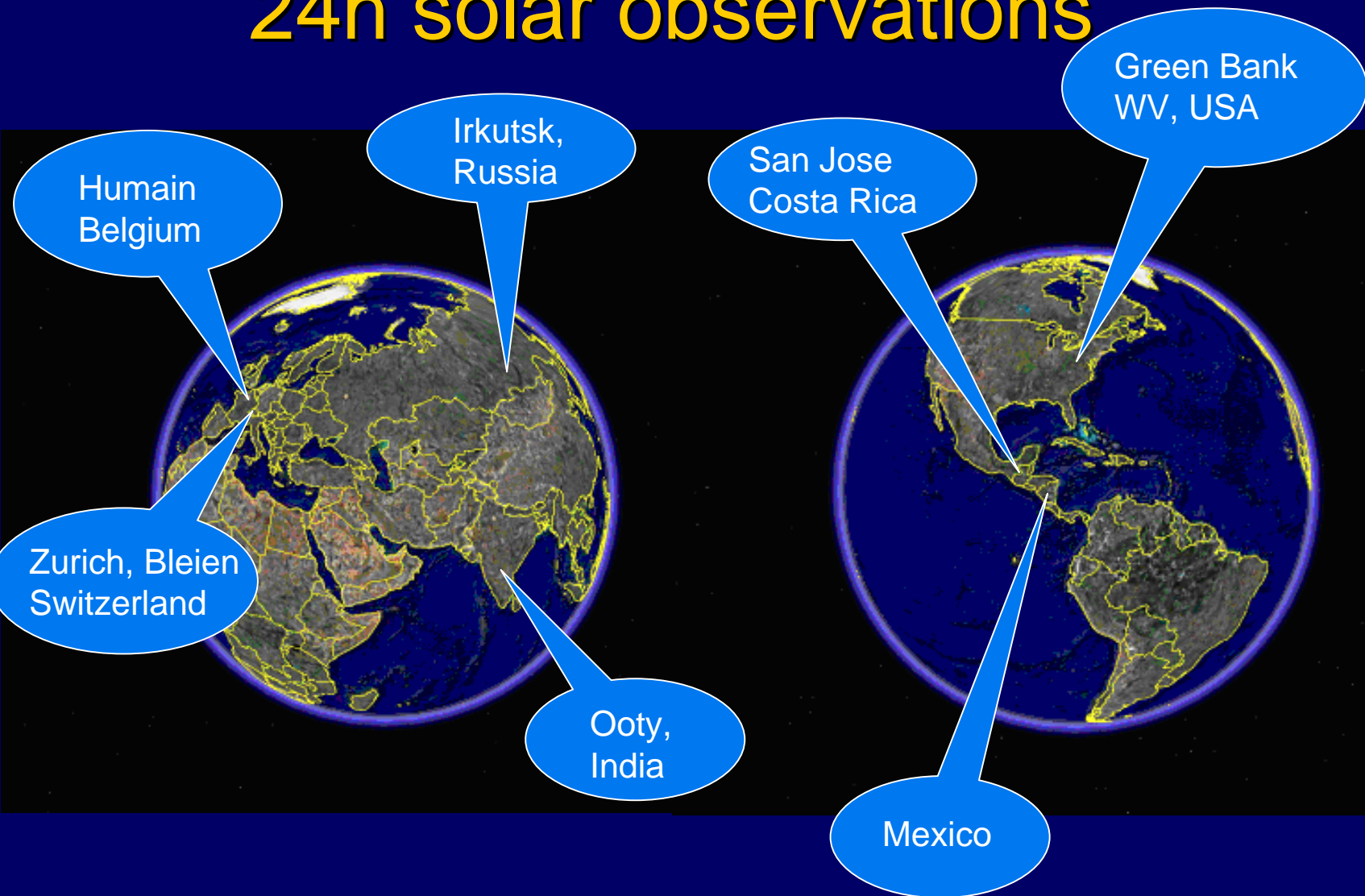


Directory

- Worldwide distribution, 24h of observation
- Usage sites
- DiRaC
- Instrumental parameters, Specifications
- Basic schematic diagram
- Double heterodyne receiver RX
- Option: Focal plane unit FPU
- Overall bandwidth
- Overall dynamic range
- Overall noise figure
- Allan – time, Allan - variance
- Maximum sampling speed
- Radio interference in Switzerland
- First solar radio noise
- First results 1, 2, 3, 4
- Callisto as a backend for other receivers
- Team members
- Material costs & production times
- Callisto related URL`s



24h solar observations



Wanted: type II bursts, CME, shock waves, type III bursts etc.



Usage sites 1



5m antenna Zürich 1 ... 8.6 GHz (system tests only)



5m antenna Bleien 45-870 MHz, 1 - 6 GHz



7m antenna Bleien 100 MHz - 4 GHz



OLVBI 13m at Green Bank Observatory West Virginia



Usage sites 2



Jorge Paez San Jose / Costa Rica, 7m dish



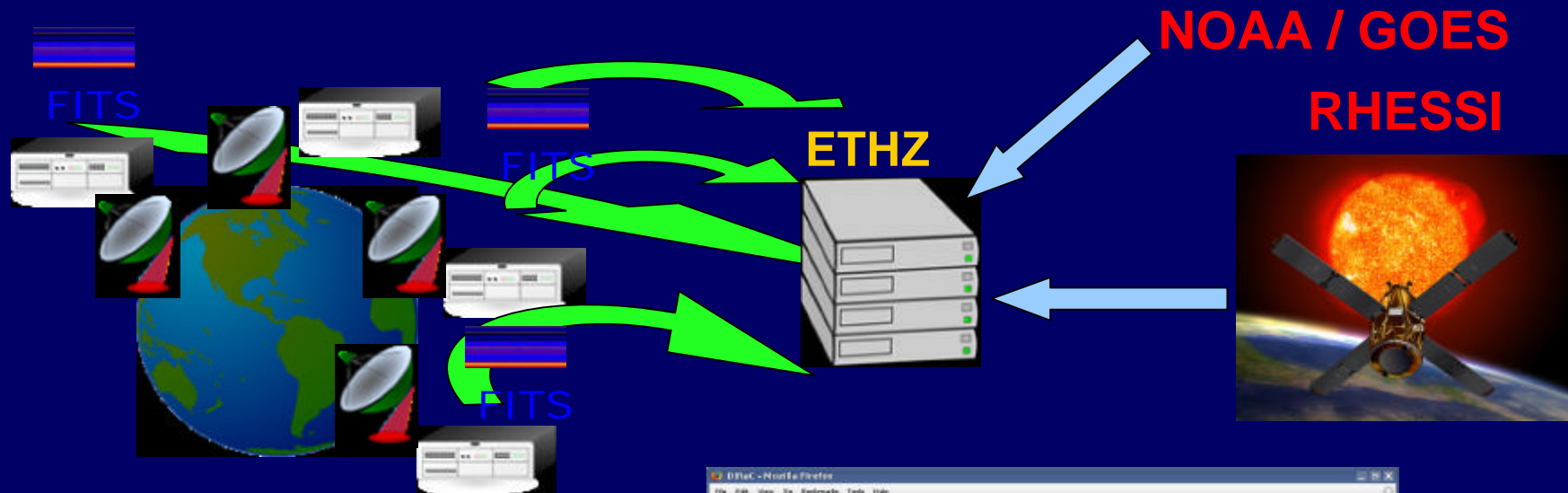
Frederic Clette
Station Humain,
Royal Observatory
of Belgium



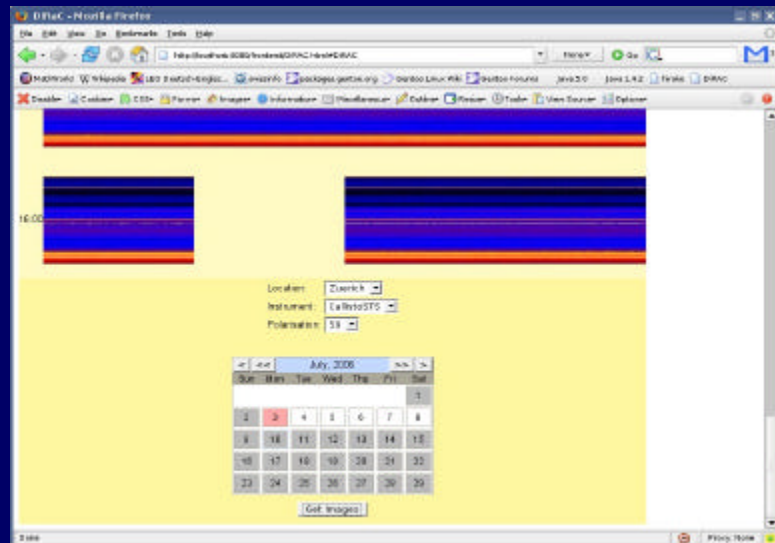
Sergey Lesovoi ISZF
Irkutsk / Russian Federation

Who`s next?

How does DiRaC work



Di = Distributed
Ra = Radiospectrometer
C = Control





Instrumental parameter

Parameter

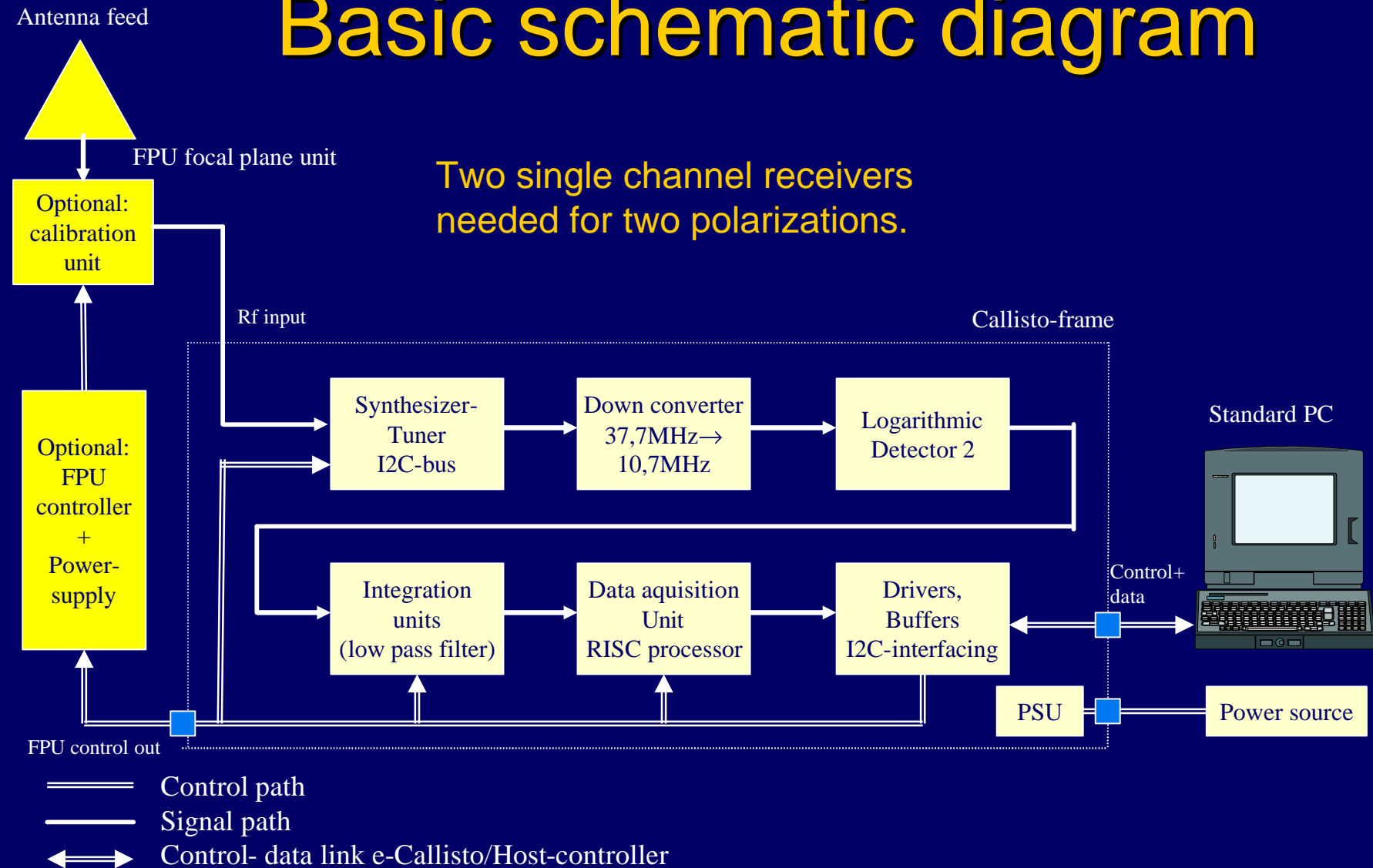
Specification

Frequency range	45.0MHz ... 870.0MHz (in 3 sub-bands)
Frequency resolution	62.5KHz
Radiometric bandwidth	300KHz/-3dB
Dynamic range	-120dBm ... -20dBm (depending on gain control voltage)
Sensitivity	25mV/dB +/-1mV/dB
Noise figure	< 10dB
Sampling frequency	internal clock 800 s/sec max, external clock 1000 s/sec max
Number of channels	1...500, nominal 200 frequencies per sweep
Supply	12V +/- 2V / 225mA
Weight	~ 800 grams
Dimensions	110mm x 80mm x 205mm
Material cost	< 200\$ (material only)
Input	3 configuration files (config, frequency, scheduler)
Output	2 files (FITS-file and logfile)

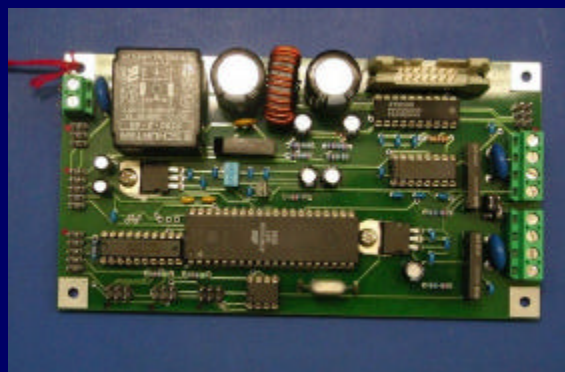
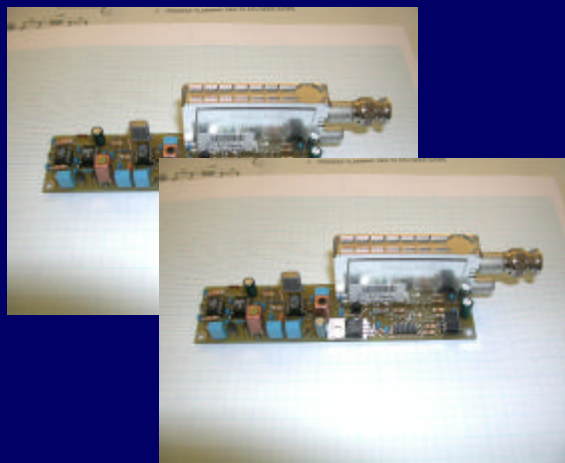


Basic schematic diagram

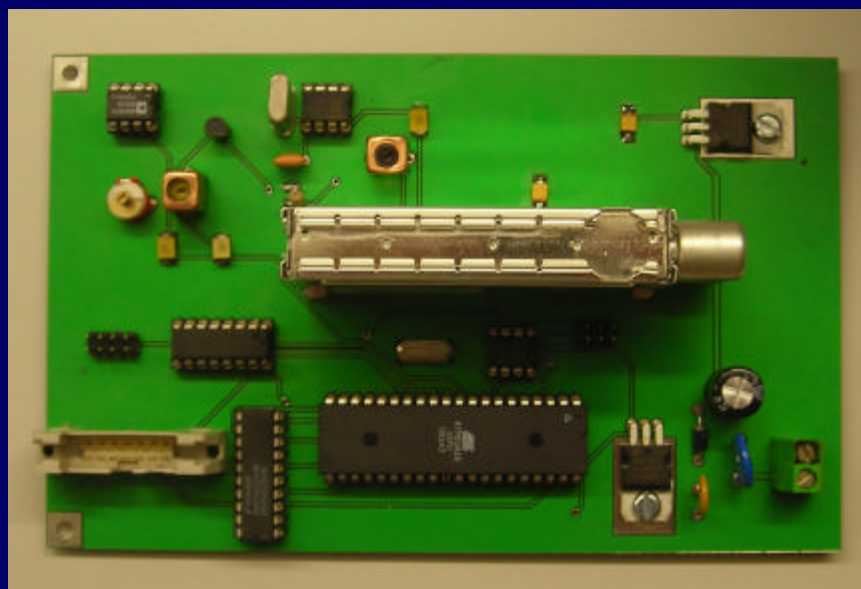
Two single channel receivers
needed for two polarizations.



Double heterodyne receiver



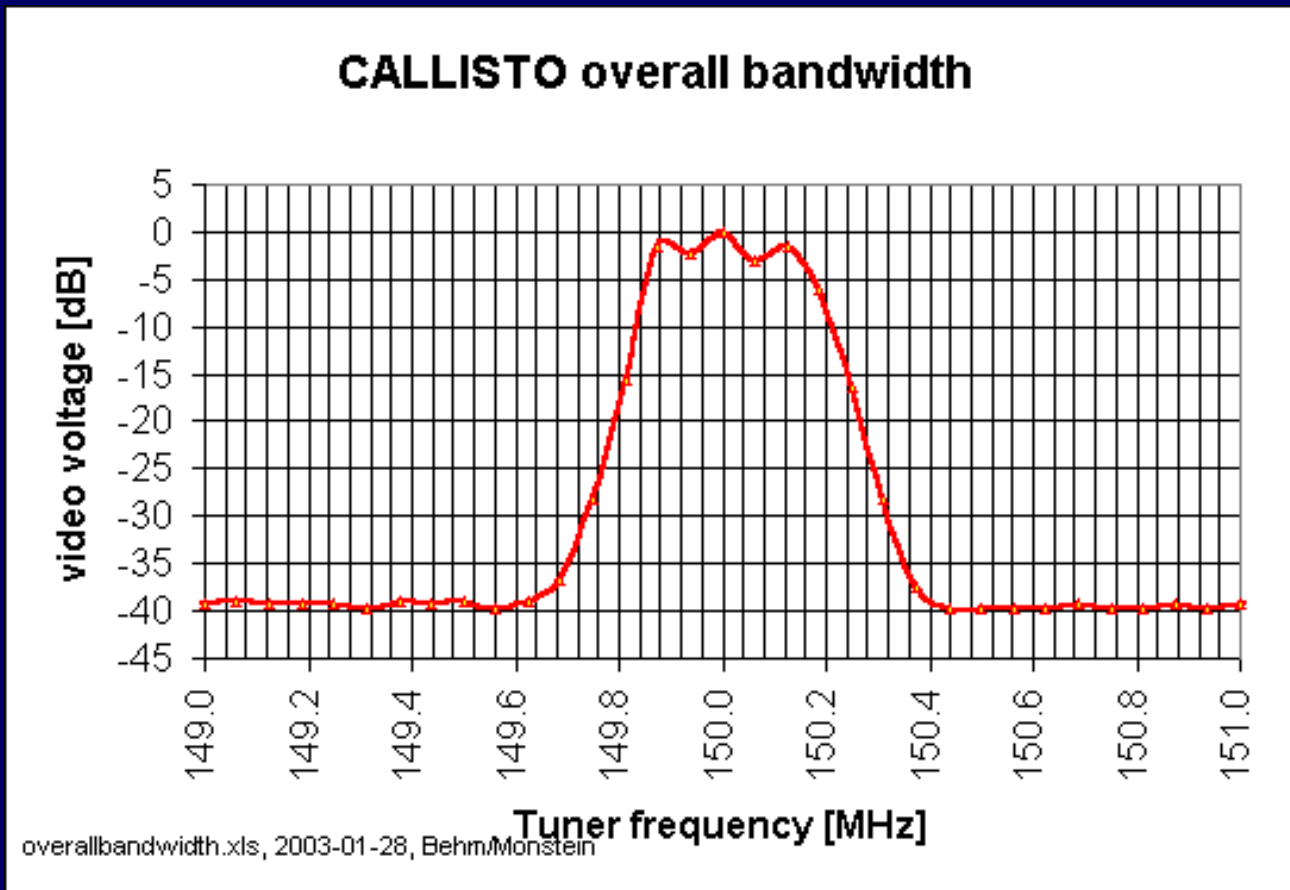
Twin spectrometer:
Callisto QM, FM1...3



Single spectrometer:
e-Callisto QM, eC01, eC02, eC03,...?



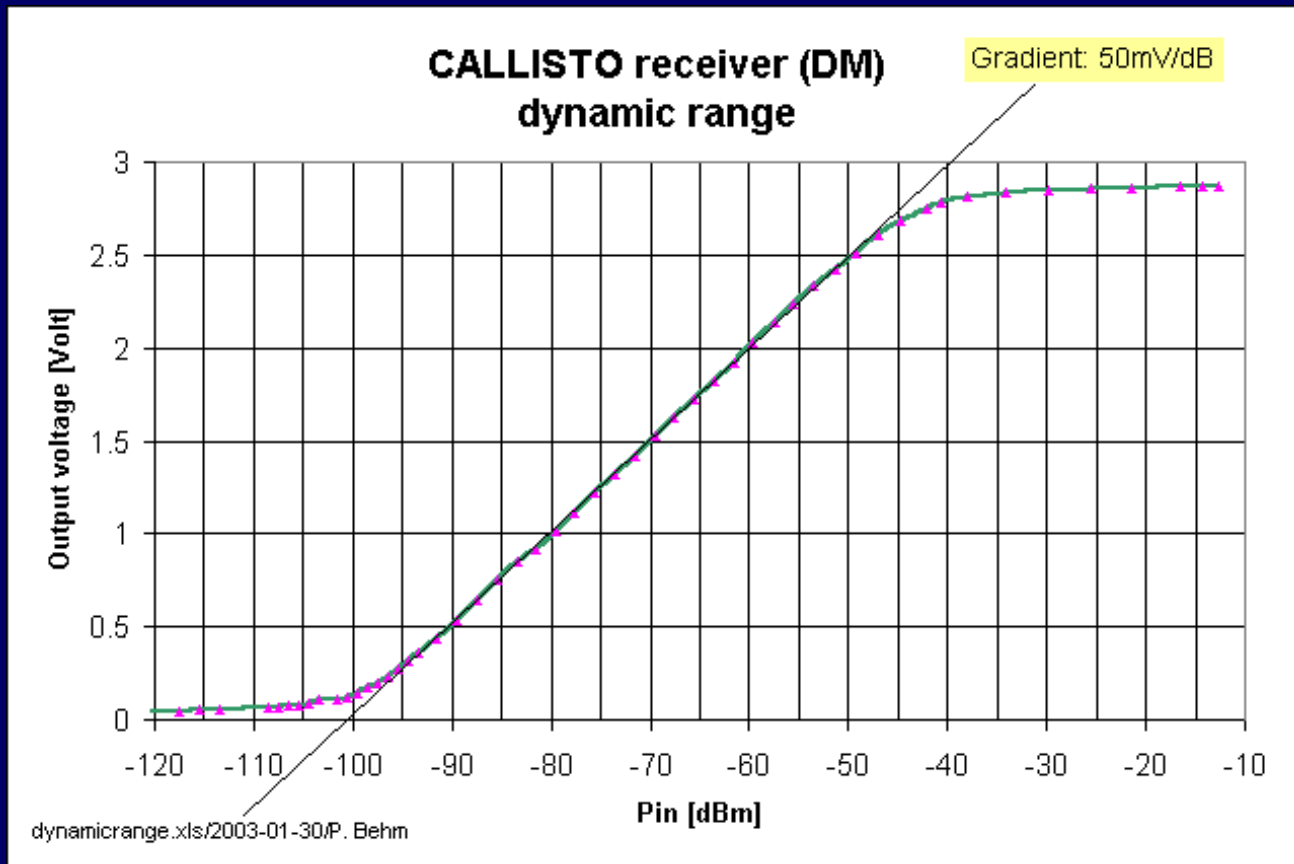
Overall bandwidth at 150.000MHz



BW(-3dB) = 299KHz, BW(-10dB) = 378KHz



Overall dynamic range

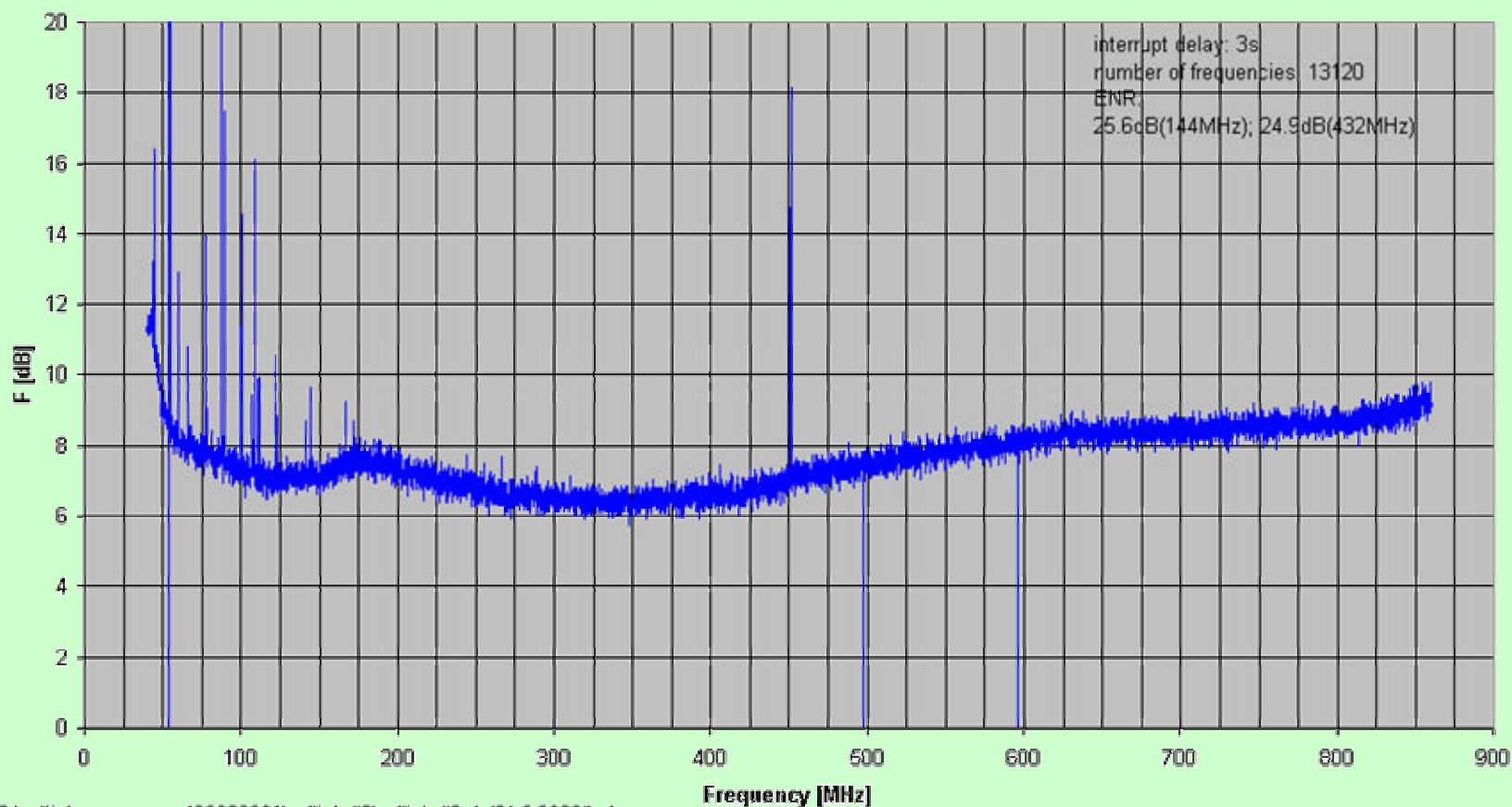


Detector = AD8307; dynamic range > 50dB



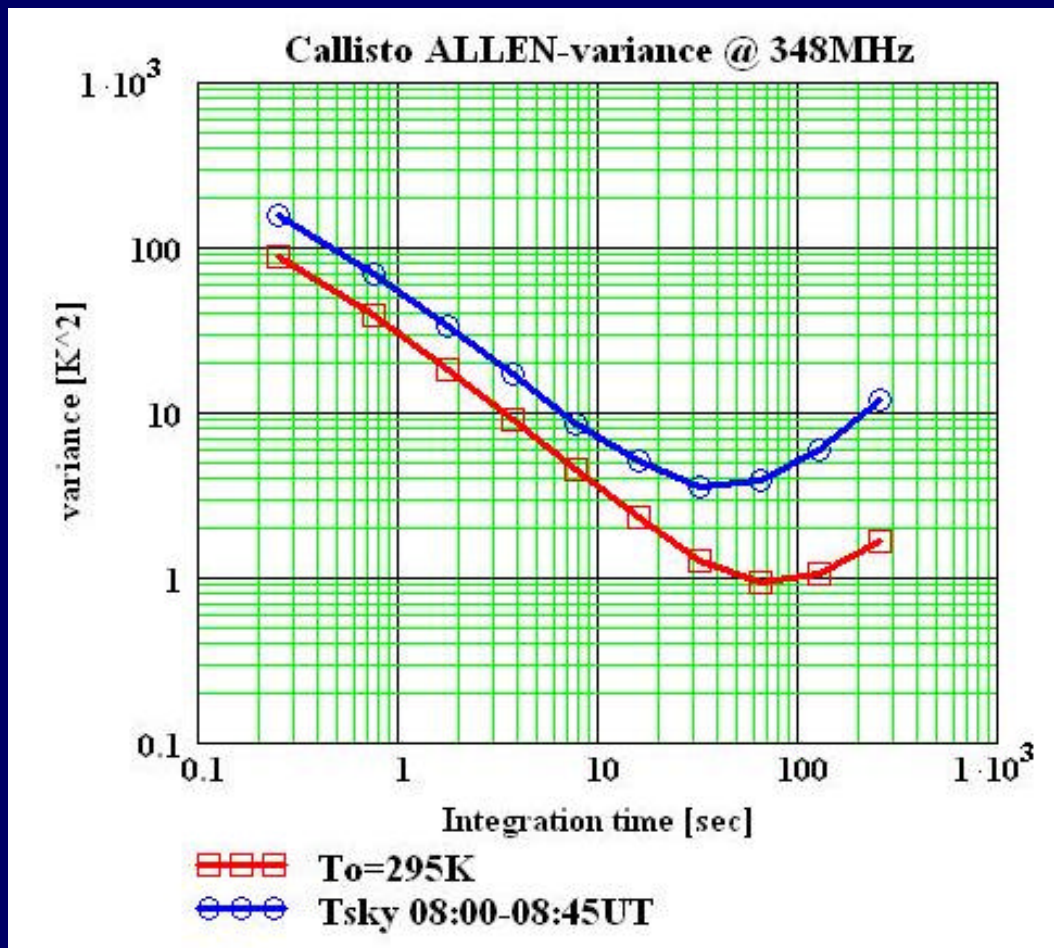
Overall noise figure

Noise Figure CALLISTO FM receiver #6



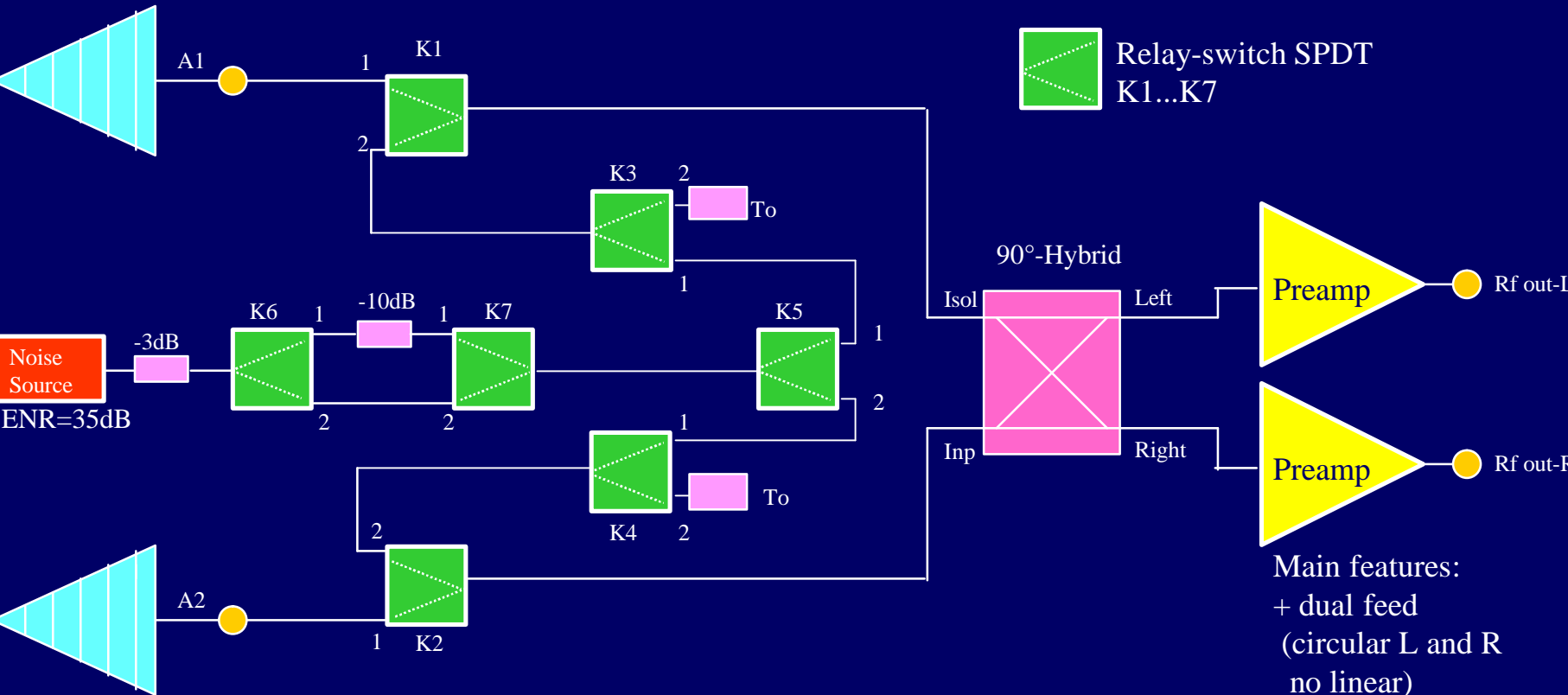


Allan-time: how long am I allowed to integrate?





Focal plane unit FPU



 Relay-switch SPDT
 K1...K7

Noise Source
 ENR=35dB

To

-3dB

-10dB

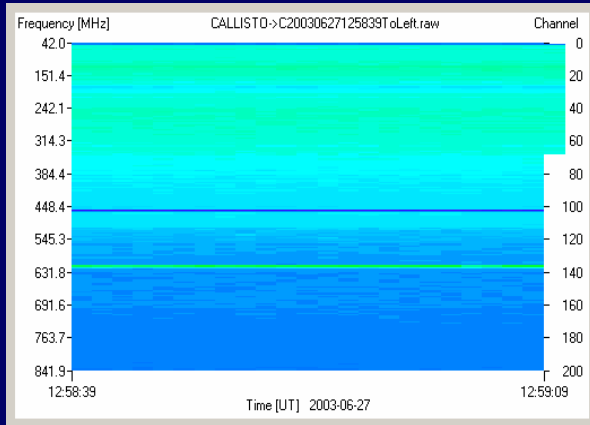
To

To

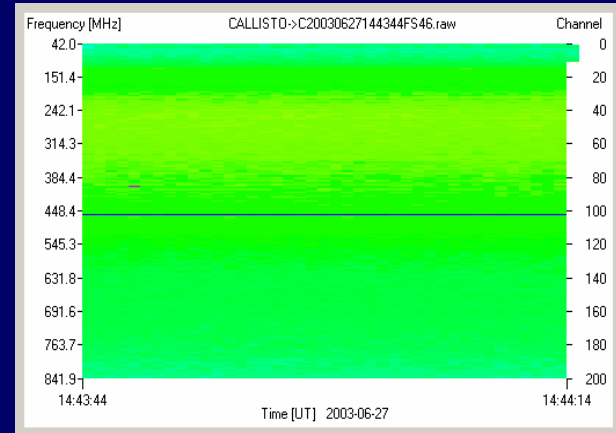
Power supply: +15V, +28V, +5V, -15V
 Surveillance electronics
 Peltier cooler/heater
 Humidity/thermal sensors

- Main features:
- + dual feed
 (circular L and R
no linear)
 - + very low noise
 - + low cost
 - + 3 point calibration
 - reduced bandwidth
 due to 1 hybrid

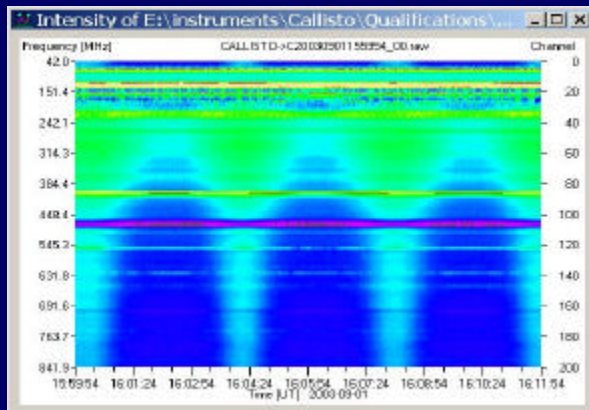
Calibration



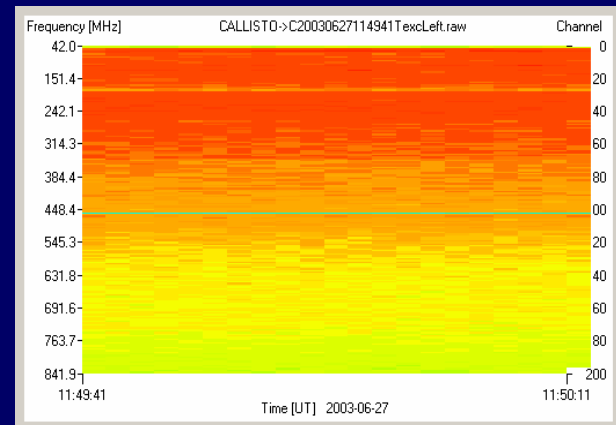
T0 applied



+22dB ENR applied



Passage through sun



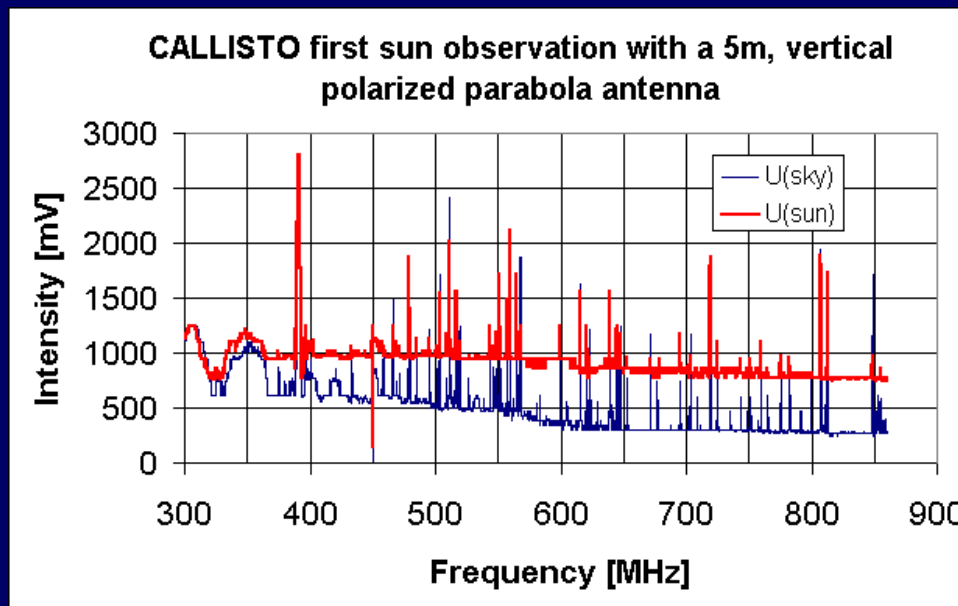
+32dB ENR applied

First solar radio noise



5m parabola at Bleien observatory
with linear vertically polarized feed
HL-040 from Rohde & Schwarz
400MHz...3GHz

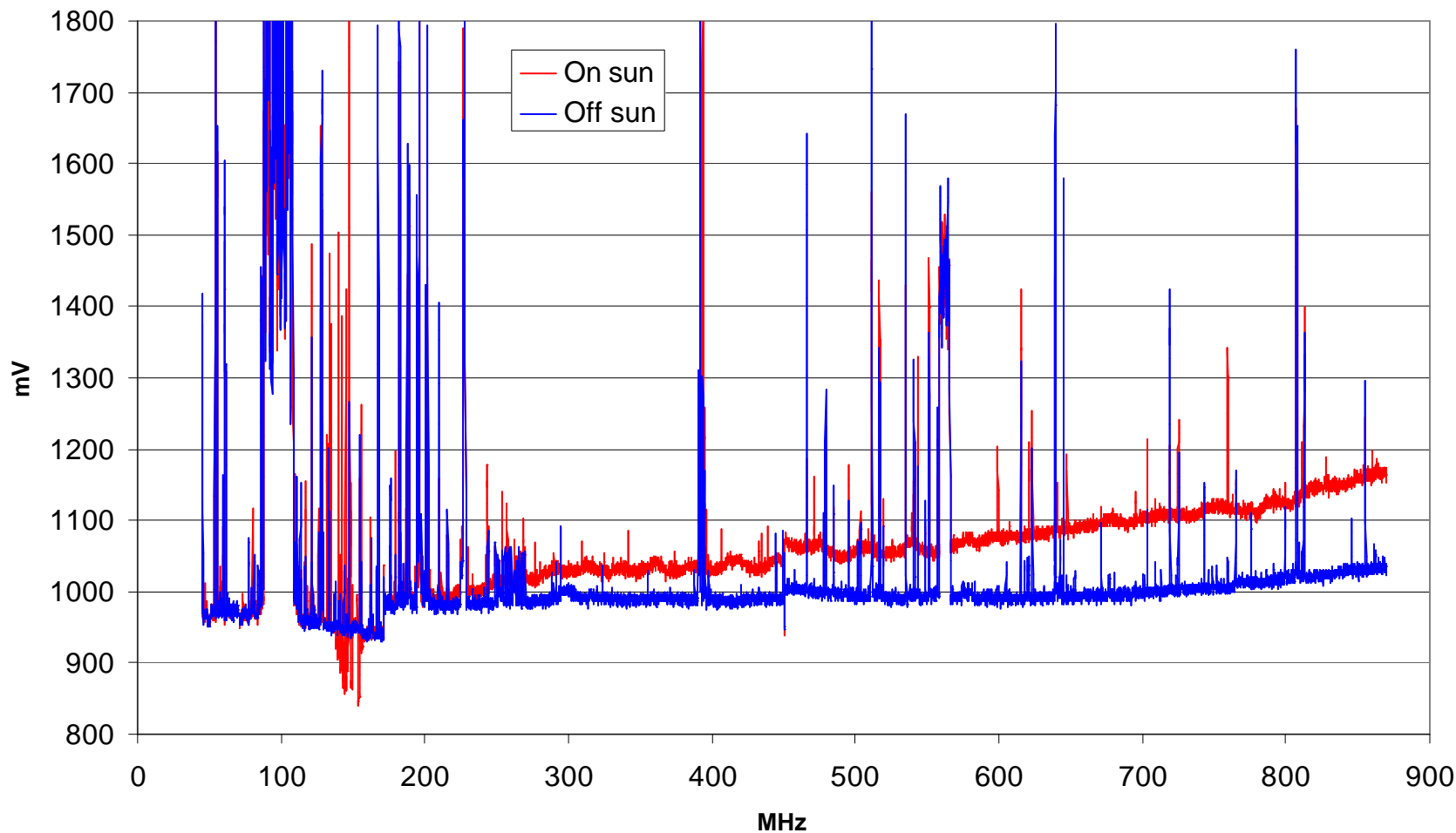
Sun is 500mV \sim 10dB
'hotter' than background
level.





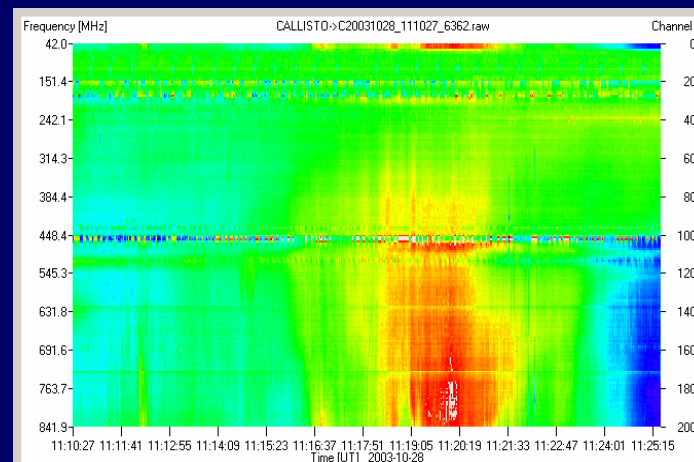
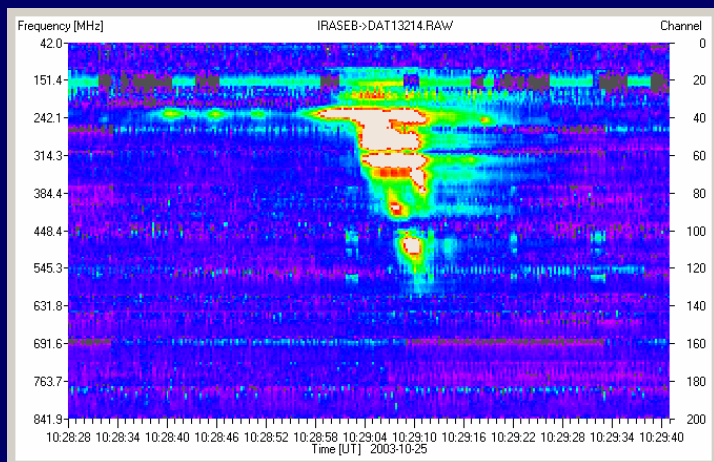
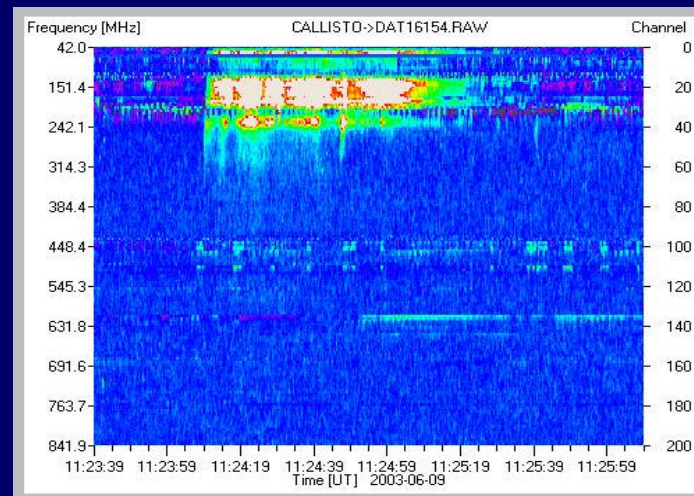
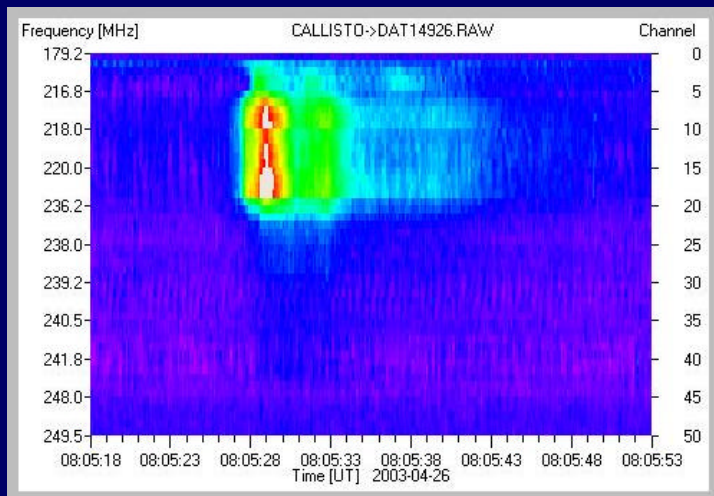
Radio interference

Callisto at 7m-dish LHCP in Bleien/Switzerland



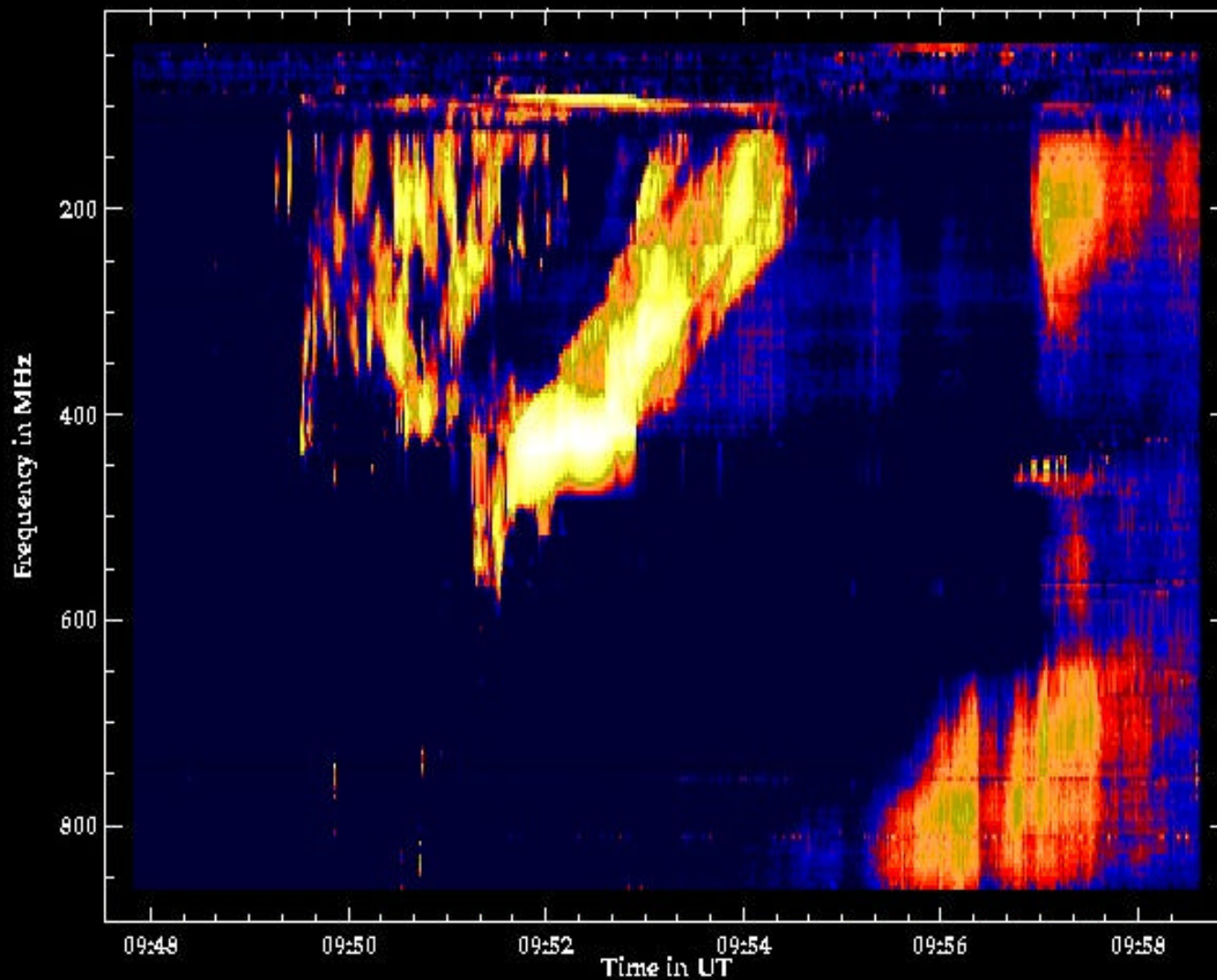


First results #1



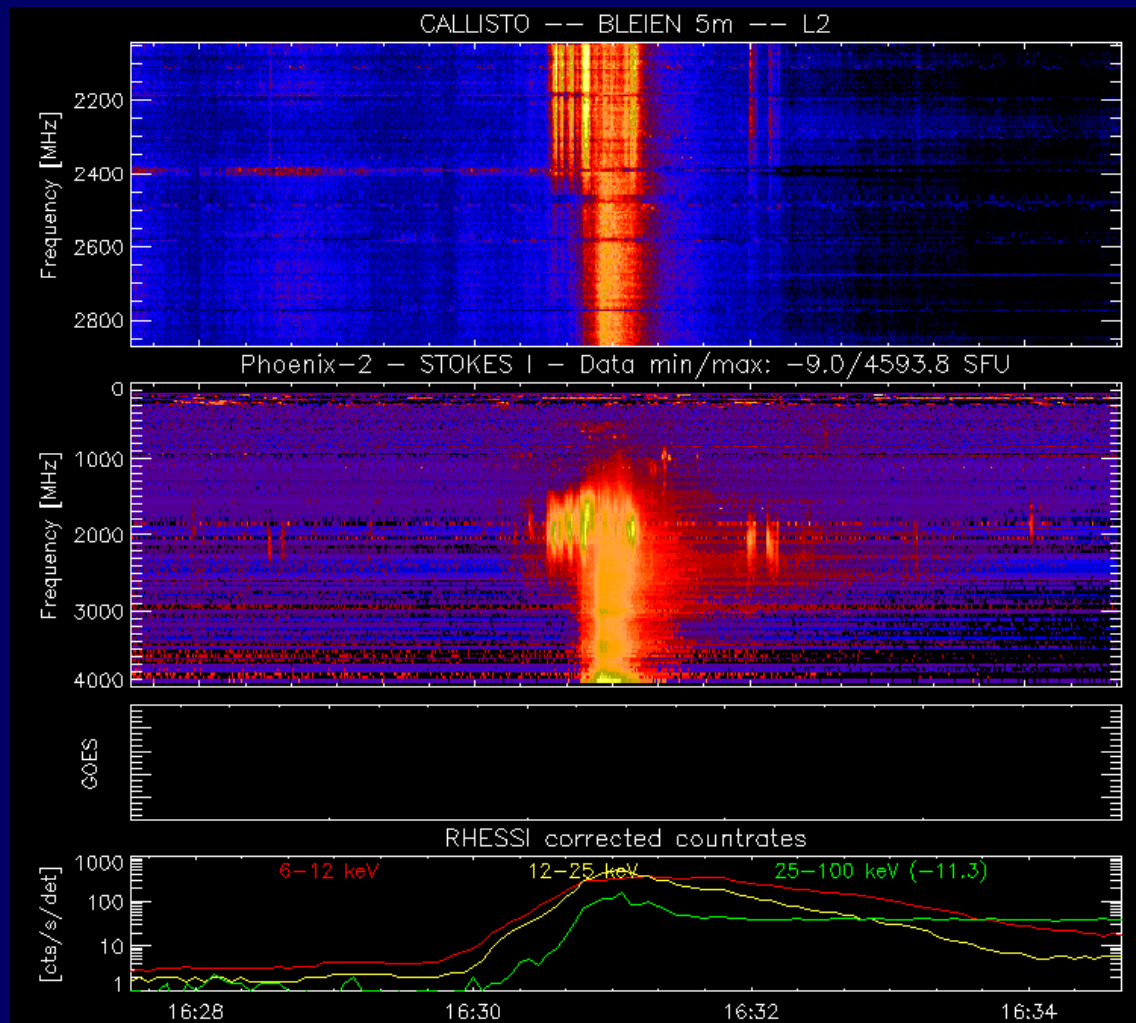


2003/11/03, CALLISTO, ETH Zurich





Callisto as a backend for other receivers (down converters)



Callisto as a backend to a commercial S-band LNC 2040MHz ... 2850MHz

Phoenix-2 100MHz ... 4GHz

RHESSI



Material costs & production time

Component	Material cost	Manufacturing time
Receiver modul	< 200 \$	Production < 1 day Qualification < 1 day
Power supply, PC + Win XP	~ 1000 \$	Configuration ~ ½ day
Antenna, amplifier, Cables, connectors	>200 \$	Very different
Spectrometer total	>1200 \$	~ 2 days



Team members

Defending NF-budget & requirements

Mechanical design & manufacturing

Software RISC processor (C)

Software preprocessing (C++)

Software postprocessing (Perl, IDL)

Software tools (Java)

Manufacturing receiver RX

Manufacturing receiver control unit RCU

Conceptual & hardware design

Prof. Arnold Benz

Frieder Aebersold

Hansueli Meyer

Christian Monstein

Christina Pöpper

Peter Messmer

Pascal Behm

Pascal Behm

Christian Monstein

Callisto related URL`s

<http://www.astro.phys.ethz.ch/rapp/>

http://www.astro.phys.ethz.ch/instrument/callisto/callisto_nf.html

<http://www.astro.phys.ethz.ch/instrument/callisto/ecallisto/applidocs.htm>

ETH Zurich
Astronomical Institute
Christian Monstein
Scheuchzerstrasse 7
CH-8092 Zürich
Switzerland
monstein@astro.phys.ethz.ch

