ATLASGAL images from eso1606

The Structure of the Milky Way: View from the Southern Hemisphere

S.P.I.R.A.L.S : Southern hemisphere **P**arallaxes with **I**nterferometric-**R**adio **A**strometry **L**arge **S**urvey

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CfA

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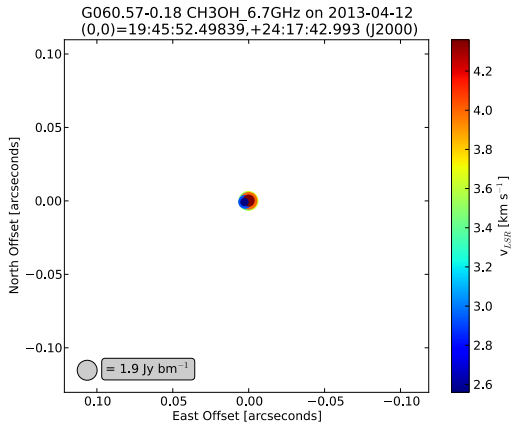
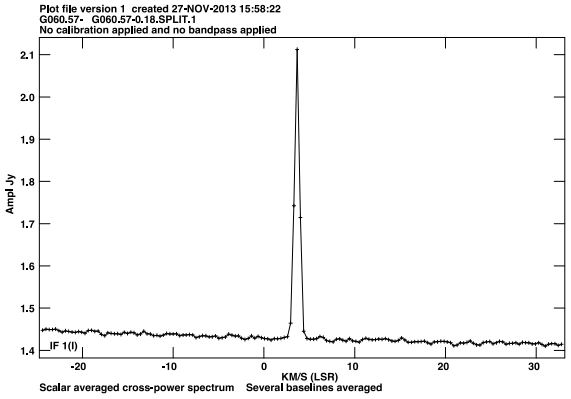
Overview

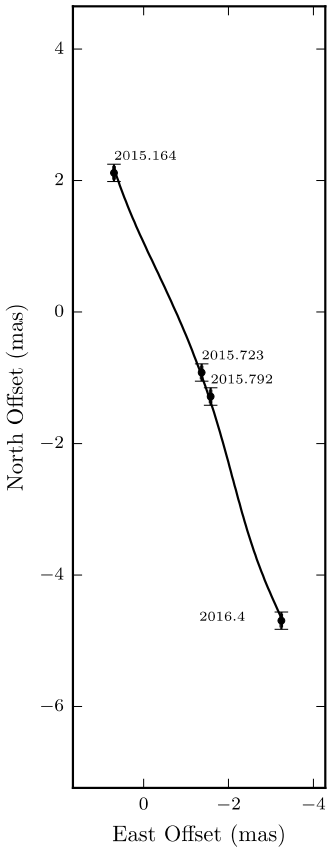


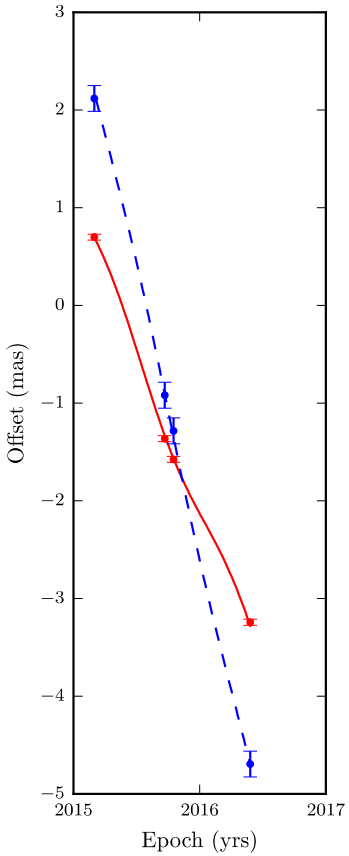
- BeSSeL vs V255 – summary;
- ASCI – A dedicated Array for Southern Hemisphere Parallaxes?
- ASCI Array – Progress and potential.

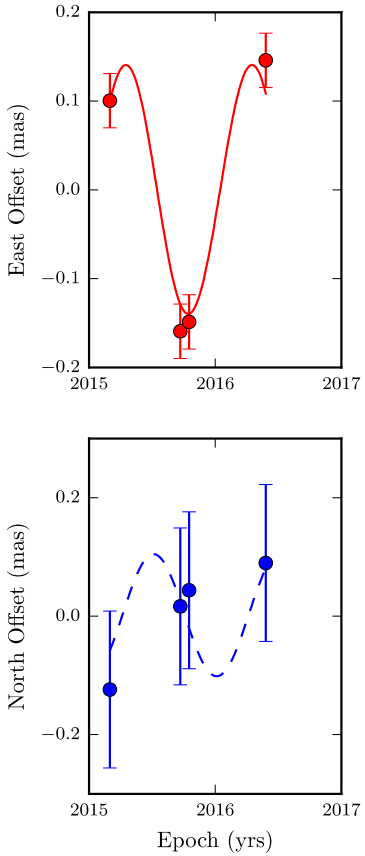
Trigonometric Parallax











Here is one I prepared earlier – Proper motion/parallax for G060.57-0.18, 0.14 ± 0.01 mas.

BeSSeL – Bar and Spiral Structure Legacy survey

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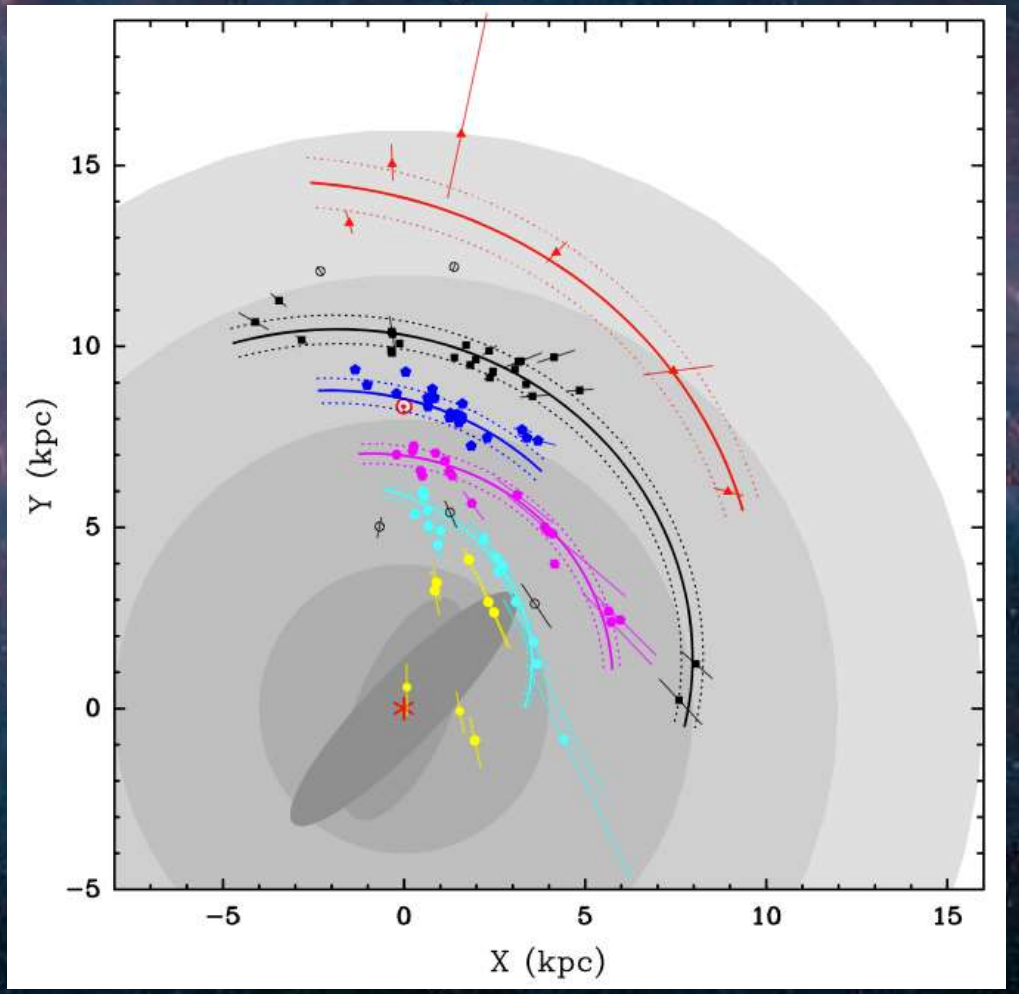
- Over 200 trigonometric parallaxes
  - 6.7, 12 GHz class II methanol
  - 22 GHz water masers
- Indicating star formation and implied spiral structure.
- VLBA – 10 homogeneous telescopes, optimal observation times, good



Reid et al 2014, ApJ, 783, 130

LBA project code V255

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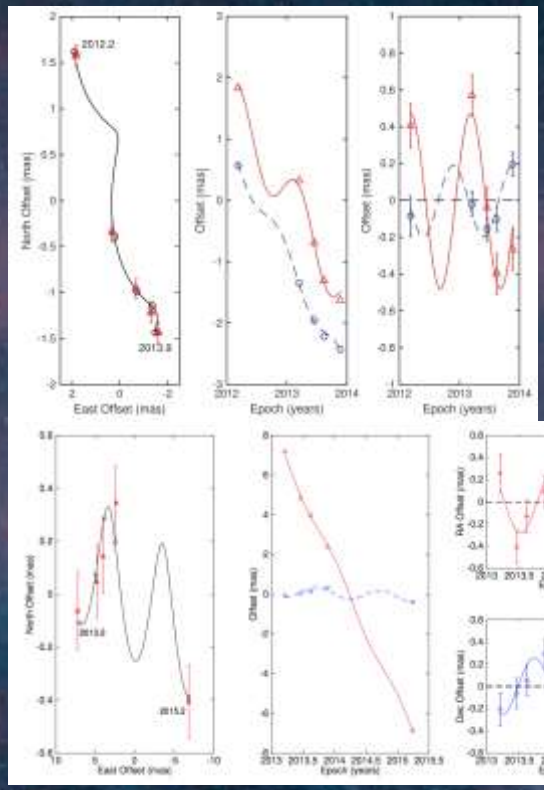
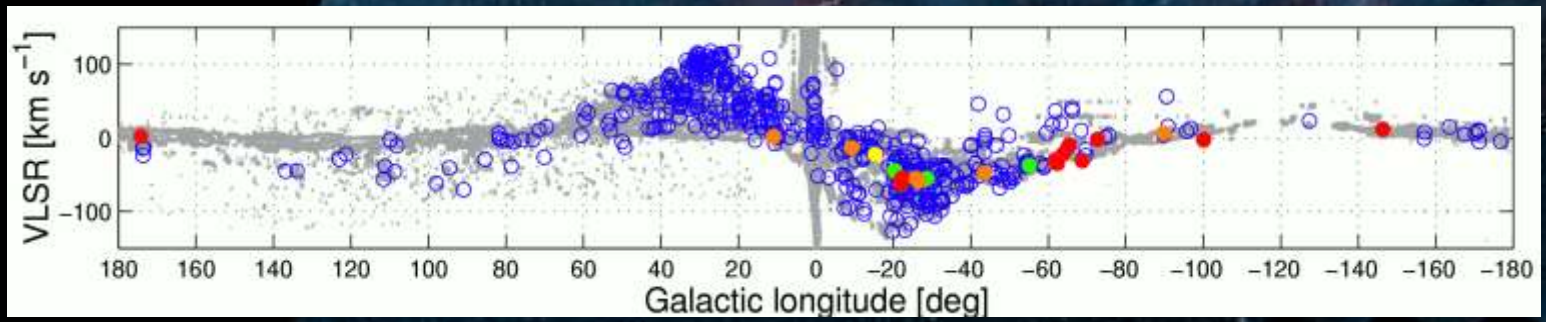
Source	Epochs	Experiments	Investigator
G9.62+0.20	2008 Mar, Aug ; 2009 Feb, Sep, Dec 2010 Oct	V255a,b,e,f,h,m	Simon Ellingsen
G8.68-0.73	2008 Mar, Aug ; 2009 Feb, Sep, Dec 2010 Oct	V255a,b,e,f,h,m	Simon Ellingsen
NGC6334F	2008 Nov ; 2009 Feb, Sep ; 2010 Mar, Jul	V255c,d,g,i,j,z	Simon Ellingsen
NGC6334I(N)	2008 Nov ; 2009 Feb, Sep ; 2010 Mar, Jul	V255c,d,g,i,j,z	Simon Ellingsen
G329.066-0.308	2010 Jul, Oct ; 2011 Mar, Jul, Nov	V255k,l,n,o,p	Jimi Green
G329.029-0.205	2010 Jul, Oct ; 2011 Mar, Jul, Nov	V255k,l,n,o,p	Jimi Green
G329.031-0.198	2010 Jul, Oct ; 2011 Mar, Jul, Nov	V255k,l,n,o,p	Jimi Green
MonR2	2011 Mar, Jul, Nov ; 2012 Mar	V255n,o,p,q	Bo Zhang
G188.95+0.89	2011 Mar, Jul, Nov ; 2012 Mar	V255n,o,p,q	Bo Zhang
G339.884-1.259	2012 Mar ; 2013 Mar, Jun, Aug, Nov ; 2014 Mar,Nov	V255q,r,s,t,u,v,w	Vasaant Krishnan
G339.681-1.208	2012 Mar ; 2013 Aug, Nov ; 2014 Mar,Nov	V255q,t,u,v,w	Vasaant Krishnan
G339.682-1.207	2012 Mar ; 2013 Aug, Nov ; 2014 Mar,Nov	V255q,t,u,v,w	Vasaant Krishnan
G305.200+0.019	2013 Mar, Jun, Aug, Nov ; 2015 Mar	V255r,s,t,u,x	Vasaant Krishnan
G305.202+0.208	2013 Mar, Jun, Aug, Nov ; 2015 Mar	V255r,s,t,u,x	Vasaant Krishnan
G305.208+0.206	2013 Mar, Jun, Aug, Nov ; 2015 Mar	V255r,s,t,u,x	Vasaant Krishnan
G263.250+0.514	2013 Mar, Jun, Aug, Nov ; 2015 Mar, Jul; 2017 Aug	V255r,s,t,u,x,y,ad	Nobuyuki Sakai
G287.371+0.644	2014 Mar, Nov ; 2015 Mar, Jul, Sep; 2017 Aug	V255v,w,x,y,z,ad	Lucas Hyland
G291.274-0.709	2014 Mar, Nov ; 2015 Mar, Jul, Sep	V255v,w,x,y,z	Lucas Hyland
G316.640-0.087	2014 Mar, Nov ; 2015 Jul, Sep	V255v,w,y,z	James Chibueze
G316.811-0.057	2014 Mar, Nov ; 2015 Jul, Sep	V255v,w,y,z	James Chibueze
G345.003-0.224	2015 Jul, Sep ; 2016 Mar, Jun	V255y,z,aa,ab,ac	Lucas Hyland
G345.003-0.223	2015 Jul, Sep ; 2016 Mar, Jun	V255y,z,aa,ab,ac	Lucas Hyland
G345.010+1.797	2015 Jul, Sep ; 2016 Mar, Jun	V255y,z,aa,ab,ac	Lucas Hyland
G345.010+1.792	2015 Jul, Sep ; 2016 Mar, Jun	V255y,z,aa,ab,ac	Lucas Hyland
G269.456-1.467	2016 Mar, Jun ; 2017 Mar	V255aa,ab,ac	Lucas Hyland
G269.658-1.270	2016 Mar, Jun ; 2017 Mar	V255aa,ab,ac	Lucas Hyland
G294.990-1.719	2016 Mar, Jun ; 2017 Mar, Aug	V255aa,ab,ac,ad	Lucas Hyland
G298.262+0.739	2016 Mar, Jun ; 2017 Mar, Aug	V255aa,ab,ac,ad	Lucas Hyland
G326.475+0.703	2016 Jun ; 2017 Mar, Aug	V255ab,ac,ad	Lucas Hyland
G328.808+0.633	2016 Jun ; 2017 Mar, Aug	V255ab,ac,ad	Lucas Hyland
G328.809+0.633	2016 Jun ; 2017 Mar, Aug	V255ab,ac,ad	Lucas Hyland
G339.617-0.117	2017 Aug	V255ad	Lucas Hyland
G340.050-0.250	2017 Aug	V255ad	Lucas Hyland



Krishnan et al 2015, 2017

Red =1
Orange = 2
Green = 3
Yellow = 4



Australian and New Zealan participating telescopes

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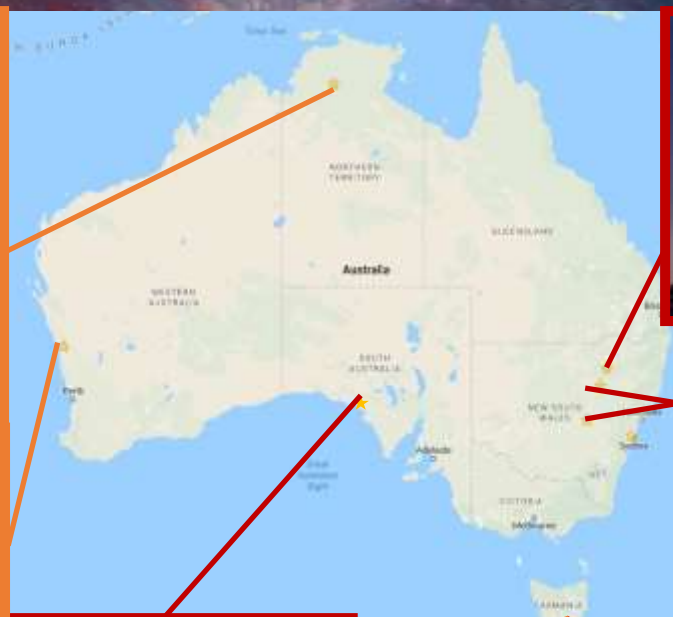















Issues

- We are currently achieving astrometric accuracy of around 100μas, an order of magnitude poorer than the VLBA. This is due to a combination of:
  - An heterogeneous array with very limited mutual frequency coverage (6.3-6.8 GHz);
  - Sampling at non-optimal times;
  - Very limited recorder system configurations (effectively 2x32 MHz bands).
- The LBA only operates for a few weeks each year,
  - In order to get 100 parallaxes, it would take 15-20 years at the current rate.

- We need a more suitable backend that is compatible across the telescopes.
  - That is to say, we need 'better' receivers and a more suitable recording setup.
- Require more time, and we need to be able to choose when to observe (scheduling);
- More effective techniques to calibrate residual ionospheric effects (maybe ~5 TEC residual currently).

Callisto Wideband Receive

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- A collaboration involving UTAS, CfA, Geoscience Australia, CASS, MPIfR, Auckland University of Technology and Callisto Space has put together $A850k to design and construct 2.3–14 GHz receivers for AuScope*.

- We tested the prototype receiver 2016/2017 and have recently 'received' the three new receivers



Wideband receiver prototype



AuScope – Ceduna Interferometer (ASCI)

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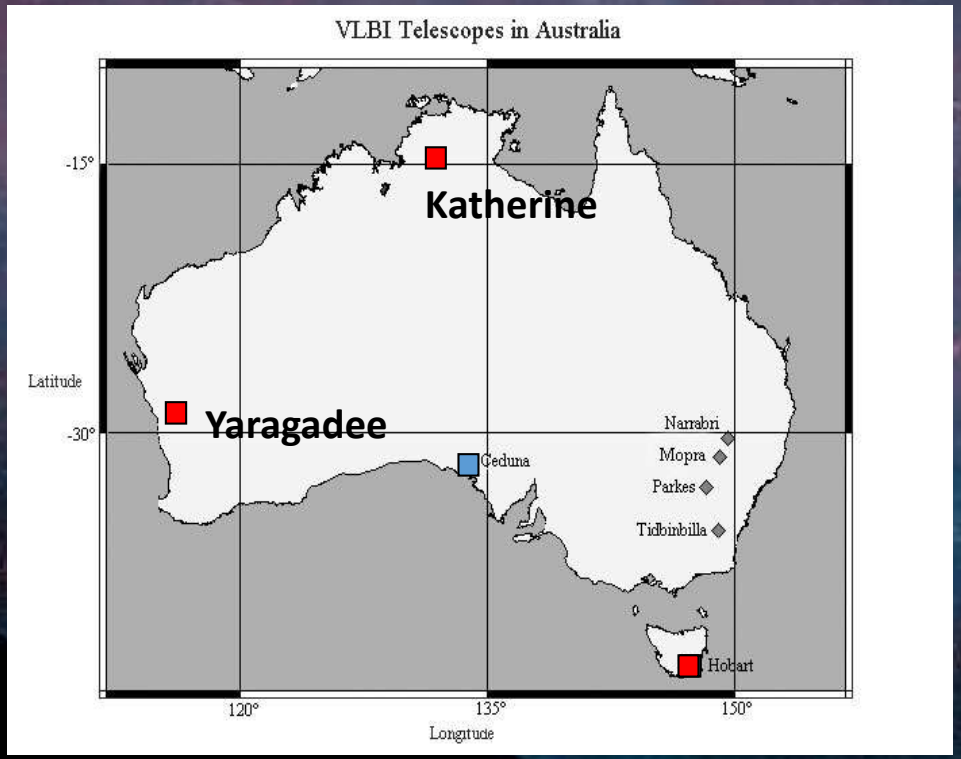

Wikipedia

- The receivers are part of the VGOS upgrade to the UTAS 12m AuScope network;
- The 3x12m antennas have 100+ days a year that they are free;
- UTAS operate the three telescopes, including the 26m at Hobart and the 30m telescope at Ceduna.

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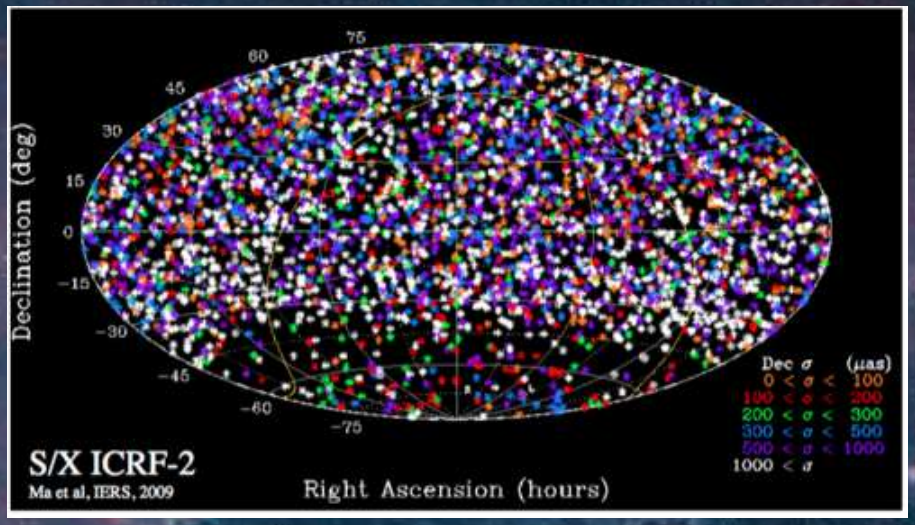
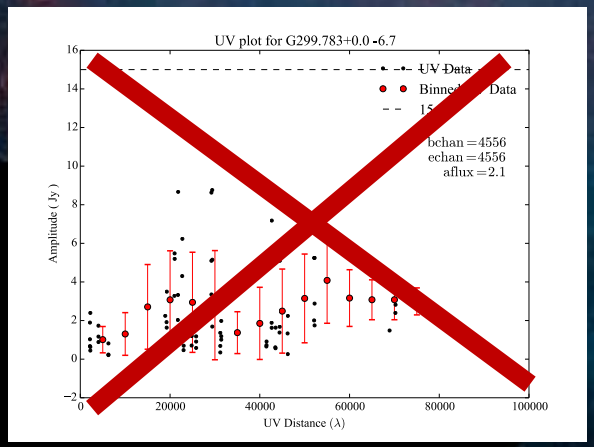
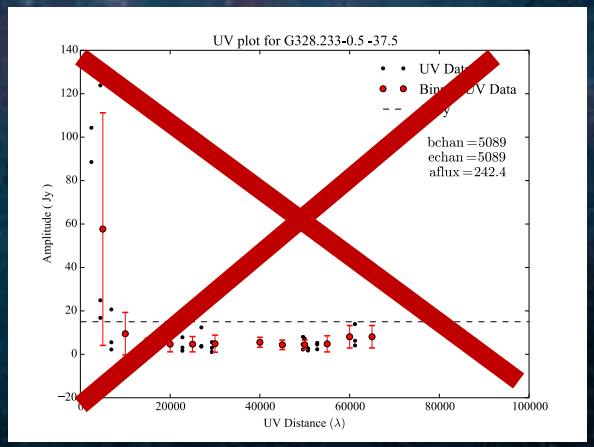
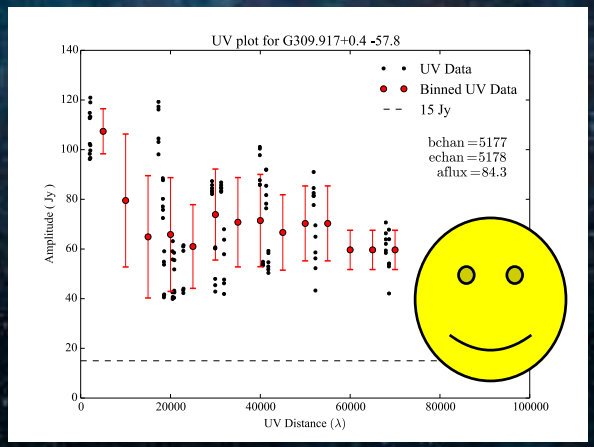
Preparations

- Search for suitable phase calibrators close to the Galactic plane (C3083).
- Observations of all southern 6.7 GHz methanol masers with a peak flux density > 10 Jy to find those which have compact emission (V534).









Preparations 2

- Inclusion of Ceduna 30m telescope in observations
  - more UV coverage and sensitivity;
  - but small mutual bandwidth (currently).

- We have a grant to improve Ceduna's operating systems, aka another Callisto receiver.

- Multiview proof on concepts (Maria Riojas talk) with ASCI array – ionospheric and tropospheric corrections. Data taken thus far with S/X receivers on 3 telescopes and with Ceduna. Results pending.



www.exploroz.com/places/103554/sa/ceduna-radio-astronomy-observatory

Preliminary Test – Fringes

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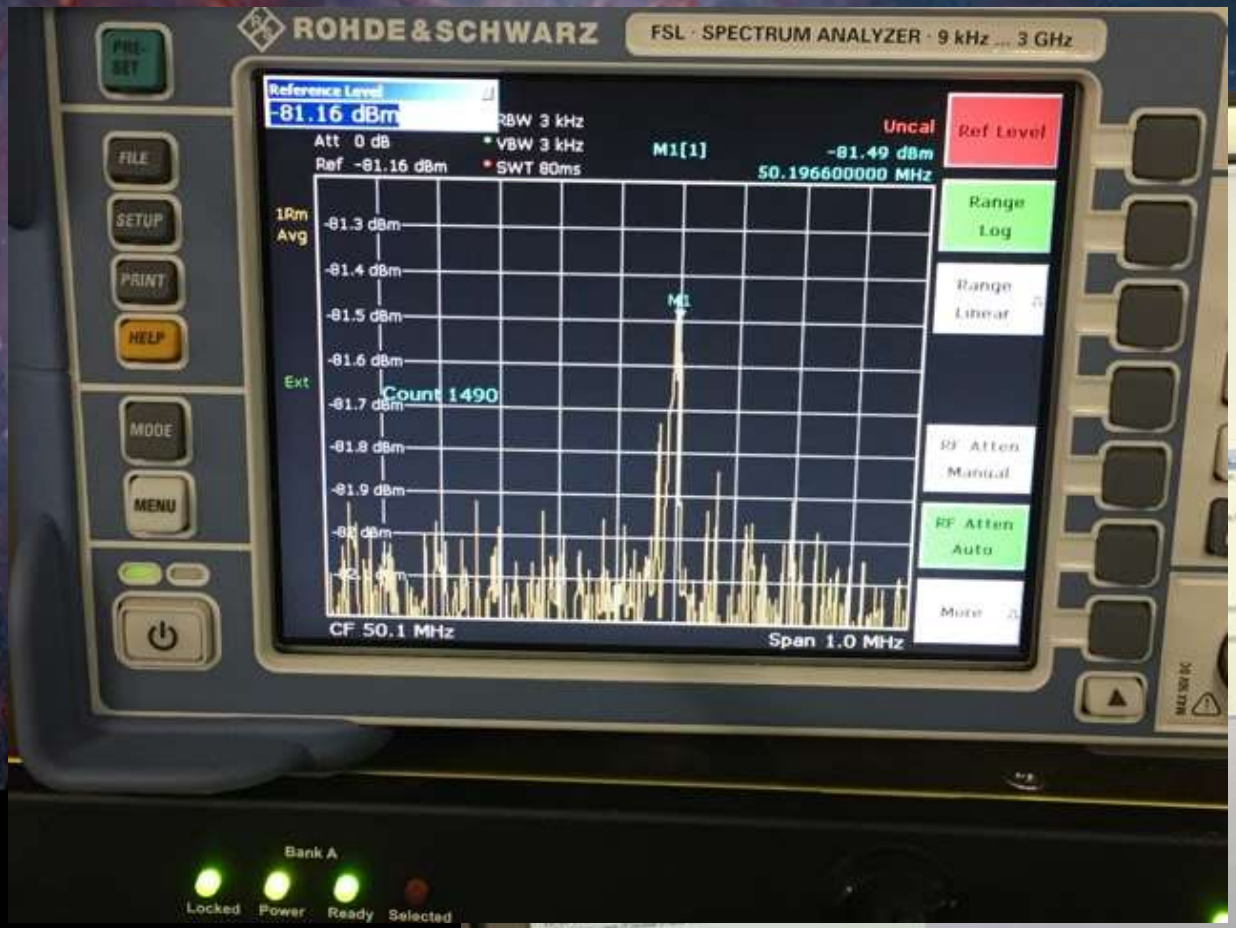

Wishful thinking – LBA++

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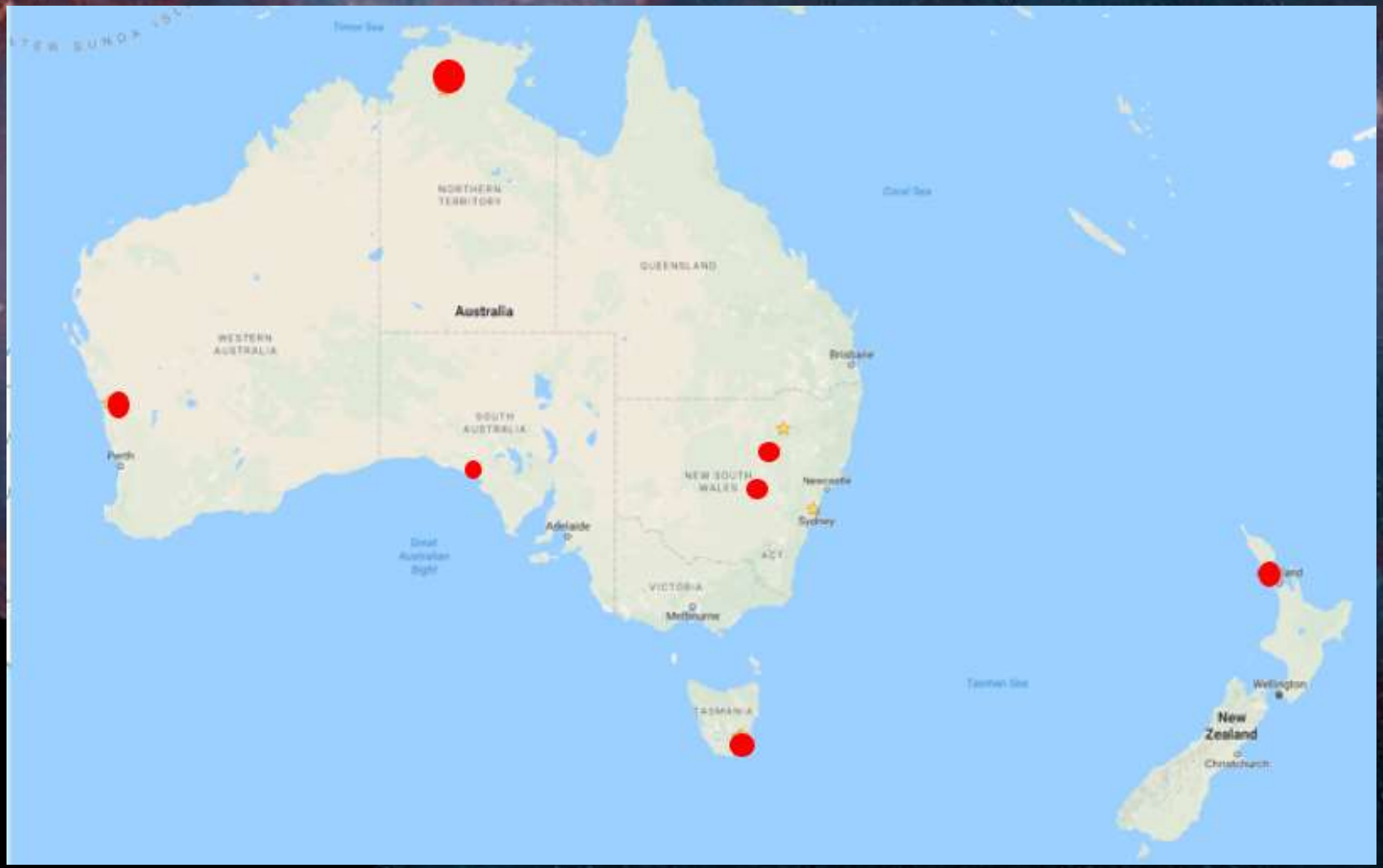

Summary

- S.P.I.R.A.L.S is a combination of the LBAV255 and the (name tba) ASCI array projects to measure Southern Hemisphere parallaxes to compliment those from the Northern Hemisphere BeSSeL project.
- We expect ASCI to be operational early next year, with first results the following year.
- Reduction of archival data is still underway, but requires a not-insignificant amount of thought and time.