EVLA overview

Current and future capabilities

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Atacama Large Millimeter/submillimeter Array

Expanded Very Large Array

Robert C. Byrd Green Bank Telescope

Very Long Baseline Array

What is the EVLA?

A very quick introduction

28x25m antennas, 8 feeds, 0.035-36.4 km

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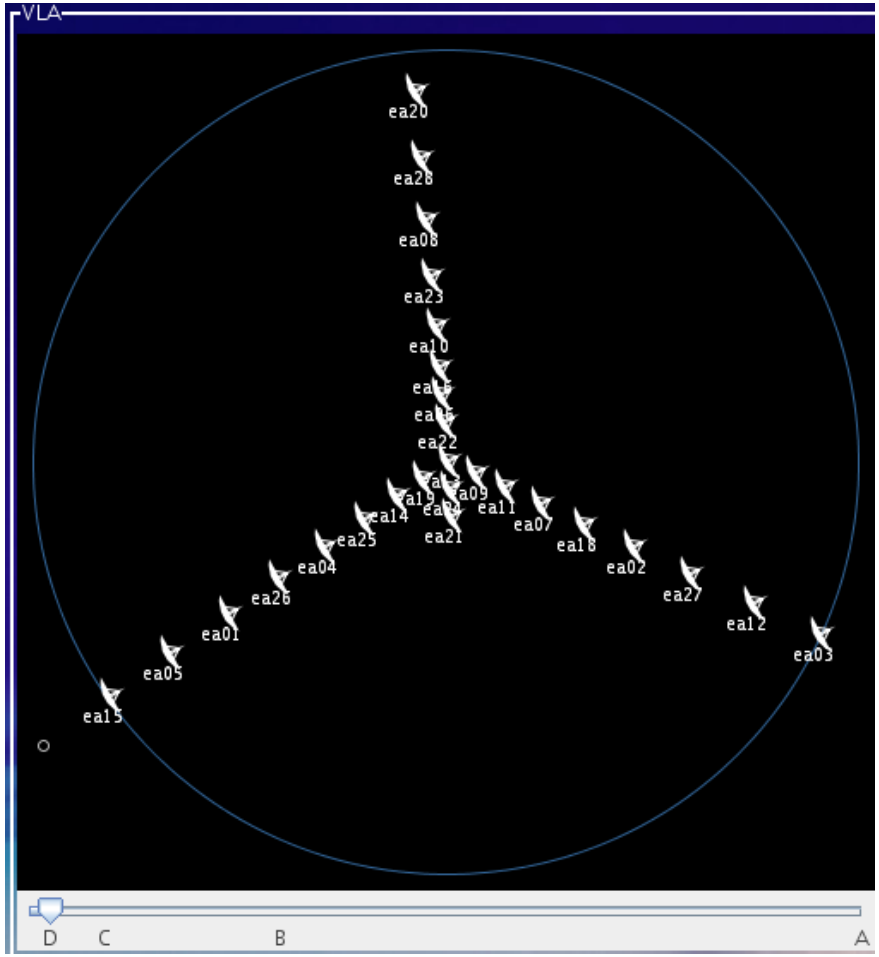
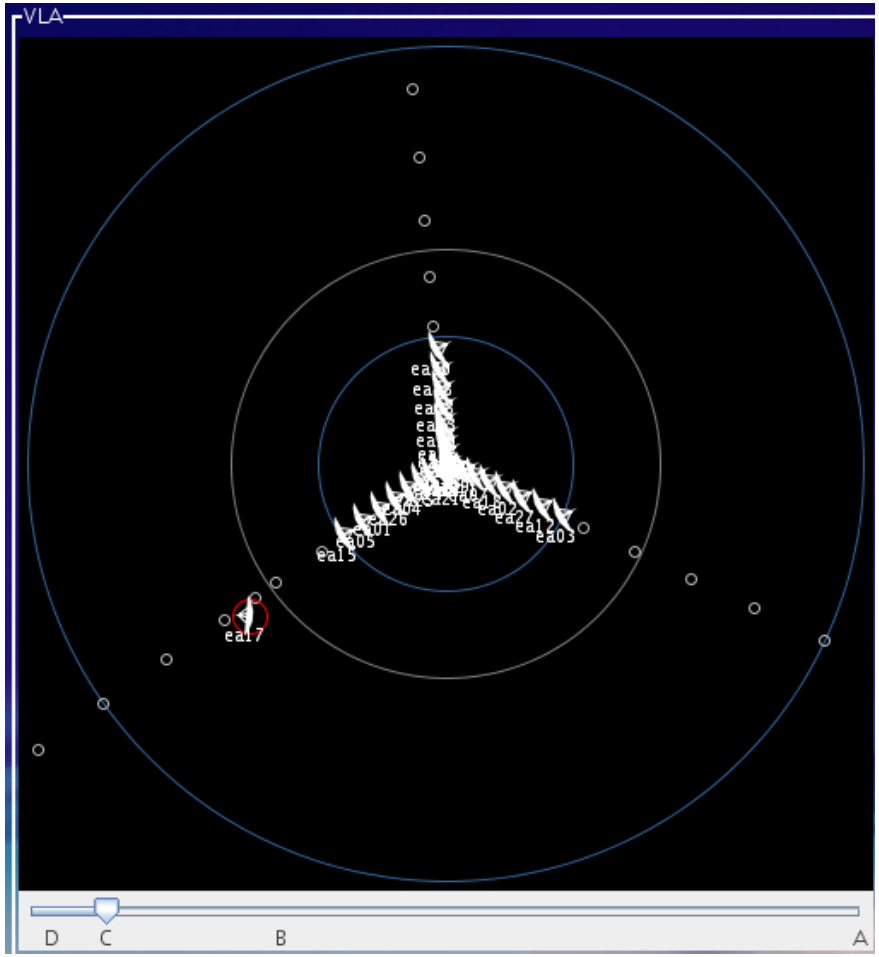


28x25m antennas, 8 feeds, 0.035-36.4 km



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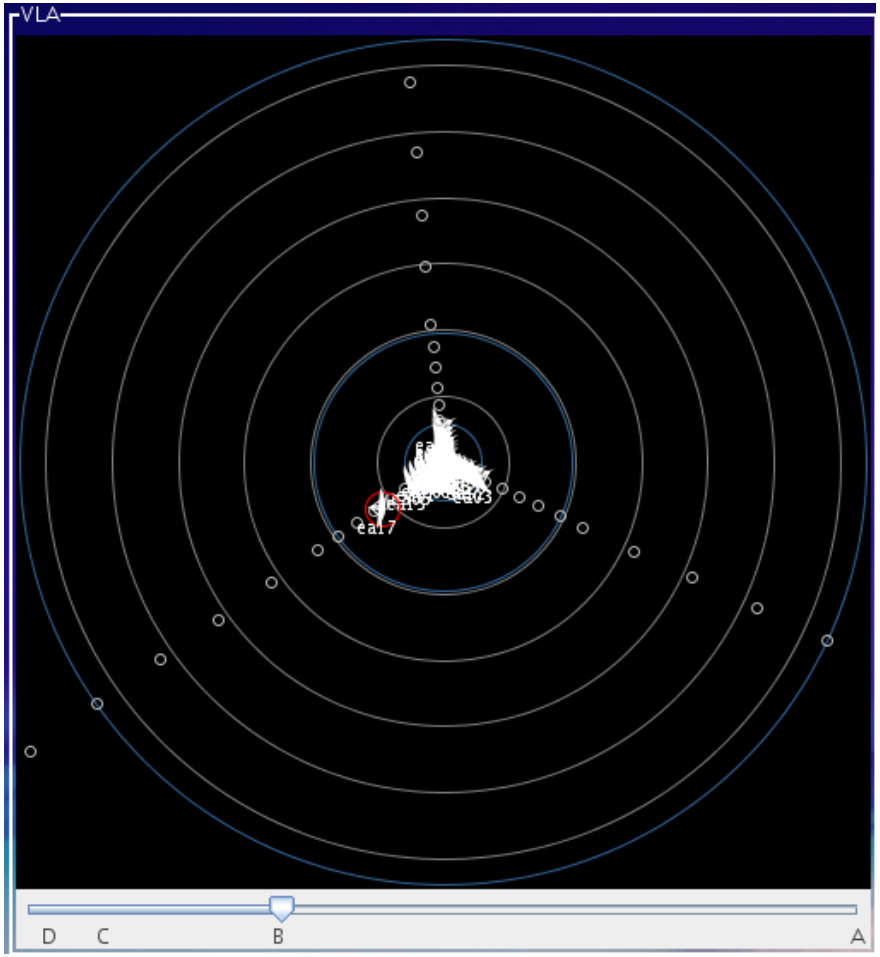

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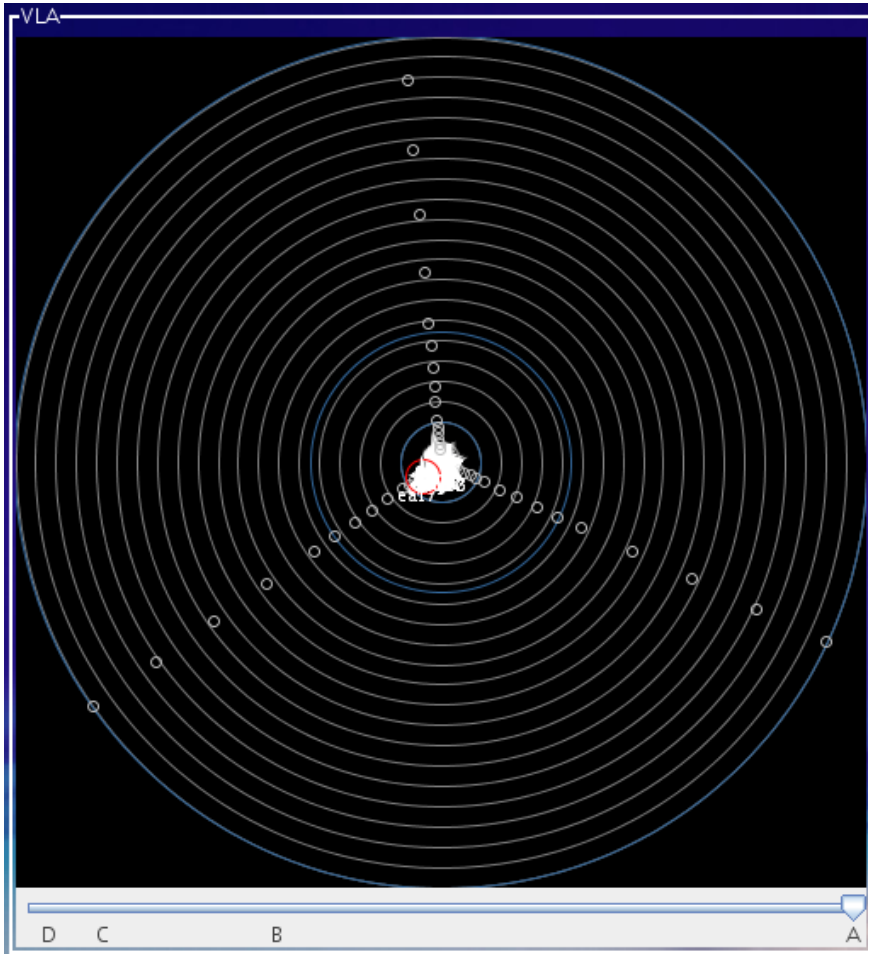
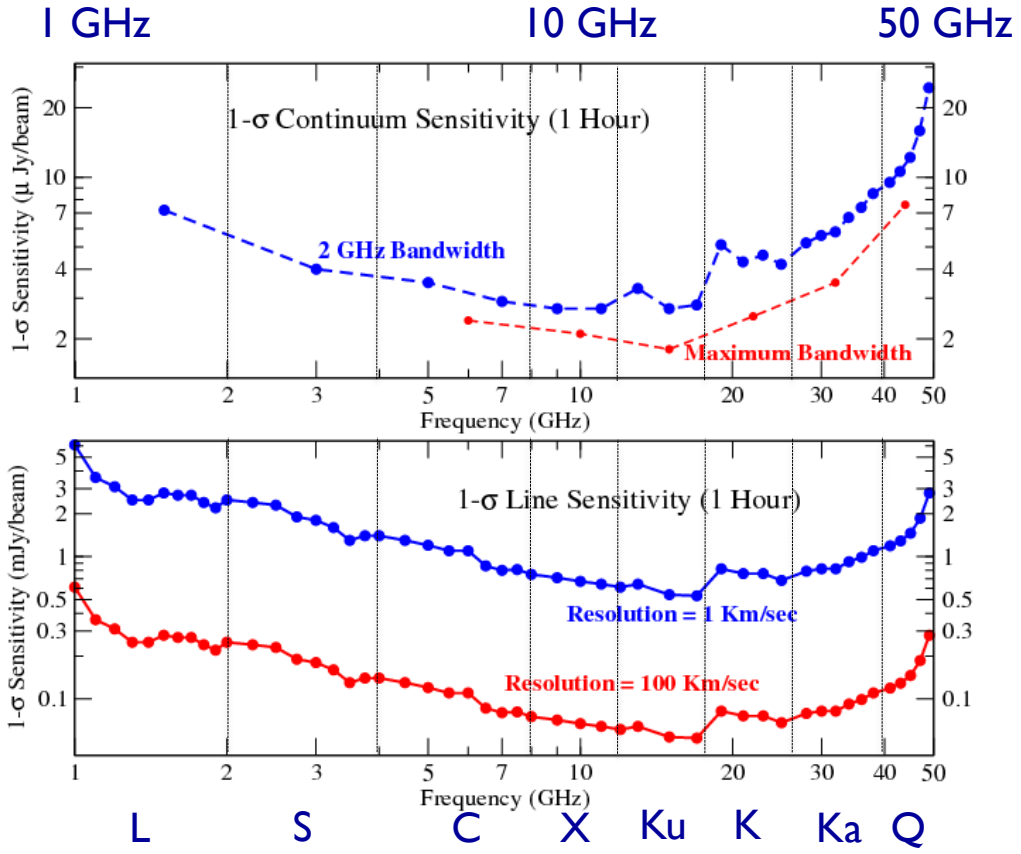


28x25m antennas, 8 feeds, 0.035-36.4 km

Basic scientific capabilities

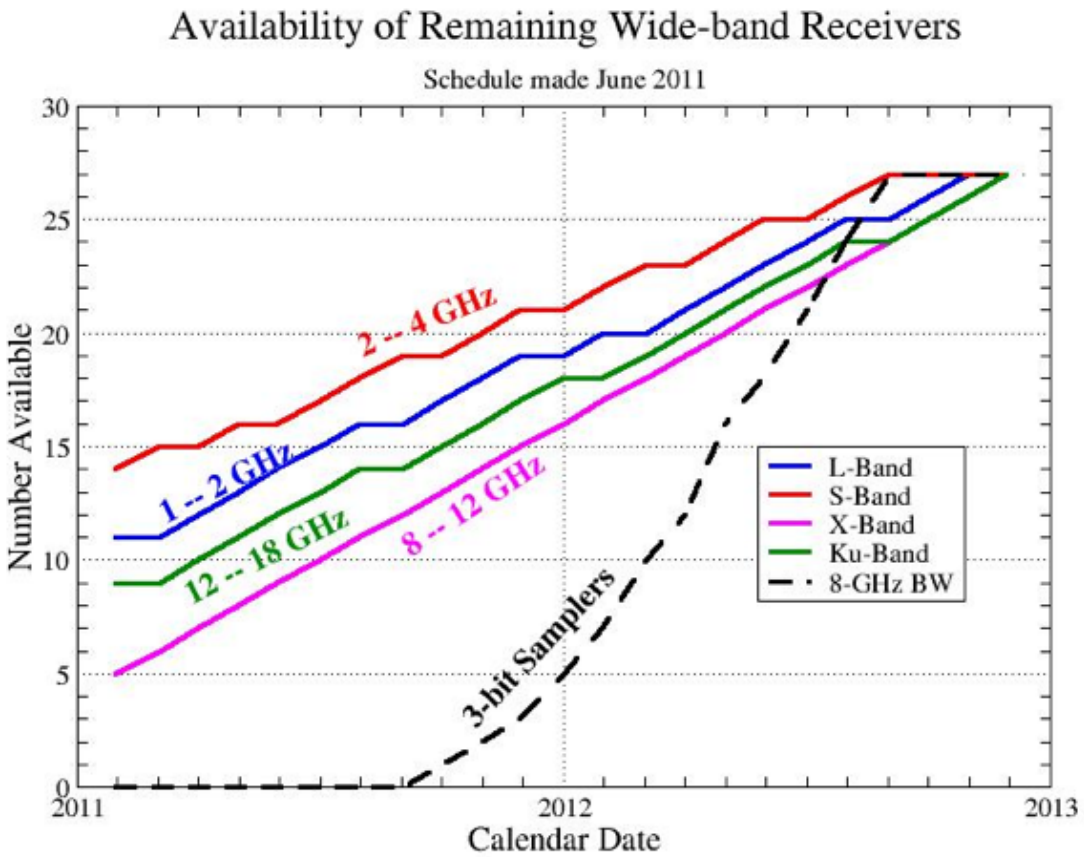


Sensitivity & frequency coverage

Pull down 2 x 1 GHz (4 GHz) at once, within a given band

~20sec to change bands

Assumes all antennas fully outfitted

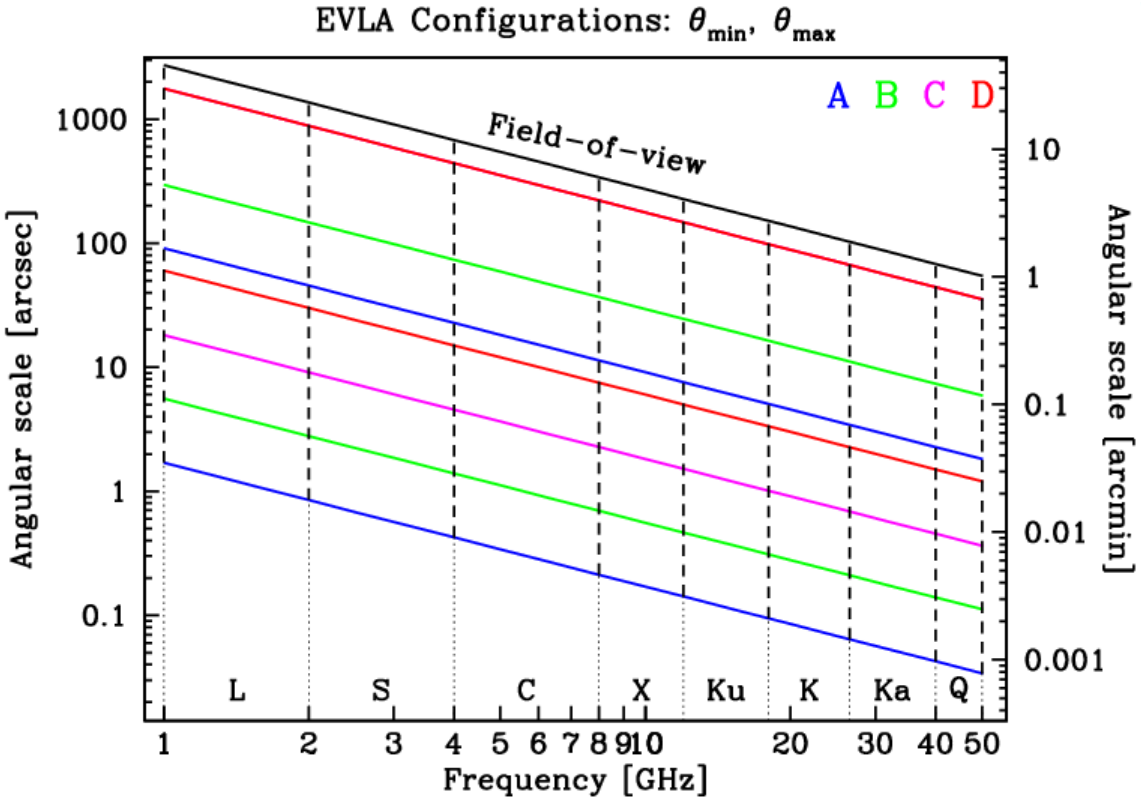


Receiver availability

1-4 GHz: new OMTs (better polarization performance)

8-12 GHz: wideband receivers

3-bit samplers: 2 x 8 GHz bandwidth. This has slipped by a few weeks



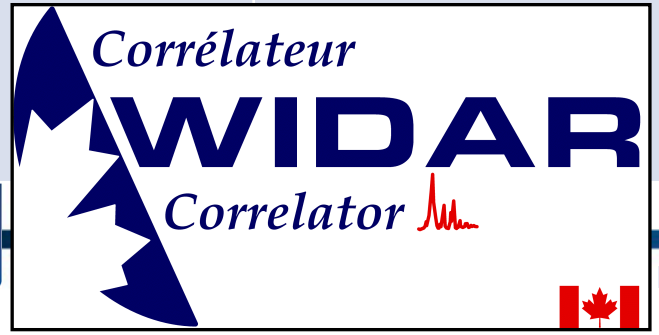
Angular resolution, largest angular scale, & field-of-view

4 configurations: A → big; D → small

~4 months in each configuration, cycling D C B A

(plus hybrids for southern sources)

	VLA	WIDAR-now	WIDAR-2013
Quantization	3-level	16-level	16/**256**-level
# antennas	27	28	**32**
Max. bandwidth	0.2 GHz	10 GHz	**16 GHz**
# subband pairs	1 - 2	1 – 48	1 – **64**
# channels (total)	2-512	256 – 32,768	256 **– 4,194,304**
Max./min. δv	50 MHz / 381 Hz	2 MHz / 122 Hz	2 MHz / **0.12 Hz**
dt_{min}	1.7 sec	0.1 sec	**0.01 sec**
Max. data rate	3.3 x 10^3 vis/sec	6 x 10^6 vis/sec	**7.5 x 10^6 vis/sec** (1600-16000 x 10^6 vis/sec)
Extras	Phasing VLBI Subarrays	Phasing Subarrays Auto-correlation	Phasing **VLBI** Subarrays **Pulsar phase bins** **Burst mode** Auto-correlation



Flexibility: truly independent subbands

64 independent Spectral Windows

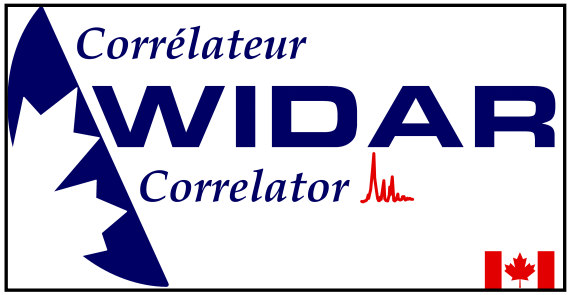
Ability to make simultaneous continuum & multiple line measurements (e.g., L band, all at once:

continuum

galactic + extragalactic HI imaging & absorption

OH lines

>10 radio recombination lines)

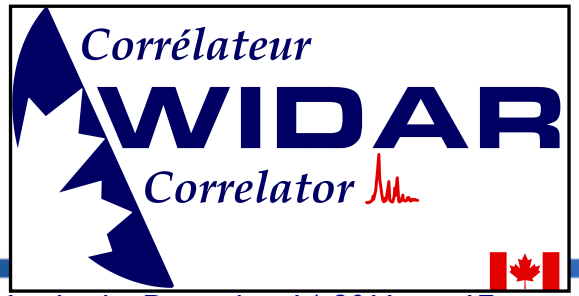


Flexibility: truly independent subbands

64 independent Spectral Windows

Requires each subband be truly independent:

- Tuning
- Bandwidth (31.25 kHz – 128 MHz)
- Number of polarization products (single, dual, full)
- Number of channels
- Trade time resolution for channels (recirculation)
- Trade subbands for channels (hardware stacking)
- Dump rates



Computing challenges

- The EVLA produces a **LOT** of data: ~50 MB/s now, ~75 MB/s for this proposal cycle
  - 1 hour= 180 GB @ 50 MB/s
  - Simply transferring the data is painful → internet or disks
- Complete frequency coverage and wide bandwidths
  - Radio frequency interference (RFI) *everywhere*
  - Instruments vary (e.g., field-of-view goes as wavelength)
  - Sources vary (e.g., freq^2 → factor 4 different in flux over 2:1 bandwidth ratio)
  - Extremely sensitive → sidelobes and dynamic range issues
  - LOTS more science: lines, spectral shapes, polarization, mosaics, on-the-fly mapping

Dynamic scheduling

- Everything is dynamically scheduled
- Can't tell exactly when your schedule will run, or what will have been observed just before that
  - Initial slew is uncertain
- Scheduling is based on:
  - TAC priority (A B C, science, etc.) – i.e., competition
  - *Current* weather (rms phase, wind – by-band defaults, which you can override) – note we do not yet look at the ionosphere, weather predictions, solar activity, opacity, RFI
  - Efficiency

Dynamic scheduling

- Getting on the telescope:
  - Get your observing schedules in early
  - Short blocks are easier…but require more overhead
  - Can request `filler' time (short bad weather blocks) – note we are accepting much more Priority C than in the past
  - Daytime is harder (competes with commissioning, maintenance)
  - The weather changes during the year

Commissioning while observing

- We are **still commissioning** the EVLA
- Shared risk: we do our best, but we do sometimes make mistakes
- Commissioning: we're still putting the system together
  - Capabilities are not all there
  - We are still learning the best & most efficient ways to reduce the data
  - Ten steps forward, two steps back (hey, we're getting better!)
  - The staff is very busy these days – be patient with us please!

Commissioning while observing

- We take scientific/TAC priorities very seriously
- We take Resident Shared Risk Observing very seriously (see next few slides)

Proposing for the EVLA

February 1, 2012 call for proposals

February 1, 2012 deadline

- This call only: only BnA and A configurations
- Covers 7sep12-7jan13
- Regular, Rapid response, Filler proposals (<10 GHz, anytime, 30-60mins)
  - Key science
  - Proprietary period normally 12months since last observations
- Please note:
  - Observing time *includes* overheads (flux, phase, bandpass calibration; slew time; dummy scans)
  - OSRO has become much more impressive (next slide)
  - Referees, scientific groupings, and TAC have changed
- Joint proposals with Fermi, Chandra
- Future calls: Feb 1, Aug 1
  - Exploratory/DDT proposals anytime (<=6 mos. proprietary period)

Open Shared Risk Observing (1feb12)

Table 2: Correlator capabilities per sub-band for dual polarization

Sub-band BW (MHz)	Number of channels/poln product	Channel width (kHz)	Channel width (km/s at 1 GHz)	Total velocity coverage (km/s at 1 GHz)
128	128	1000	300/v(GHz)	38,400/v(GHz)
64	128	500	150	19,200
32	128	250	75	9,600
16	128	125	37.5	4,800
8	128	62.5	19	2,400
4	128	31.25	9.4	1,200
2	128	15.625	4.7	600
1	128	7.813	2.3	300
0.5	128	3.906	1.2	150
0.25	128	1.953	0.59	75
0.125	128	0.977	0.29	37.5
0.0625	128	0.488	0.15	18.75
0.03125	128	0.244	0.073	9.375

- 2 basebands
- 8 contiguous subbands per baseband (8x128-8x0.03125 MHz)
- Full, **dual**, single pol'n products
- Within a baseband all subbands have same BW, number of channels, pol'n products
- Lower sensitivity at subband edges
- No Doppler tracking

Resident Shared Risk Observing (1feb12)

- Up to 25% of observing time
- Full access to EVLA capabilities at the time of observing…
- In exchange for helping us out with commissioning
  - Come to Socorro for at least 3 months (1 mo./10 hrs of obs time)
  - Work in commissioning group
  - Proposal includes a technical justification of your proposed commissioning work
  - Commissioning part of proposal is separately reviewed, after passing the scientific TAC
- Possible areas: fast dumps, pulsars, VLBI, planetary observing, OTF mosaicking, automatic flagging, solar observing, advanced imaging algorithms and data analysis tools, pipeline, …

Resident Shared Risk Obs.

Dates	Array config.	Max. total bandwidth per poln.	No. sub-band pairs	Channels per sub-band pair (4 poln products)	Max allowed data rate	Cumulative Capabilities
2010 Mar - 2010 Sep	D	2 GHz (8-bit samplers)	16	64	15 MB/s	- Sub-bands identical - Sub-bands indep. tunable with restrictions - Can trade polarization products for channels
2010 Oct - 2011 Jan	C	2 GHz	**more than 16**	64	15 MB/s	- Can trade sub-bands for channels
2011 Feb - 2011 Apr	B	2 GHz	**64**	64	15 MB/s	- 64 Sub-band pairs available
2011 May - 2011 Aug	A	2 GHz	64	**up to 16,384**	**25MB/s**	- Recirculation enabled - Fewer restrictions on Sub-band tuning - N_chan * N_pol restricted by max data rate
2011 Sep - 2011 Dec	D	2 GHz	64	up to 16,384	25 MB/s	- Sub-bands can be independently tuned
2012 Jan - 2012 Apr	C	2 GHz	64	up to 16,384	**50 MB/s**	- Sub-bands may have different BW & N_chan
2012 May - 2013 Jan	B, A	**2/8 GHz (3-bit or 8-bit samplers)**	64	up to 16,384	**75 MB/s**	- Basebands either 1 GHz or 4 GHz BW

1feb12 deadline ➔

31dec12 Formal end of construction project

Resident Shared Risk Observing (1feb12)

Table 3: Correlator capabilities per sub-band with recirculation; the number of polarization products may be traded for number of channels

Sub-band BW (MHz)	Number of poln. products	Number of channels/poln product	Channel width (kHz)	Channel width (km/s at 1 GHz)	Total velocity coverage per sub-band (km/s at 1 GHz)
128	4	64	2000	600/v(GHz)	38,400/v(GHz)
64	4	128	500	150	19,200
32	4	256	125	37.5	9,600
16	4	512	31.25	9.4	4,800
8	4	1024	7.813	2.3	2,400
4	4	2048	1.953	0.59	1,200
2	4	4096	0.488	0.15	600
1	4	8192	0.122	0.037	300
0.5	4	16384	0.031	0.0092	150
0.25	4	16384	0.015	0.0046	75
0.125	4	16384	0.0076	0.0023	37.5
0.0625	4	16384	0.0038	0.0011	18.75
0.03125	4	16384	0.0019	0.00057	9.375

What NRAO can do for you

After the proposal

Documentation on the Web

Go to www.nrao.edu, click on astronomer, then EVLA:

- **Observational Status Summary**: basic introductory guide with (almost) everything in this talk, and more!
- **EVLA Exposure Calculator**: how long does it take to get to 1microJy/beam?
- **FAQs**: how much overhead do I need?
- **eNews:** late-breaking news for our observing community
- **Data archive**: all VLA, VLBA, EVLA data are accessible through the NRAO archive
- Plus information on proposal submission, observing scripts, memo series, RFI plots and lists, data reduction…

Training

- **Community days**
  - Berkeley, CA Jan 13, 2012
- **AAS splinter sessions & NRAO booth**
- **Data reduction workshops**
  - Caltech, CA Jan 19-20, 2012
  - Socorro, NM Feb 22-Mar 1, 2012
- **Synthesis Imaging Workshop** (and books) every two years
  - Socorro, NM May 29- Jun 5, 2012
  - Single dish workshops in Green Bank, WV every other year
  - Lectures are on the Web
- **Visit NRAO**
  - Observing & data reduction trips

Support

- **Travel support**
- **Preprint and page charges**
- **Large proposal/key science support**
- **Students (undergraduate and graduate)**
  - Summer students
  - Student observing support (also class observations in some cases)
  - Co-op program (undergraduates)
  - Graduate student internships
  - Graduate fellowships
- **Postdoctoral fellowships (Jansky and others)**
- **Short- or long-term visits**
  - PhD astronomers or radio engineers, preferably junior

NRAO staff

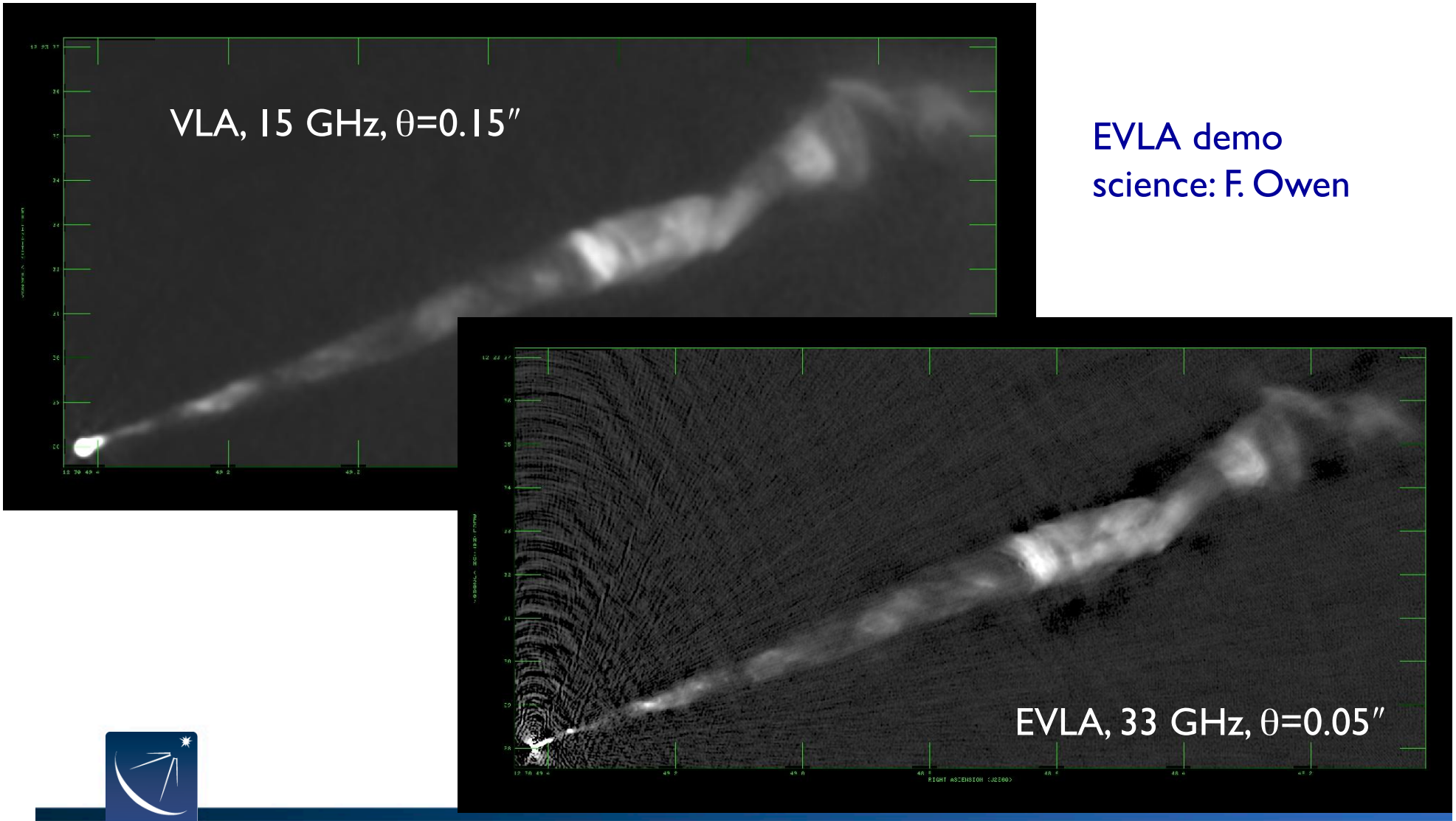
- **Helpdesk**
- **E-mail, telephone**
- **Wide variety of radio expertise**
  - Data analysts
  - Software engineers
  - Hardware gurus
  - Scientific staff
- **Friendly** (mostly), **helpful** (usually)
  - **We really do like working in a *national* observatory**
  - **You can't possibly have crazier ideas than we do**

Some recent results (just for fun)

Recent demo/science results from the EVLA

The jet of M87, then and now

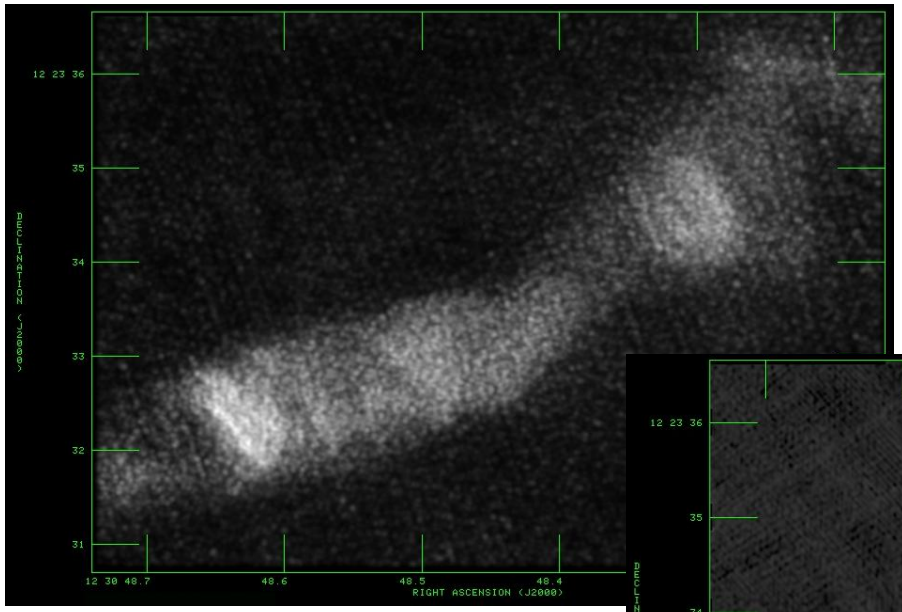
EVLA



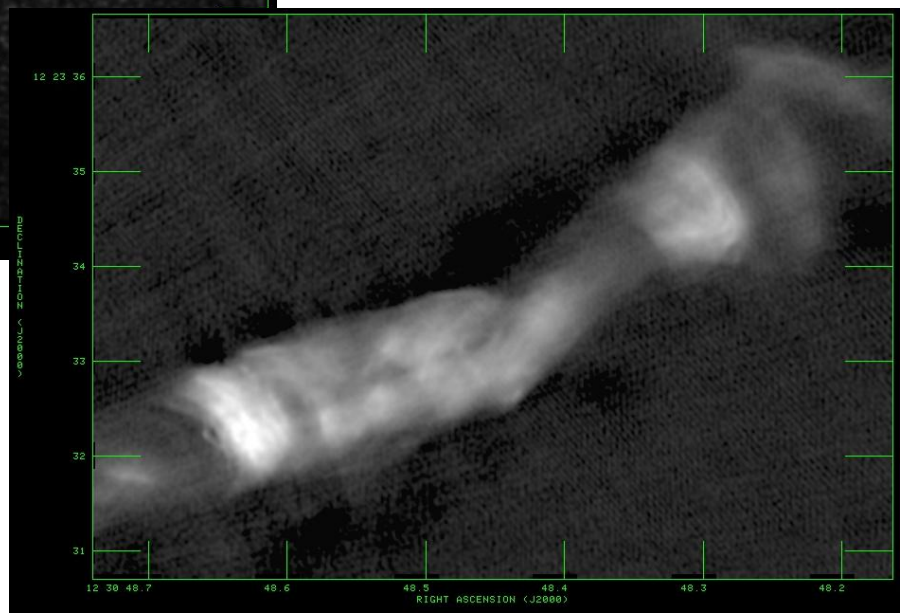
EVLA demo science: F. Owen

The jet of M87, then and now

VLA,
44 GHz



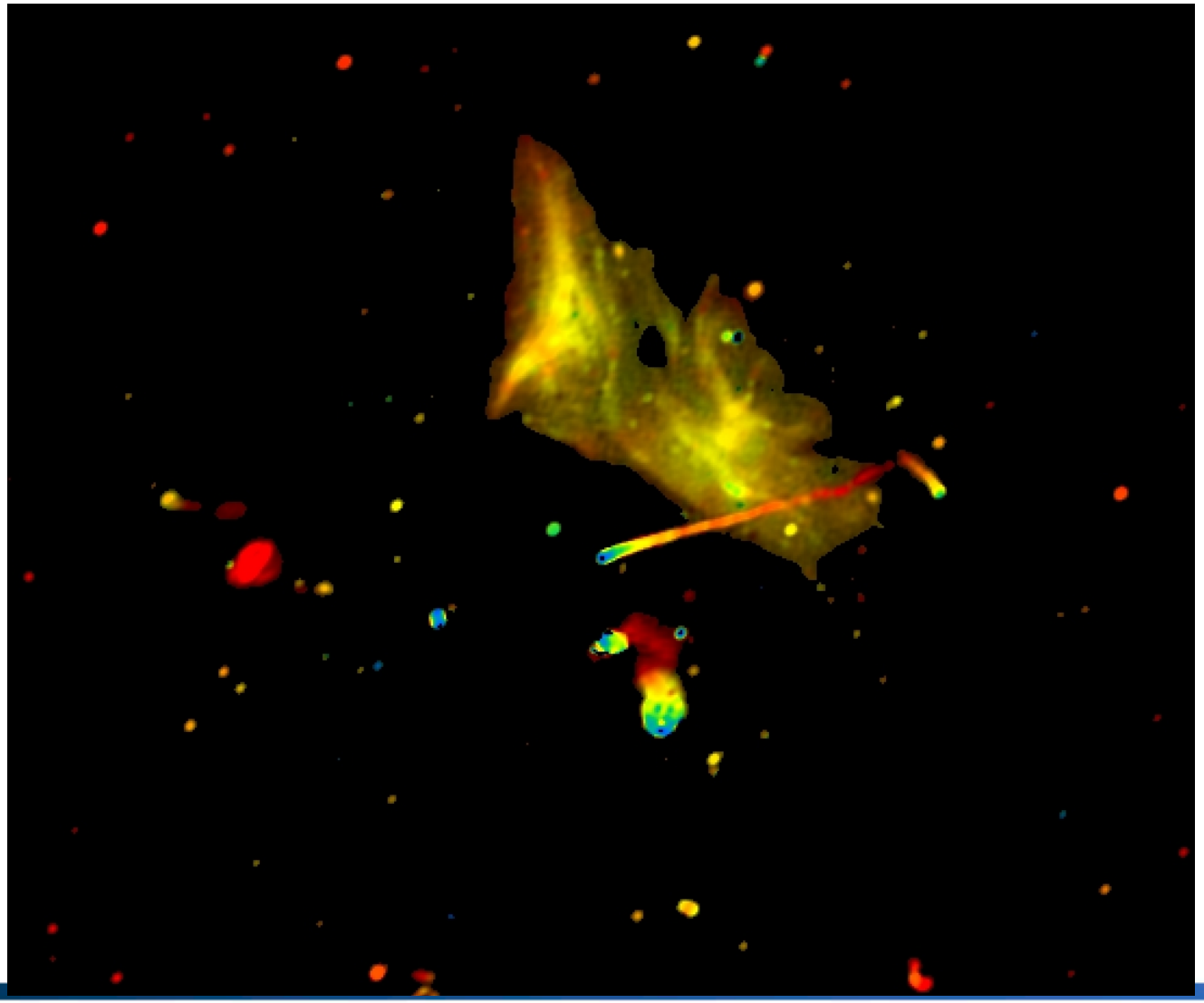
EVLA demo
science: F. Owen



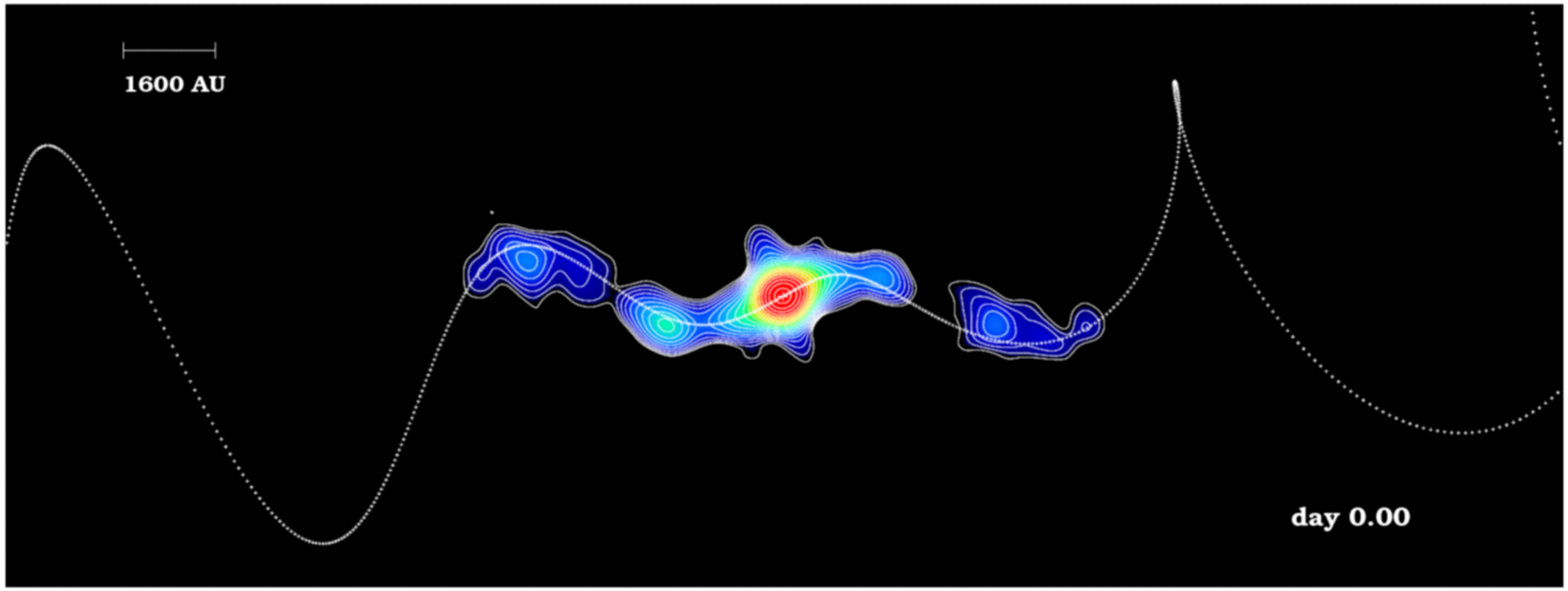
EVLA, 33 GHz

Relics and jets in Abell 2256

- 1–2 GHz, 20-arcmin on a side; color corresponds to spectral index (Owen, Rudnick, Eilek, Rau, Bhatnagar, Kogan)

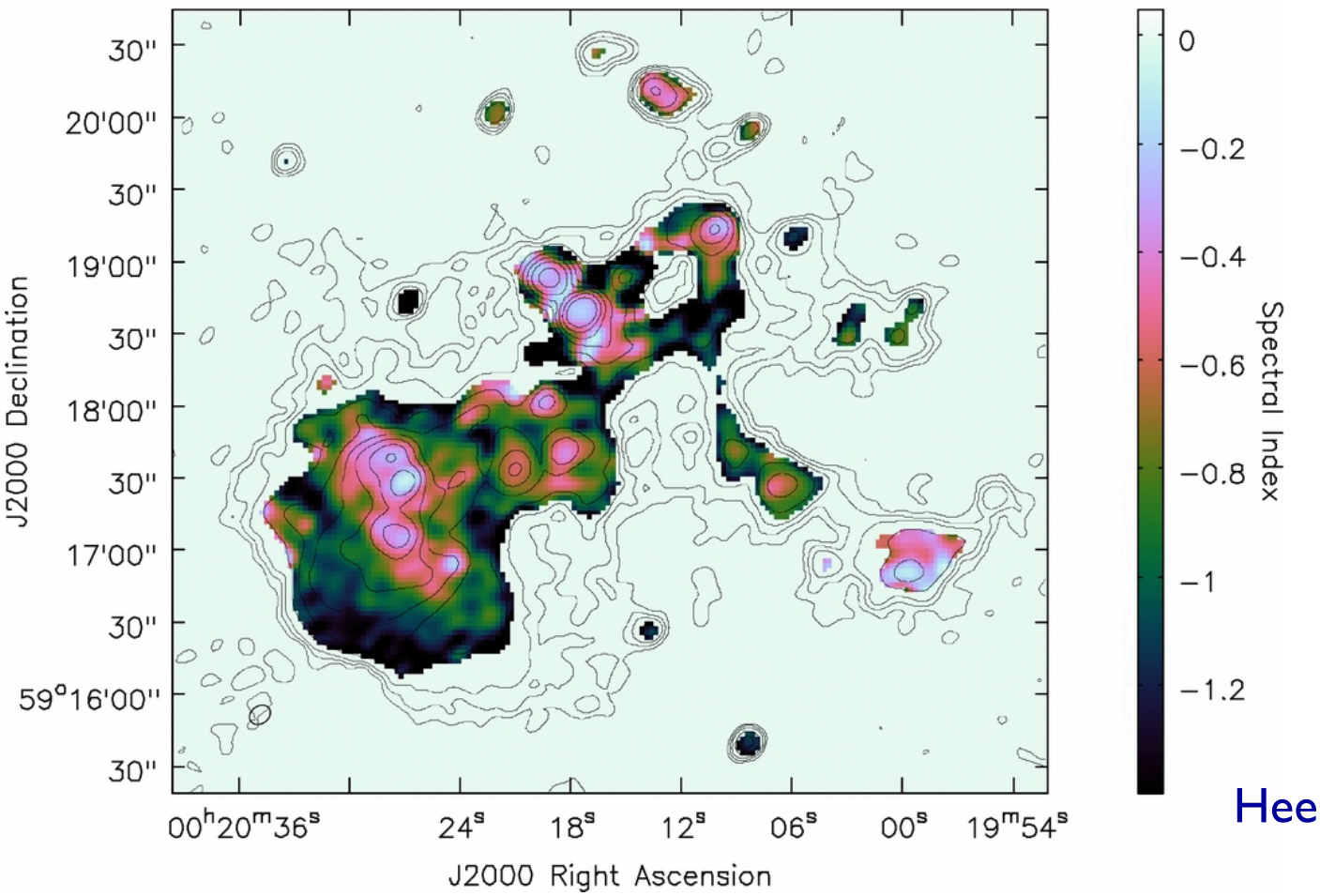


SS433 @ 26 GHz: 12 ~weekly snapshots



Miller-Jones et al./demo science

IC10 (dwarf galaxy) at 6cm



Heesen et al.

Backup slides

Low frequencies

A few more pics

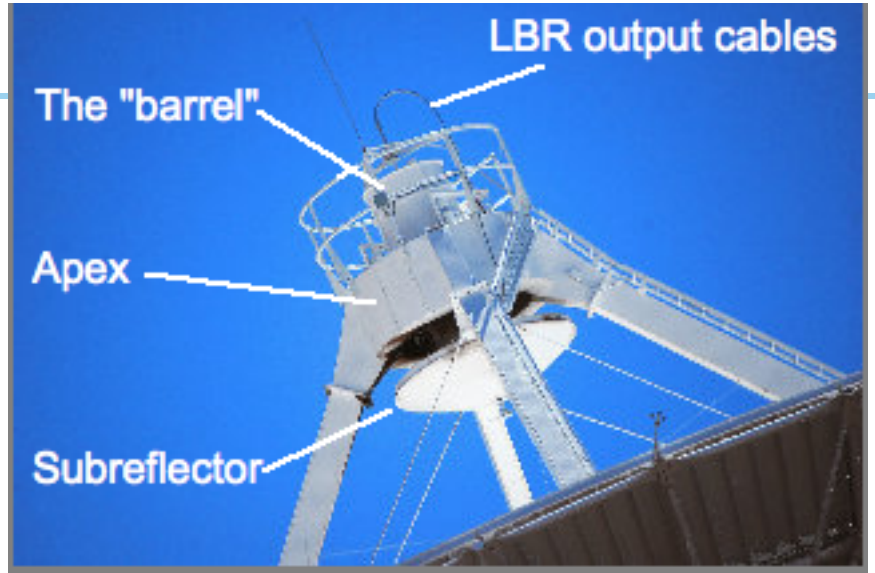
Below 1 GHz at the EVLA: receivers

- Lowband: 58-84, 230-430 MHz
- First receiver set in the lab being tested; 2nd in final stages of construction
- An optimistic schedule of getting them on the array:
  - Jan 2012: 2
  - Mar 2012: 6
  - End 2012: 28
- RSRO would really help, in the second half of 2012
  - Probably could get a bit of ToO time (<10hrs per project) on that timescale
  - Optimistically might hope for "regular" RSRO call in Aug 2012 (for 2013)
- Pretty pics: http://www.aoc.nrao.edu/~pharden/LBR/lbr.htm

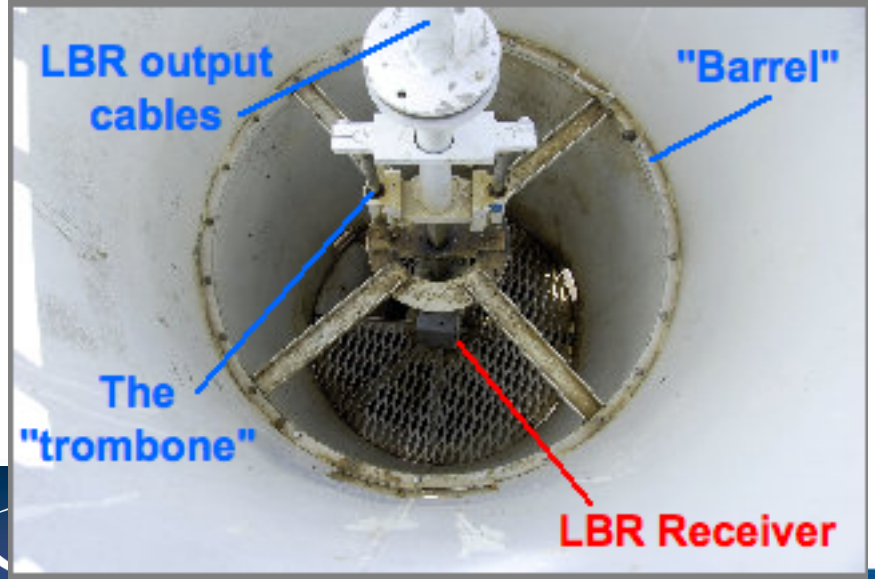
Below 1 GHz at the EVLA: feeds

- Initially use the old 4, P band dipoles
  - Means special campaigns for lower band – upper should be available all the time
- New feed based on Harun & Ellingson (Va Tech) is in the early stages of design
- 74 MHz dipoles:

  http://www.aoc.nrao.edu/~pharden/LBR/PIX/pix.htm#74dipole



The LBR will be mounted inside the "barrel" at the VLA antenna apex



Inside the "barrel"

Below 1 GHz at the EVLA: pretty pics