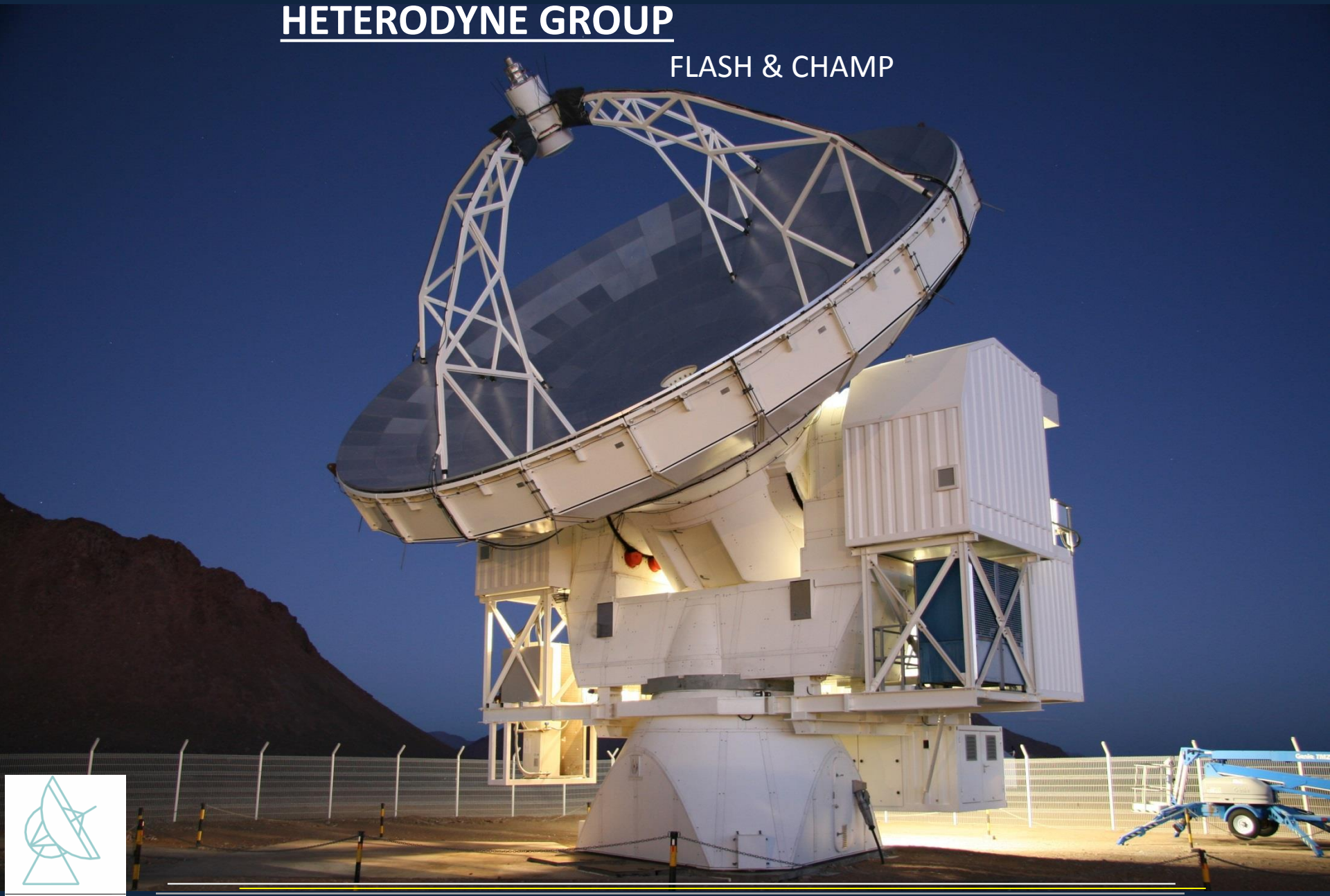
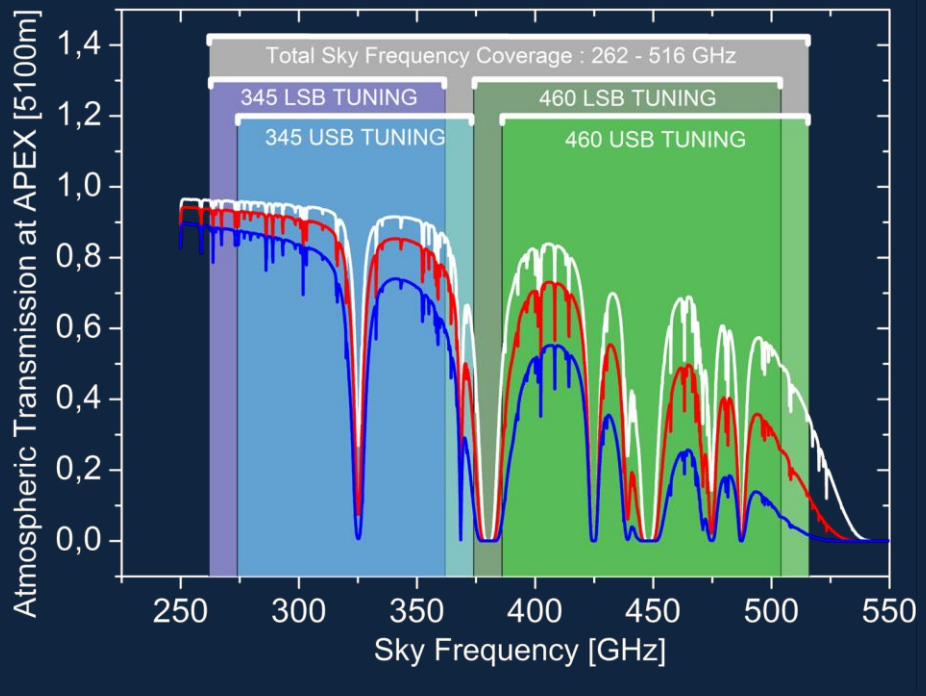
HETERODYNE GROUP

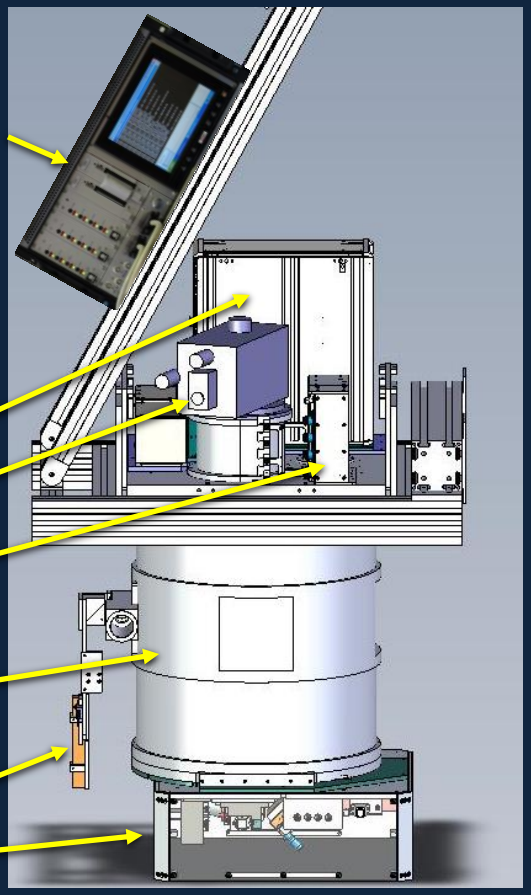
FLASH & CHAMP

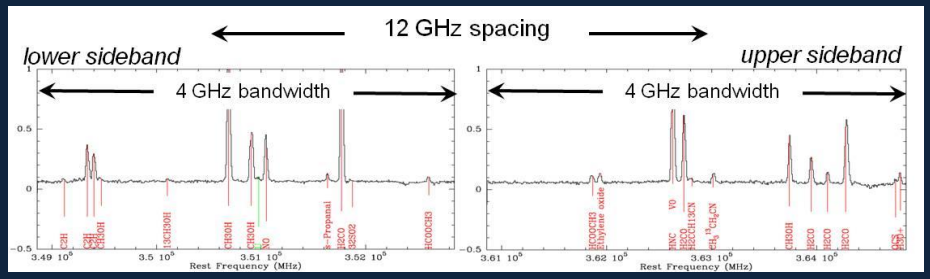


FLASH+ instrument - receiver capabilities

- simultaneous observations at 870µm and 630µm atmospheric windows
- 2SB (sideband separating) state of the art SIS mixer devices [ALMA spin off]
- tuning range 262 – 374 and 374 – 516GHz
- 4-8GHz IF bandwidth per sideband [16GHz total processing bandwidth]
- fast tuning procedures
- full remote operation with no engineering support on site

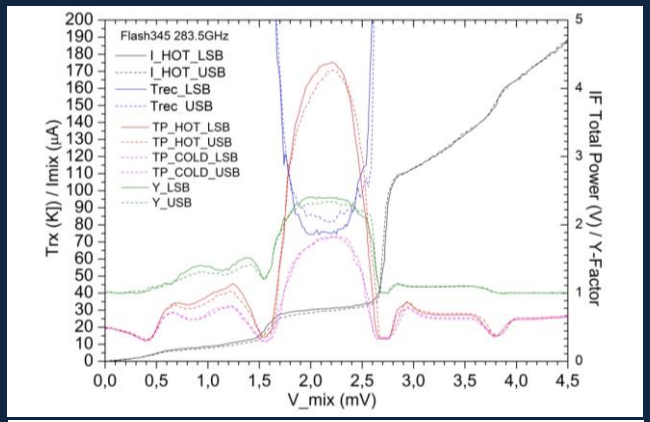


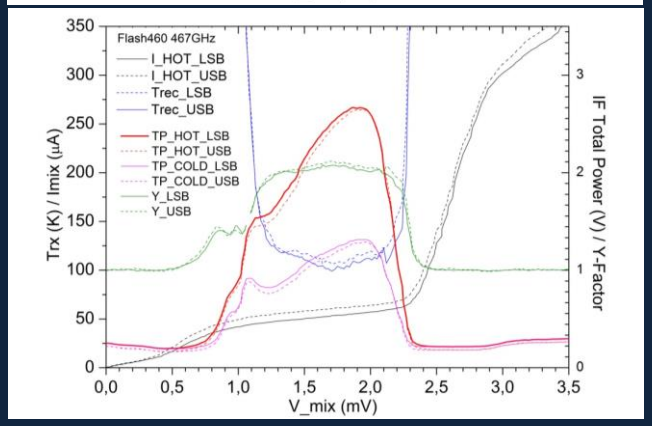




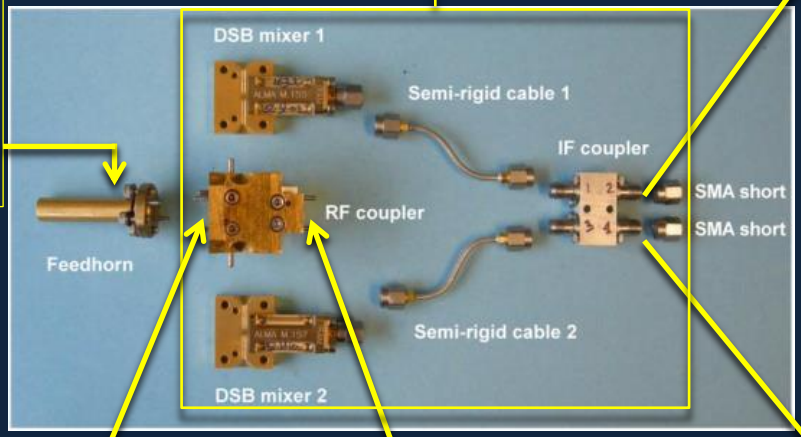
FLASH+ sideband separating mixers

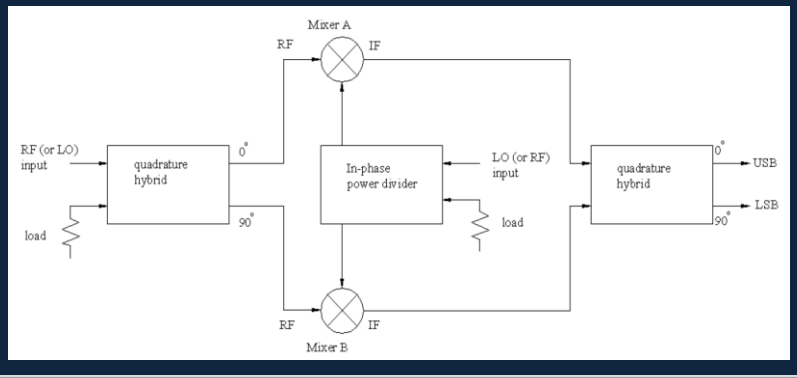
- sideband separating mixers, build up of different components:
  - RF coupler - signal & LO waveguide (!) input
  - 2 SIS DSB mixers
  - IF coupler - generating USB and LSB IF output
  - DC bias feed via IF port
- each sideband fc = 6 GHz with bw=4GHz
- everything x2 (bias, IF processing, ..)

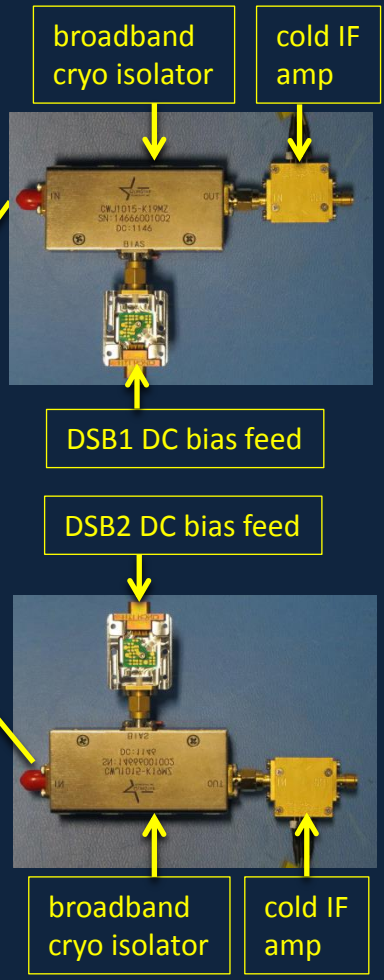




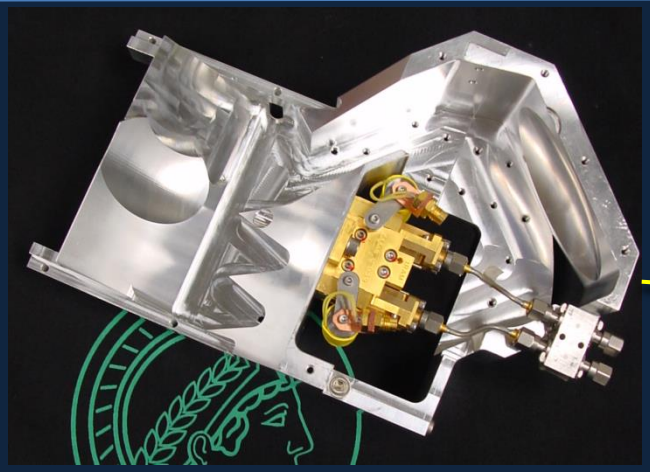
IRAM - ALMA Band VII 2SB mixer assembly



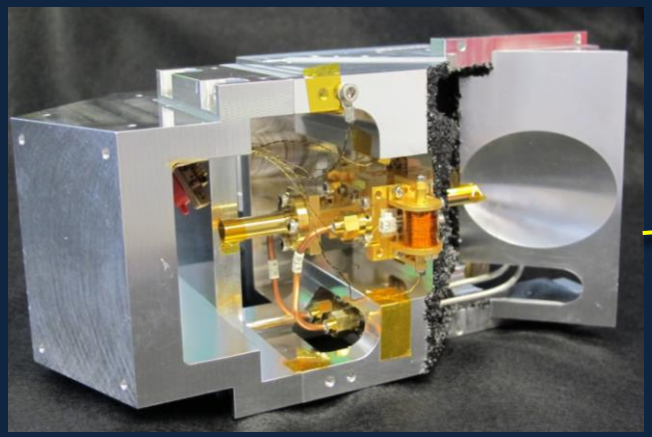




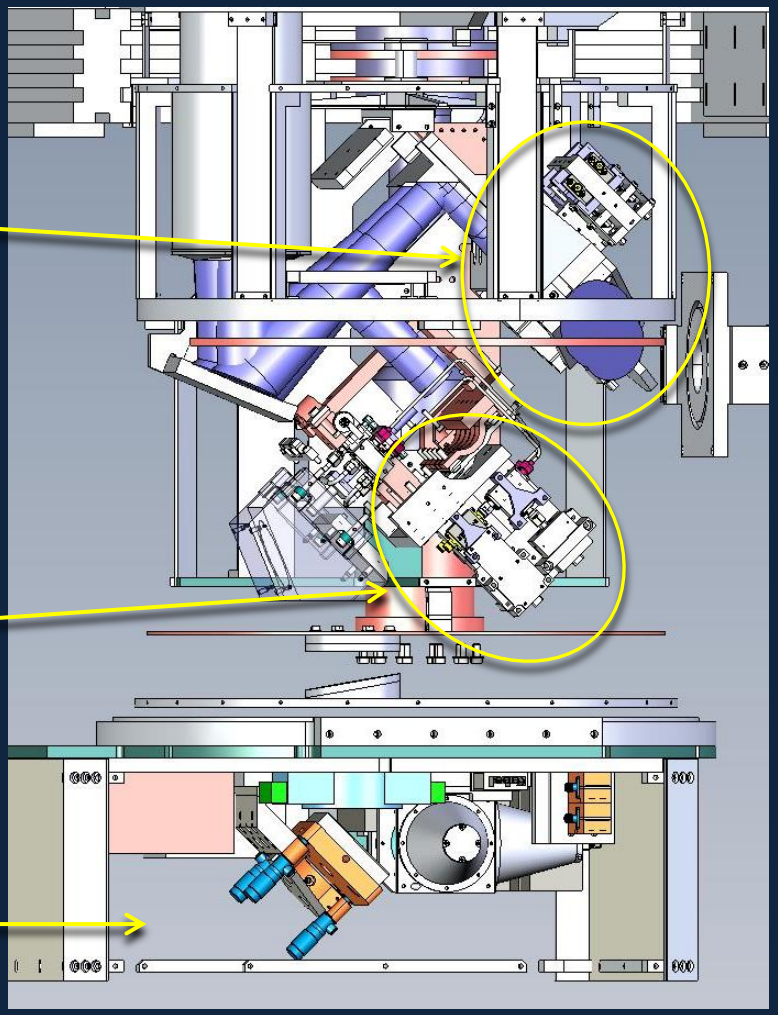
FLASH+ frontend insides

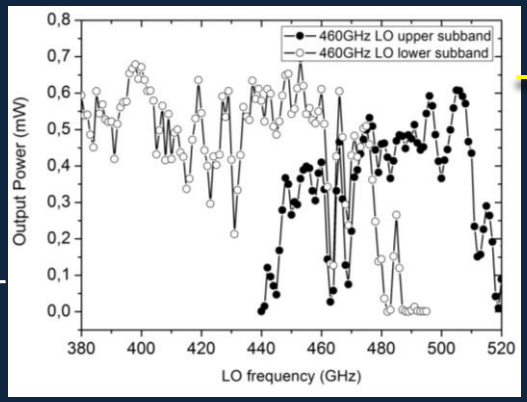


345GHz mixer assembly



460GHz mixer assembly

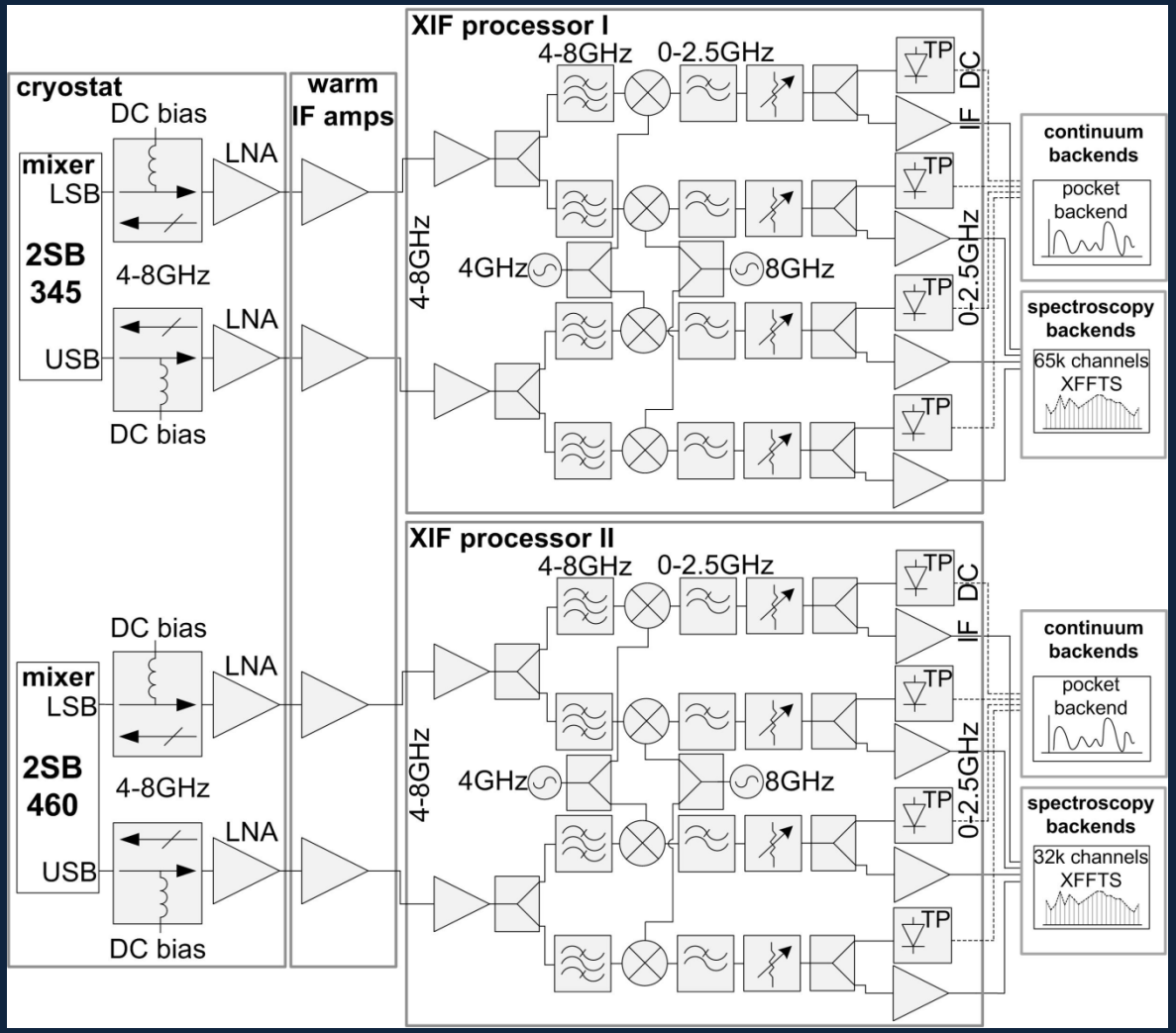




460GHz LO system

- mixer assemblies: containing mixer, optics, IF parts almost monolithically fabricated
- simplifies alignment, integration and maintenance
- 460GHz VDI LO low/high subbands
  LO synthesizers controlled by APECS
  safety reasons --> 460L, 460H

FLASH+ IF scheme



- XIF processors input bandwidth 4-8GHz
- 4 IF sub-bands (345LSB + USB, 460LSB + USB)
- 1 TP detector per chain (continuum measurements: focus scans, pointings) detector bw 2.5GHz
- 2x 2.5GHz XFFTS for each sub-band (1GHz overlap)
- backend resolution 65k channels (2^16)
- backend resolution 32k channels (2^15)

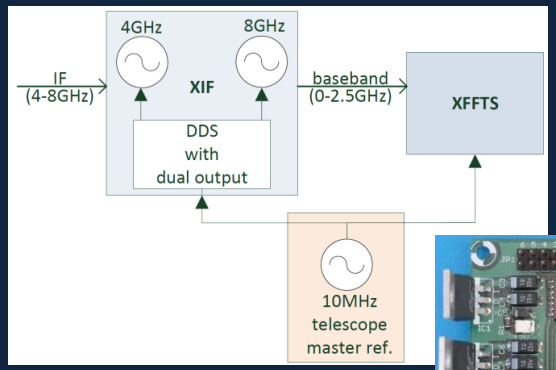
FLASH+ IF processing specialty

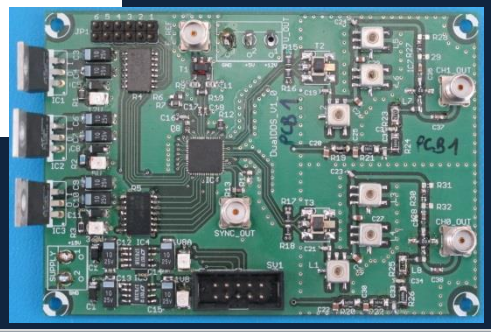
lesson learned during integration tests

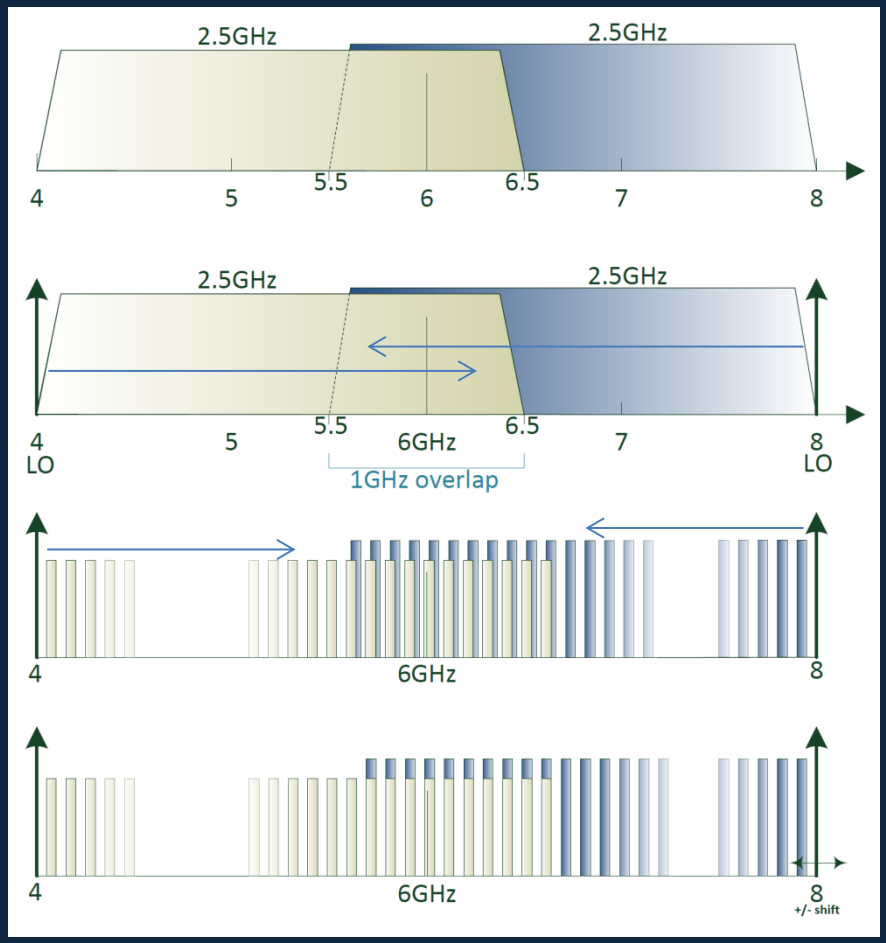
- XFFTS input limitation 0-2.5GHz
- IF split into two XFFTS bands (1GHz overlap)
- requirement for processing the full band (CLASS) channels in overlap range need to be centered on each other

- µwave synthesizers with resolution in Hz regime expensive --> shift on 10MHz reference level

- generation of reference signals for 4 & 8GHz LO by Direct Digital Synthesizer (in-house design)



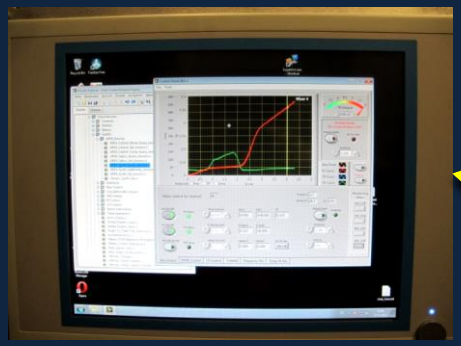


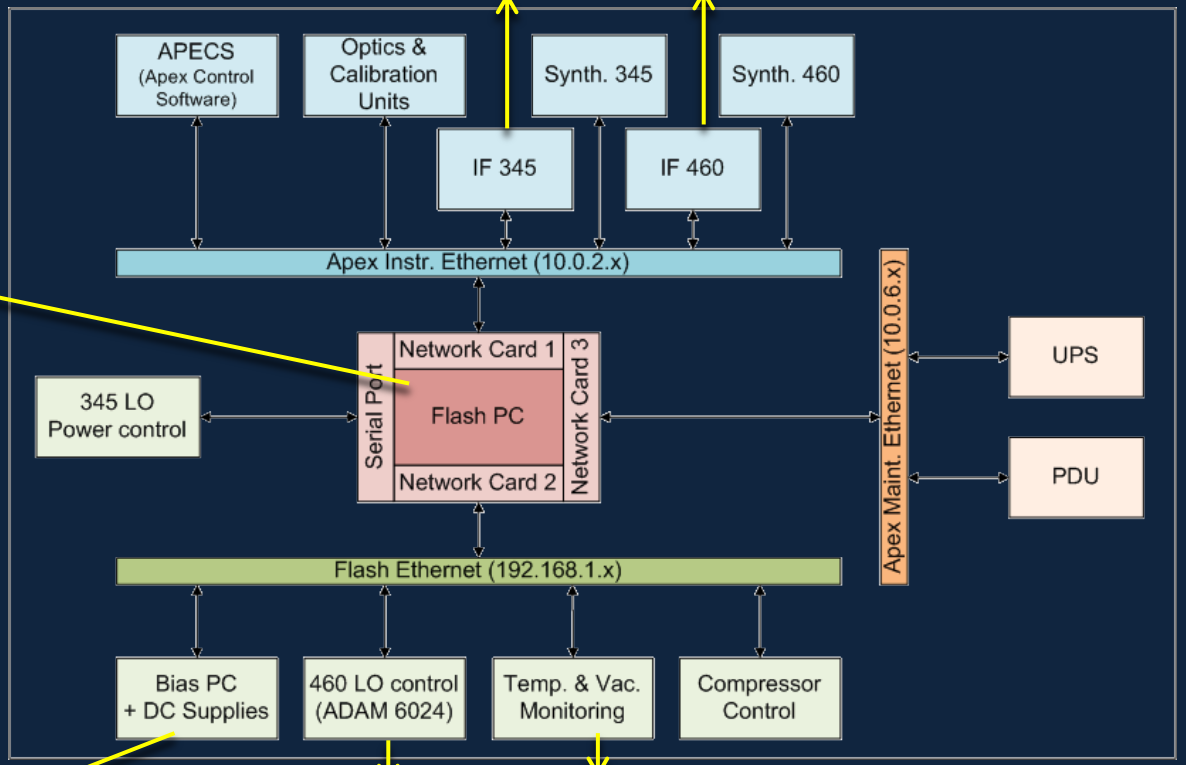


- full signal processing chain needs to be locked to one reference → also XFFTS!

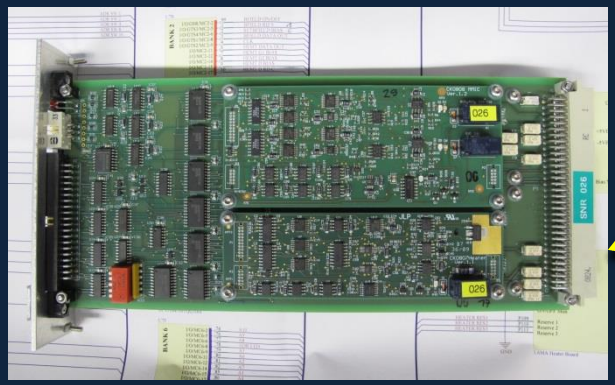
FLASH+ control

- almost fully ethernet based infrastructure
- 100% remote operation
- flexible and modular hardware and software design



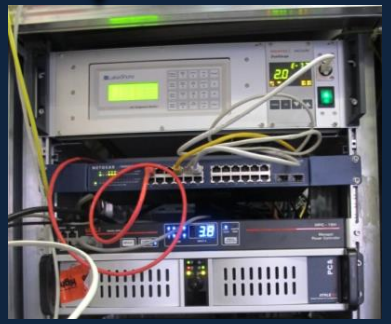


- fully integrated bias supply provides DC bias for one sideband



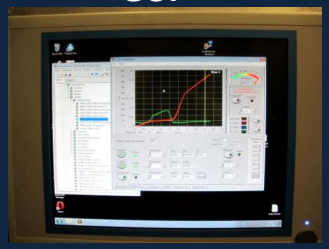
SIS mixer bias
mixer B-Field
mixer heater

2 stage MMIC
>120pps/channel
(IV + TP sweeps)

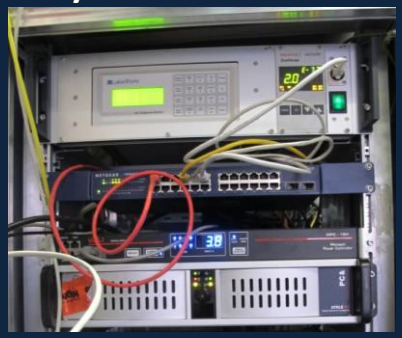


FLASH+ 'distribution' over the telescope

GUI



system electronics



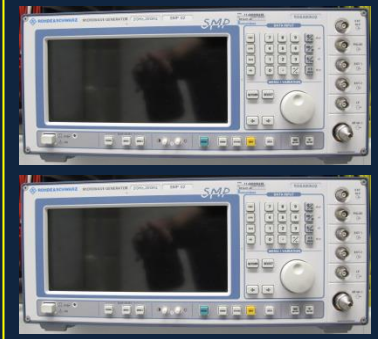
frontend

XIF processors

Nasmyth receiver cabin A

instrument cabin

LO driver synthesizers



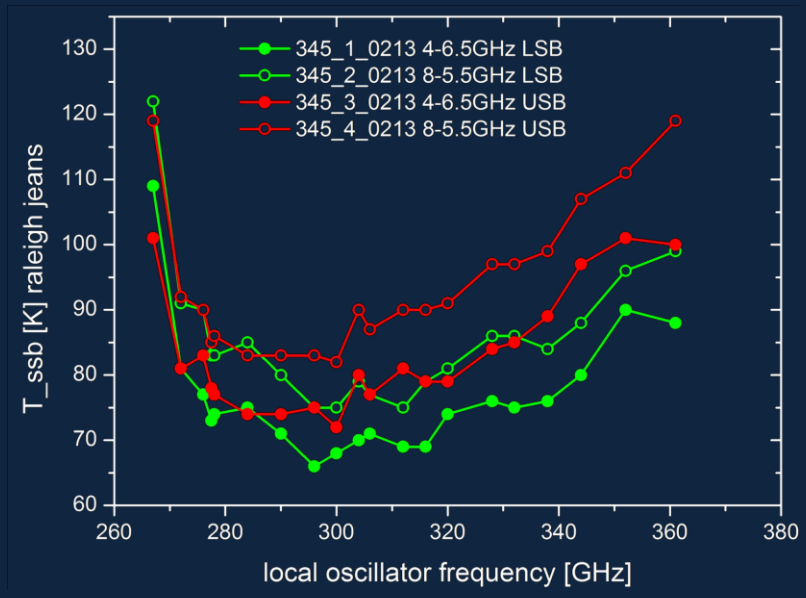
spectroscopy backend

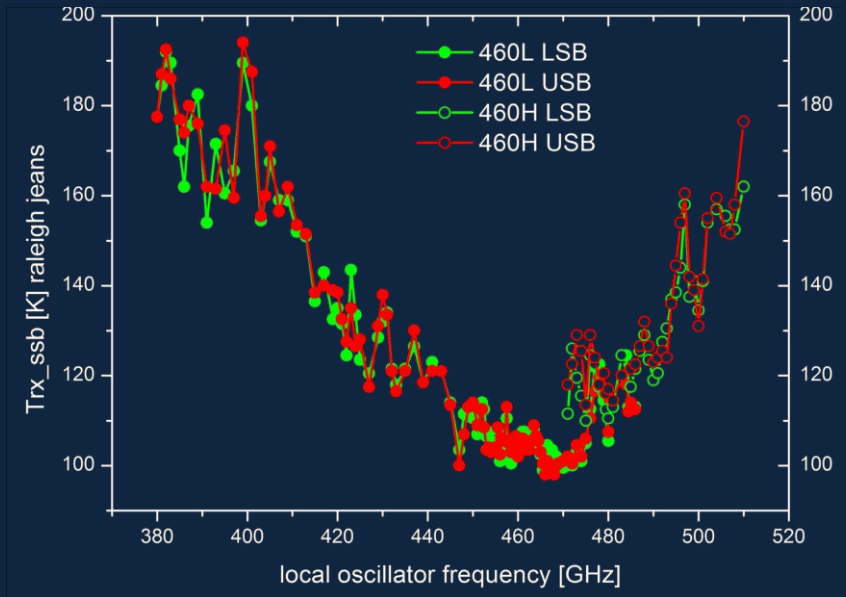
compressor level

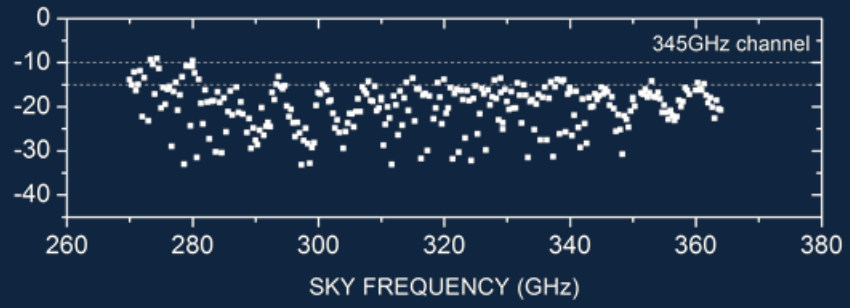
He compressor

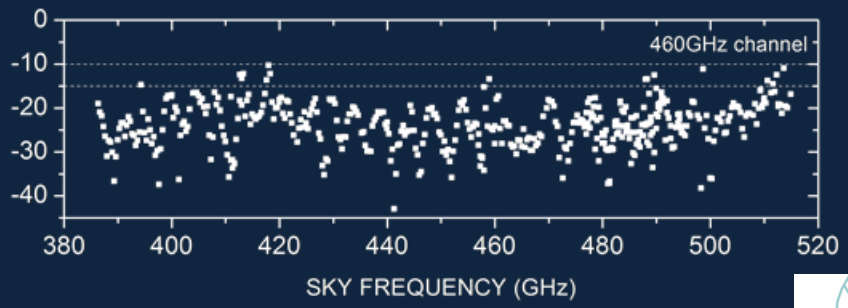
FLASH+ system performance at APEX

- excellent Trx in both receiver channels
- good SSB rejection
- high instrument stability, Allan Variance Time of more than
  >80sec total power and >150sec in spectroscopy mode









CHAMP+

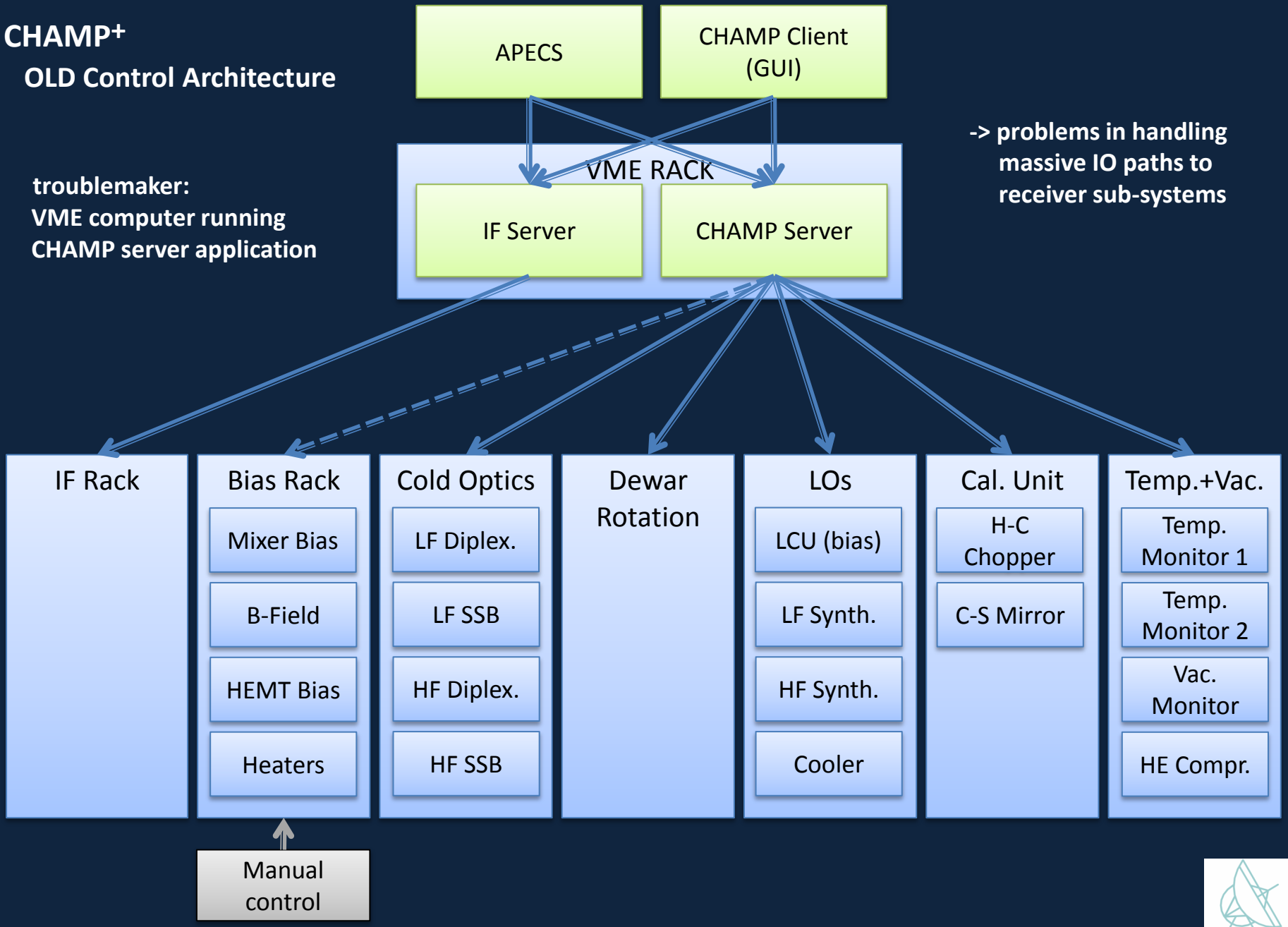
in mid 2013

- **successful refurbishment of receiver control infrastructure**
- **changes on hardware and development of new control software**
- **goals: - improve system stability (operational-wise)**
  - add remote capabilities for diagnostics and maintenance
  - base for further upgrades

CHAMP+

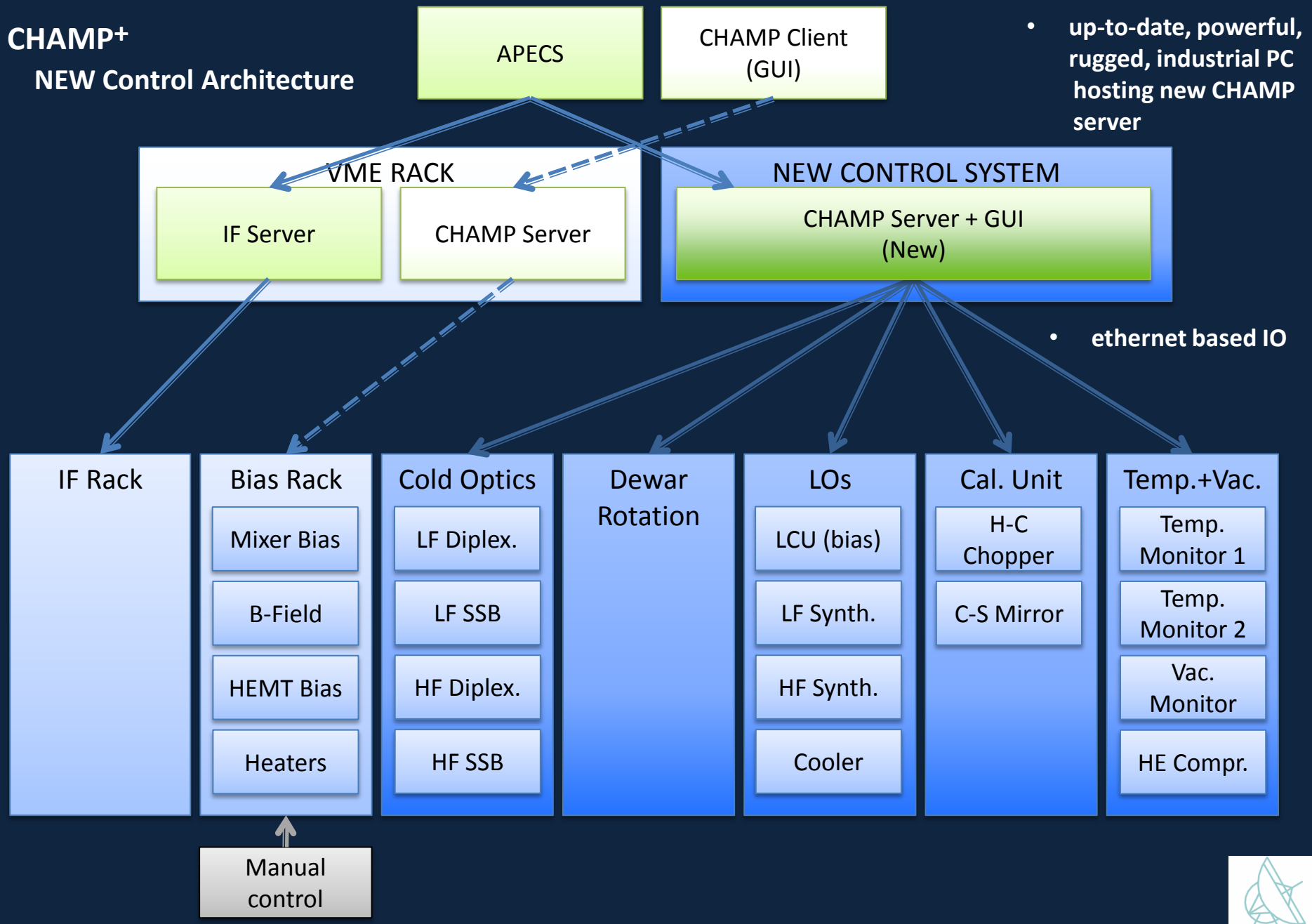
OLD Control Architecture

- troublemaker:
  VME computer running
  CHAMP server application



CHAMP+

NEW Control Architecture



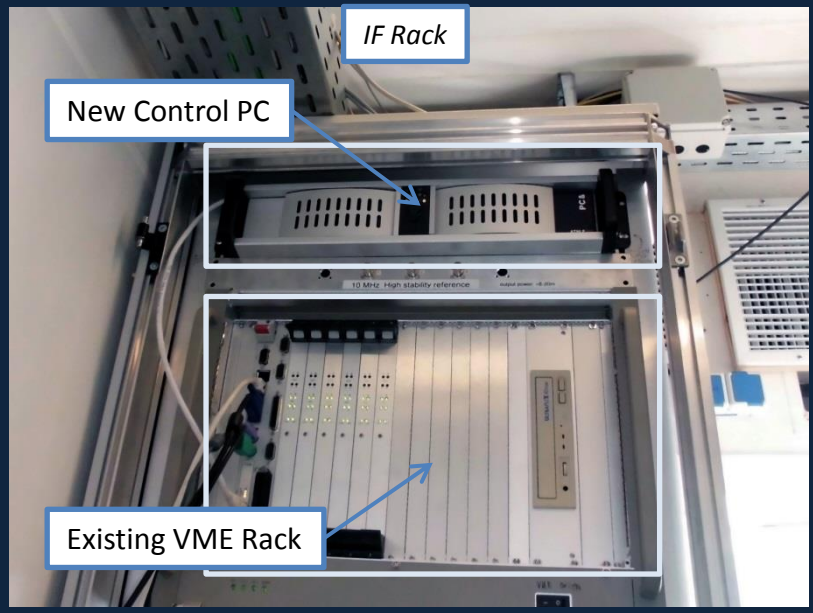
- up-to-date, powerful, rugged, industrial PC hosting new CHAMP server
- ethernet based IO

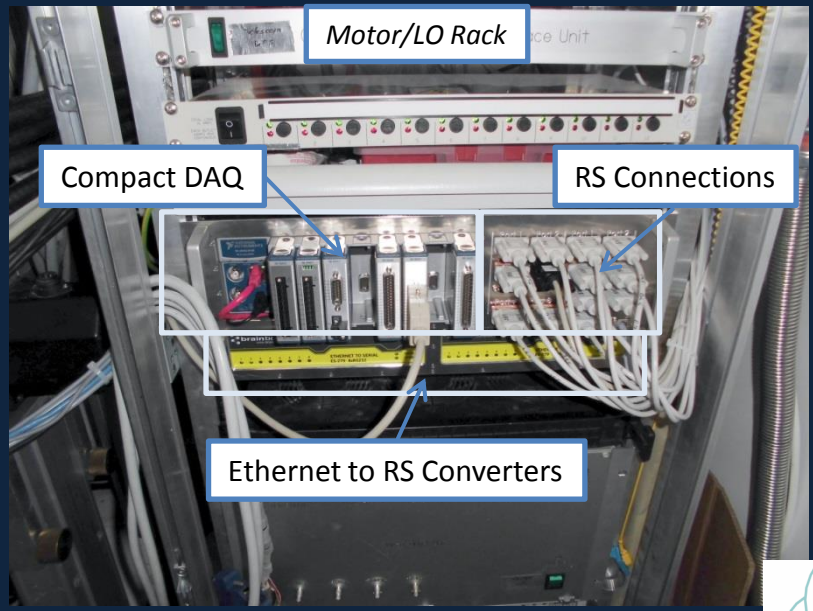
Hardware Changes:

- New Ethernet-based internal system architecture (as used for FLASH+)
- VME PC replaced by a modern Industry Standard, Intel i5-based Rack PC (as used for FLASH+)
- VME Analog/Digital IO modules replaced by a National Instruments Ethernet based compact-DAQ system
- VME serial communication cards replaced by BrainBoxes multiport Ethernet to Serial converters
- New dewar rotation encoder (RS-compatible)

NOTE:

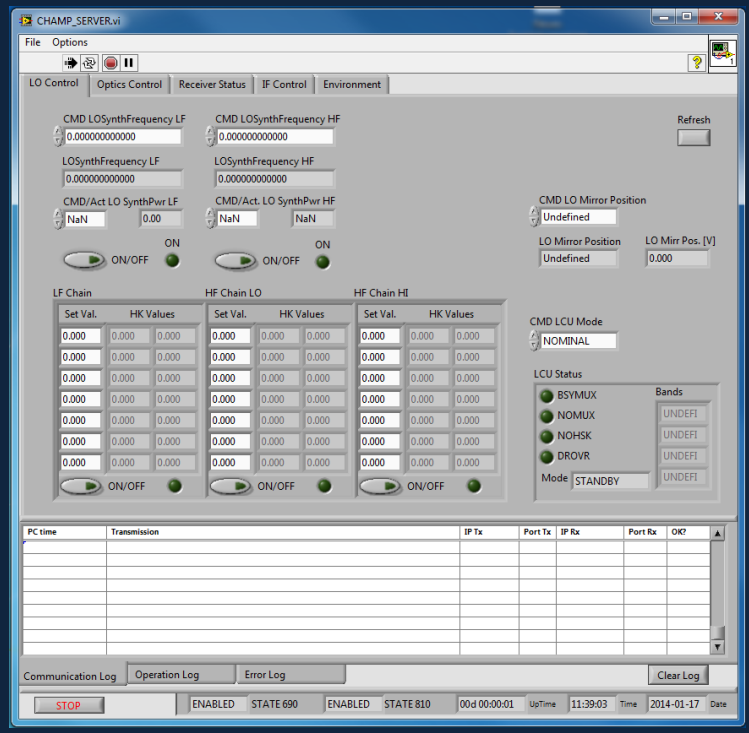
- *IF control not changed, IF rack still controlled over IF server on the VME PC!*
- *Front end bias control not changed, still set by hand or using the old Client/Server configuration!*

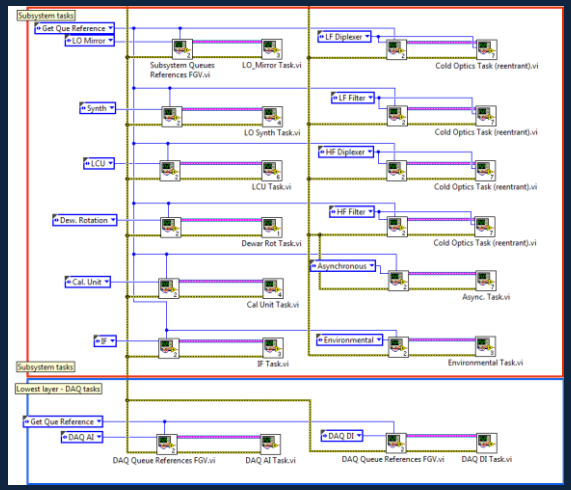




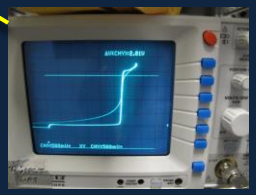
Software Changes:

- Completely new LabView-based server software
  → ability to modify/debug almost “on-the-fly“
- Server and GUI in one single application
- Multitasking and multithreading operation for better performance
  → simultaneous execution of tasks on diffrent subunits of the receiver, faster user interface response
- Comprehensive logging capabilities (separate logs for operations, APECS communication and errors)
  → easier debugging and thus faster improvements
- Implementation of a simple IF control based on the communication with the old IF server
- Testing and implementation of further functionality in progress



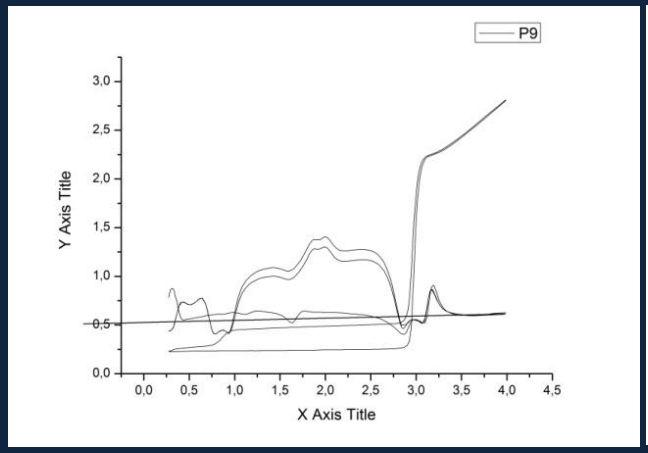


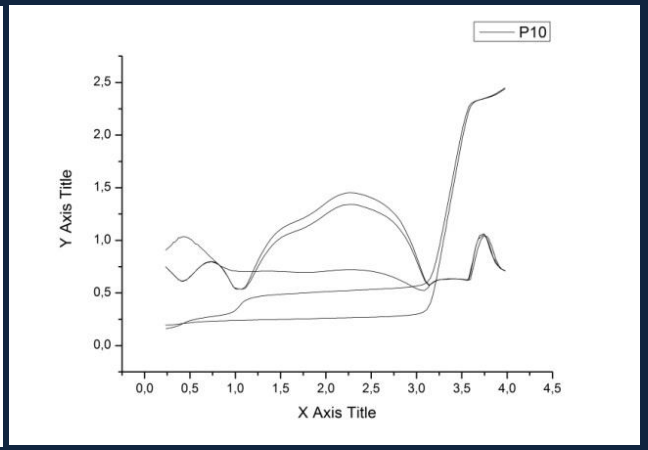
CHAMP+



LFA 625 – 720 GHz 4.6 – 7.4 GHz IF 16k Trx_ssb 400-500K
HFA 780 – 950 GHz 4.6 – 7.4 GHz IF 16k Trx_ssb 900 – 1800K

oscilloscope for tp and IV trace for one mixer





CHAMP+

- things that should belong to the past:
  - -checking the vitality of the ‚chamserver' task
  - -power cycling of the VME computer in the B-cabin
  - -error message in APECS: G2I too high!
    (old recommendation: repeat tuning
    change tuning to an adjacent frequency
    then return to the nominal frequency
    report the frequency)

    → should be eliminated due to a more sophisticated tuning algorithm

- tunings especially when switching LO bands (800 to 900 LO) take time!
  ramping down and up of the LOs, moving mirrors, setting diplexer and ssb filter……

  → please be patient, don`t cancel the tuning after a view seconds