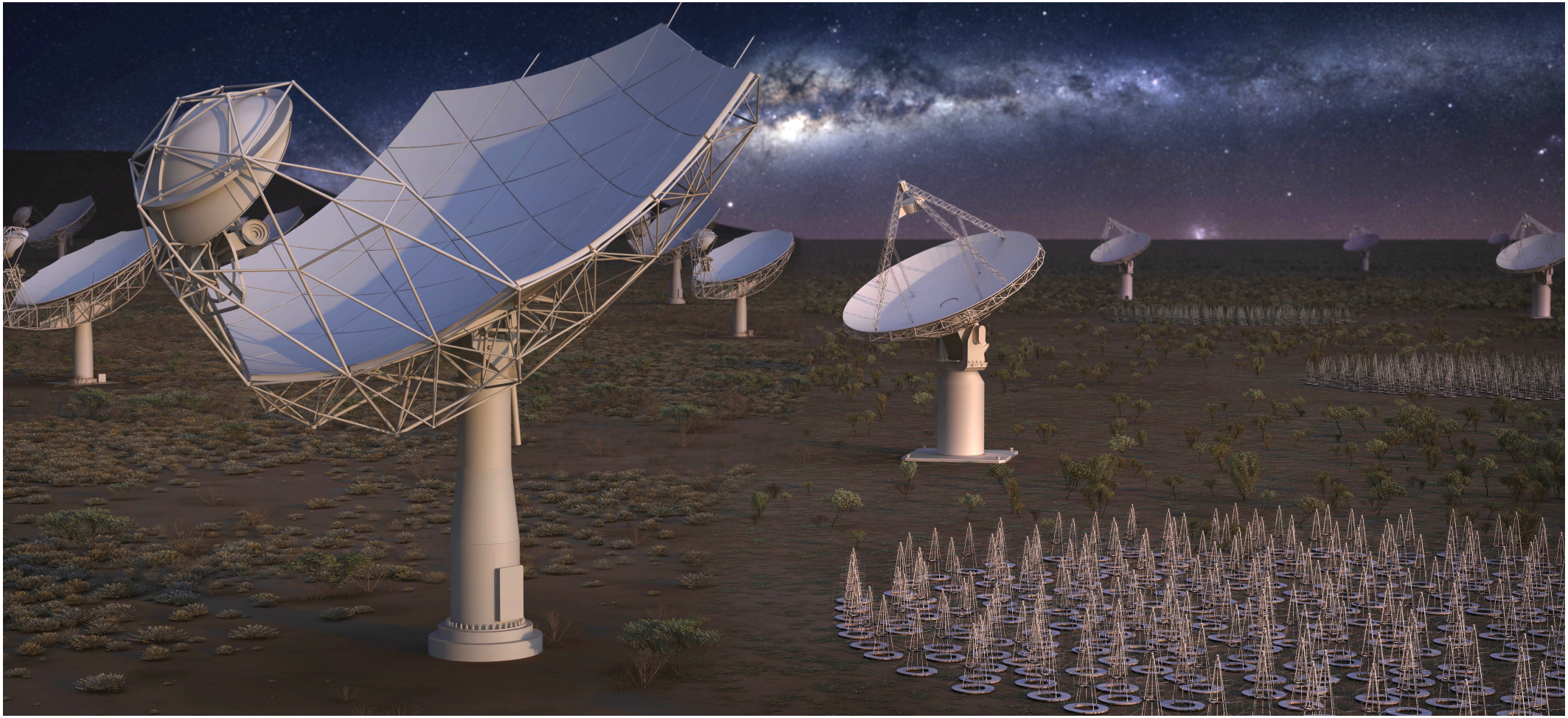
VLBI with the SKA

Jumping JIVE WP10



SQUARE KILOMETRE ARRAY

Exploring the Universe with the world's largest radio telescope

Antonio Chrysostomou (SKA, Head of Science Operations)
Zsolt Paragi (JIVE, Head of User Support)

Outline

VLBI with the SKA

Overview of science cases

Update on Band 5 split

Outline of work tasks for WP10

VLBI with the SKA

Aim is to bring the sensitivity of the SKA to a global VLBI network

To use this as a driver to pursue the globalisation of VLBI

- Global VLBI Consortium

Specific question/issues to be addressed by this WP

- what is the operational model for SKA-VLBI?
- are the current L1 requirements "fit-for-purpose"?
- are the interfaces for SKA-VLBI sufficient?
- commissioning, test procedures and requirement verification for SKA VLBI, followed by performance verification
- how will VLBI fit into the KSP framework?
- is there opportunity and capability for commensal VLBI operations?
- what will the demand for SKA-VLBI time be?
- can we trigger EVN follow up with SKA transients?

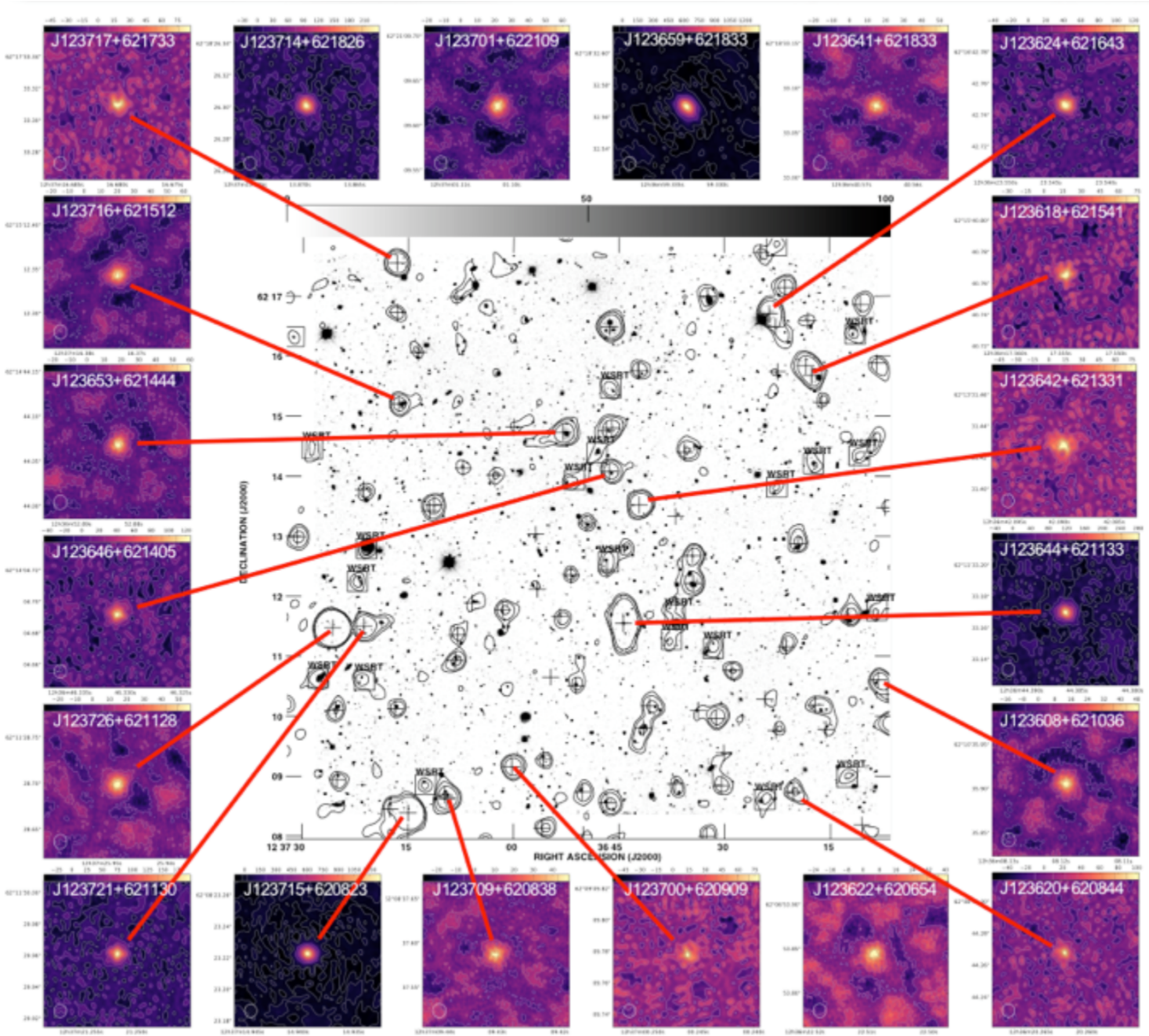
Science cases

VLBI is an important and useful tool for a number of scientific applications

- complement to many of the SWGs as they develop their KSPs
- important for SKA-VLBI to be science driven, not technique driven
- if KSPs want to include VLBI in their proposal, then we should help them to do so
  - SKA VLBI Working Group

Sub milli-arcsec resolution astronomy at μJy sensitivity

- identification of extragalactic source population in wide area radio surveys
- environments of SMBH, AGN and extragalactic jets



VLBI of Hubble Deep Field-N

5 µJy/beam @ 4mas resolution

20 VLBI detections

25% of star forming galaxies contain faint AGN

Radcliffe et al.

From Agudo et al. SKA Science meeting, Goa 2016

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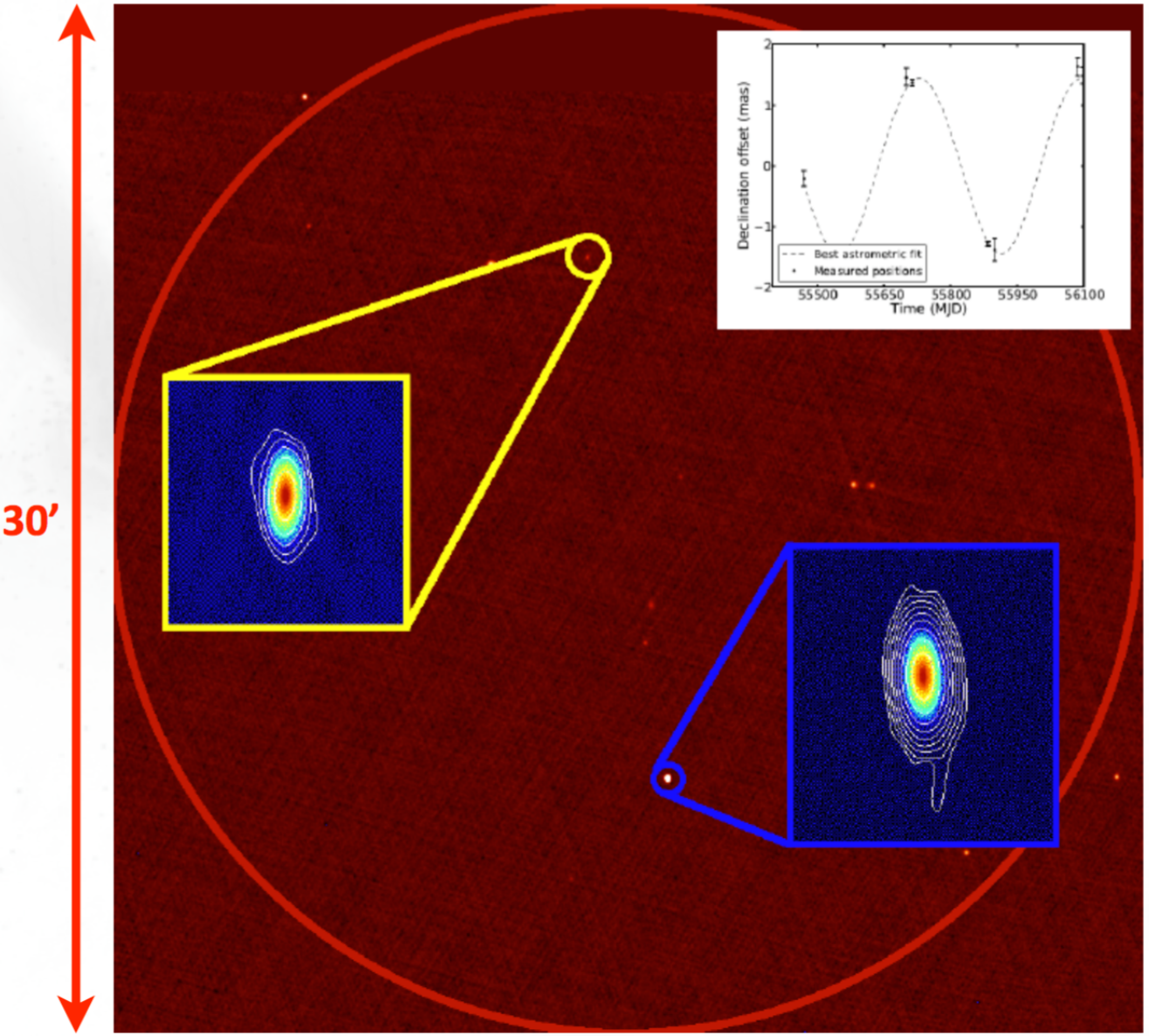
- environments of SMBH, AGN and extragalactic jets

- distances out to 10s of kpc



Deller et al. (2013)

VLBI Astrometry of J2222-0137

Parallax distance determined as 267.3 pc to 0.4% accuracy

With SKA it will be possible to determine distances out to 10s of kpc

From Agudo et al. SKA Science meeting, Goa 2016

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Sub milli-arcsec resolution astronomy at μJy sensitivity

- identification of extragalactic source population in wide area radio surveys
- environments of SMBH, AGN and extragalactic jets
- distances out to 10s of kpc
- precision localisation of transients

EVN localisation of FRB121102

Good agreement between the location of the persistent radio source and the FRB

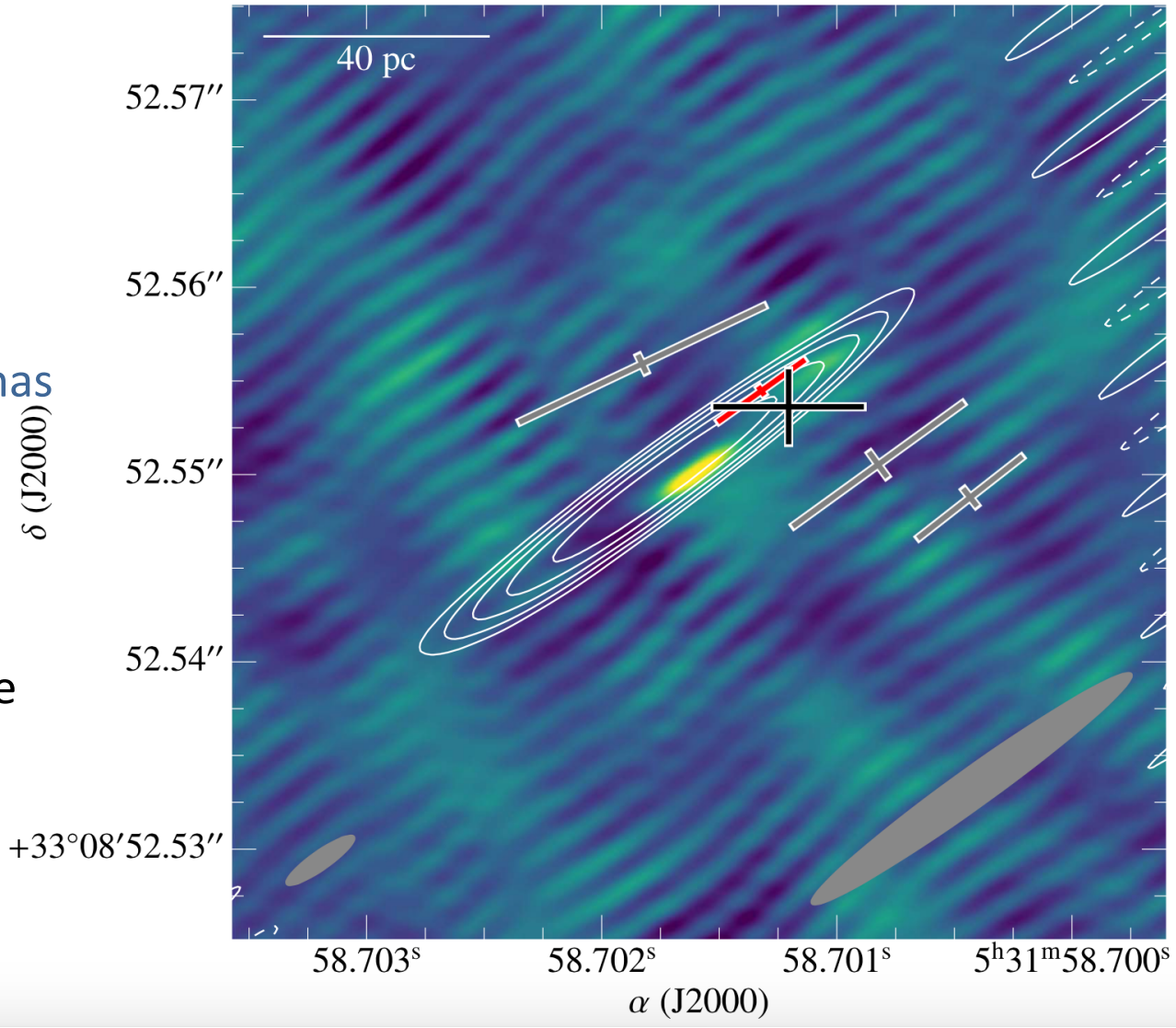
- coincident within 40 pc
  ⇒ ~ 12 mas
- JVLA localisation to ~100 mas

Image: Arecibo @ 5GHz

Contours: EVN @ 1.7GHz

Crosses: localisations of separate burst events

Black cross: weighted mean location of FRB position



Marcotte et al. 2017, ApJL, 834, L8

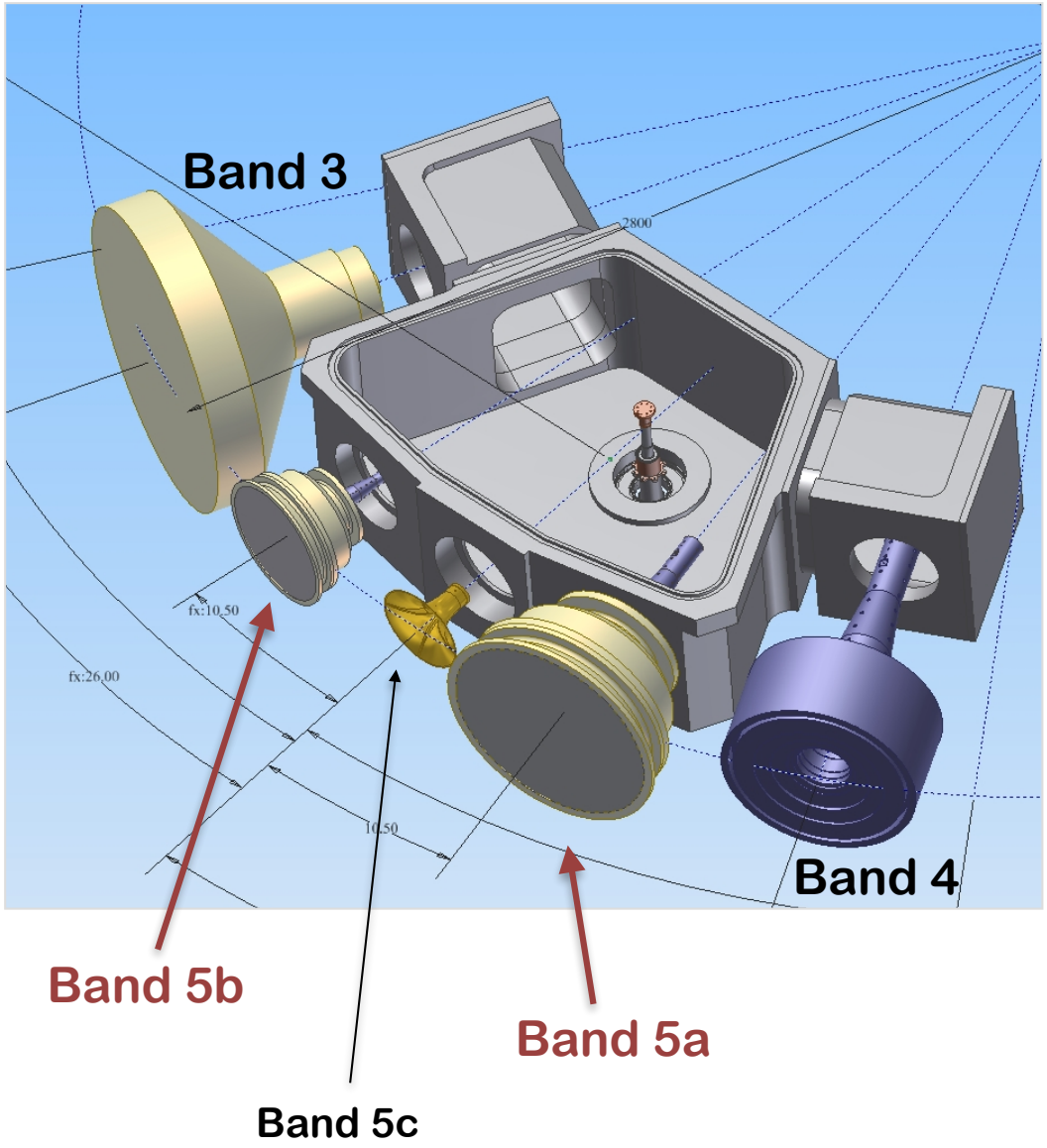
Band 5a/5b split

The ECP to split Band 5 into two has been approved and the teams are undertaking final refinements to the design and documentation

Frequency splits at:

- Band 5a: 4.6 – 8.51 GHz
  - allows for simultaneous tuning of C-band and most of X-band for VLBI
- Band 5b: 8.3 – 15.35 GHz
  - tuning for upper end of X-band for VLBI

Should result in increased sensitivity relative to previous design



Outline of SKA-VLBI work package

Operational Model

Commissioning Plan Including Performance Verification

Working with KSP science working groups

Operational Model for SKA-VLBI

What is the optimum way that we can operate SKA-VLBI?

- maximise the operational efficiency of the observatory
- deliver high quality VLBI science

The science cases can feed into use cases for

- proposal handling
- time allocation
- observation scheduling and execution
- data quality assessment and calibration
- data delivery

Commissioning VLBI

A commissioning plan for SKA-VLBI needs to be developed

- verification requirements and test procedures are being developed by AIV for the construction phase
- performance verification will follow, lead by the Science and Operations team
- need to review the verification and test procedures
- need to develop a plan for VLBI performance verification and how it will integrate into the global VLBI network

Continued development of VLBI within Science Working Groups

- advocate use of VLBI as part of KSPs

Global VLBI Consortium

An operational plan that governs all the global VLBI sites is needed

- agreements with correlator centres
- agreements with data networks
- agreements with observatories for fixed observing sessions
  - would we want to operate VLBI in a responsive manner (e.g. ToO observations)
- common proposal and assessment process

VLBI at the SKA

To address these, and other, issues WP10 has advertised for a SKA-VLBI Scientist

- a 2-year post based at the SKA in Jodrell Bank
  - closing date Feb 28th (next week!)

To provide a person in the SKA office whose primary role is to think about VLBI

- currently this is missing in the SKA office
- critically review VLBI requirements
  - there just isn't the effort and/or domain expertise available in the office
- refine the operational model
  - e.g. scheduling, data transfer, QA, ...
- work with the science working groups, and VLBI group, to drive the continued evolution of the SKA VLBI science case