



CASKAR: A CASPER concept for the SKA phase 1 Signal Processing Sub-system

Outline



- Background
- Technical
 - Architecture
 - Power
- Cost
- Schedule
- Challenges/Risks
- Conclusions

Background



CASPER
Technology
MeerKAT



Who is CASPER?



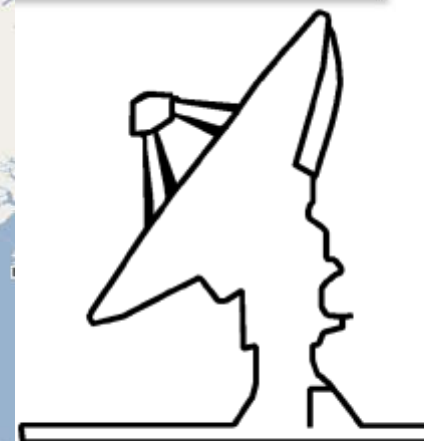
- Berkeley Wireless Research Center
- UC Berkeley Radio Astronomy Lab
- UC Berkeley Space Sciences Lab
- Karoo Array Telescope / SKA - SA
- NRAO - Green Bank
- NRAO - Socorro
- Allen Telescope Array
- MIT Haystack Observatory
- Harvard-Smithsonian Center for Astrophysics
- Caltech
- Cornell University
- NAIC - Arecibo Observatory
- UC Berkeley - Leuschner Observatory
- Giant Metrewave Radio Telescope
- Institute of Astronomy and Astrophysics, Academia Sinica
- National Astronomical Observatories, Chinese Academy of Sciences
- CSIRO - Australia Telescope National Facility
- Parkes Observatory
- Center for Astrophysics and Supercomputing, Swinburne University of Technology
- Nancay Observatory
- Oxford University Astrophysics
- Metsähovi Radio Observatory, Helsinki University of Technology
- New Jersey Institute of Technology
- West Virginia University Department of Physics
- University of Iowa Department of Astronomy and Physics
- Ohio State University Electroscience Lab
- Hong Kong University Department of Electrical and Electronic Engineering
- Hartebeesthoek Radio Astronomy Observatory
- INAF - Istituto di Radioastronomia, Northern Cross Radiotelescope
- University of Manchester, Jodrell Bank Centre for Astrophysics
- Submillimeter Array
- NRAO - Tucson / University of Arizona Department of Astronomy

CASPER workshop 2010



Exploring the Universe with the world's largest radio telescope

Where is CASPER?



CASPER

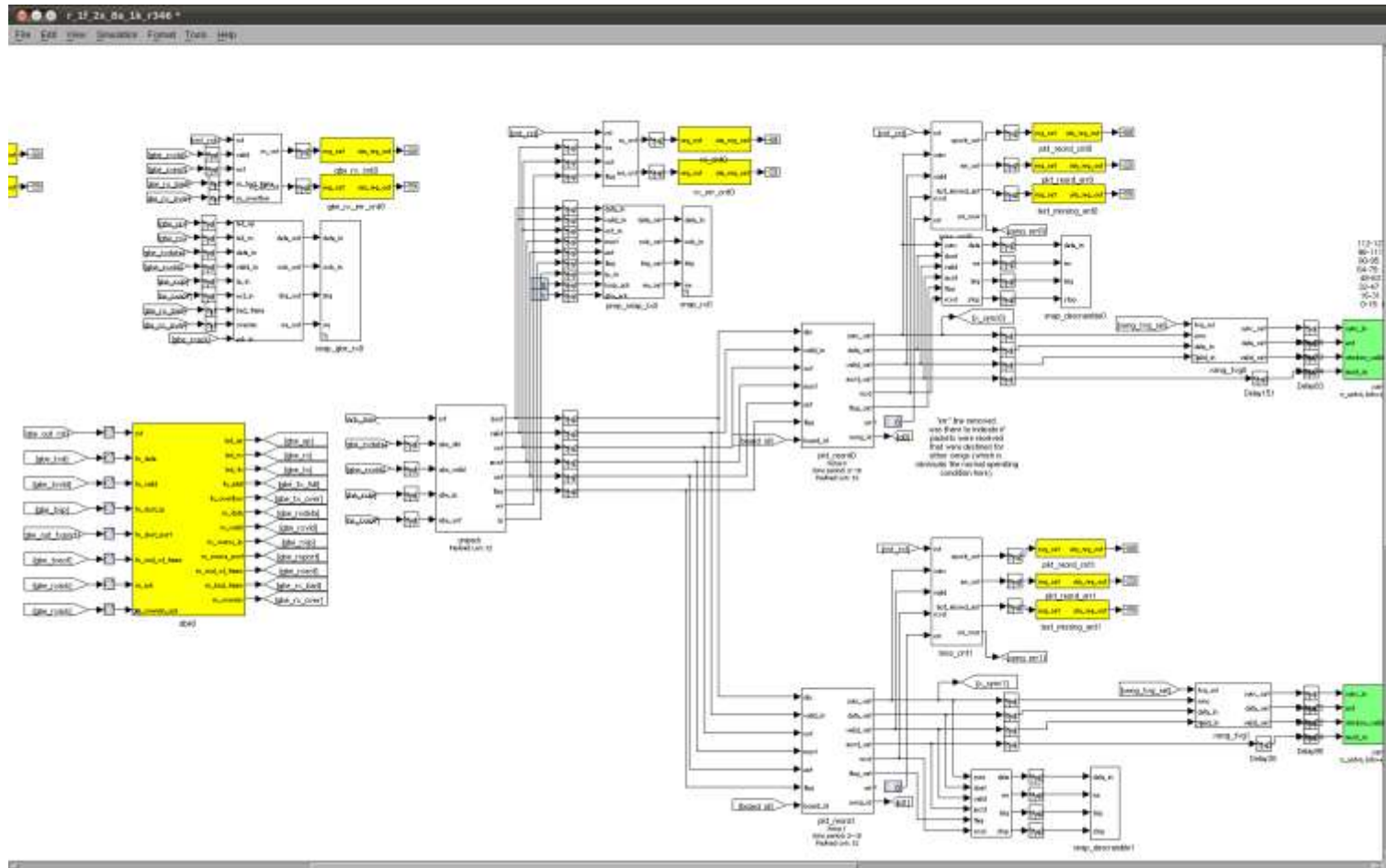
World's largest radio telescope

What CASPER does

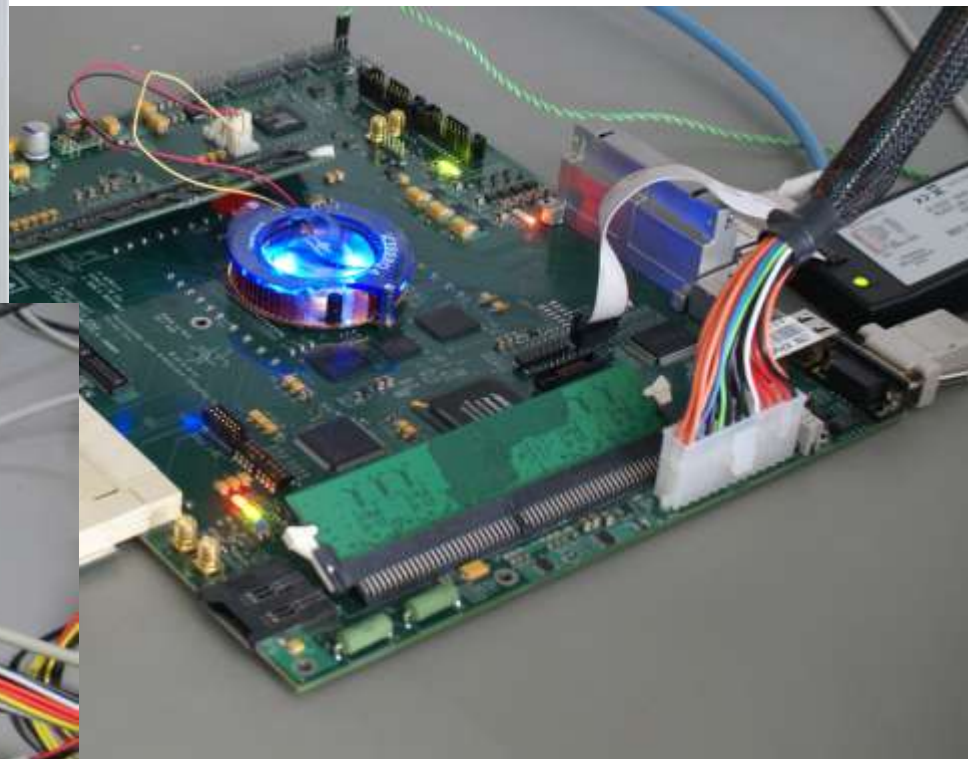


- Standard Hardware
 - Limited number of platforms
- Standard Libraries
 - “Rapid application” design flow
- Community Support
 - Tutorials
 - Workshops and training sessions
 - Some “canned” applications
- Interface standardisation: SPEAD

For Example ...1



For Example ...2

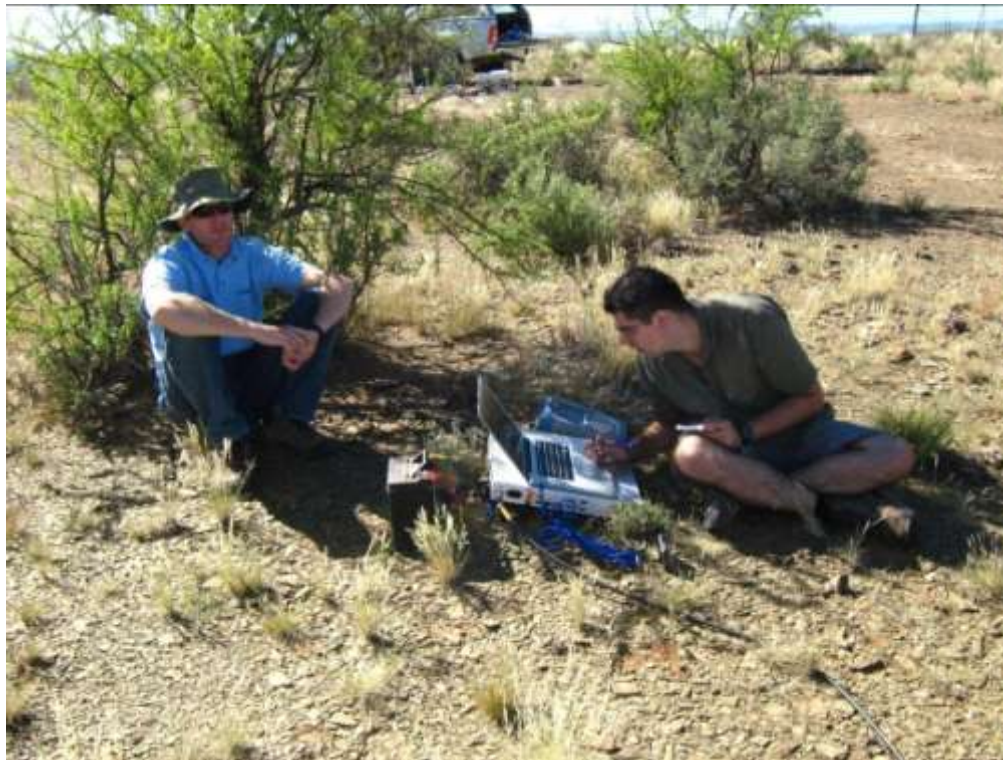


For Example ...3



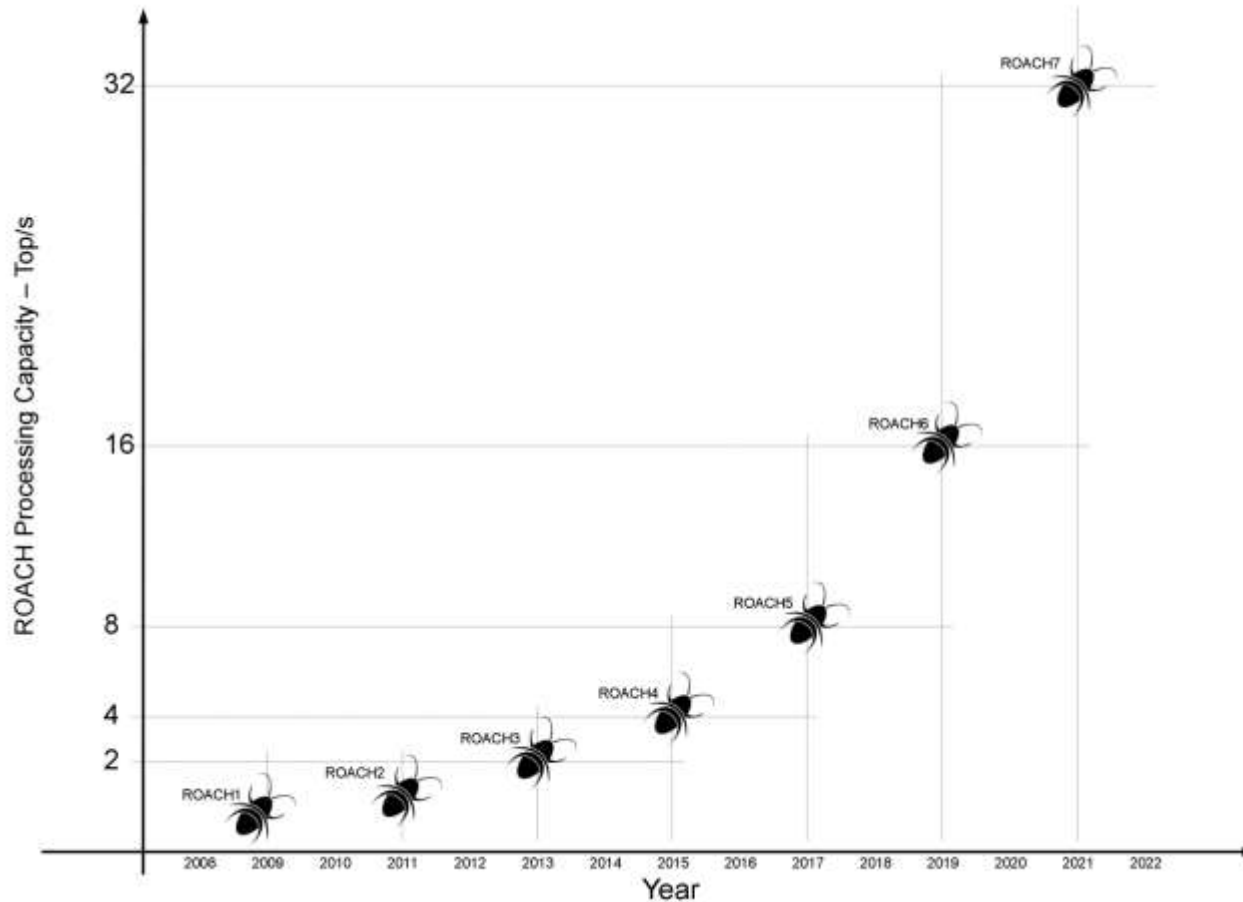
Exploring the Universe with the world's largest radio telescope

For Example ...4



Exploring the Universe with the world's largest radio telescope

Where is CASPER going?

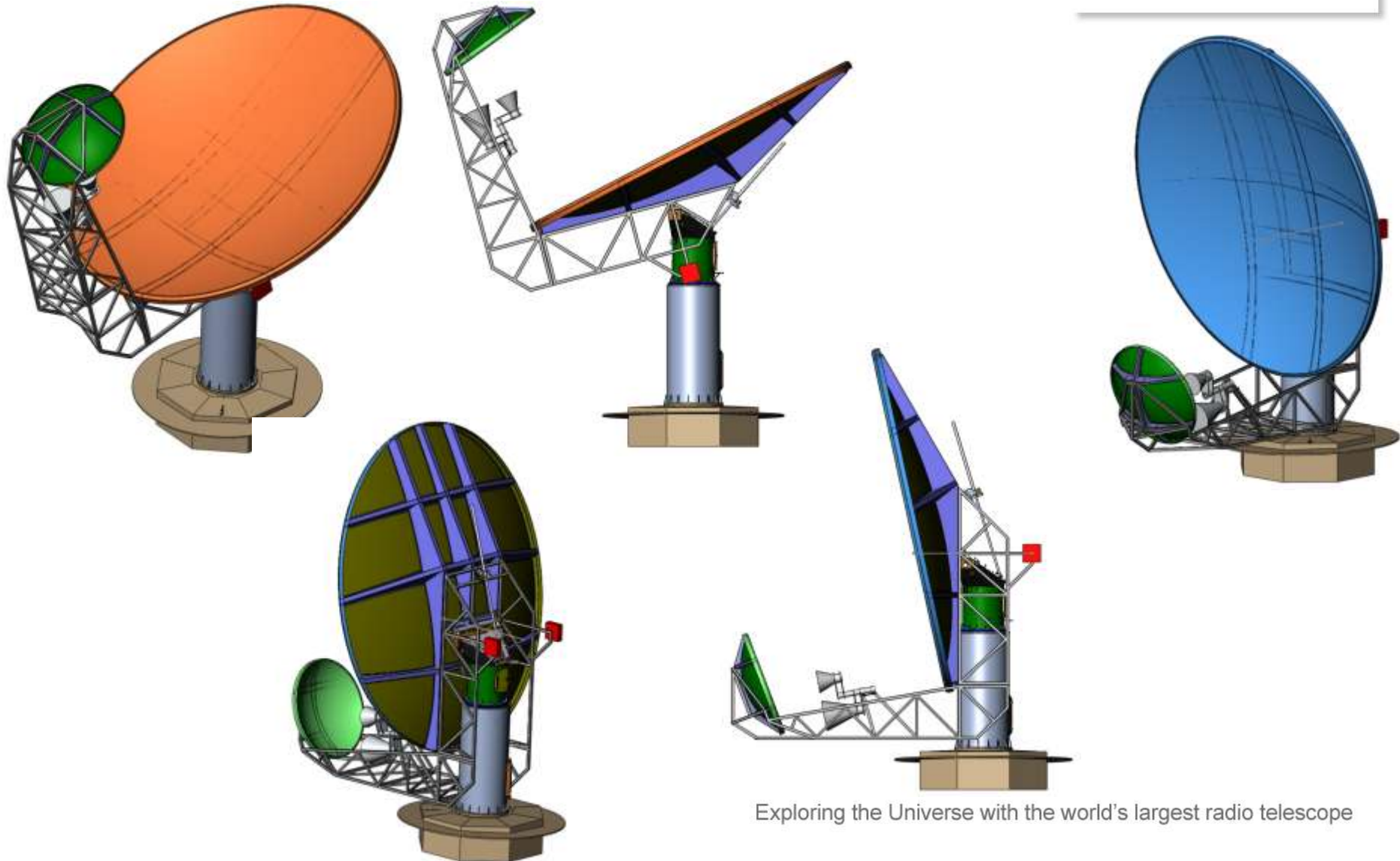


And...

- Bigger ROACH's
- Faster Sampling
- Heterogeneous Processing (GPU, CPU)
- Better Tools

- Array of 64 x 13.5m offset Gregorian Dishes
- Feed indexer:
 - 590 MHz – 1.015 GHz
 - 1 GHz – 1.75 GHz
 - 8 – 14.5 GHz
- MeerKAT Large Survey Proposals -> Concept Design -> CoDR -> Specification -> PDR

MeerKAT Dish



Exploring the Universe with the world's largest radio telescope

MeerKAT Signal Processing



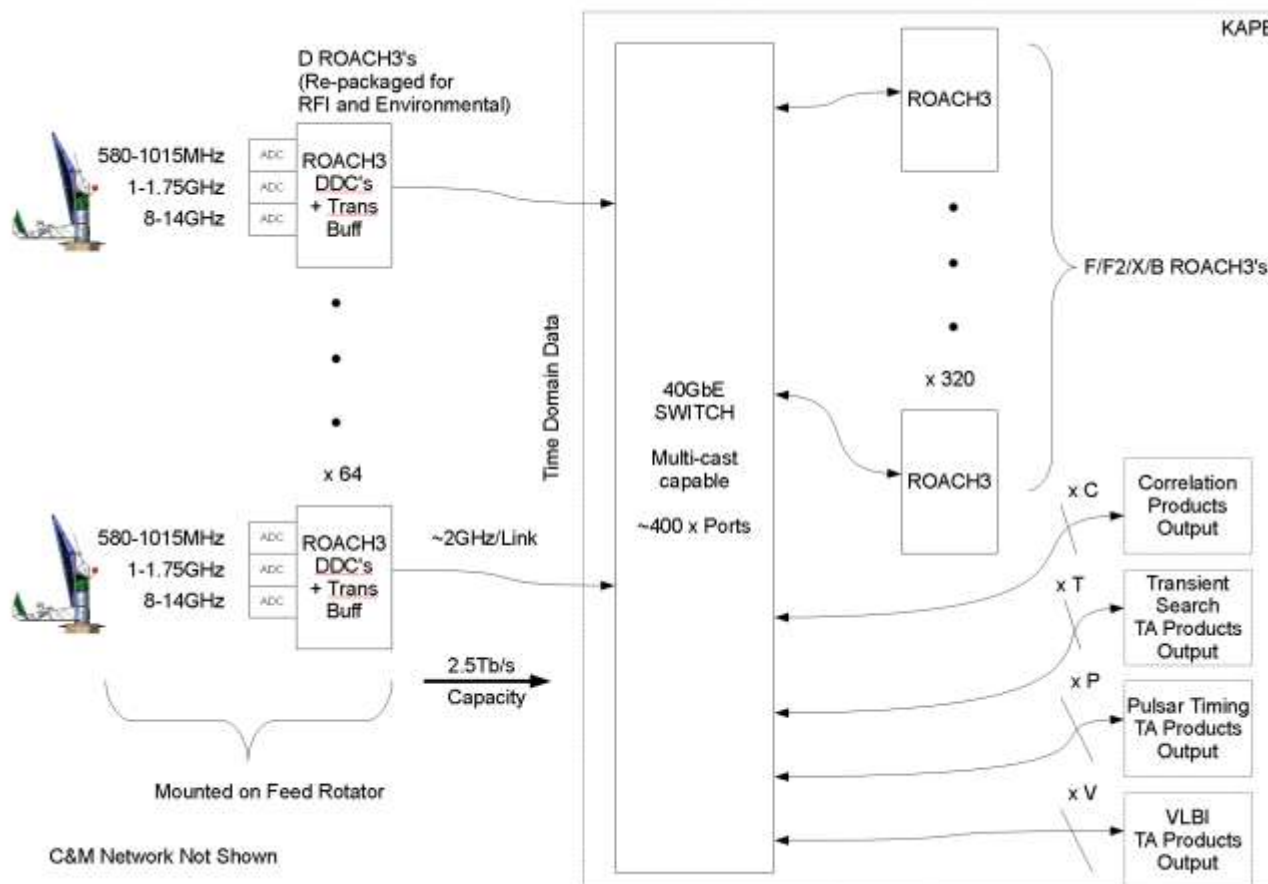
- D/F processing “at” feed, incl. Raw transient buffer
- Integrated RF design of Feed-Receiver-Digitiser
- Digital Fibre to KAPB
- “CASPER” ROACH3 processing cluster in KAPB
- 40GbE (or Infiniband) interconnect

MeerKAT System Considerations



- Resource Shared: Continuum, Spectral Line and Transient Search Beam Former modes
- Time Shared: Pulsar timing
- Redundant hardware for reliability (keep maintenance simple, infrequent)
- Antenna based hardware packaged for rugged environment and RFI
- Remote operation

MeerKAT DBE

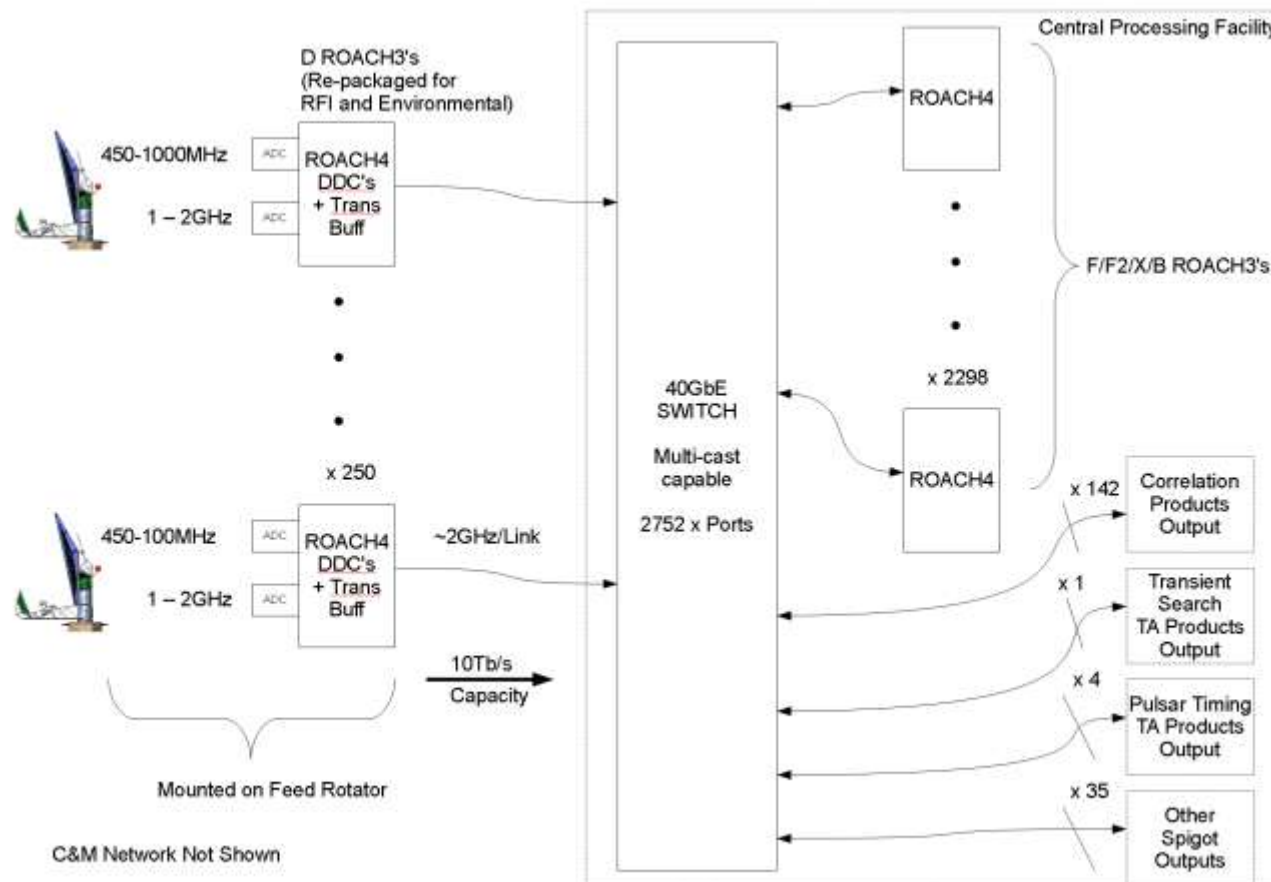


MeerKAT vs SKA phase 1 (Dish)

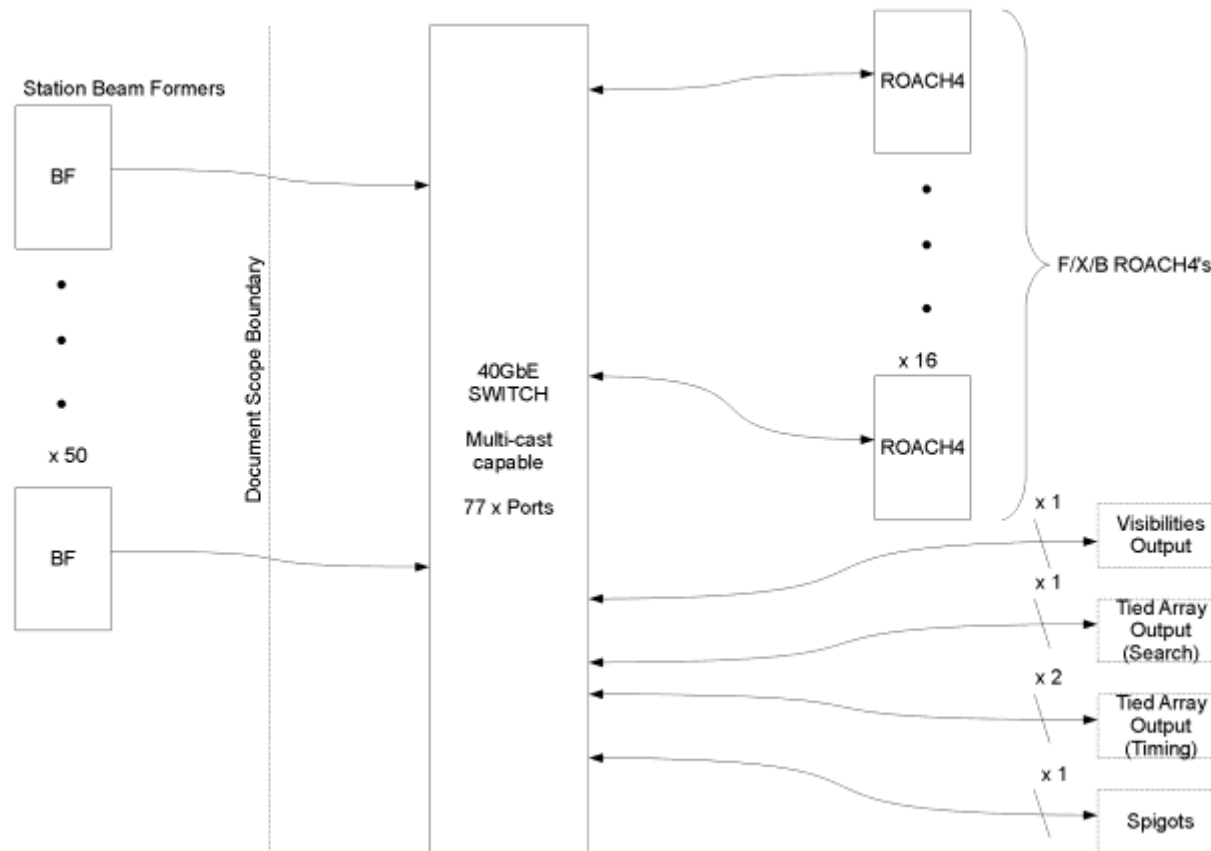


Specification	MeerKAT	SKA Phase 1
Number of Antennae	64	250
Dish diameter	13.5m	15m
Min Baseline	29m	?
Max Baseline	8km	<200km
Number of Feeds/Antenna	3	2
Feed 1	590 – 1015 MHz	450 – 1000 MHz
Feed 2	1 – 1.75 GHz	1 – 2 GHz
Feed 3	8 – 14.5 GHz	Up to 10 GHz (Ph 2)
Instantaneous Bandwidth	1 GHz – 2 GHz	1 GHz
Spectral Resolution (Continuum)	200 kHz	7.5 kHz
Spectral Resolution (Line)	1.8 kHz x 20k	1 kHz

CASKAR Dish Architecture



CASKAR AA Architecture

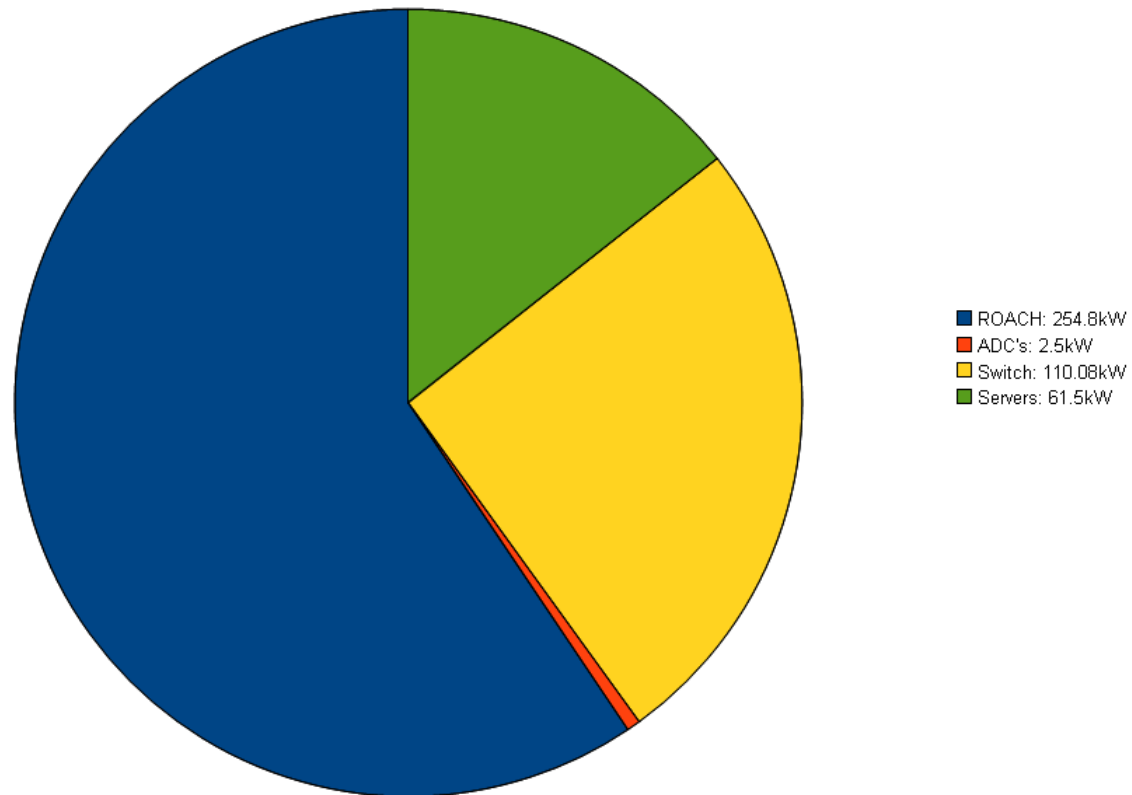


Power: Dish



Power Breakdown

SKA 1 Dish

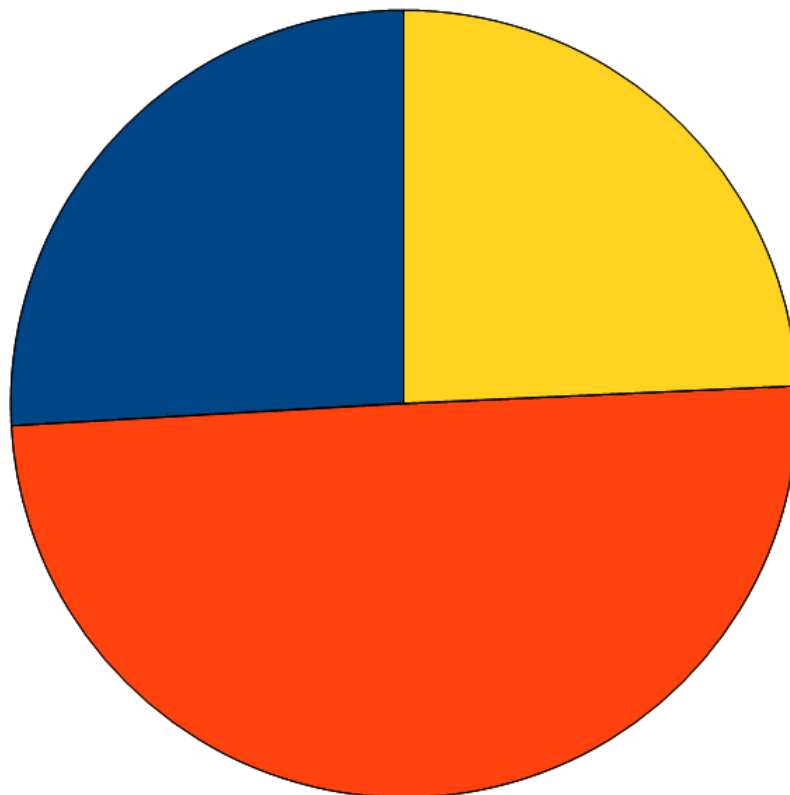


Total: 428kW

Power: AA (Per Beam)



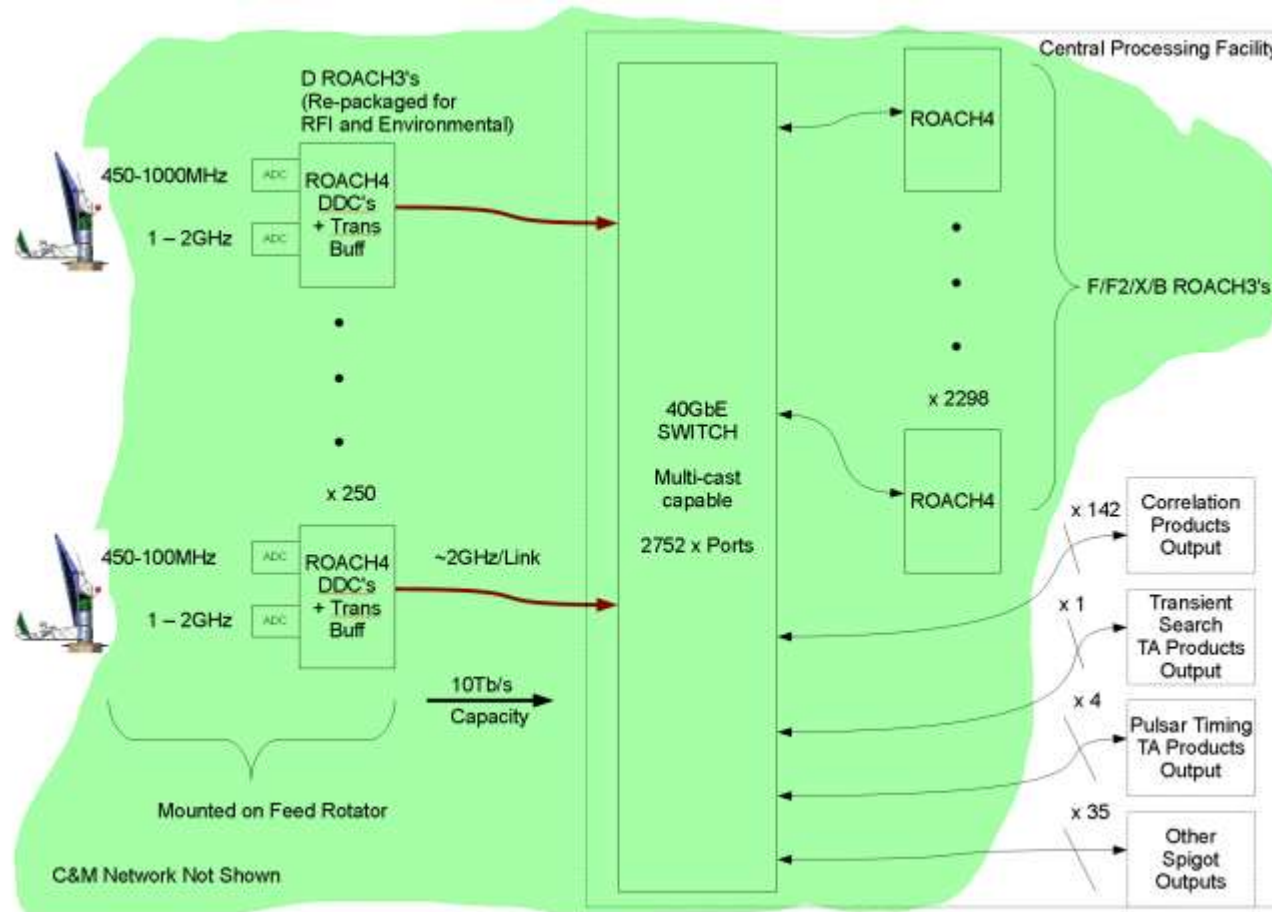
Power Breakdown
SKA 1 AA (per Beam)



- ROACH: 1.6kW
- Switch: 3.08kW
- Servers: 1.5kW

Total: 6.2kW

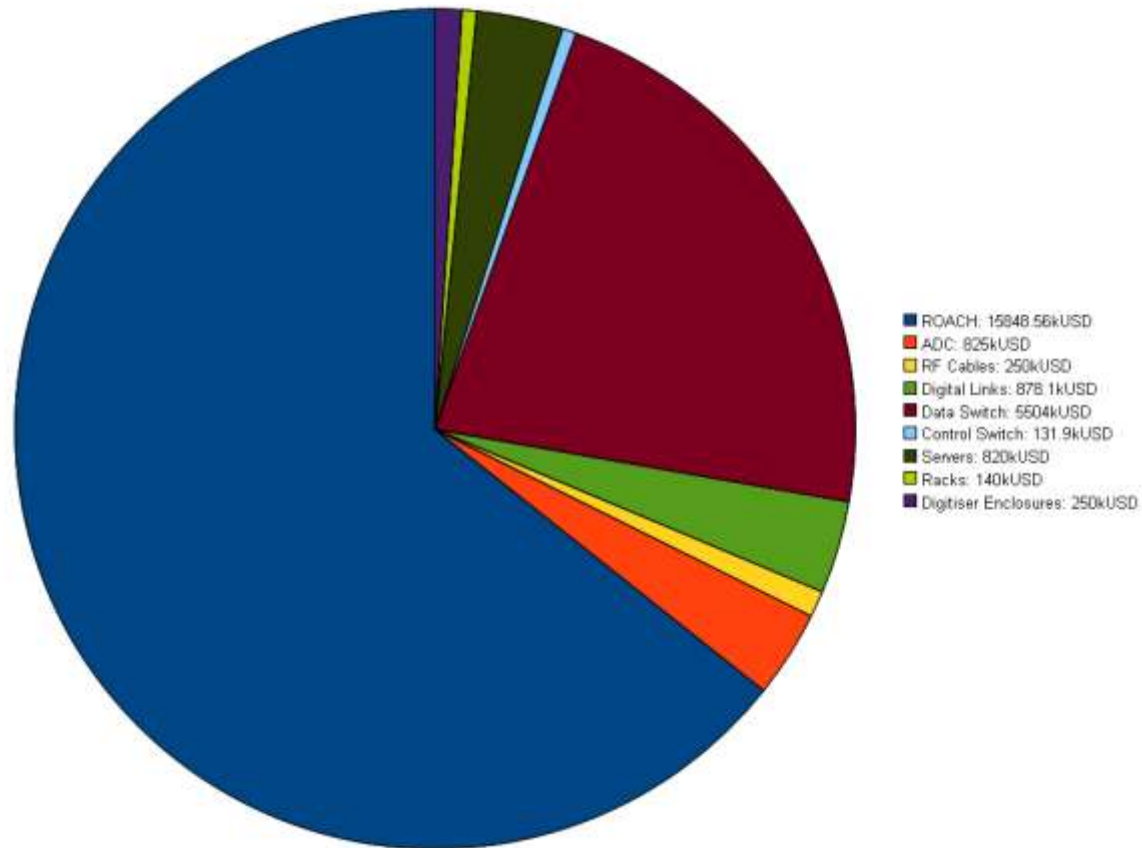
Costing: Dish System Boundary



Cost: Dish



SKA 1 Dish Cost

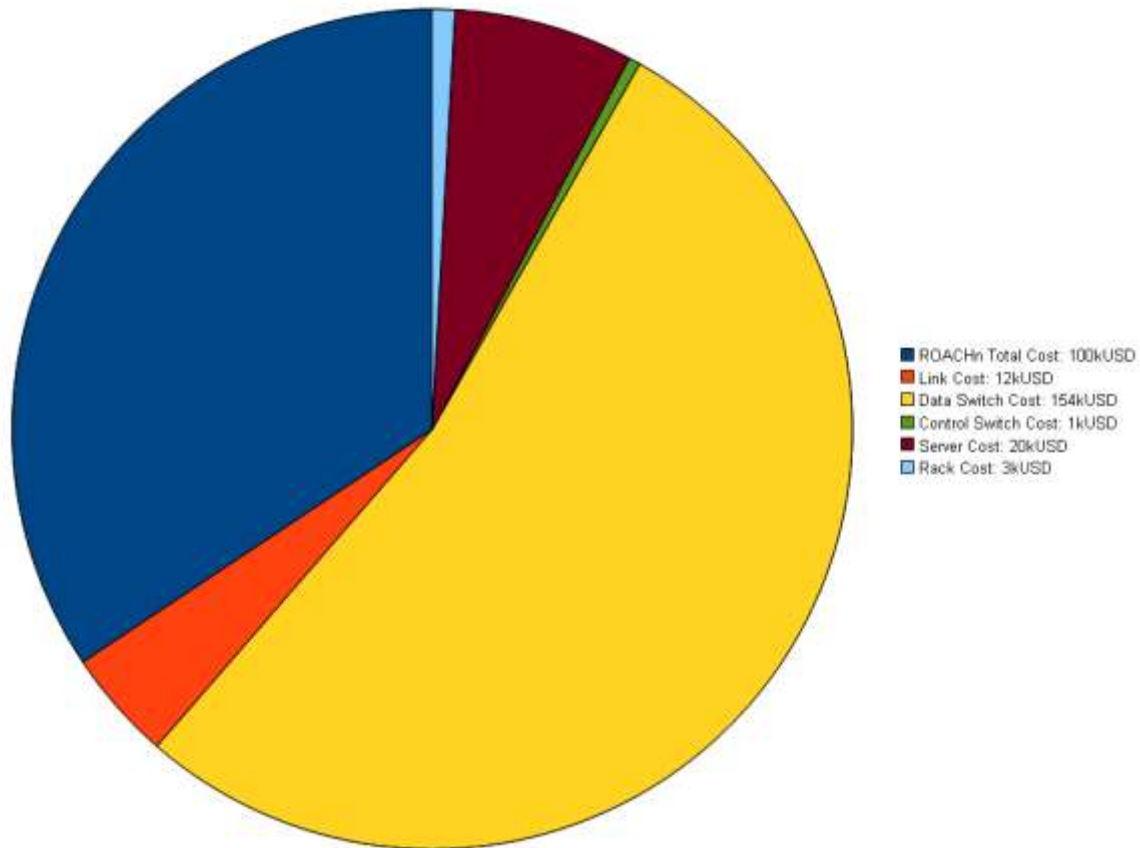


Total: 24.6MUSD

Cost: AA (Per Beam)

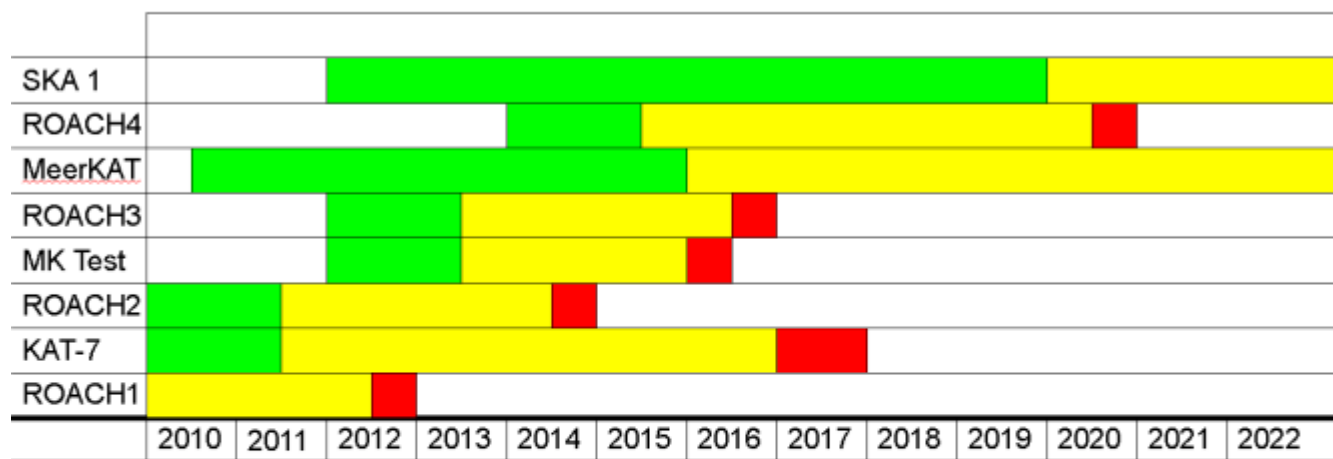


SKA 1 AA Cost



Total: 289kUSD

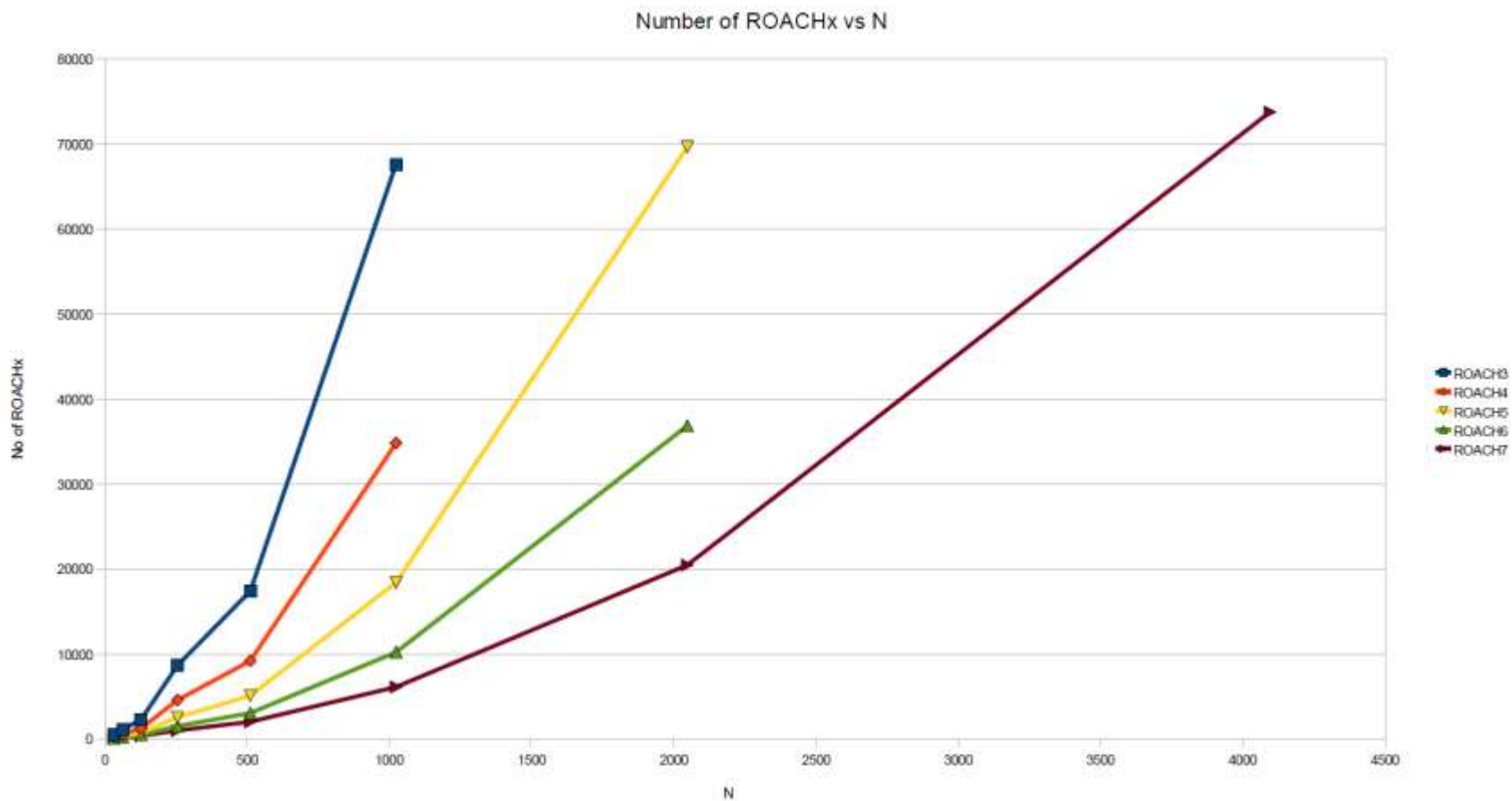
CASKAR Schedule



KEY:



Scaling Up?



Challenges/Risks



- Switch
- Samplers
- ROACH4
- Digital Fibre
- Power

Conclusions 😊



- Collaborative model with significant momentum
- Shared Development
- Flexibility
- Easy Upgrade/Part of Maintenance
- CASPER library model enables R.A.D.
- Near-commodity hardware
- Re-purpose hardware
- CASPER builds skills

Conclusions ☹️



- Phase 2 still very expensive
- Aperture Array specification is a challenge

And finally...



- The CASPER train is on track
- Everybody is welcome on board



CASKAR



- Questions?