

Dish Consortium Status in SKA1 Preconstruction

SKA Engineering Meeting
Rotterdam
June 11 – 16, 2017
Roger Franzen
FIEAust CPEng EngExec NER APEC Engineer, AFAIAA
SKA Dish Consortium Leader
CSIRO



Outline



- Outline of the Dish Team (Changes)
- Dish Consortium Overview
- Major Activities since last All Hands Mtg
- Key Progress in Work Elements –various
- Key Milestones

Consortium Members



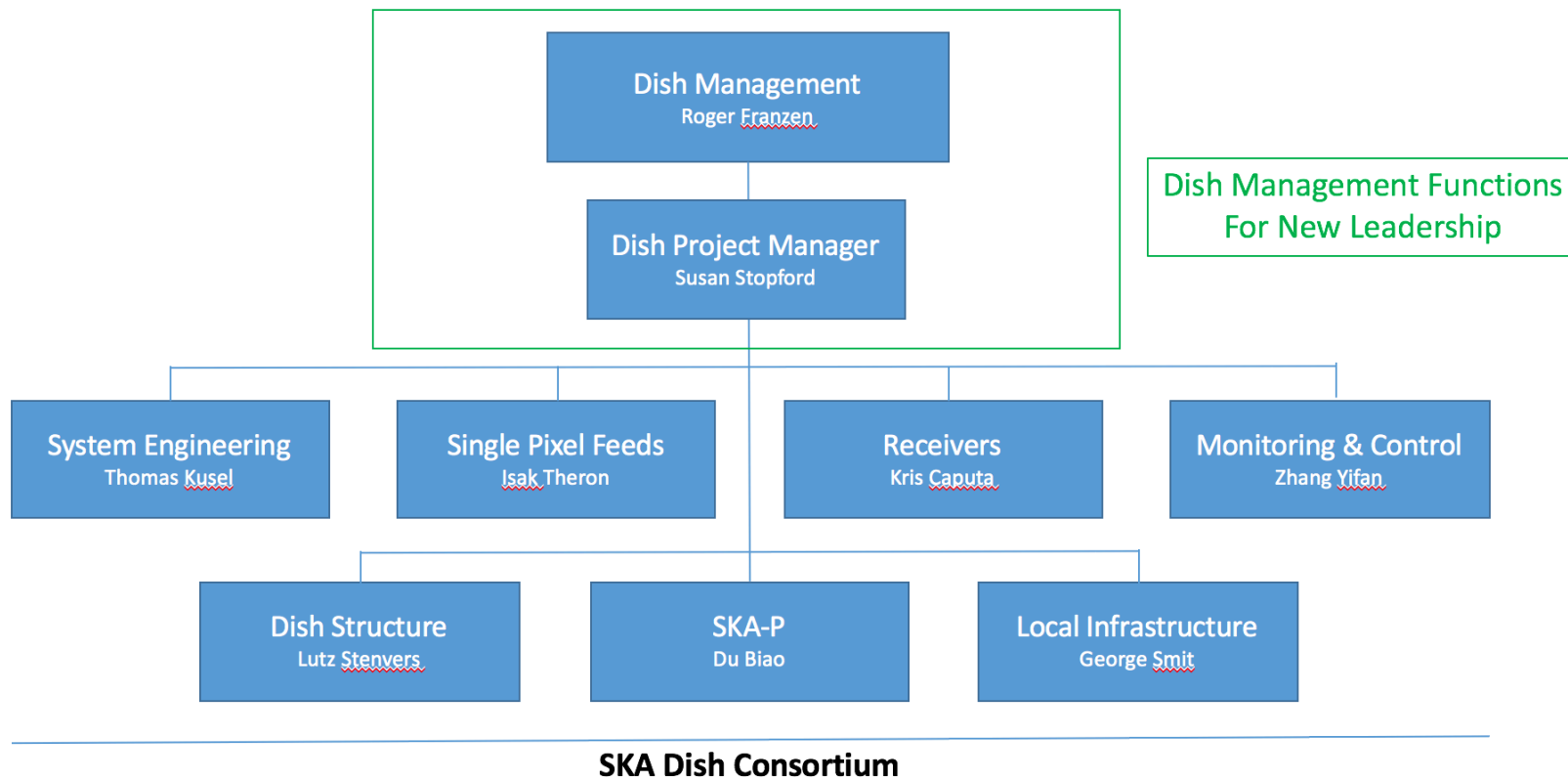
Dish Consortium: 17 institutions, 8 countries

1. Chalmers (Sweden)
2. Commonwealth Scientific and Industrial Research Organization (Australia) – **Withdrawing as DC Lead Organisation**
3. Electromagnetic Software and Systems (South Africa) – **SPF Lead**
4. European Industrial Engineering (Italy)
5. IAF Fraunhofer (Germany)
6. National Institute for Astrophysics (Italy)
7. Instituto Geografico Nacional (Spain)
8. Joint Laboratory for Radio Astronomy Technology (China) – **SKA-P and LMC Lead**
9. Max Planck Institute for Radio Astronomy (Germany)
10. National Research Council of Canada (Canada) – **SPFRx Lead**
11. Omnisys Instruments AB (Sweden)
12. RPC Technologies (Australia)
13. SKA South Africa (South Africa) – **SE and Local Infra Lead**
14. Societa' Aerospaziale Mediterranea S.c.r.l. (Italy)
15. Universidad de Cantabria (Spain)
16. Universidad Publica de Navarra (Spain)
17. Vertex Antennentechnik GmbH (Germany) –

Plus: Oxford University, Stratosat Datacom, MT Mechatronics (**DS Lead**), Engage SKA Portugal

Additional Collaborators: University of Bordeaux

Consortium Organization



Following Australian Govt Decision, CSIRO is stepping back from DC Leadership

Reminder of Dish Scope

- Dish Consortium is responsible for the design, development verification, validation and PROTOTYPE FABRICATION of dish structure, optics, feed suites, receivers, all supporting systems and infrastructure for the SKA1-Mid dishes.
- Deliver First of Type **operational** Dish System in Karoo.
- Qualify systems.
- Complete Dish Element CDR.

Major Activities



Since last Engineering Meeting, Major Activities were:

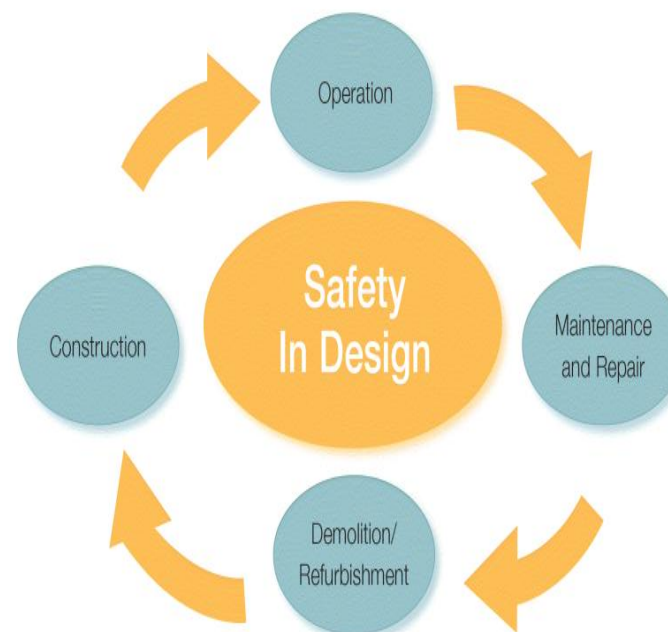
- SPF DDR November 2-4 2016 –Band 2 achieved, Band 1 passed dDDR May 19th.
- Dish Structure DDR held December 7-8, 2016 – conditional pass, prototype cleared and in construction.
- MPG Dish CDR held May 8-9 and passed.
- SPF Band 1 dDDR held May 19, 2017 and passed.
- SPFRX DDR late January, 2017 – dDDR required, QM in build.

Imminent

- Band 5 PDR scheduled for July 4-5, 2017
- SPFRX dDDR expected late July, 2017

Safety by Design

- Continuing to build proactive communications
- Mutual respect
- Trust and confidence
- A focus on Safety in Design
- Dish design & manufacturing team understands safety.



System Engineering

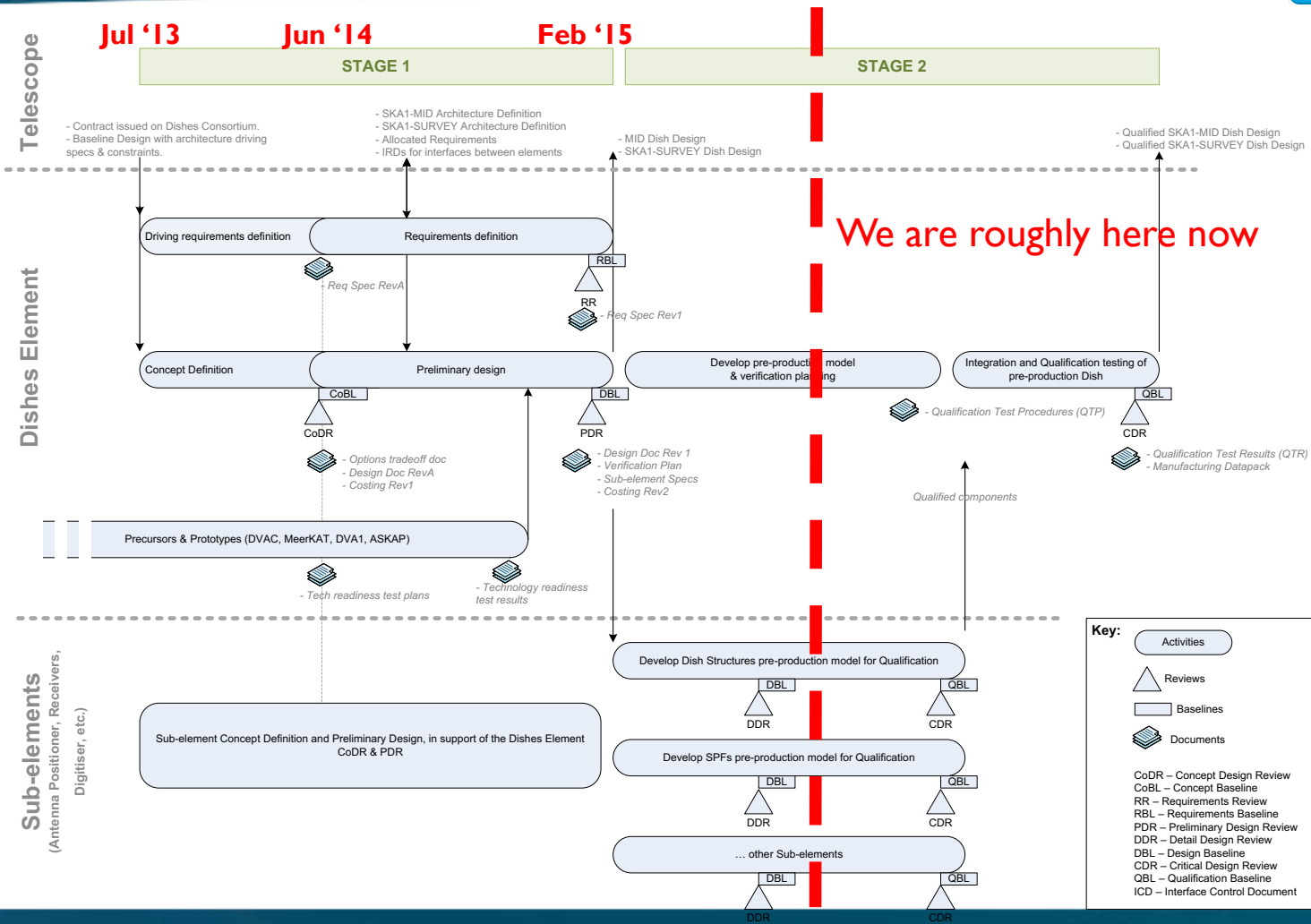
“The difference between good engineering and wasted money!”

Lead Organisation: SKA South Africa

SE Plan



DISH



Courtesy of Thomas Küsel

Baseline Status

Good progress, but still a lot of effort ahead

Dish Element		CoBL	PDBL	DDBL	QBL
Dish Structure		A	A		P
	SPF			R	P
	SPF services			A	P
	SPF B1			R	P
	SPF B2			A	P
	SPF B5		P		P
	SPFRx			P	P
	Rx B123				P
	Rx B45		P		P
	LMC			A	P
	DFN			A	P
Key:		A	Baseline approved		
		R	Review completed, baseline pending		
		P	Review Pending		
			Baseline not applicable		

CoBL = Concept Baseline
PDBL = Prelim Design Baseline
DDBL = Detail Design Baseline
QBL = Qualification Baseline

(DDBL: Equivalent to SKA CDR expectations)

- Requirements, Interfaces and Detailed Designs are now mostly frozen.
- Focus now on building qualification models, integration and qualification testing.

SKA Dish Qualification Model



Current status of Dish Foundation:



Courtesy of SKA SA

Dish Structure

**Lead Organisation: MT Mechatronics
with support from JLRAT/CETC-54/SAM**

Dish Structure

Design for the structure element of the SKA1-Mid antenna

- Feed down – Feeds at secondary focus
- Optical design – Compatible with SPF and PAF
- Panel Segmented Metal (PSM) main reflector
- Segmented carbon composite sub-reflector.
- Secondary EMI cabinet inside pedestal.
- UPS powered safe stow mode.

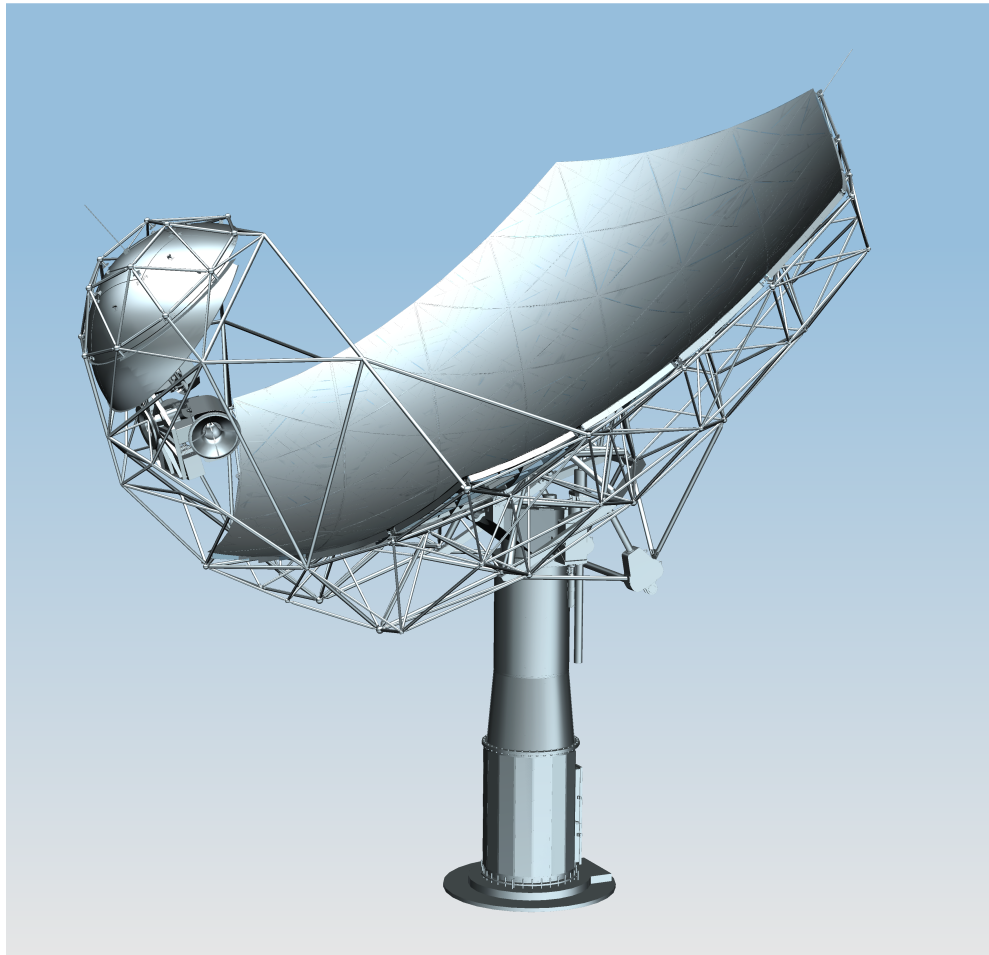
SKA Error budget Summary

		Precision Operating Conditions (5m/s)	
		95% error circle	rms
Blind Pointing Error Circle (arcsec)	Requirement	36,0	9,0
	Budget	14,9	5,6
Relative Pointing Error Circle (arcsec)	Requirement	6,5	1,3
	Budget	5,1	1,3
Tracking Stability (arcsec)	Requirement	9,0	2,3
	Budget	6,8	1,5

Design – Panel Reflector



DISH



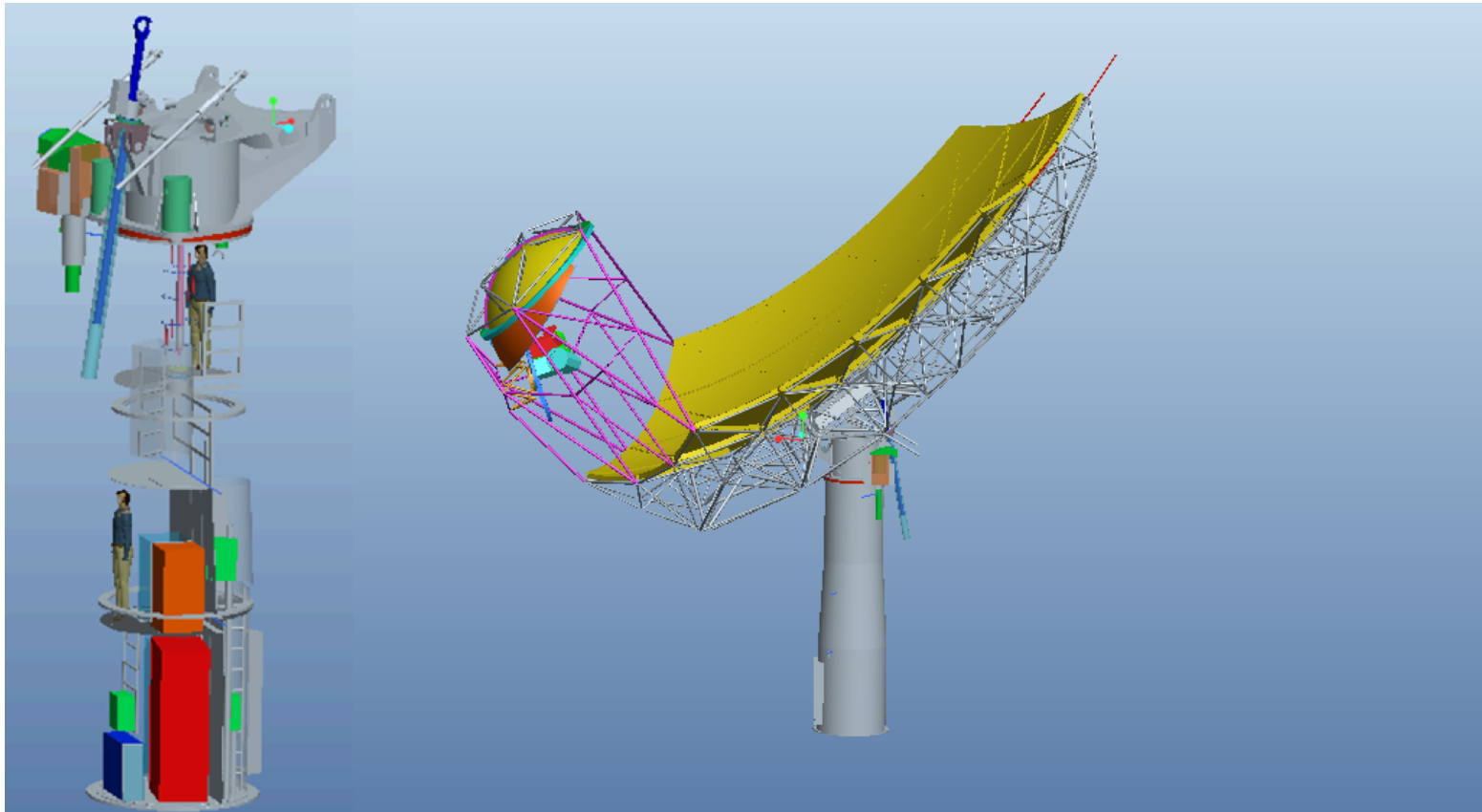
**Total Surface
RMS 350 micron**

Courtesy MT Mechatronics

DS Detail CAD Model



DISH

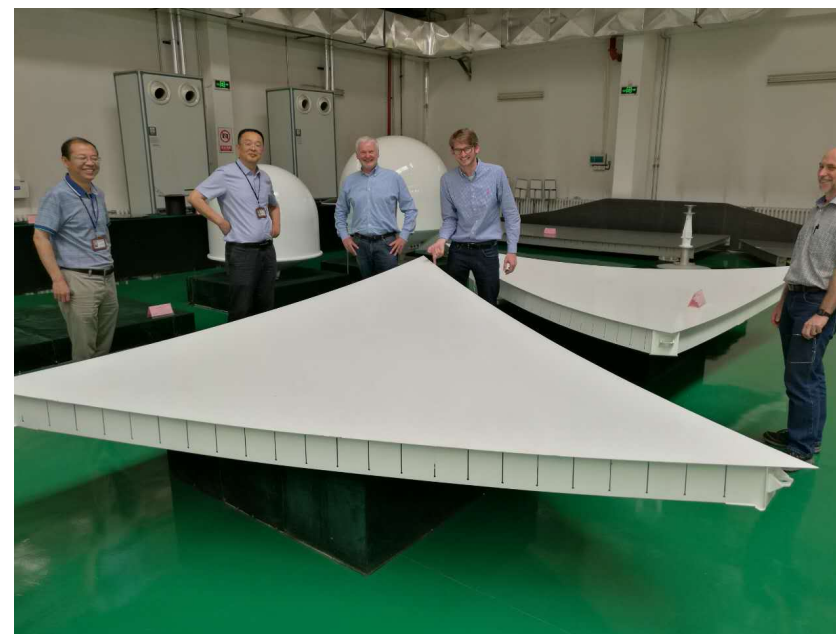


Courtesy MTMechatronics

DS First Hardware



DISH



Courtesy CETC-54

DS - More Hardware



DISH



Courtesy CETC-54

DS – Even More Hardware



DISH



Courtesy CETC-54

DS – More and More Hardware



DISH



Courtesy CETC-54

> 56 Molds now completed – Carbon Molds in Manufacture

Single Pixel Feeds

Lead Organisation: EMSS South Africa

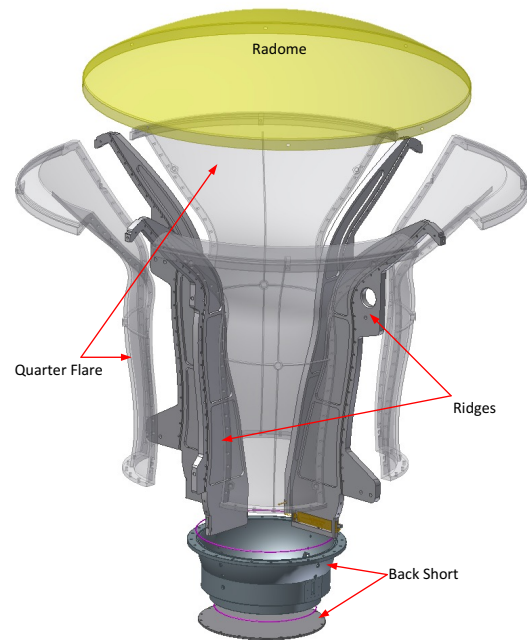
- **SPF Bands**
 - 1: 350 -1050 MHz
 - 2: 950 -1760 MHz
 - 3: 1.65 -3.05 GHz
 - 4: 2.8 -5.2 GHz
 - 5a: 4.6 - 8.5 GHz
 - 5b: 8.3 – 15.3Ghz

Band 2 is priority for Dish Element CDR

Band 1 – Moving Onward



DISH



CAD View

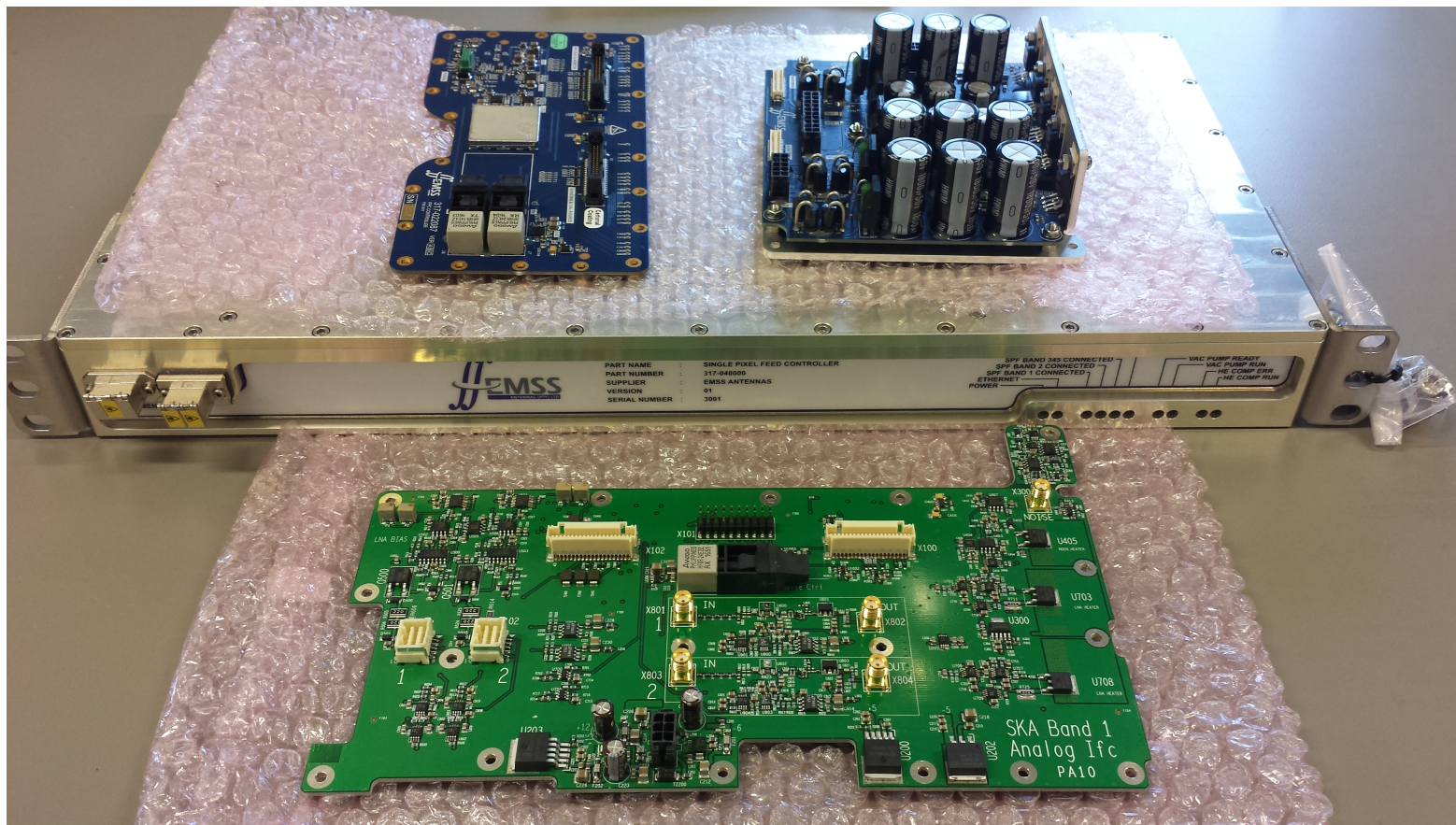


Band-I Prototype



In test on NRC DVA-I

Band 1 - Progress



EMSS SPF controller, FPGA and Power Supply boards on the back. On the front is analogue board for controlling the LNAs, Noise diode and reading temperature sensors.

Courtesy of Miroslav Pantelev

Band 1 – More Progress



DISH

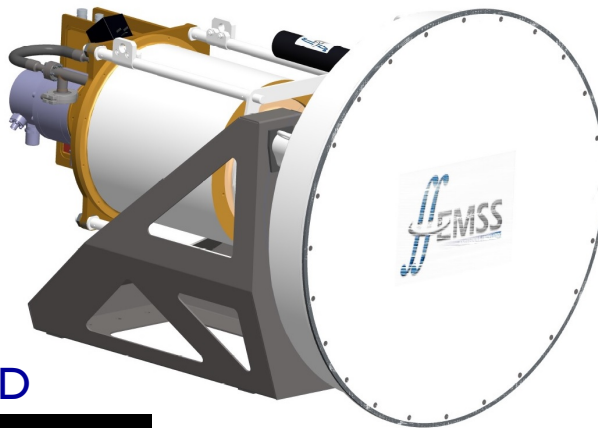


First Band – I Feed Molded Quadrant before precision finishing

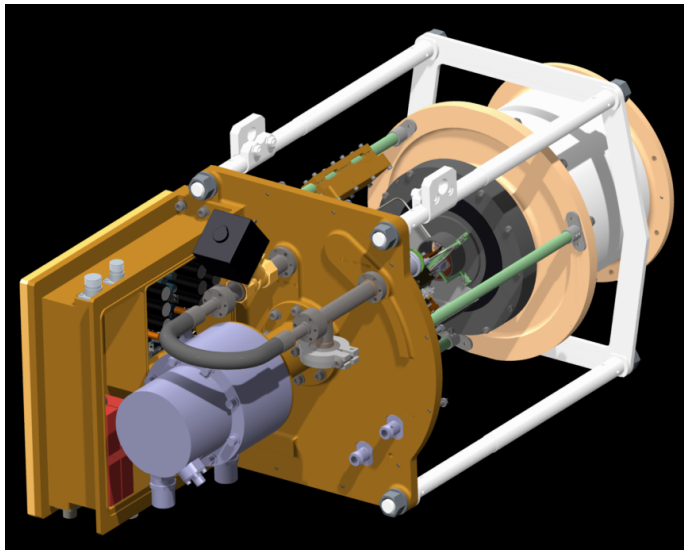
Courtesy of Miroslav Panteleev

Band 2 – Moving Onward

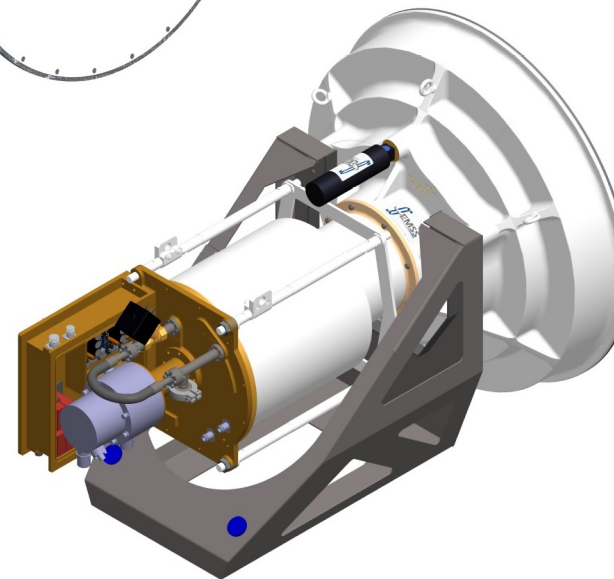
SPF Band-2 Front



SPF Band 2 Cryostat and
Control Assembly Open CAD

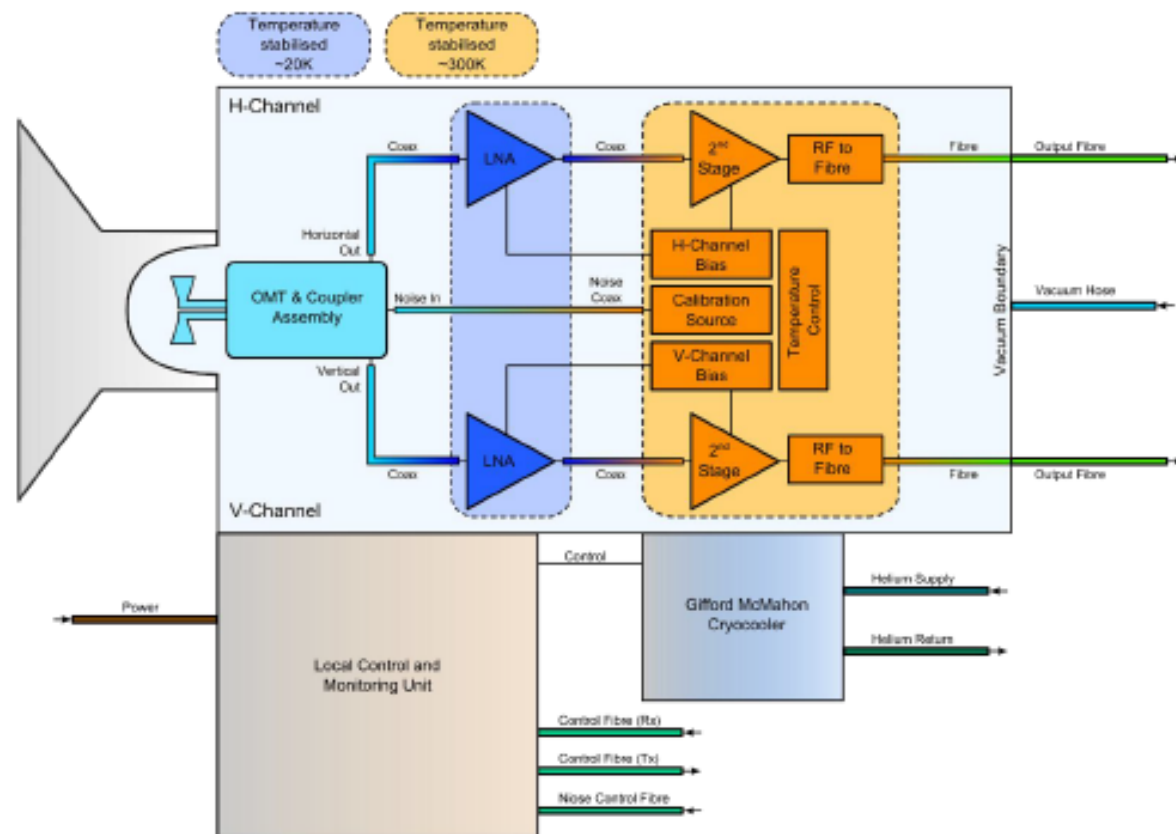


SPF Band-2 Side



Courtesy of EMSS

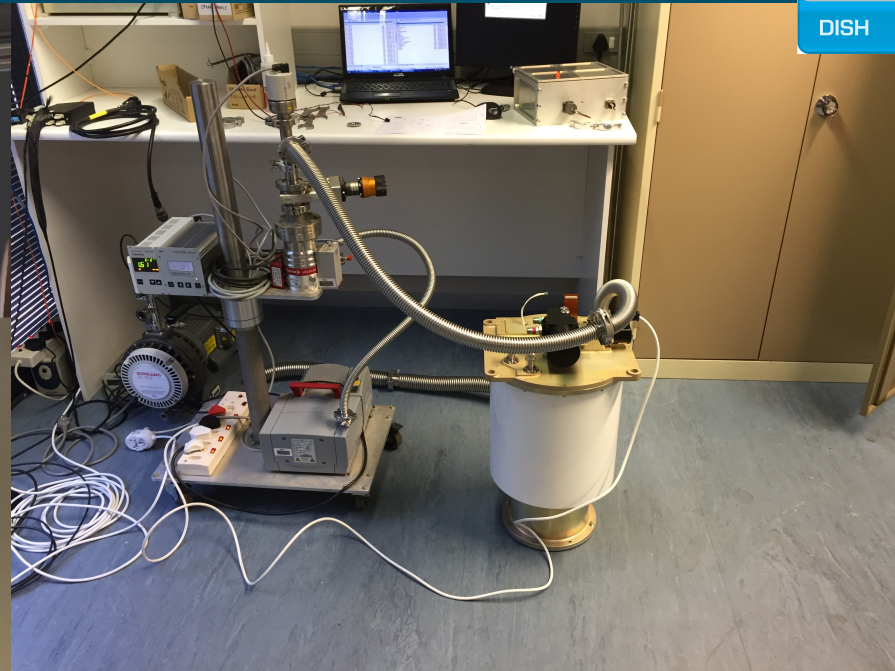
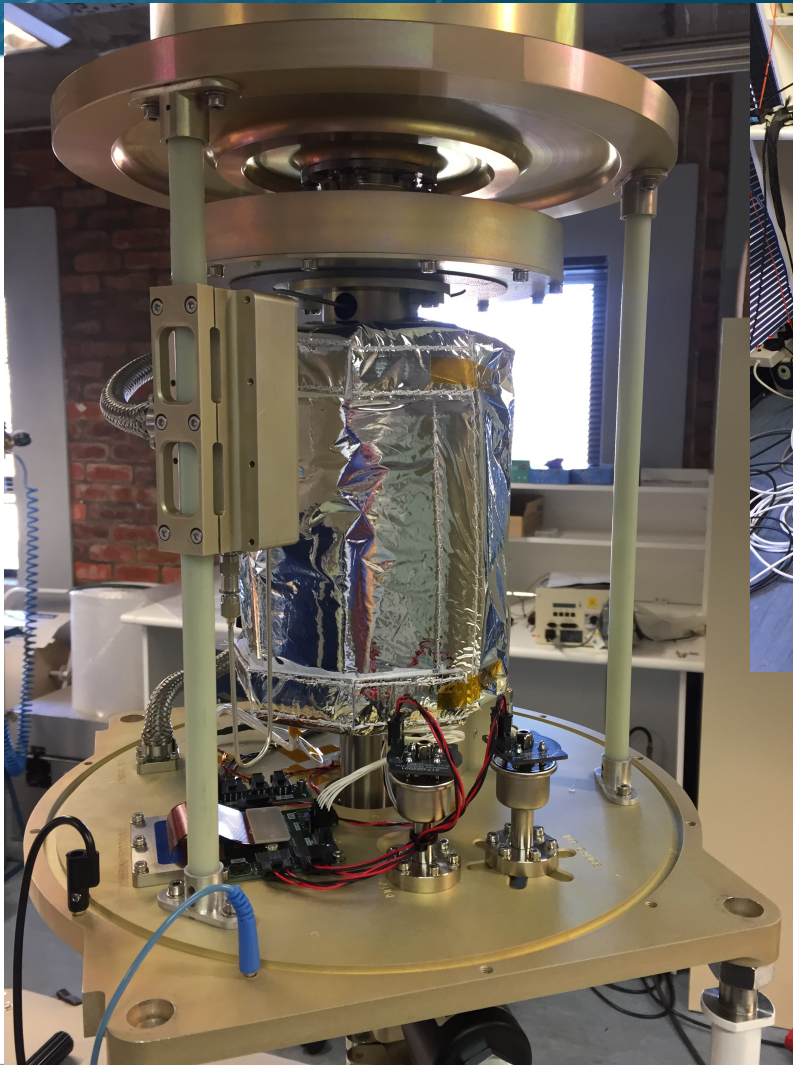
SPF Band-2



Block diagram for SPF Band 2

Courtesy of EMSS

Band 2 - Progress

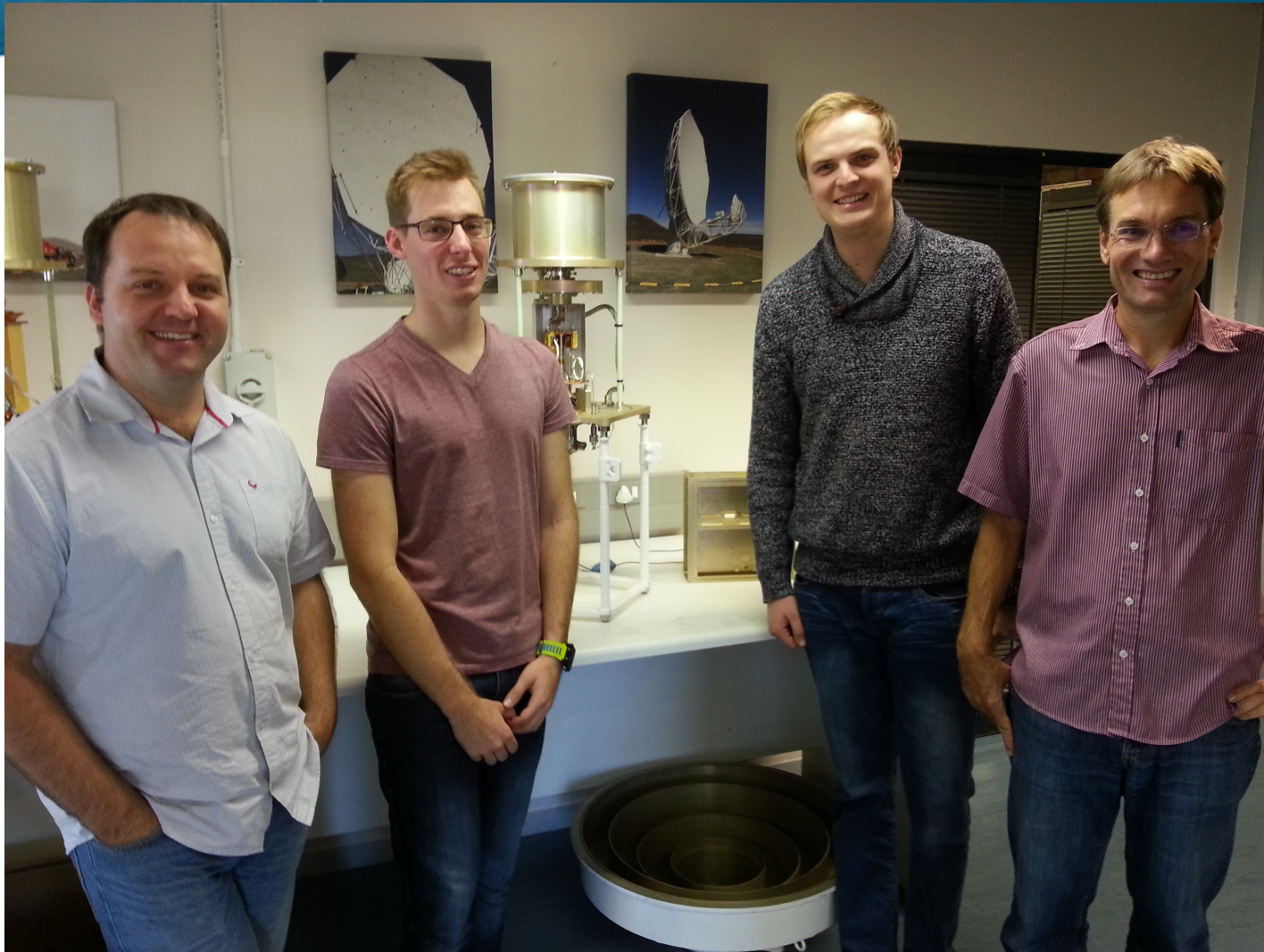


Band 2 Cryostat in test.

Band 2 – Happiness 😊

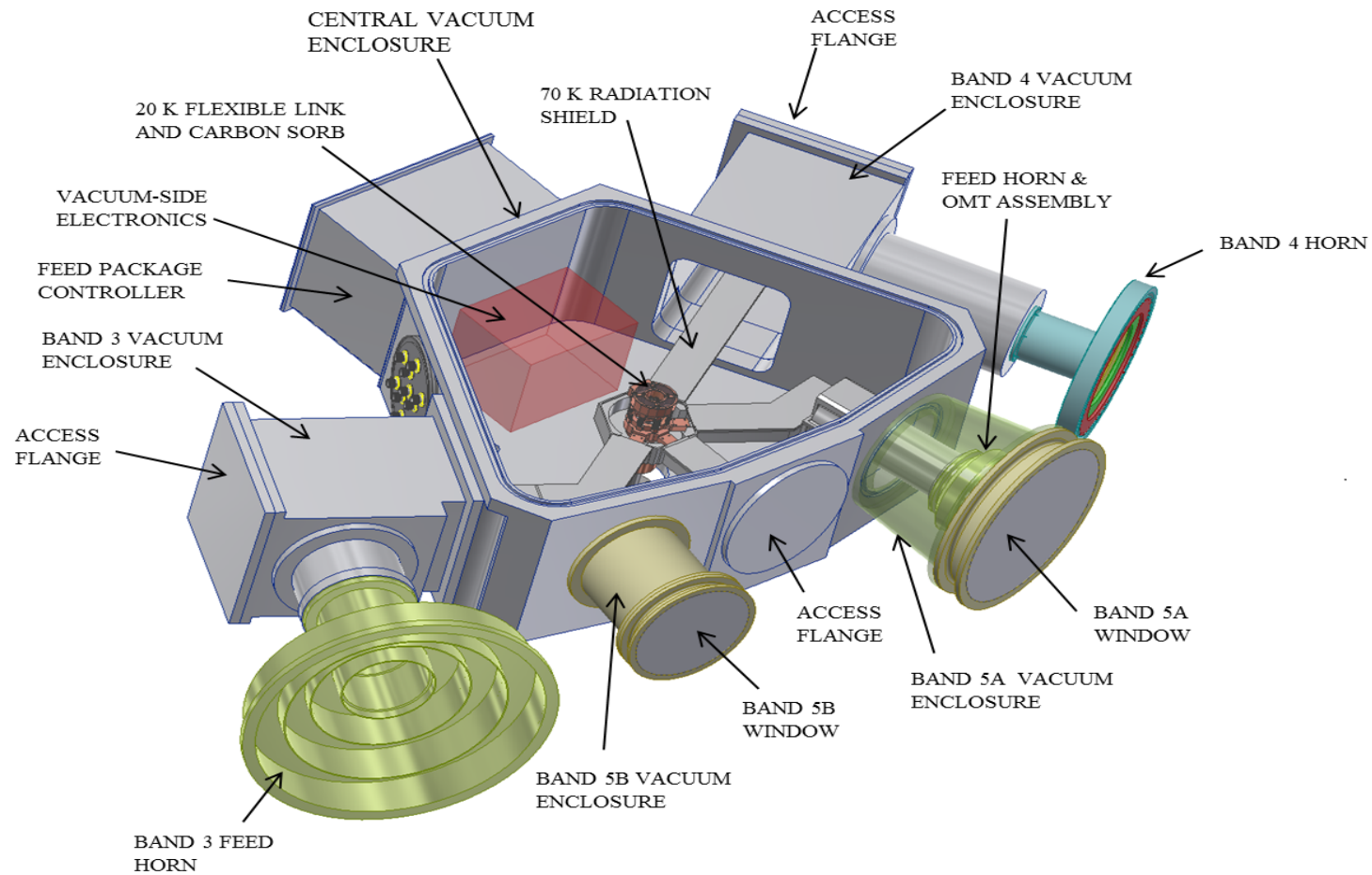


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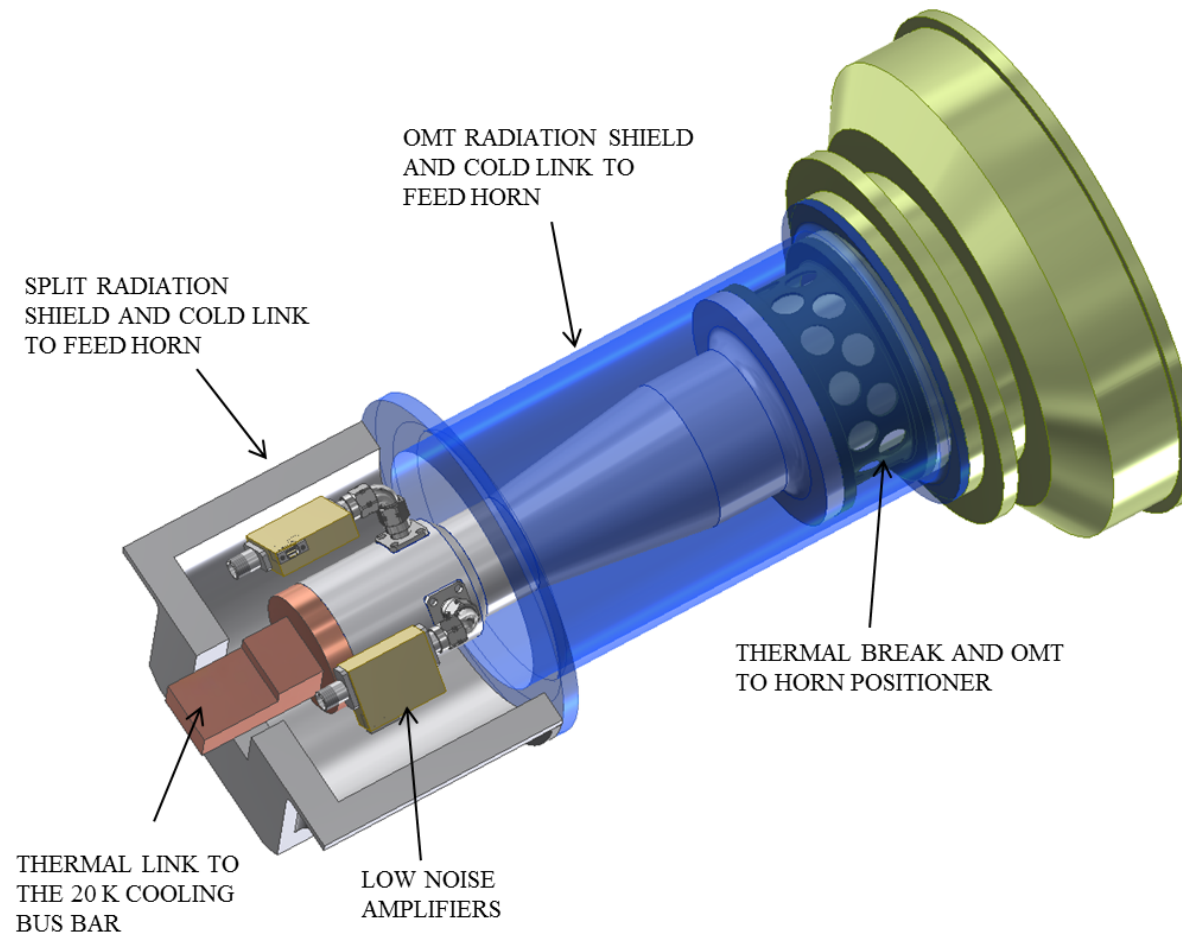
Courtesy of EMSS

Band 3,4,5 - Descriptive view



Courtesy of Prof Angela Taylor

Band 5 Feed Unit

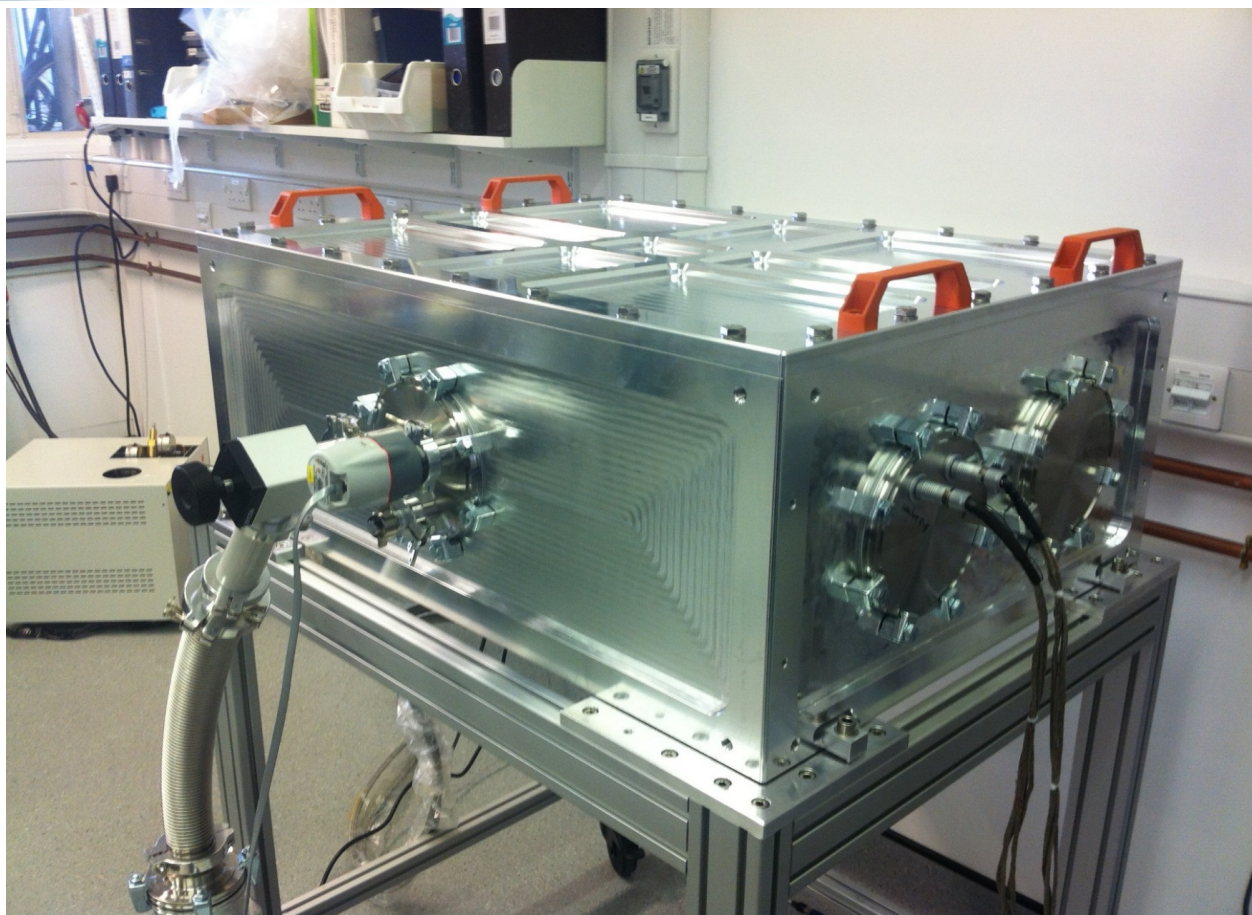


Courtesy of Prof Angela Taylor

Band 5 – Progress



DISH



Courtesy of Prof Angela Taylor

Rectangular Test Cryostat in cooldown. Cooldown was successful + no leaks.

SPFRx



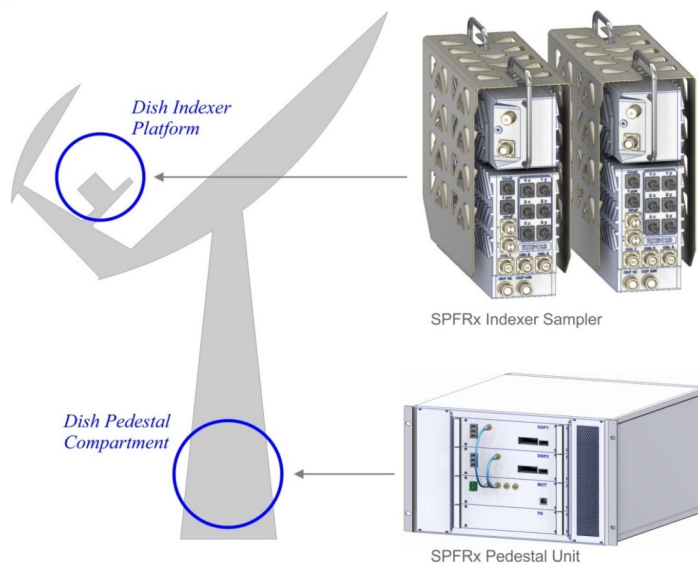
SPF Receivers

Lead Organisation: NRC Victoria Canada

SPFRx -Progress



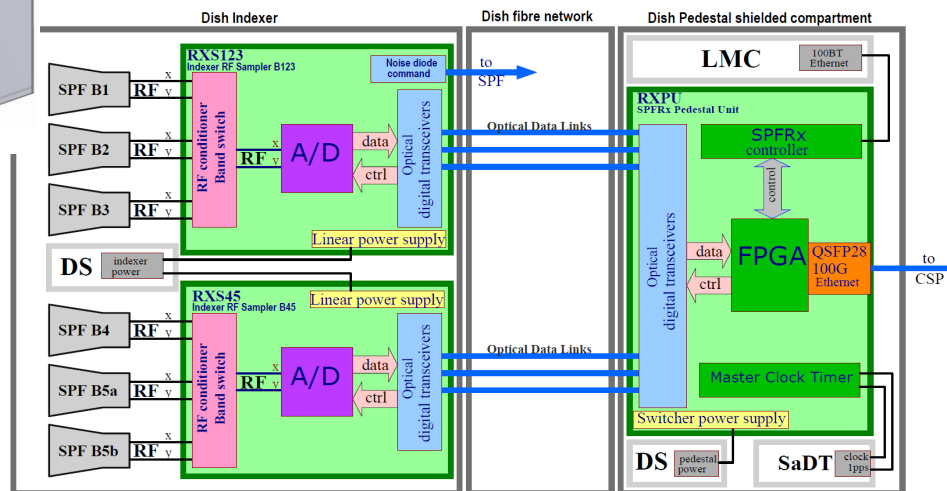
DISH



Above:
NRC SKA Mid Dish Digitizer component locations

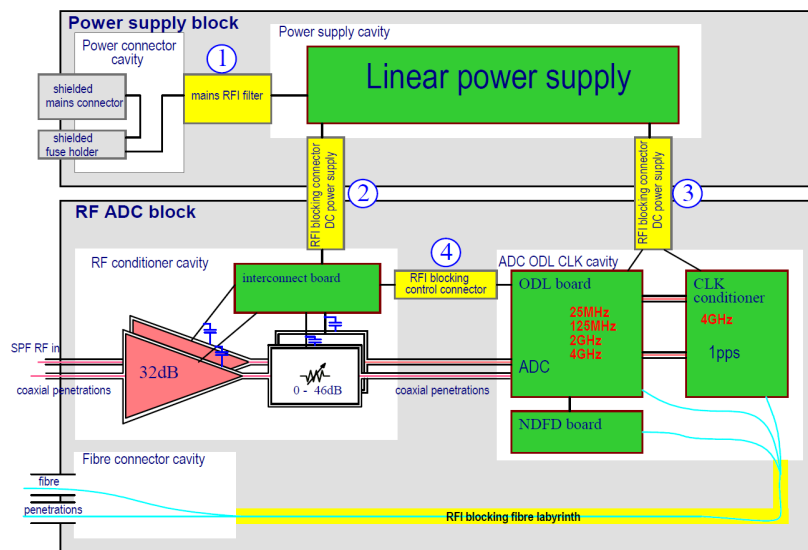
Below:

SPFRx architecture with RF samplers on Dish Indexer and digital processing and control circuits in Dish Pedestal interconnected with Optical Digital Links (ODL). SPFRx components outlined in green.

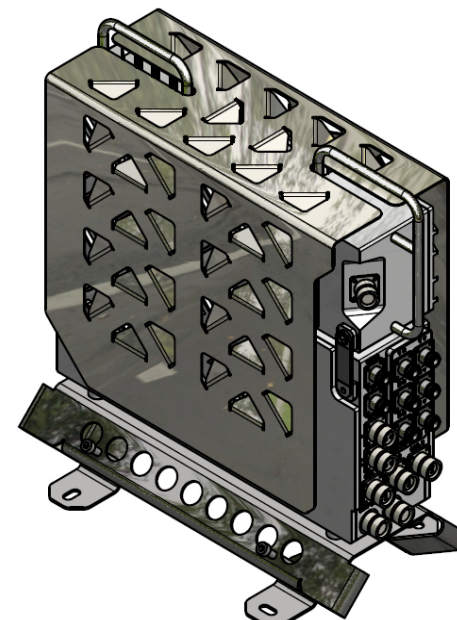


Courtesy of Kris Caputa NRC

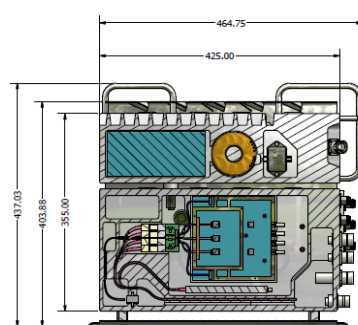
SPFRx –More Progress



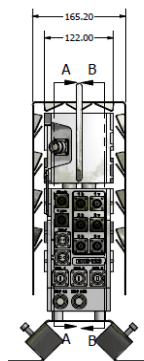
RFI shielding scheme in Indexer Sampler RXS123



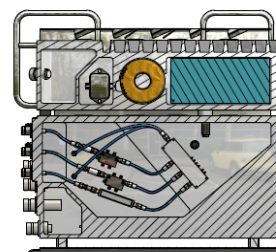
3-rendered view of indexer sampler



SECTION A-A
SCALE 1 / 4



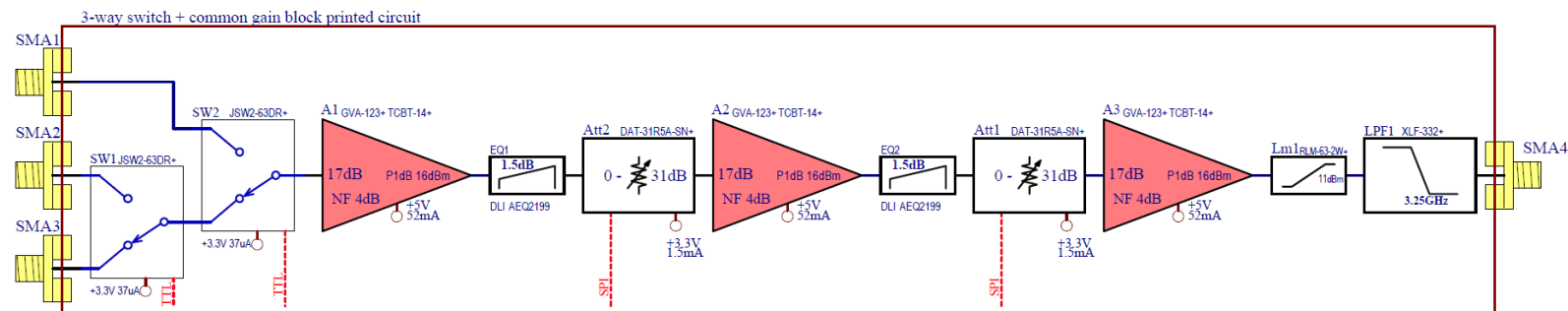
SECTION B-B
SCALE 1 / 4



Indexer sampler box RXS123, and with minimal changes RXS45

Courtesy of Kris Caputa NRC

RF chain design

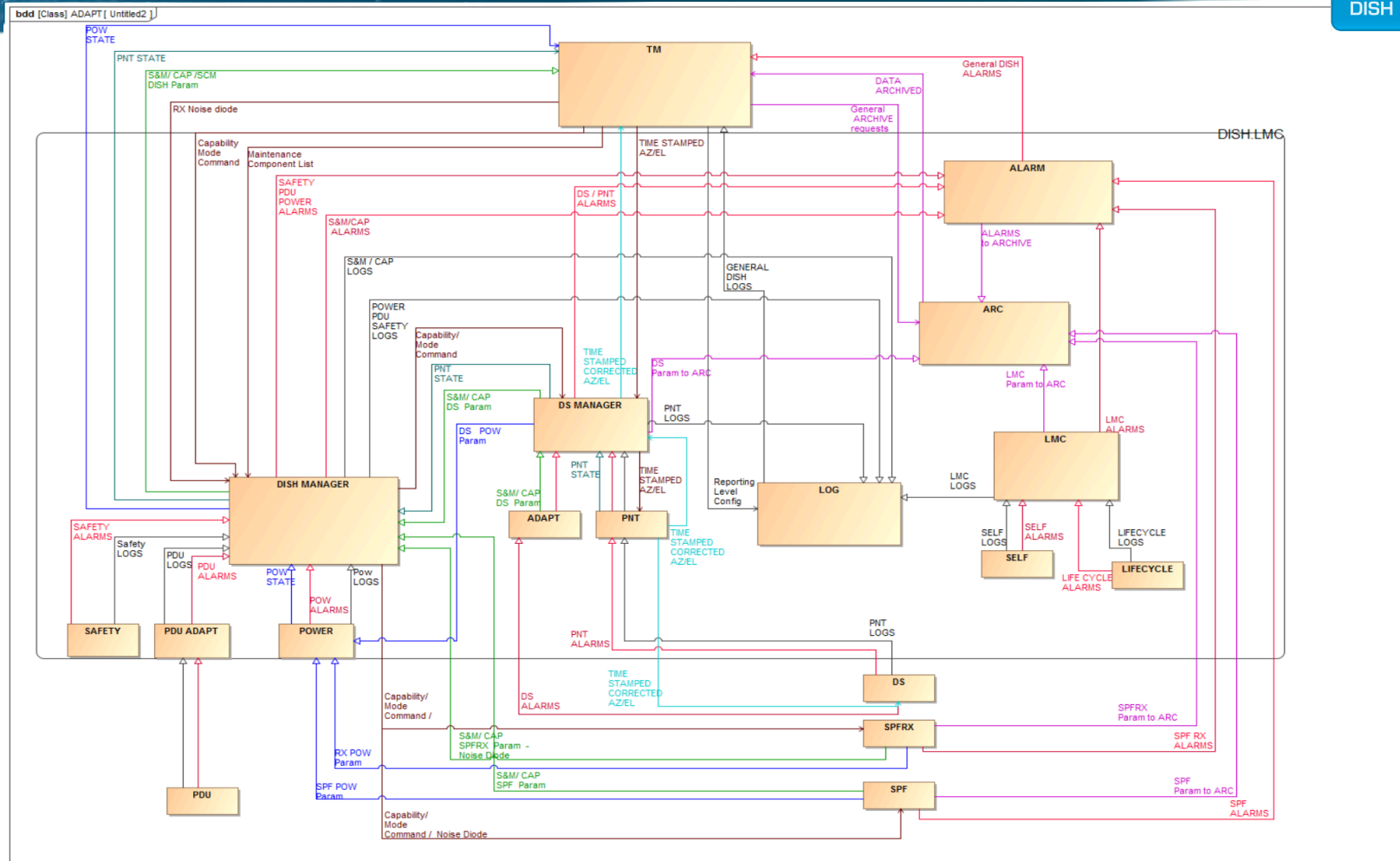


- 3-way FET RF switch
- 40 dB gain
- 0 - 42 dB variable attenuation
- 0.7 dB gain flatness in B1, B2 and B3
- NF 5 dB
- 10 dBm output limit
- MiniCircuits quote: NRE \$10k, cost \$500 in quantity 400
- Delivery in August

Local Monitoring & Control

Lead Organisation (hardware): JLRAT China
Lead Software: INAF Italy

LMC Interfaces



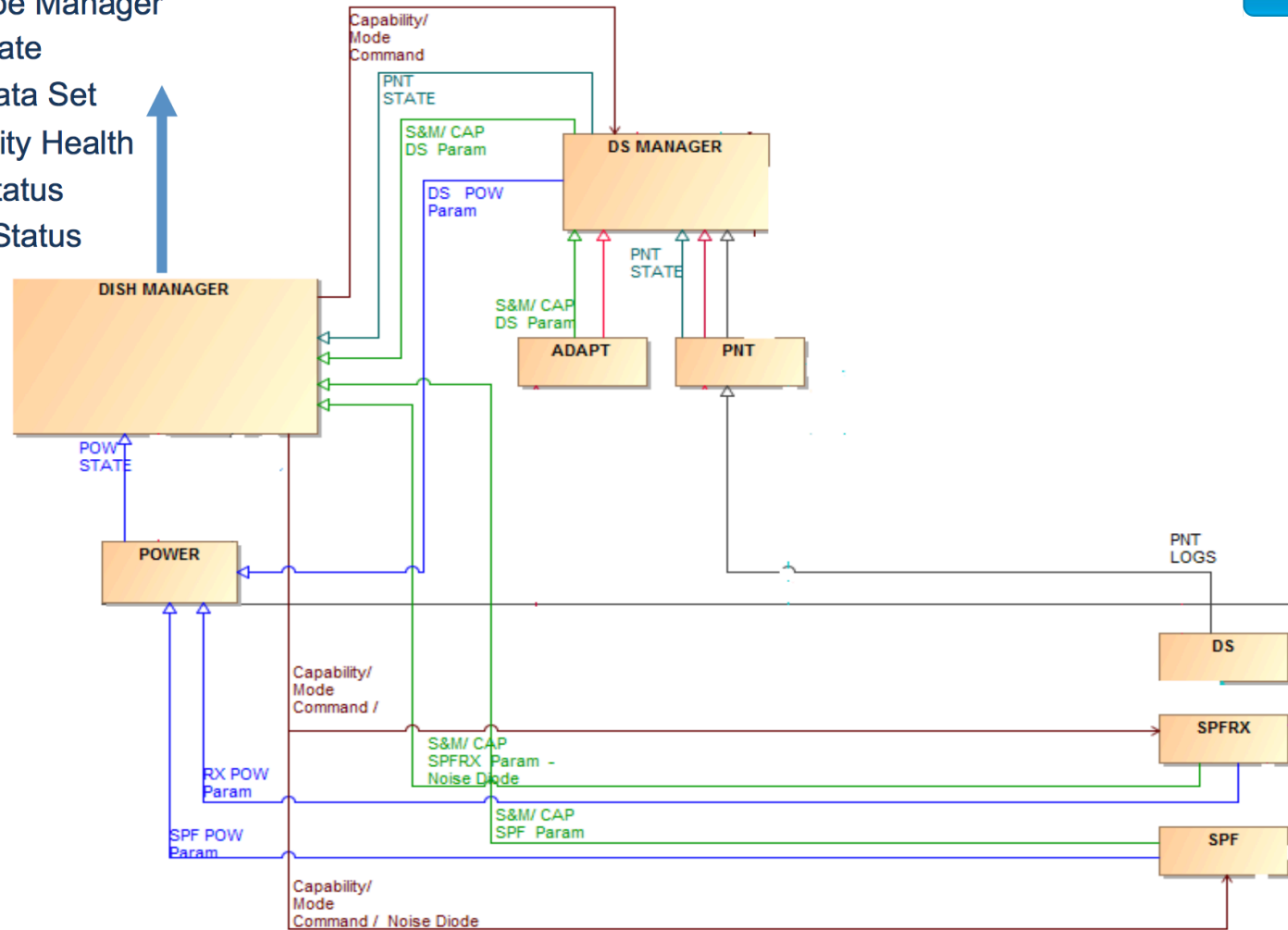
LMC Block Diagram: SKA-Mid

Courtesy of JLRAT & INAF

Architecture: Capability Management

To Telescope Manager

- DSH State
- SCM Data Set
- Capability Health
- Point Status
- Power Status



Local Monitor and Control (LMC)

- **TANGO** implemented
- Architecture of the LMC system designed
 - includes interfaces with DISH work elements and TM
- Detailed Design of the LMC system



Lets Dance the Tango!

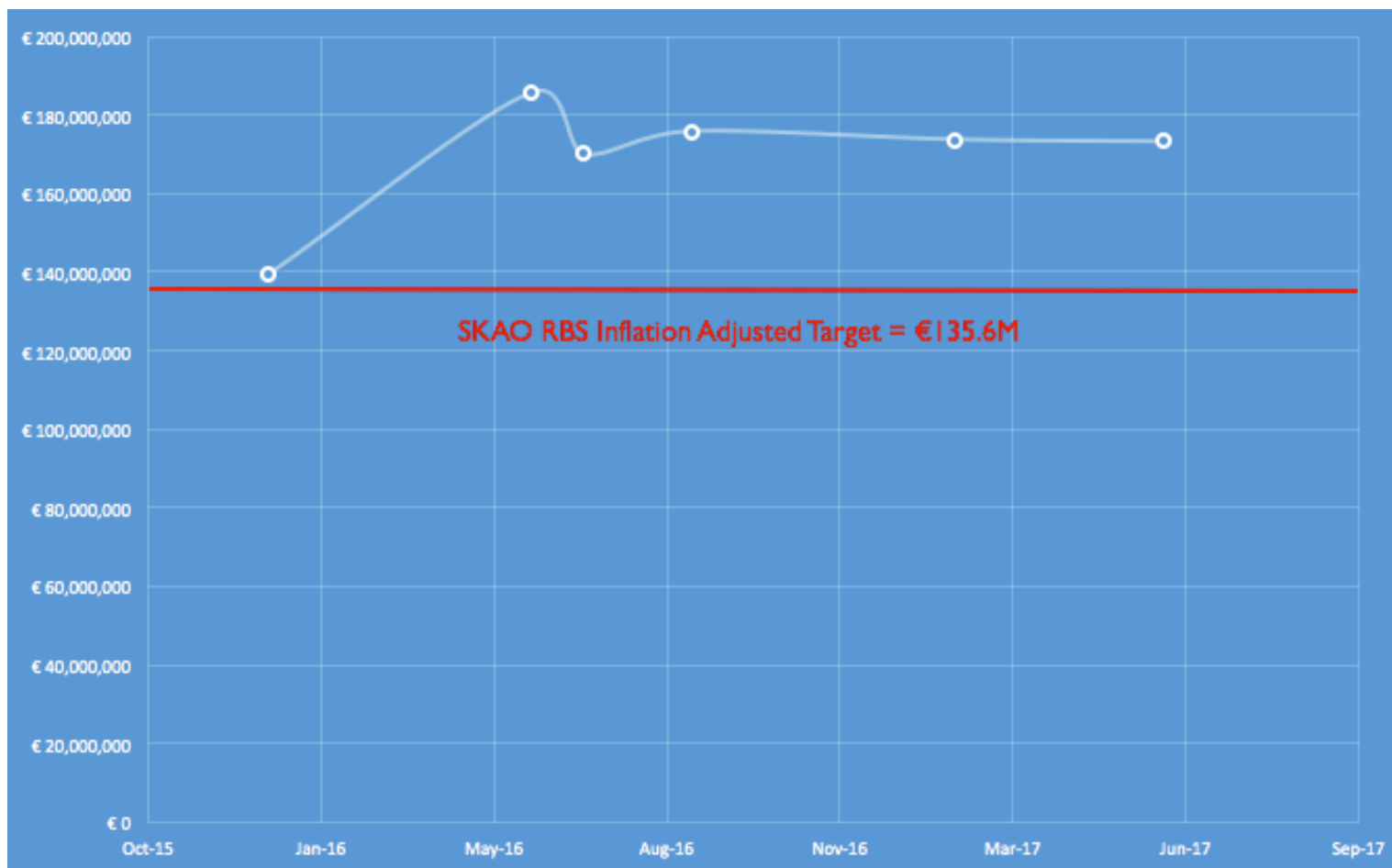
€€€€€€€€

How much?!!

Schedule – Capex Estimation



DISH



Compliant with Current Level I Rev 7 (some Rev 10+ where possible)

SCHEDULE

The length of the string is.....!

Key Dish Schedule Issue



- Dish remains under schedule pressure as it is on the SKA Critical Path.
- Dish Sub-Element Teams have made huge progress towards 1st of type Structure Prototype system in China and full Dish system ** in South Africa.
- Following is a summary of key schedule issues and milestones.

** Compliant with Current Level 1 Rev 7 (some Rev 10+ where possible)

Key Dish Element Schedule Milestones



Milestone	Est Date
SPF & SPFRx Band 5 PDR meeting	July 17
SPFRx Band 1 and 2 delta DDR closeout	August 17
Fabrication of Dish Prototype #1 ('SKA-P') in China complete	Sep 17
SKA-P testing commences in China	Oct 17
Fabrication of Dish Prototype #2 ('SKA-MPI') in China complete	Oct 17
SKA-MPI dish prototype shipped to South Africa, arrival on site	~end Dec 17
SKA-MPI limited testing on site, South Africa commences	Jan 18
SKA-MPI handed over to AIV	Mar 18
DS CDR meeting	Jul 18
Dish Element CDR (Band 2) complete	Early Q4/CY18

Dish Structure Schedule



Work Package Group	finished
Servo Systems @MTM for both Telescopes	22.11.2017
Feed Indexer Systems @SAM for both Telescopes	08.12.2017
RFI Testing (Components + Systems)	29.09.2017
DS No1 - Fabrication @ JLRAT/CETC54 [SKA-CHINA]	29.09.2017
DS No1 - Trial assembly, commissioning, FAT (China)	27.12.2017
DS No1 - Testing on site in China	27.06.2018
DS No2 - Fabrication @ JLRAT/CETC54 [SKA-MPI]	06.10.2017
DS No2 - Trial assembly, commissioning, FAT (China)	27.10.2017
DS No2 - Packing and transport to site (South Africa)	31.12.2017
DS No2 - Installation, Alignment and Limited Testing	02.03.2018
M13: SKA-MPI construction completed + hand-over to AIV-SA	02.03.2018
Test SKA-MPI Dish on site	08.06.2018
Dish Structure CDR meeting	20.07.2018

Provided By MT Mechatronics

SPF Band-1 Key Schedule Issues



- Band – 1 DDR and dDDR now conducted successfully
- Scaled prototype done.
- 1st prototype (full-scale) done.
- PCBs layout virtually completed.
- Prototype feed horn tested in Canada.
- First “Flight grade” Feed being manufactured.

SPF Band-2 Key Schedule Issues



- A relatively safe evolution of the Meerkat L-Band design.
- Revised horn prototype now tested.
- SPF Bands 2 DDR completed and successful.
- Prototype manufactured.
- Prototype undergoing lab testing.

SPF Receivers – Key Schedule Issues



- Receiver design for Bands 1 and 2 well developed
 - Receiver architecture defined
 - Digitiser location selected – Feed indexer
 - Optical Digital Link (ODL) architecture defined
 - Prototype sub-system components under test
- Band 5 split has greatly assisted development
 - Collaboration with U. Bordeaux very helpful.
 - Detailed Design Review conducted in late January 2017 – very close but a dDDR required in July '17

Key Dish Element level Risks



- Funds will need to continue to be made available for DC Members to maintain involvement and continue work during the Pre-Construction Phase through to end 2018, if not beyond.
- Impact of SKA Cost Cap and the ongoing commitment of member nations to fund the SKA to completion.
- IP – SKAO assumption is that Background and Project IP will be made available and released to the SKAO for the purpose of open market competition and use for the project.



Its been Great Working With
Team Dish
Keep Running Onward Team

Dish Consortium Leader

Roger Franzen

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SKA Dish Consortium Leader

Dish Consortium Project Manager

Susan Stopford

B Appl Sci (Hons) MIP Patent & Trade Marks Attorney

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