

R = 4
C = 2

M = 0.4

CSRI8_43LNA_01A
LAYOUT RIGHTS
FARADAY INAF-IRA
PROJECT 2005

A MULTIFEED RECEIVER IN THE 18-26.5 GHz BAND FOR RADIOASTRONOMY

A. Cremonini

A. Orfei, L. Carbonaro, A. Cattani, L. Cresci, F. Fiocchi
A. Maccaferri, G. Maccaferri, S. Mariotti, J. Monari, M. Morsiani
V. Natale, R. Nesti, D. Panella, M. Poloni, J. Roda,
A. Scalambra G. Tofani

X = 3200
Y = 2250

UG1 UG2 UG3 UG4

A-CRE
SEMINARIO UNIVERSITA
POLITECNICO

Outline

Introduction
FARADAY Receiver characteristics
Feed System
LNA
Down conversions
Cryogenics
Measurements on the Antenna



Introduction

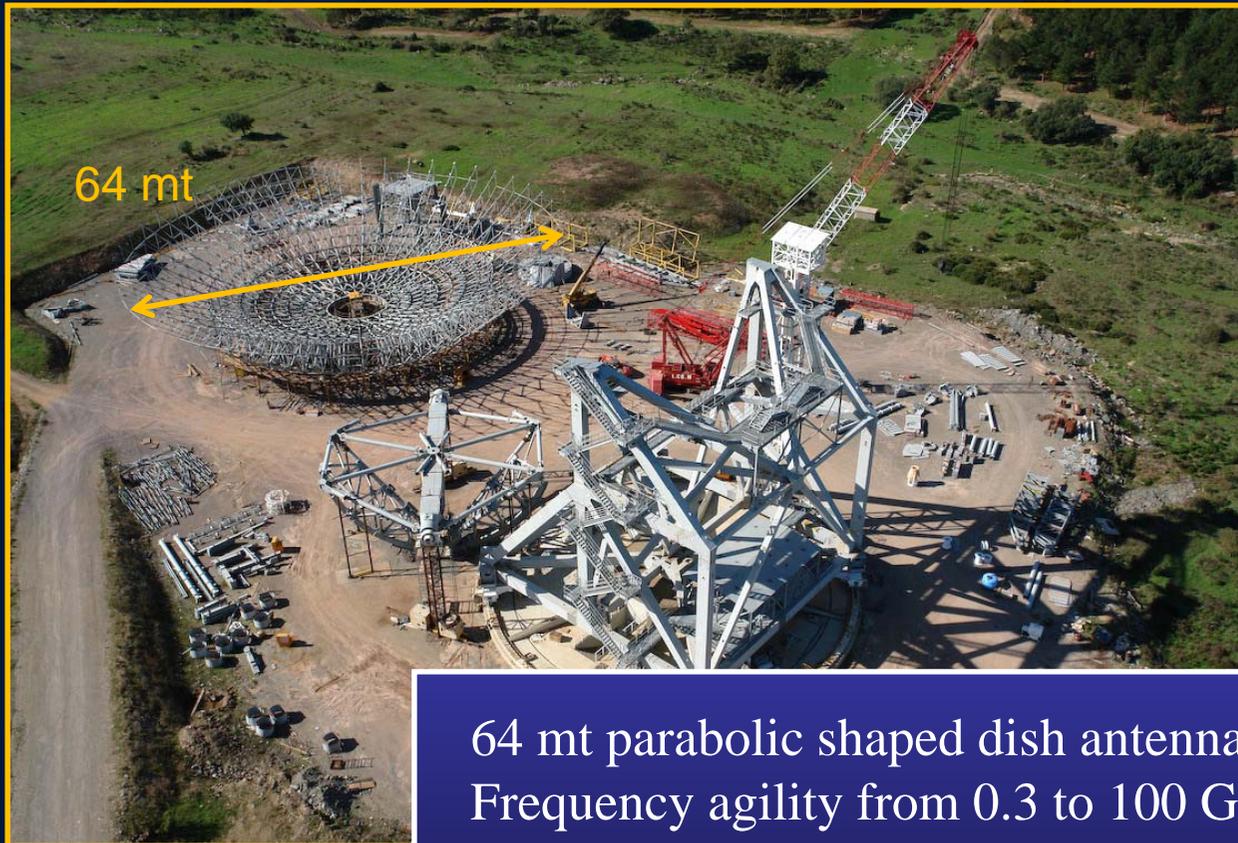
In 2002 EU funded a joint project among European institutes called "FARADAY".

The objective was to undertake the R&D required to produce two-dimensional receiver arrays to be installed at the foci of large radio telescopes and hence greatly to improve their observational efficiency.

The Italian proposal was to finalize the R&D for the construction of a cryogenic five horns system, working in the full WR42 waveguide band, 18 to 26.5 GHz to be installed on SRT



SRT – Sardinia Radio Telescope



64 mt parabolic shaped dish antenna
Frequency agility from 0.3 to 100 GHz
Active surface in order to compensate gravity deformation



FARADAY Receiver characteristics

Multifeed Focal Plane Array
7 Horns
14 Channels (dual polarization)
Working from 18-26 GHz
For Secondary Focus
Heterodyne architecture
Cryogenically cooled
Derotator Equipped



FARADAY Receiver description

Cryogenic part

14 RF outputs in the range 18 to 26.5 GHz
tapering at 9.4° subreflector edge

f (GHz)	18	22	26
Taper (dB)	-3.2	-5.3	-7.7

beam dimension: 92 arcsec at 22 GHz
separation among beams in the sky: 215 arcsec
Feed horns cryogenically cooled

!!! This Taper is for Medicina antenna with
horns optimised for SRT Optics !!!!!



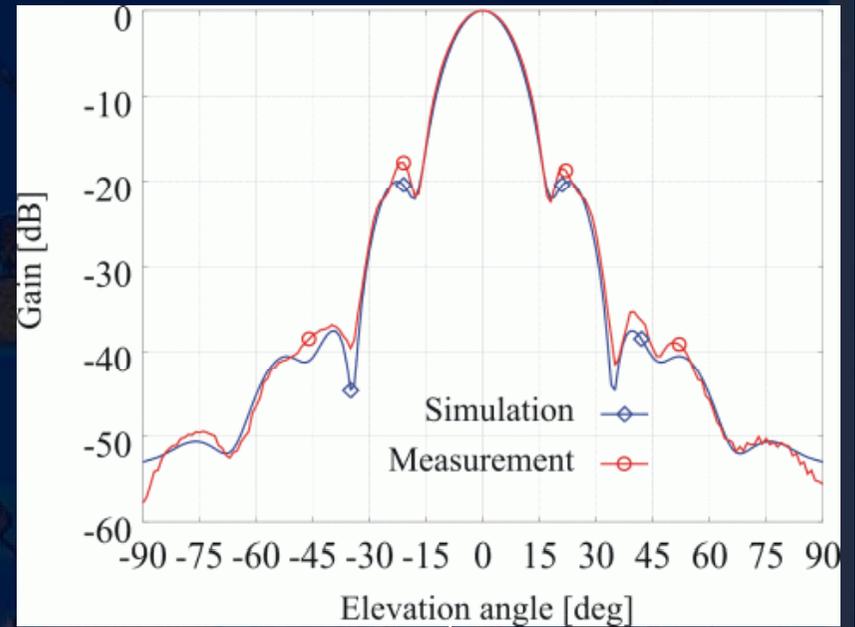
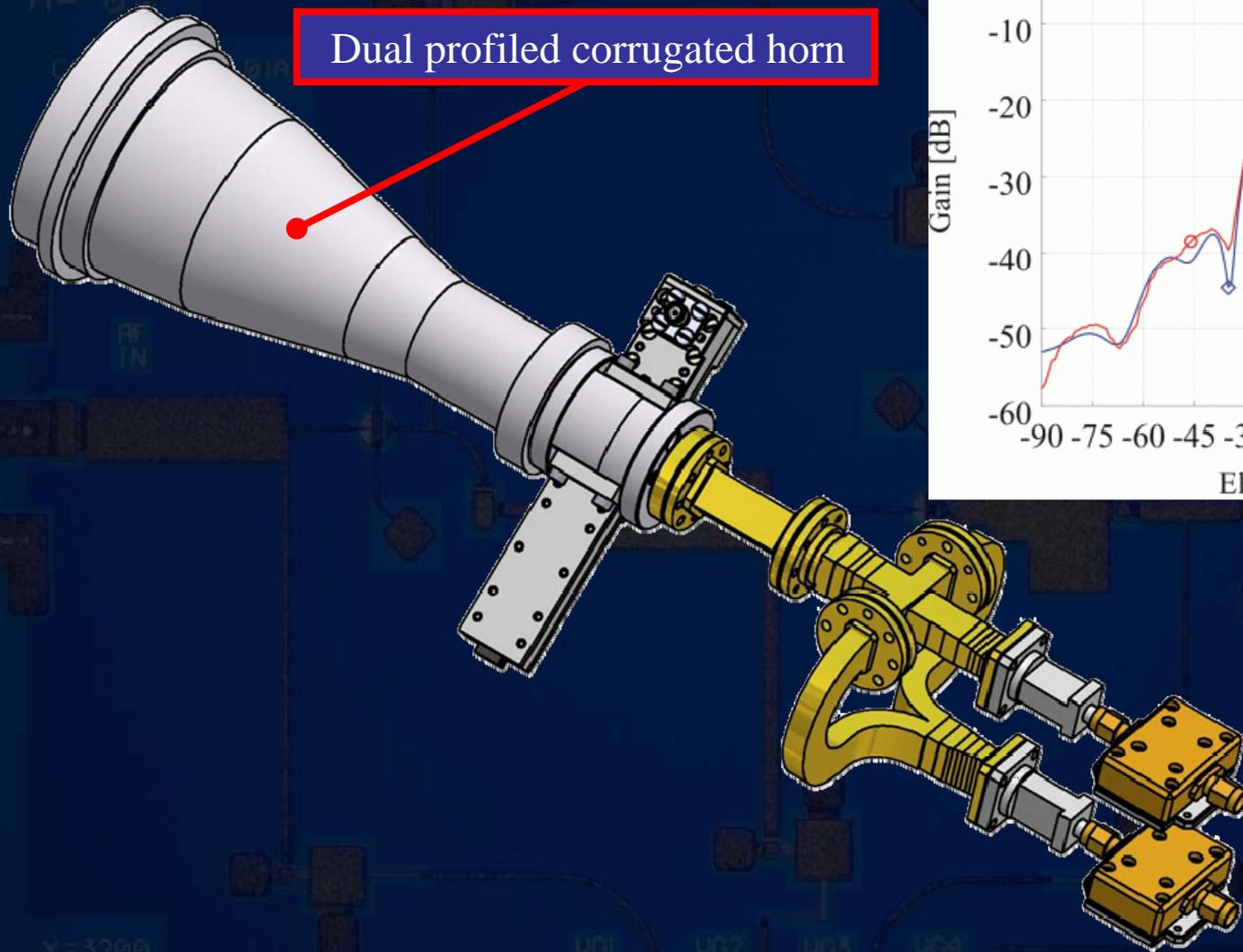
FARADAY Receiver description

Uncooled part

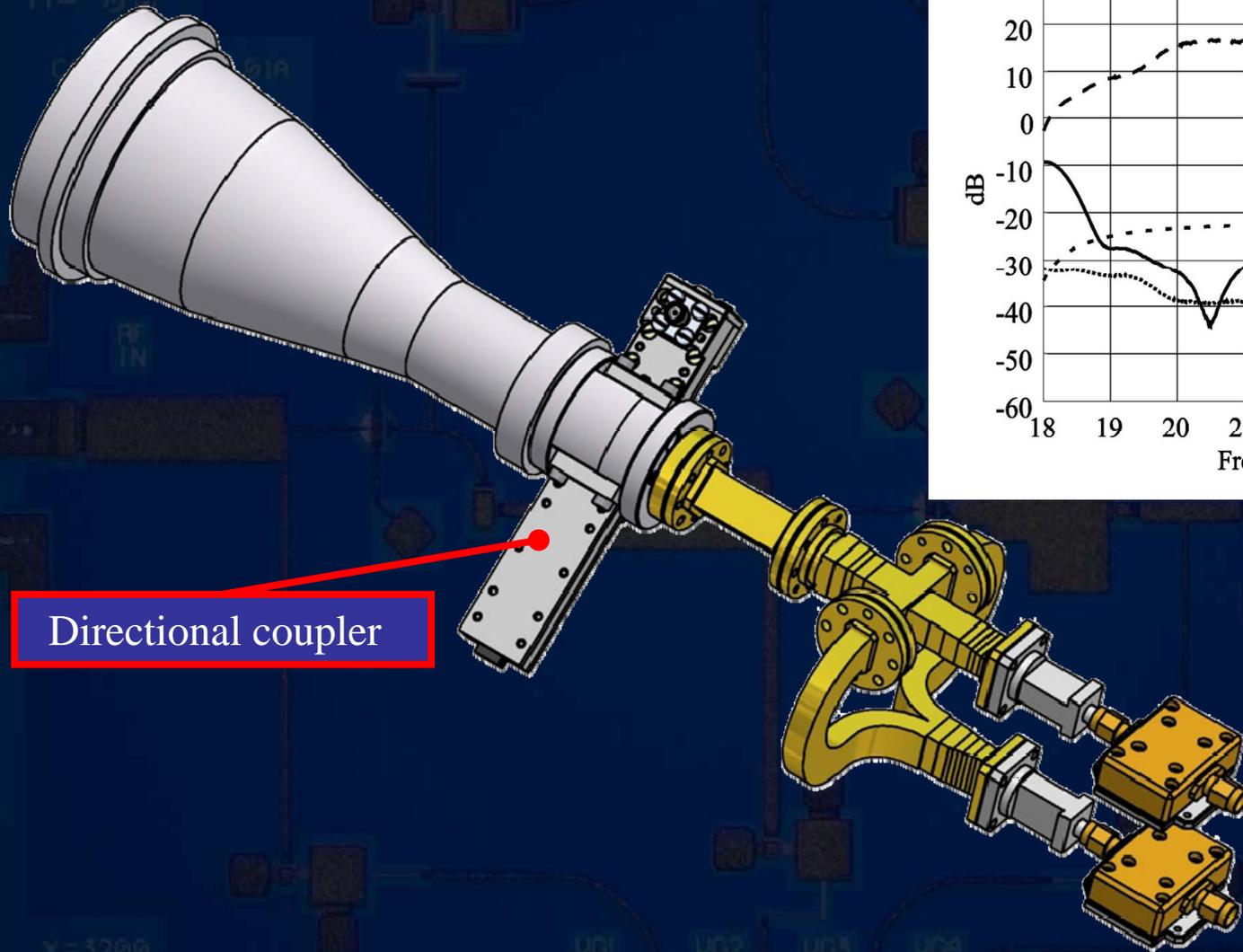
14 output bands 2 GHz wide
 IF range: 0.1 to 2.1 GHz (tunable everywhere in the RF range)
 Rotation range of the rotator: 264°
 Nominal rotation speed: 3.28°/sec
 Rotator accuracy (on the sky): < 0.1 arcsec
 Multifeed overall weight: 280 Kg
 Cryostat: 110 Kg
 Conversions rack: 90 Kg
 Rotator: 40 Kg
 Cable wrap: 40 Kg
 Multifeed overall height: 2.64 m



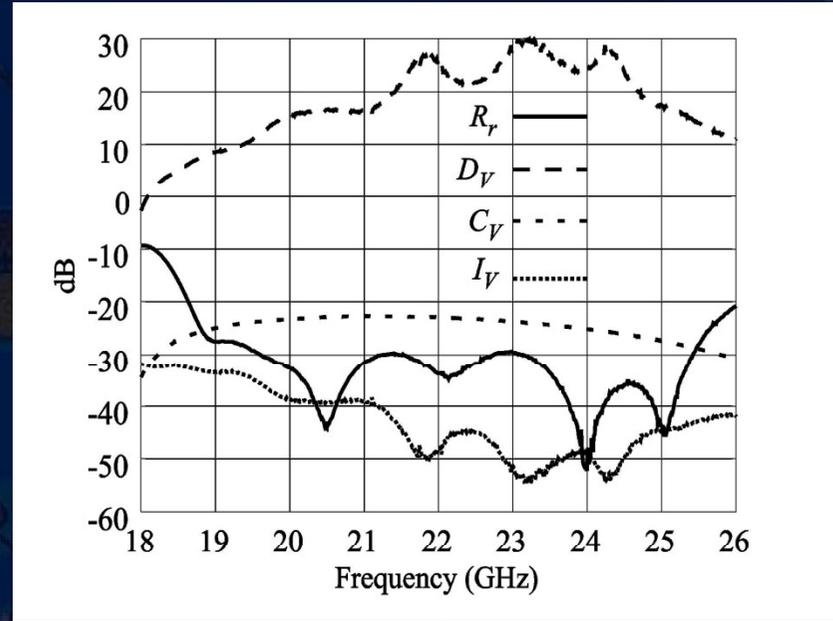
FARADAY Receiver channel



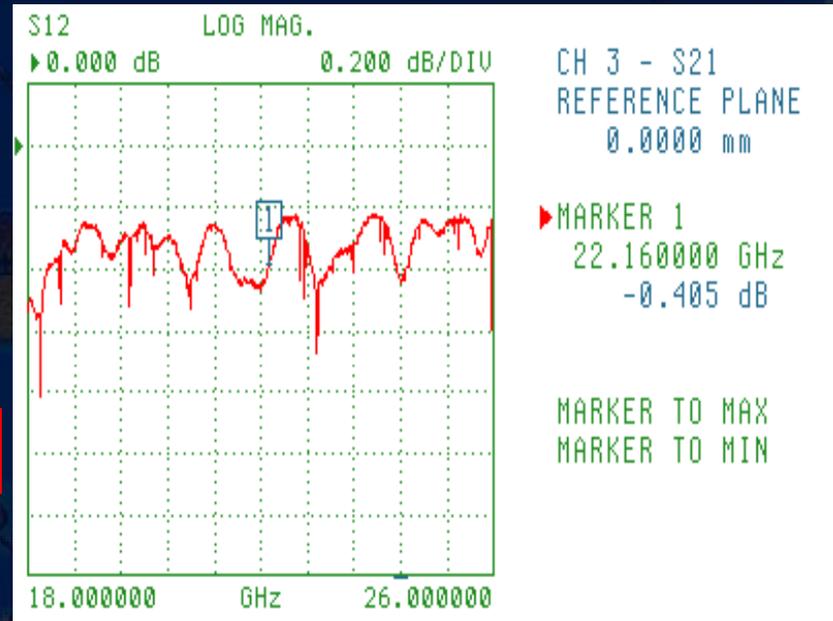
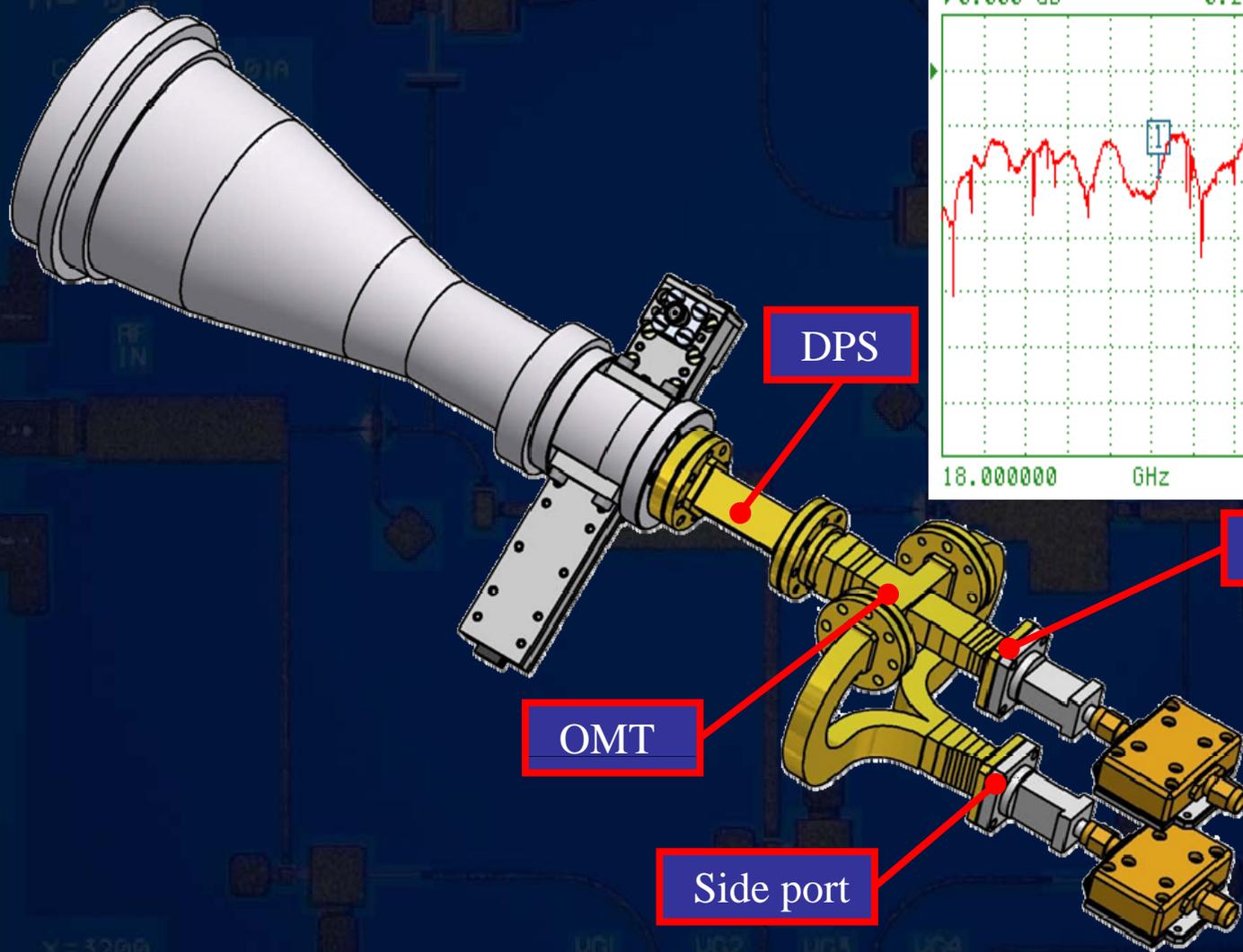
FARADAY Receiver channel



Directional coupler



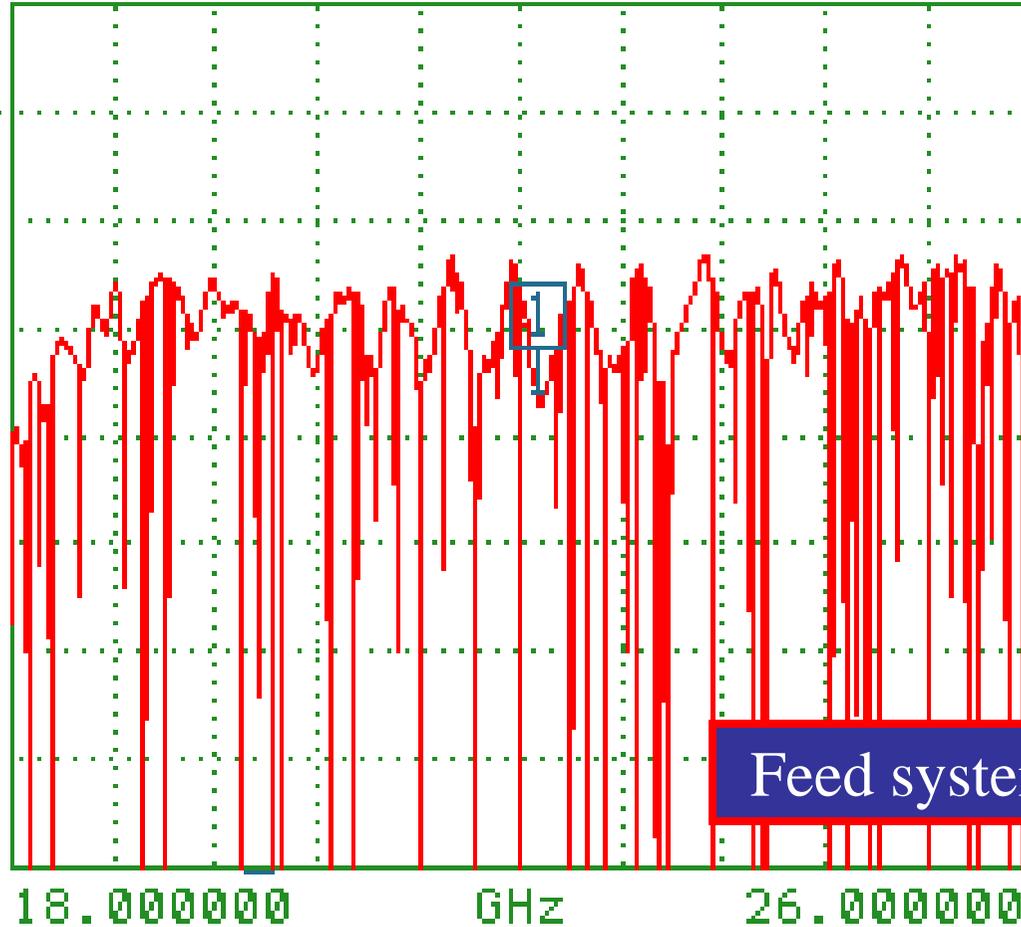
FARADAY Receiver channel



FARADAY Receiver channel

S12 LOG MAG.
 ▶ 0.000 dB 0.200 dB/DIV

CH 3 - S21
 REFERENCE PLANE
 0.0000 mm



▶ MARKER 1
 22.160000 GHz
 -0.528 dB

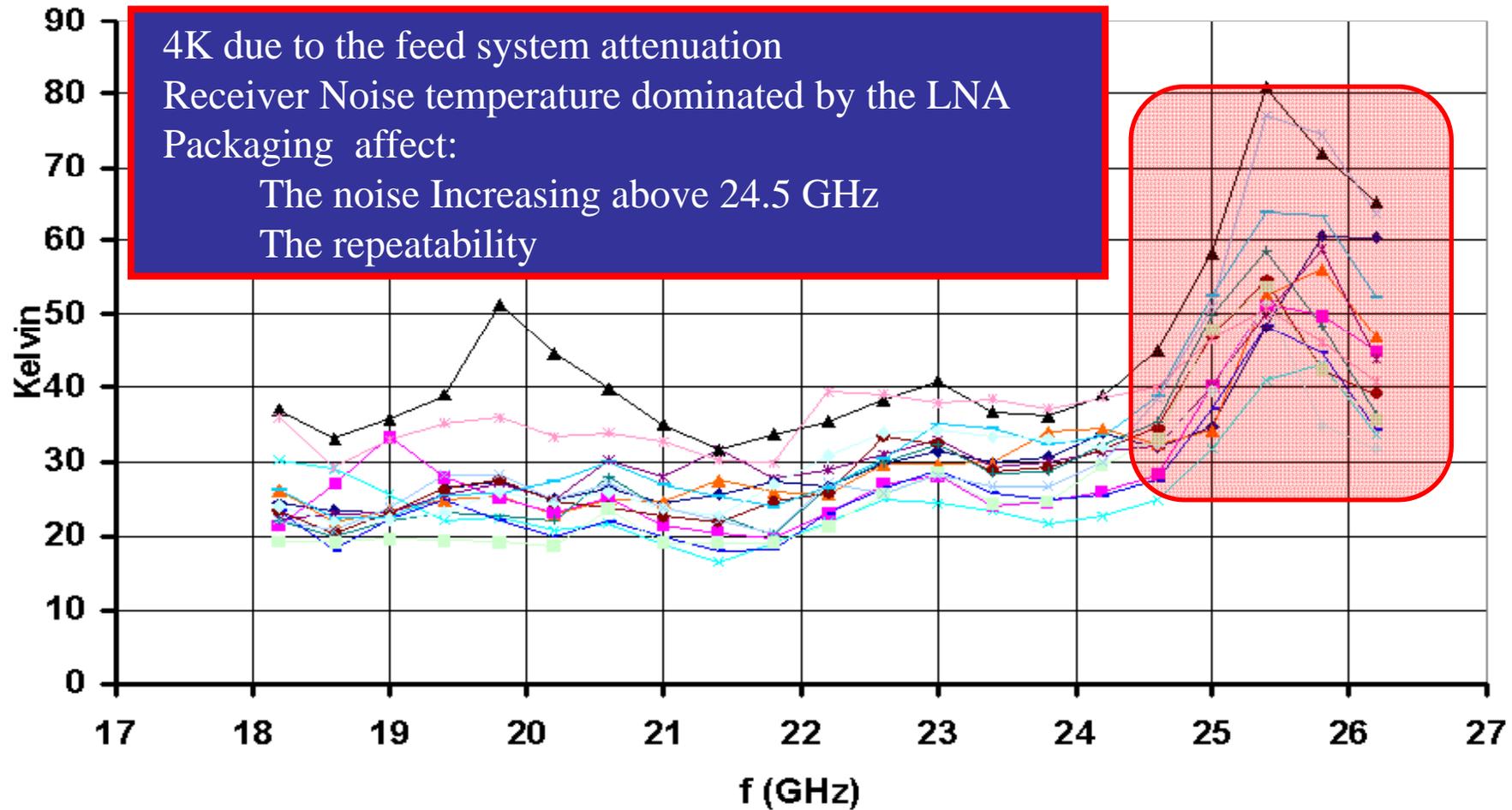
MARKER TO MAX
 MARKER TO MIN

Feed system attenuation :4K@20 K

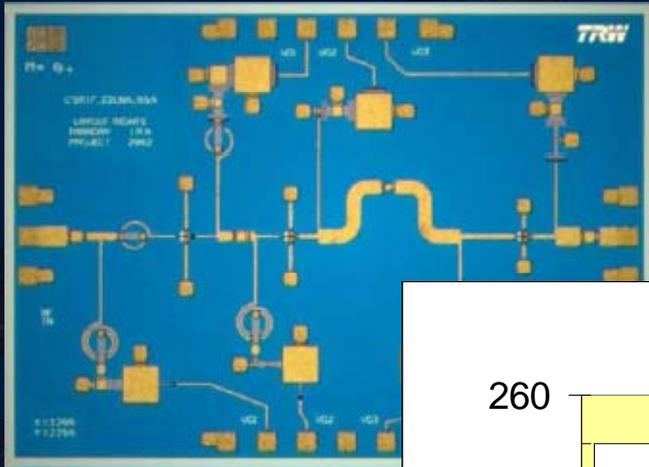


FARADAY Receiver channel

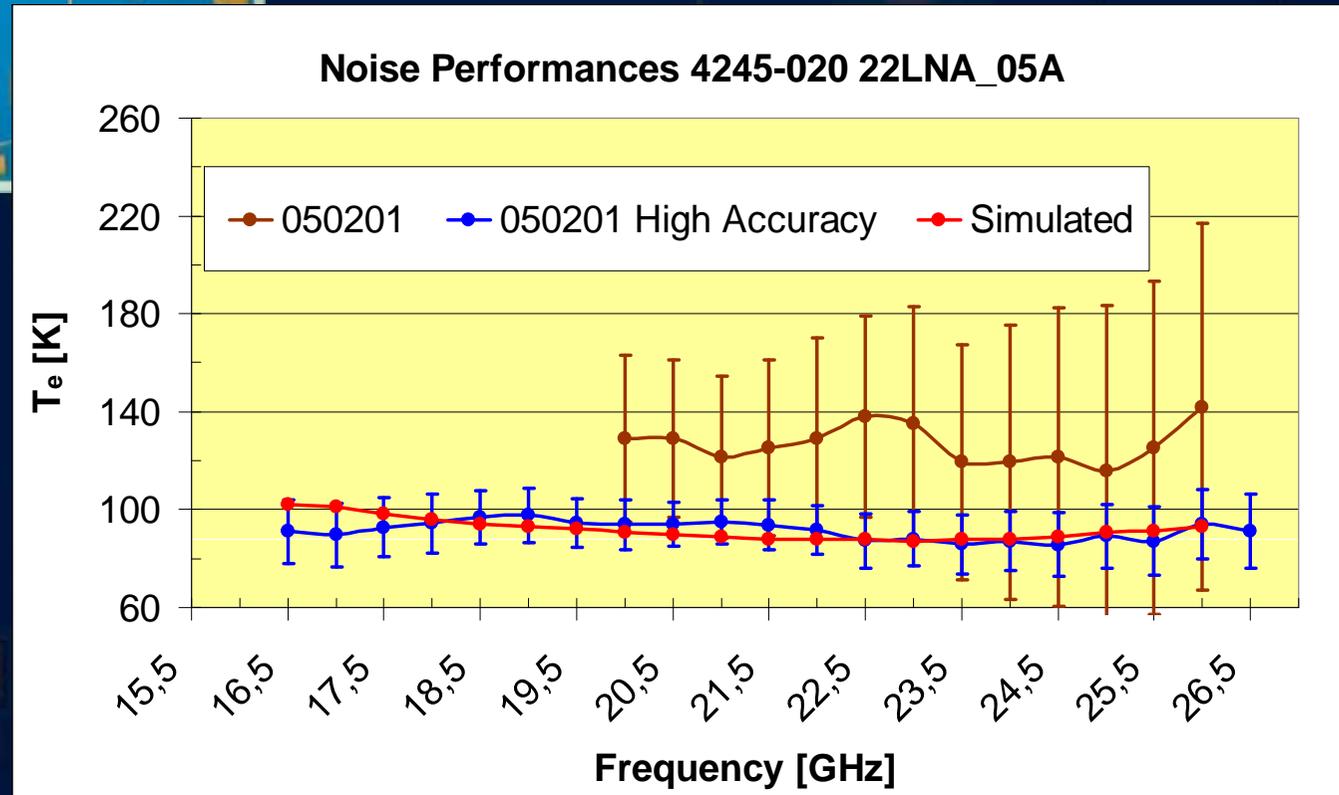
MULTIFEED RECEIVERS NOISE



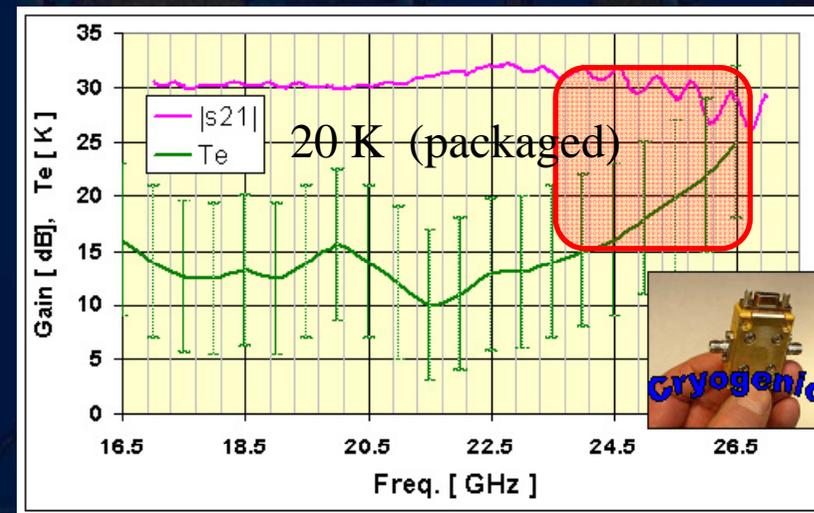
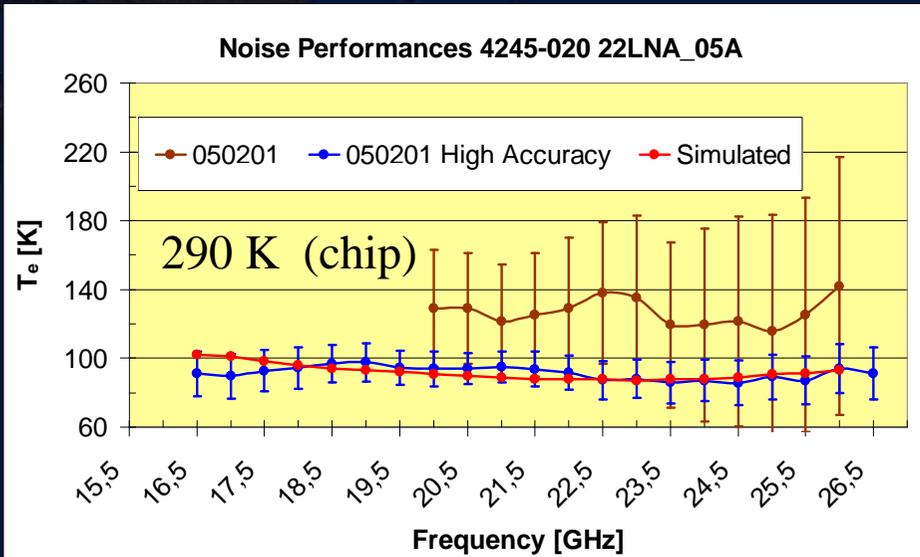
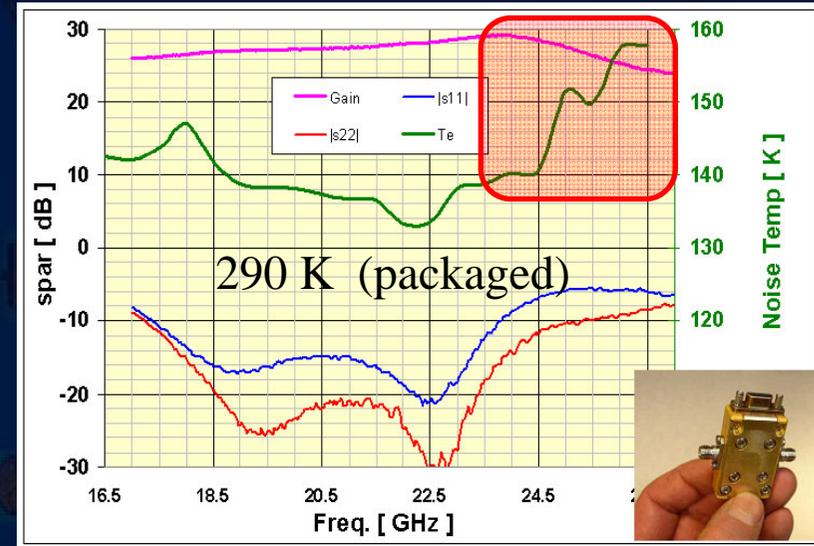
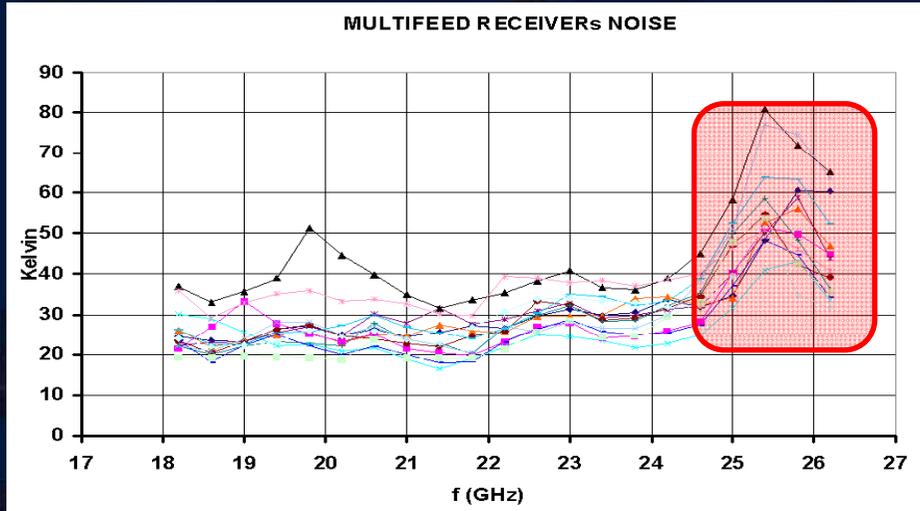
FARADAY Receiver : MMIC LNA



Noise @ 290 K on chip



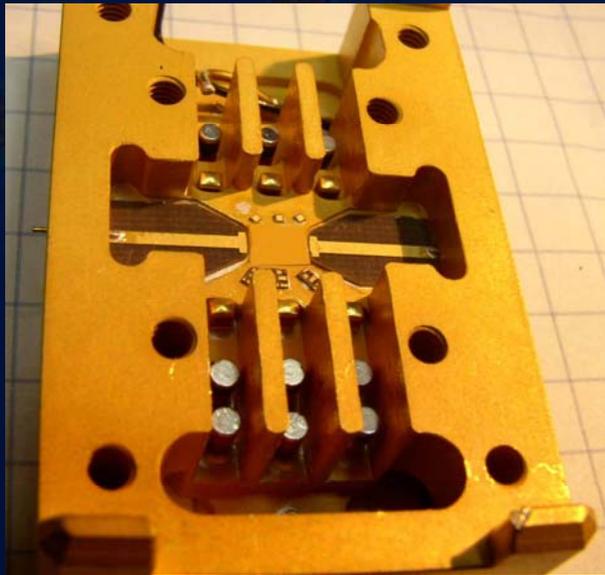
FARADAY Receiver : MMIC LNA



FARADAY Receiver : MMIC LNA

Measurement

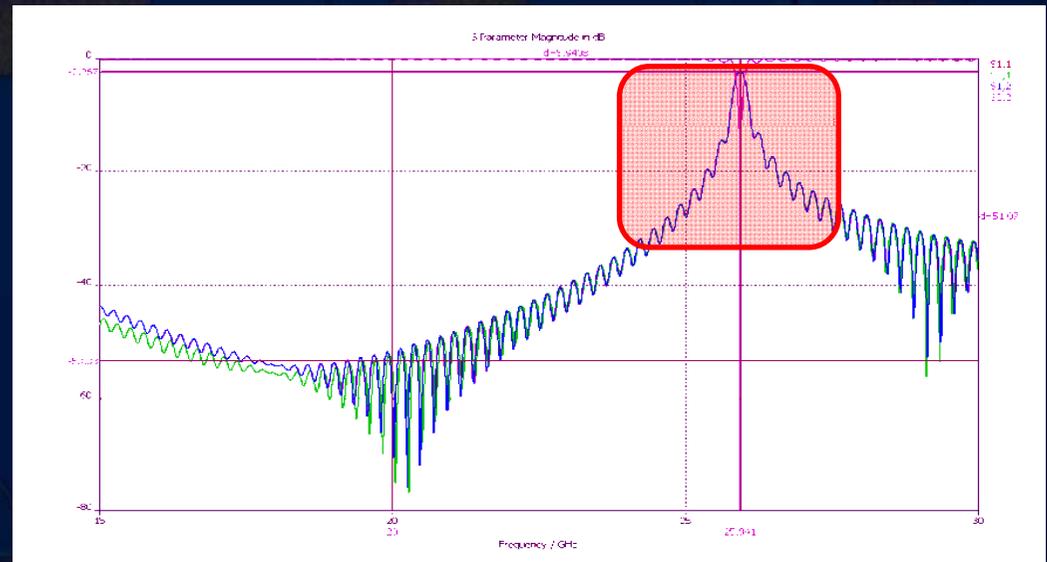
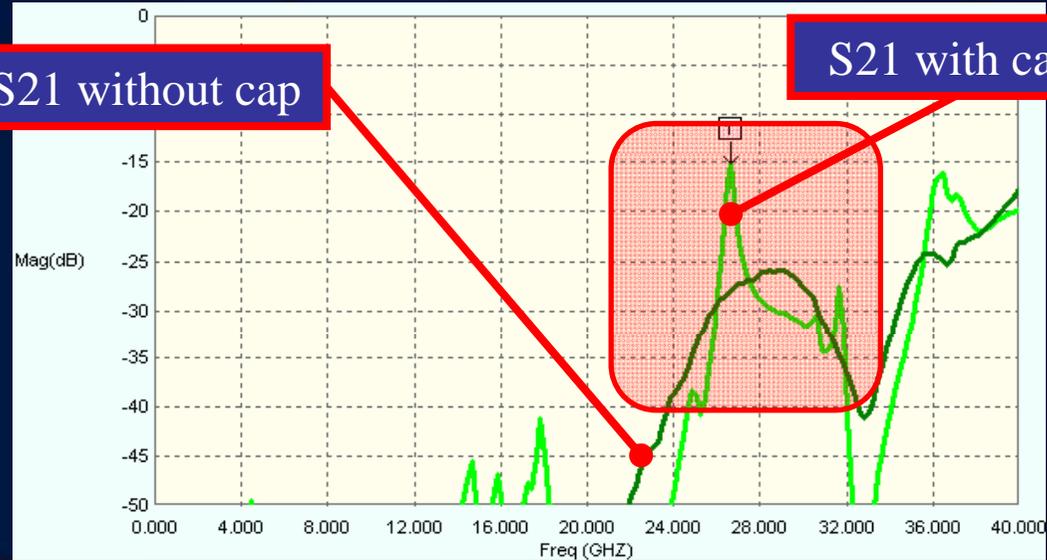
RF Propagation in the cavity



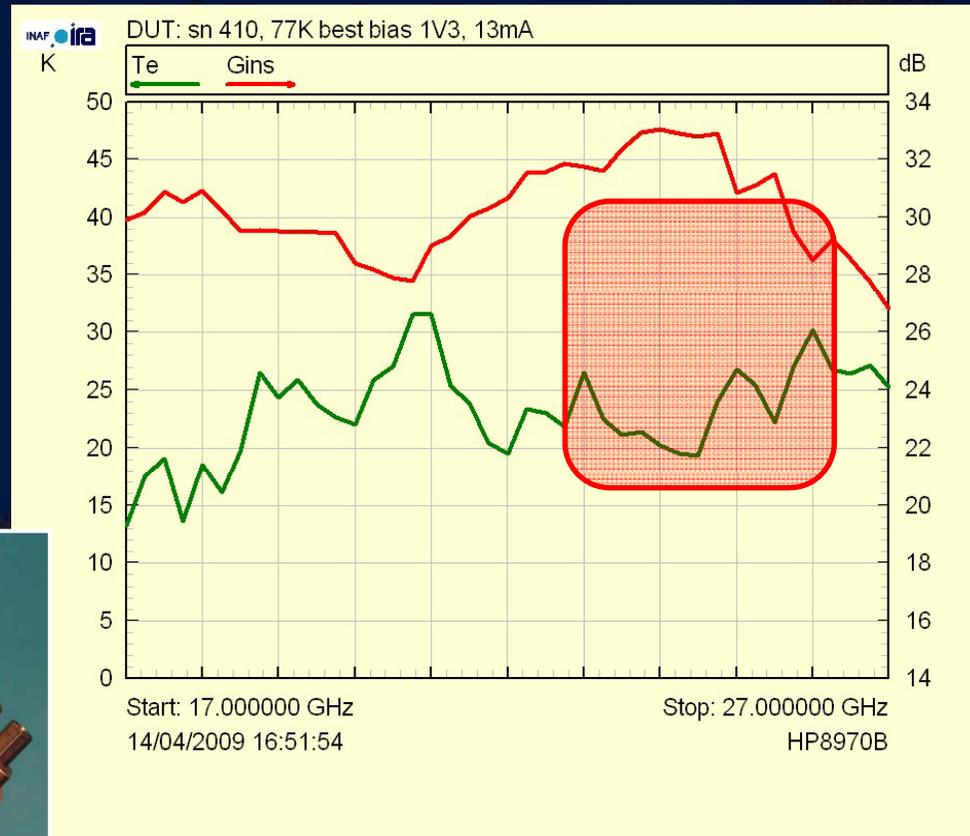
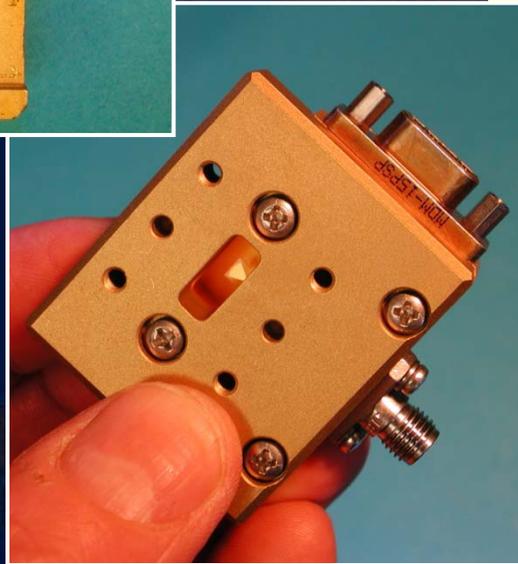
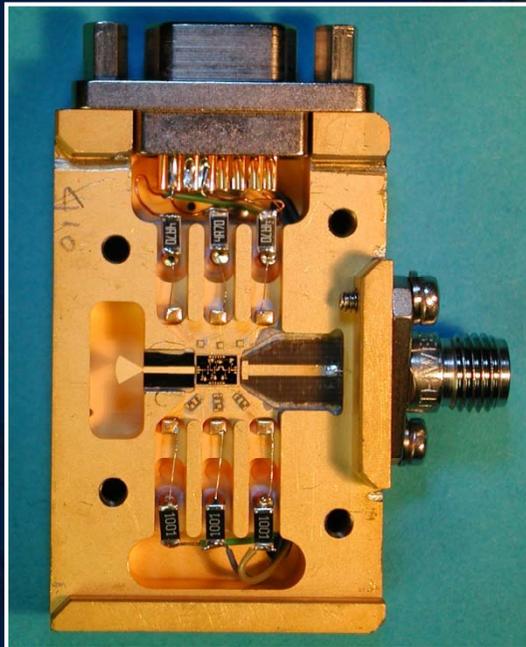
3D EM Simulation

S21 without cap

S21 with cap



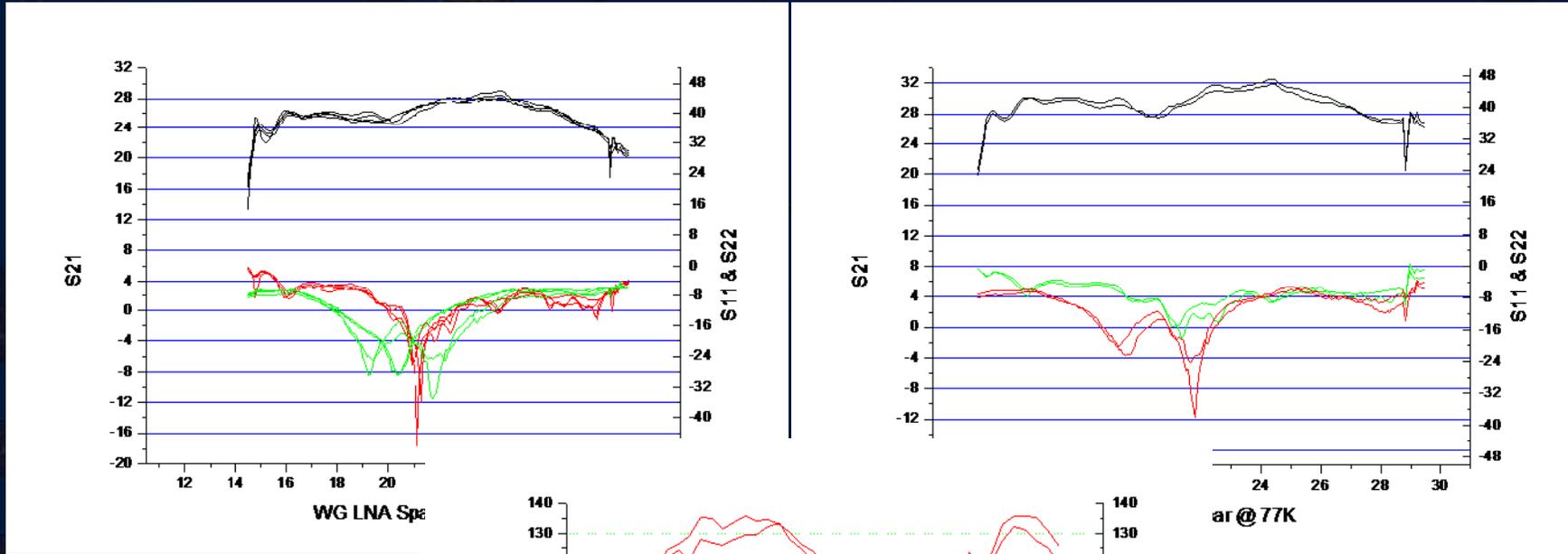
FARADAY Receiver : MMIC LNA



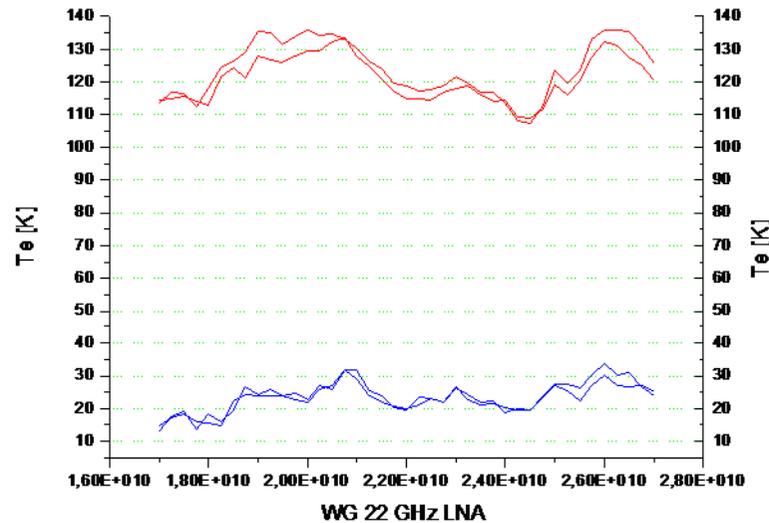
22GHz LNA Waveguide Version
 Not yet optimised For Te and Input
 matching but ...



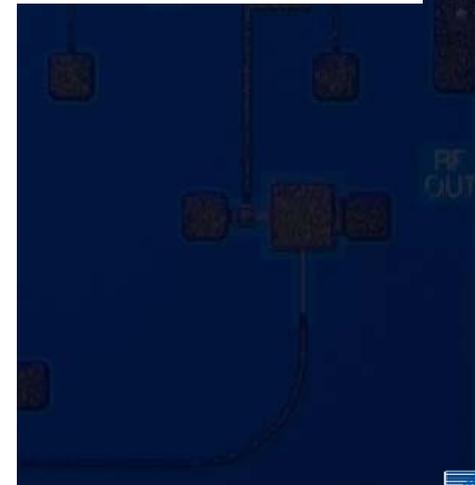
FARADAY Receiver : MMIC LNA



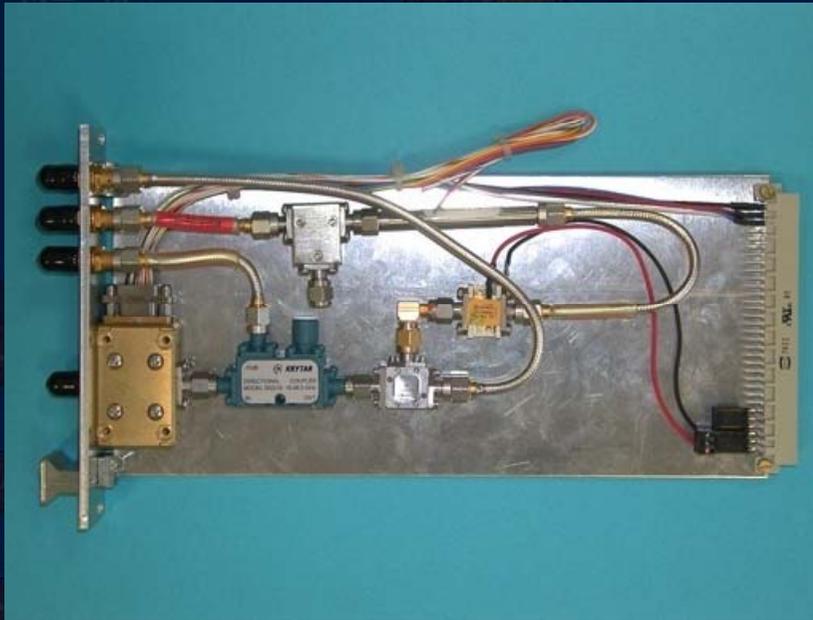
Higher repetibility
Noise more flat !...



ar@77K

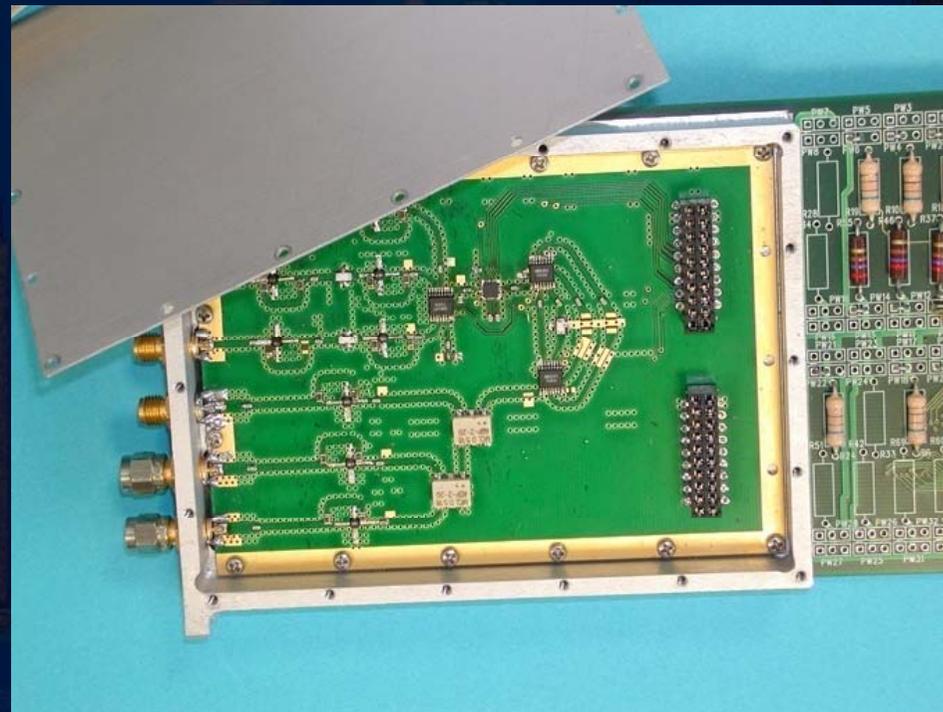


FARADAY Receiver :Down Conversion and LO distribution



1st conversion board (one for each channel)
Bolted coaxial arrangement
2 GHz Bandwidth (6-8 GHz)
Variable LO 12 to 18.5 GHz

2nd conversion board (one for two pol.)
PCB
2 GHz Bandwidth (6-8 to 0.1 2.1 GHz)
Fixed LO at 5.9 GHz



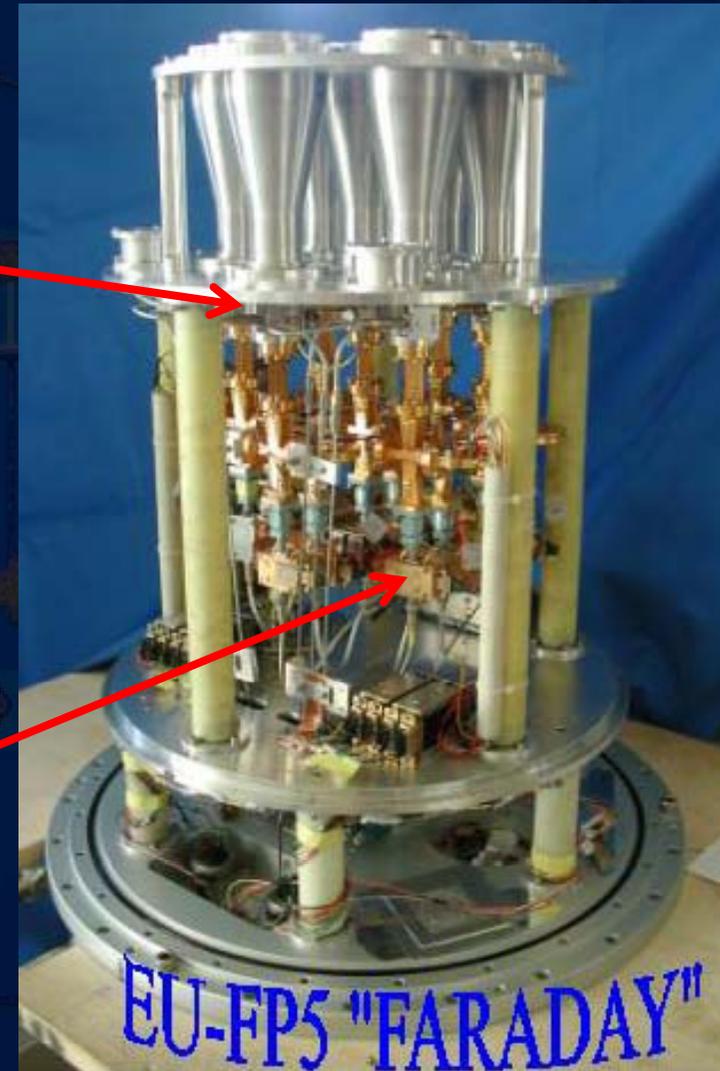
FARADAY Receiver : Cryogenics

Horns are fastened to a 5 mm thick aluminum plate

The plate is cooled down to second stage by using 0.5mm thick Cu straps

LNAs directly connected to the second stage of the cryogenerator, via a massive U shaped Cu plate and straps.

Helix-CTI 350 cryogenerator.



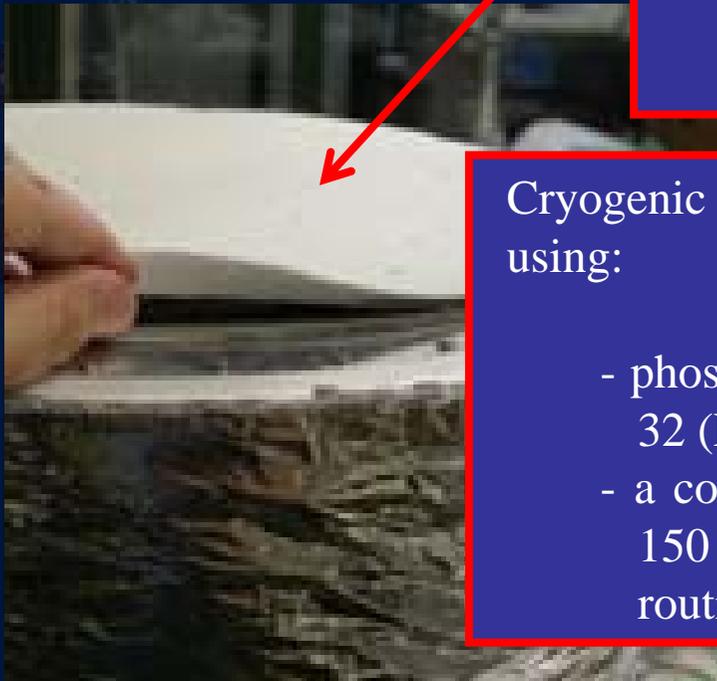
FARADAY Receiver : Cryogenics losses

A 350 mm wide optical window provide about 25 W

A multilayer infrared blocking filter has been used.

Thermal radiation transmission of the multilayer is estimated to be less than 8%.

Vacuum window foam support acts as an additional and powerful thermal filter.



Cryogenic Wiring losses minimization has been obtained by using:

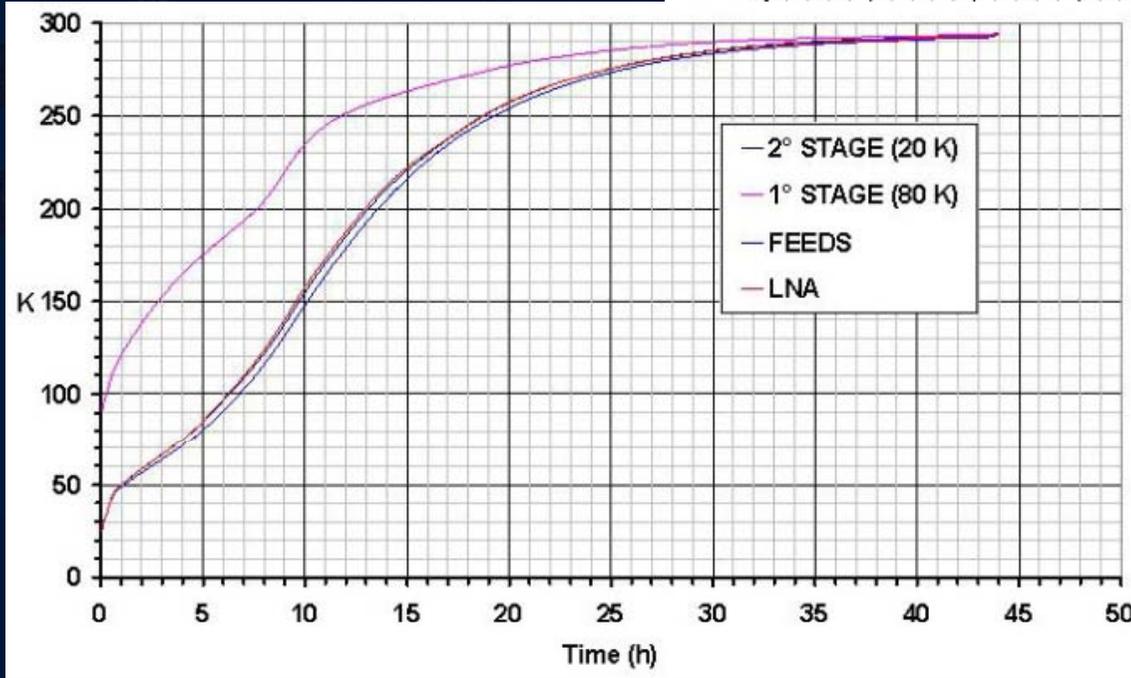
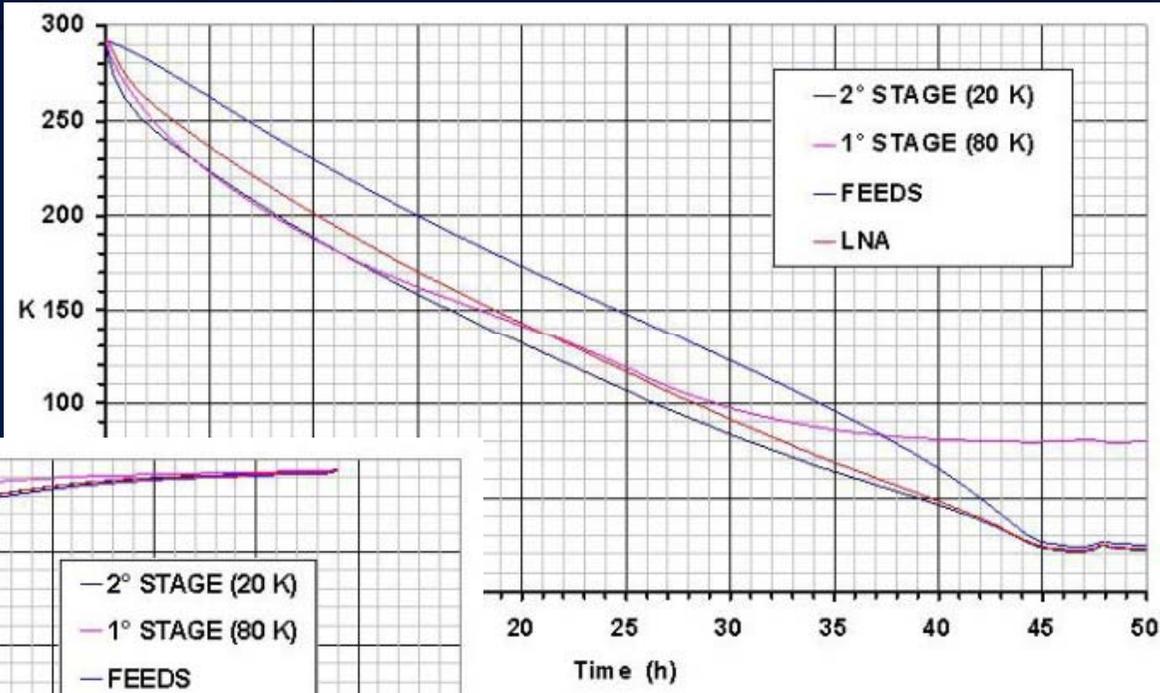
- phosphorous bronze Quad-Lead™ Cryogenic Wire – QL-32 (Lake Shore) for the LNA bias,
- a combination of low loss Cu coaxial cables and about 150 mm long SS85 stainless steel coaxial cables, for routing each RF path from 300 K to 20 K.



FARADAY Receiver : Cool down and Warm up

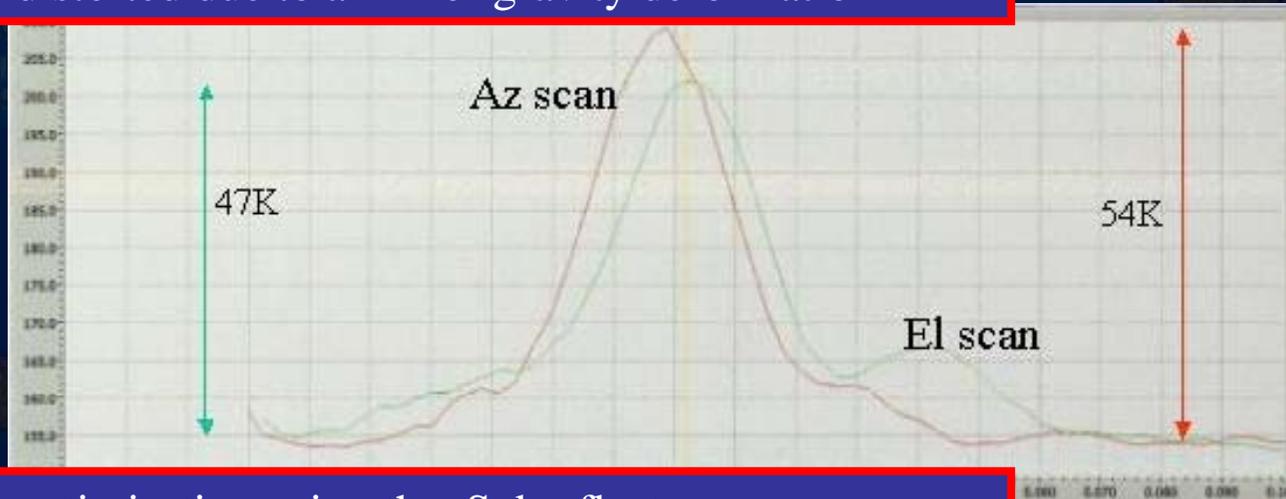
M = 0.1

CSRI6_43LNA_01A
LAYOUT RIGHTS
FARADAY INAF-IRA
PROJECT 2005

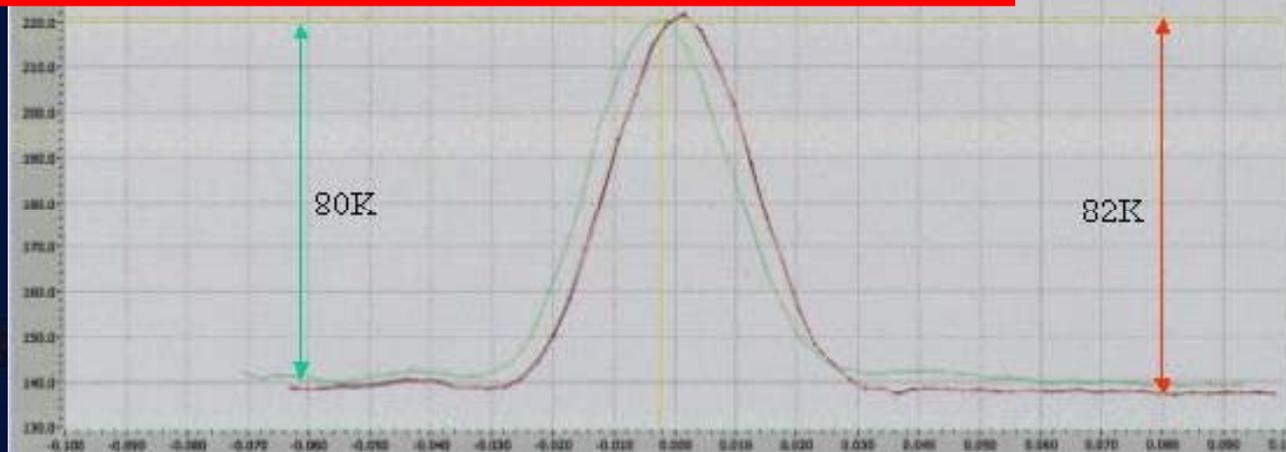


FARADAY Receiver : Measurements on the 32m antenna

Beam pattern distorted due to a mirror gravity deformation

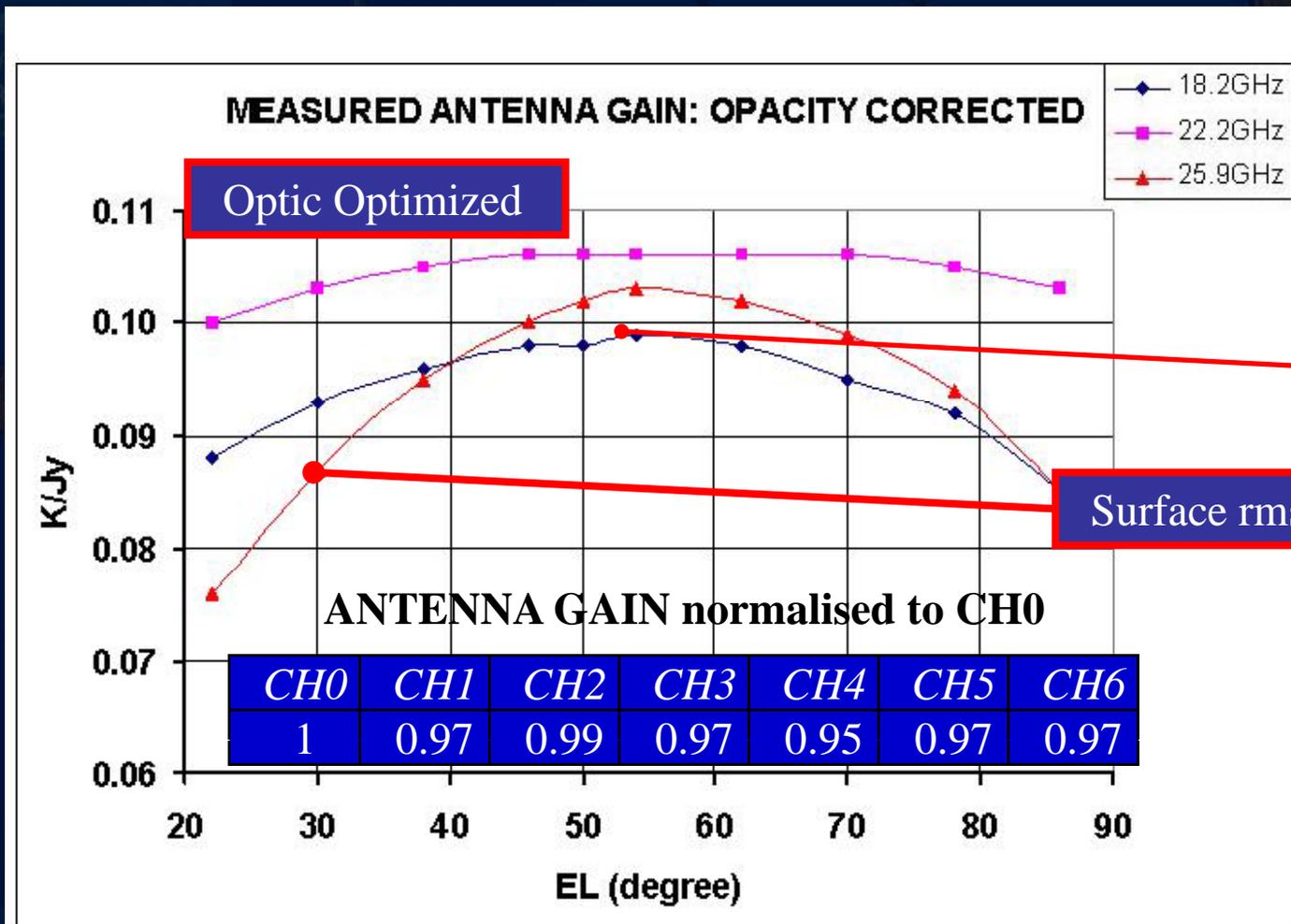


Beam pattern optimisation using the Subreflector

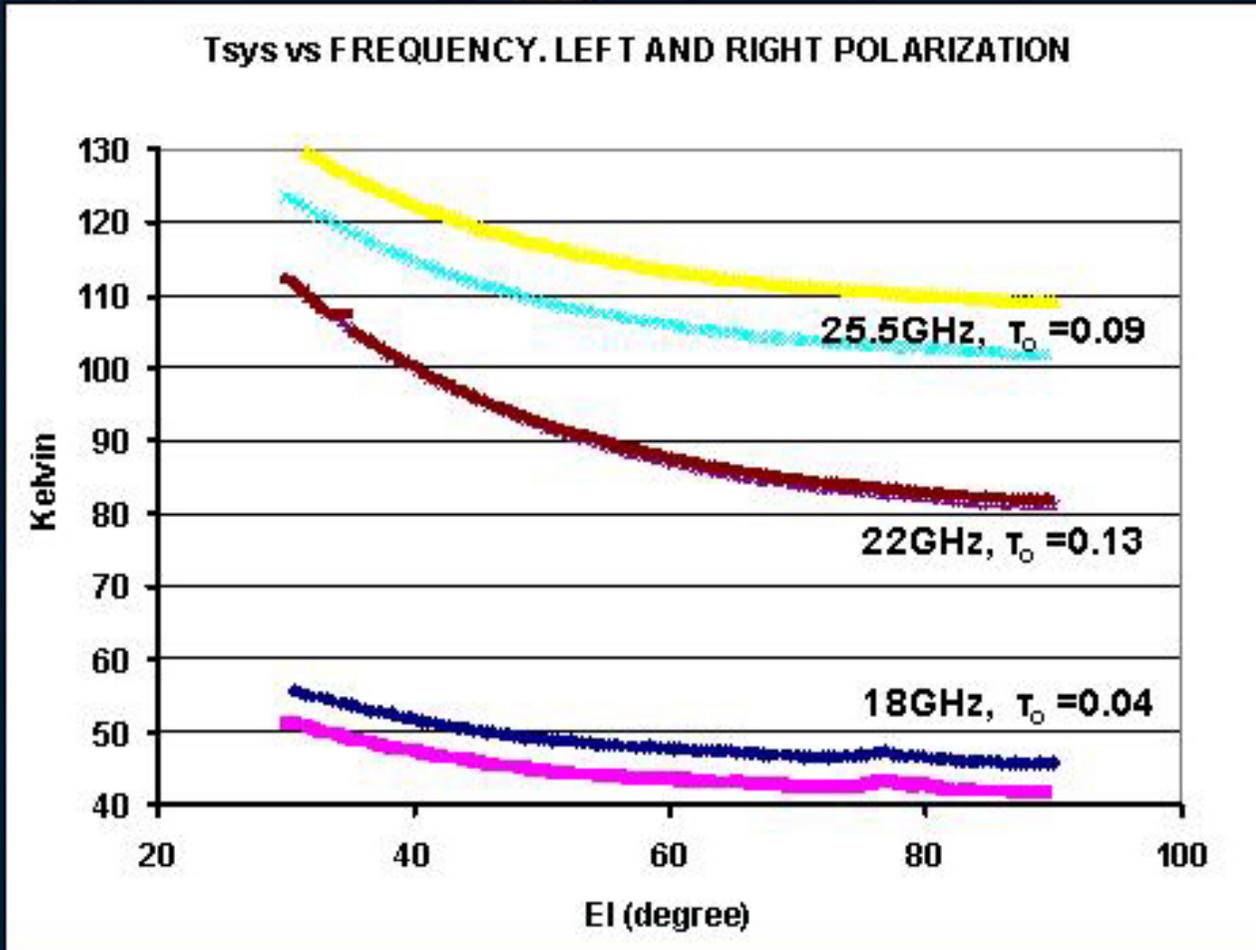


FARADAY Receiver : Measurements on the 32m antenna

ANTENNA GAIN



FARADAY Receiver : Measurements on the 32m antenna

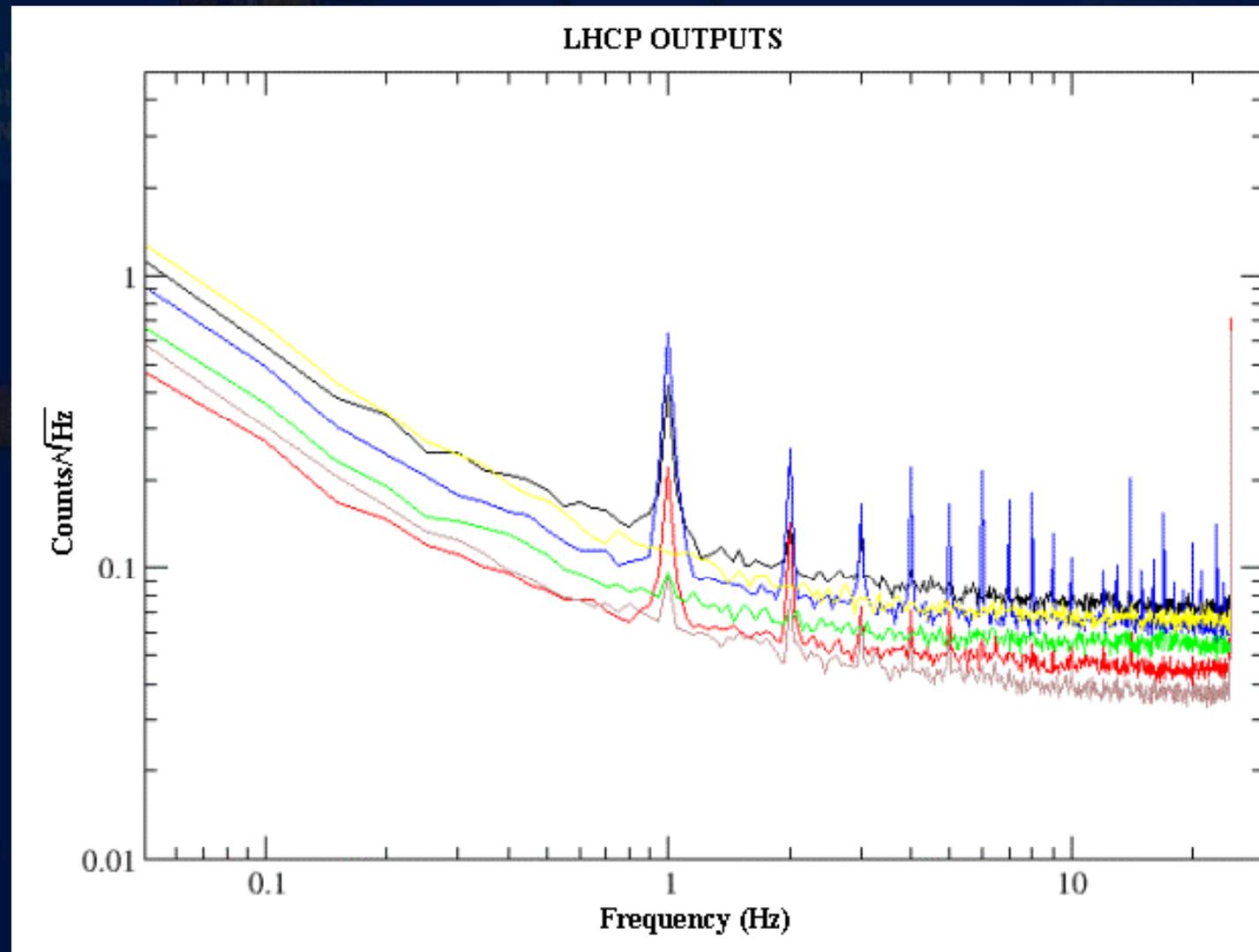


22 GHz Zenith Tsys

CH0	CH1	CH2	CH3	CH4	CH5	CH6
88	85	91	85	93	89	93



FARADAY Receiver : Measurements on the 32m antenna



F = 4
G = 2

M = 0.1

CSRI6_43LNA_01A
LAYOUT RIGHTS
FARADAY INAF-IRA
PROJECT 2005

Commissioning Phase will start Autumn 2010

X = 3200
Y = 2250



R = 4
C = 2

M = 0.5

CSRI8_43LNA_01A
LAYOUT RIGHTS
FARADAY INAF-IRA
PROJECT 2005

Thanks For your attention

A. Cremonini



RF IN

RF OUT

X = 3200
Y = 2250

UG1 UG2 UG3 UG4