ESTRELA MEETING
January, 2009 Medicina (Bologna, Italy)

SKADS

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Introduction

4 Years

New Components

New Architectures

New Technologies

New Software Algorithms

SKA

26 Partners

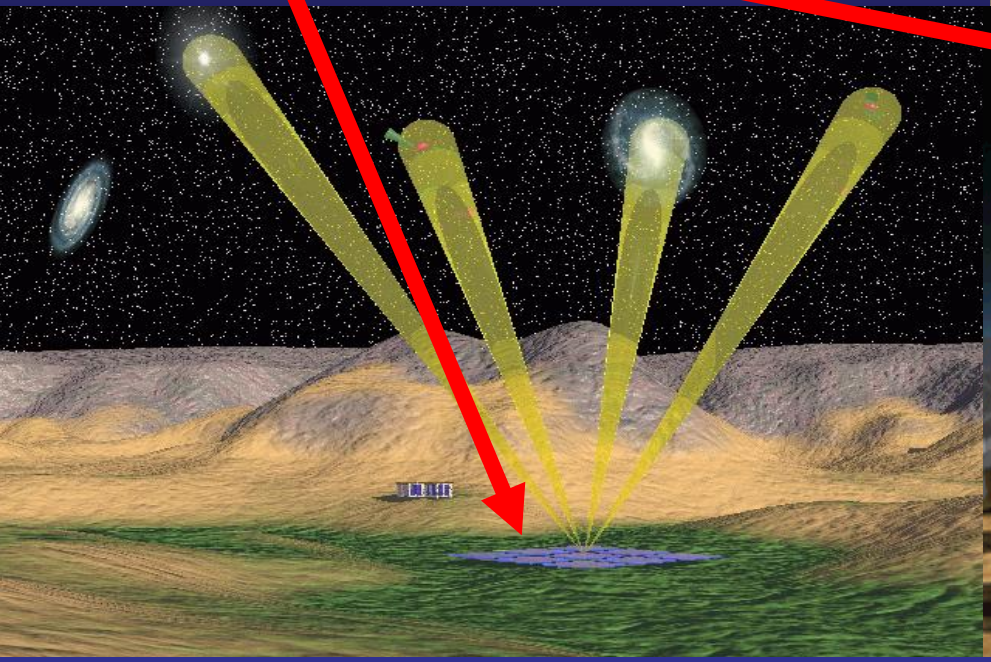
13 Countries

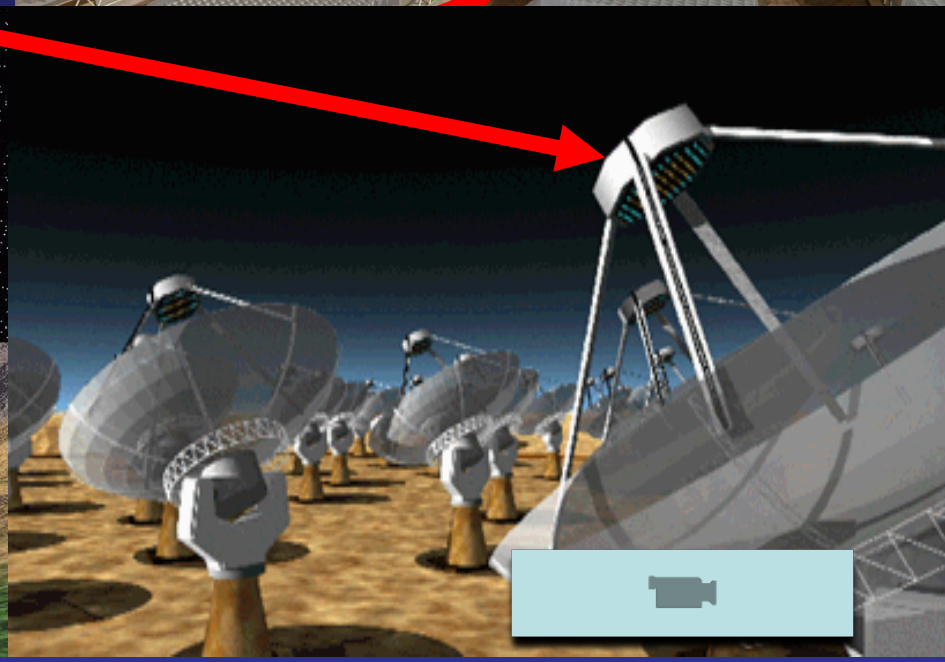
SKADS in SKA

Reference Design:

- Small Dish equipped by single wide band feed and/or FPA (from ~1GHz to 20GHz) both in the core and in the remote stations
- Aperture Array only in the core (<1.5GHz)

SKA key technology!





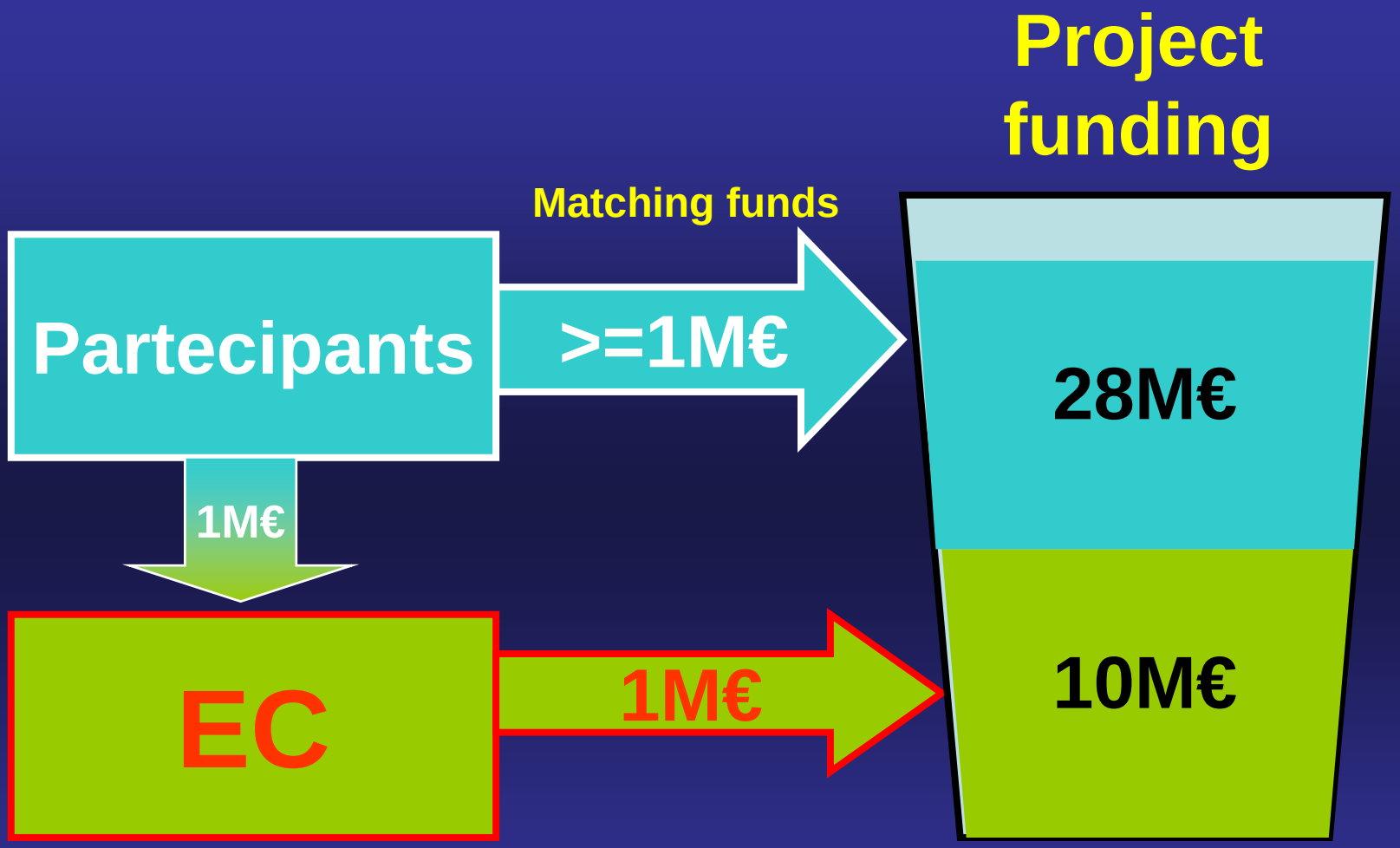
-High sensitivity - Large FOV - Multibeam

Core technology for small dish+FPA

SKADS brief history

- First meeting in December 2002
- Proposal to EC in March 2004
- Contract signature in November 2005
- First founds in late 2005
- Formal start of project July 1st 2005
- Project was fully underway 3.5 years after conception!

A co-funded project



SKADS partners

1. ASTRON	2. University of Manchester	3. JIVE	4. Observatoire de Paris	5. INAF-IRA
6. Fundacion General de la Universidad de Alcalá	7. Max Planck Institut für Radioastronomie	8. Oxford University	9. CSIRO, Australia	10. Pushchino Radio Astronomy Observatory
11. National Research Council, Canada	12. National Research Foundation, South Africa	13. Torun Centre for Astronomy	14. Chalmers University	15. Cambridge University
16. Kapteyn Institute, Rijksuniversiteit Groningen	17. University of Leiden	18. Cardiff University	19. Glasgow University	20. Swinburne University of Technology
25. Université d'Orléans	26. Centre National de la Recherche Scientifique	28. University of Leeds	29. Universidad de València	30. OMMIC, France
31. IST/CENTRA, Portugal				

21 from 9 EU

5 from 4 non- EU

After the SKADS start:

Some AU Univ. out

Portugal in

Organizational structure

DS 4

Technical Foundation and Enabling technology
2-PAD Demonstrator

DS4-T1: Front End Technologies

DS4-T2: Signal conditioning and Digitization

DS4-T3: RFI Mitigation Strategies

DS4-T4: Wideband Integrated Antennas

DS4-T5: Beamforming at Patch and Tile level

DS4-T6: 2-PAD Demonstrator

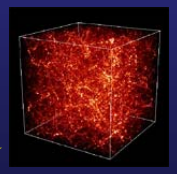
DS 1

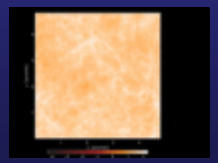
- Management of SKADS
- Leading partecipants: ASTRON

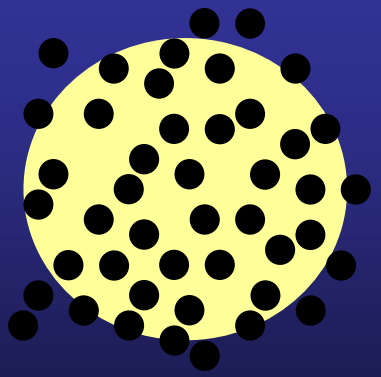
Arnold van Ardenne

DS 2

What science?





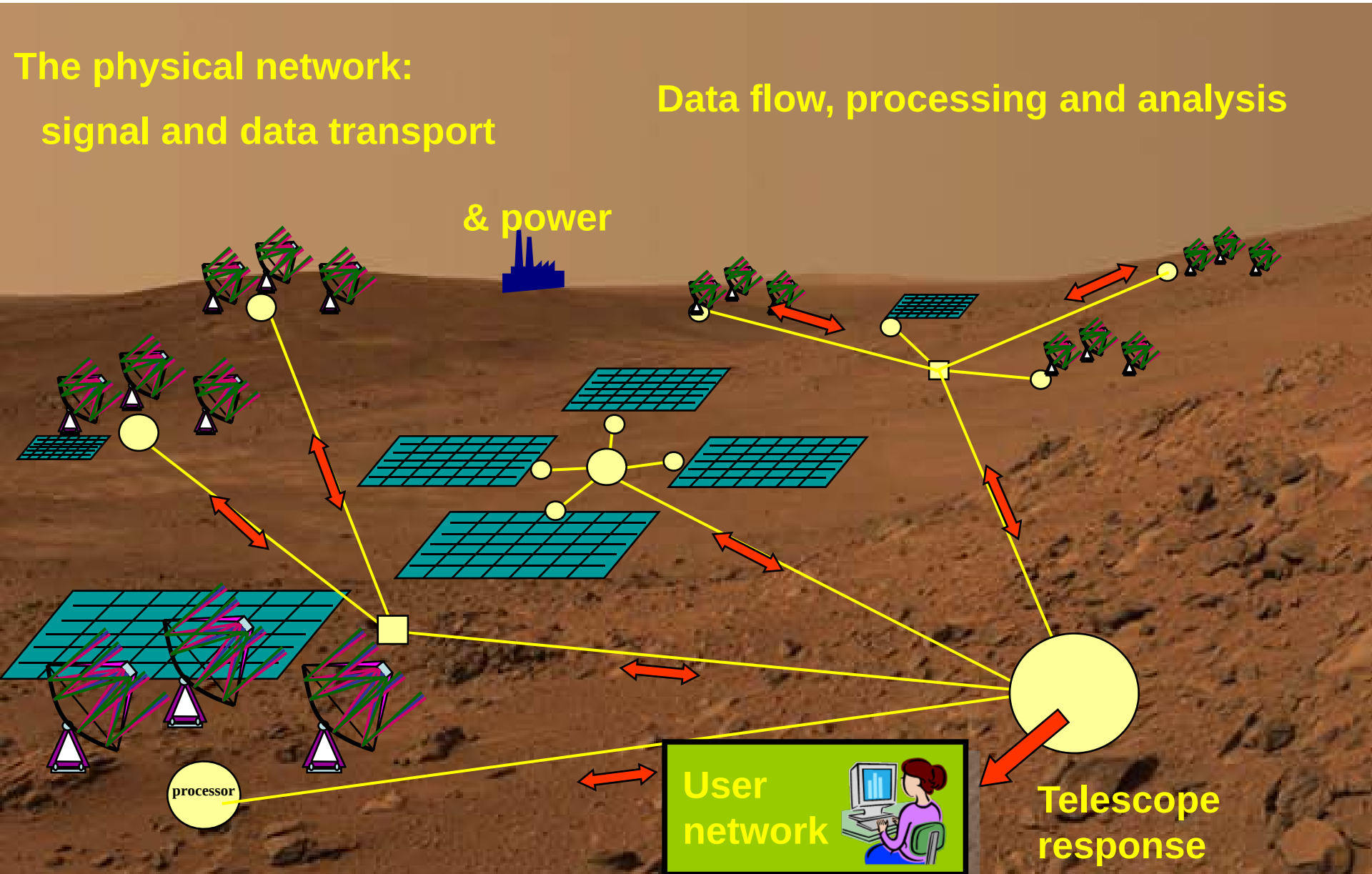


DS 3

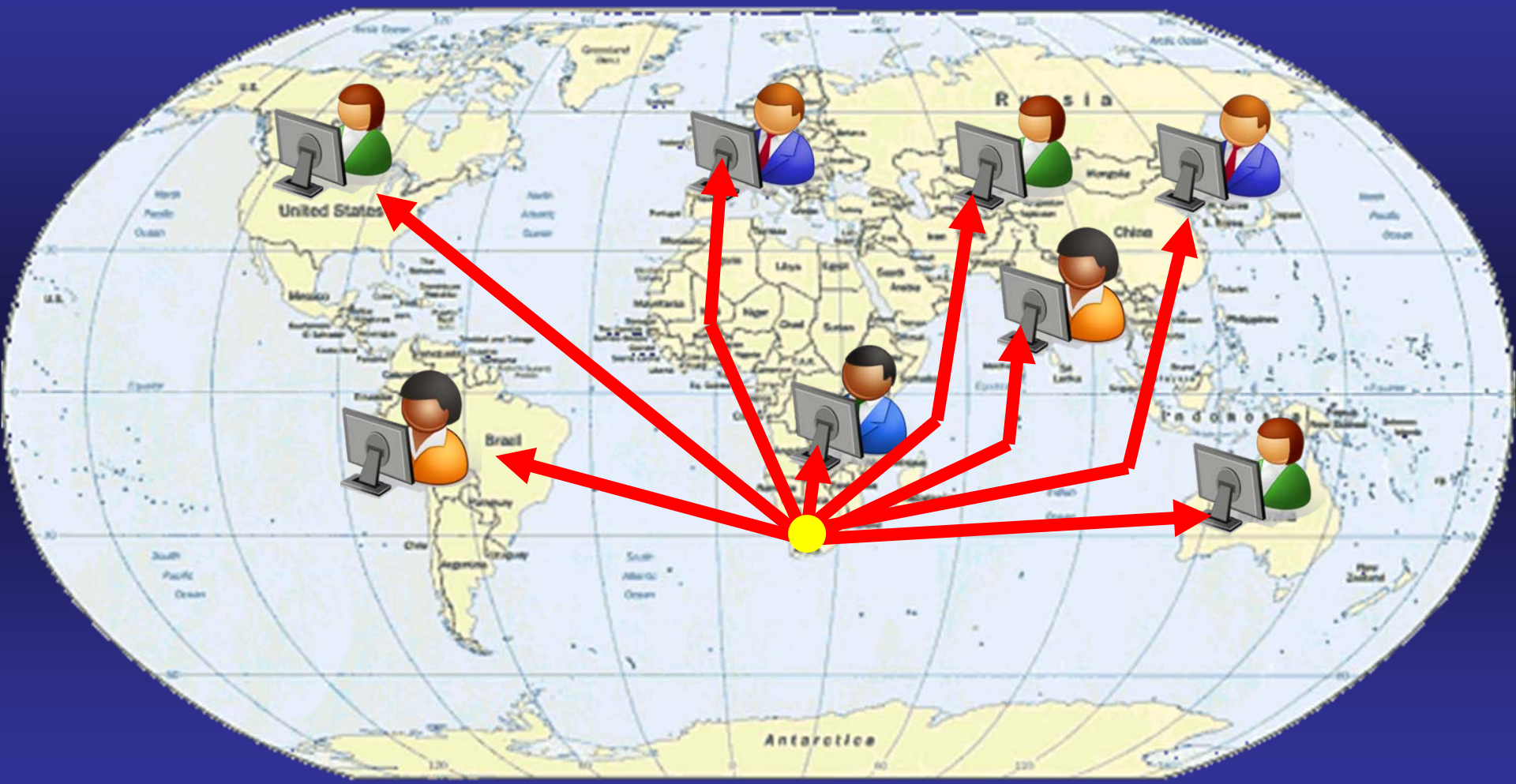
The physical network:

signal and data transport

Data flow, processing and analysis



DS 3



DS4, DS5 & DS6

2-PAD

2

Polarisation

All

Digital tile

R&D at intra-tile level

EMBRACE

Electronic

Multi Beam

Radio Astronomy

ConcEpt

R&D at tile and station level

Mass production

BEST

Basic

Element

for SKA

Training

R&D at station level

DS 7 and DS 8

- Assessment of Preparatory Work and Studies
- Leading partecipants: OPAR

Wim van Driel

- Overall System Design and Preliminary SKA plan
- Leading partecipants: Univ. Manchester

Peter Wilkinson

Dates to remember

- T0 = July 1st 2005
- Midterm Review (~T0+24) = October 12th 2007
- End of the project = July 2009 (4 years duration)

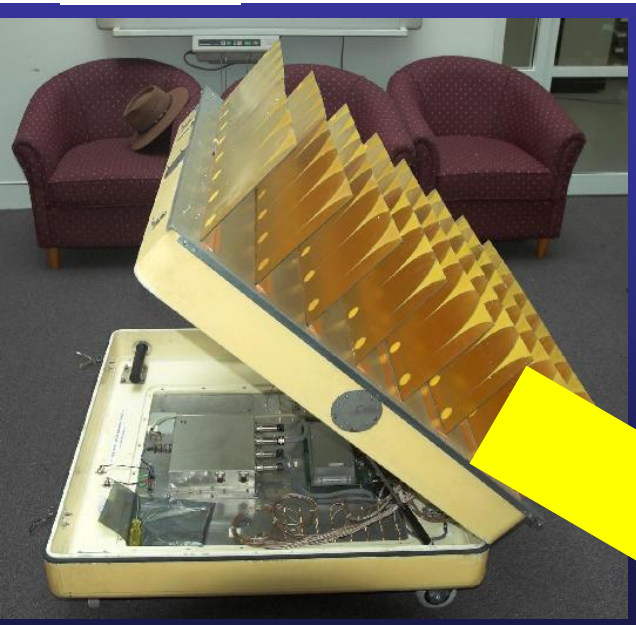
SKADS on the web

www.skads-eu.org

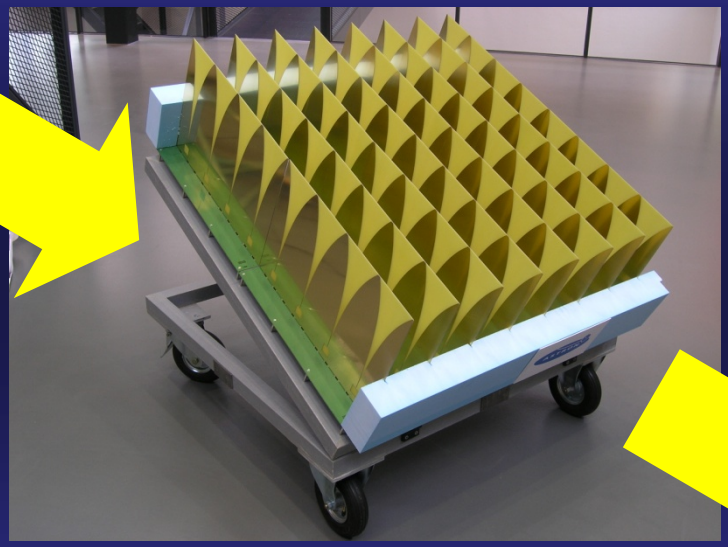
Part 2: The demonstrators

1. 2-PAD
2. EMBRACE
3. BEST

DS4 2-PAD



THEA

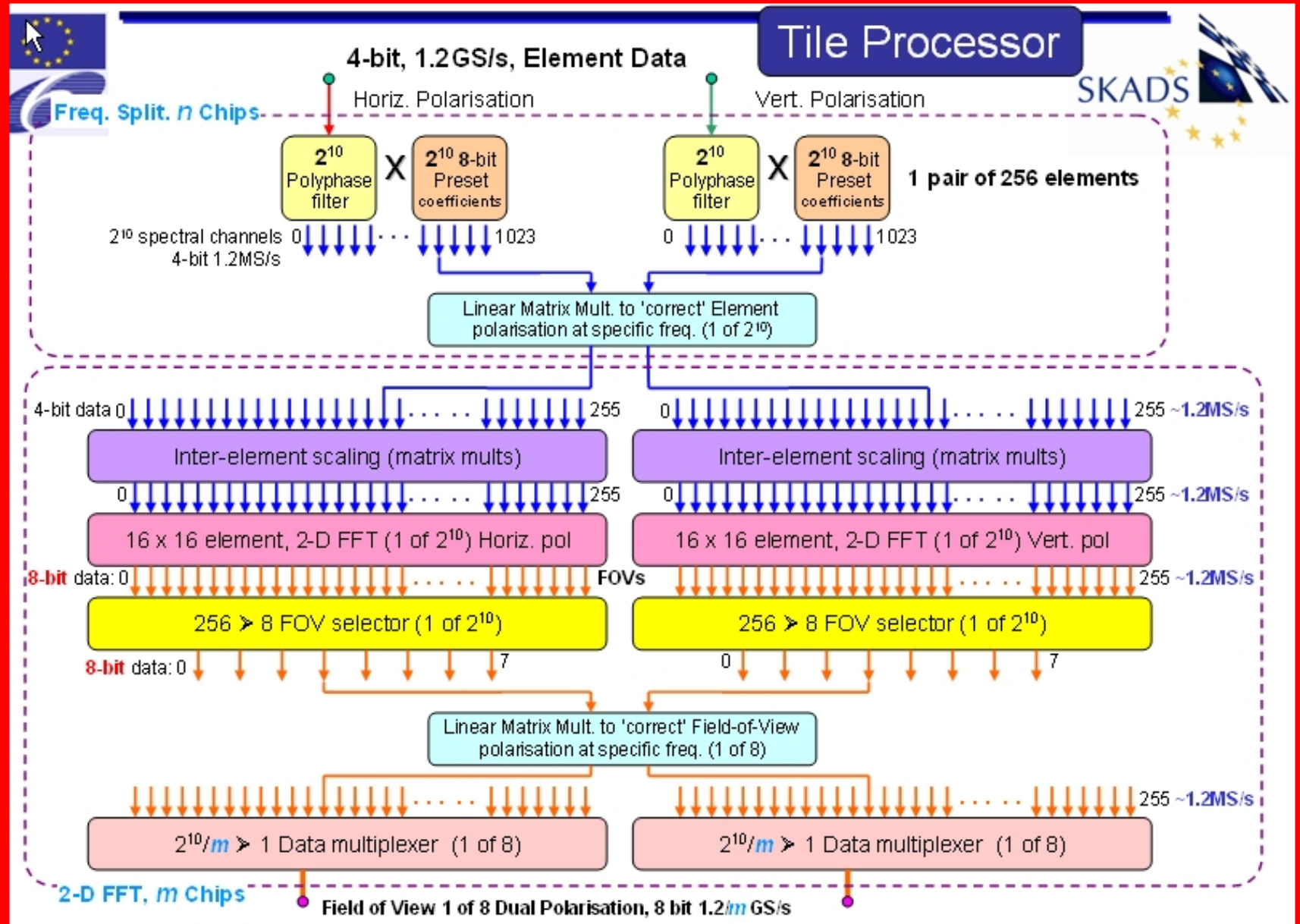


EMBRACE

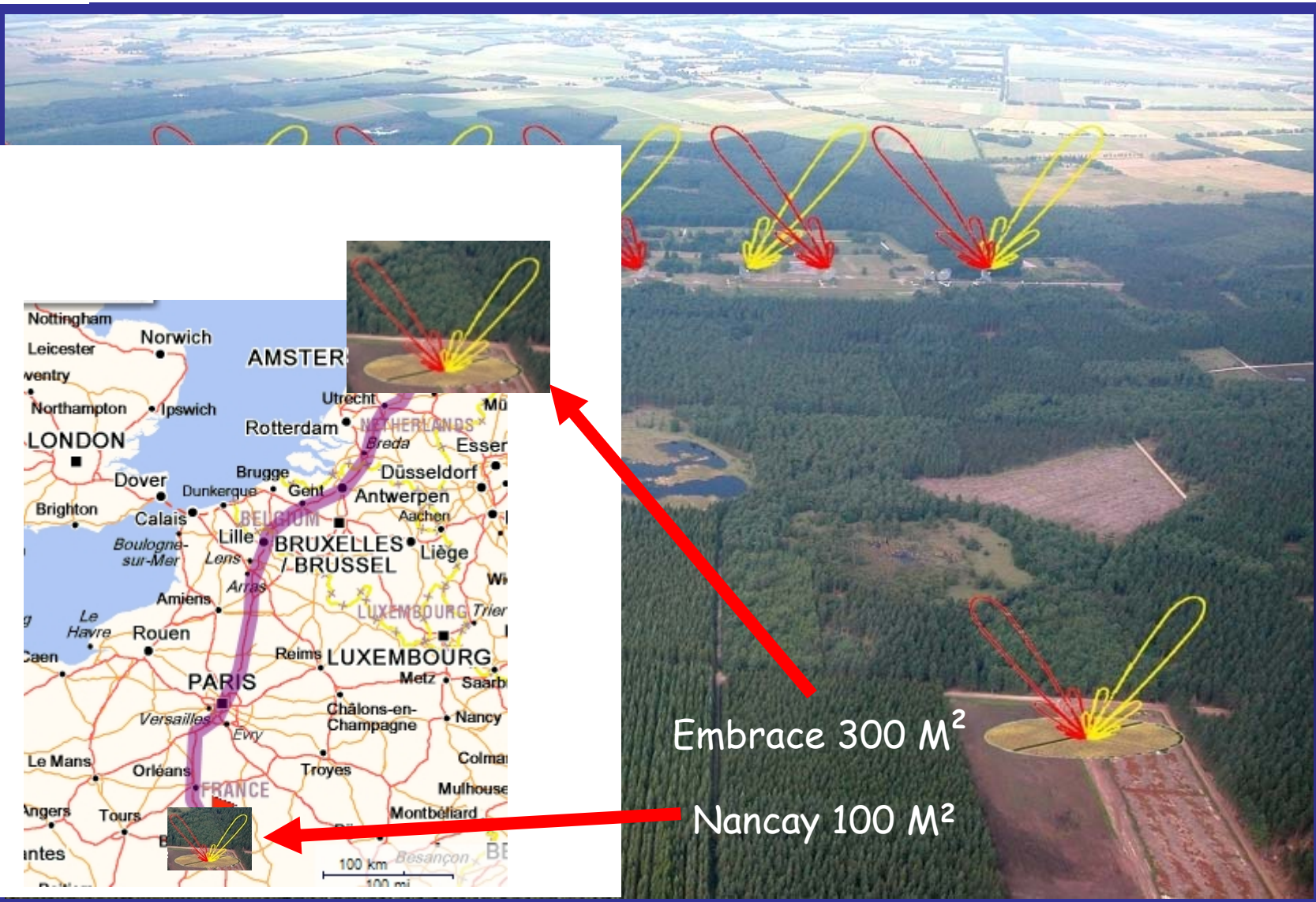
?

2-PAD

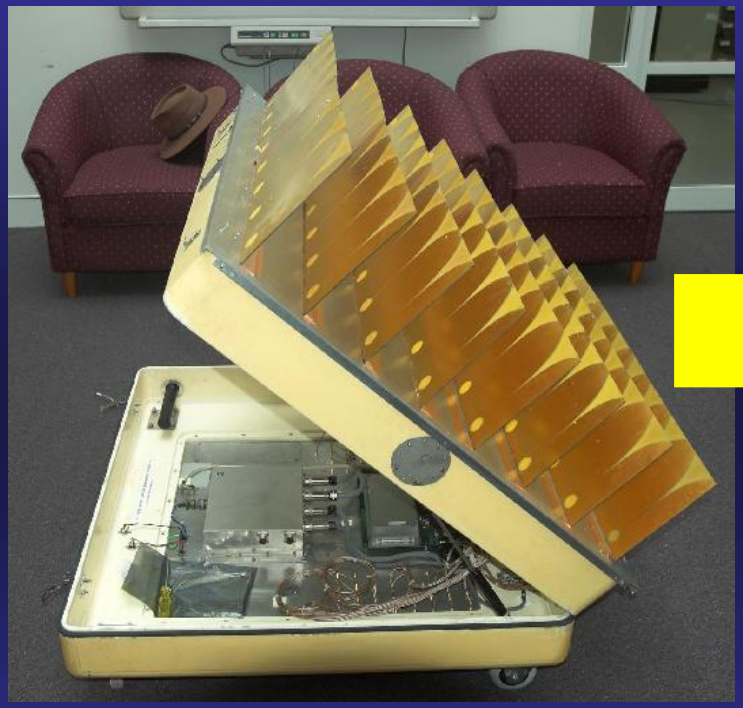
All Digital tile

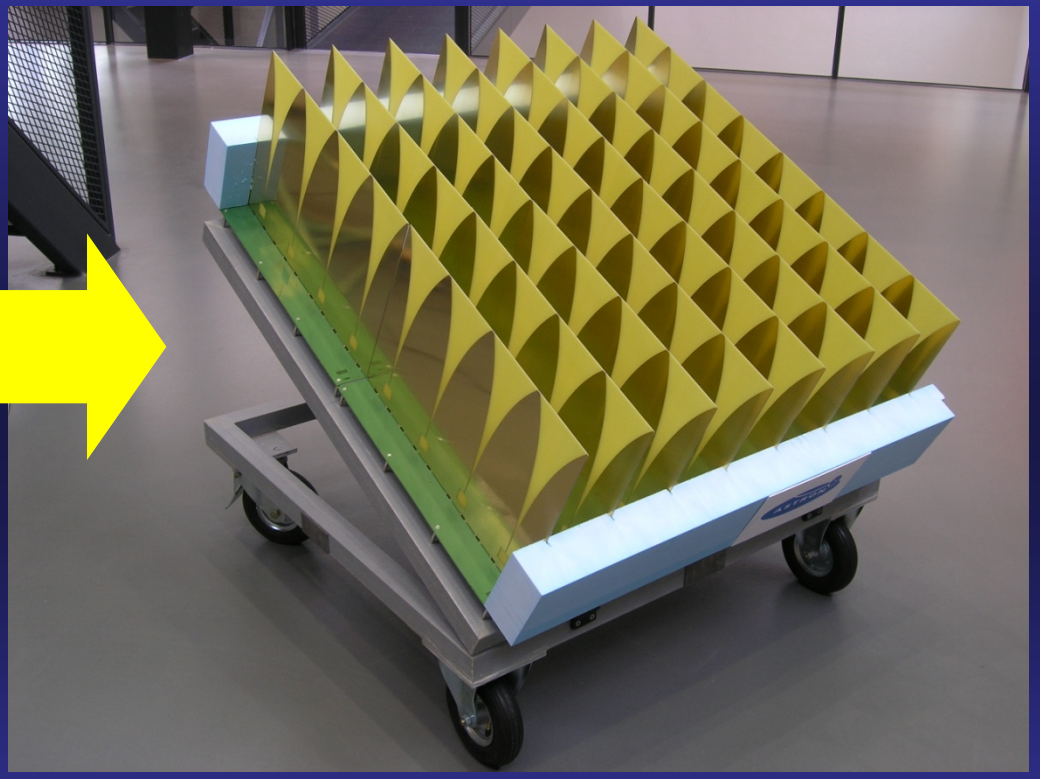


DS5 EMBRACE


Nottingham
Norwich
Leicester
Northampton
Ipswich
LONDON
Dover
Brighton
Calais
Boulogne-sur-Mer
Dunkerque
Brugge
Gent
Lille
Lens
Arras
Amiens
Le Havre
Rouen
Caen
PARIS
Versailles
Evry
Le Mans
Orléans
Tours
Troyes
Reims
Rotterdam
Utrecht
Breda
Antwerpen
Aachen
BRUXELLES / BRUSSEL
Liège
Düsseldorf
Esser
LUXEMBOURG
Metz
Châlons-en-Champagne
Nancy
Mulhouse
Montbéliard
Besançon
100 km
Embrace 300 M²
Nancay 100 M²

From THEA to EMBRACE





~10K€/tile

<1K€/tile

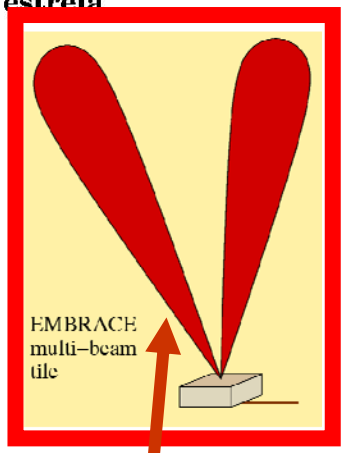
EMBRACE Requirement Specs

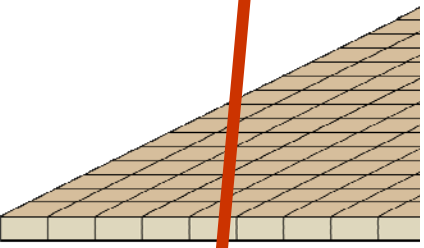
Frequency range	500 MHz - 1500 MHz.
Polarisation	Single polarisation
Physical Collecting area	~300 m^2 WSRT (100 m^2 Nançay)
Aperture Efficiency	> 80%
Electronic Scan Range	+-45 deg
T_{sys}	<100K @ 1GHz (aim for 50K)
Element phase control accuracy	3 bit (also time delays)
Instantaneous bandwidth	40 MHz (increased further with time delays)
Dynamic range A/D Converter	60dB (effective # of bits)
Number of independent FoV (RF beams)	2
No of digital beams	8+

System level overview

estrela

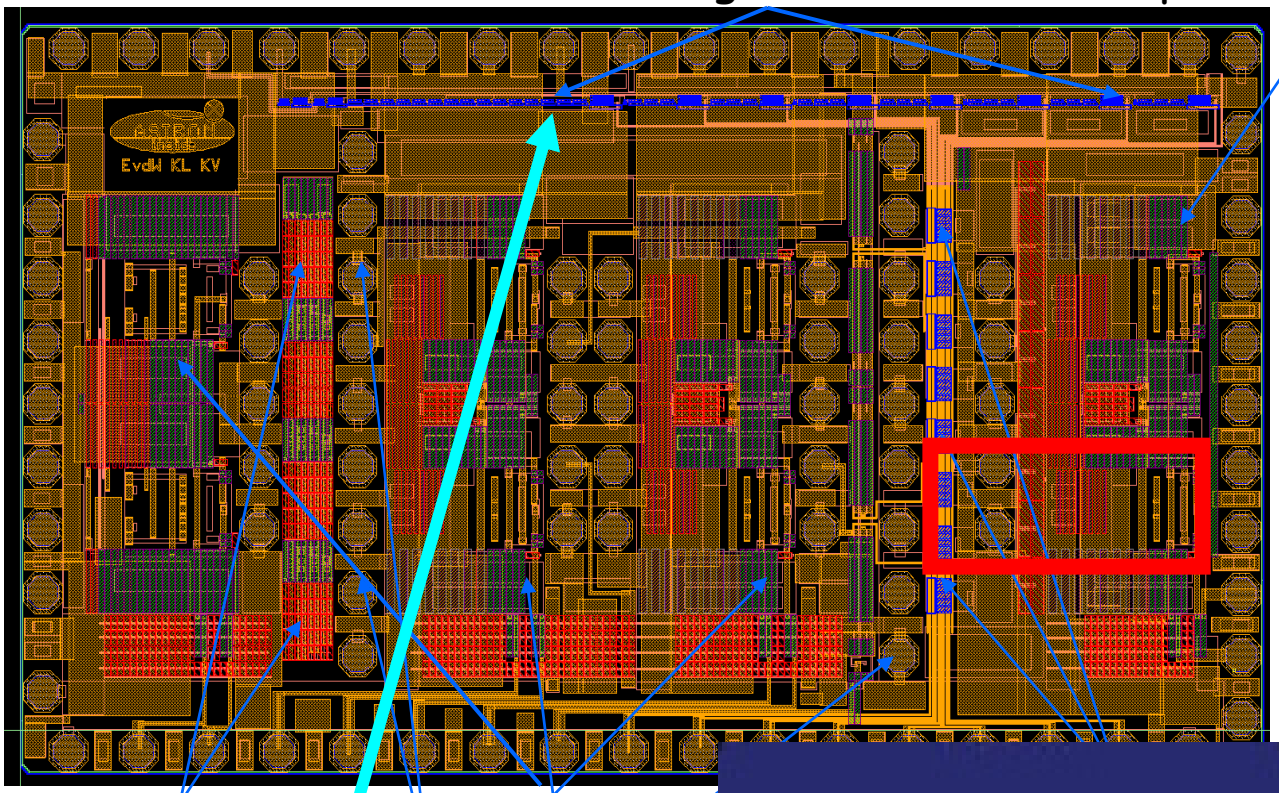
INAF





Layout of the RF BF chip (ASTRON)

Digital Controls Output amplifier



Polyphase Filter Butter amp ining

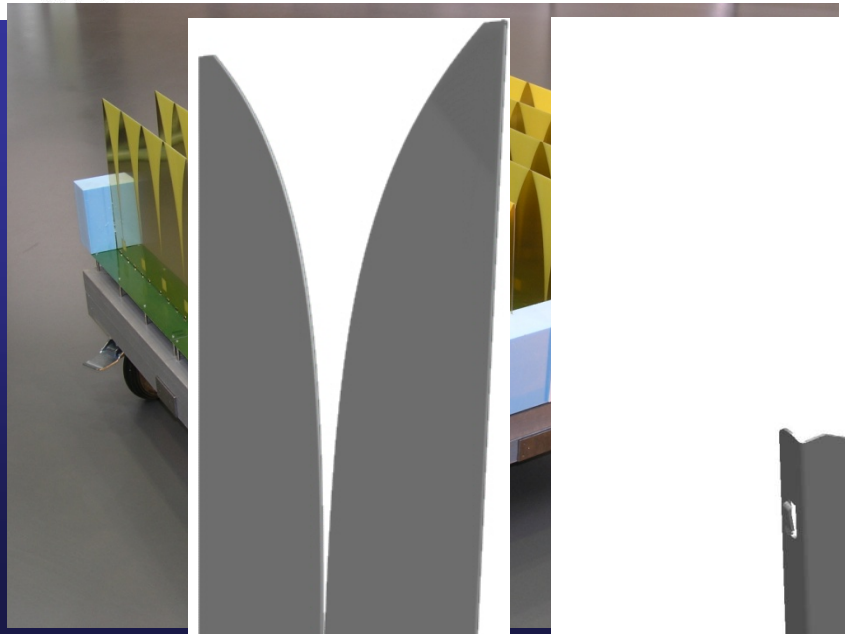
Pads for probing

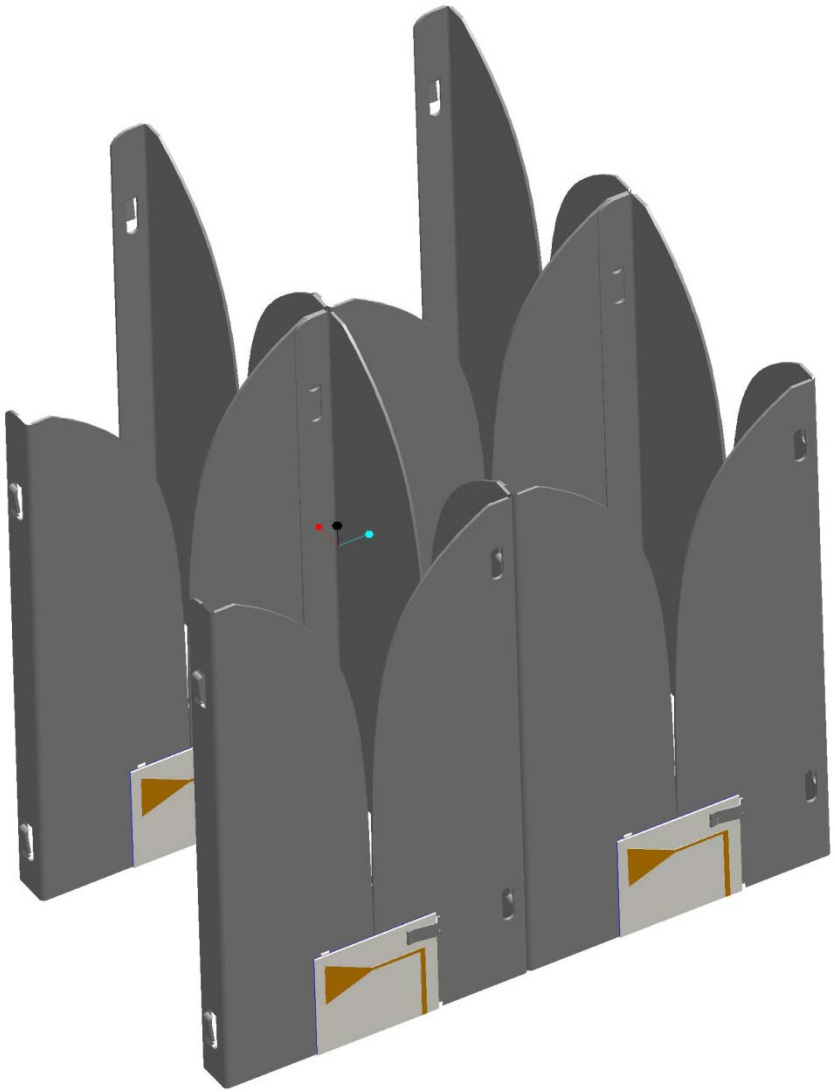
Analog beamforming at tile level

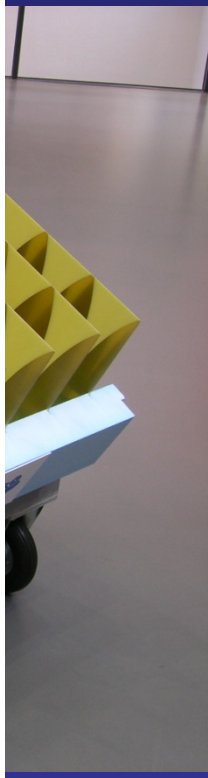
Digital beamforming at station level

LOFAR

The antenna tile are improving



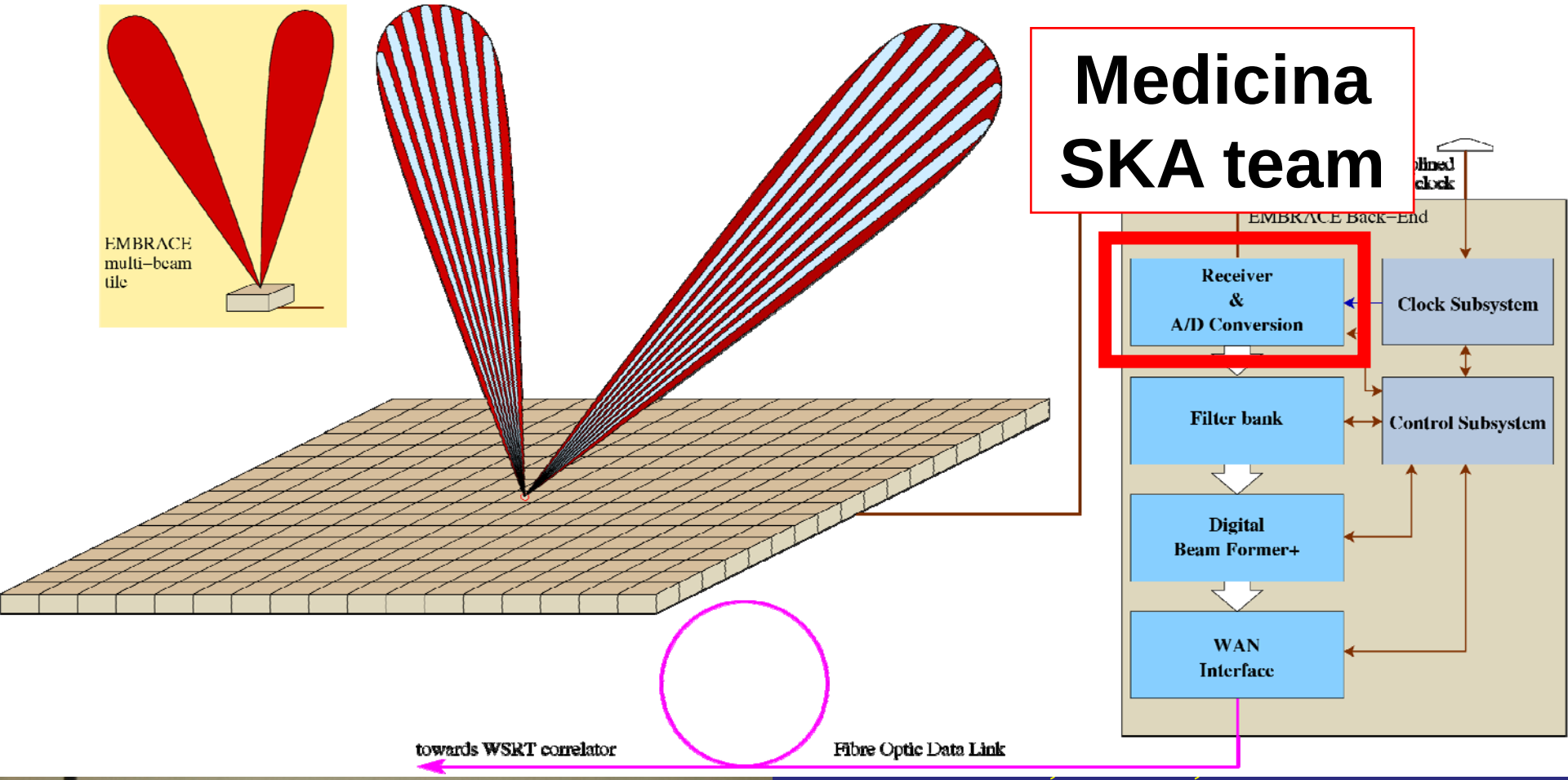




The EMBRACE receiver

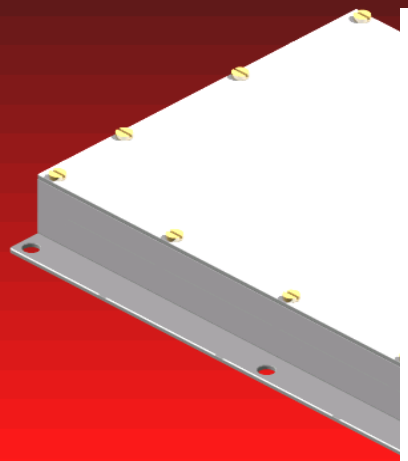
estrela

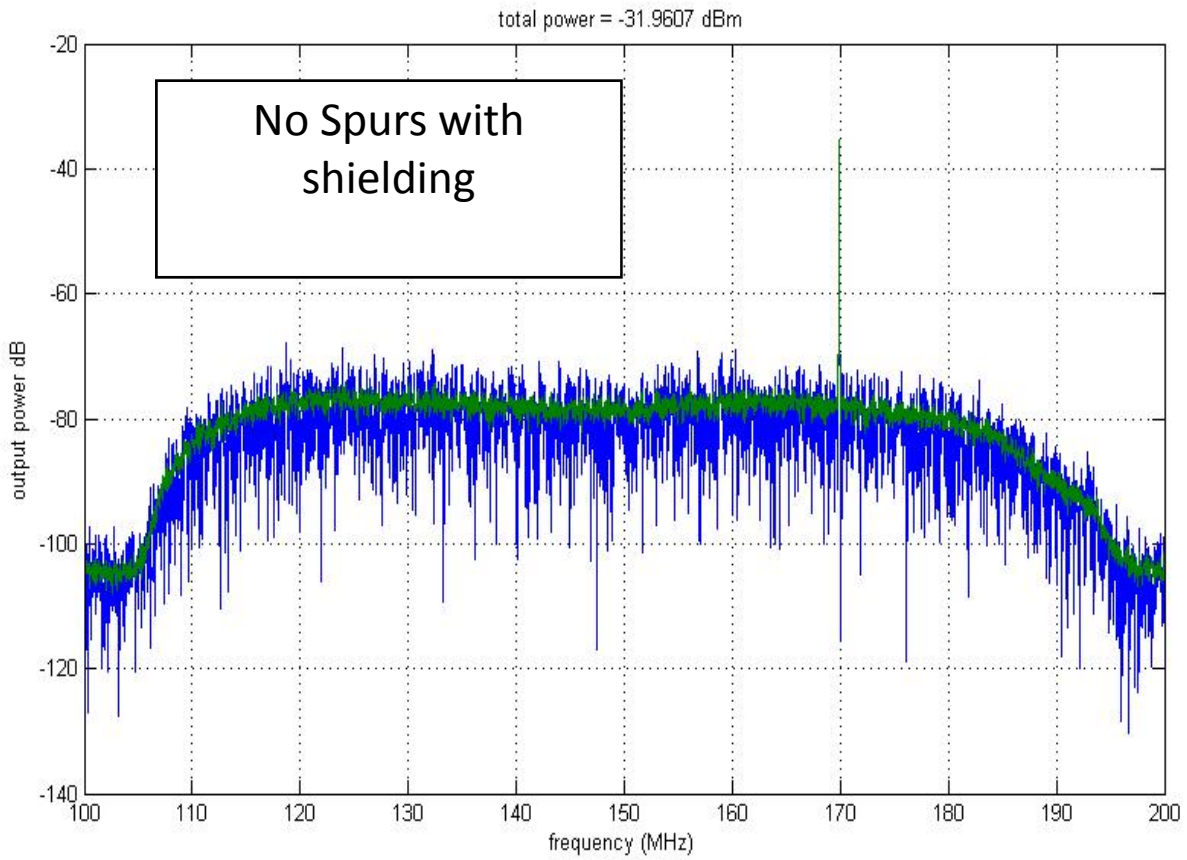
INAF



- Eurocard Standard Dimension (160x100)

The receiver shielded box



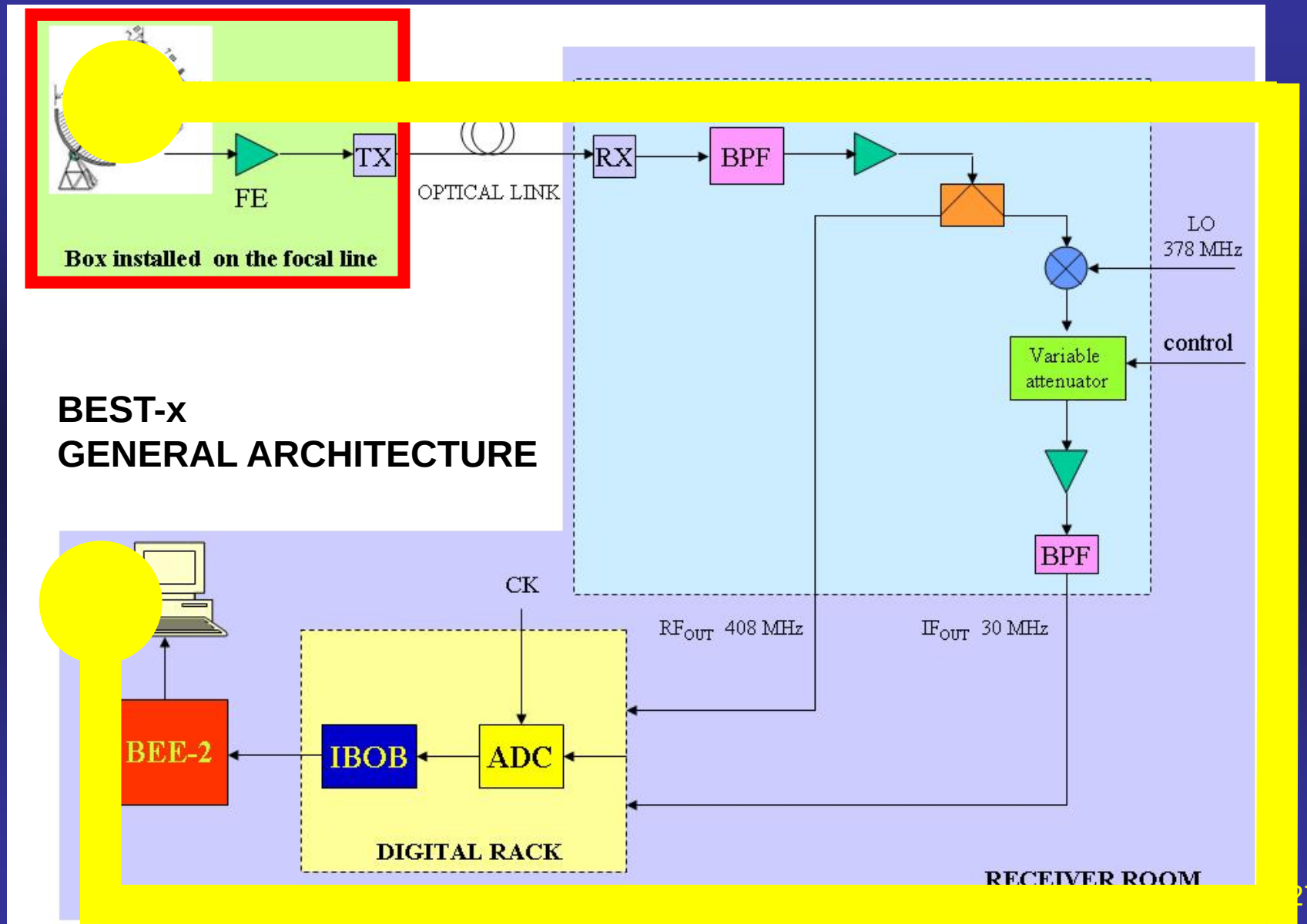


DS6 BEST

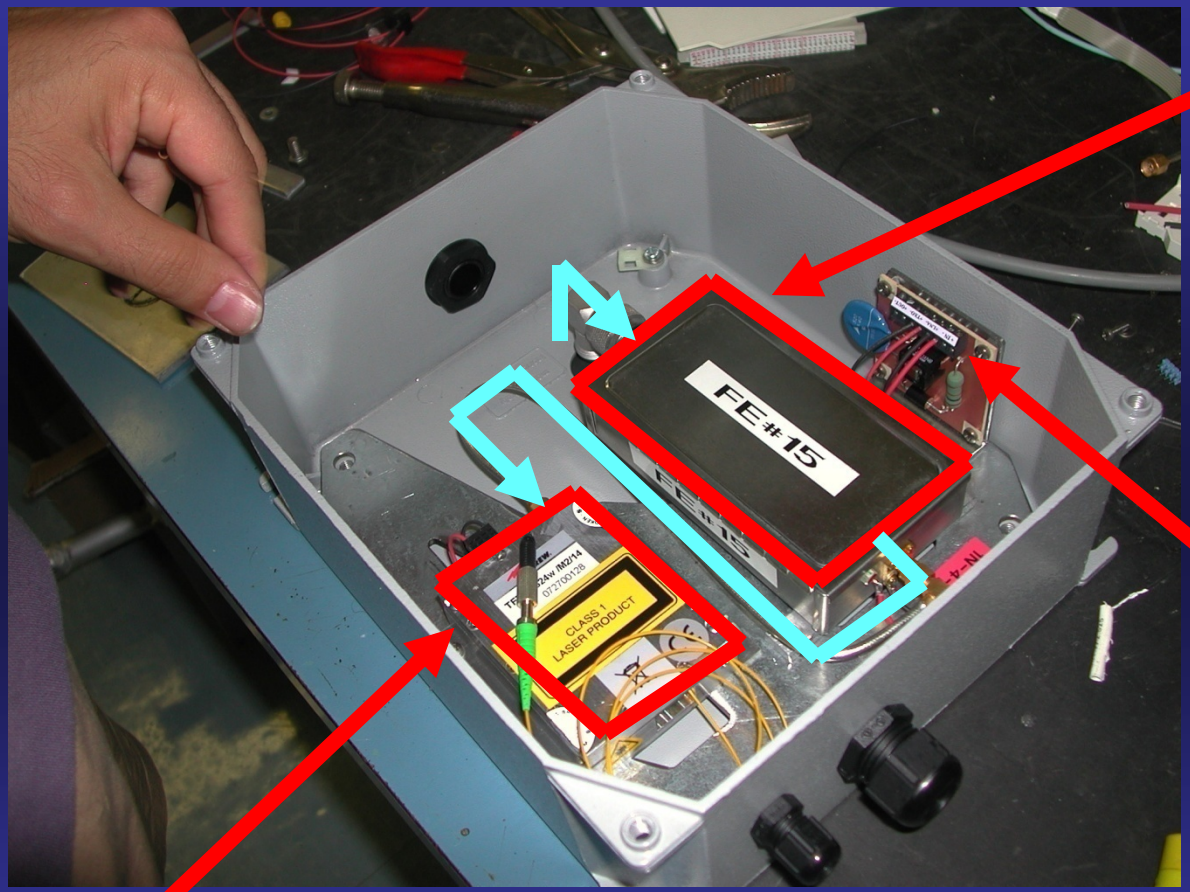
DS 6

- **Low cost, high performance, easily replicable technology**
- **Investigation beamforming algorithms for RFI rejection and multibeaming**
- **Possibility to test concepts, algorithms and technology on a large demonstrator ->high sensitivity and high RFI**
- **1 % SKA large test bed: possibility to generate *Science***
- **Transfer technologies and algorithms to the European SKA Concept (EMBRACE).**

BEST general architecture



Inside the boxes

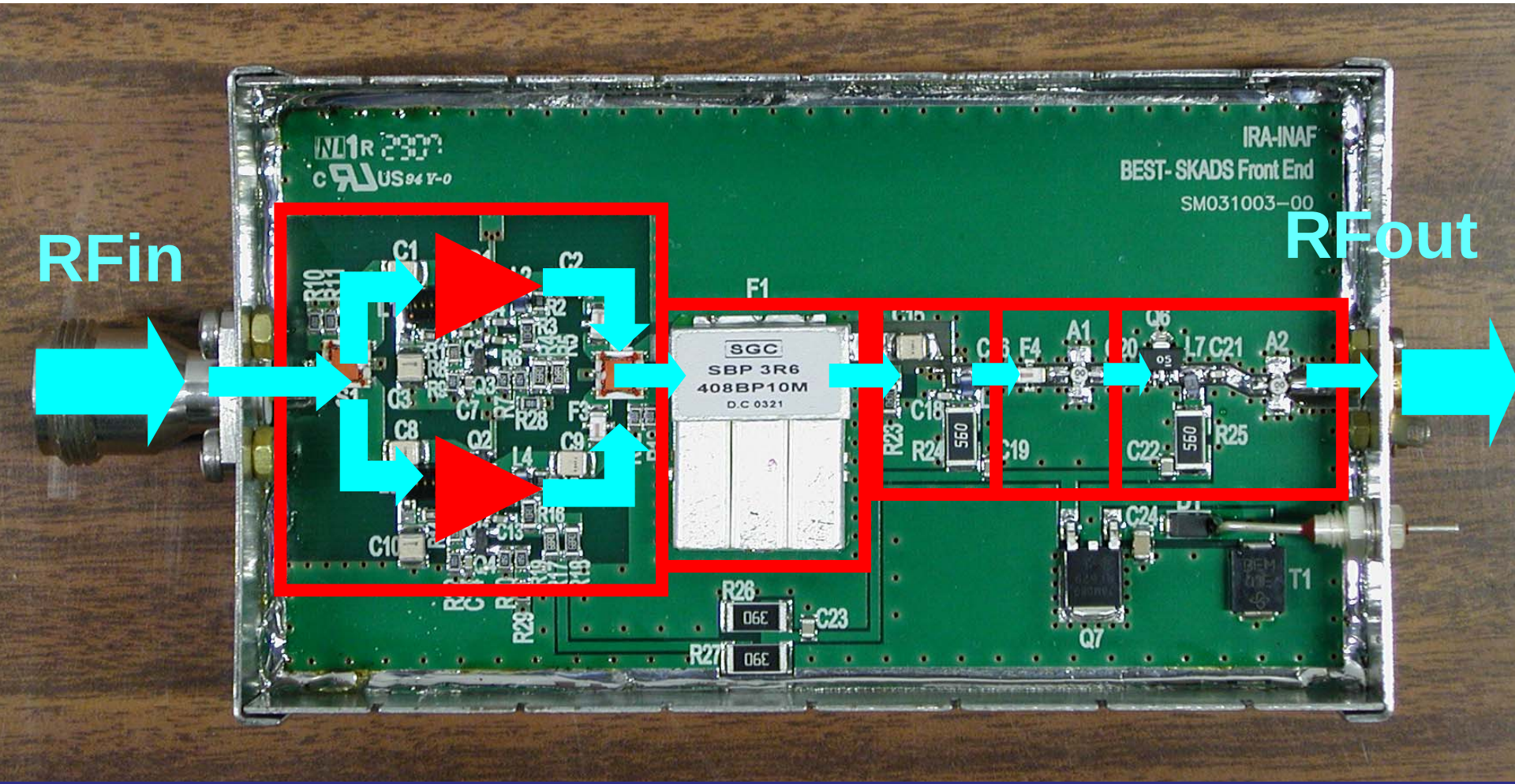


3 stages FE

Discharges protection circuit

Opt. TX

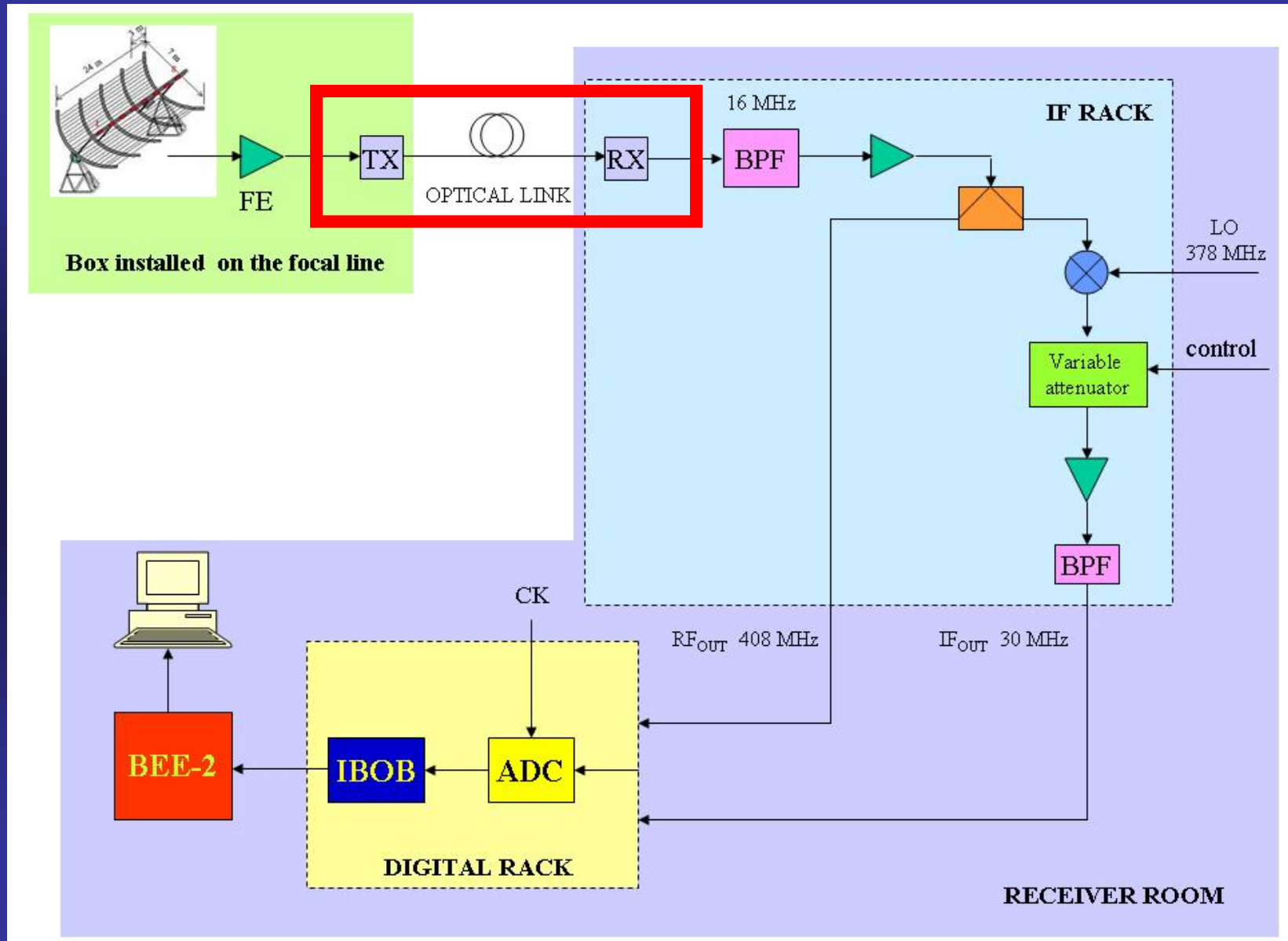
Inside the Front End



NF=0.45dB Tn=32K Gain=60dB BW=16MHz@408MHz OIP3>+33dBm

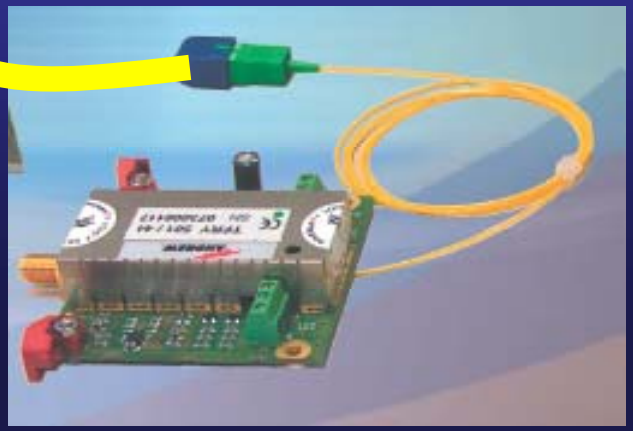
Input RL>15dB Output RL>10dB Power Supply=10-15Volt@=245mA

BEST general architecture



The fibre optic cables

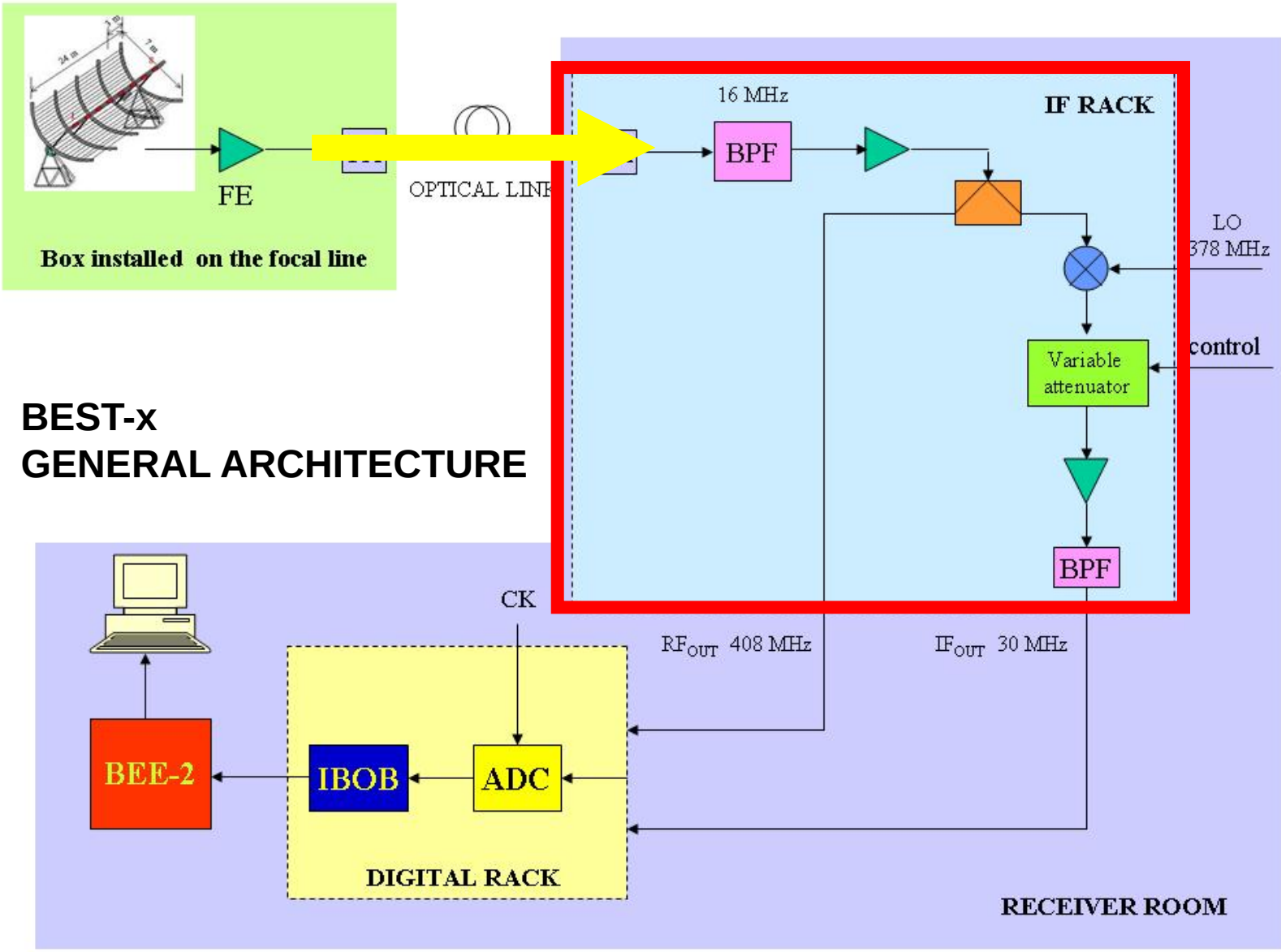
700mt long



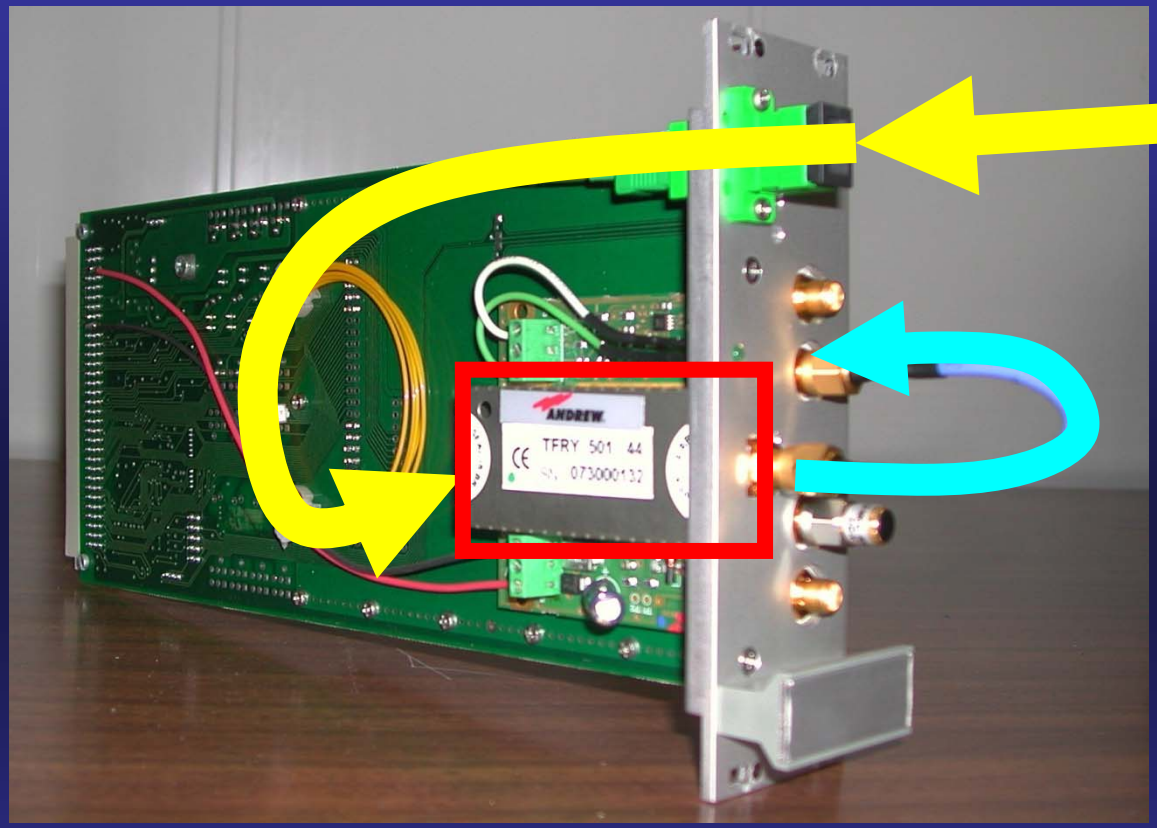
Loose cable construction min ($\Delta\phi/\Delta T$)

Dielectric protection against rodents

Inside the analogue receiver

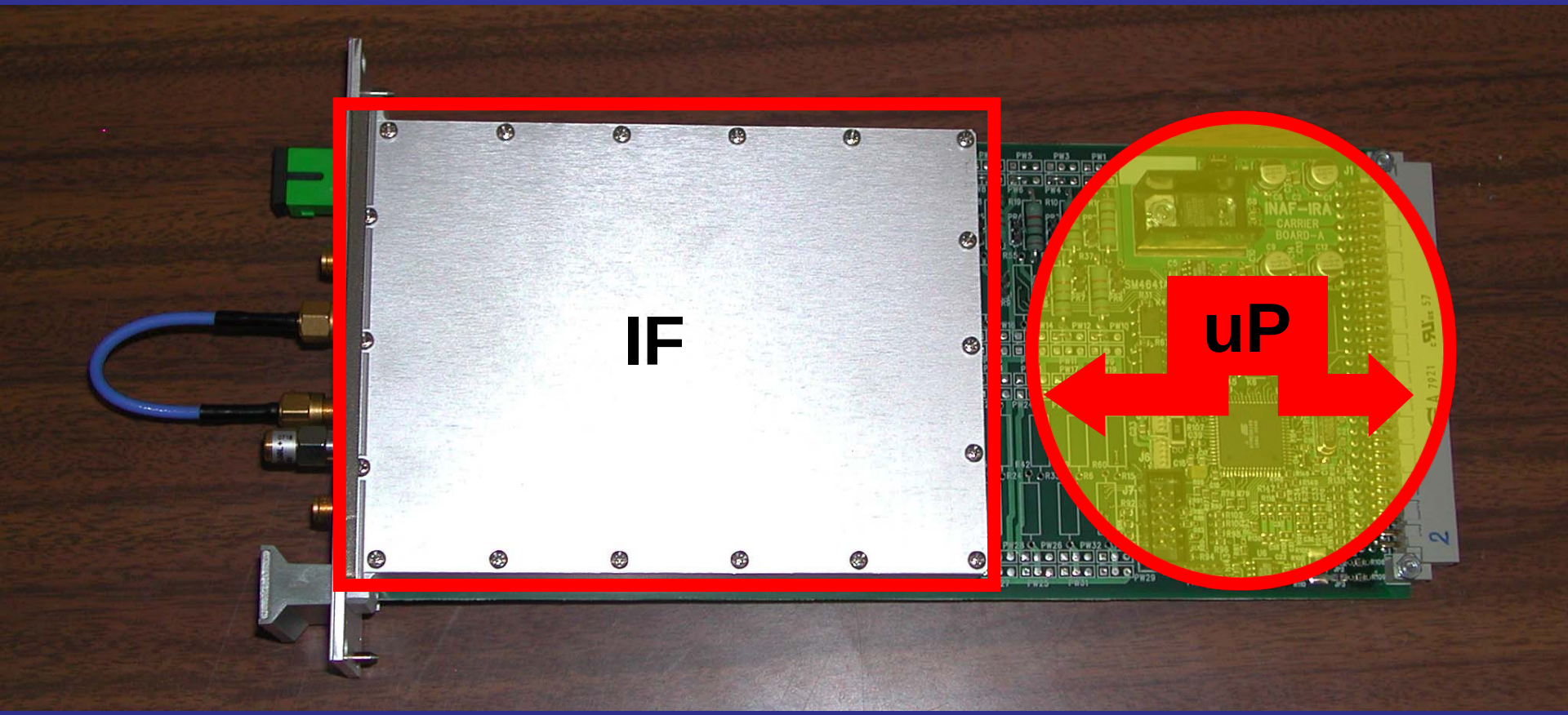


Back to the RF domain

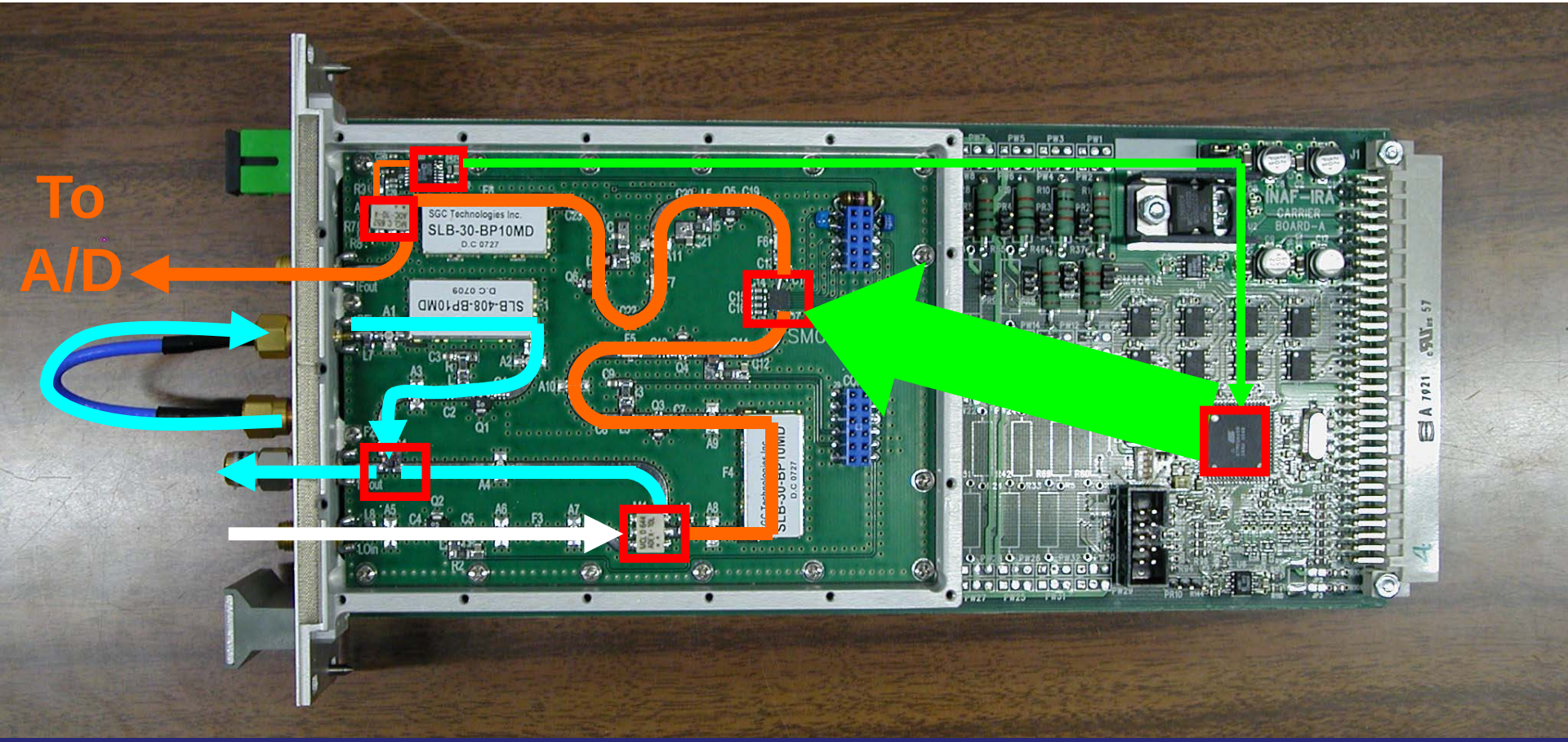


Light

The “carrier board”

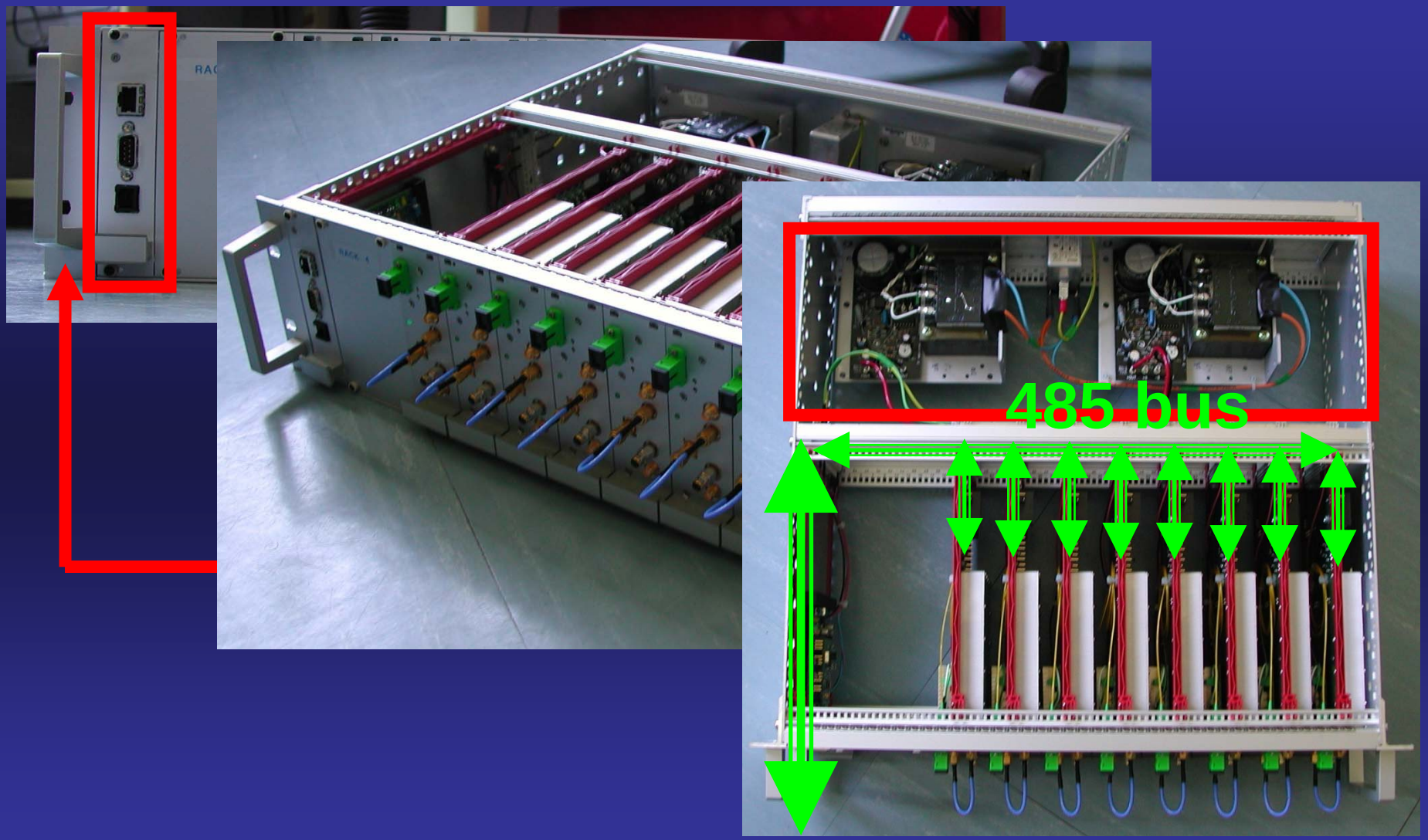


Inside the IF receiver

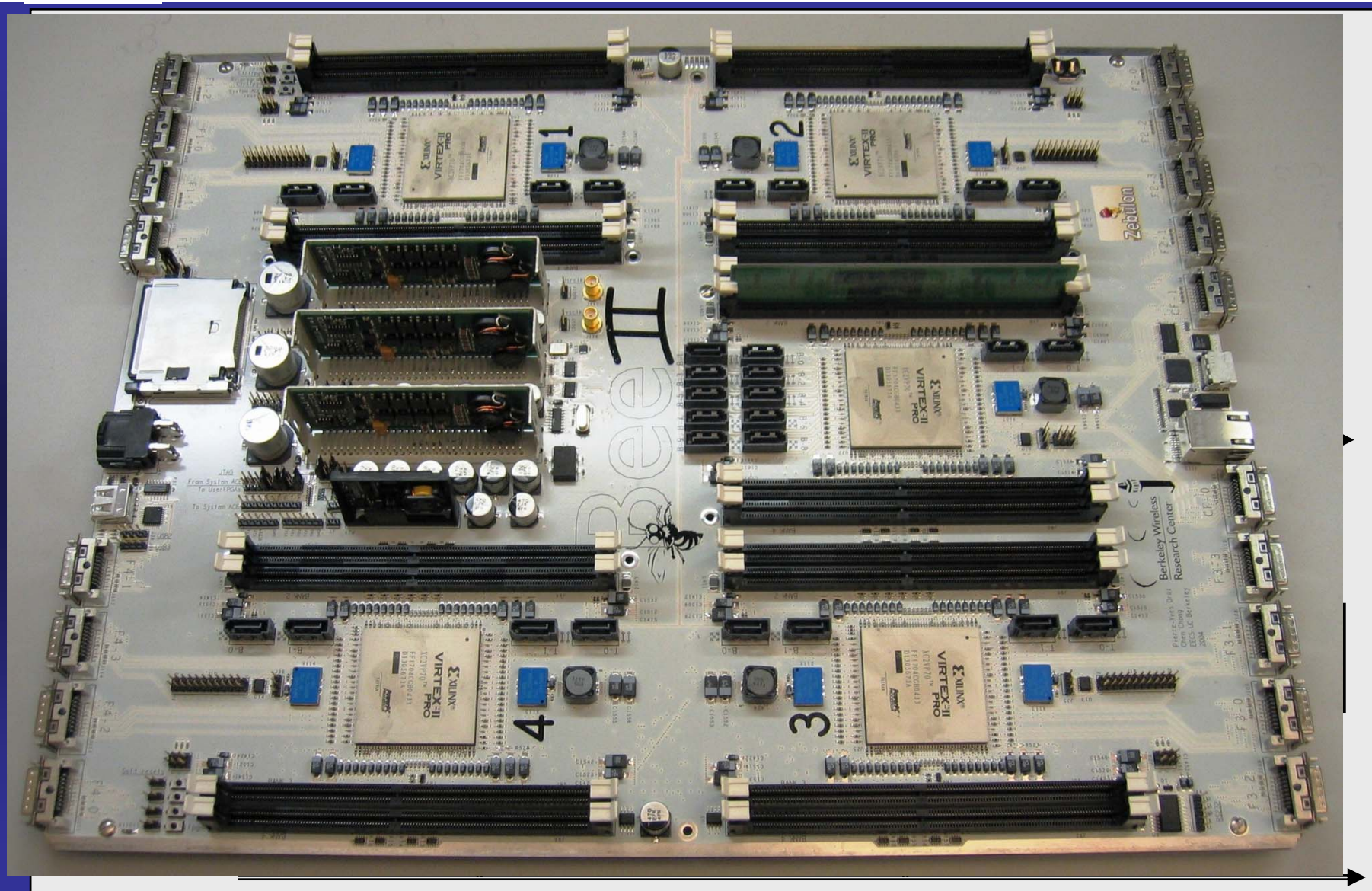


Signal paths: RF, IF, OL and digital control and monitor.

A complete rack



At the end.. The Back End

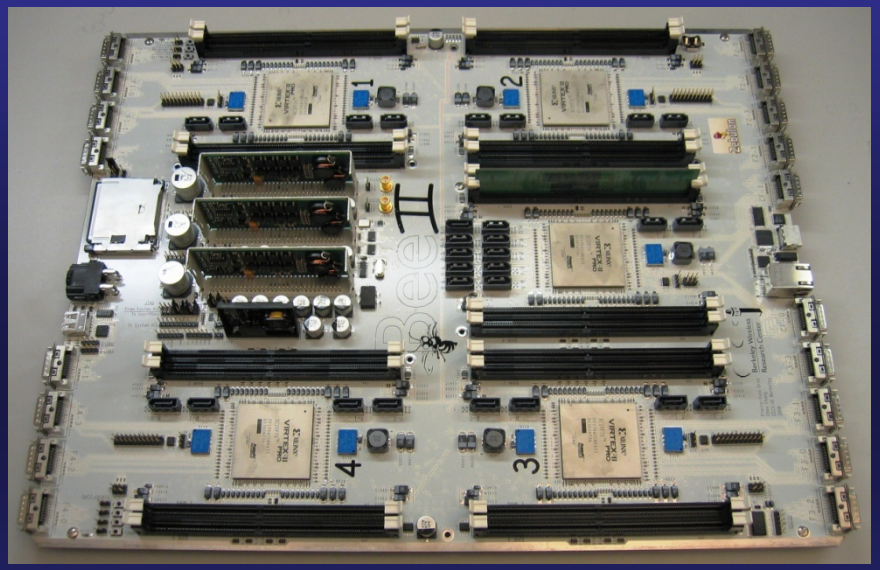


A re-programmable Back End

Fully programmable

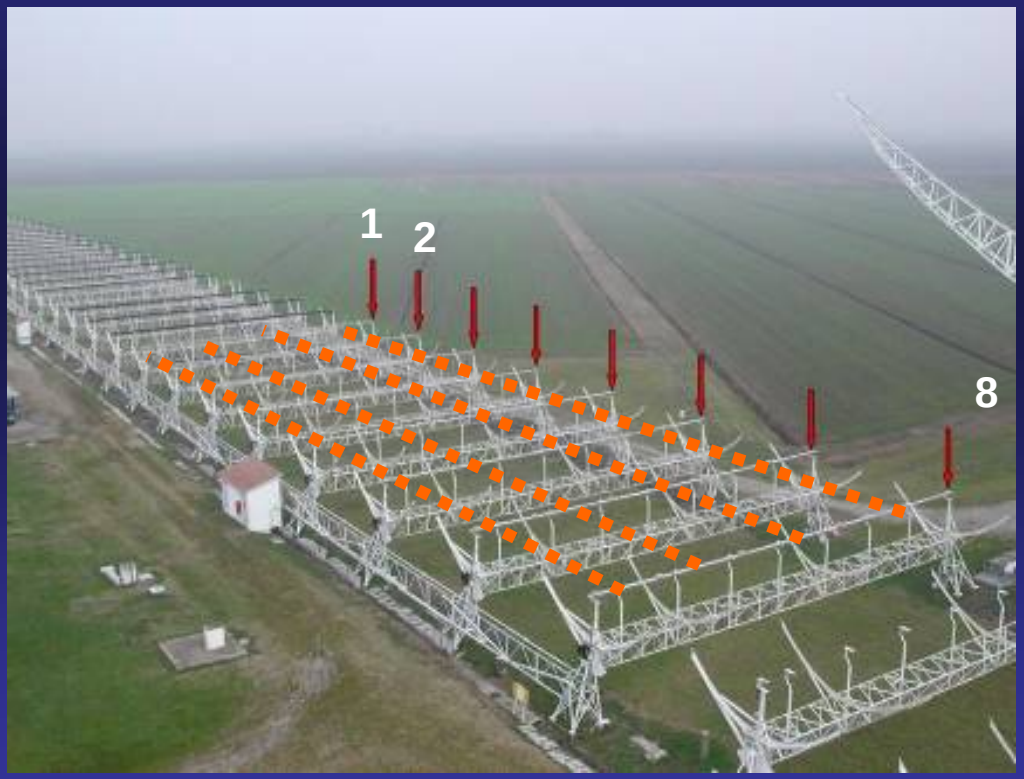
500 Gops/sec

- **BEST FX correlator**
- **Adaptive beamforming**
- **Multibeaming**



BEST 2

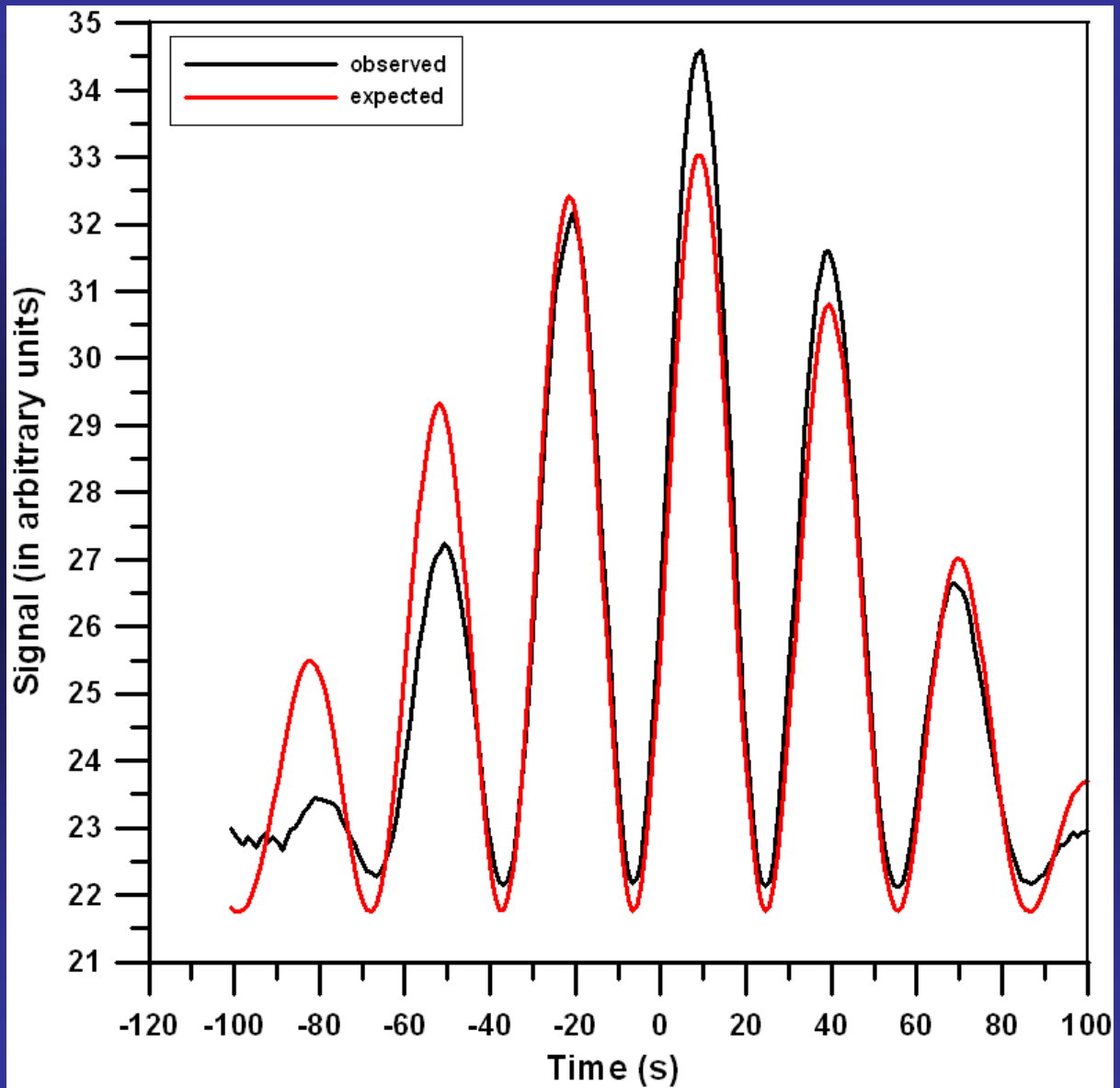
The Best-2 platform is composed of 32 receivers 8 cylinders and offers about 1440 m^2 of collecting area.



A/D and data Processing

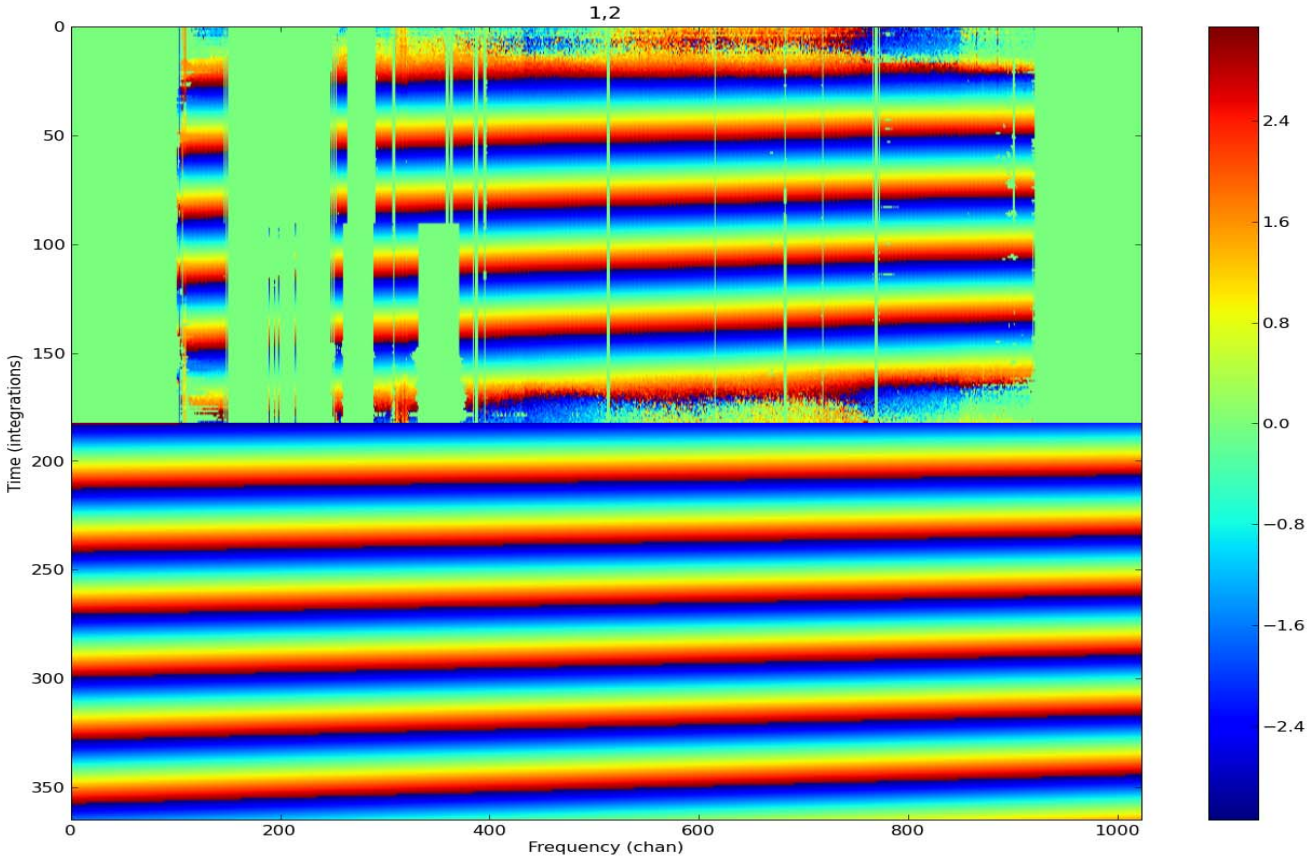
A 32 receivers FX correlator (2048 ch) has been programmed in 1 week under the collaboration between South Africa (*Alan Langman, Jason Manley*) → IRA and Berkeley (*D. Werthimer, Aaron Parsons*).

Simulated Vs observed fringes comparison



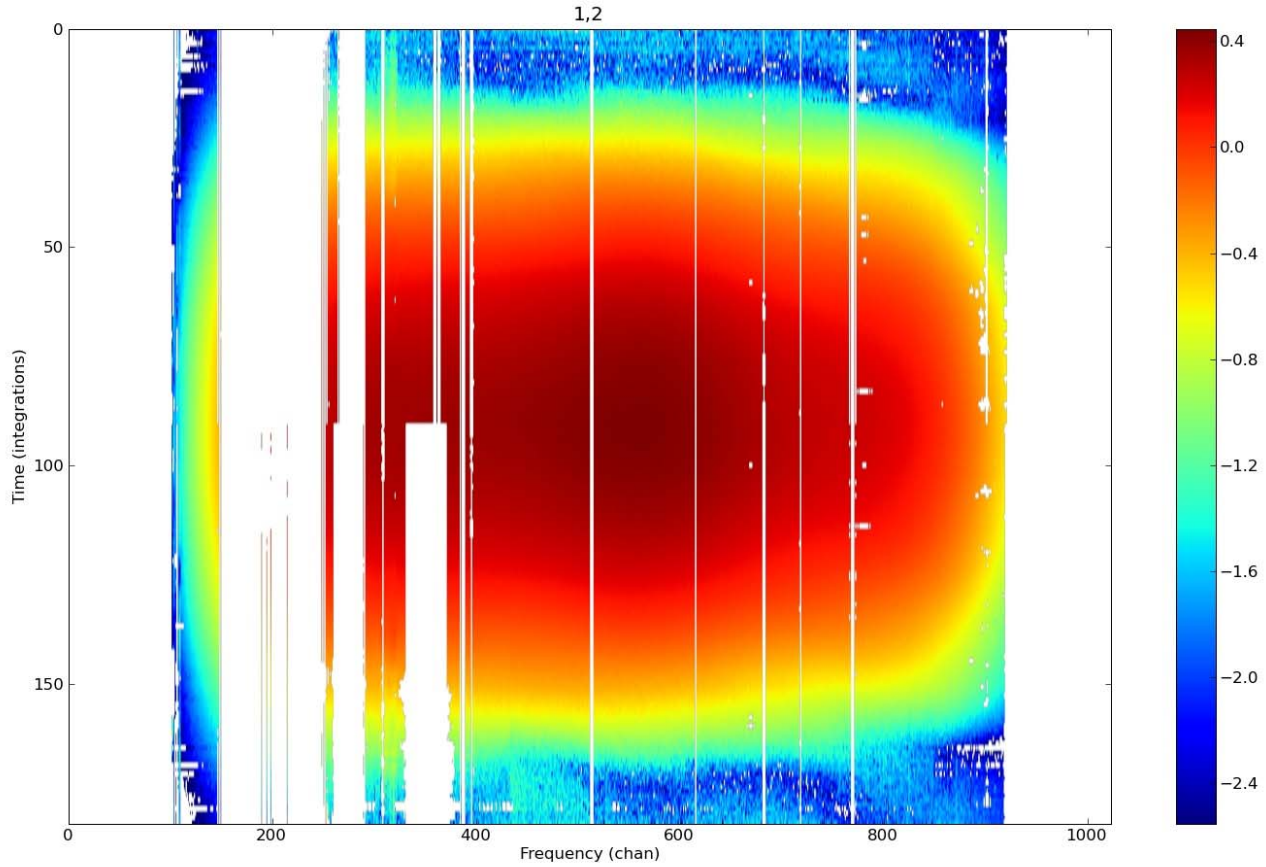
Rx1, Rx 2 baseline (outermost receivers).

Simulated Vs observed fringes comparison



The fringes are clearly visible (RFI coarsely flagged out).

CAS. A, 1ST Map



CAS.A with strong RFIs (the Tv station in the lower part of the band are mitigated)

CONCLUSIONS

- SKADS program is underway and the conclusion will be soon

- Three European SKA demostrator: 2-PAD, EMBRACE and BEST

- SKADS has allowed to Transfer technologies and algorithms to the final SKA Concept

- New programs, PrepSKA and AAVP, have created to pass to the next SKA design phase