WBSPF – AIP
Status and plans

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Consortium members

Band A 1.6 GHz-5.2 GHz (= B3+B4)

China

- JLRAT – overall management
- NAOC – Feed and LNA design
- CETC54 – Feed design, integration and tests
- TIPC – WBSPF Cryostat design
- SHAO – LNA design

US (sub-contractor to JLRAT)

Caltech – LNA design and Feed/Cryogenic consultancy

Band B 4.6 GHz-24GHz (= B5a+B5b+B5c)

Sweden

- Onsala Onbservatory – Consortia lead, - integration, system tests
- Chalmers/MEL – LNA design
- Low Noise Factory – LNA prototyping
- Chalmers/S2/Antenna group - feed design

France

- University of Bordeaux / LAB – receivers

Germany

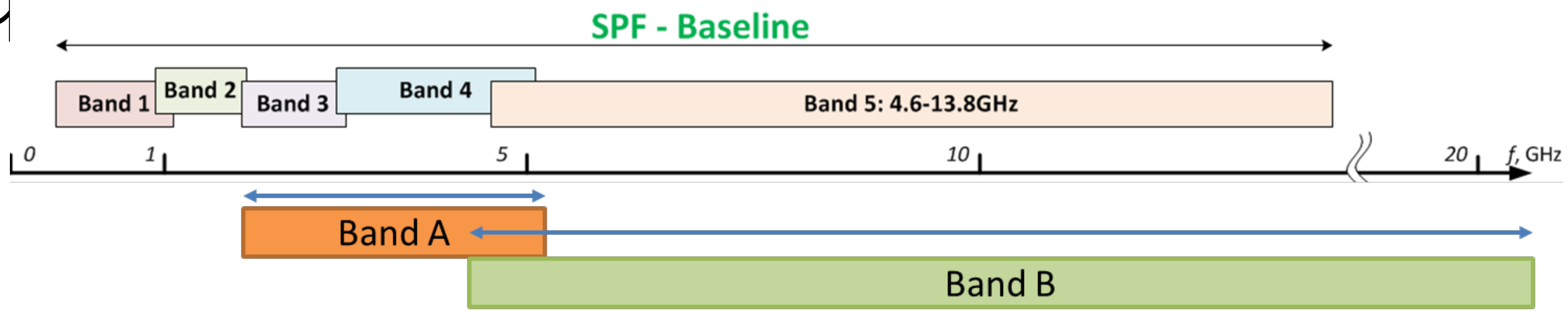
- IAF – MMIC processing
- MPIfR – LNA design and testing

Netherlands

ASTRON – cryogenics and system tests

Earned value for the consortia 2.7MEuro

Requirements



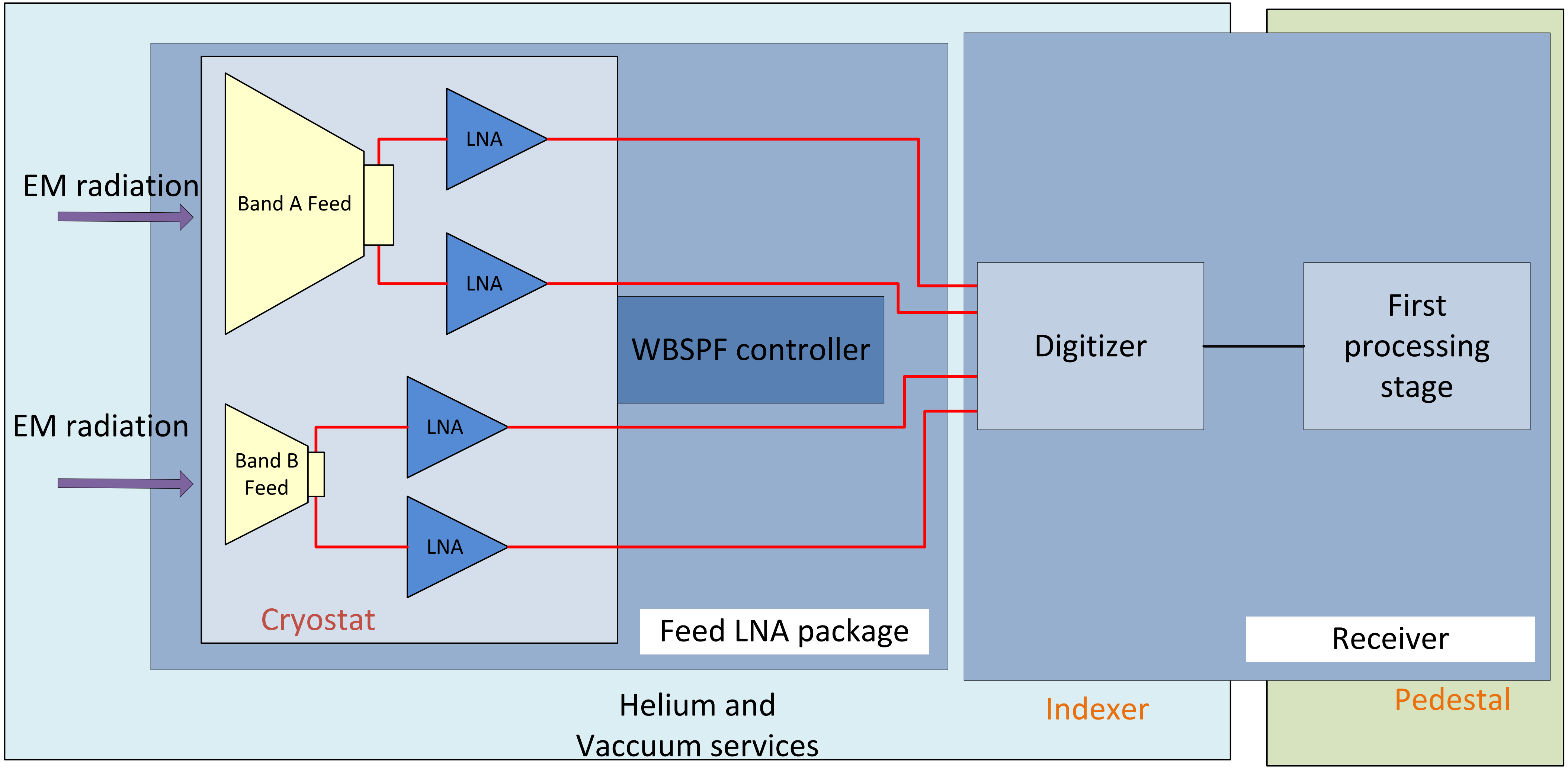
- Sensitivity requirement (Goal)
  - Band A (1.6 – 5.2 GHz) : 6.5 m^2/K (η ≈ 78%)
  - Band B (4.6 – 24 GHz):

    6.1 m^2/K from 4.6 – 13.8 GHz (η≈70%)

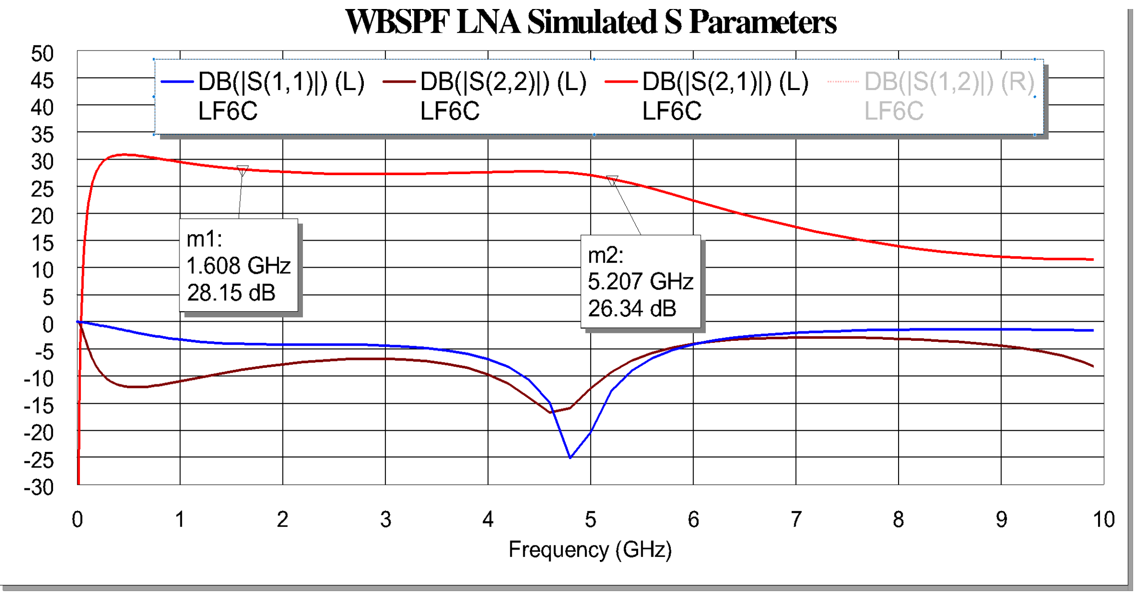
    4.7 TBC m^2/K from 13.8 – 20 GHz (η ≈ 65%)

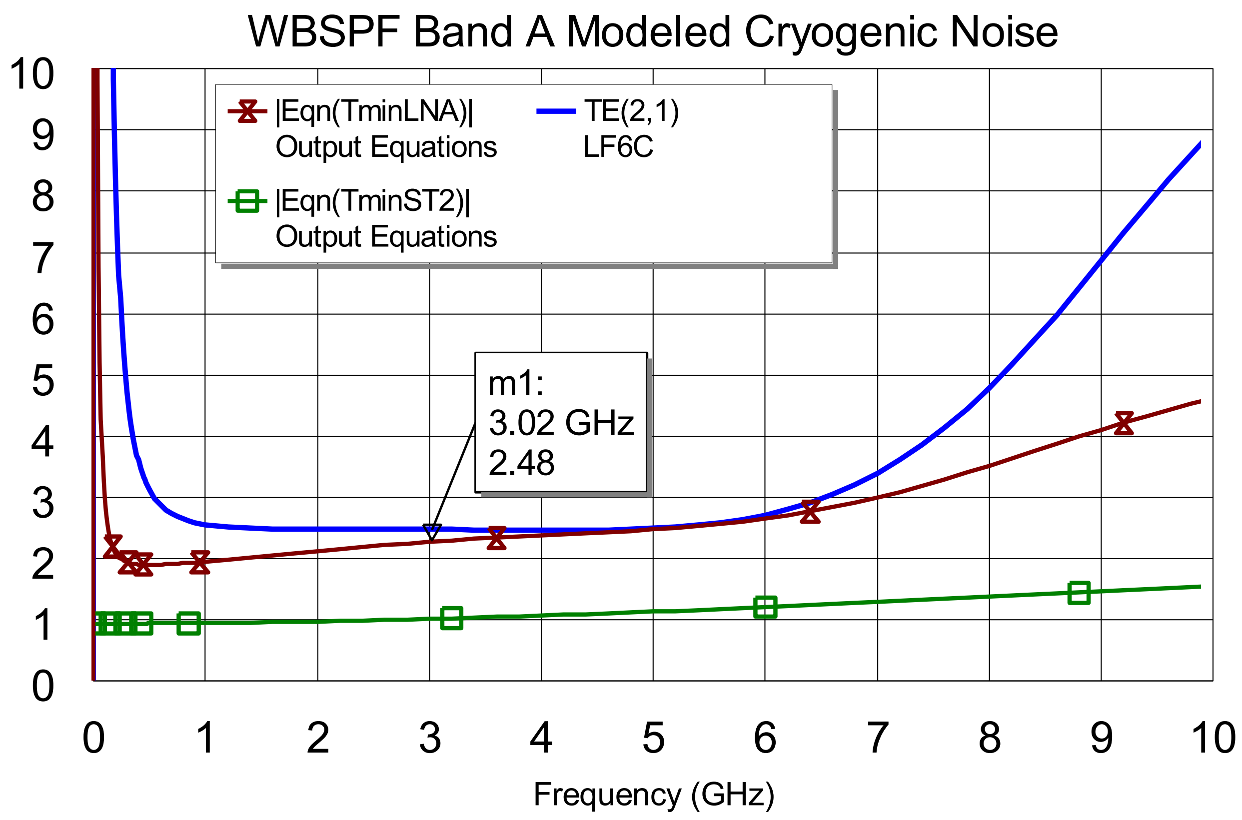
    3.5 TBC m^2/K from 20.0 – 24 GHz (η ≈ 60%)

WBSPF block diagram diagram

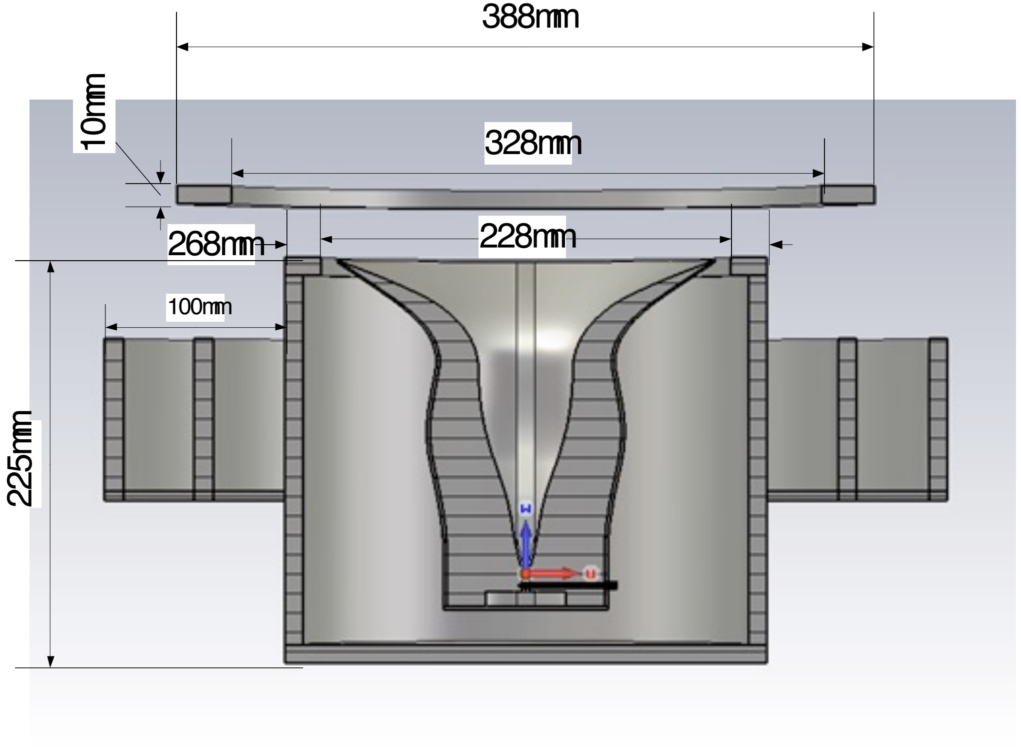


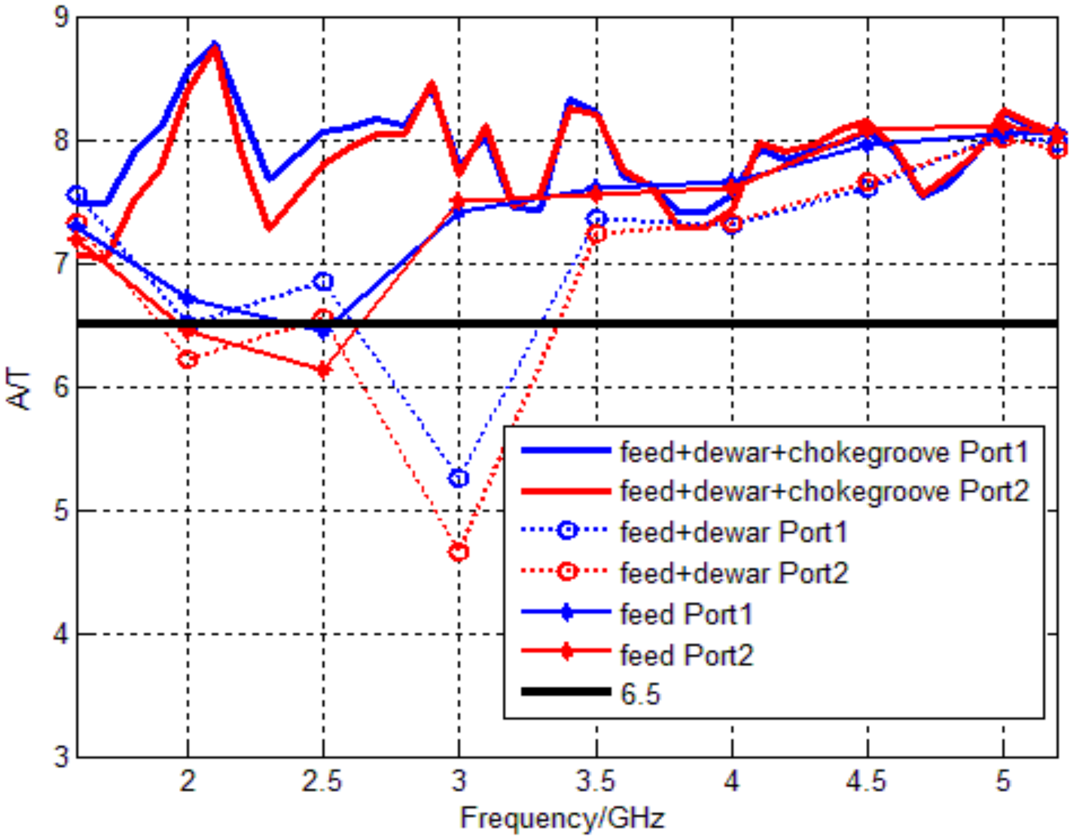
Design of WBSPF Band A LNA at Caltech





Band A Feed and dewar



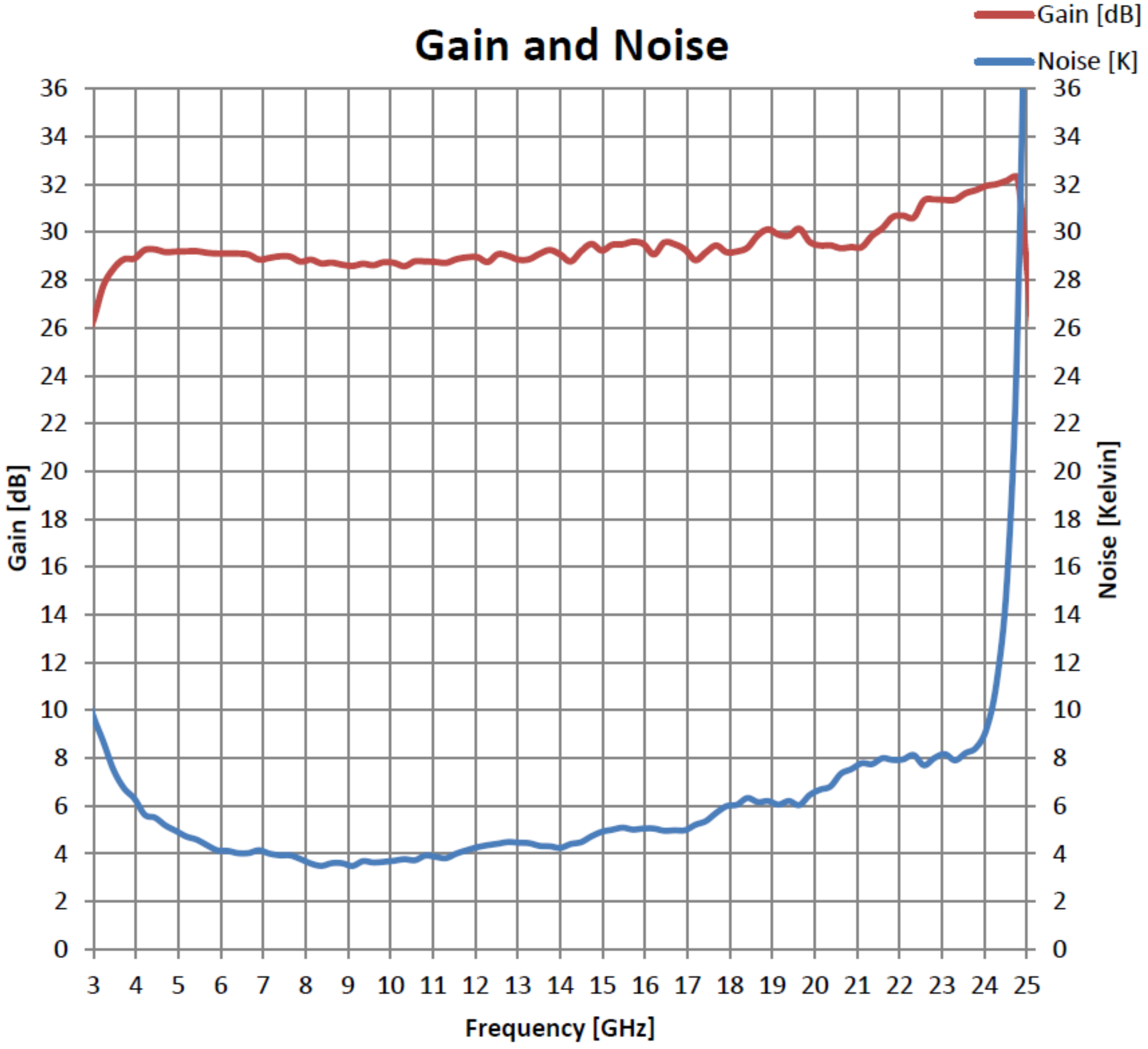


Choke ring has effectively reduce the back lobe of the feed, and enhance the sensitivity
The receiver temperature used is roughly linearly increased with frequency, varying from 10.27K @ 1.5GHz to 14.77K @5.5GHz.

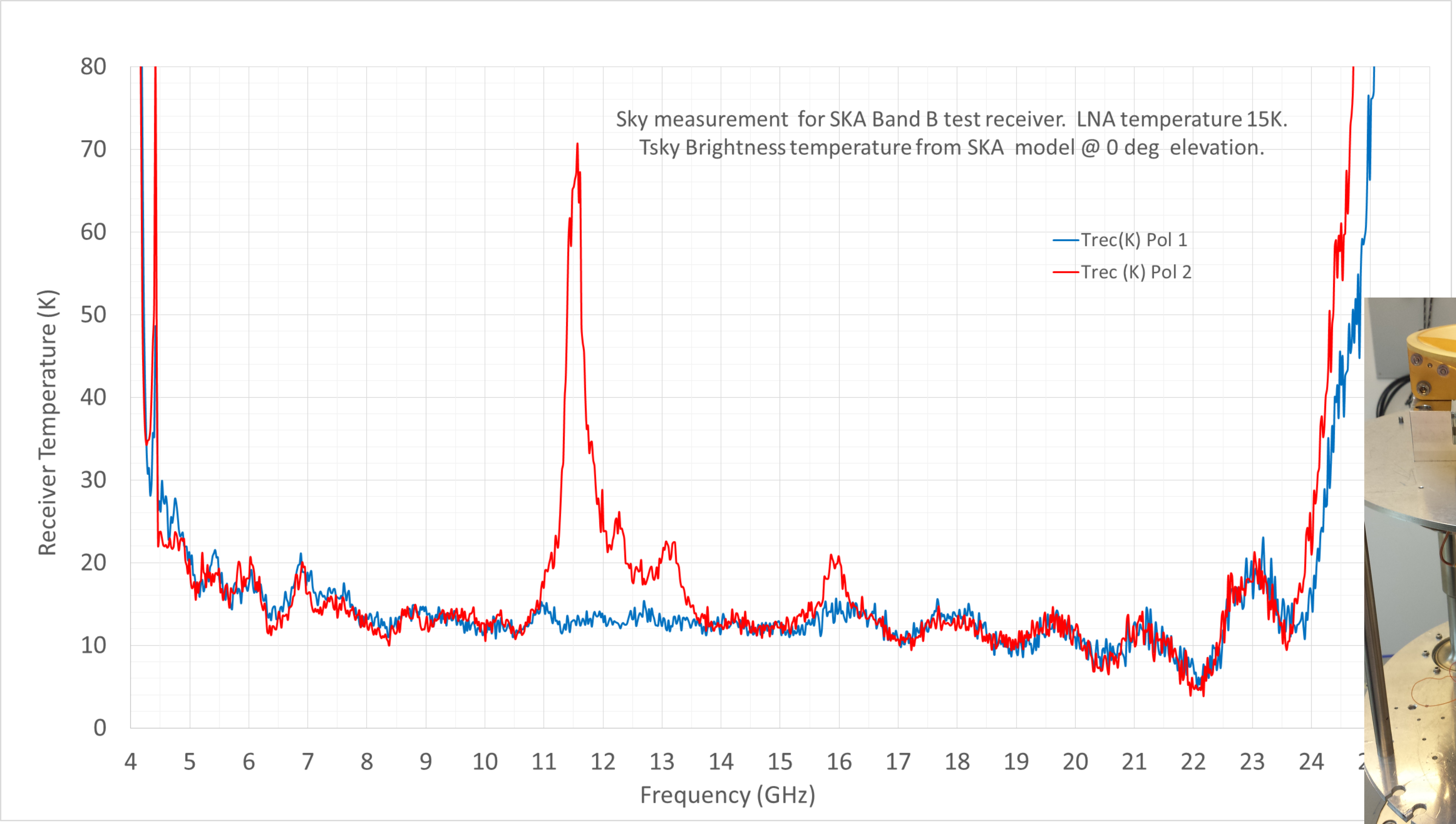
Band B
InP LNA

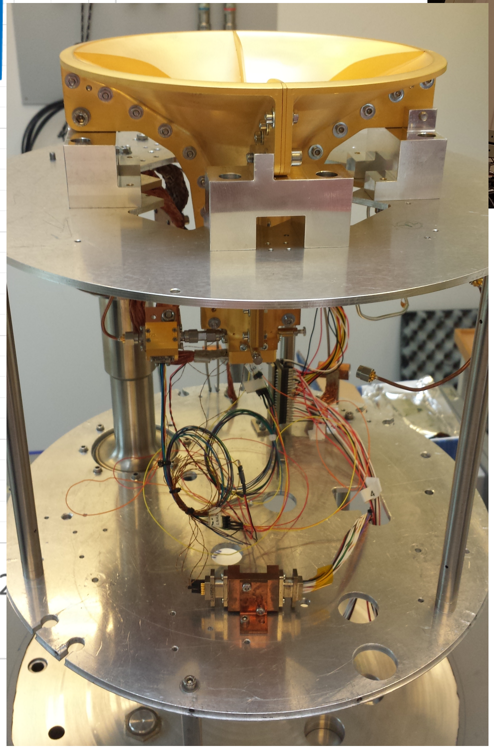
Build in Chalmers University Clean room by Low Noise Factory company.
T_LNA = 4K.

LOW NOISE FACTORY
www.lownoisefactory.com

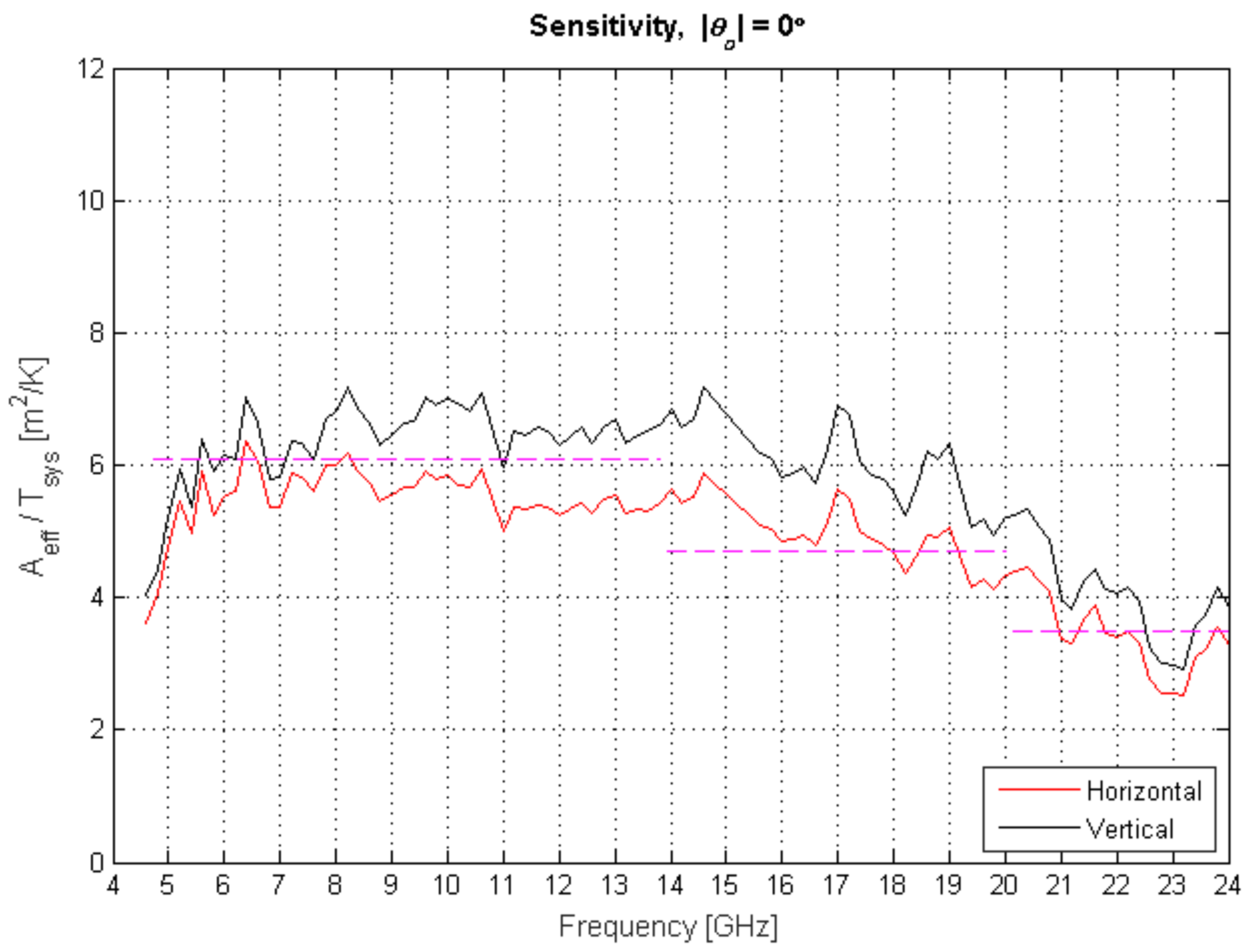


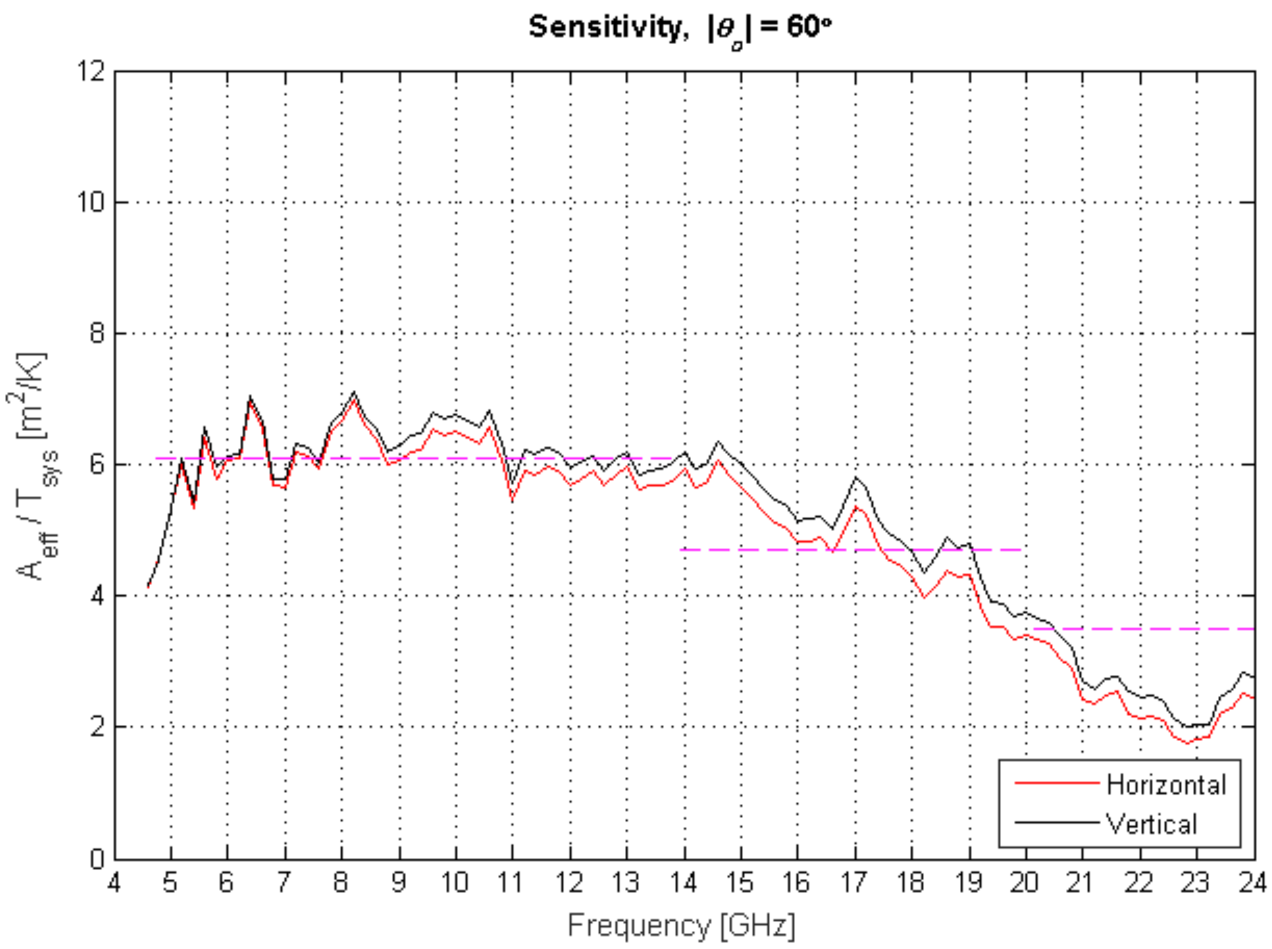
Measured Y – factor with Band B feed and LNA - Trec = 13K





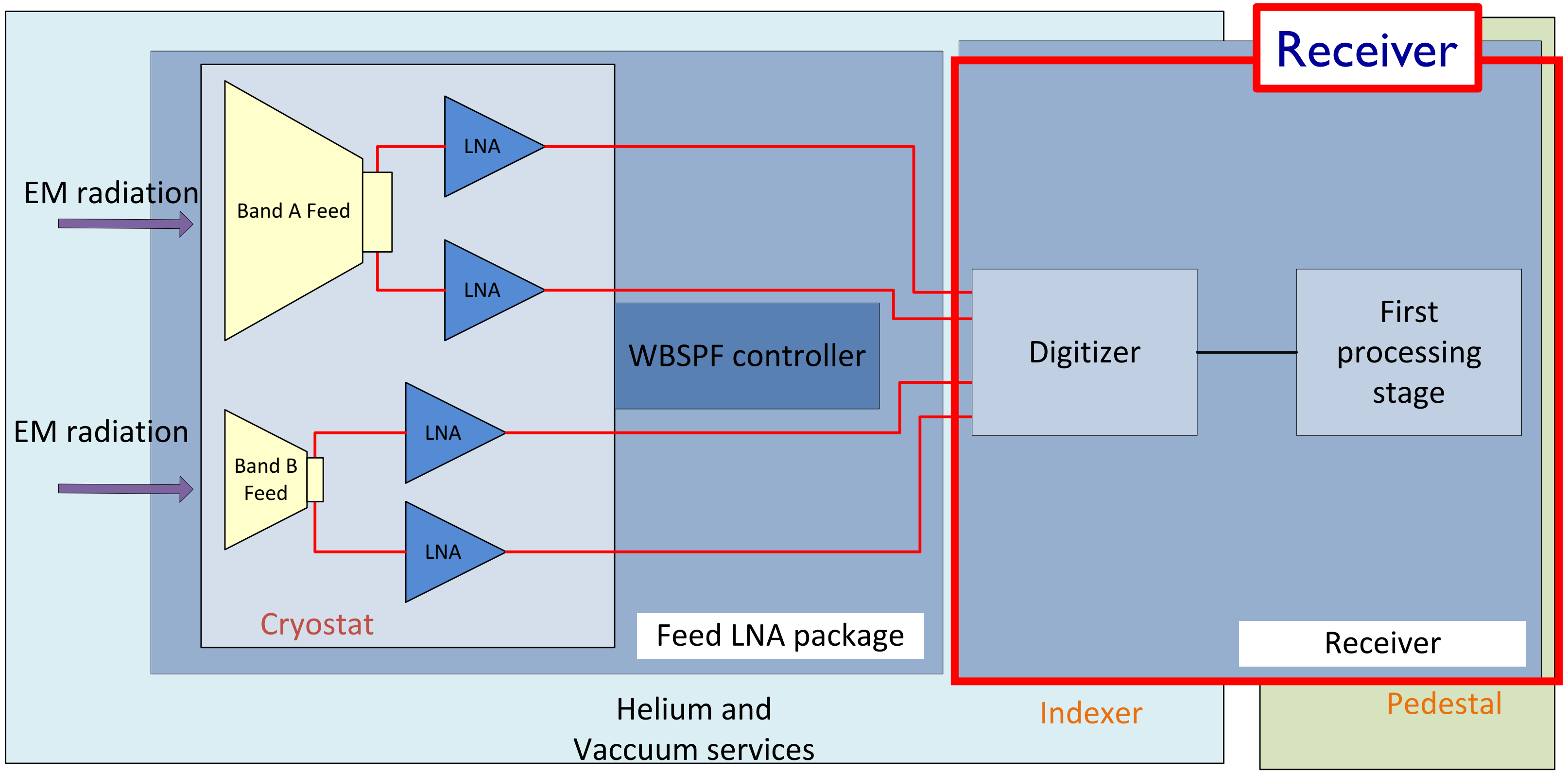
Sensitivity calculated with measured beam paterns and measured T_rec





Receivers

Stephane Gauffre - CNRS-University of Bordeaux



- For the first demonstrator: the band 5 (band B) will be split into 3 sub-bands (5a, 5b and 5c).

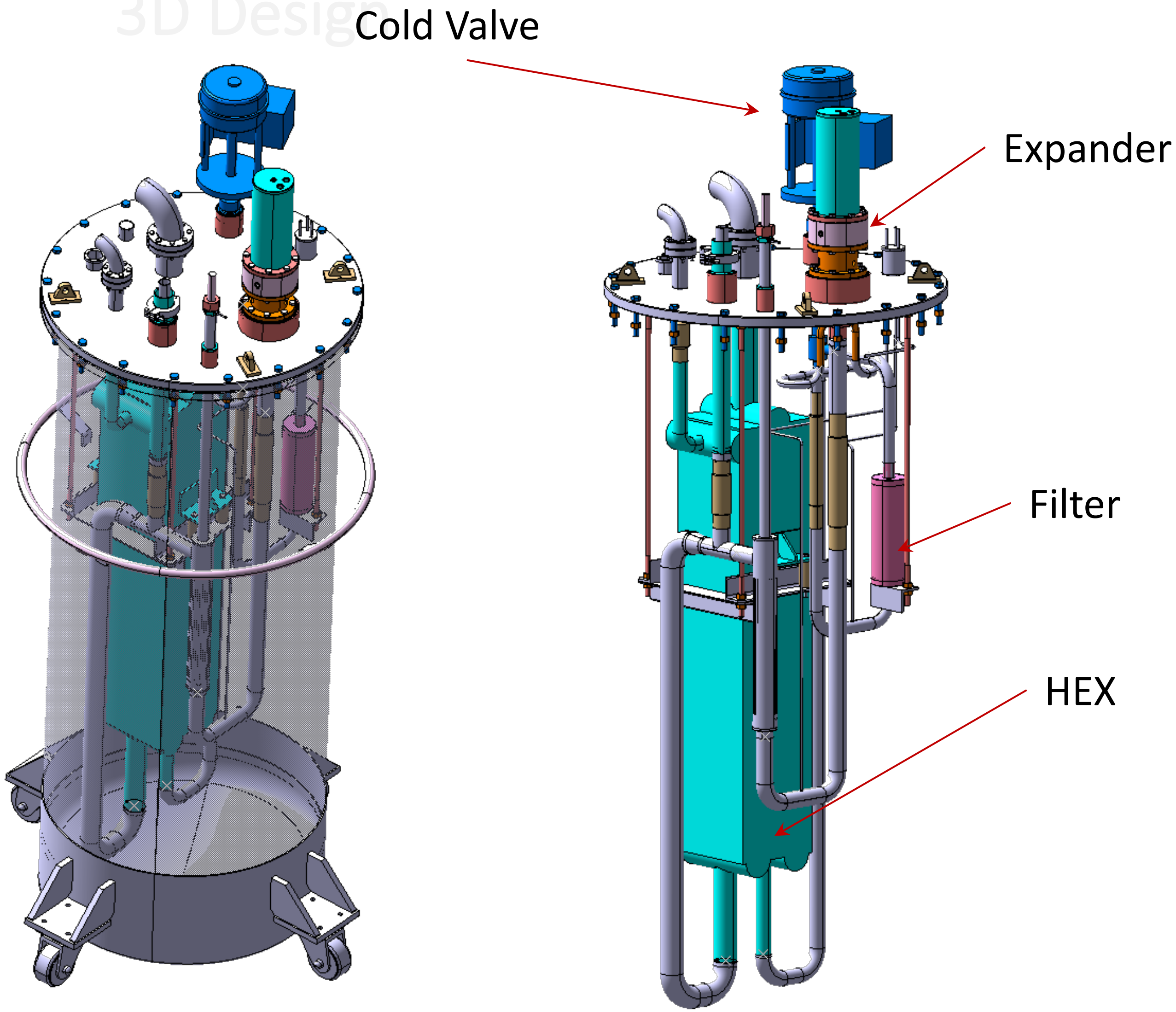
	Freq. Range	Inst. BW	Min bit depth	Transport
Band 5a	4.6 - 8.5 GHz	3.9 GHz	3	2×6 GSps
Band 5b	8.3 – 15.3 GHz	7.0 GHz	3	2×6 GSps
Band 5c	15 – 19.5 GHz**	4.5 GHz	3	2×6 GSps

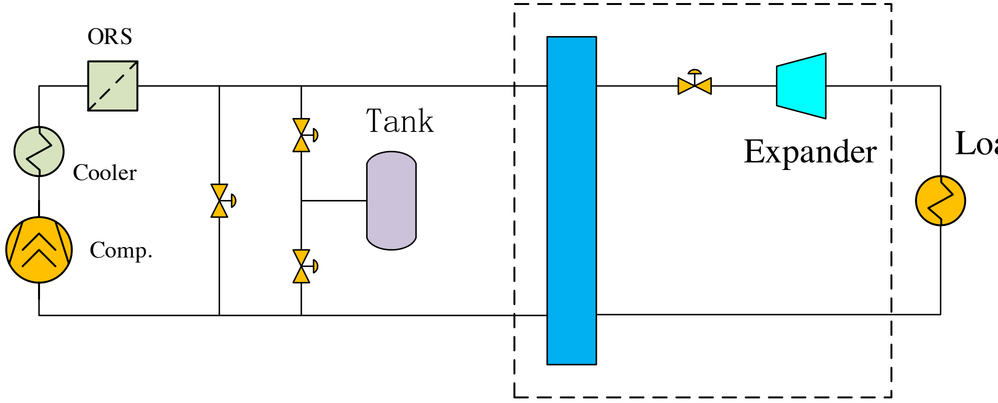
** limitation due to the ADC BW

- 2016: 4-bit at 10 GSps (interleaved) with FPGA for data transfer
- 2017: 3-bit at > 20 GSps (non interleaved)
- 2017+: 4-bit, 25 GHz, 25 GSps will be tested by Alphacore in March 2017
- 2018: 6-bit, 25 GHz, 25 GSps will be developped in 2017 by Alphacore and tested in 2018.
- > 2018: 7-bit, 20 GHz, 40 GSps is planned

Turbo Brayton Cooler design

3D Design





General thoughts about Wide-Band –Long term view

- **Great Future for Wideband feeds + RX** - have 3:1 feed fo **Band 1** (350 MHz – 1050 MHz) is already in **SKA baseline** (designed at Onsala; part of Dish Consortium, with Trec =13K) .

- **BUT** impact of wideband on initial SKA1 deployment limited at higher frequency limited- IF Bandwith (2.5GHz or 2x2.5GHz - less than present JVLA) – means that octave feeds 'win' in overall sensitivity (i.e. see Band 5 down-select) - But when the correlated BW increases this tradeoff changes.

Long term view

- SKA lifetime to year is to 2070 - as correlated BW increases – then WBSPF cf Octave will be **both higher capability** (wider correlated continuum bands,so more continuum sensitivity + multiple spectral lines in band) and **lower cost** than octave feeds, fewer band **(!)** Note EVN working toward 1.5GHz – 15GHz (13.5GHz IF) for EU BRAND project –also similar planning for NGVLA

- WBSPF (i.e. VGOS – geo VLBI 2-3- 14GHz or EU BRAND for EVN 1.5 – 15GHz to **feed back** into future SKA

General thoughts about Wide-Band –Shorter term view

- Work of existing for Band A (1.4 GHz – 5.2 GHz) and Band B – (4.6 GHz – 24GHz) **complete work to PDR during 2017** -possible options for SKA2 -- file for possible future use.
- On feed (and LNA) side engineering issues specific to particular frequency ranges - without specific guidance/commitment from office - not clear were to put effort.
- On the other hand within WBSPF there are work-packages of general interest for all future single pixel systems. i.e. wideband sampling, cooling – need to continue and ’have a home’.
- Also provides a way for other work on Wide band feeds (VGOS, BRAND to feed back into SKA).

Remaining and future Business

- 1) Close gap between initial deployment (<670M€) and the Design Baseline - restore capabilities – No/very little design work needed? – But cost of this may ‘steal’ money from SODP ??
- 2) Case of the receiver bands for SKA-mid, Band 3, 4, and 5c (14GHz- 24GHz) – parts of design with slots in telescope left to be filled but no detailed designs yet – work to PDR/CDR as part of SODP.
- 3) Long term development for single pixel technology for SKA2 for 2030?- clear role for ODP – part of SODP – run as devlopment partnership with annual reviews.

ODP maybe should have different parts/budget for cases 2 and 3 (and 1, which is really not part of ODP at all?) ?

Proposed future development of WBSPF

- Current work finished by end of 2017. Keep a home for 2018+ for long term developments for single pixel dish technologies, wide samplers, cooling, wide feed development from VLBI and elsewhere.
- During 2018 only, if there institutions wanting to start work on bands 3,4 and 5c (14GHz – 24GHz) – the consortium could also provide a temporary home (but maybe split off 2019 - as separate ODP packages since timescales are different than long term).
- In light of more general focus on long term technology for single pixel (cooling, wide samplers, also needed for 5c) + wideband feeds – maybe rename **WBSPF** to **ASPFR** (Advanced Single Pixel Feeds and Receivers) - to logically complement PAF and MFAA
- Ask for refresh of consortium project description (and name?) for November SKA board meeting?