Status of GGAO and Westford VGOS Stations

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Overview

- VGOS in one slide
- Hardware status
  - Overall signal chain
  - Feeds / frontends
- Recent measurements
- Future enhancements
  - Field System support
  - Wider up/down converter frequency range
  - Cable delay measurement system

VGOS = VLBI Geodetic Observing System

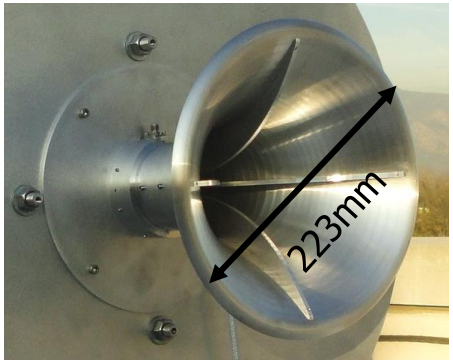
- Primary technical goal
  - 1-mm position accuracy in 24 hours
- Limiting error sources
  - Variable atmospheric delay
  - Sensitivity
- Strategy
  - Use fast-slewing (5°/s - 12°/s) antennas
  - Reduce delay error through high data rate and wide spanned BW (broadband delay)
- Implementation specifics
  - Antennas of ≥12m diameter
  - Data rates ≥8 Gbps using 4 dual-pol bands of 0.5-1.0 GHz BW each
  - Bands spaced over 2.2 GHz to ~14 GHz

VGOS Signal Chain at GGAO and Westford

- Cryogenically cooled broadband QRFH (Quadruple-Ridged Flared Horn) feed
  - 2 linear-polarization coaxial outputs
  - Designed by Ahmed Akgiray (Caltech)
- Cryogenically cooled LNAs (Caltech CRYO1-12), 1 per polarization
- Pulse cal (5 MHz rep rate) and noise cal injection between feed and LNAs
- RF separated into low (coax or fiber downlink) and high (fiber) frequency bands
- Four up/down converters (UDCs)
- Four RDBE-H backends with 3.0 firmware
  - 1024 MHz sample clock
  - Two 512-MHz inputs (two polarizations)
  - Complex samples
  - Output = sixteen 32-MHz-BW PFB channels (8 dual-pol or 16 single-pol)
  - Pulse cal tone extraction
  - 10-100 Hz noise cal synchronous detection
- One Mark 6 recorder

GGAO antenna/feed

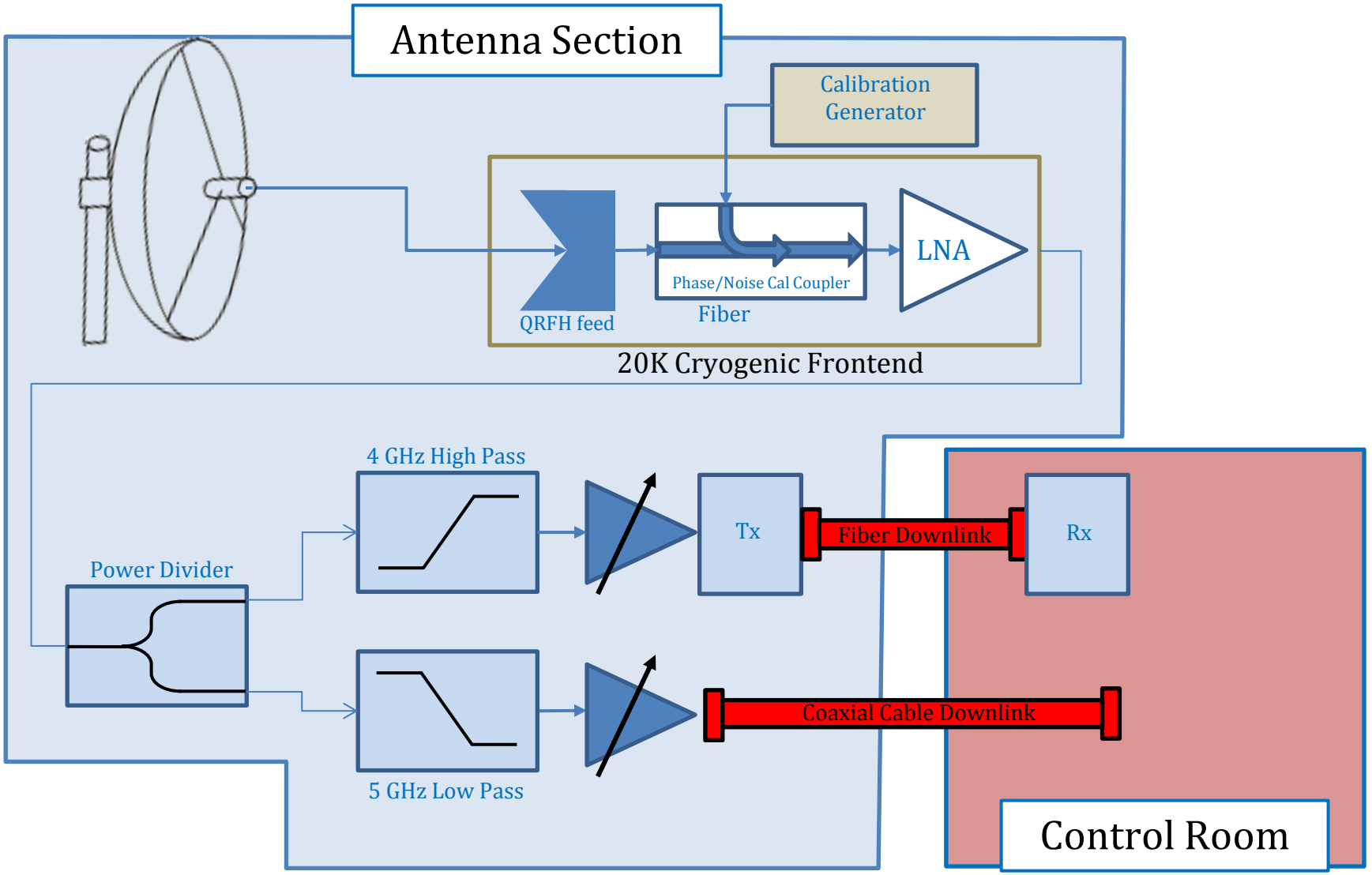
- 12 m diameter antenna
  - Cassegrain optics
  - Shaped reflectors
  - 50° feed optical half angle



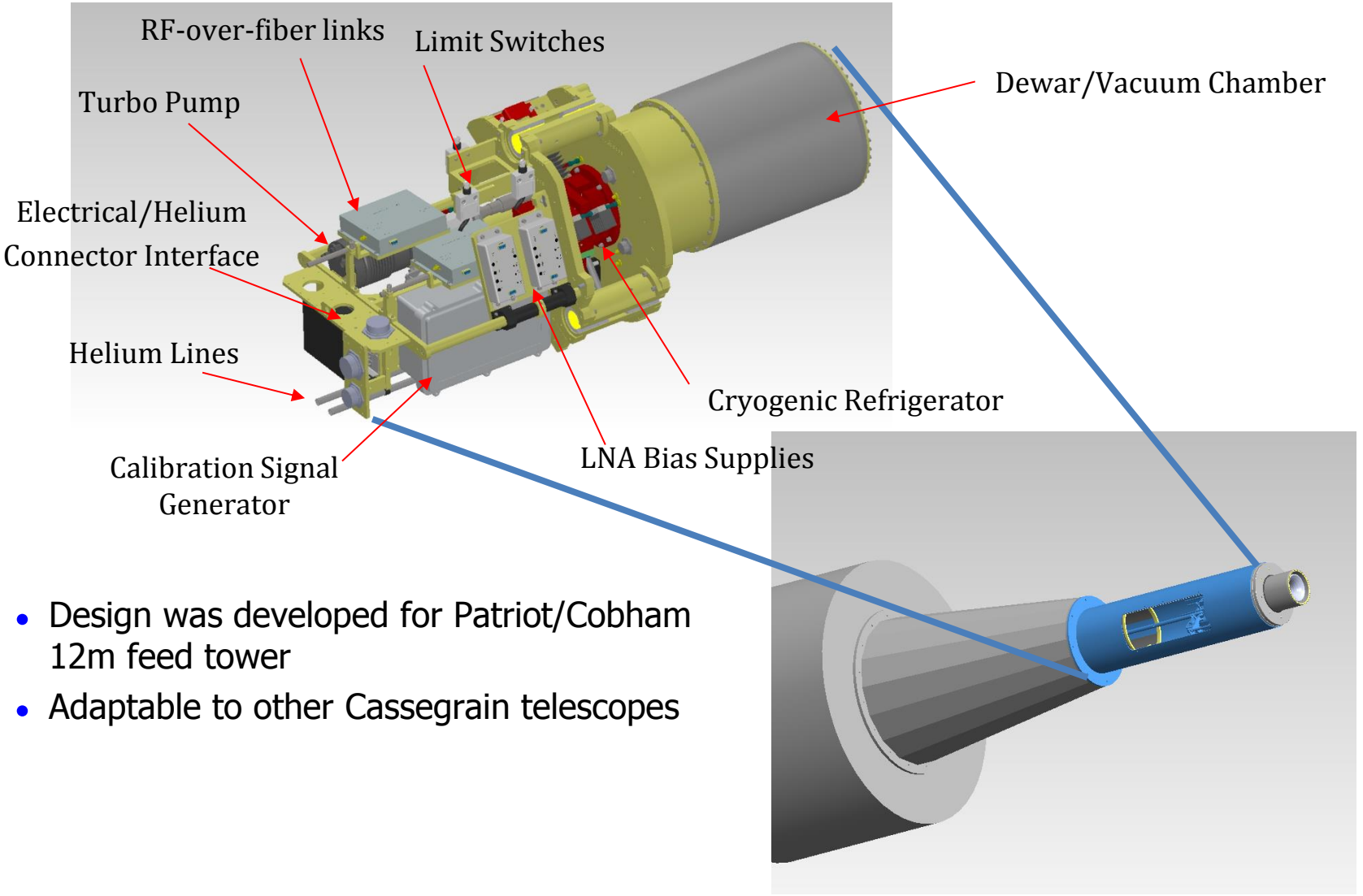
- QRFH feed
  - Optimized for
    - 12m optics
    - 2-12 GHz

GGAO receiver design

2 overlapping bands

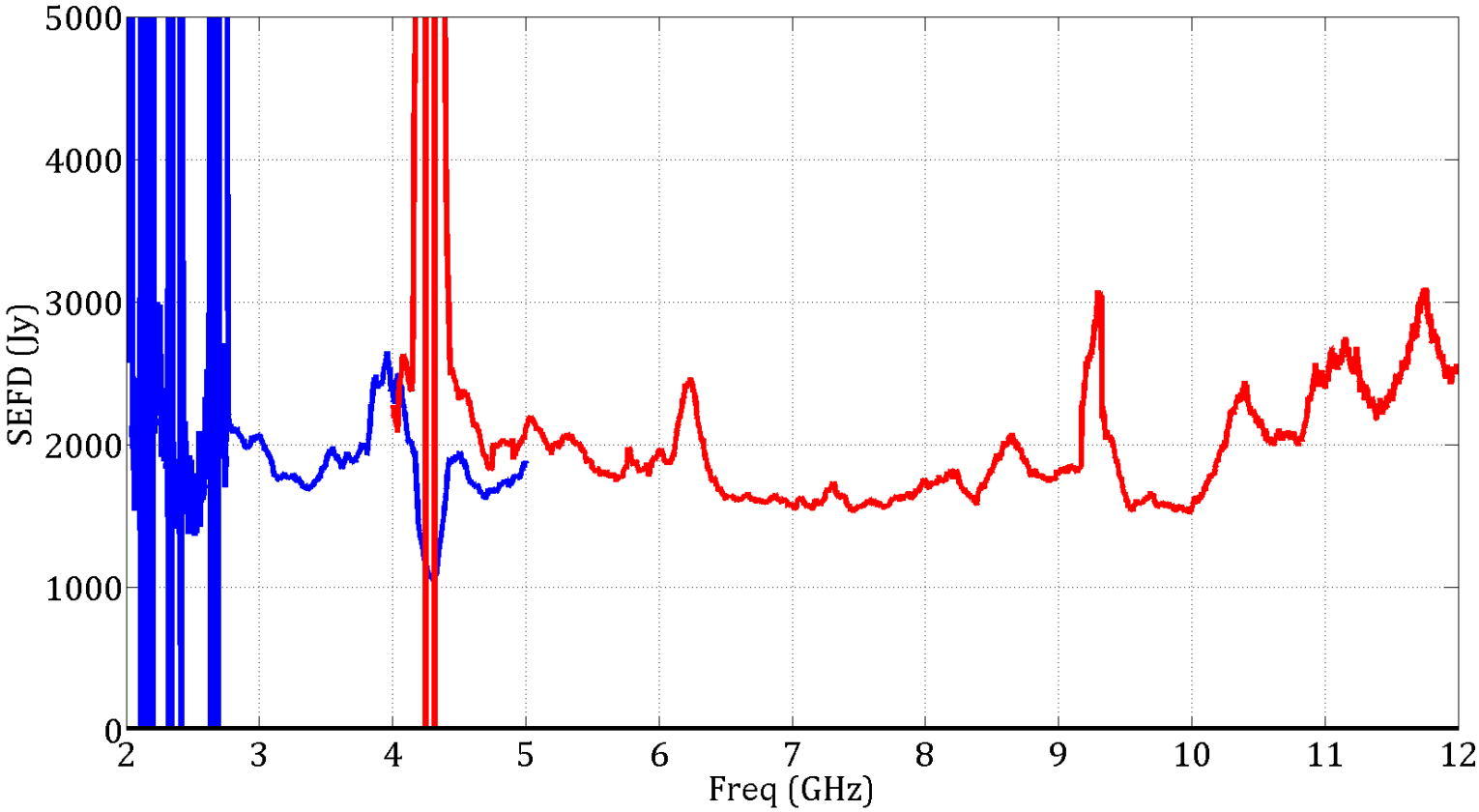


GGAO frontend mechanical design



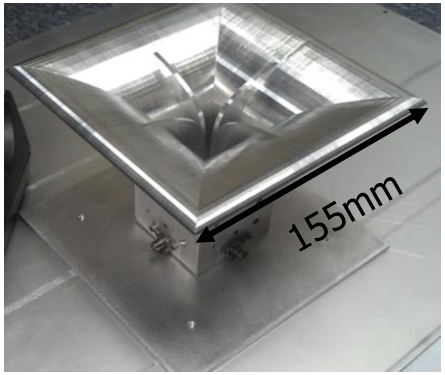
- Design was developed for Patriot/Cobham 12m feed tower
- Adaptable to other Cassegrain telescopes

GGAO SEFD



Westford antenna/feed

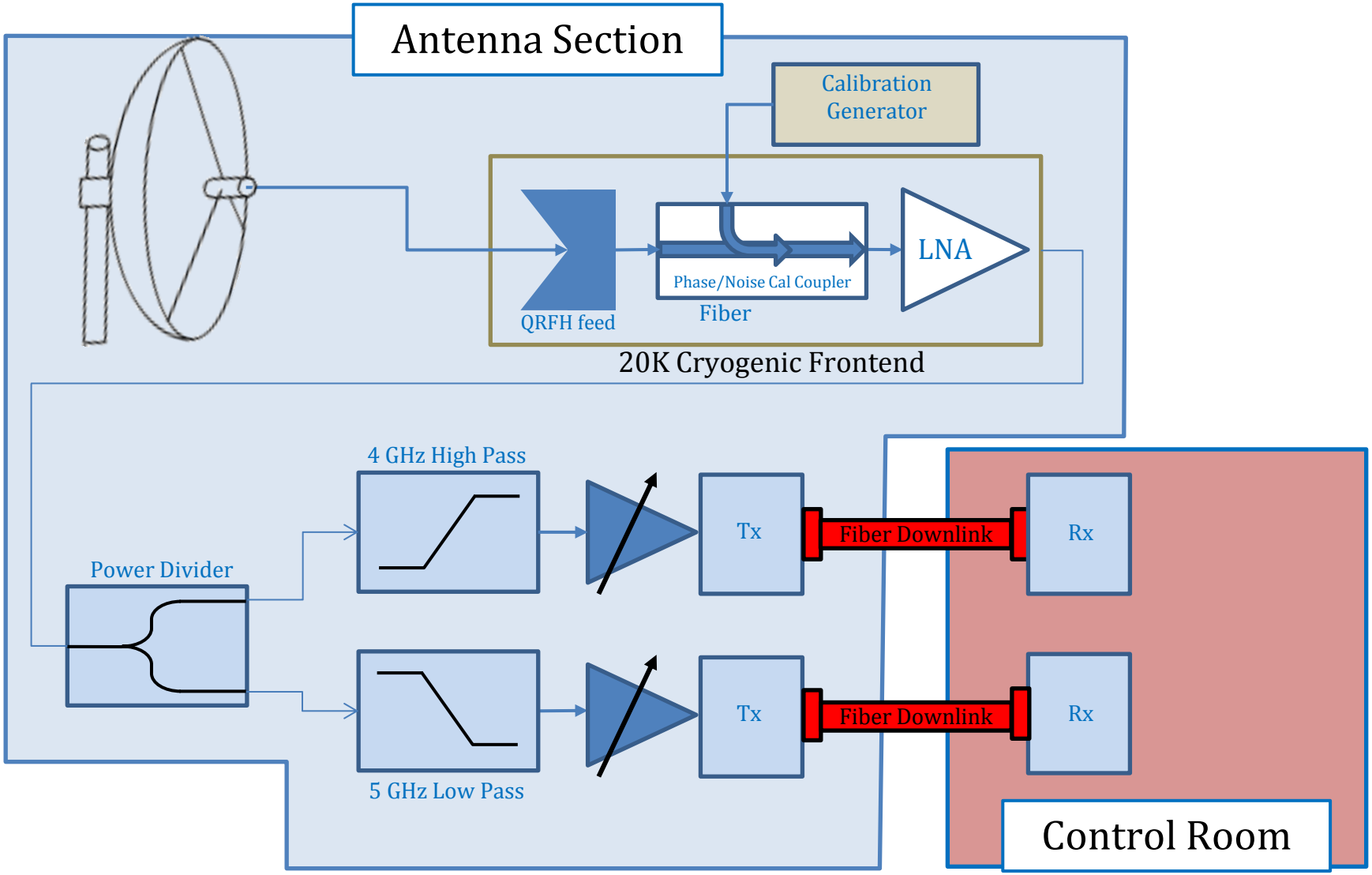
- 18 m diameter antenna
  - VGOS feed at prime focus
  - f/D 0.3 paraboloid primary
  - 80° feed optical half angle



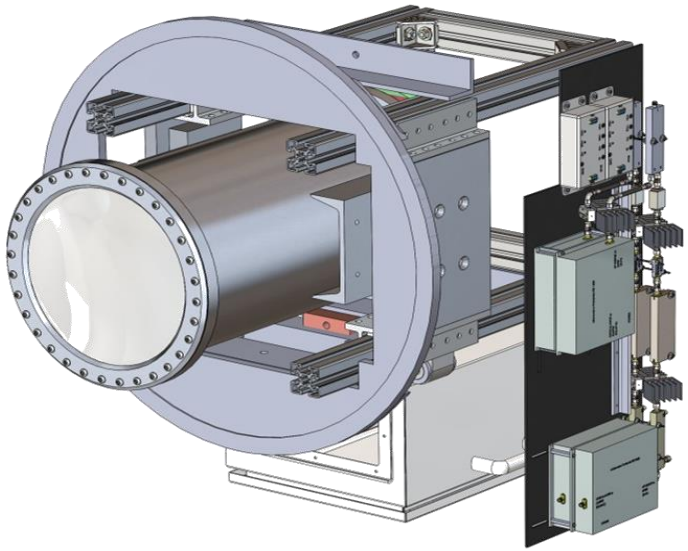
- QRFH feed
  - Optimized for
    - Westford prime-focus optics
    - 2-14 GHz

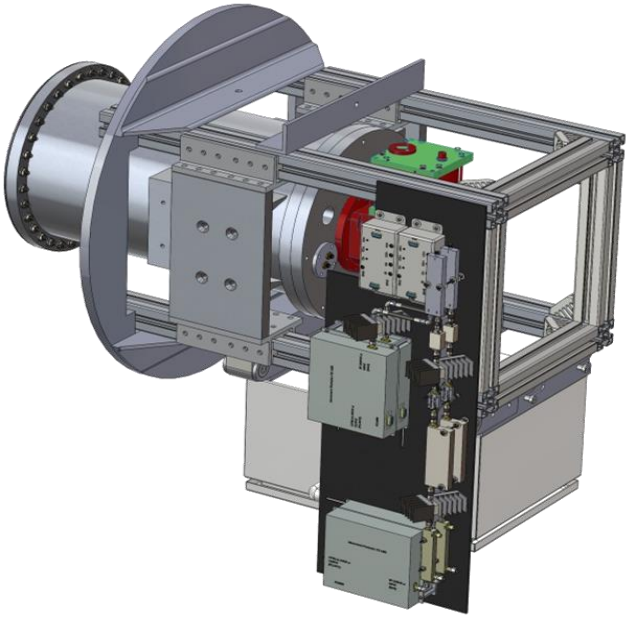
Westford receiver design

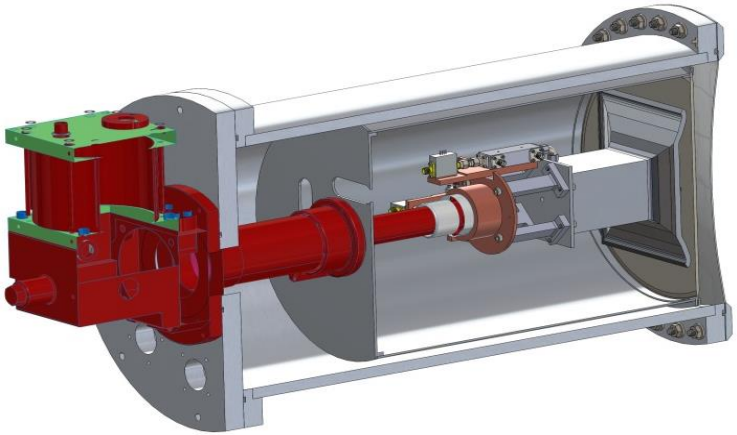
2 overlapping bands

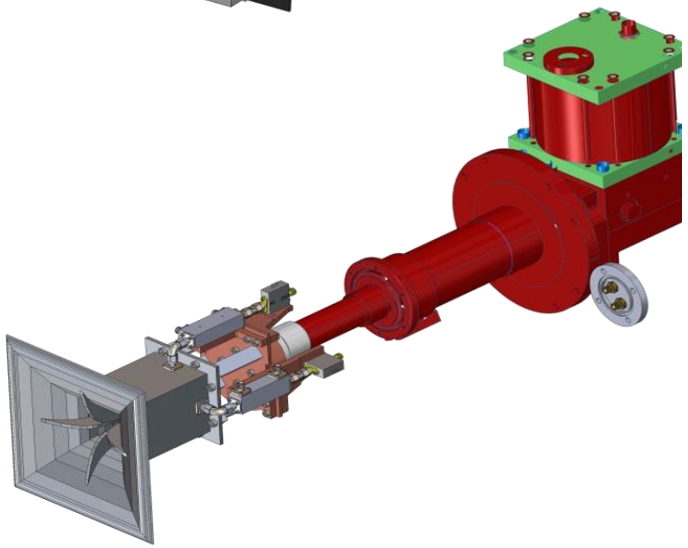


Westford frontend mechanical design



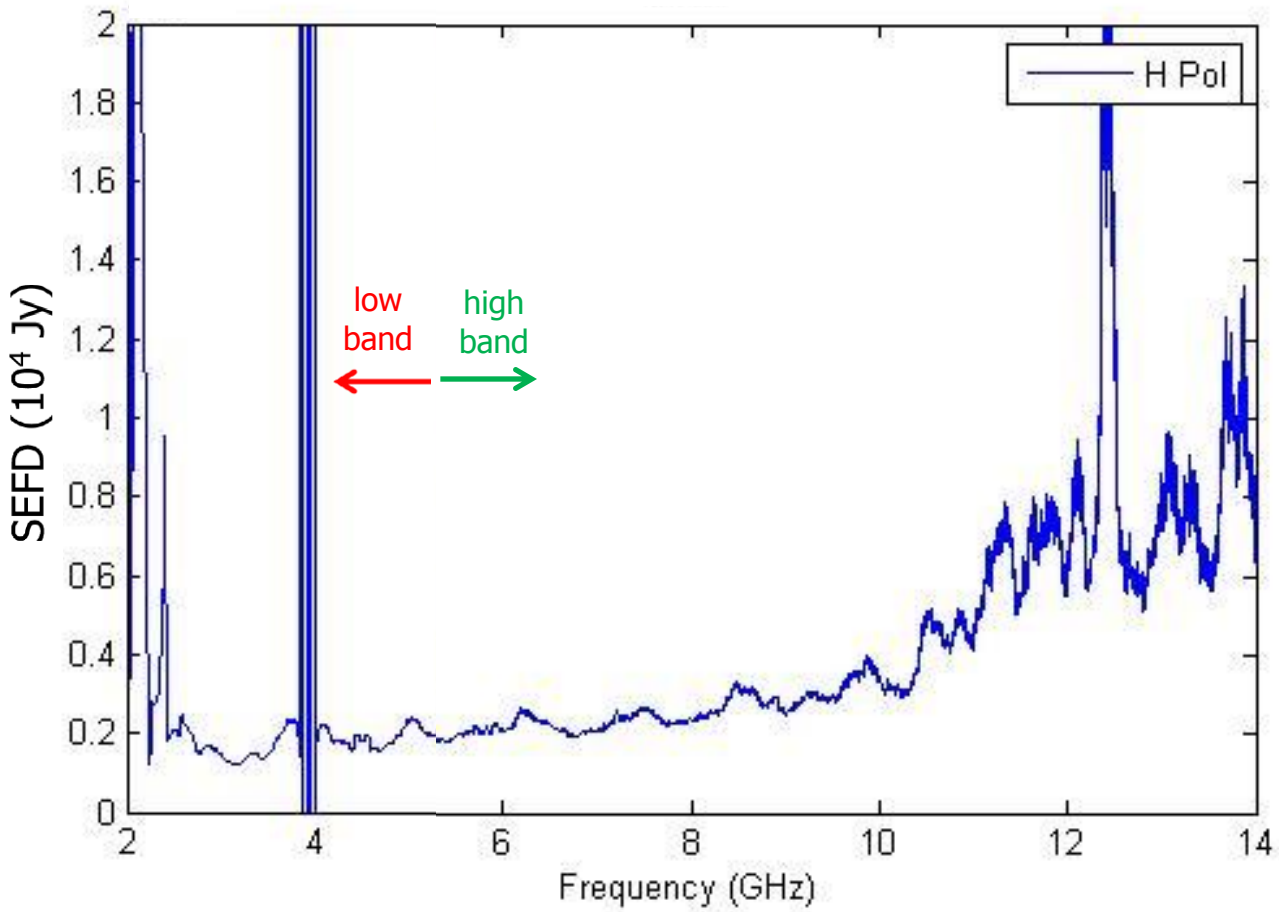




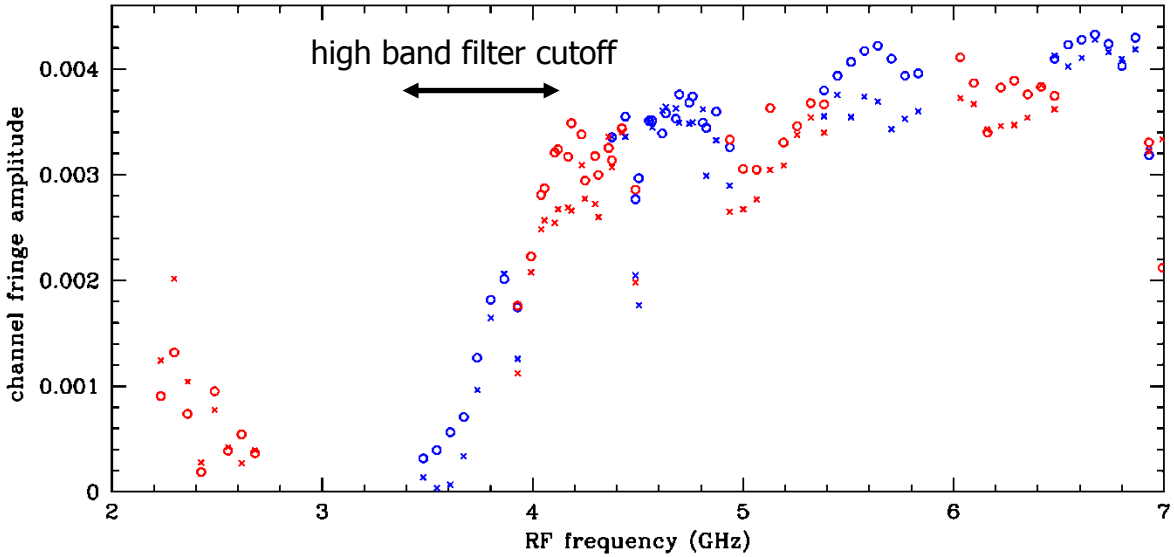


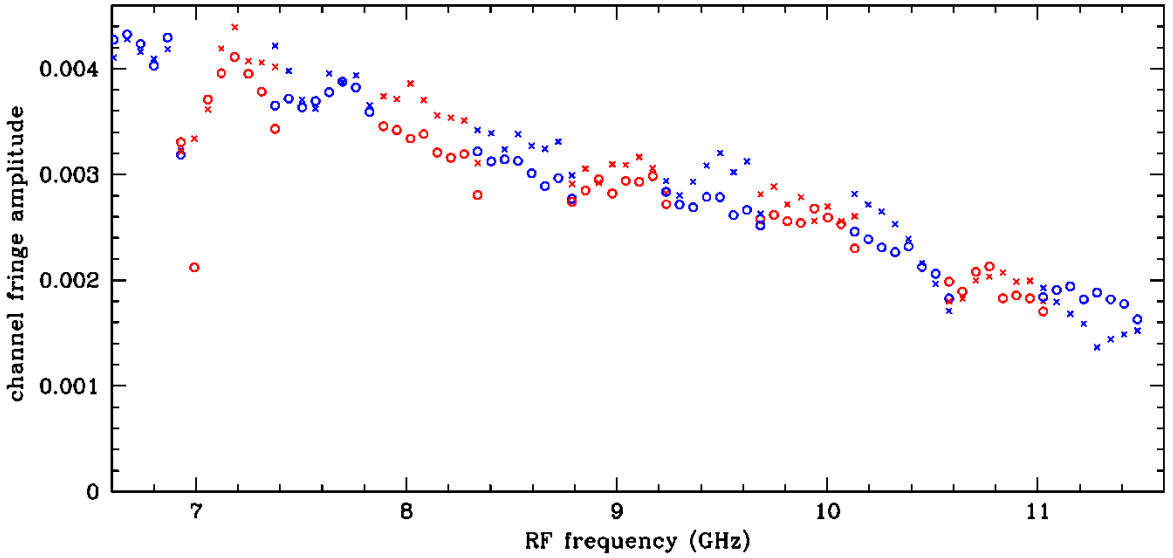
Westford SEFD

Preliminary result –
feed position not yet optimized



GGAO-Westford fringe amplitude spectrum on 4C39.25



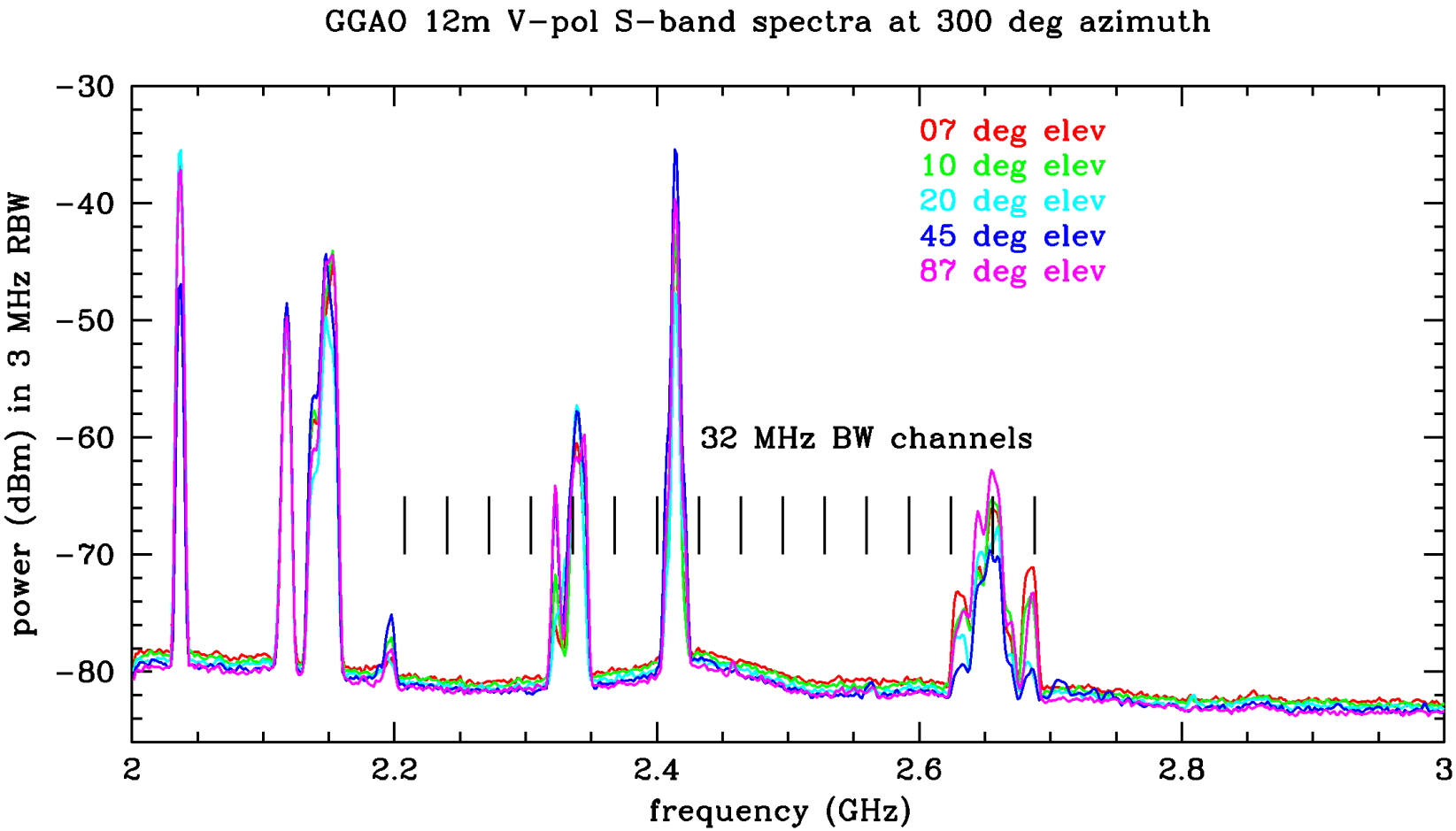


x = HH

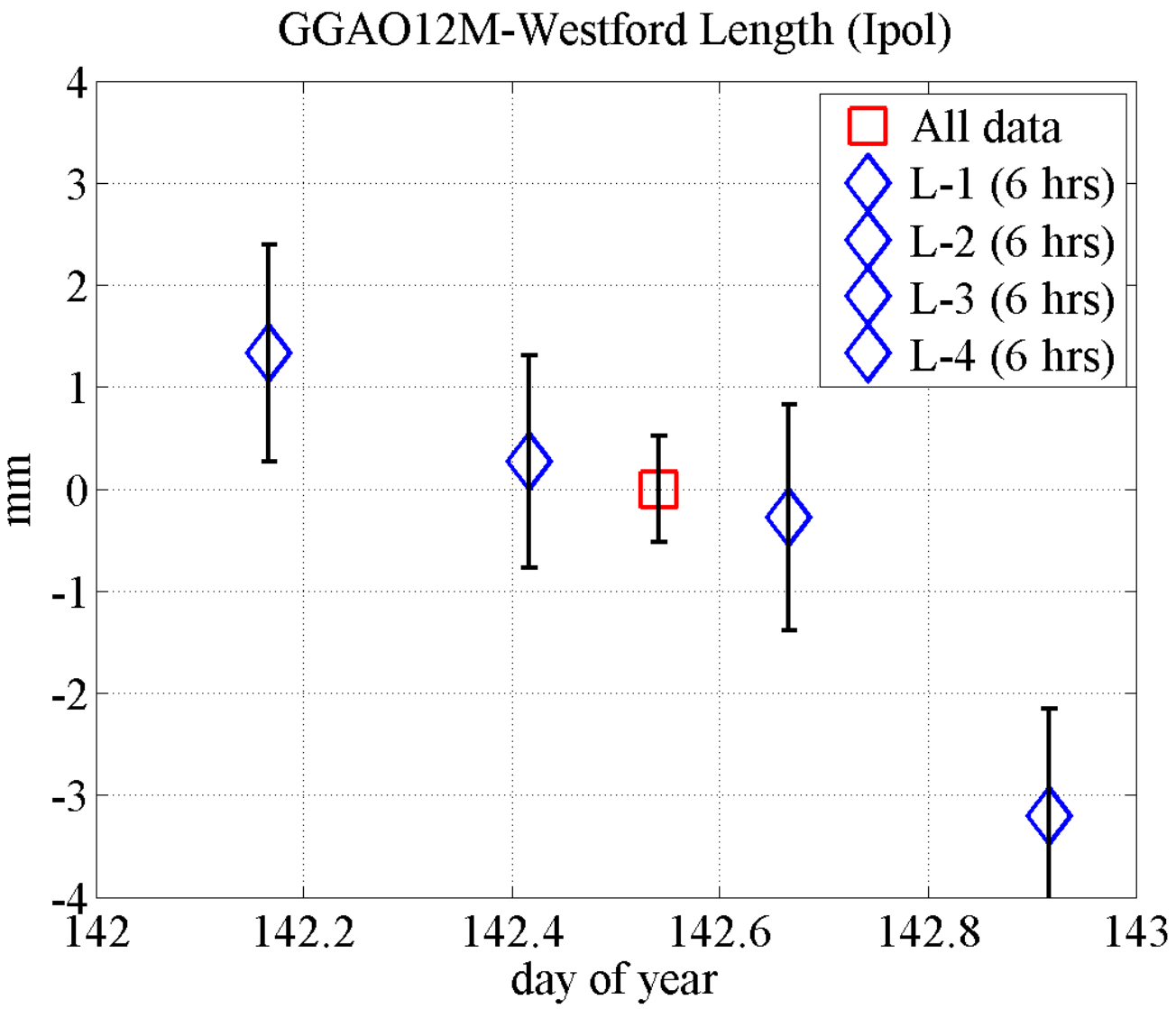
o = VV

S-band RFI at GGAO

There are enough 32-MHz-wide holes to do geodesy!



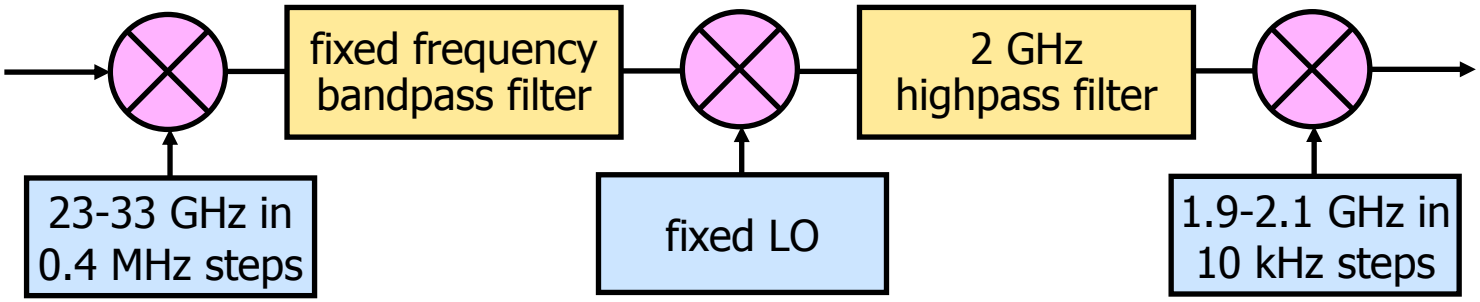
Baseline length repeatability during 24-hour session



Future enhancements

- Field System support for up/down converters, RDBEs, and Mark 6 coming soon!

- Up/down converter
  - With current 0.5-GHz-BW NZ2 filters, present design covers only 1-11.5 GHz input range.
  - Adding a 3rd mixer stage and changing frequencies of bandpass filter and 2nd LO allow:
    - Input range 2-14 GHz to be covered with 0.5-GHz-BW NZ2 or 1.0-GHz-BW NZ1 filters
    - Finer tuning of net LO frequency



Future enhancements -- continued

- Cable Delay Measurement System with sub-ps accuracy under development
  - Needed to measure cable delay variations for 5 MHz to pulse cal generator
    - Thermally driven variations
    - Systematic variations from cable stress in az/el wraps