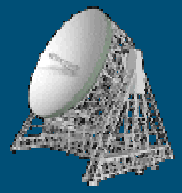


e-MERLIN & EVLA

P.J.Diamond

MERLIN/VLBI National Facility

Jodrell Bank Observatory

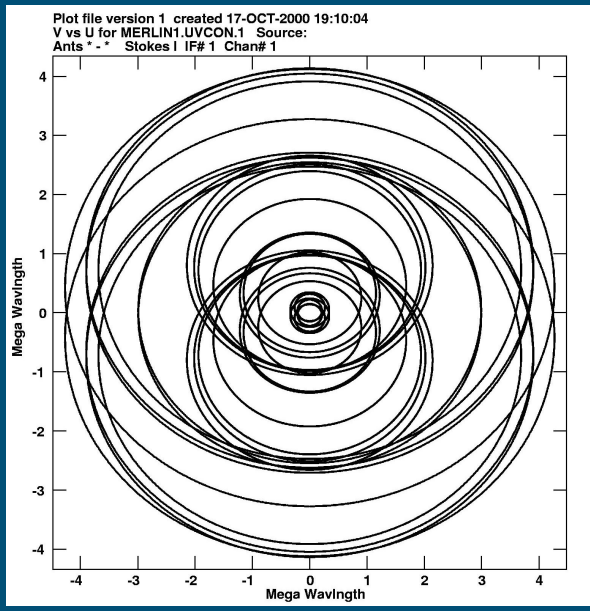
University of Manchester

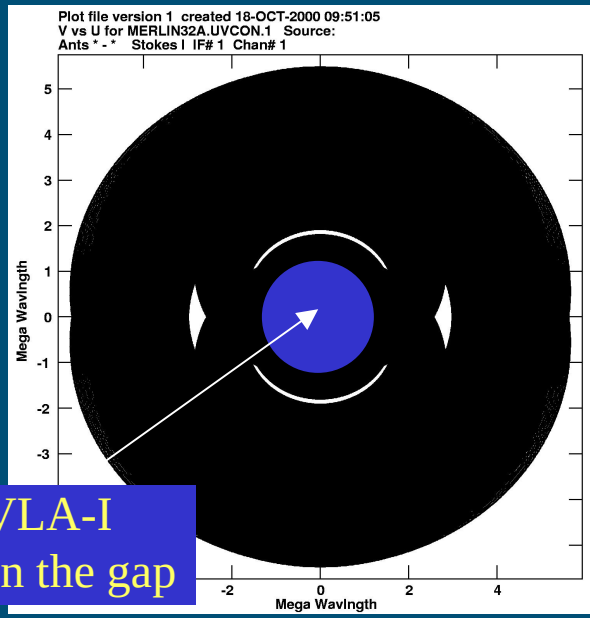
24/8/01

e-MERLIN : current specification

www.merlin.ac.uk/e-merlin

- Fibre connection to telescopes; new correlator
- 1.5 GHz/pol instantaneous bandwidth, steerable sub-bands
- Data rate increases from 128Mb/s/tel (via microwave links) to 32Gb/s/tel
- Sensitivity ~ 1.6 μJy/b in 12hr (> 30 over current system)
- Correlator operates in permanent wide-field mode
  - e-MERLIN will provide FOV ~ 0.5 degree at 1.4 GHz, ~10 arcmin at 5 GHz. Images will have as many pixels as VISTA – 400,000,000 per channel
  - Output data rate 0.5 TB/day
  - Hundreds of sources in each observation – superb high-res archive for data mining (AstroGrid, e-science)
- Complete aperture coverage via MFS
- L, C and K band systems upgraded in baseline project
- Cost: £7.8M ($11.3M)





EVLA-I
Fills in the gap

e-MERLIN capabilities

Band	Frequency (GHz)	Current Sensitivity (μJy)	***e*-MERLIN sensitivity (μJy)**	Brightness (K)	Resolution (arcsec)
UHF	0.327/0.408	700	**200**	7020	0.5
L	***1.0 – 2.0***	***35***	***4***	***140***	***0.14***
C	***4.0 – 8.0***	***50***	***1.6***	***53***	***0.04***
X	8.0 – 12.0	N/a	**1.6**	53	0.02
U	12.0 – 18.0	N/a	**3.4**	117	0.013
K	***18.0 – 26.0***	***400***	***12.7***	***440***	***0.008***

Key programme sensitivity: 200 hours at 5 GHz → 350 nJy rms

e-MERLIN vs. NMA/EVLA

Frequency (GHz)	***e*MERLIN (μJy)**
0.327/0.408	**200**
1.0 – 2.0	***4***
4.0 – 8.0	***1.6***
8.0 – 12.0	**1.6**
12.0 – 18.0	**3.4**
18.0 – 26.0	***12.7***

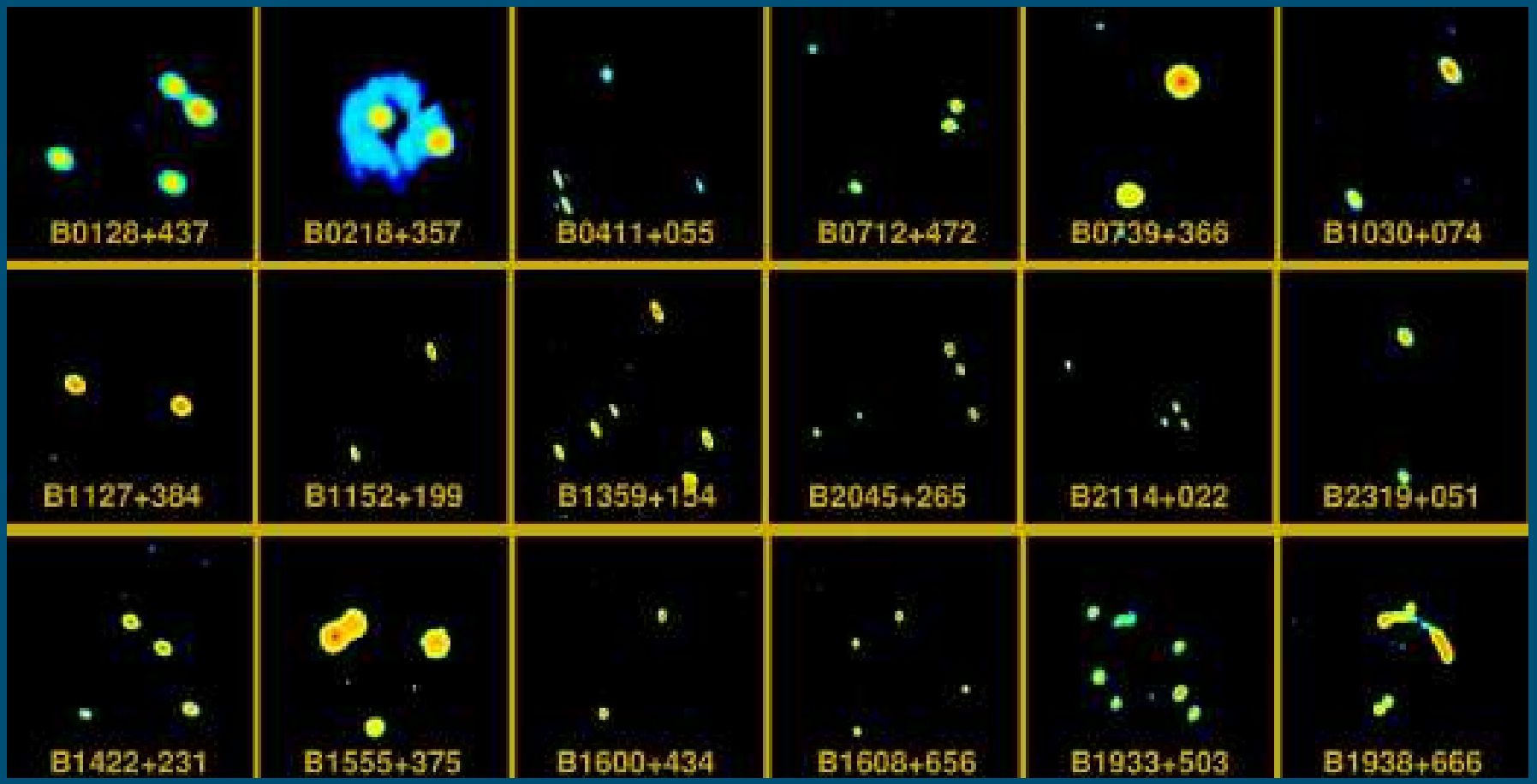
Frequency (GHz)	**NMA sensitivity (μJy)**
0.20-0.30	**167.**
0.30-0.45	**79.**
0.45-0.70	**37.**
0.70-1.00	**15.**
1.0 – 2.0	***8.3***
2.0-4.0	**5.1**
4.0 – 8.0	***3.5***
8.0 – 12.0	**4.2**
12.0 – 18.0	**4.2**
18.0 – 26.5	***5.1***
26.5-40.0	***4.6***
40.0-50.0	***11.***

Frequency (GHz)	**EVLA sensitivity (μJy)**
0.20-0.30	**36**
0.30-0.45	**17**
0.45-0.70	**8.1**
0.70-1.00	**3.3**
1.0 – 2.0	***1.8***
2.0-4.0	**1.1**
4.0 – 8.0	***0.75***
8.0 – 12.0	**0.90**
12.0 – 18.0	**0.90**
18.0 – 26.5	***1.1***
26.5-40.0	***1.0***
40.0-50.0	***2.3***

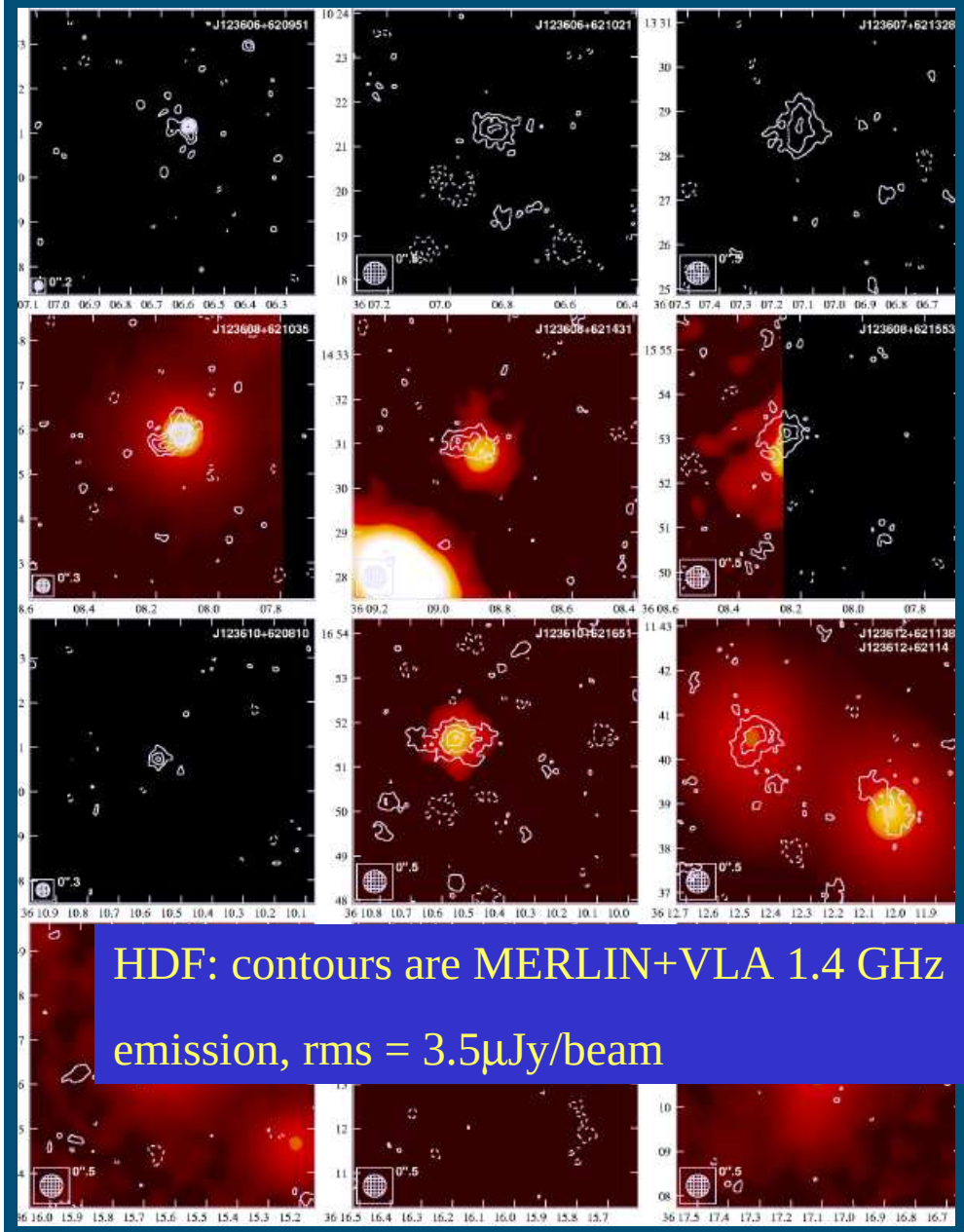
e-MERLIN Science – resolution and sensitivity

- Cosmology – gravitational lenses, JVAS/CLASS. Vast expansion of capabilities through e-MERLIN
- Constraints on cosmological parameters, e.g Ω_m and Ω_λ

Gravitational Lenses from JVAS/CLASS



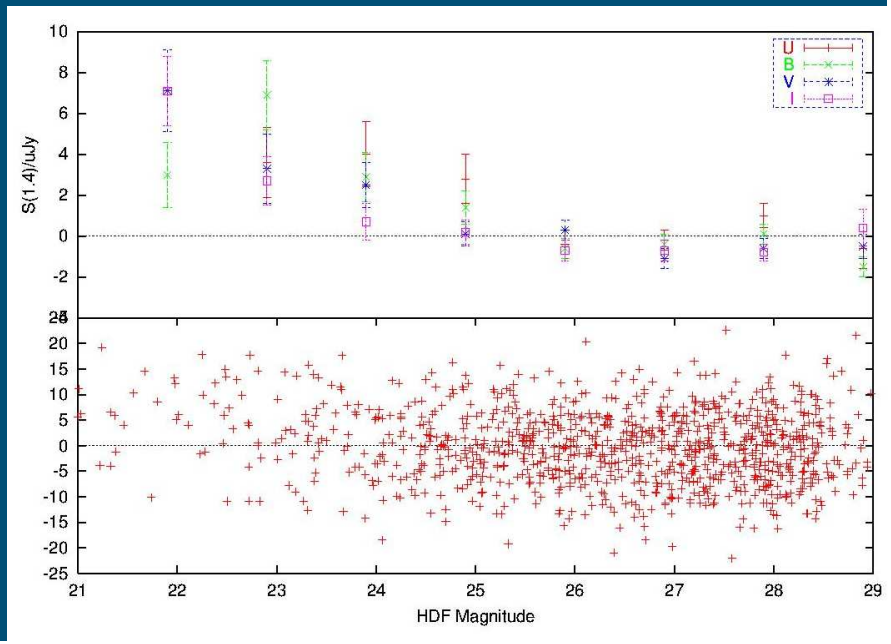
e-MERLIN Science – resolution and sensitivity



HDF: contours are MERLIN+VLA 1.4 GHz emission, rms = 3.5μJy/beam

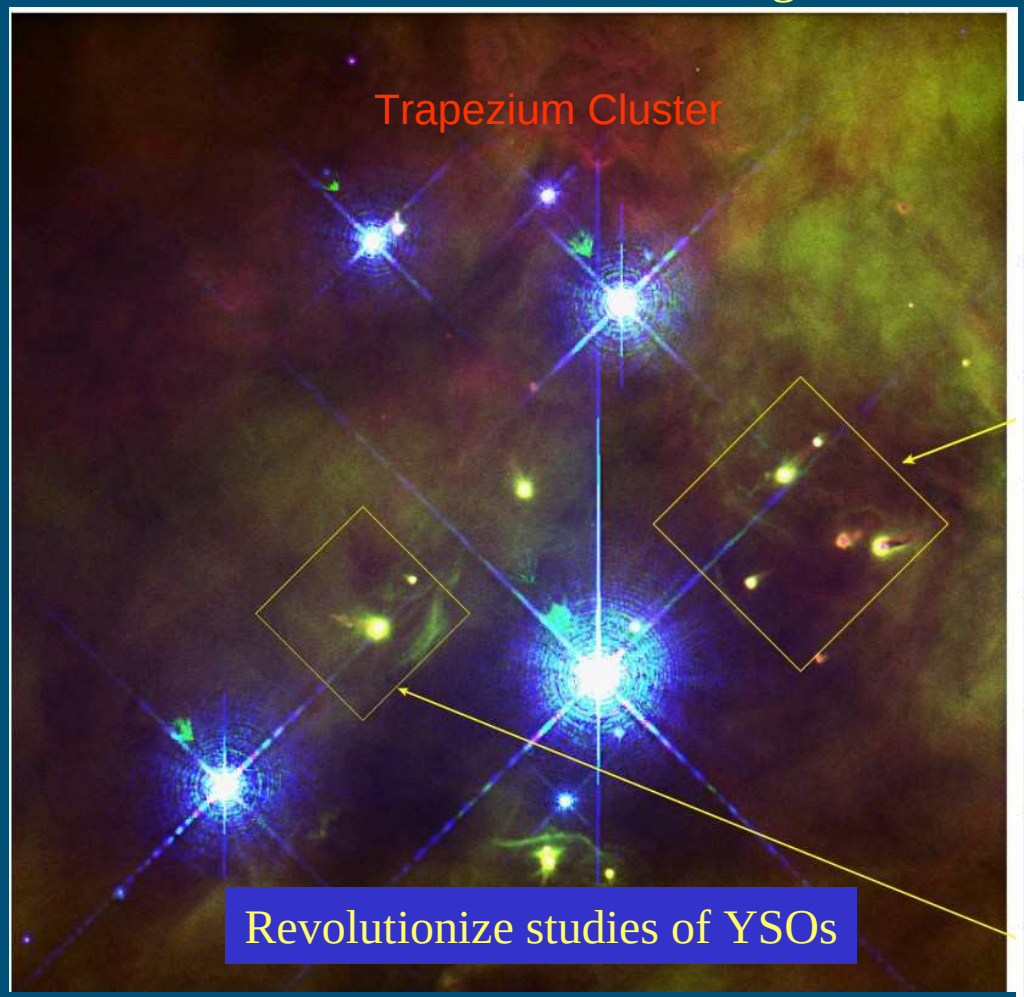
- Galaxy Formation & Evolution: nature of submm galaxies, starbursts, X-ray background.
- 100's of sources in primary beam.

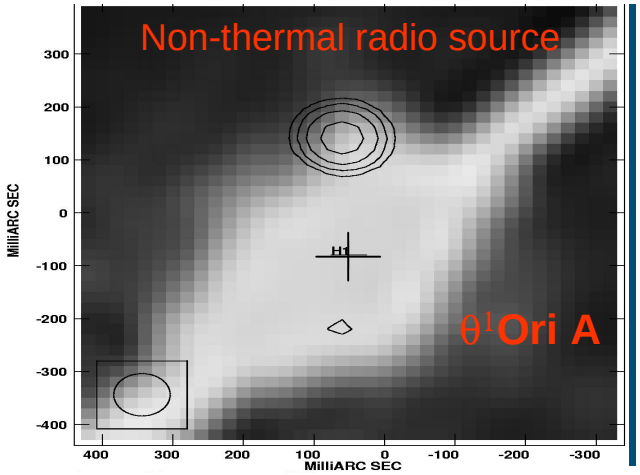
Statistical detection of < 10μJy sources in HDF.
Excess radio emission clearly seen for I <26, implying majority of galaxies at this level detectable by e-MERLIN

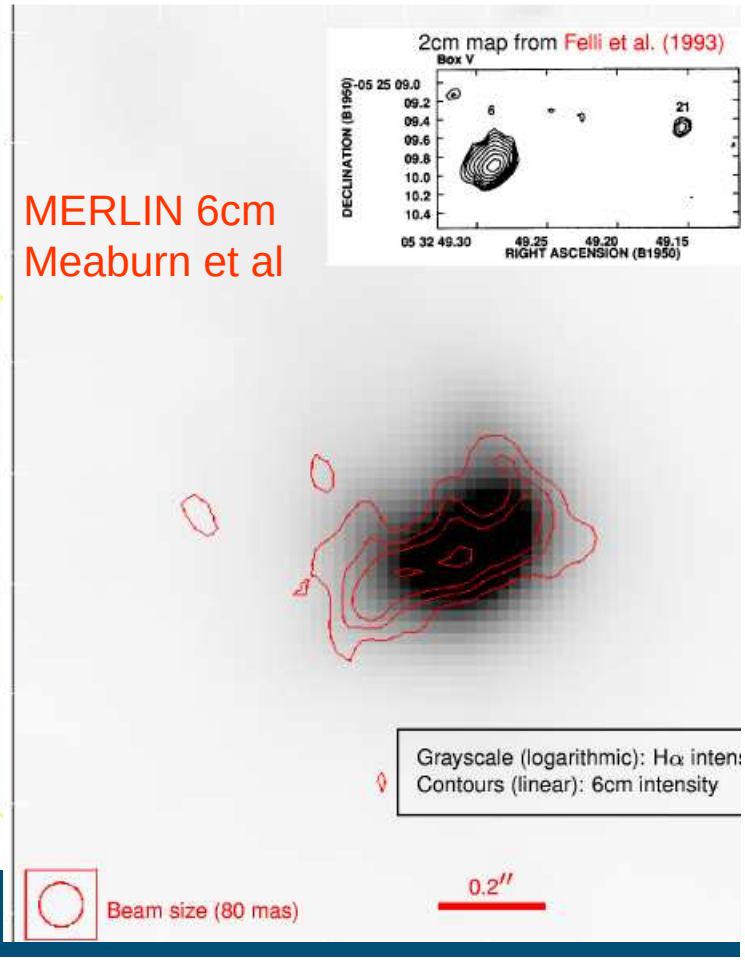


e-MERLIN Science – resolution and sensitivity

- Star-formation:
  - Imaging thermal jets and outflows in YSOs
  - Maser emission in star-formation regions

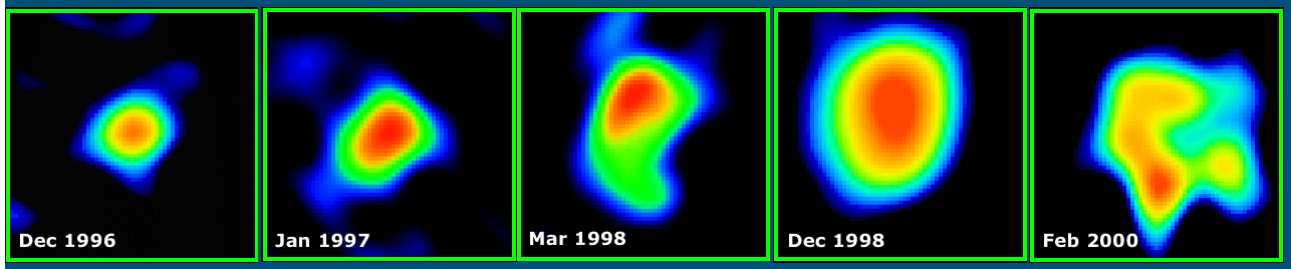






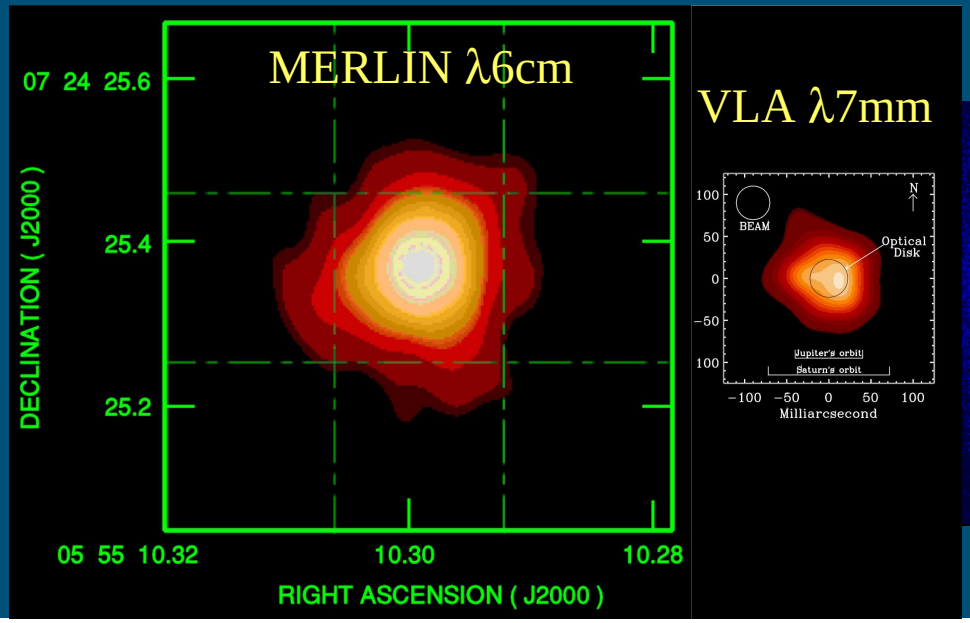
e-MERLIN Science – resolution and sensitivity

- Main sequence and evolved stars – novae, stellar coronae, planetary nebula, surfaces of supergiants/giants

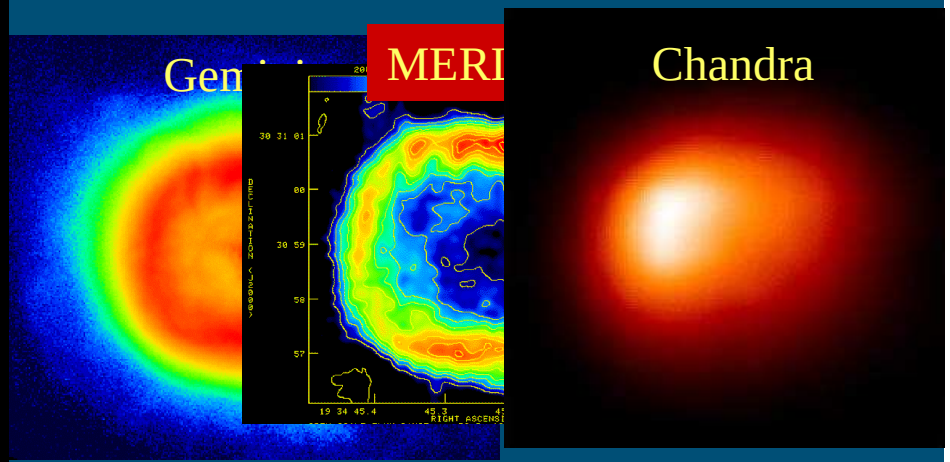


Nova V723 Cas

Imaging stellar surfaces



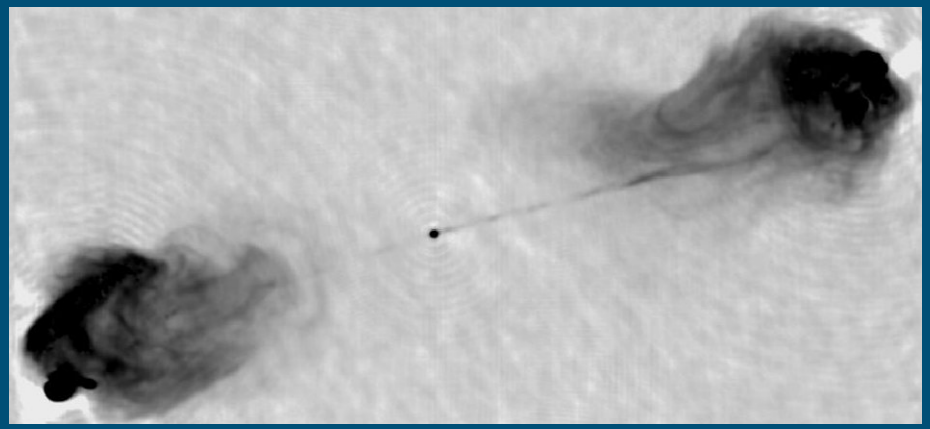
Planetary Nebulae



BD +30° 3639

e-MERLIN Science – resolution and sensitivity

- Extreme environment astrophysics –
  - micro-quasars,
  - relativistic jets in AGN,
  - pulsar proper motions,
  - GRBs ……

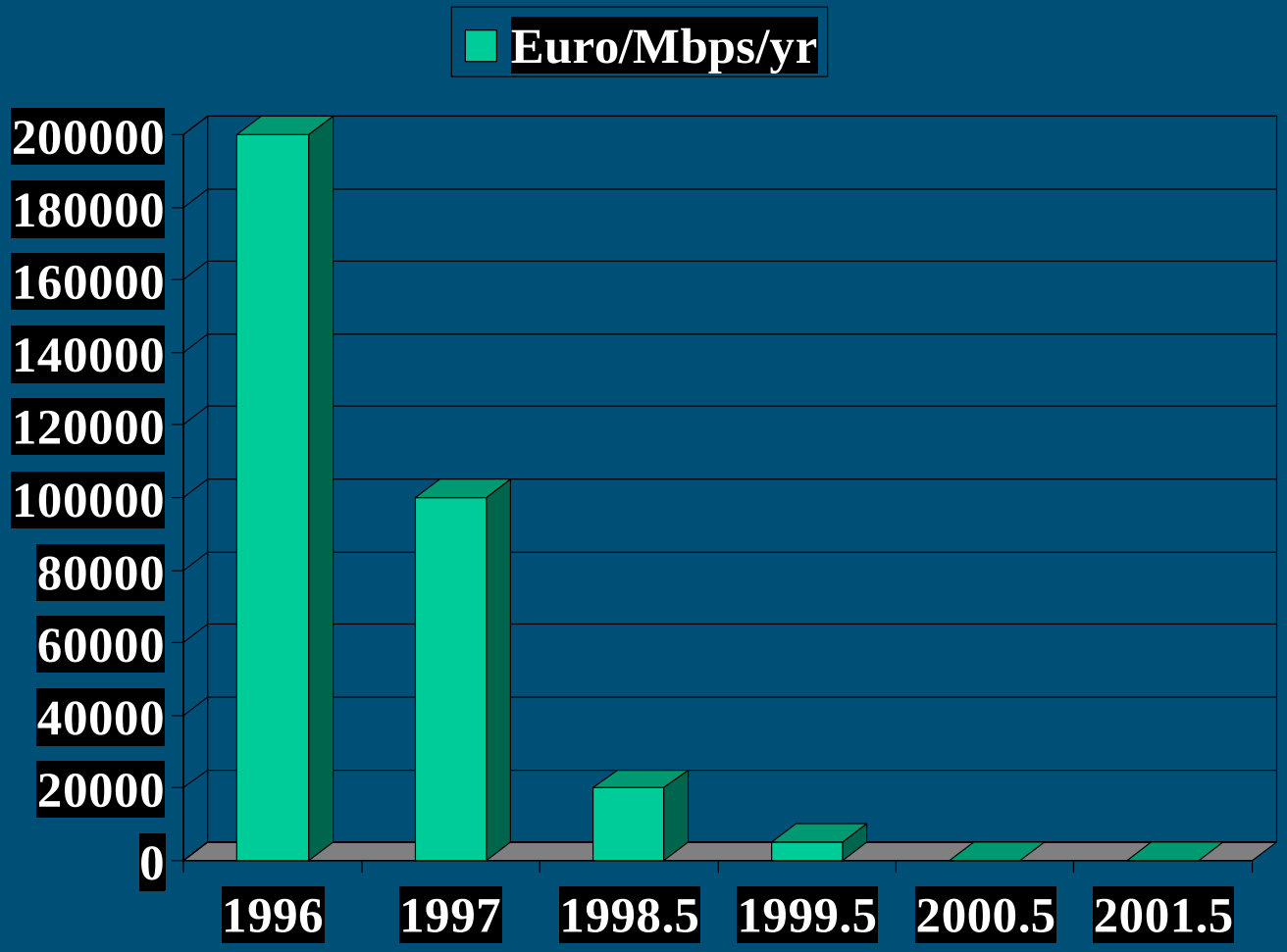


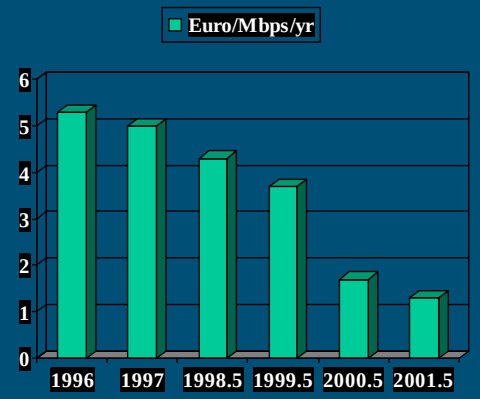
e-MERLIN will provide detailed images of Cygnus A-like objects at 10 times the distance currently possible.

e-MERLIN timetable (milestones only)

- Sept 12, 2001: risk, cost, management assessment
- Oct 2001: go/no go decision from PPARC
- Jan 2002: funds available
- Oct 2002: Lovell Telescope upgrade finished, available @ 5GHz
- Dec 2002: C-band receiver upgrade complete
- Dec 2003: L-band receiver upgrade complete
- Oct 2005: L-band lens system installed on all E-systems dishes
- Dec 2005: IF/LO system complete, correlator chip run begins
- Jan 2006: installation of fibre (details depend on fibre procurement arrangements)
- July 2006: MERLIN shutdown for commissioning
- Q1 2007: correlator delivered (!), operations soon after

Cost of leasing dark fibre, generic numbers for moderate bandwidths within Europe





Ordinate in log form

No decision as yet on final form of e- MERLIN fibre contract

e-MERLIN and the EVLA

- Complementary:
  - e-MERLIN and EVLA-I can build on strong legacy of previous joint observations: HDF, M82, DRAGNs, planetary nebula, etc…
  - Two arrays will have similar sensitivities, previous disparities will be minimal at MERLIN's prime observing bands
  - Sharing of technology: Jodrell Bank and NRAO are co-operating on ALMA fibre developments, e-MERLIN will adopt that solution as will EVLA(?)
- Competition:
  - Why? At the sensitivitites expected for EVLA and e-MERLIN there will be many millions of radio sources detectable. Enough to share. There is is more than one 8-m telescope on the planet.
  - NMA will have better performance at high frequency and probably low frequencies (< 1 GHz)
  - e-MERLIN may reach operational status first

Issues and questions

- What will be the relationship between the VLBA and NMA?
- Will the NMA continue to operate if the EVLA is in a compact configuration? Will outlier telescopes remain at the end of the arms to provide uv-coverage?
- Is there a plan for integration of the VLBA with the NMA/EVLA?

- At what level can JBO and NRAO share technologies and software developments during the EVLA development?