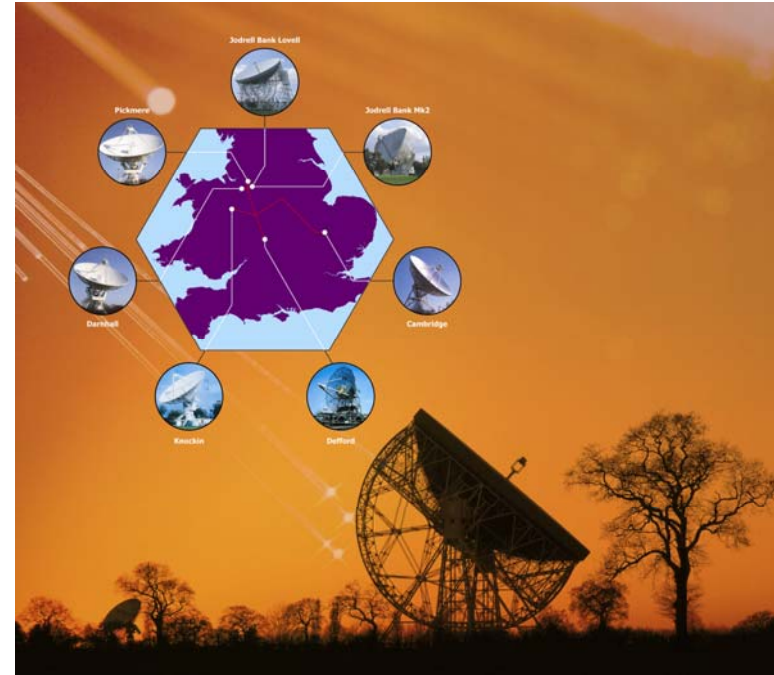


# e-MERLIN

MERLIN background

e-MERLIN

- Project
- Science



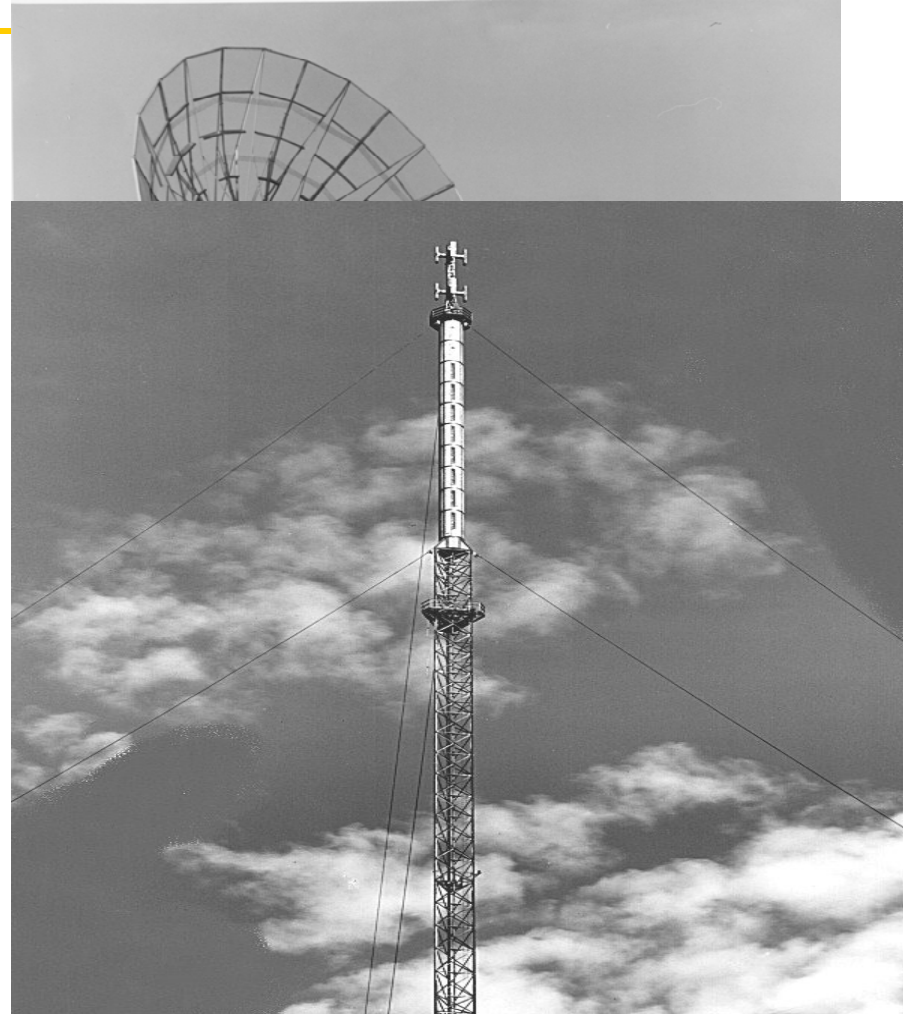
# MERLIN: background (1)

Jodrell Bank pioneered long-baseline interferometers (>100km) with small remote telescopes and radio links

Driven by quest to establish nature and size of 'radio stars' : 1950's & 60's

Key technical development was 'phase stable link' (1973)

- Most of information through phase
- Allows coherent integration to make deep images



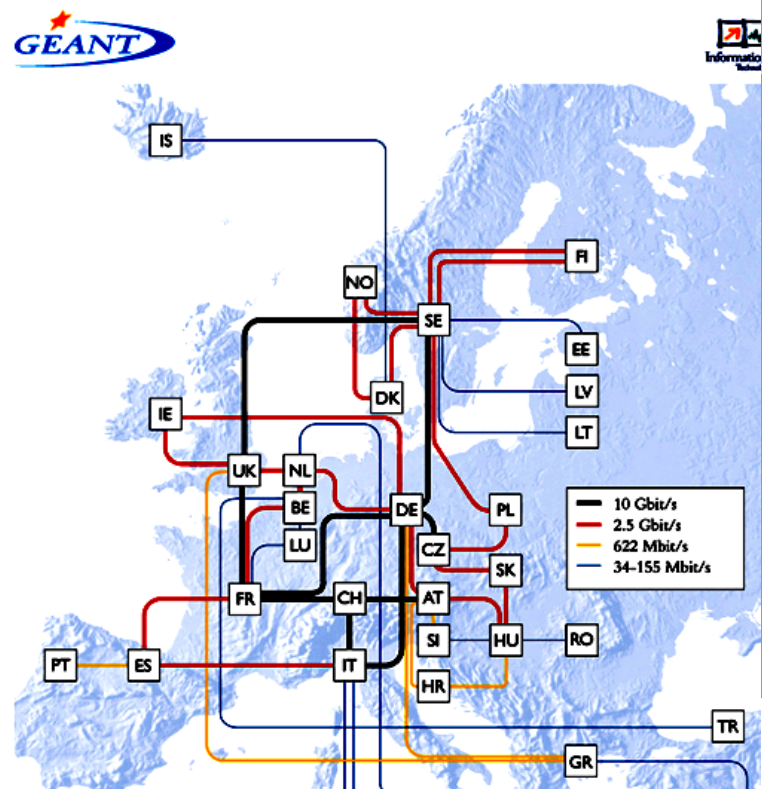
## MERLIN: background (2)

- By 1980 developed into **MERLIN**
  - Network of 6 telescopes; 127km
  - Extended to 217km with telescope at Cambridge (1990)
- Motivated by high resolution (50 – 150 mas at cm wavelengths); real time
- 7x resolution of VLA: can resolve
  - Novae; SNR shells in M82
  - Starforming galaxies at  $z \sim 1$
- Key technical advances
  - Affordable data links with 30 MHz b/w
  - Clock distribution (few ps)
- Sensitivity limited by link bandwidth
  - $\sim 50 \mu\text{Jy}/\text{beam}$  at 5 GHz



# Optical fibres

- Optical fibres allow  $\sim$ Tb/s per fibre over 100km without amplification  
already used in ATCA, GMRT  
key part of ALMA, EVLA
- Available as part of national and international commercial and research communications infrastructures
- Can support GHz bandwidths for e-MERLIN and Gb/s realtime operation for EVN



# e-MERLIN Project

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- Funded from 2002: Univ Manchester, NWDA, PPARC/STFC, Cambridge, UMIST, LJMU. £8M
- Tightly focused on sensitivity upgrade using fibre links for 2 GHz bandwidth
- Design goals
  - 2 GHz bandwidth (in each pol)
  - New C-band: 4-8 GHz Rx suite
  - Upgrade L-band: 1.3-1.7 GHz
  - Upgrade K-band: 22-24 GHz
  - Rapid (1min) change between bands
  - No compromise in phase stability
  - Correlator: Wide-field ( $<0.5\text{MHz}$ ) & spectral line ( $<0.5\text{ kHz}$ )
- Low-cost
  - share development (ALMA/EVLA/e-MERLIN DTS)
  - Re-use some components



# e-MERLIN: Progress

- Receivers: done
- IF & electronics: prototype
- Fibre network: in progress
- Correlator: DRA prototype
- Software: in progress
- First fringes with correlator: Mid October



Photo: Dave Holman

Photo: Dave Holman

# WIDAR Correlator

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- Developed by DRAO, Penticton (Canada) and NRAO [for EVLA]
- 2 x 2 GHz wide band sampled at telescope (2x 4 Gs/s with 3 bit samples) and transmitted using 3 x 10Gb/s optical wavelengths with custom transmission equipment
- Correlator splits input to 16 x 128 MHz sub-bands using digital filters
- Sub-bands correlated using 16 x 64 x 2048 complex-lag correlator chips
  - 0.25 MHz channel resolution for 4 polarisations at maximum bandwidth
  - KHz resolution for spectroscopy, Hz resolution for radar

# Capabilities

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- 150, 40, 10 mas resolution at L[20cm],C[6cm],K[1,3cm]
- ~2 uJy sensitivity in typical runs
  - <uJy in deep fields
  - ~30 uJy in ~1 min
- Wide fields
  - Out to HPBW of 25-m [9,30 arcmin]
- Spectroscopy
  - 16 placeable sub-bands; >512 channels/pol; recirculation
  - Can mix/trade bandwidths; no. of channels, polarisations
- Much improved aperture coverage
  - Via frequency coverage
  - May help snapshots too
- Spectral mapping
  - 1.3-1.7; 5-7/4-8 GHz
- Polarization (L,R → IQUV)
- Astrometry
  - Goal is < 1 mas wrt ICRF

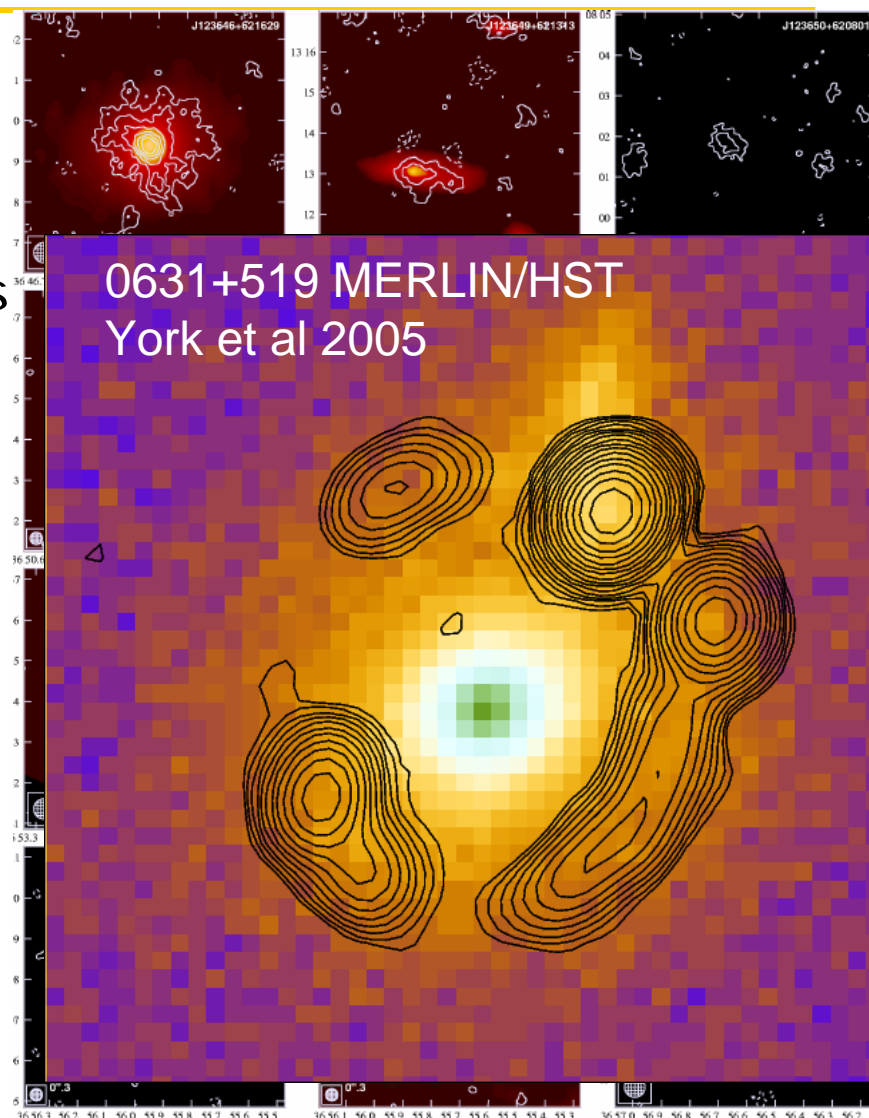


# e-MERLIN: Science



# e-MERLIN: Science

- Key topics:
  - Formation processes of stars
    - Jets, winds, disks
  - Activities in nearby galaxies
    - Black holes, supernovae, starclusters
  - Distant galaxies
    - Starformation & AGN
  - Gravitational lenses
    - Dark matter distribution
- All require  $>100$  km baselines



# Using MERLIN

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- Open facility
- Propose using Northstar tool
- Deadlines Mar & Sep
- Limited observations in 2008
- [www.merlin.ac.uk](http://www.merlin.ac.uk)

# Using e-MERLIN

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- Powerful new combination of high resolution and sensitivity
- Data analysis similar to MERLIN, EVLA
- Open facility
- Legacy programme for large projects  
[www.merlin.ac.uk/e-merlin\\_legacy.html](http://www.merlin.ac.uk/e-merlin_legacy.html)  
Projects being designed now, teams open
- Commissioning & early science 2008
- Full operations 2009