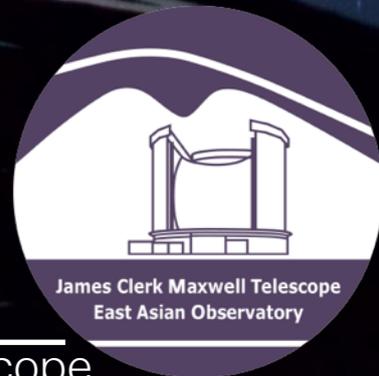


EAO's JCMT and its future with SMA

Or: Why Acronyms Should be Banned
Jessica Dempsey

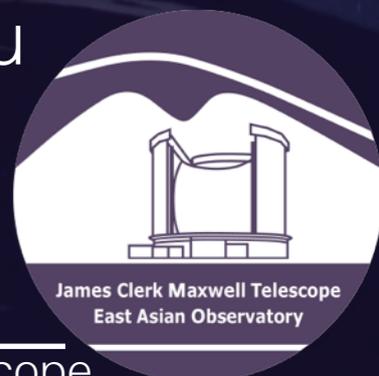


The East Asian Observatory

- The UK operation of JCMT in February 2015 (partnership operation with Canada and the Netherlands ceased in 2014)
- The East Asian Observatory (China, Japan, Korea and Taiwan) was incorporated in late 2014 and took over JCMT operations in March 2016

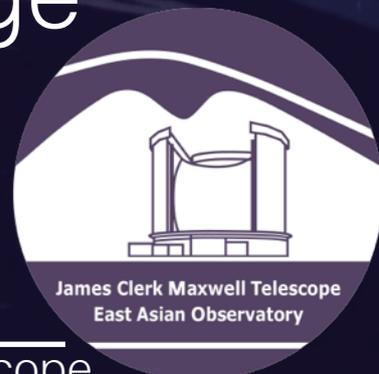


- The United Kingdom and Canada continue to participate as operational partners in the facility
- EAO regional astronomers will have access to propose at Subaru and SMA from next semester



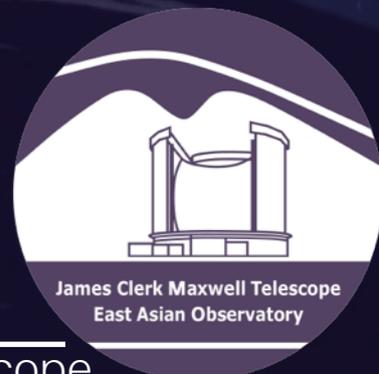
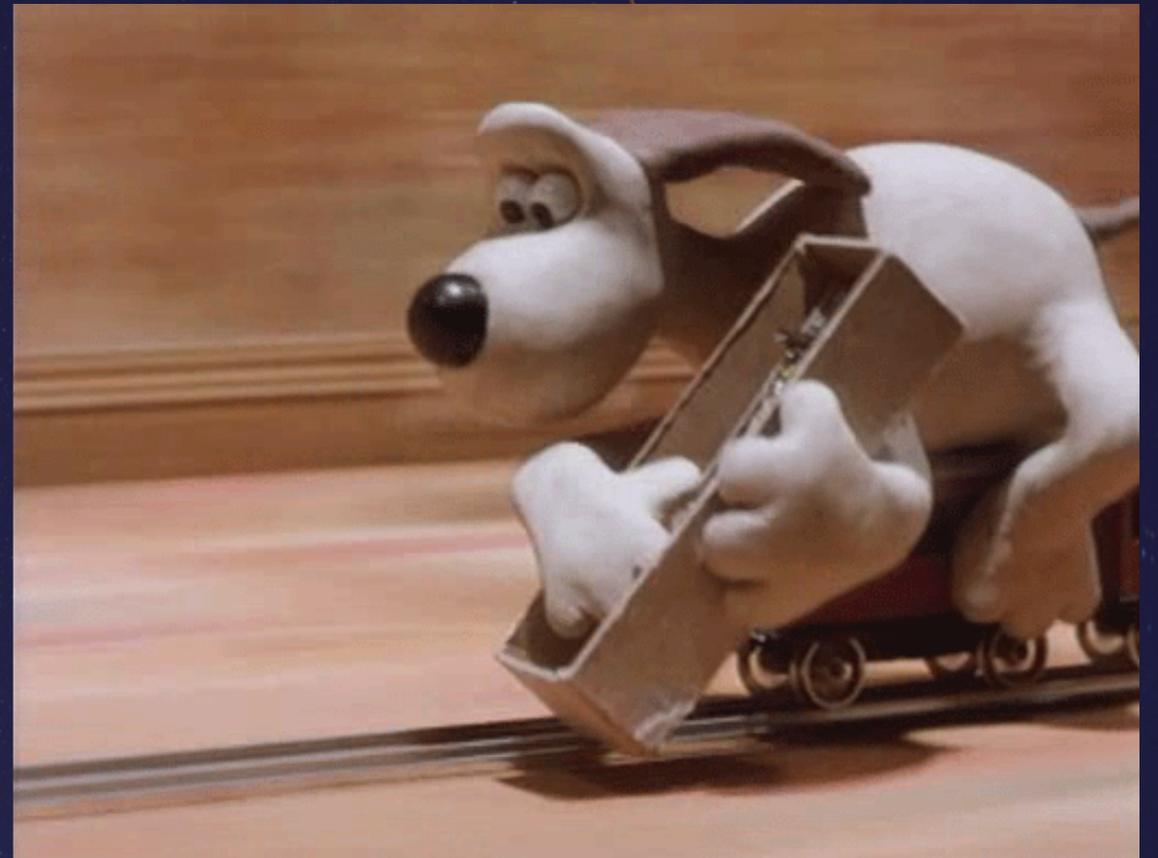
Why JCMT for EAO?

- **Operations:** tested and efficient by design and adversity - software, systems and policies are highly transferable to other EAO projects
- **Instrumentation:** new instrument plans perfectly tap into the skills and interests of EAO regional labs - bigger, better instruments are possible
- **Science:** JCMT becomes testing ground for how best to merge and enhance regional scientific cooperation and push out past the cutting edge



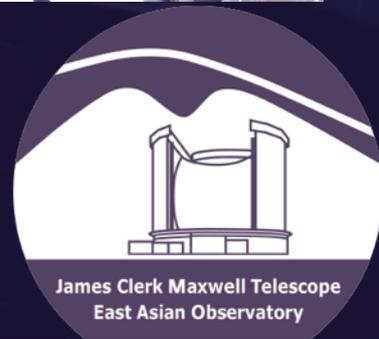
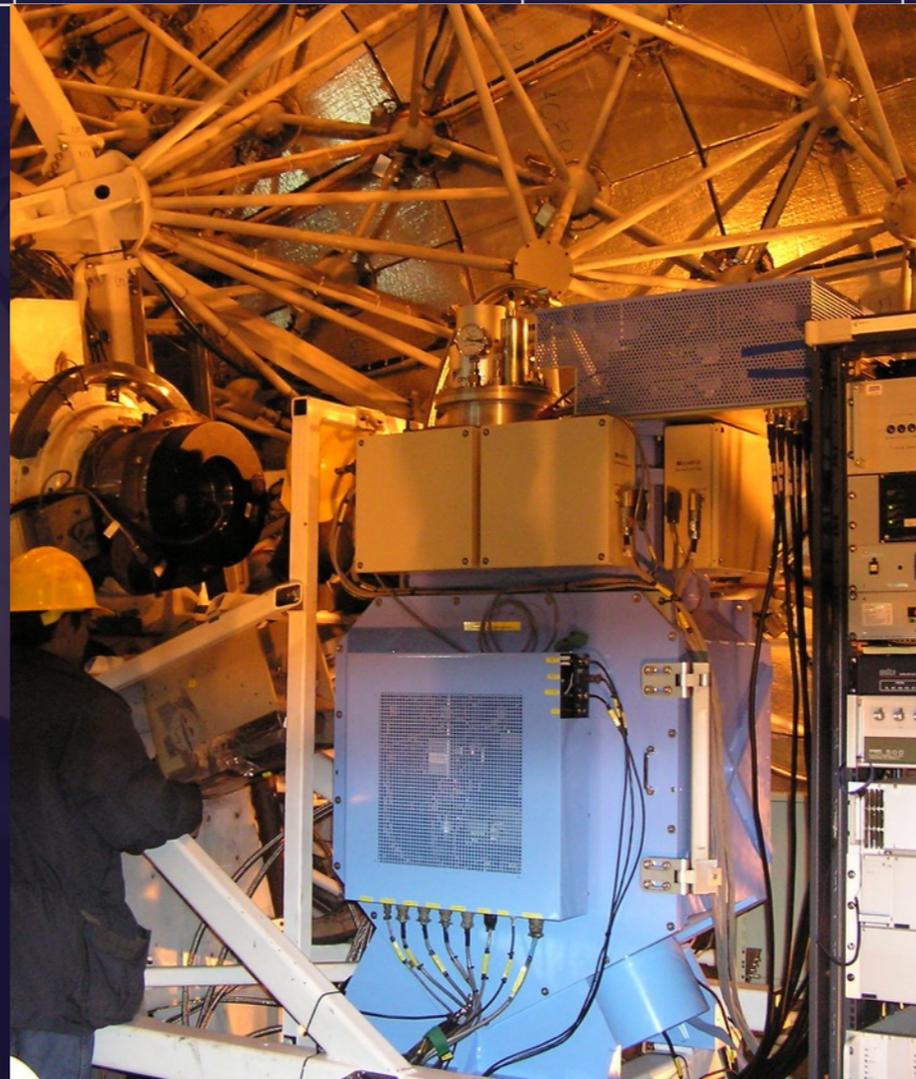
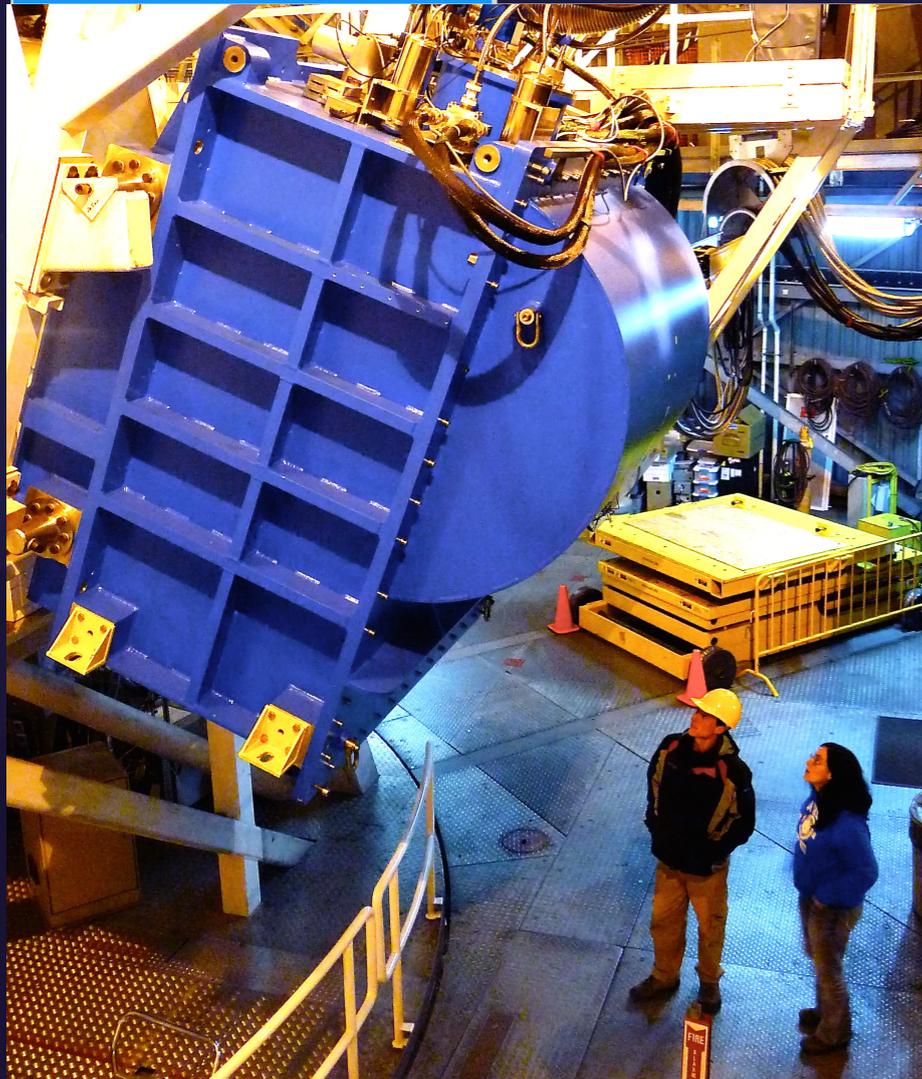
JCMT Operations

- Observing time distribution: 50% Large Programs; 50% PI Proposals
- TAC: one unified TAC process - priority on telescope by science ranking
- Observers: Scheduled Projects send Observers, observer project priority if in weather grade - **in one year we have had over 150 scientists visit to observe with us**
- Queue Mode: Flexible Schedule according to Weather
- Currently partial on-site and partial remote night observing (1/3 of time) + extended observing



The JCMT instrument suite

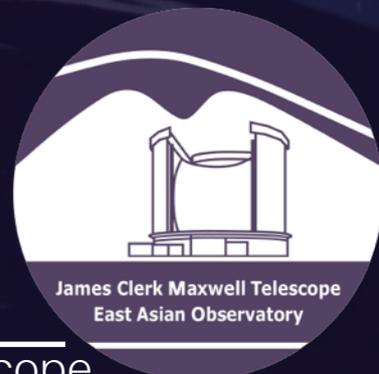
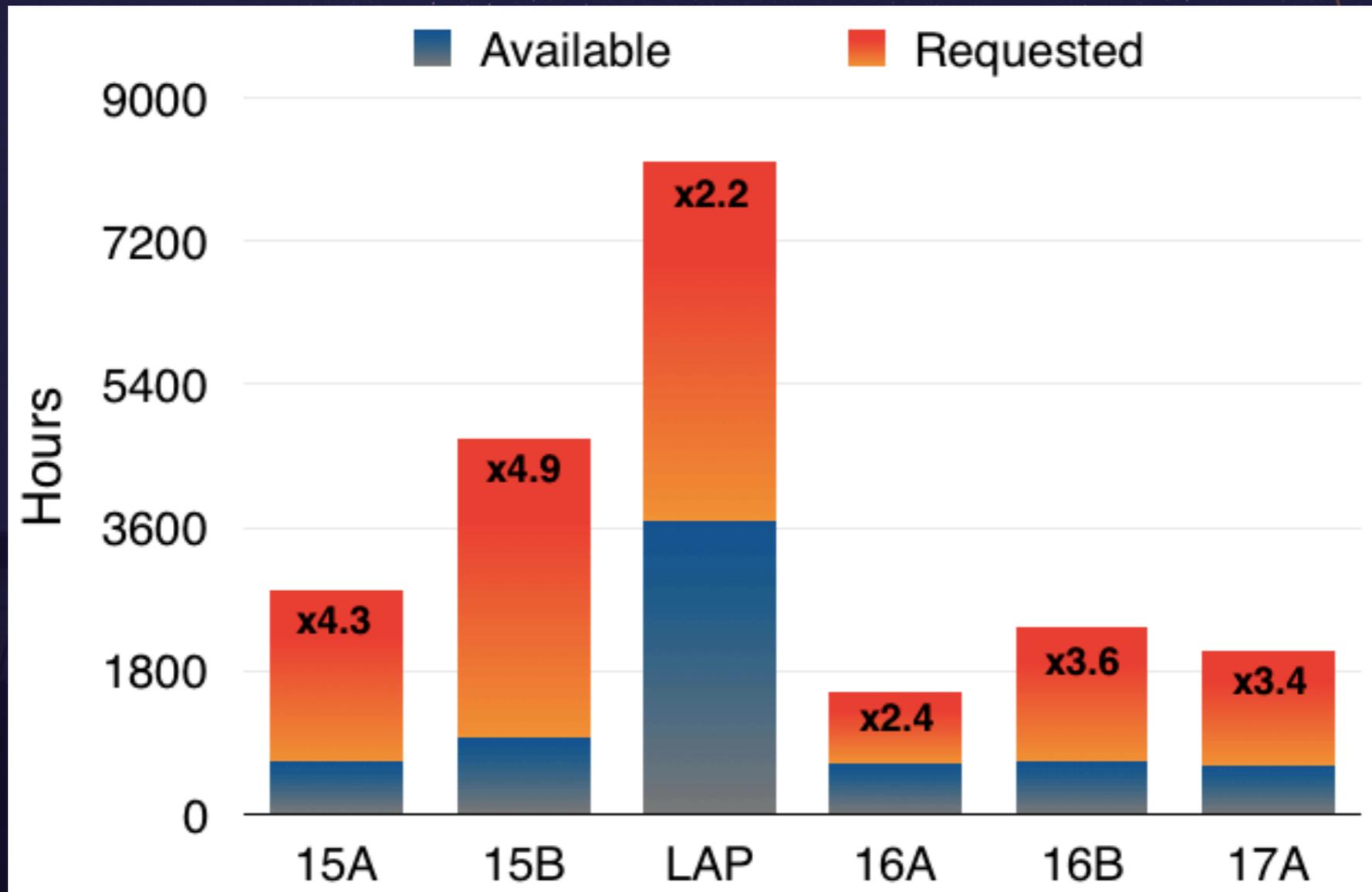
Instrument	Type	Frequency	Pixels	Bandwidth	Commissioned
SCUBA-2	Continuum	850/450 μm	5120/5120	-	2010
SCUBA-2: Pol-2	Polarimeter	850/450 μm			2016
SCUBA-2: FTS-2	FTS	850/450 μm			ongoing
HARP	Heterodyne	325 - 375 GHz	16	3 - 5 GHz	2006
RxA	Heterodyne	219 - 272 GHz	1	3 - 9 GHz	1995



Science Calls

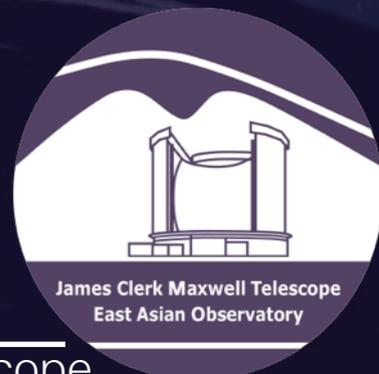
In 18 months we have had six proposal calls (4 in first five months) 22,000 hours requested, and over 1200 astronomers involved in proposals

Average oversubscription of 3.5



What EAO wants to do

- Combine and focus the vast potential of the East Asian regions
- Stronger collaborations to improve science quality and diversity
- Increase student opportunities to broaden experience
- Multi-telescope access: Current opportunities with Subaru (17A EAO proposals (x5 oversubscription, 14 proposals submitted), and upcoming with SMA
- Increase scope and size of instrument projects



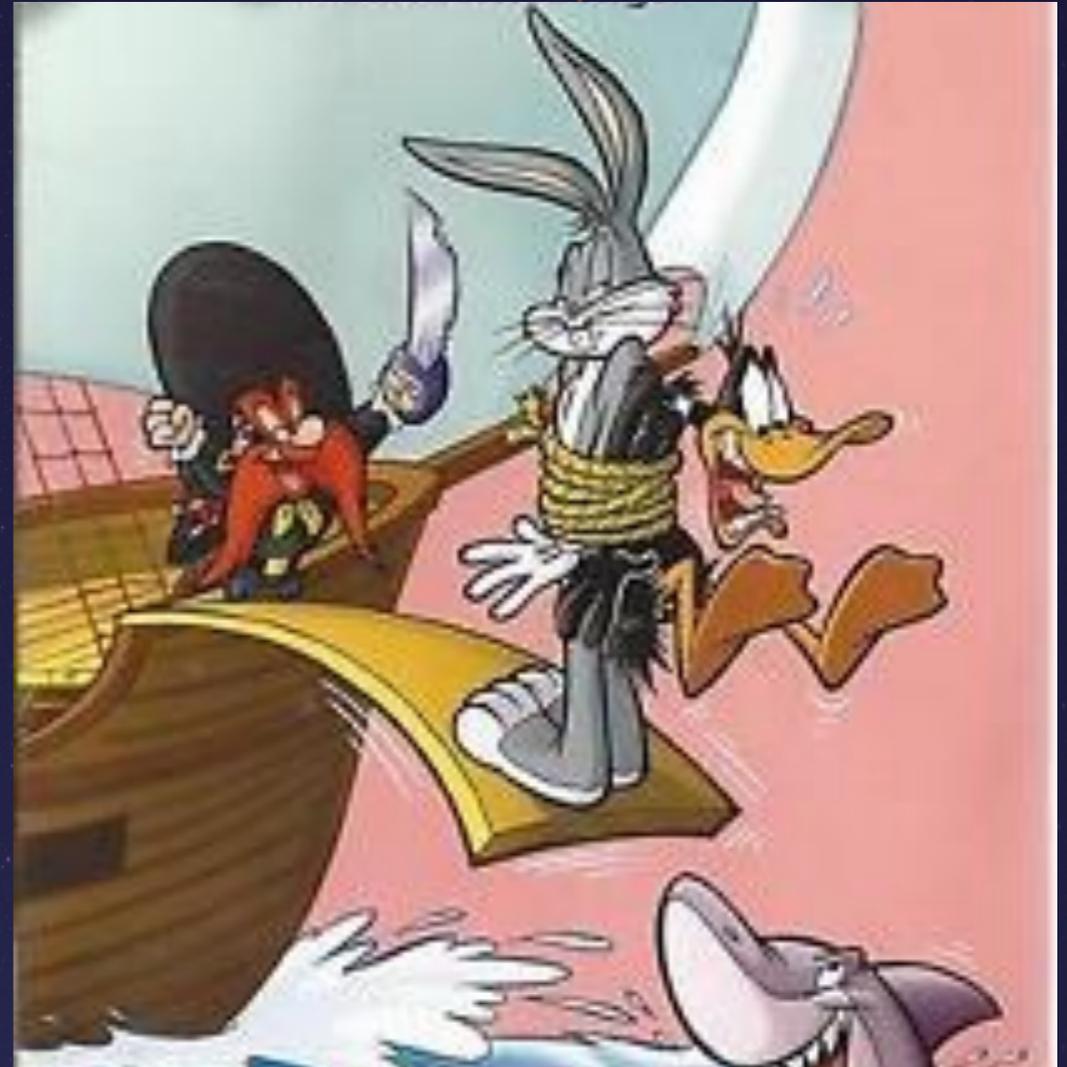
How to create collaboration?

Encourage (carrot)

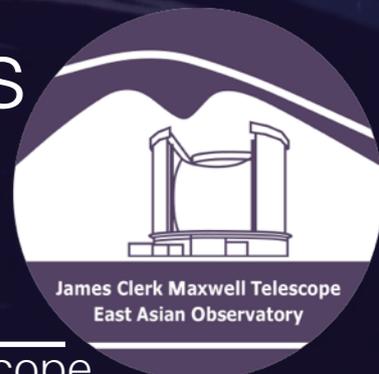


PI programs

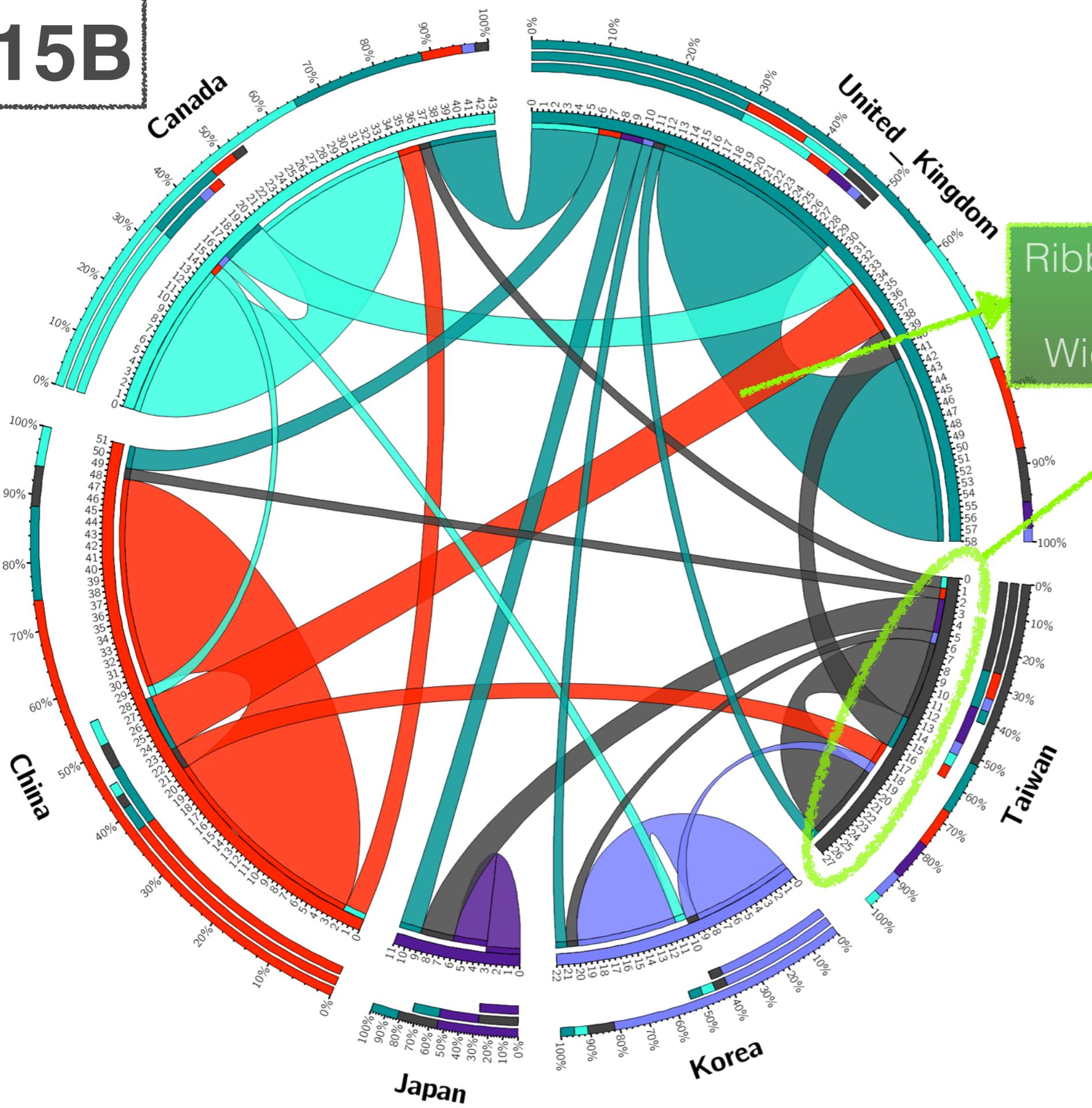
Enforce (stick)



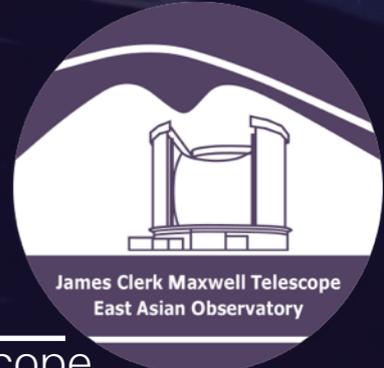
Large programs



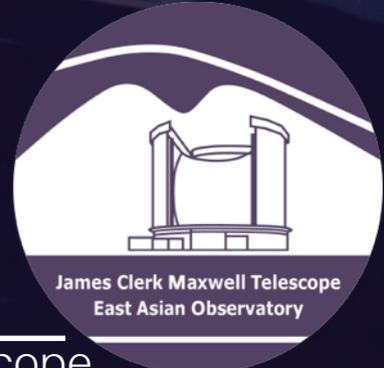
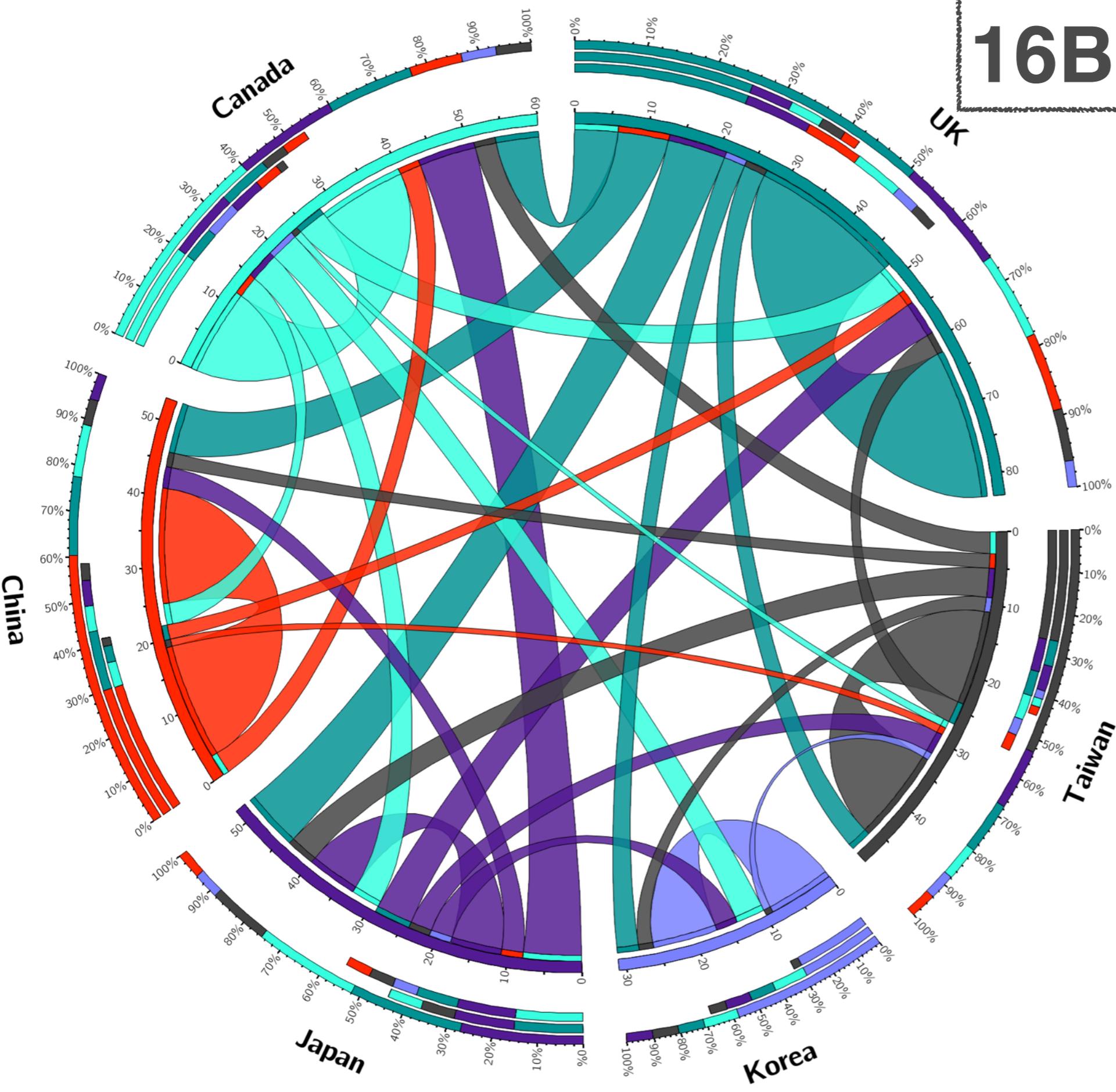
15B



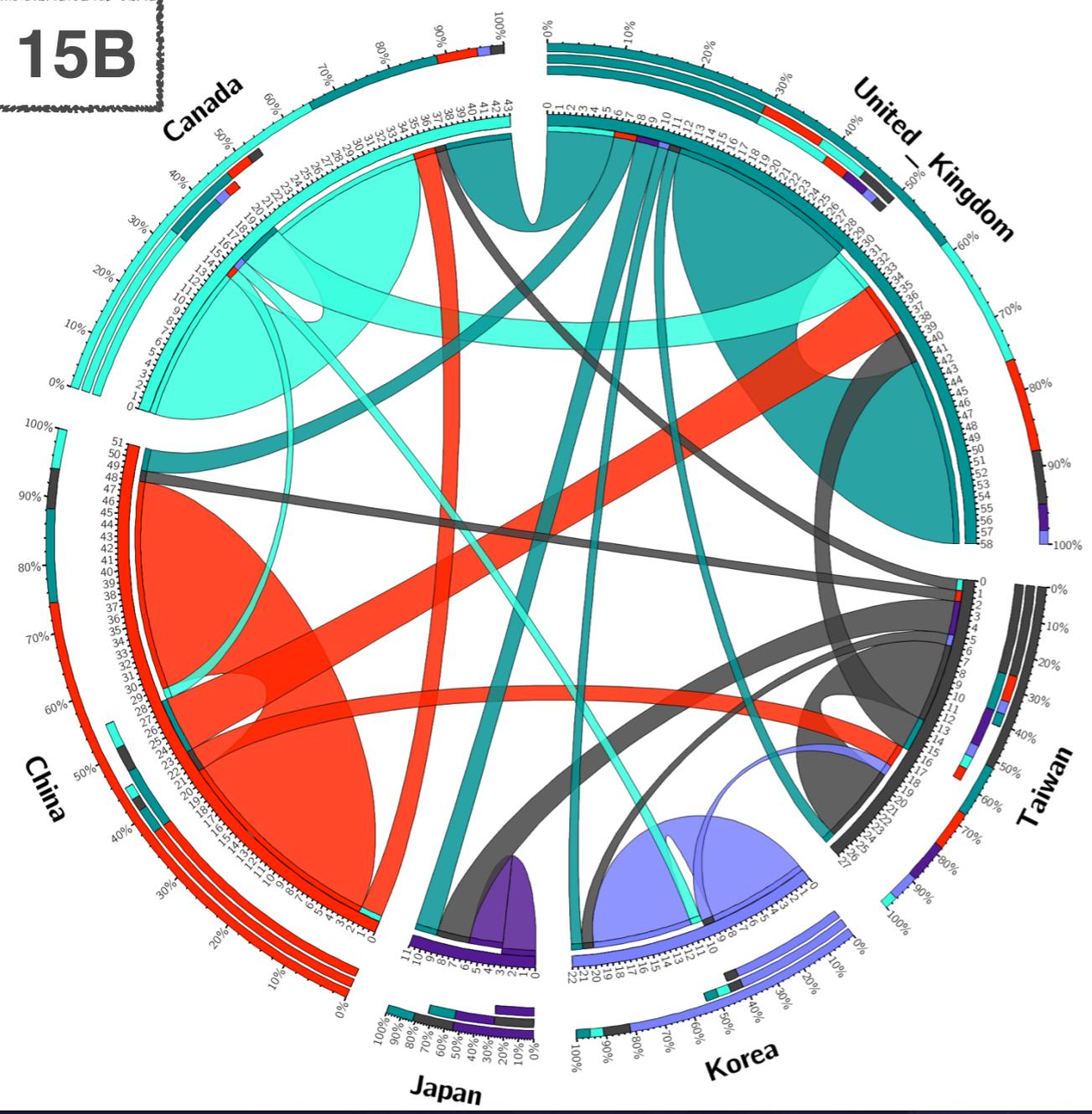
Ribbon shows collaboration
Colour = Region
Arc length =
Width = total # investigators



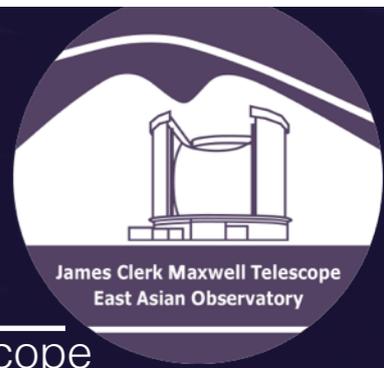
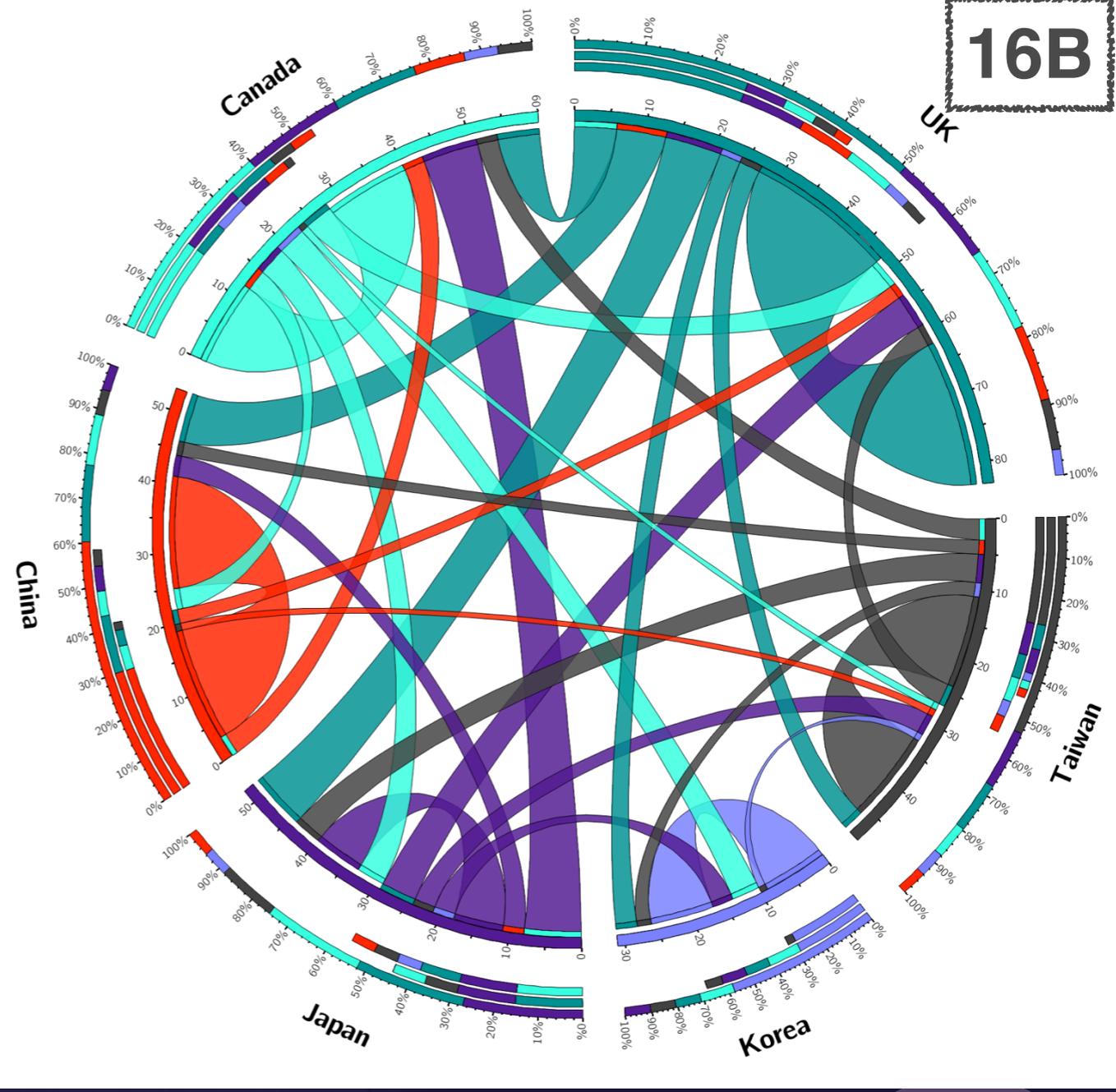
16B

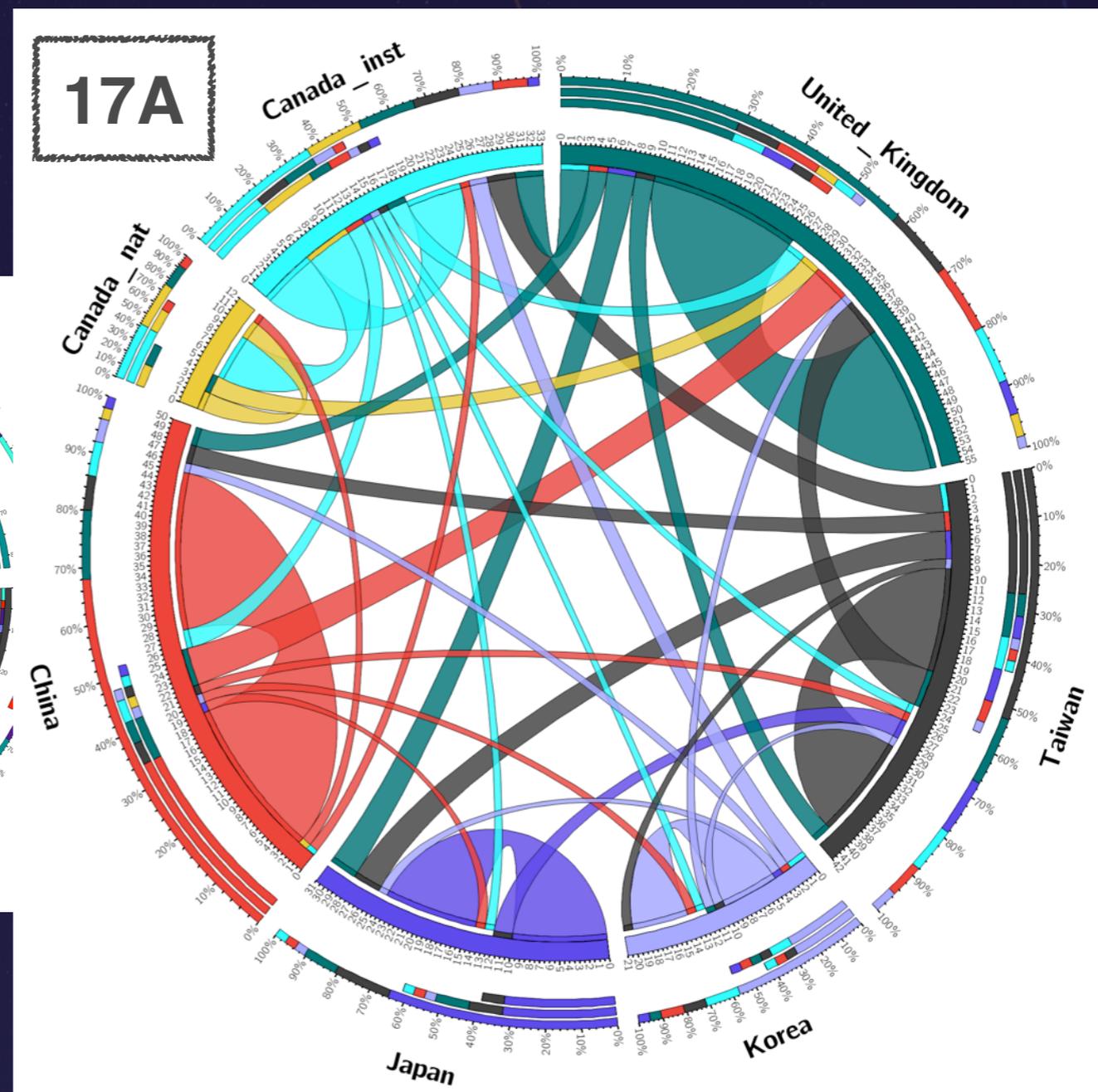
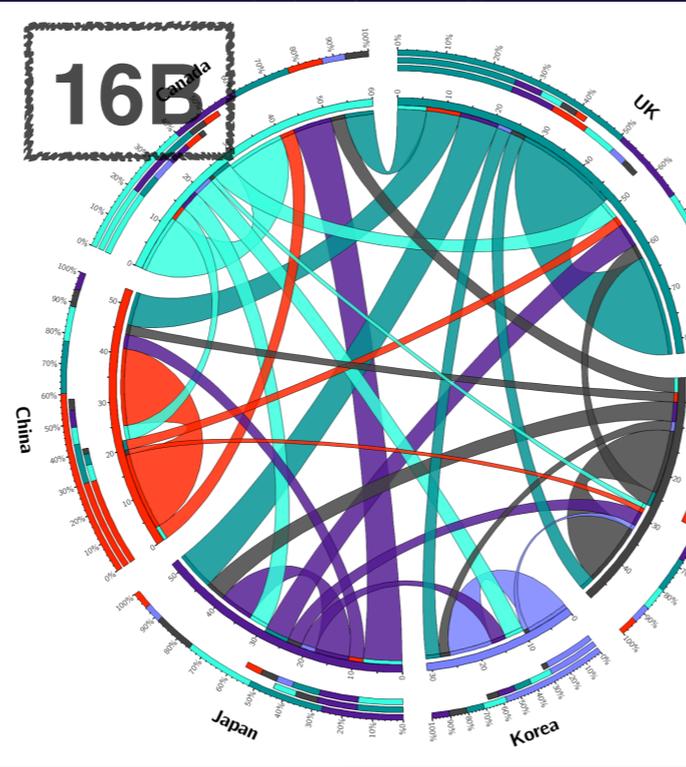
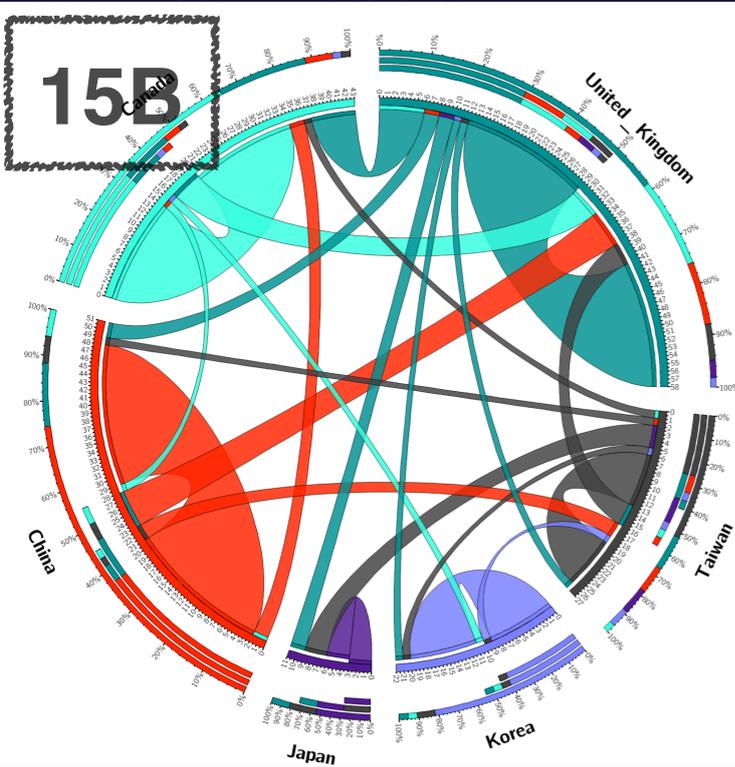


15B

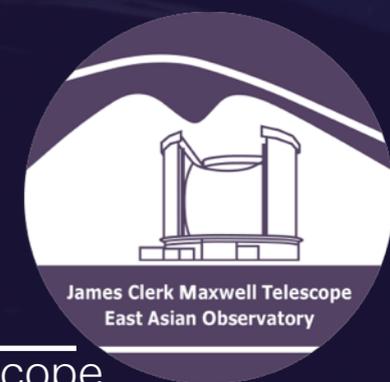


16B



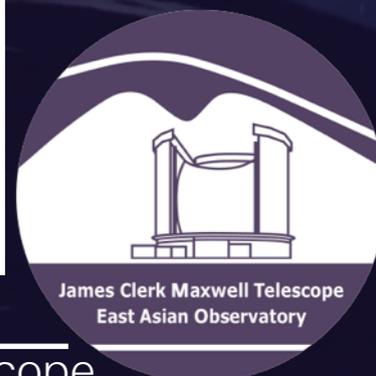
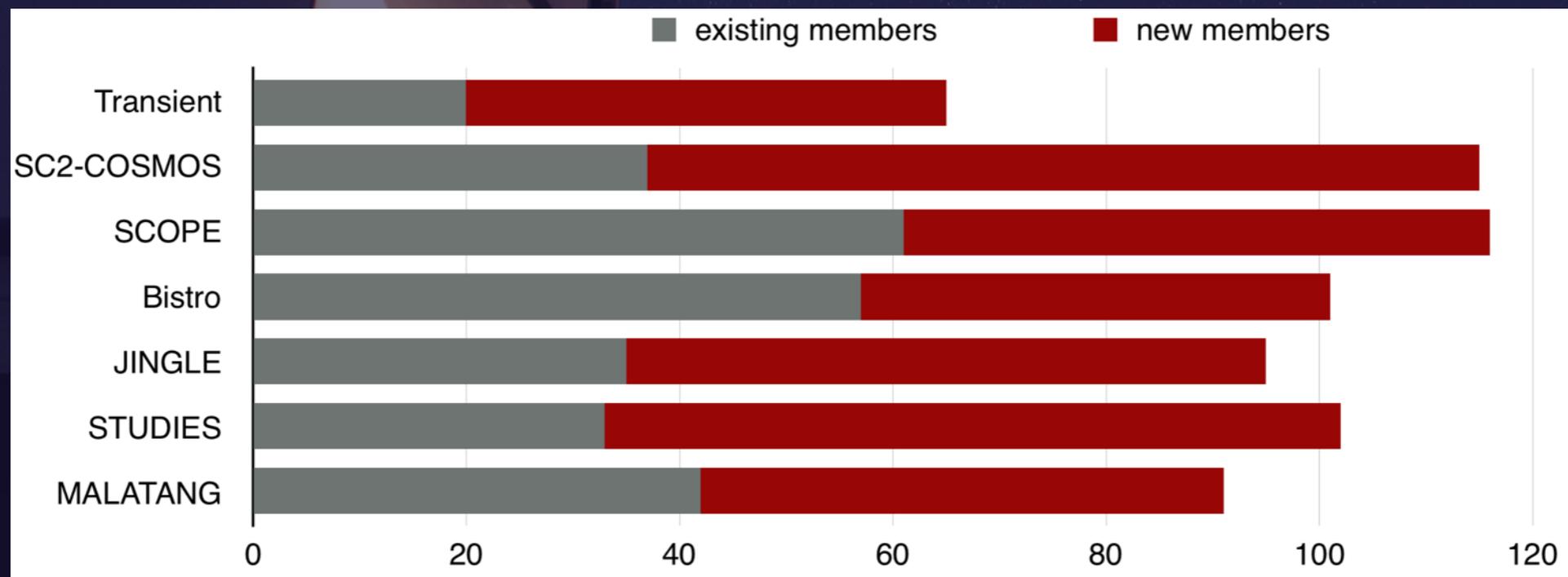


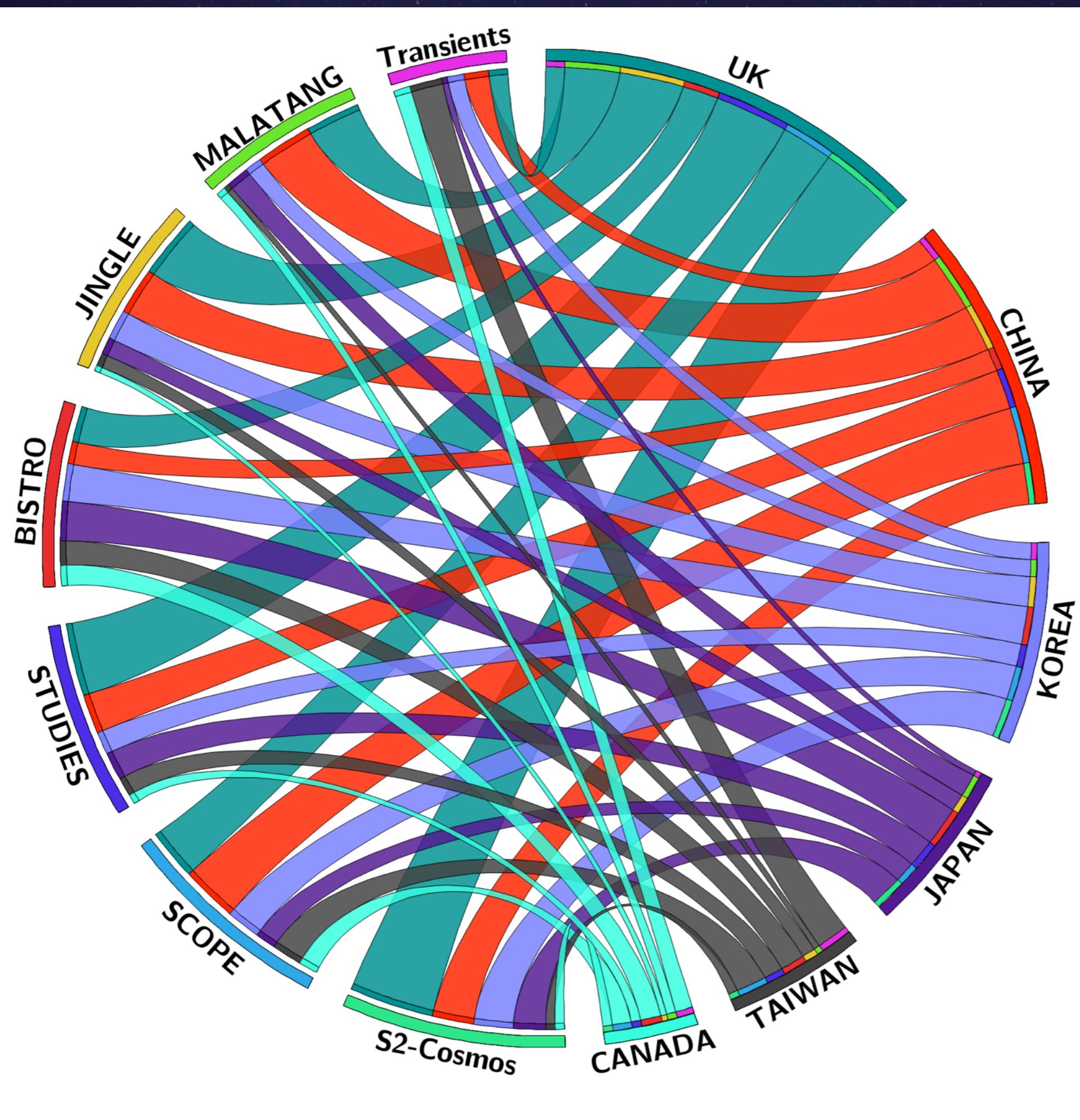
Chord diagram software:
<http://mkweb.bcgsc.ca/tableviewer/>



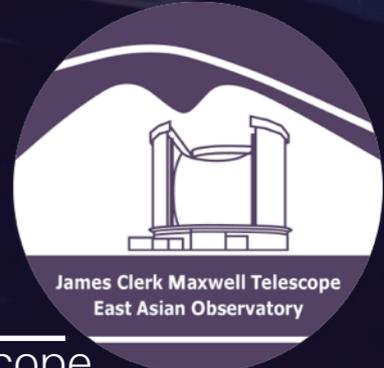
JCMT Large Programs

- Requirements for consideration included demonstration of interest and active collaboration from at least two EAO regions
- After successful programs were awarded time a period of 'open enrollment' allowed any EAO regional astronomer to sign up as a participant in any Large Program
- Additionally, PIs from each region must be selected
- A mid-term review is required in order to demonstrate adherence to their publication plan, with the TAC and finally Board, able to rescind further time allocations if performance is not good enough





- Over 700 astronomers from six regions involved in 7 programs
- Regional participation is roughly proportional to community size (with Canada and Taiwan punching well above their weight)



Large Program science progress

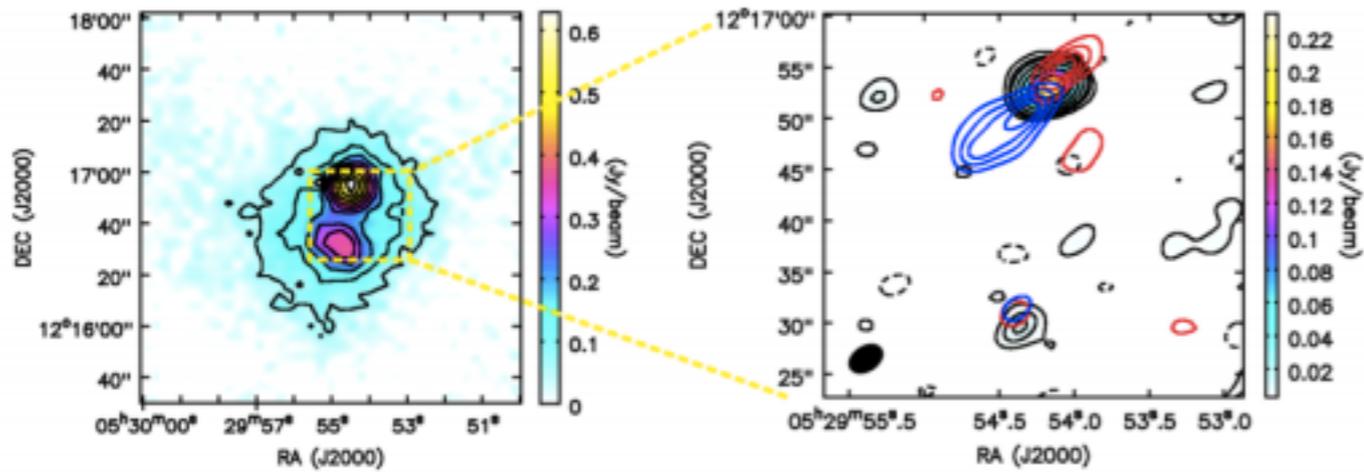


Figure 16: Left panel: SCUBA-2 850 micron continuum of PGCC G192.32-11.88. Two dense cores (north: G192N and south: G192S) were detected. Right panel: SMA 1.1 mm continuum is shown as color image and black contours. CO outflows are shown in red and blue contours.

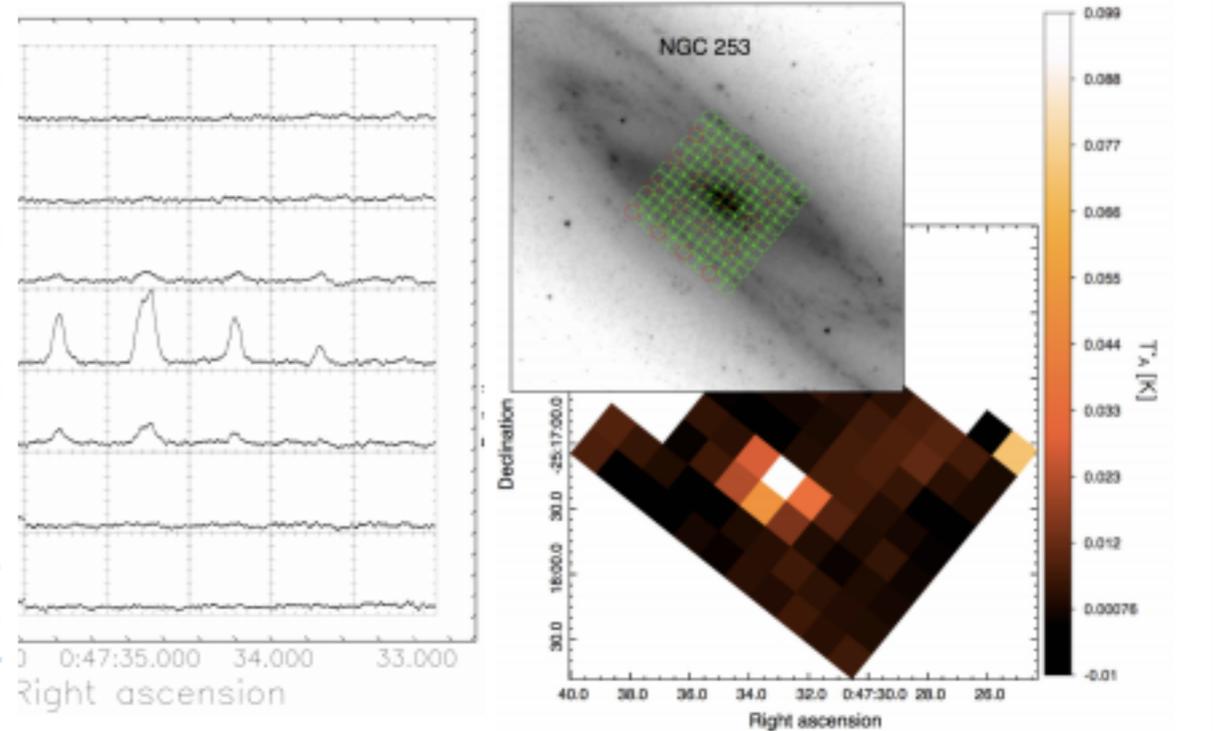


Figure 14: Preliminary MALATANG data of the nearby galaxy NGC253,

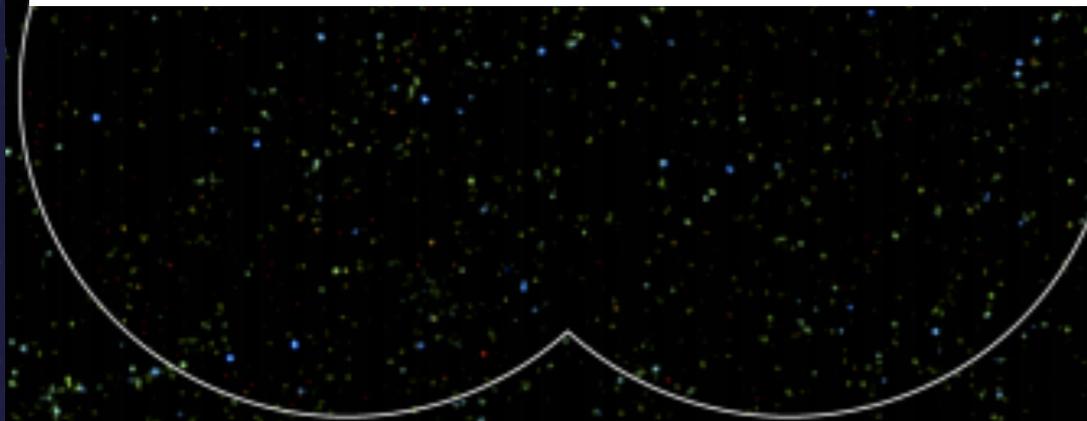


Figure 11: A "true-colour" image of the COSMOS field created from SCUBA-2 850um (red) and Herschel SPIRE 250 and 350um (blue and green respectively) maps. This map highlights the rare, red dusty sources which are likely to include some of the highest redshift examples of this population. The wide-field available in COSMOS allows us to use SCUBA-2 to construct a large sample of these sources needed to understand their nature and to study their environment. The white line shows the coverage of the 1.4x1.4 degree SC2-COSMOS map.

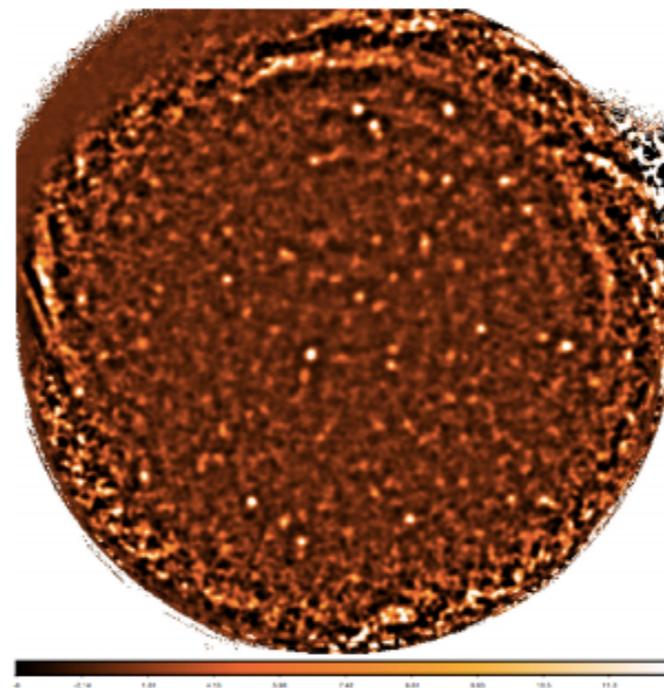


Figure 9: Latest STUDIES 450 um image. The total diameter of the map is 15 arcmin. The color scale is in unit of mJy/beam. The noise at the map center is 1 mJy. Roughly 40 sources are detected. Because of the steep counts in the submillimeter, we expect the number of detected sources to dramatically increase after we further deepen the image in 2017 and 2018.

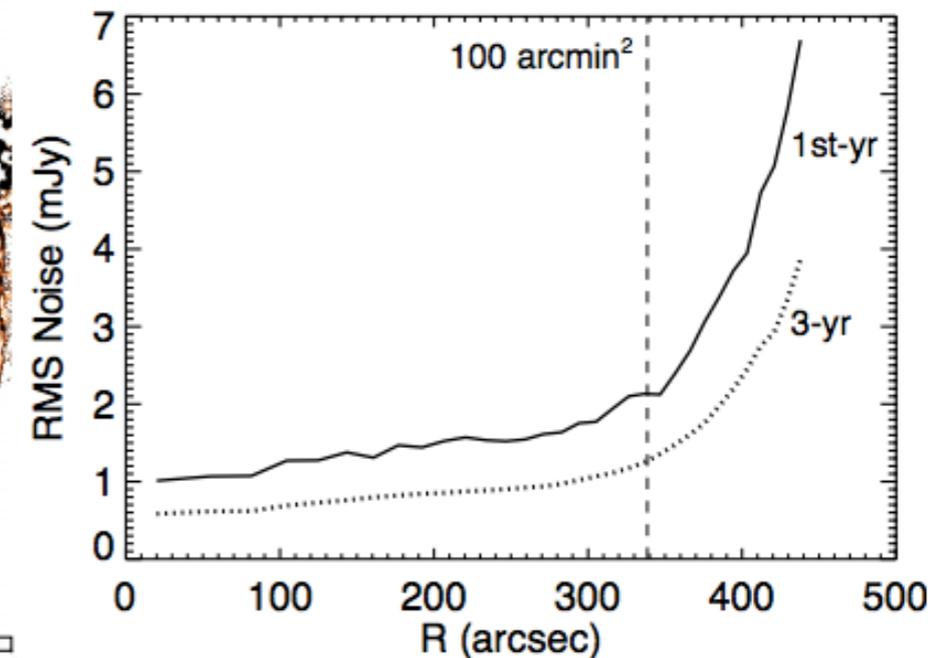
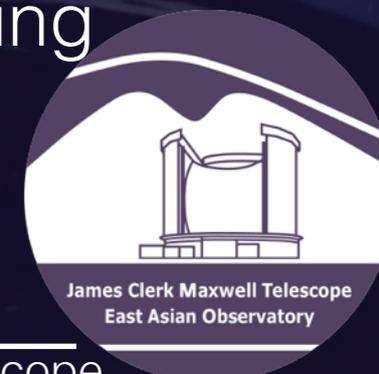


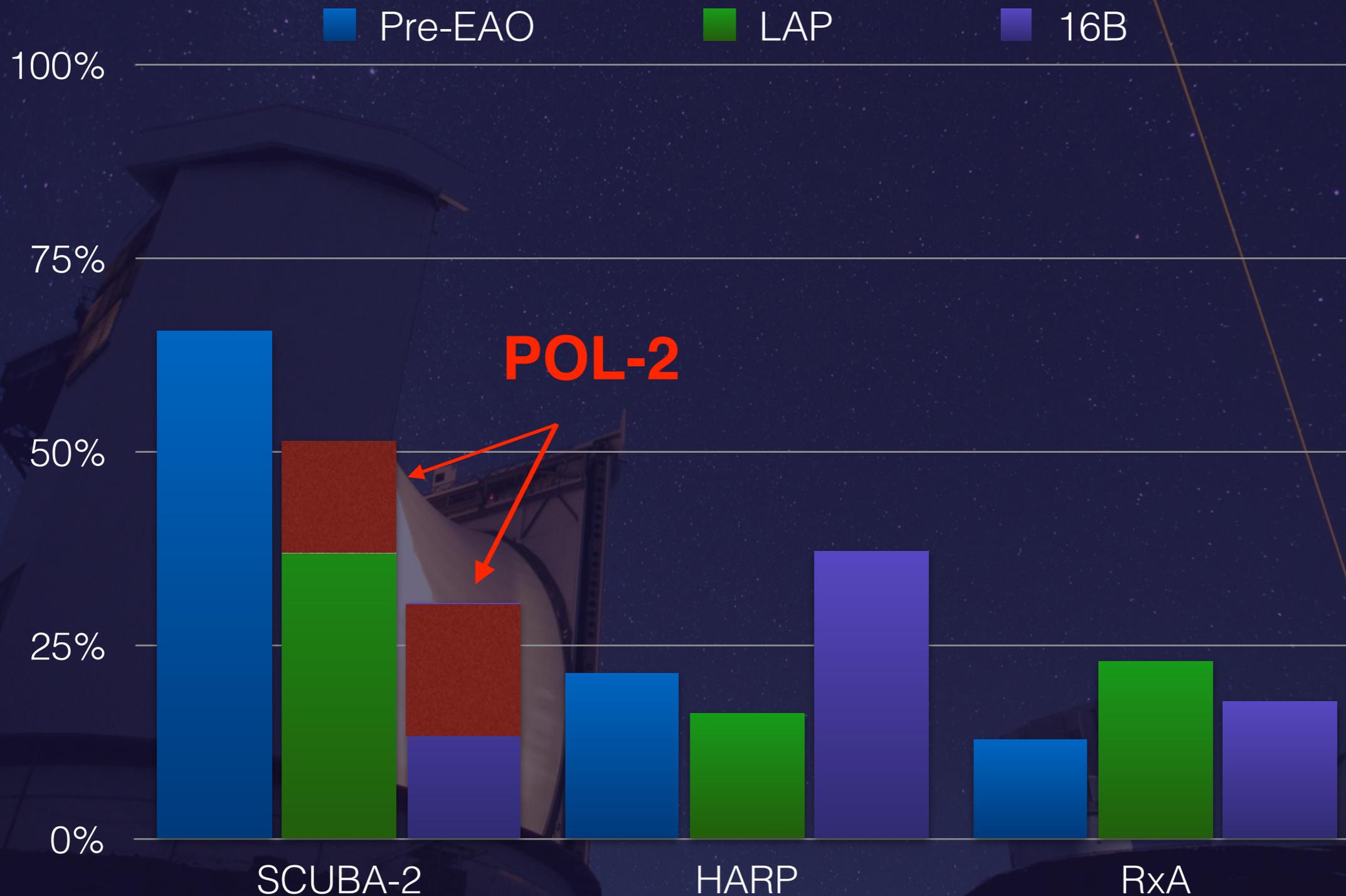
Figure 10: The distribution of rms noise in Fig. 9 (solid curve) and the expected rms after we complete the survey in three years (dotted curve). The vertical dashed line indicates the radius where the survey area is 100 arcmin².

EAO and JCMT meetings

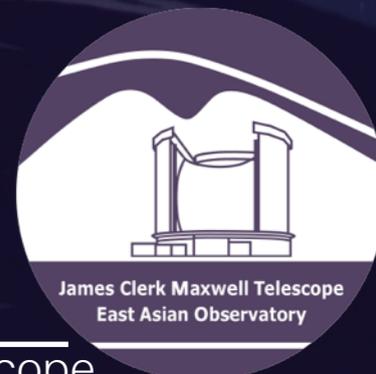
Date	Location	Meeting topic
17-18 October 2016	Shanghai, China	JINGLE meeting
20 - 21 October 2016	Nanjing, China	MALATANG meeting
15 - 16 December 2016	Beijing, China	SCOPE meeting
Jan/Feb 2017	Nanjing, China	Transients meeting
13 - 15 February 2017	Nanjing, China	JCMT Users' meeting
3 - 7 July 2017	Taipei, TW	Asia Pacific Regional IAU Meeting



Instrument demand

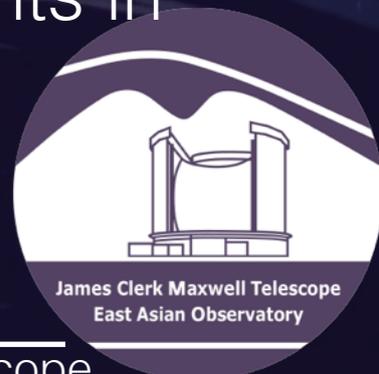


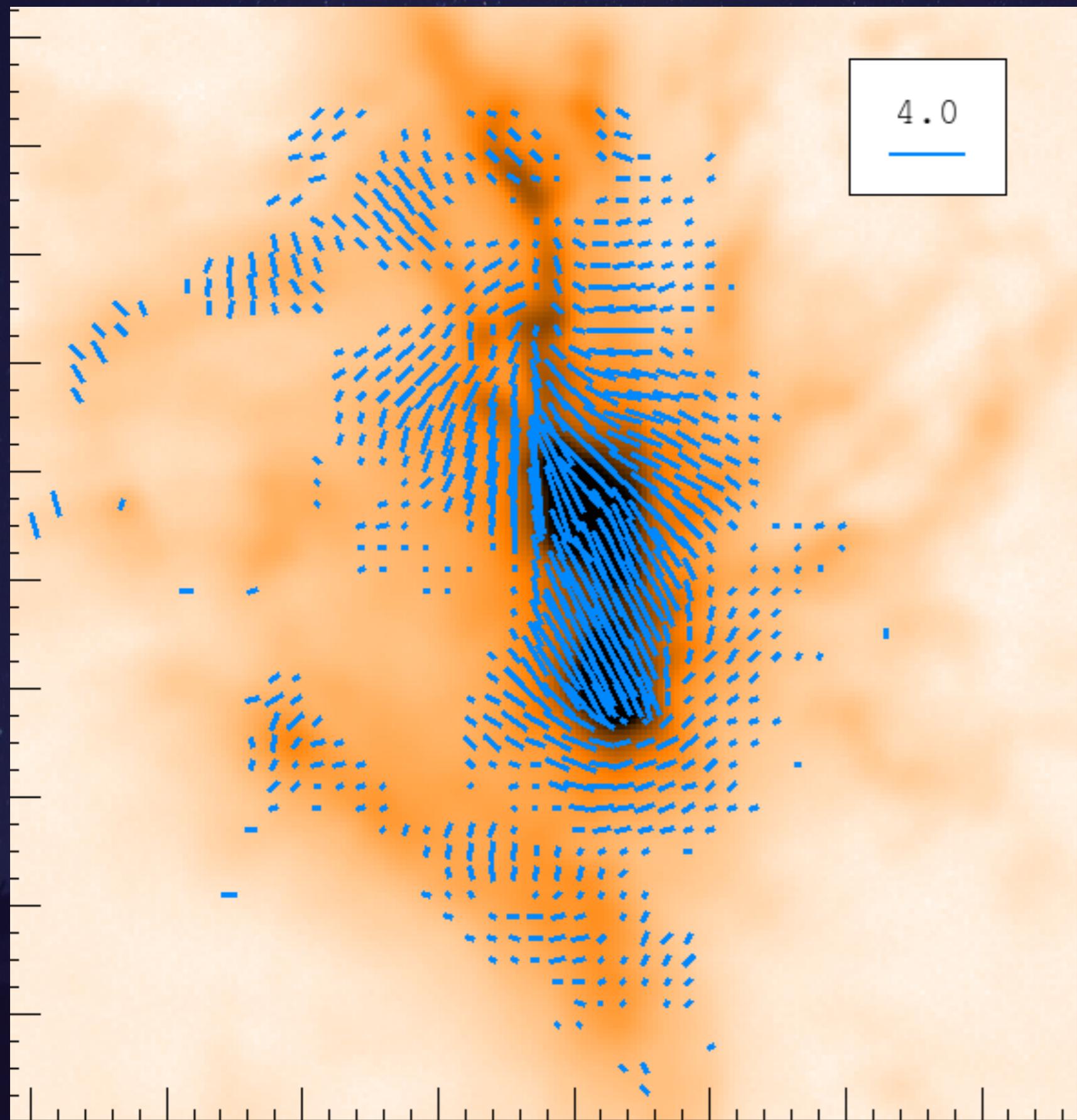
- Instrument demand has shifted from primarily continuum to requests for both heterodyne and continuum observing under EAO



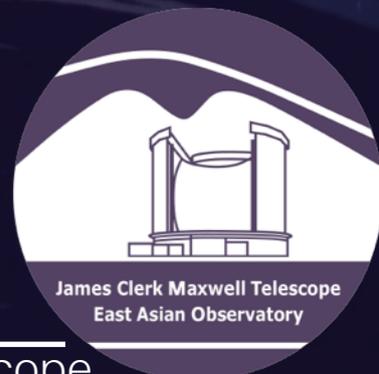
JCMT instrument Project

- Community consultation began in July 2015
- JCMT Board initiated project in October 2015
- Instrument Panel formed in November 2015 and met formally in March 2016 to review potential instrument directions and assess the interest and capabilities of the EAO regions and partners
- Key goals for JCMT future instrumentation:
 - Capitalise on EAO region instrumentation facilities and expertise
 - Provide premier capabilities for areas of key interest to EAO region and partner astronomical communities
 - Niche is large-scale, high-speed mapping - aim: x10 improvements in speed



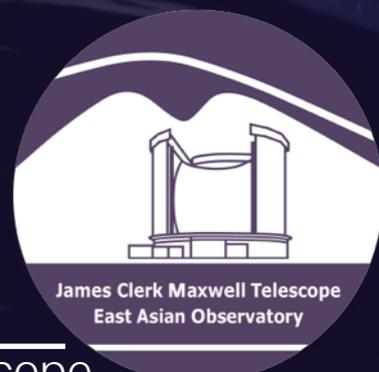
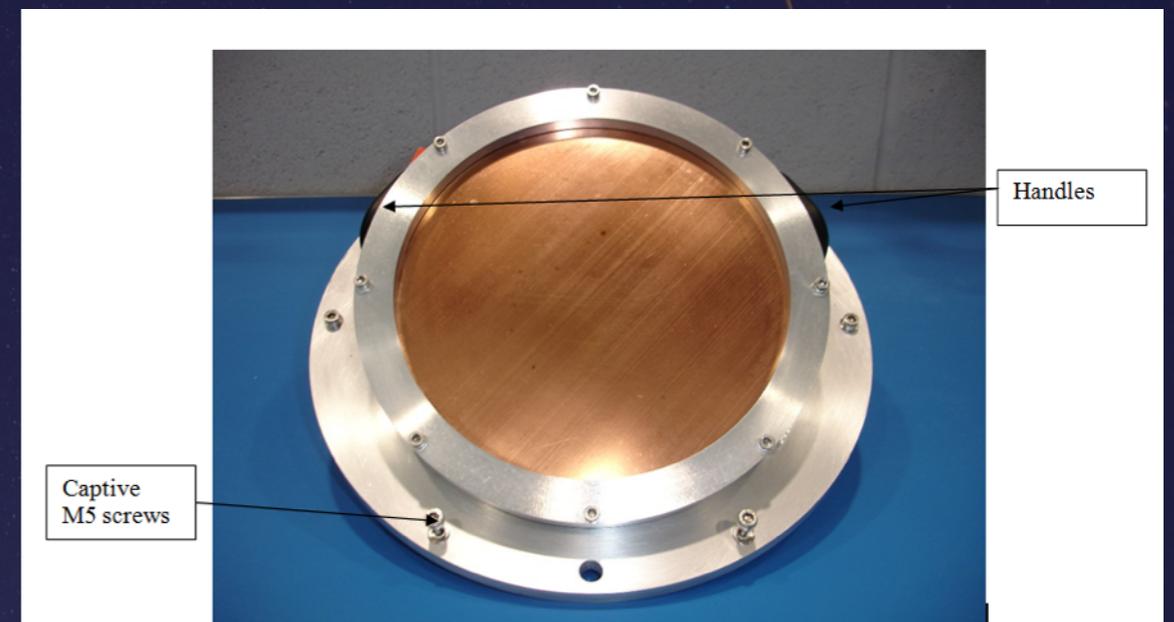
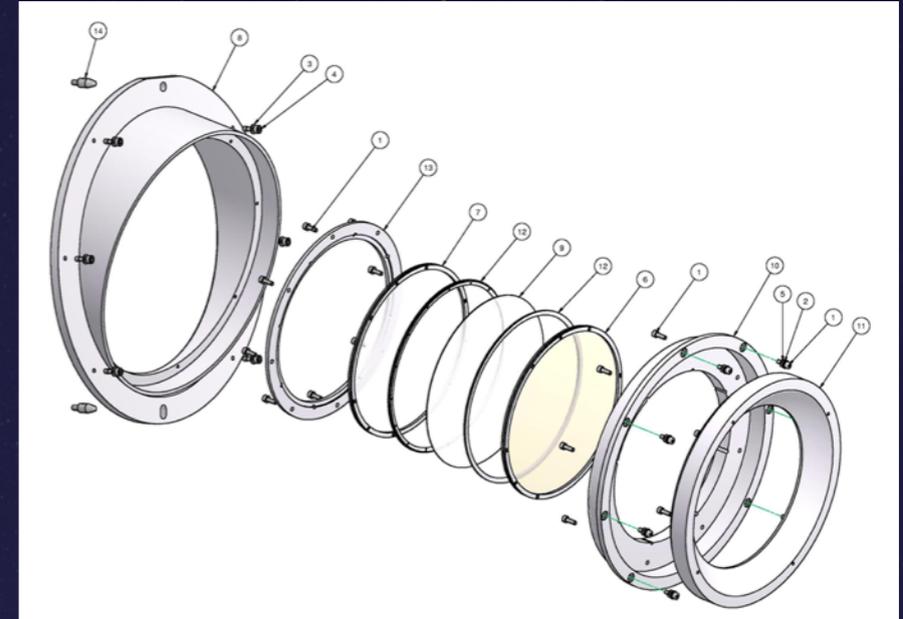


- OMC-1 (orange background is SCUBA-2 850 μm intensity map)
- Blue vectors are polarized intensity as measured by Pol-2
- 14 hours of observing
- 2 mJy rms
- Key 4.0 length represents 4% polarized intensity
- Hints as wealth of star formation discoveries that can be now quickly uncovered by probing magnetic fields



SCUBA-2 upgrades

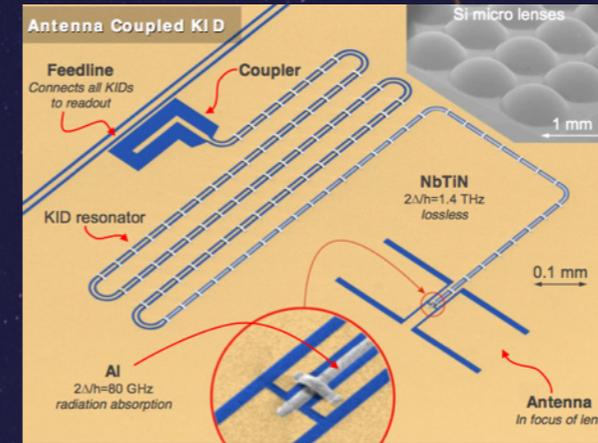
- Filter modeling suggests possible x2 decrease in optical loading
- Modeling done and filters now being tested downstairs...
- SCUBA-2 is currently off the telescope and installation of new filters will take place next week



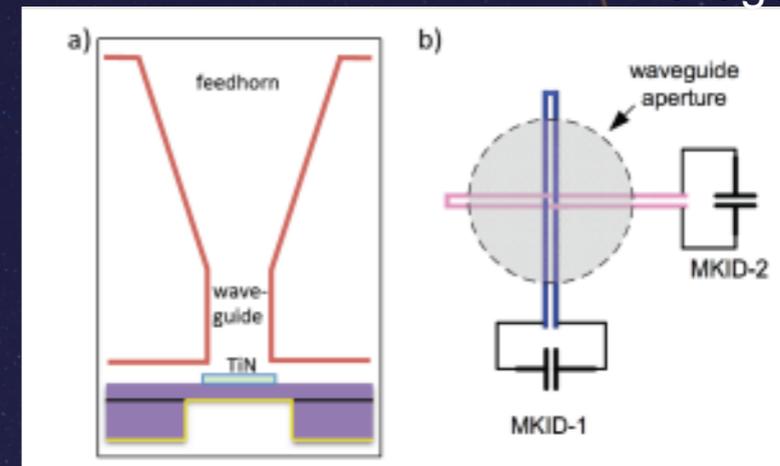
Options for new arrays

- TES new 32 x 40 sub-arrays (most likely based on GSFC BUG architecture)
- Larger TES arrays 40 x 40 (increase pixel count by factor of ~2) using larger 6 inch wafer. So far only NIST has this process worked out (making Advanced ACTPol detectors)
- KID arrays at least 40 x 40 sub-arrays
- [could move 450 to $F\lambda/2$ spacing - 80 x 80 sub-arrays]
- Horn coupled KID arrays with $2F\lambda$ spacing
- (See Griffin, Bock, Gear 2002)
- Dual-Polarisation sensitive KID array (BLASTpol pixel)
- 2 KIDs per pixel

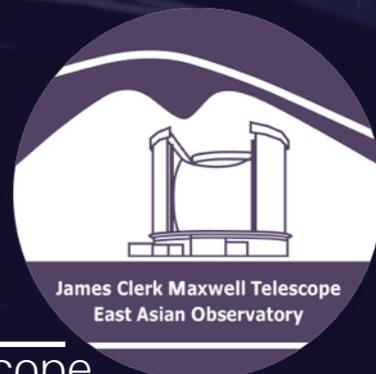
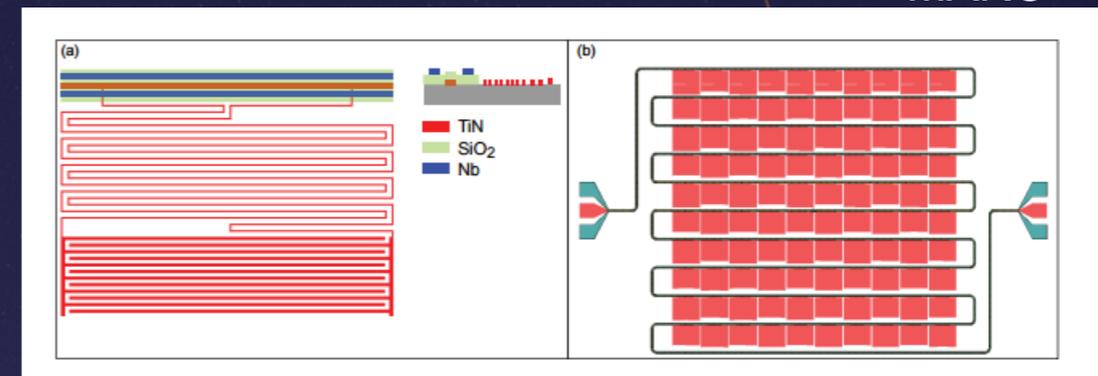
AMKID



Next gen BLASTpol

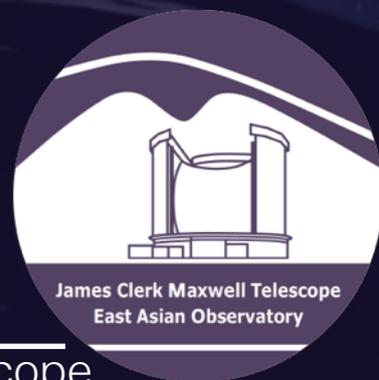
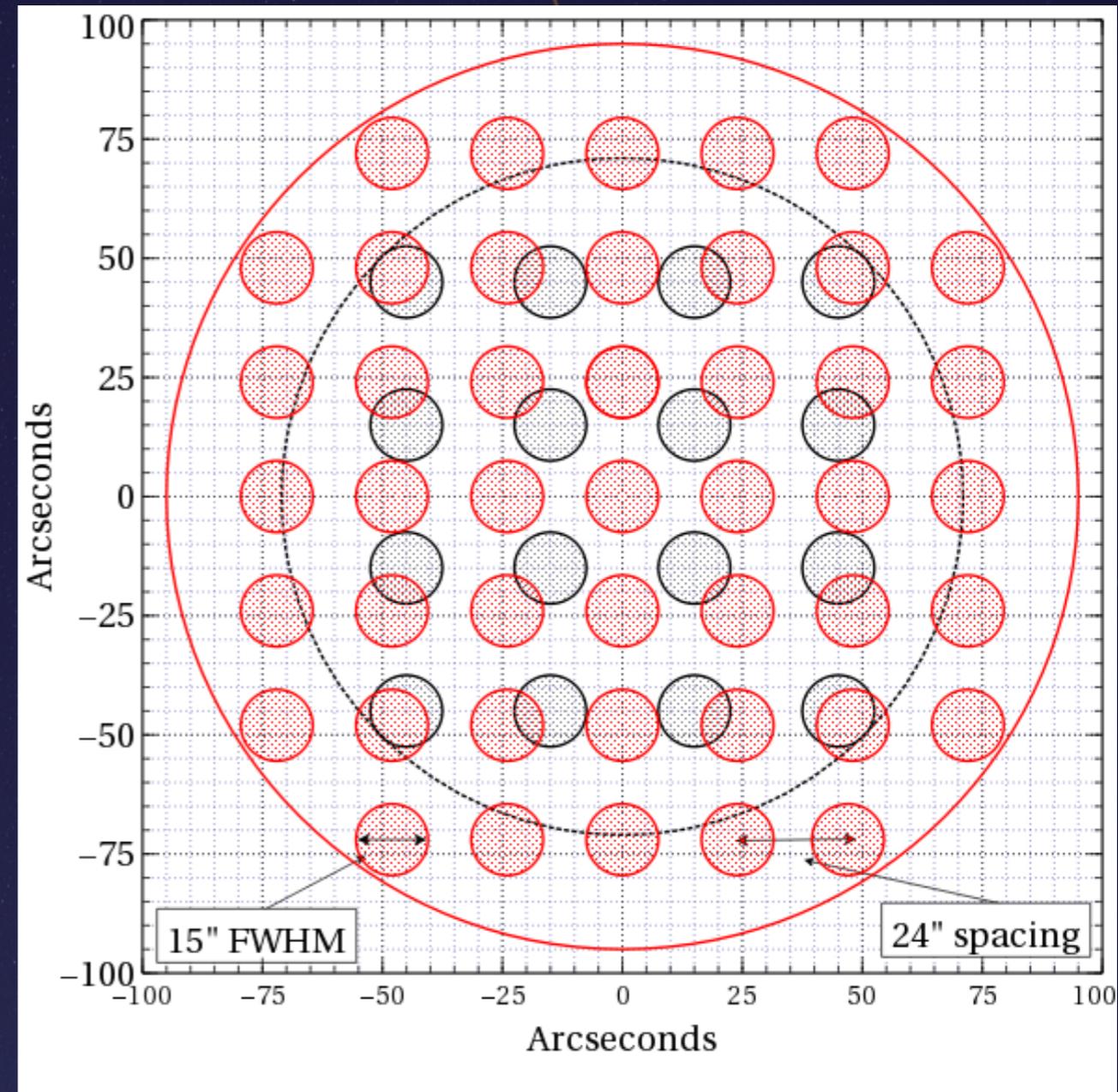


MAKO



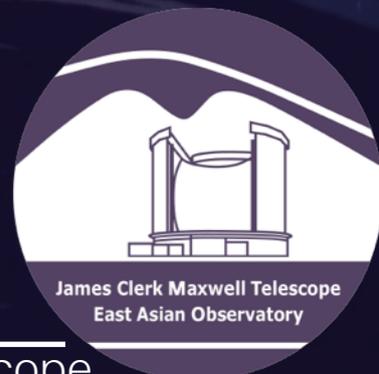
New 345GHz heterodyne array

- Recall that mapping speed goes as $N / (T_{\text{sys}}/\eta_b)^2$
- Noise Temperature
 - ALMA band 7 had Trx (SSB) ~ 65K. Aim here is for 50K Trx. Results in $T_{\text{sys}} < 200\text{K}$ in good cond.
- Polarization / Sidebands
 - Dual polarisations with a mixer at each polarisation
 - Side-band separating mixers
- Possible architecture:
 - 7x7 with 4 corners removed.
 - Gives 45 pixels on 24 arcsec spacing
 - x2 for second polarization increases to 90 mixers



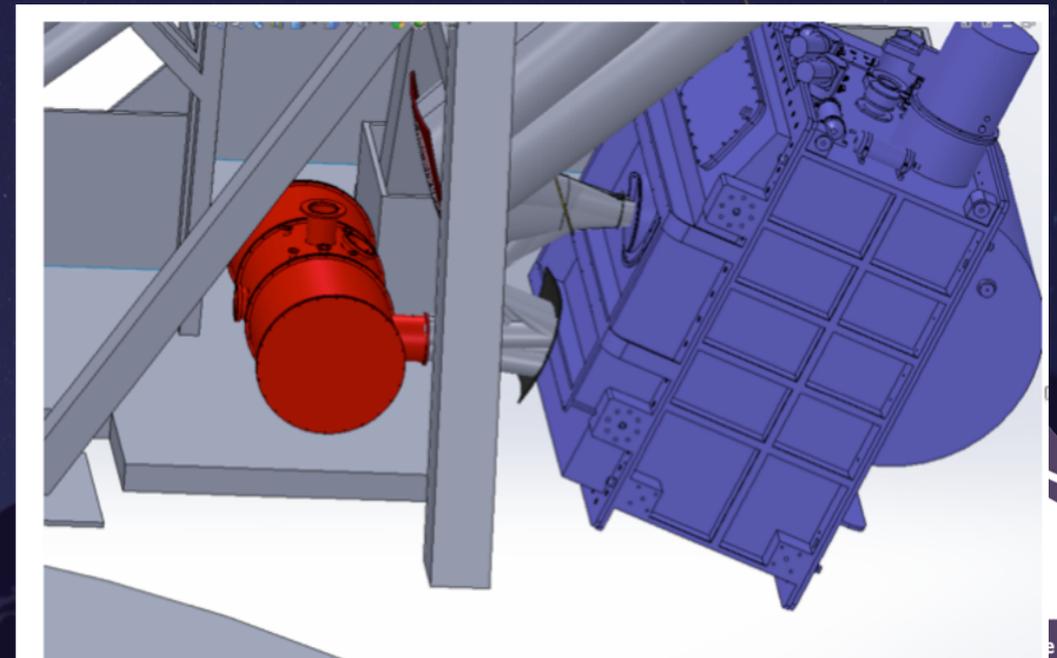
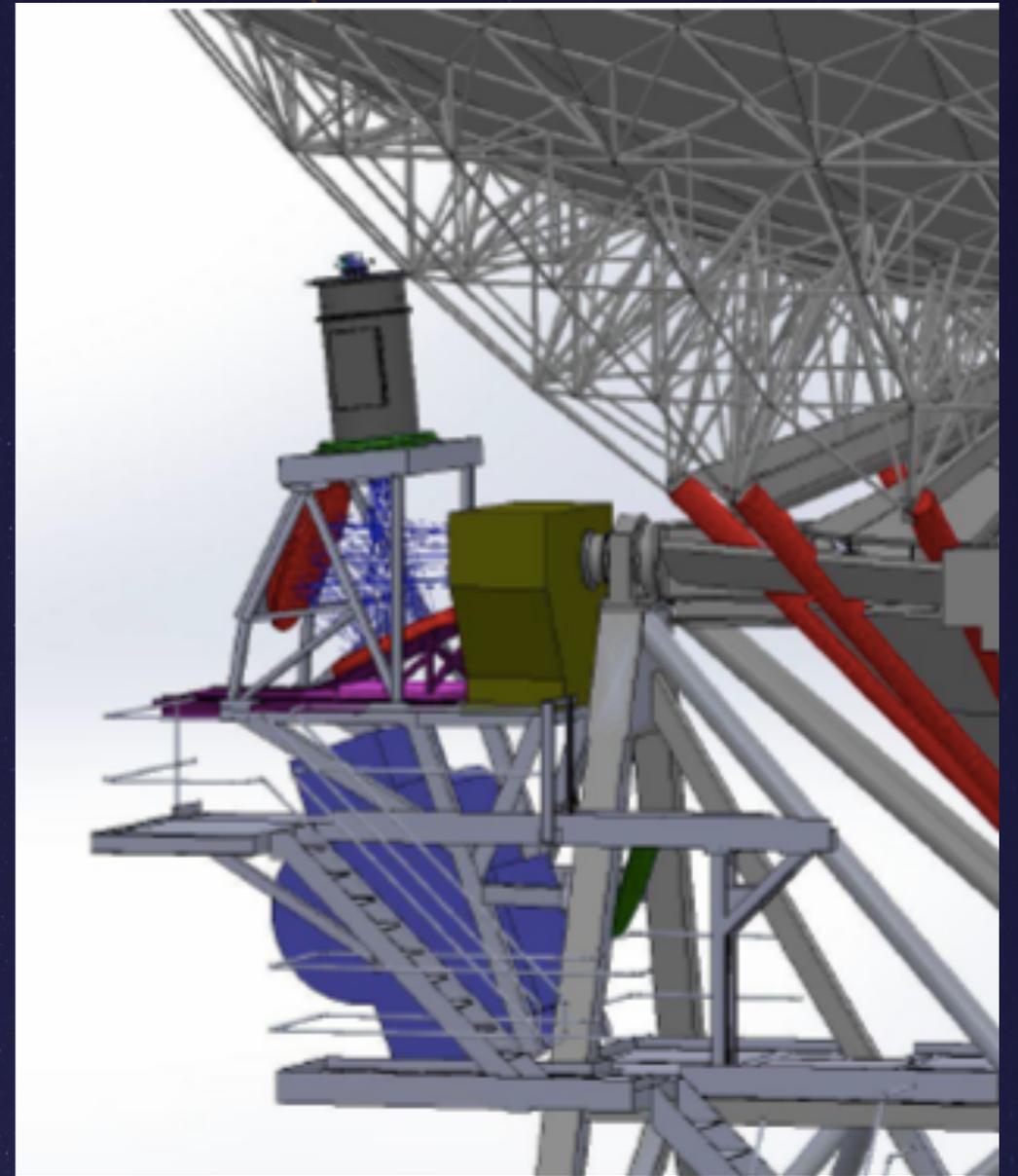
New Spectrometer

- Of necessity, a new spectrometer will be needed to handle the increased bandwidth and channel requirements of the new heterodyne receivers
- Current plans are to design a modular system to first use for the new 230GHz back-end, that can be tested and then scaled upwards for the greater demands of the new 90-pixel heterodyne instrument
- Up to 50 wide-band channels, multi-sub-bands at each input and fast readout to support rapid scanning
- FPGA-based digital electronics using Casper consortium's ROACH boards are under consideration



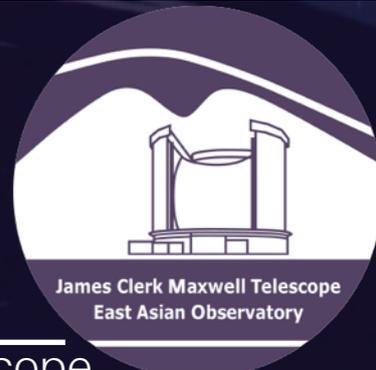
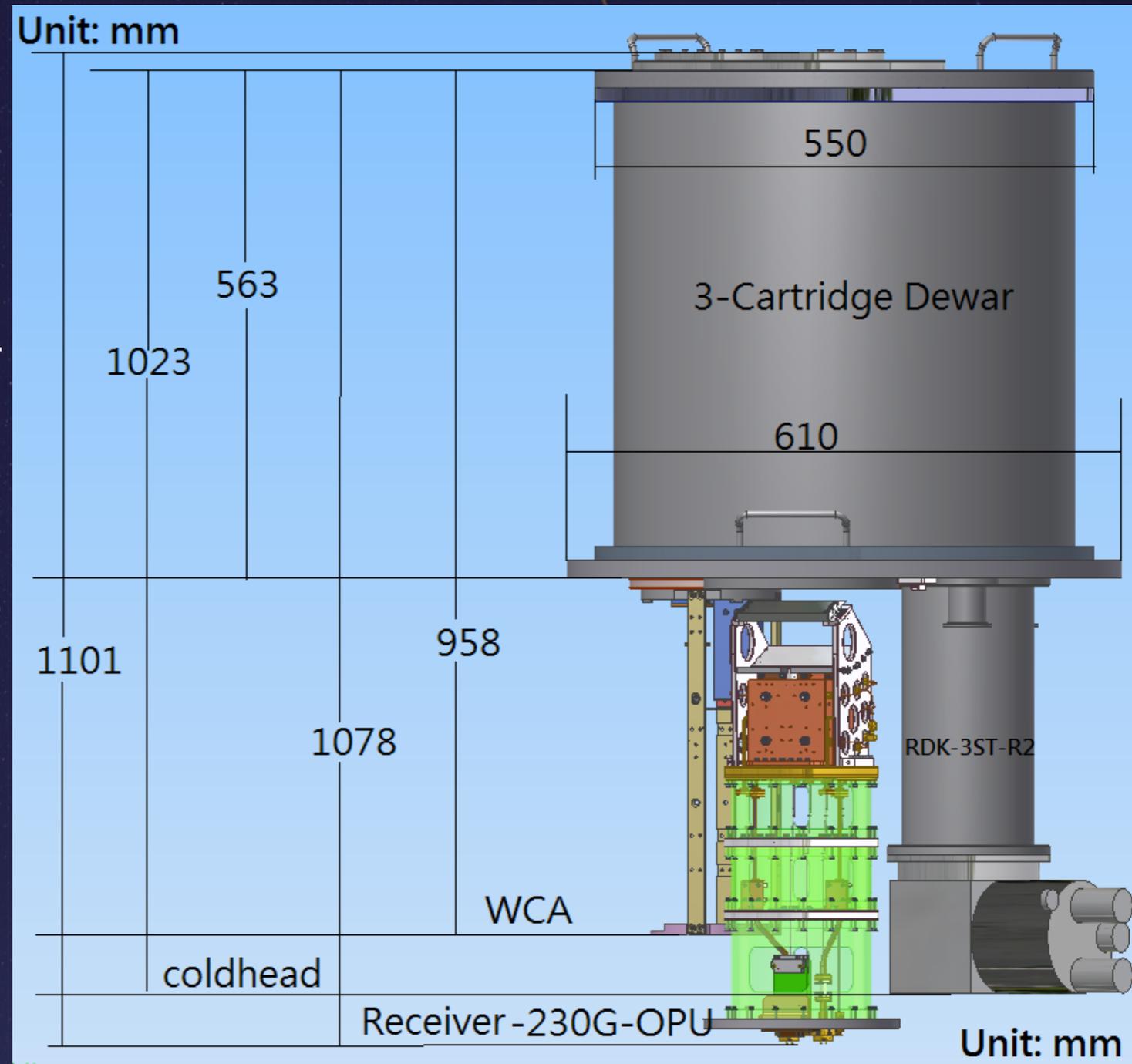
Visiting instruments

- TimePilot (Bok et al., Caltech) - C + intensity mapping in the epoch of deionization, kinematic SZ effect measurements, 32 waveguide grating spectrometers
- GISMO-2 (Staguhn et al.), continuum instrument: 32x40 and 16x16 arrays at 1.2 and 2 mm, respectively
- ALMA new technology cartridge testing possible with new 230 GHz dewar

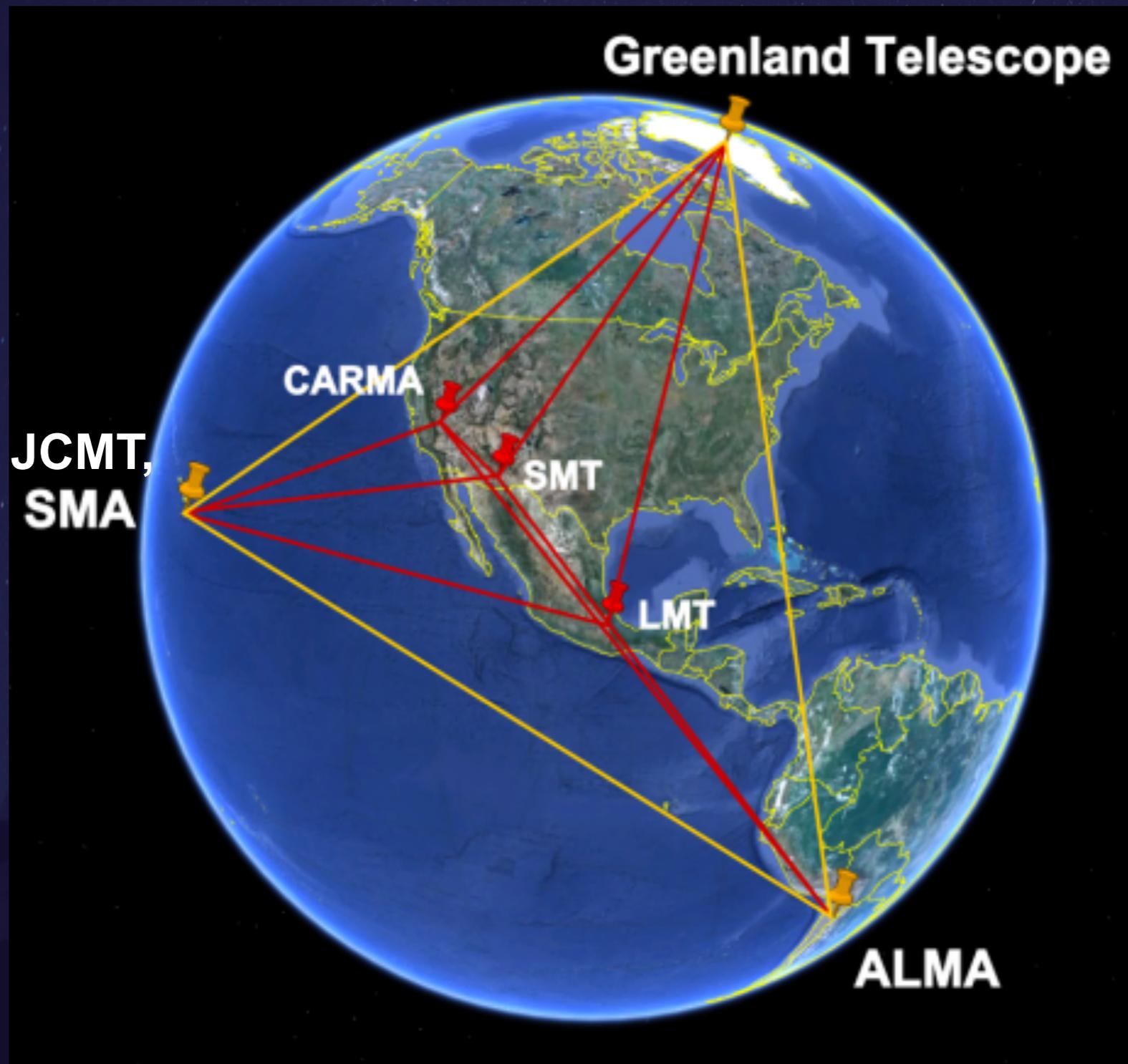


New 230GHz receiver

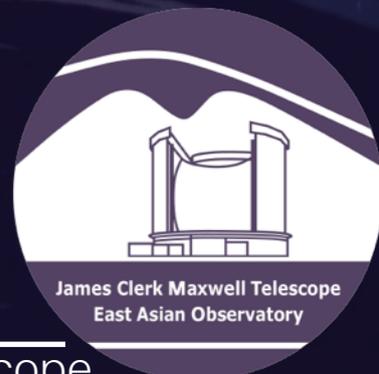
- Identical 3-cartridge dewar design as for the GLT
- Much better compatibility for EHT - first 230GHz cartridge with dual-polarization
- 345GHz cartridge following (HARP is ill-suited for VLBI)
- Remaining cartridge space for new ALMA technology testing, GLT testing, low-frequency East-Asian VLBI



Event Horizon Telescope

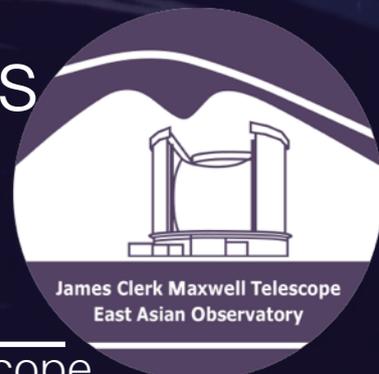


- JCMT is part of EHT
- $D \sim 9000$ km
- Resolution $\sim 10\mu\text{as}$
- Goal: Resolve Black Hole shadow; measure spin and mass
- Fringes with ALMA in Sept 2015



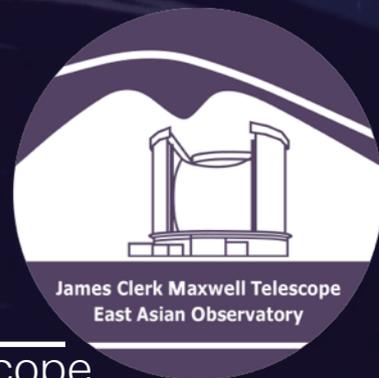
VLBI plans at JCMT

- Intent is to move to stand-alone VLBI station
- This reduces impact on SMA and allows full use of all antennas
- Current RxA receiver has new mixer for better compatibility with EHT frequencies
- First aim: EHT VLBI run in April to be using current receiver, but as a stand-alone station
- New 230GHz receiver in place by next run
- Obvious synergies with SMA offer further opportunities



Instrument Project summary

Instrument	Type	Frequency	Pixels	Pols	Bandwidth	Tsys/ NEFD	F.O.V. (arcmin ²)	Map speed (x)	Timescale
RxA (230 - current)	Heterodyne	219 - 272 GHz	1	1	3 - 9 GHz	140	0.1	1.0	
New 230 receiver	Heterodyne	210 - 275 GHz	1	2	4 - 10 GHz	100	0.1	3.9	2017
HARP (345 - current)	Heterodyne	325 - 375 GHz	16	1	3 - 5 GHz	250	2.3	1.0	
New 345 receiver	Heterodyne	320 - 375 GHz	45	2	4 - 8 GHz	200	7.1	8.8	Nov. 2021
SCUBA-2	Continuum	850/450 μ m	5120	-	-	93	30.1	1.0	
SCUBA-2+	Continuum	850/450 μm	6400	-	-	35	48.4	11.3	Dec 2016 / Nov 2020



EAO access to SMA time

- EAO regional astronomers will have the opportunity to apply for SMA time in the next semester
- EAO regional astronomers will have the opportunity to apply for SMA time in the next semester
- Collaboration with an ASIAA investigator will be strongly encouraged - this is well within the goals of EAO-collaboration policy



- I'm matchmaking!
- If you are willing to be a contact and/or collaborator for interested EAO investigators in SMA proposals, please come see me

