Max-Planck-Institut
für Radioastronomie

SEVENTH FRAMEWORK
PROGRAMME

Analogue Photonics

Broadband analogue RF transmission via optical fibre

Max-Planck-Institut
für Radioastronomie

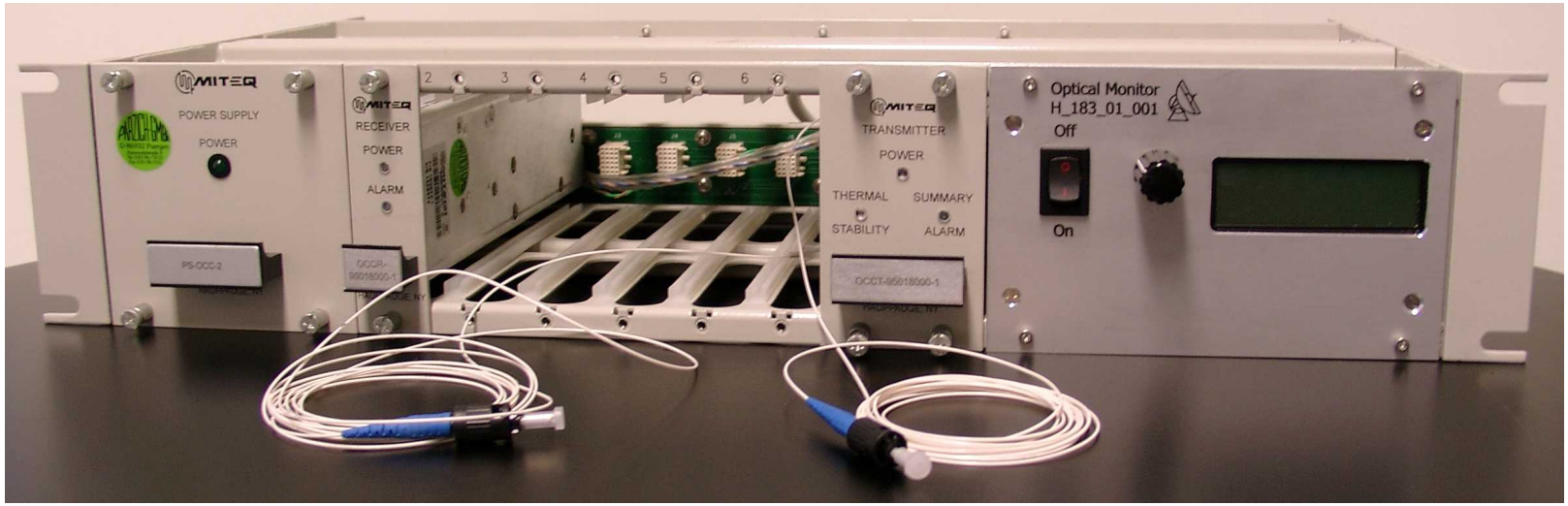
topics

SEVENTH FRAMEWORK
PROGRAMME

Environmental influences

- Signal in telescope environment (1)
  (focus on temperature behavior)
- Signal in telescope environment (2)
  (focus on mechanical stress caused by telescope movement)
- Signal in lab environment (3)
  (focus on stability of the link)
- Long wavelength VCSEL
- Summary
- Questions / Discussion

Investigated System



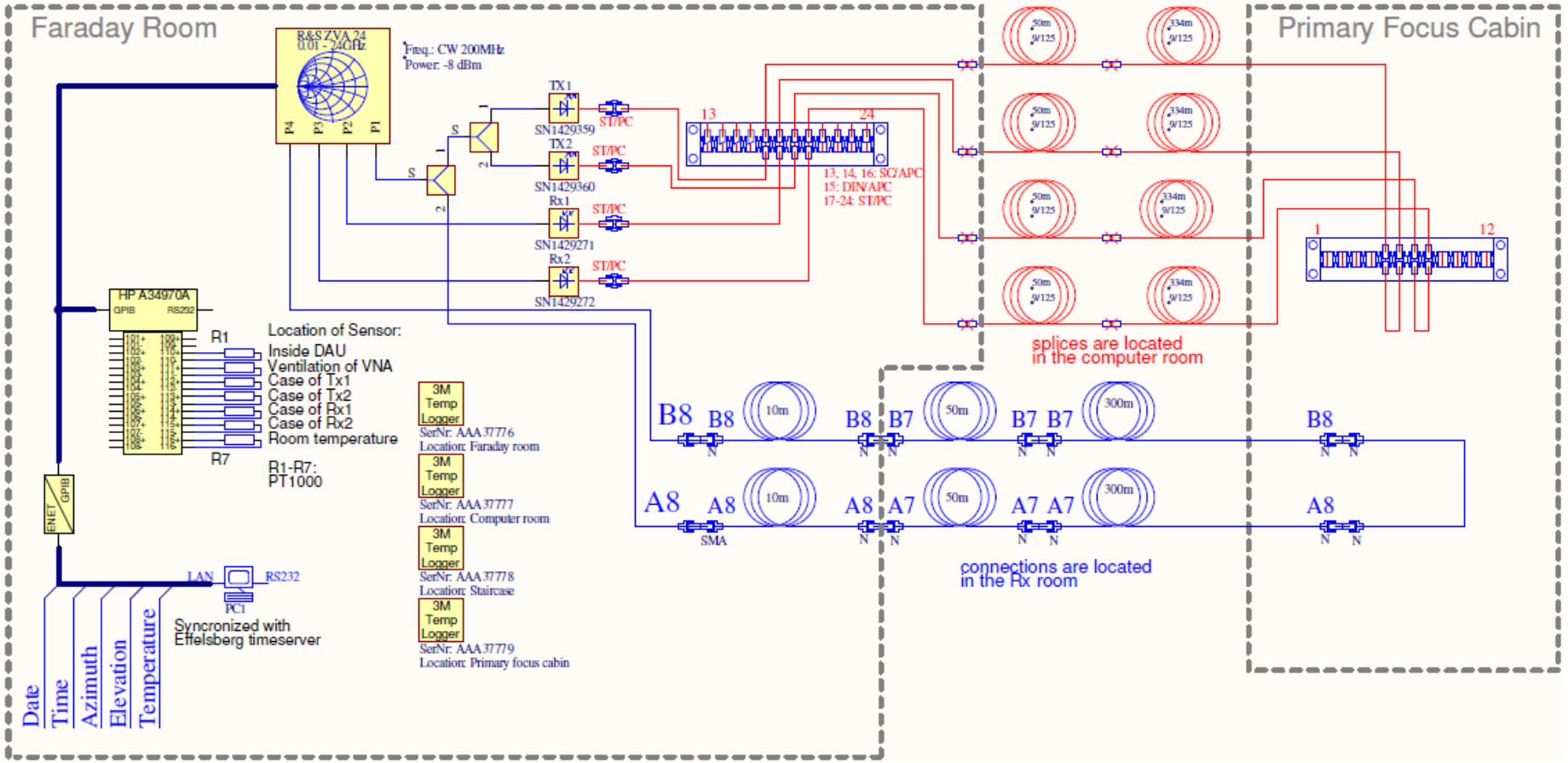
- Miteq Tx:OCCT-95018000-1 & Miteq Rx: OCCR-95018000-1
- Bandwidth: 950 MHz – 18 GHz
- Wavelength: 1310 nm

Environmental influences 1

Max-Planck-Institut für Radioastronomie

SEVENTH FRAMEWORK PROGRAMME

Measurement setup in the Effelsberg 100m telescope



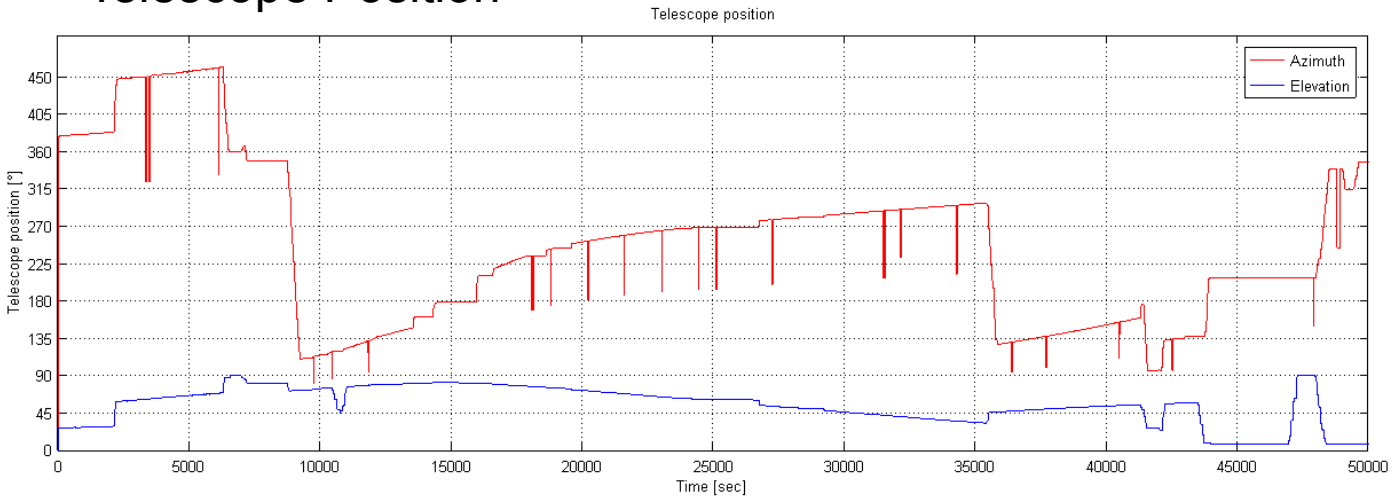
Influences 1: overview

Max-Planck-Institut für Radioastronomie

SEVENTH FRAMEWORK PROGRAMME

„normal“ telescope movement

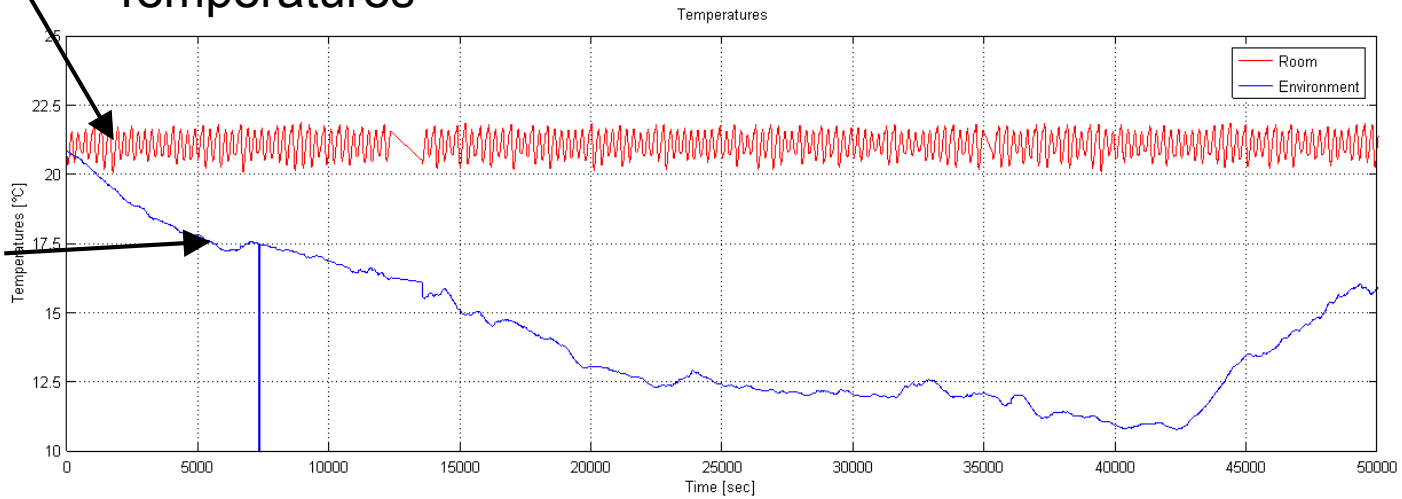
Telescope Position



~2°C room temperature change

~10°C outside temperature change

Temperatures



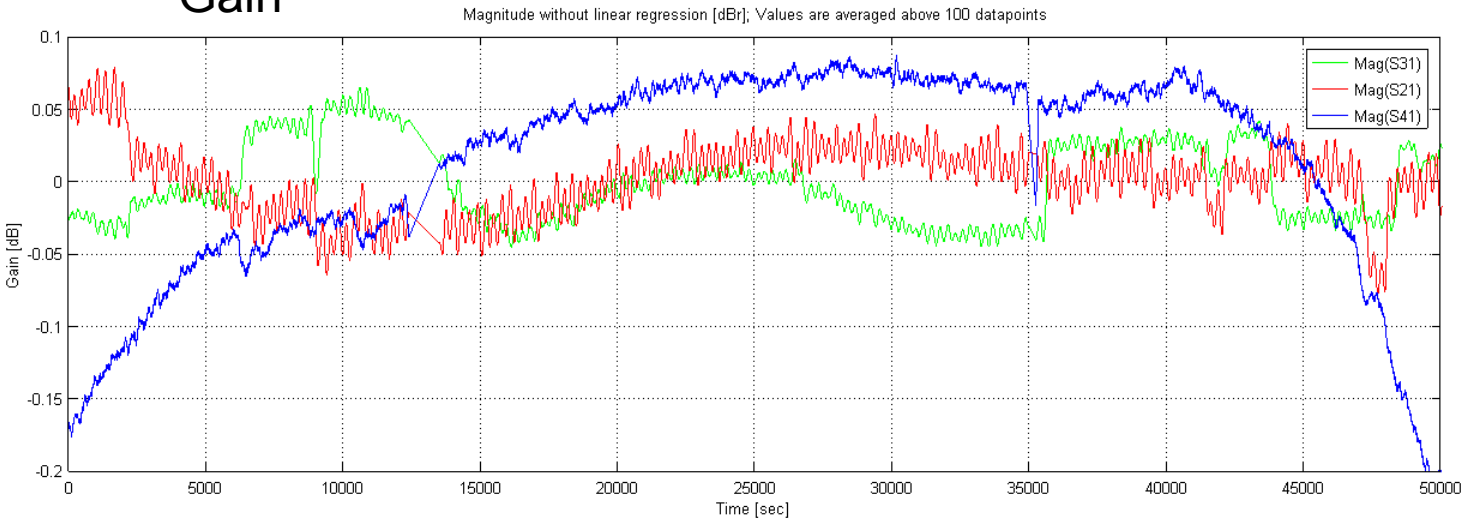
Influences 1: overview

Red (S21): RFoF link 1

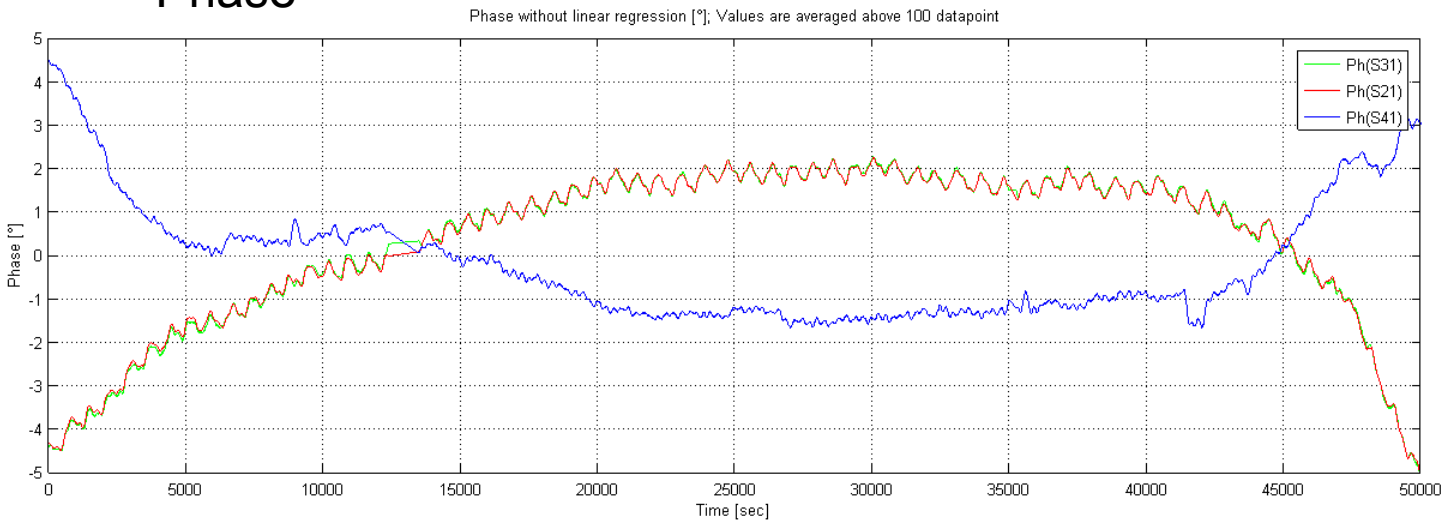
Green (S31): RFoF link 2

Red (S41): Coaxialcable

Gain



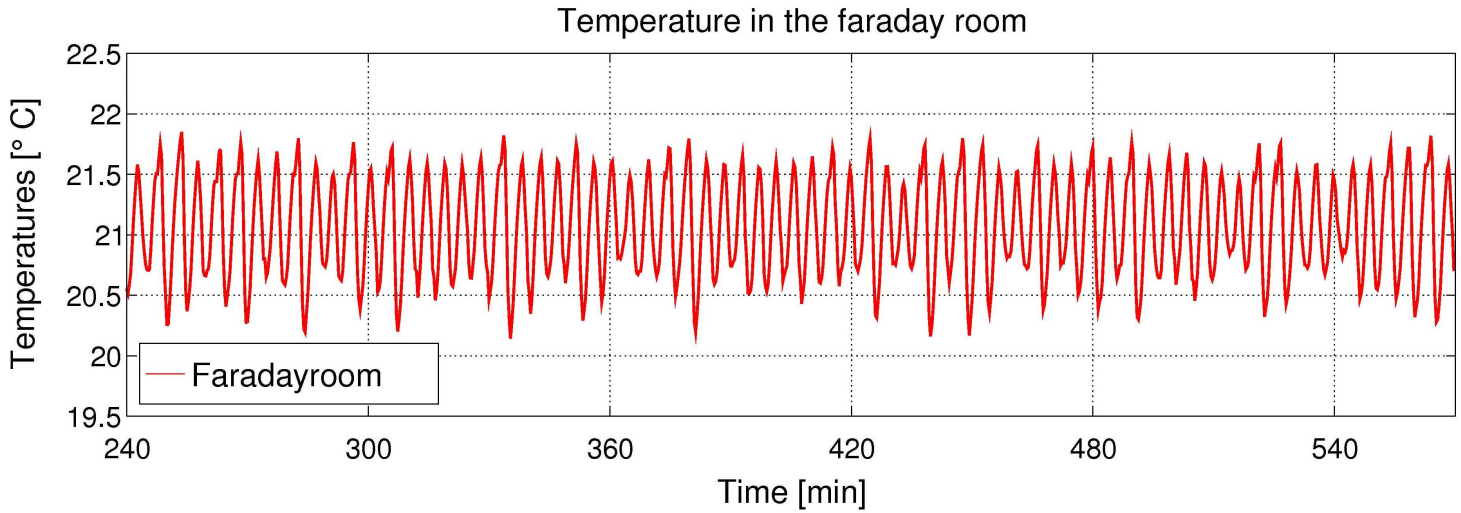
Phase

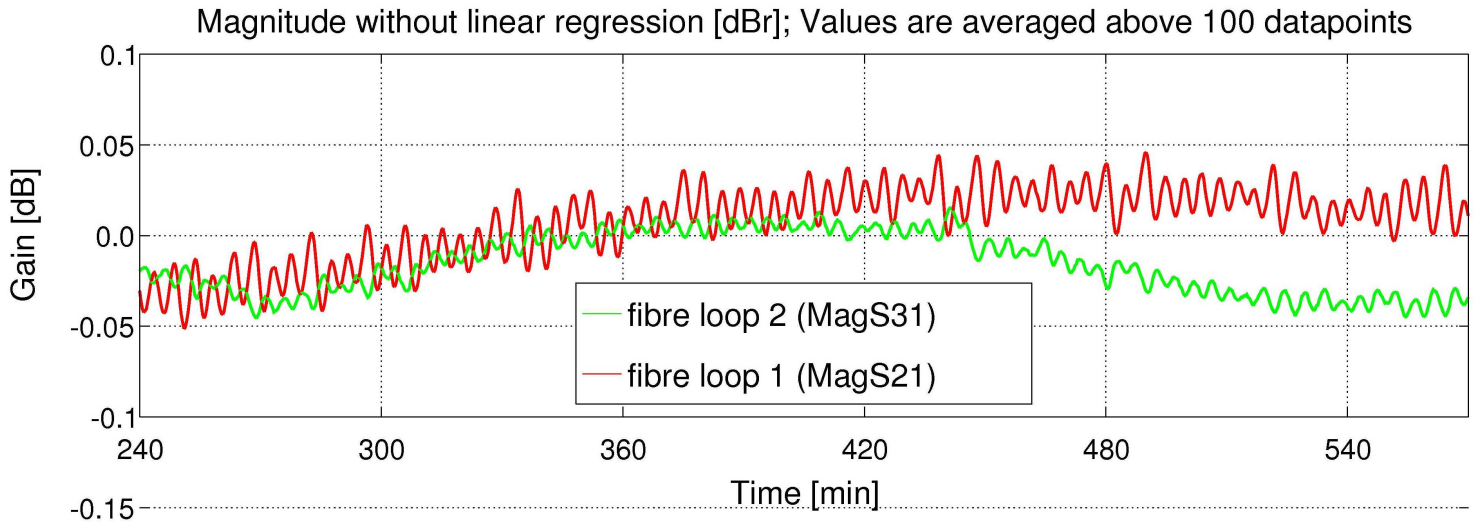


All Phases and the coaxial cable gain strongly influenced by outside temperature

Influences 1: gain

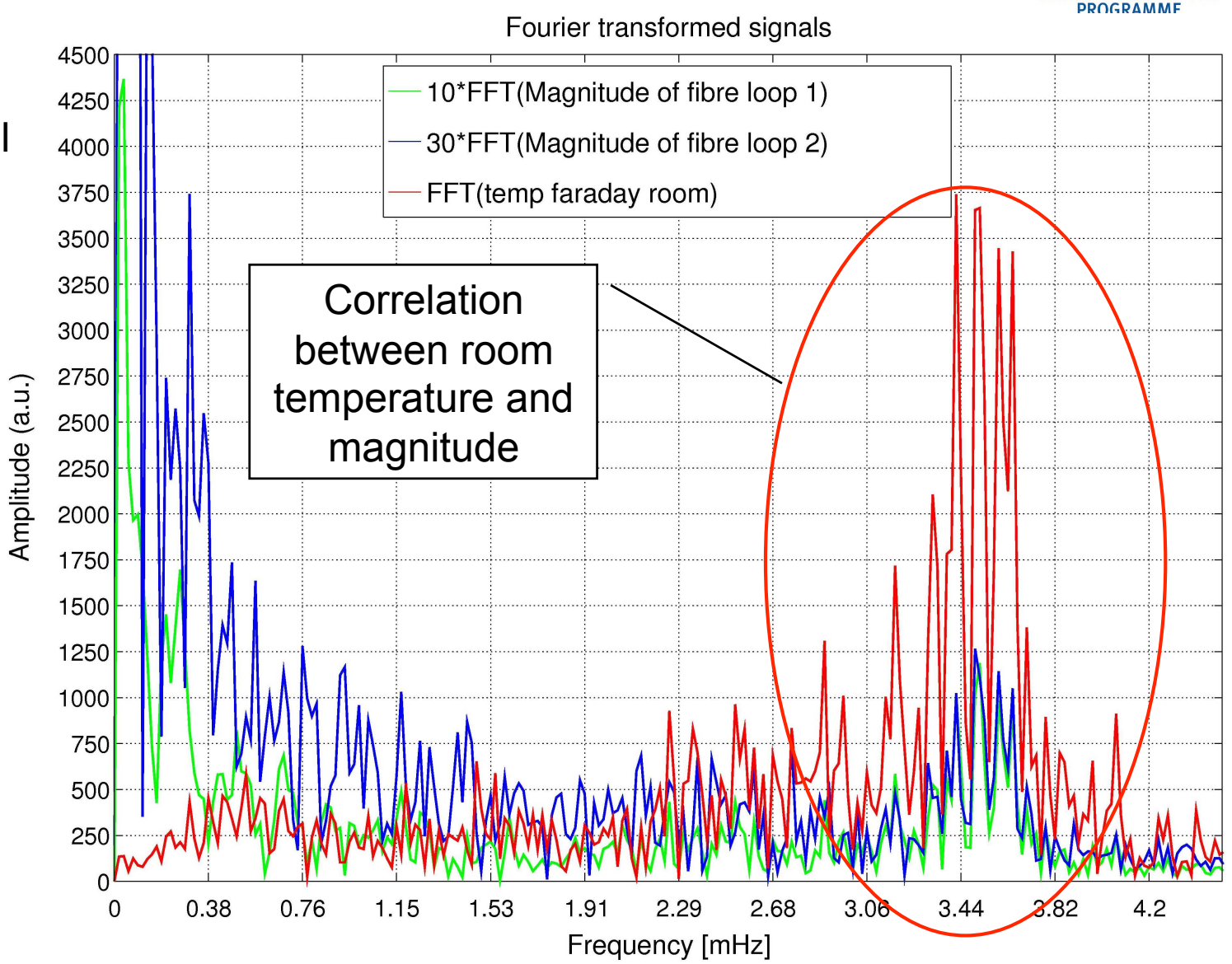
Gain of signal seems to be strongly influenced by the room temperature





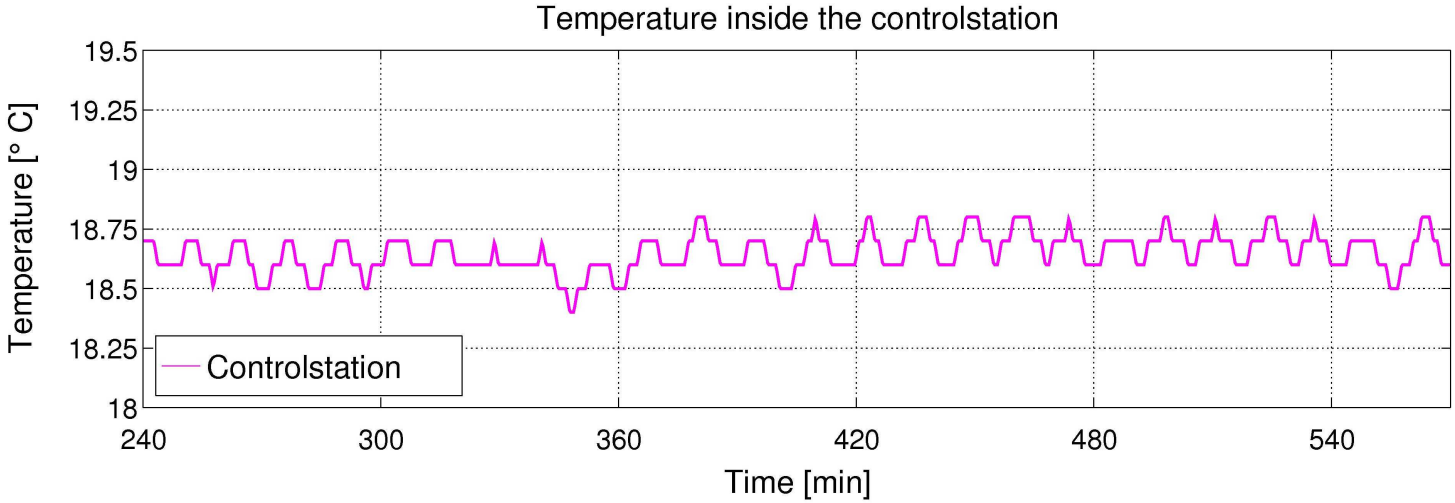
Influences 1: gain

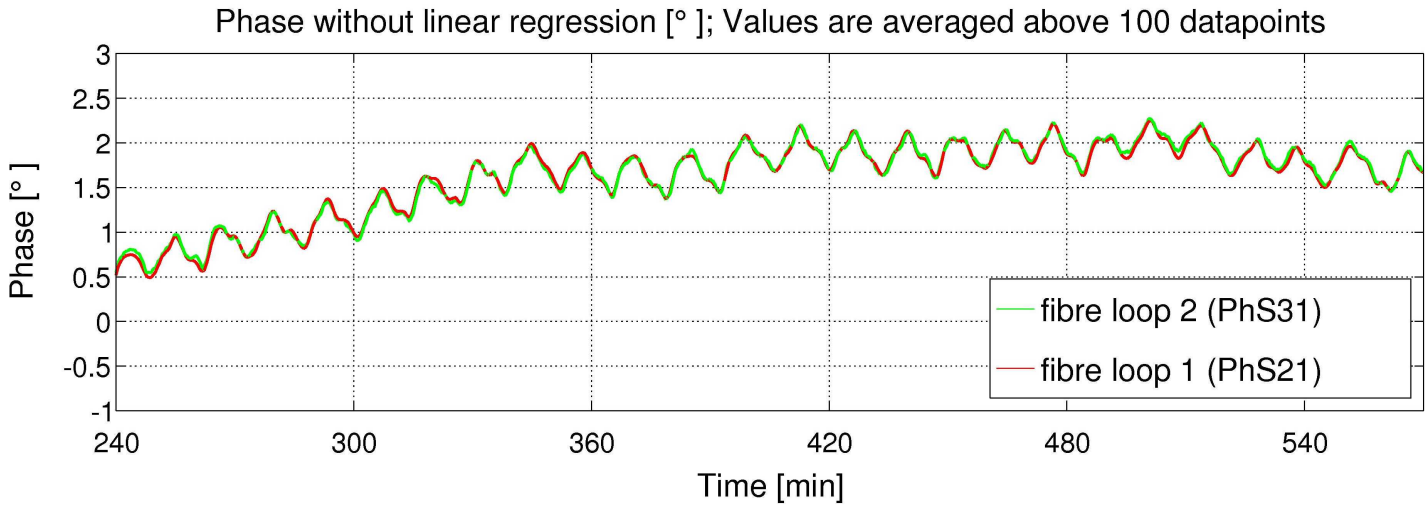
Magnitude of transmitted signal



Influences 1: phase

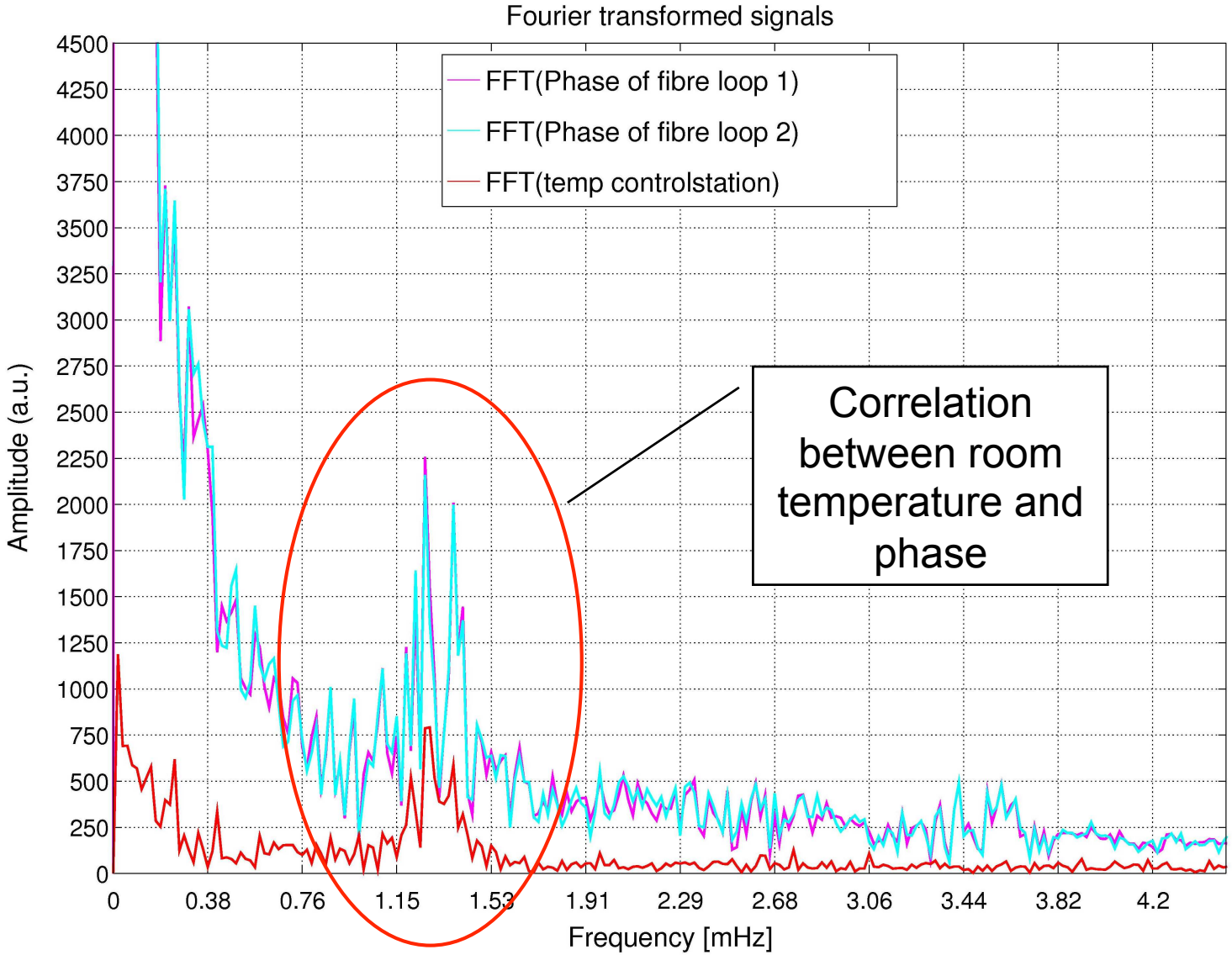
Same frequency of temperature inside the controlstation and the phase of the signal





Influences 1: phase

Phase of transmitted signal



Environmental influences 1

Max-Planck-Institut für Radioastronomie

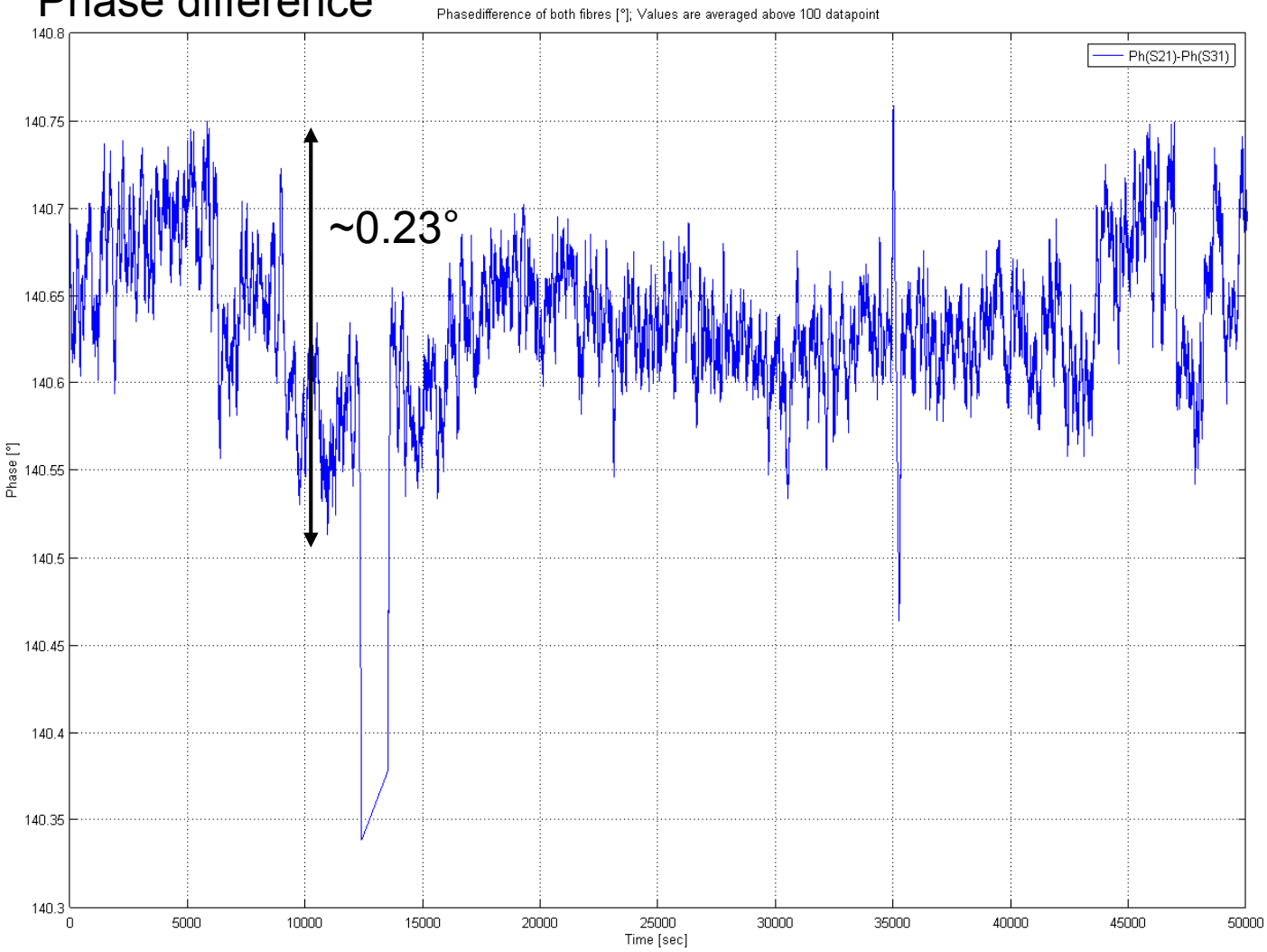
SEVENTH FRAMEWORK PROGRAMME

Very low phase difference (0.23°) between both fibre links.

Both fibres where part of the same loose tube cable

(Measurement frequency: 200 MHz)

Phase difference

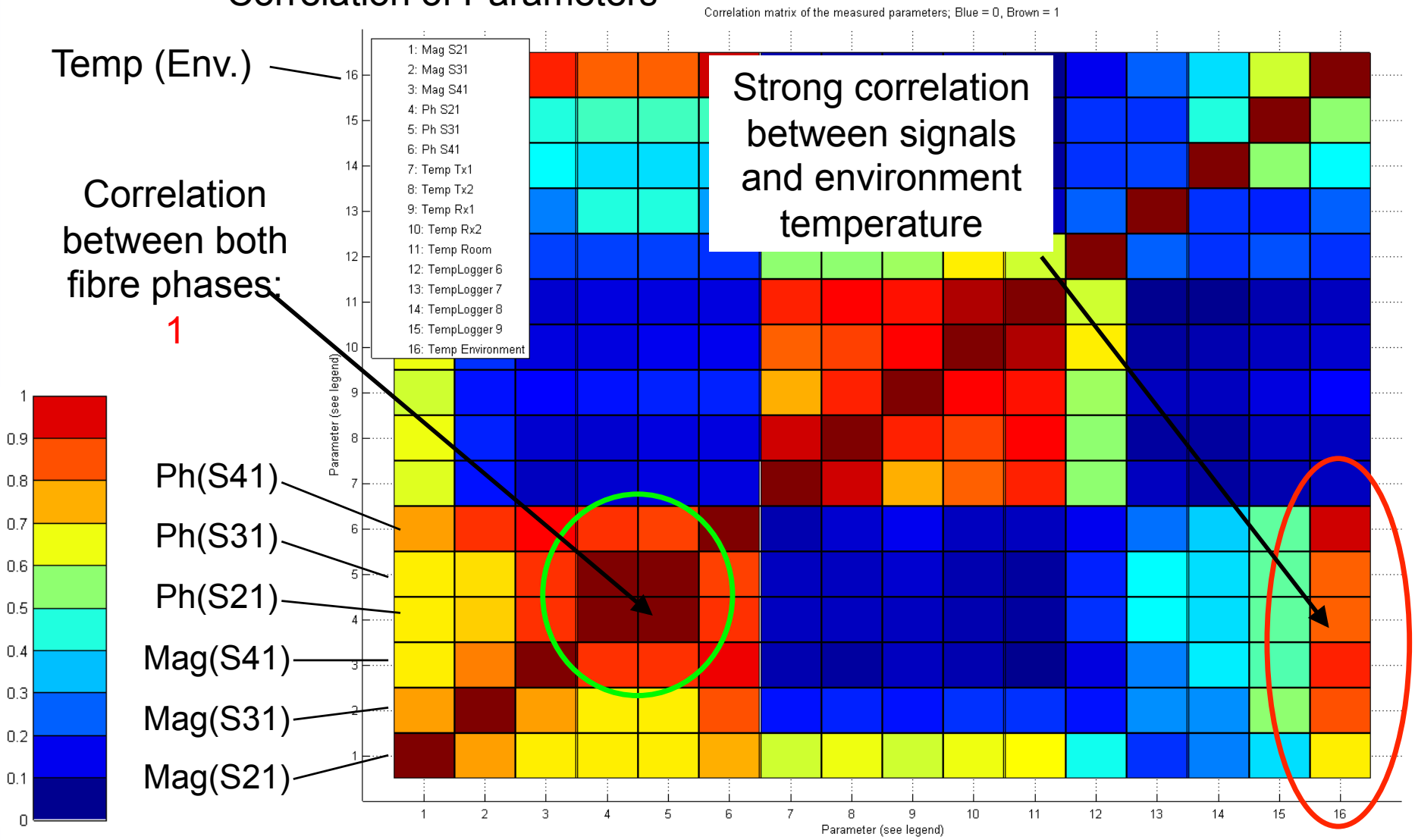


Environmental influences 1

Max-Planck-Institut für Radioastronomie

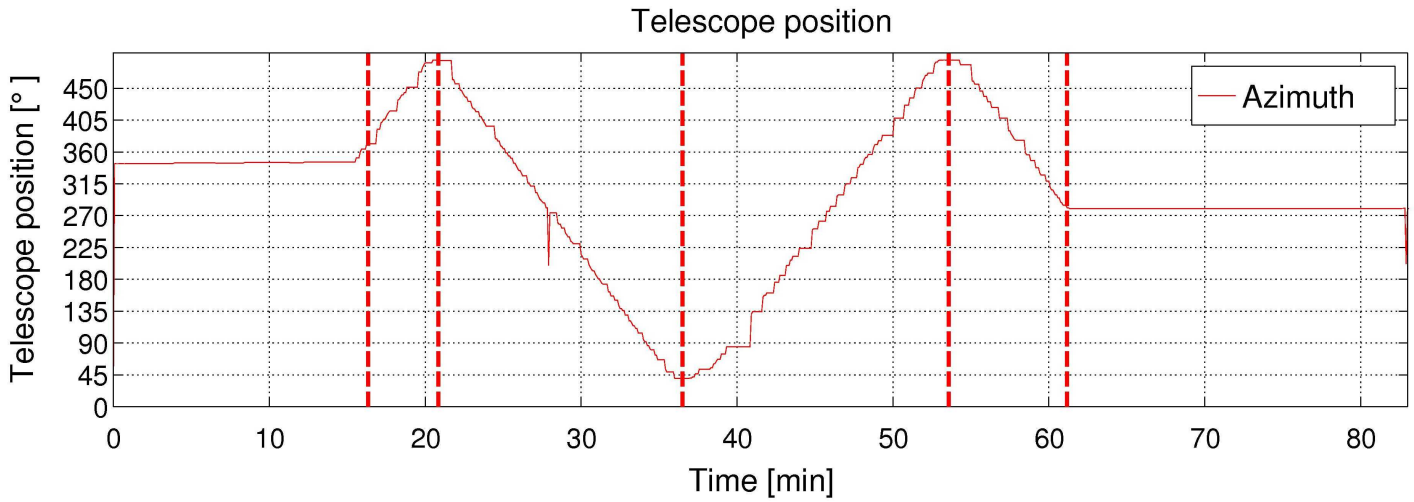
SEVENTH FRAMEWORK PROGRAMME

Correlation of Parameters

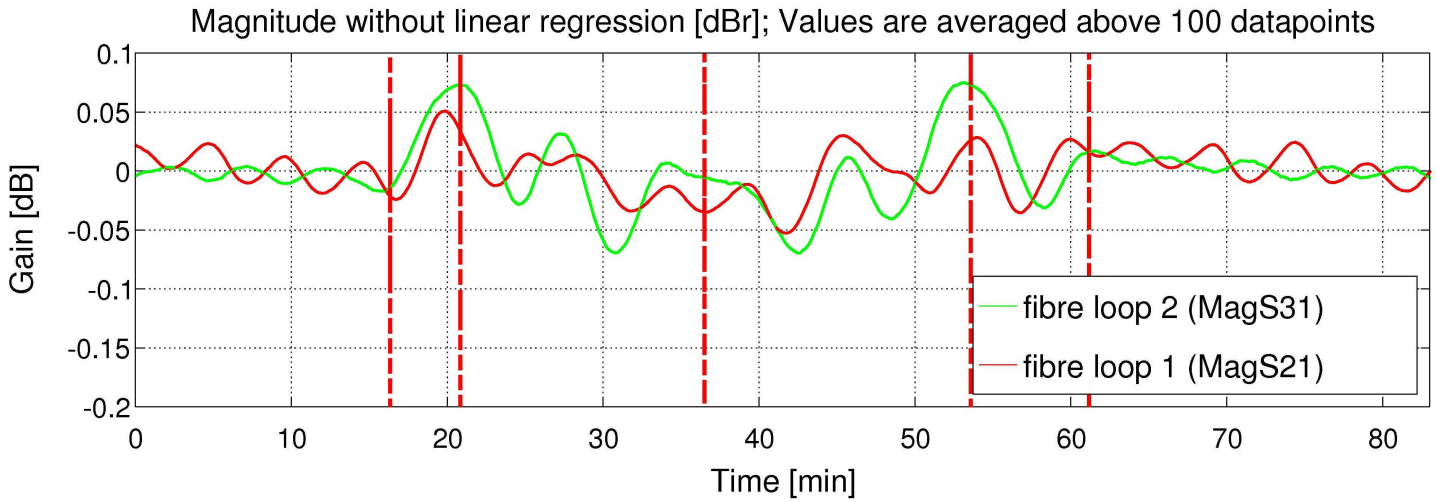


Influences 2: magnitude

- Strong azimuth dependence

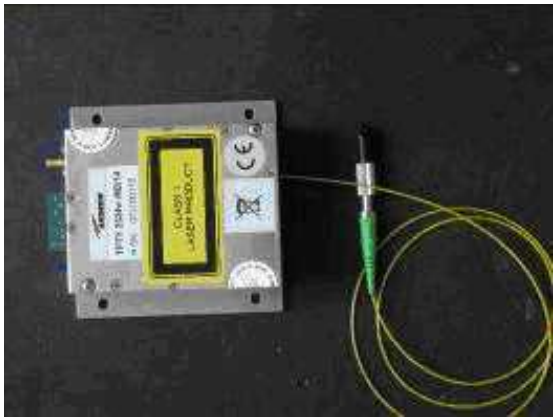


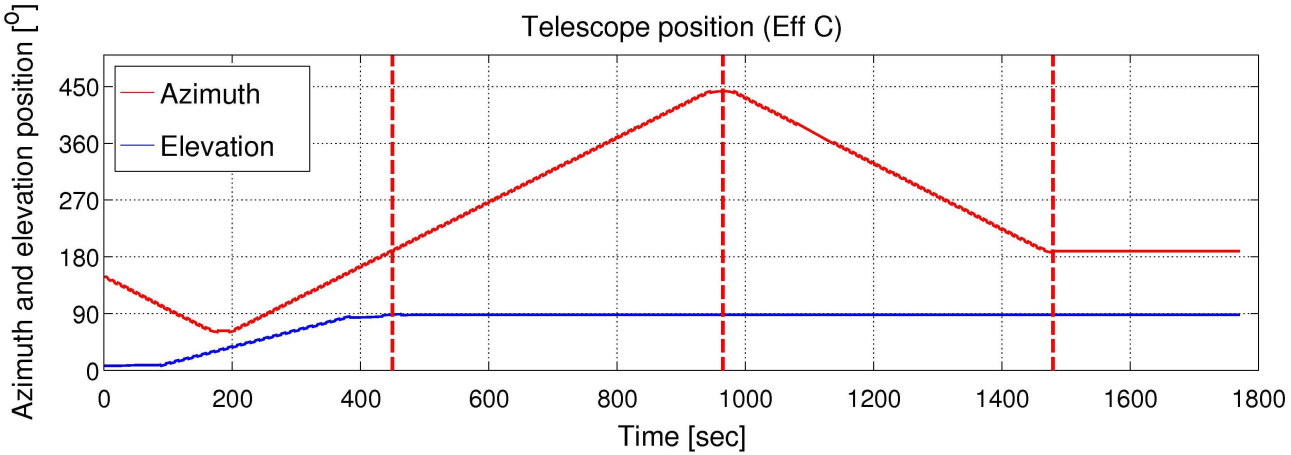
- Symmetrical to azimuth minimum

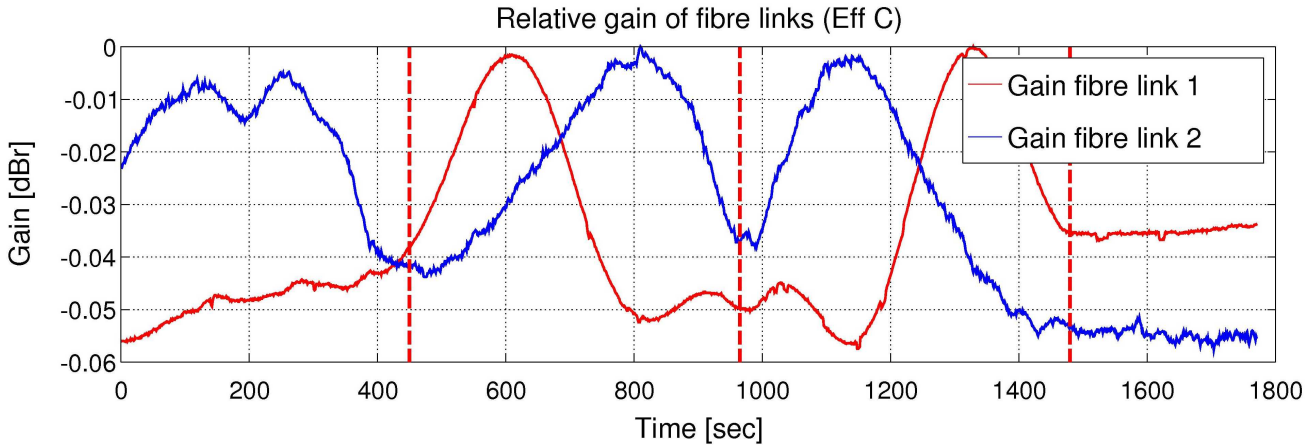


Influences 2: magnitude

Comparison with prior measurements (Andrew fibre optic link)

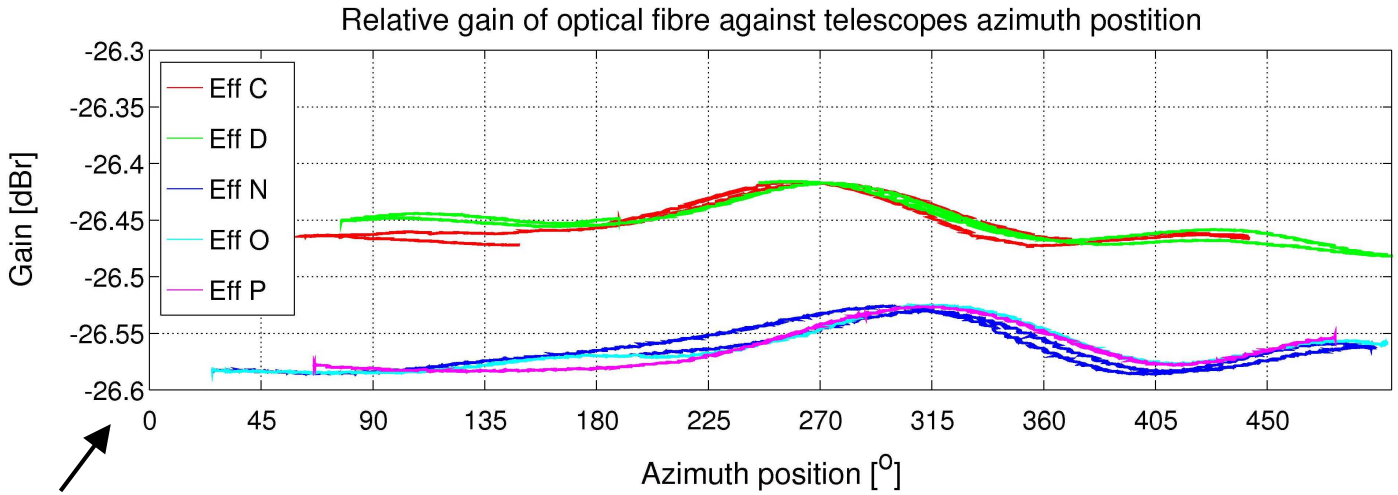






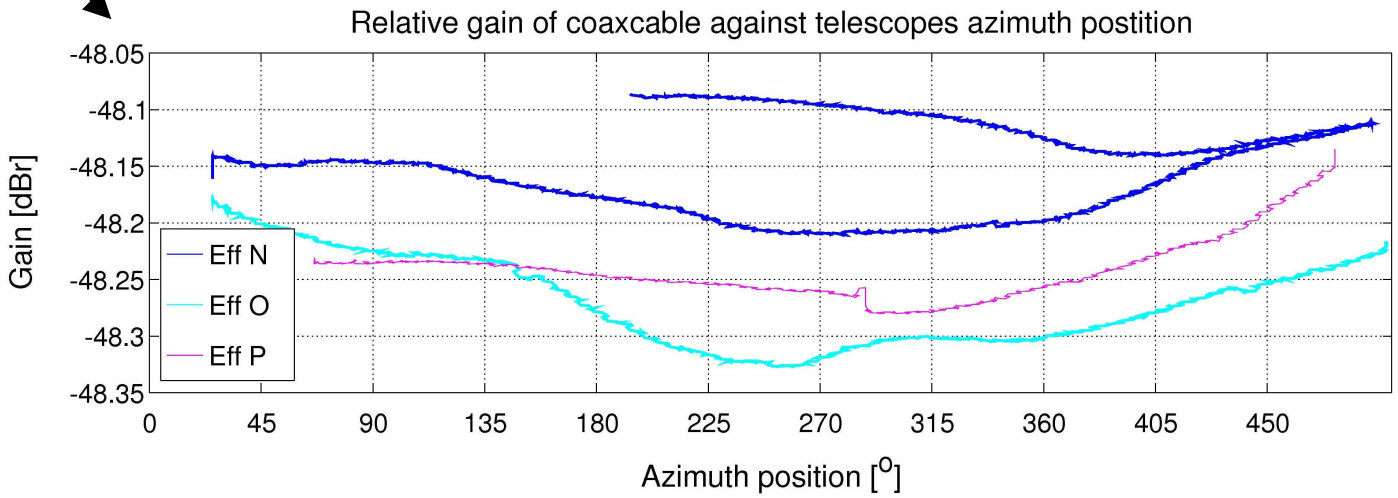
Comparison fibre - coax

Repeatable behavior of fibre links



Same scale

Non repeatable behavior of coaxial cable



Comparison of gain variation

	Gain variation of fibre links during azimuth movement	
	Link 1	Link 2
Miteq link	0.104 dB	0.145 dB
Andrew link	0.057 dB	0.058 dB

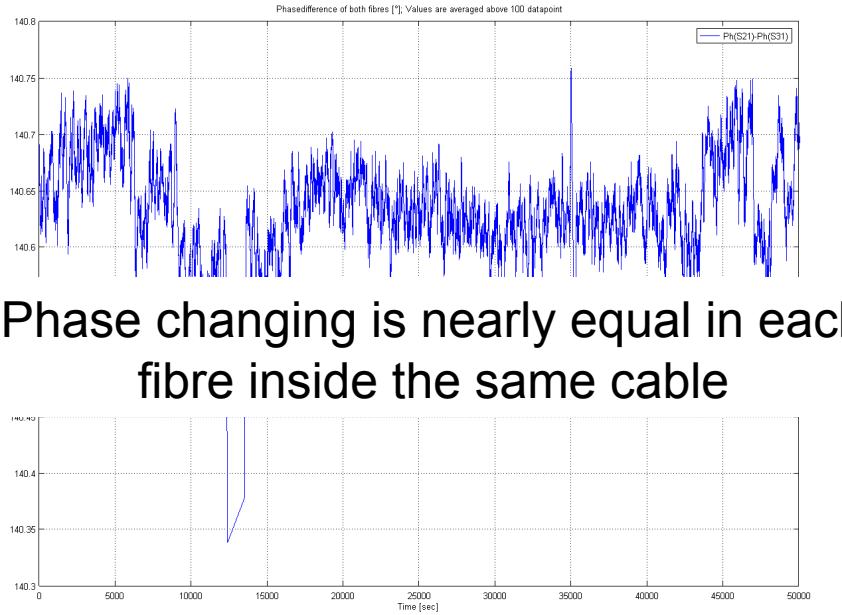
Same measurement setup but Andrew link is twice as good as the Miteq link

→ Variation depends on the modules (laser or photodiode)

Influences: summary

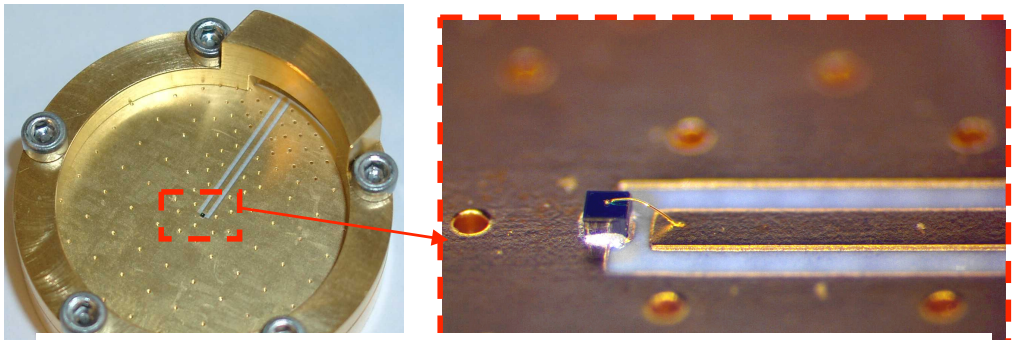
Two main problems:

- Phase of link strongly influenced by temperature (length and refractive index changing of the fibre)



Phase changing is nearly equal in each fibre inside the same cable

- Gain of link depends on telescope azimuth position (possibly due to birefringence of the fibre and a polarisation sensitive photodiode)

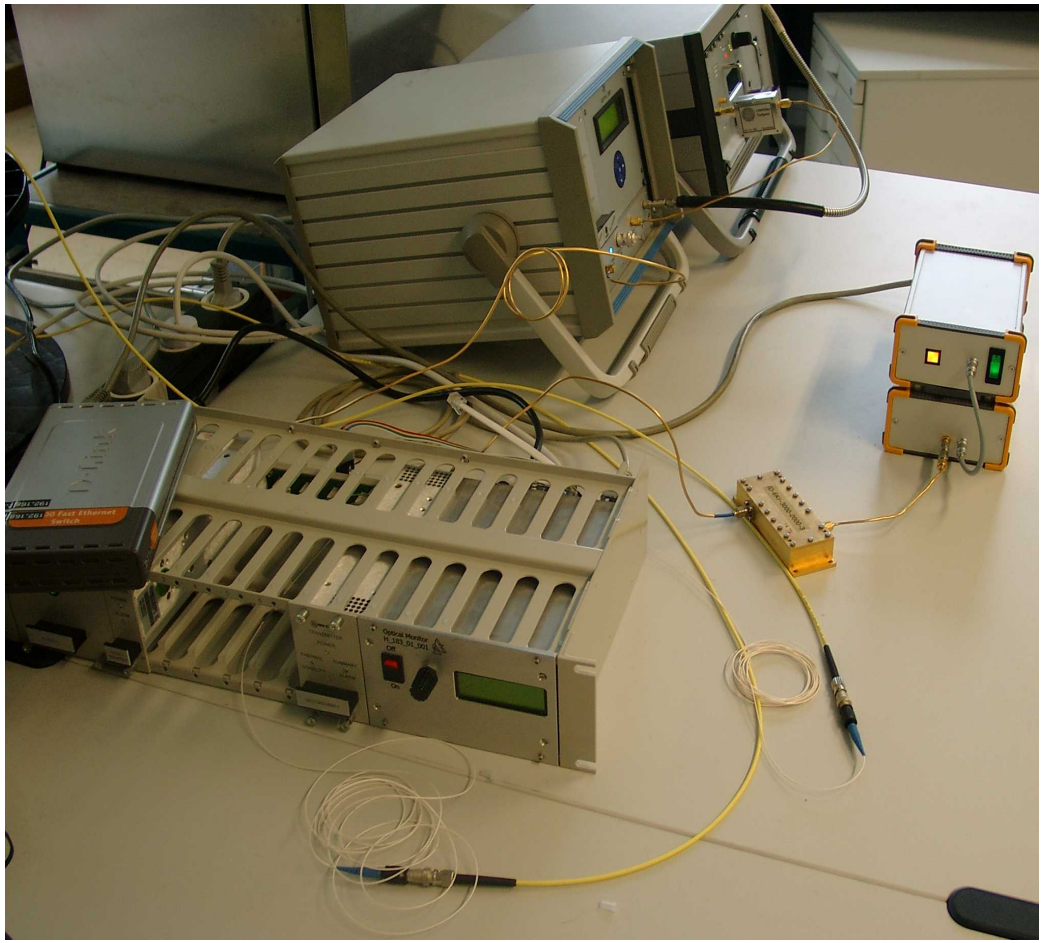


Tests with a planar „butt coupled“ diode

Environmental influences 3

Measurement Setup:

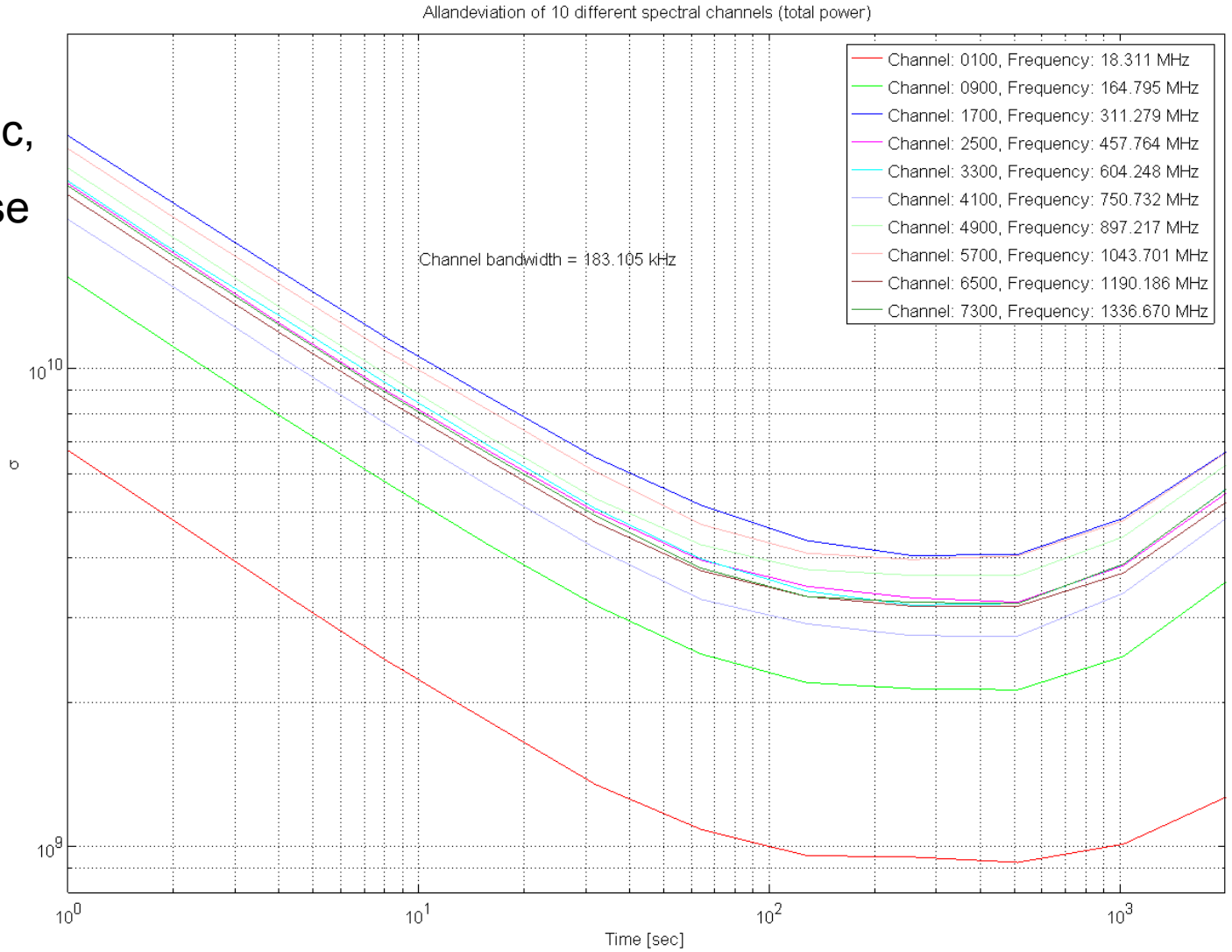
- Broadband noise source
- Fibre optic link (400m)
- IF section
  (2-4 GHz → 0-2 GHz)
- Anti aliasing filter
  (1.5 GHz)
- Digital Spectrometer
  (1.5 GHz at 8192 Channels,
  → 183.105 kHz each Channel)



Allan deviation of Miteq 18GHz

Stability in all channels: ~500 sec,

dominated by noise source



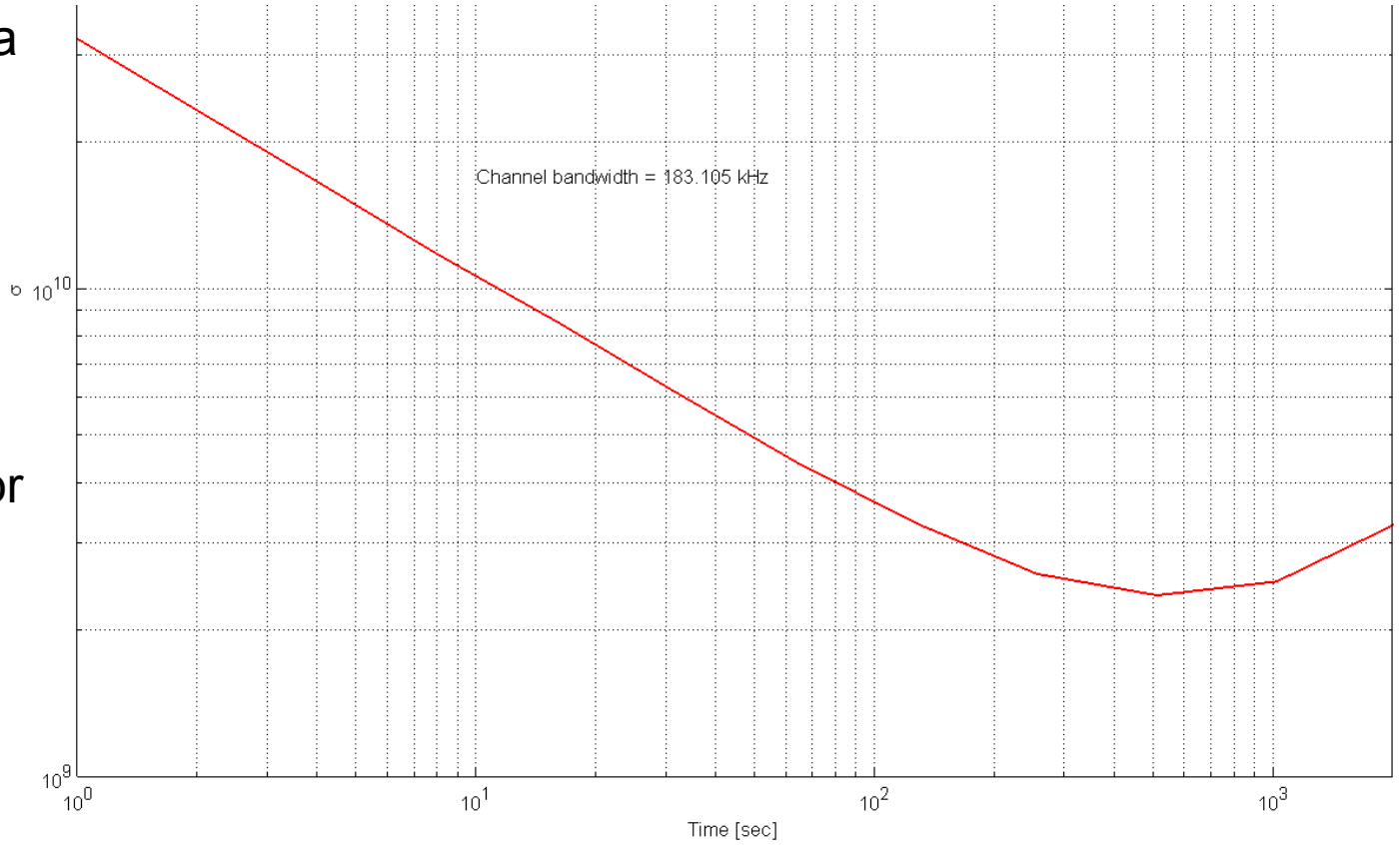
Allan deviation of Miteq 18GHz

Diagram shows allan deviation of

Channel 900 (164.79 MHz) – Channel 6500 (1190.2 MHz)

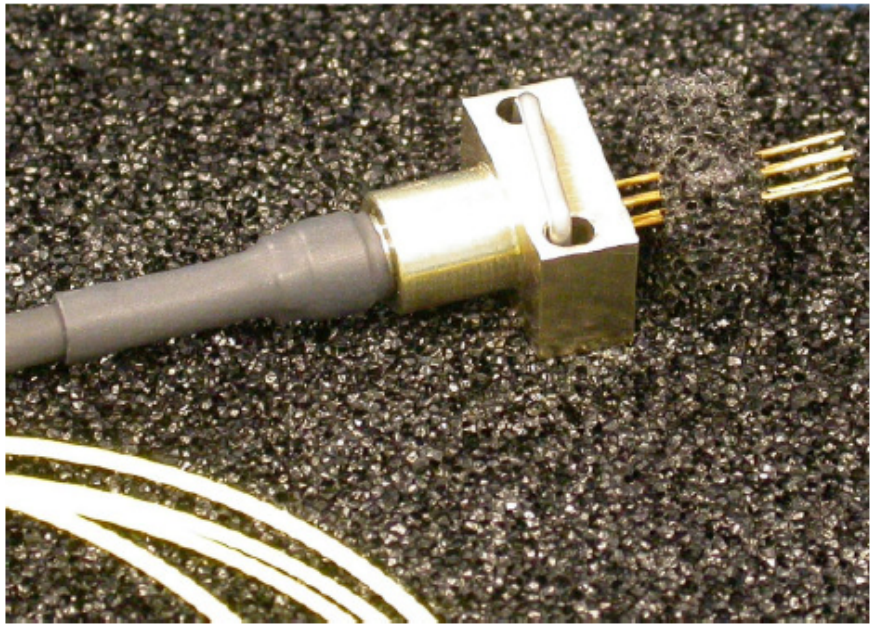
same stability as a single channel (~500 sec)

→ No change in bandpass behavior observable



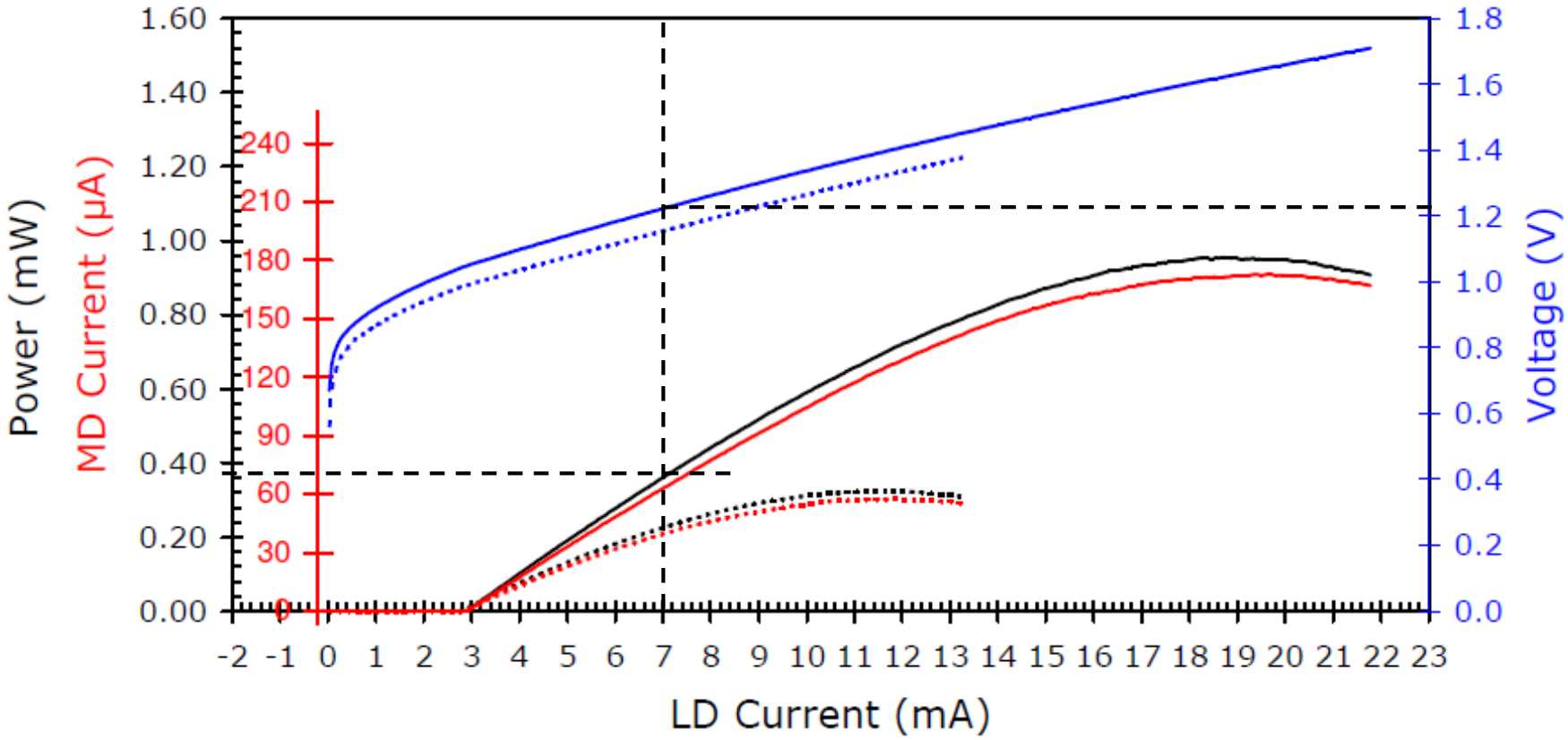
Long Wavelength VCSEL

- 10 GBit/s
- Wavelength:
  1310nm / 1550nm /
  customizeable bzw. tuneable
- Very low threshold current and therefore low power consumption
- P_{out}~ 1 mW



Long Wavelength VCSEL

Example: 1.22 V * 7 mA = 8.54 mW

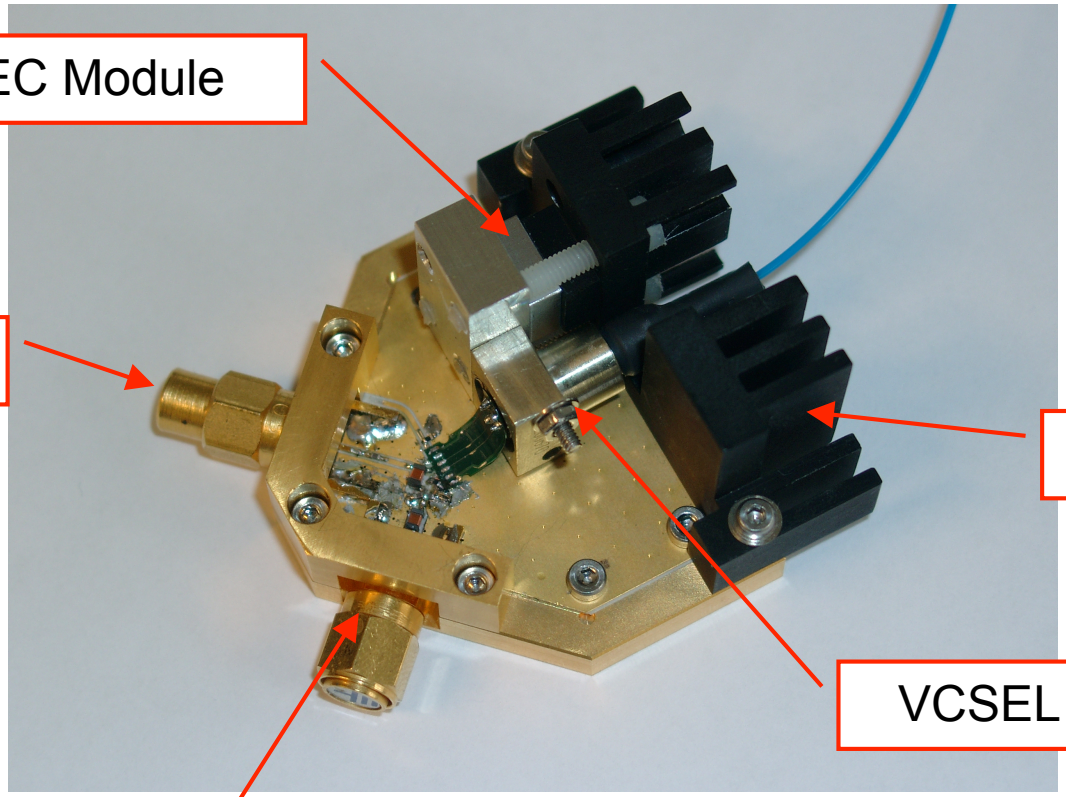


Long Wavelength VCSEL

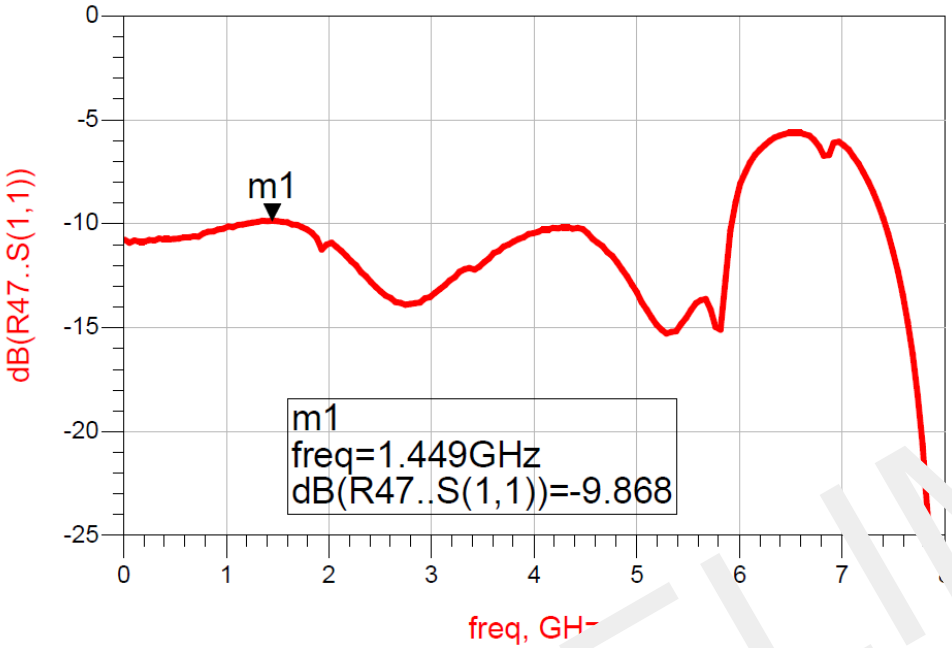
Max-Planck-Institut für Radioastronomie

SEVENTH FRAMEWORK PROGRAMME

Current test implementation of VCSEL diode

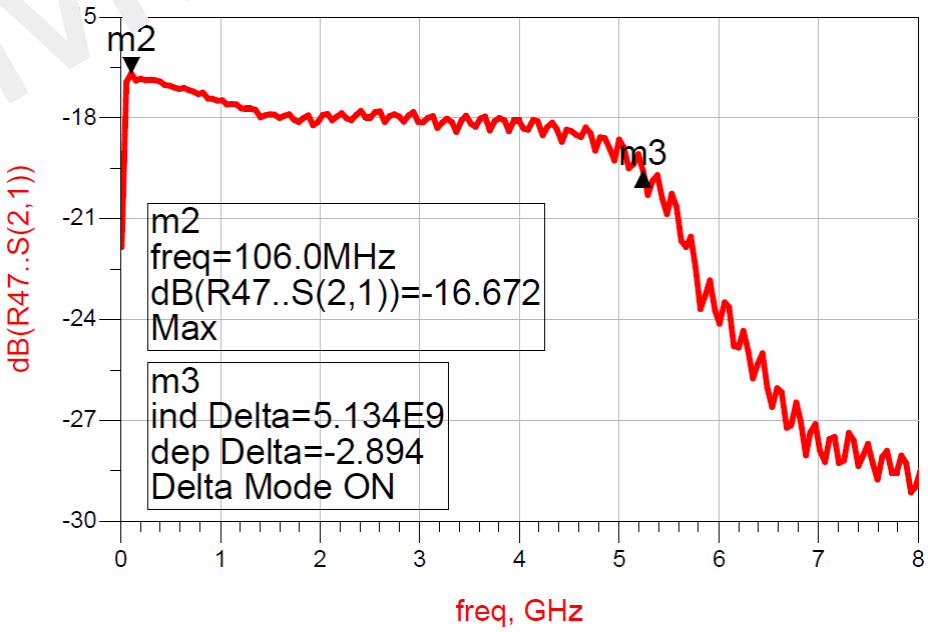


Long Wavelength VCSEL



Good matching (10dB) of input impedance up to 6 GHz with minimum effort

Bandwidth up to 5.1 GHz



Max-Planck-Institut
für Radioastronomie

Summary

SEVENTH FRAMEWORK
PROGRAMME

- Strong dependence of the transmitted signal on phase and gain for coaxial cable and fibre
- All fibres in a single cable behave the same (looking at the phase of the signal)
- Good configuration of photodiode can possibly solve the polarization dependence and therefore the mechanical influence to the signal
- Stability of the analog link is better than the measurement equipment
- Current investigated long wavelength VCSELis able to transmit up to 5.1 GHz analogue bandwidth

Max-Planck-Institut
für Radioastronomie

Questions / Discussion

SEVENTH FRAMEWORK
PROGRAMME