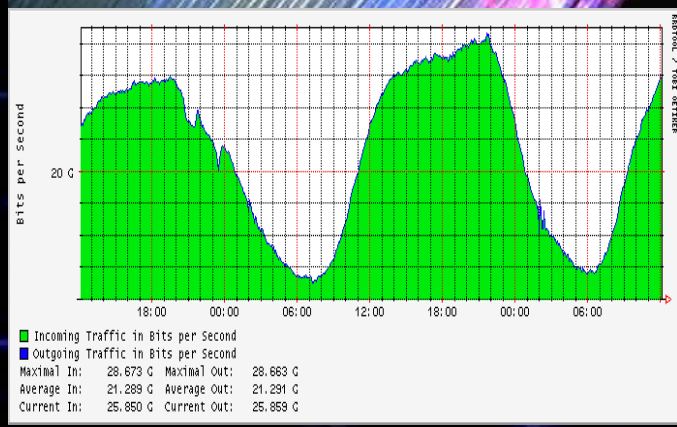
e-EVN: *a Real-time Radio Telescope as large as Europe with sub-microJy sensitivity.*

Mike Garrett (JIVE)

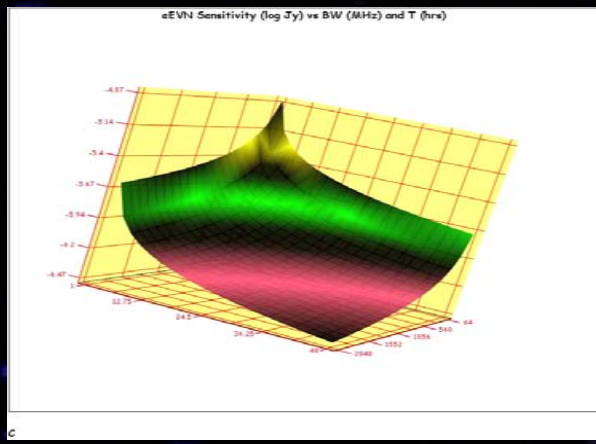
1 September 2004

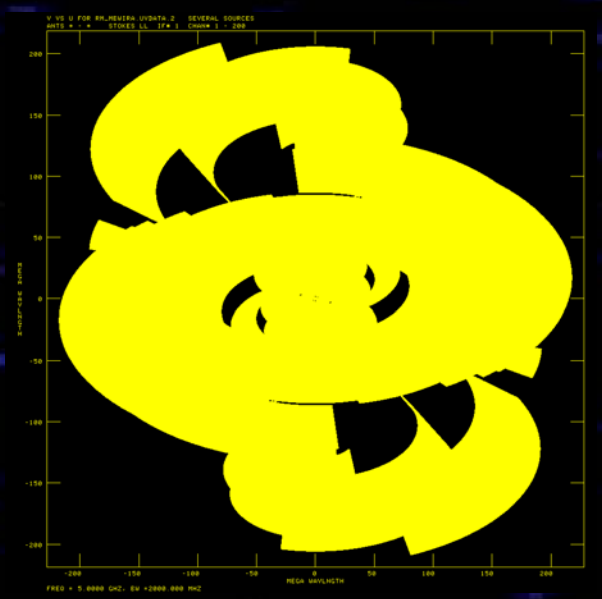
- *e*-VLBI goal is to connect radio telescopes around the world via broad-band optical fibre networks.
- *e*-EVN will use GÉANT to transport 1-10 Gbps from each EVN telescope to JIVE.
- Gbps data rates will permit noise levels better than 1 microJY.
- Current status:
  - JIVE connected to GÉANT at 6 x 1 Gbps,
  - Five EVN telescopes "on-line",
  - First e-EVN Proof-of-Concept tests already under-way…



e-EVN Design Goals (1)

- *Embarrassingly* sensitive:
  - Sub-microJy noise levels achieved in 12 hours.
- Full uv-coverage via Multi-frequency Synthesis.
- Frequency Flexibility & Broad Coverage:
  - 0.3-1 GHz
  - 1-3 GHz
  - 4-8 GHz (incl. Methanol)
  - 15, 22, 43 GHz.



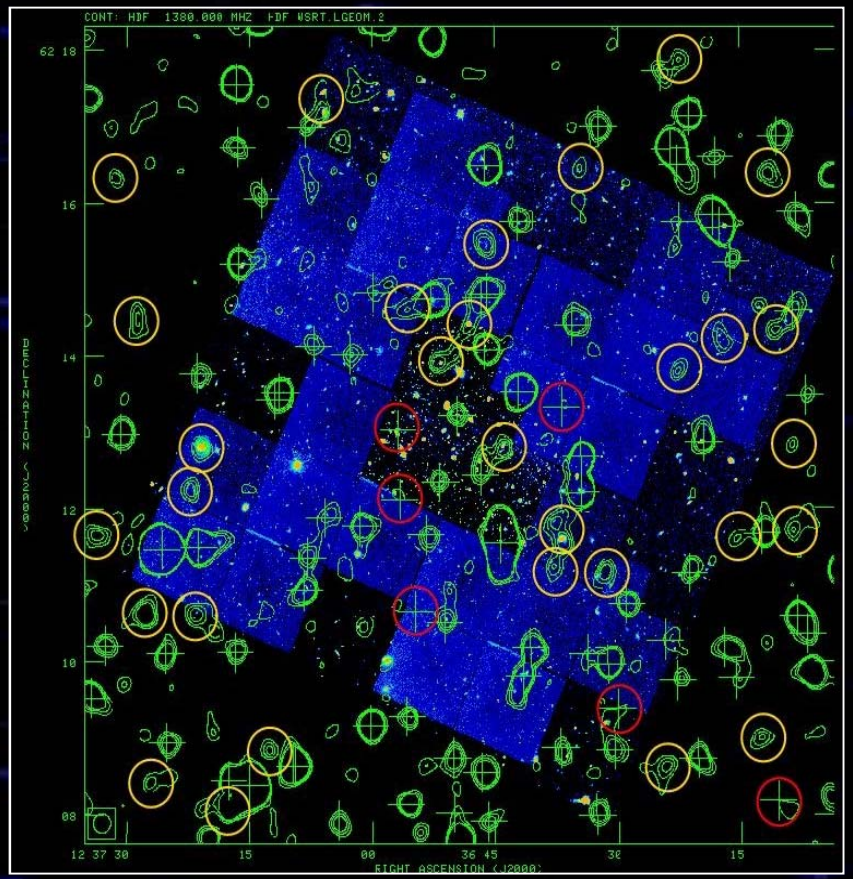


e-EVN Design Goals (2)

- Milliarcsecond Resolution & sub-milliarcsecond Astrometry.

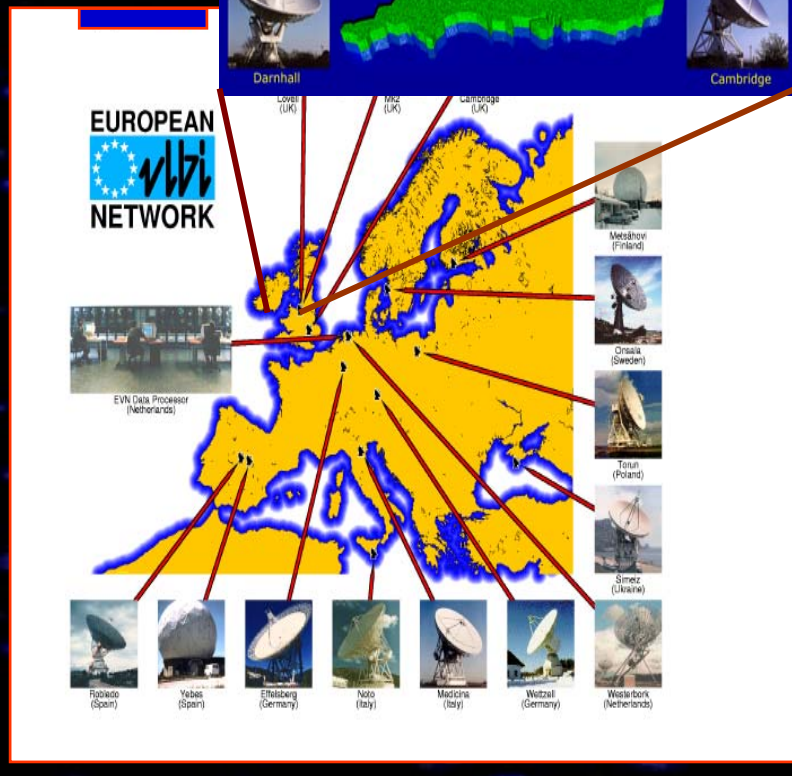
- Wide-field Imaging as a standard correlator mode:
  - Field-of-view of 10 arcmins at 1.4 GHz,
  - AVO-like archive to interface with pipelined images.

- "Phase stable" at 1-10 GHz using "full-beam" calibration.



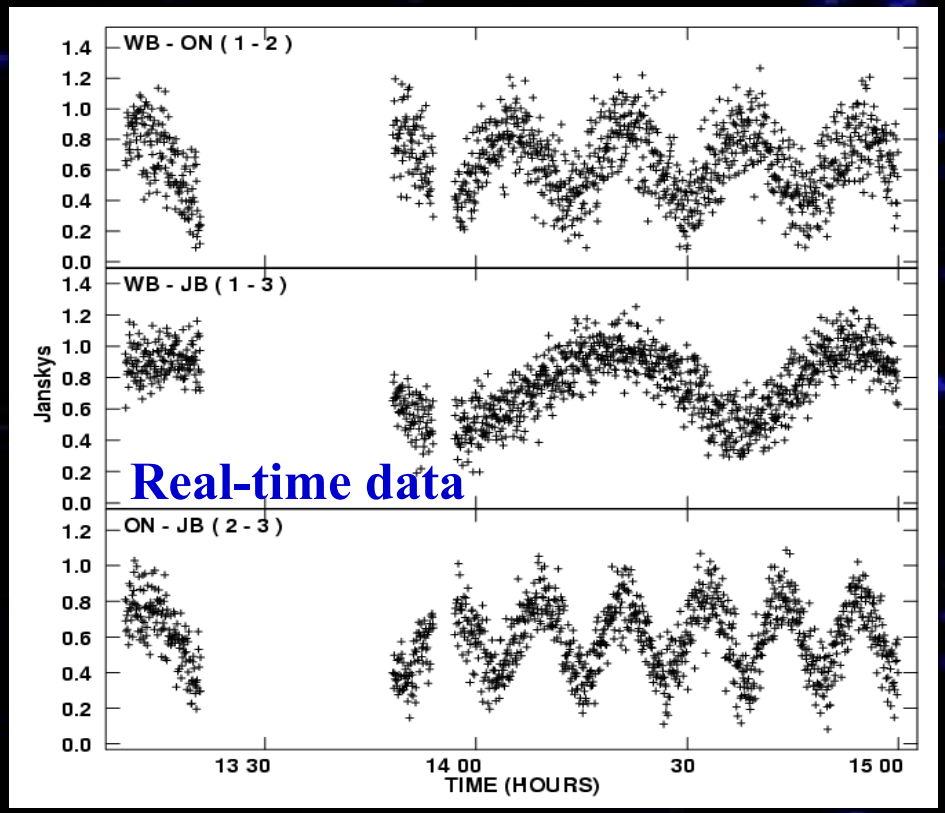
e-EVN Design Goals (3)

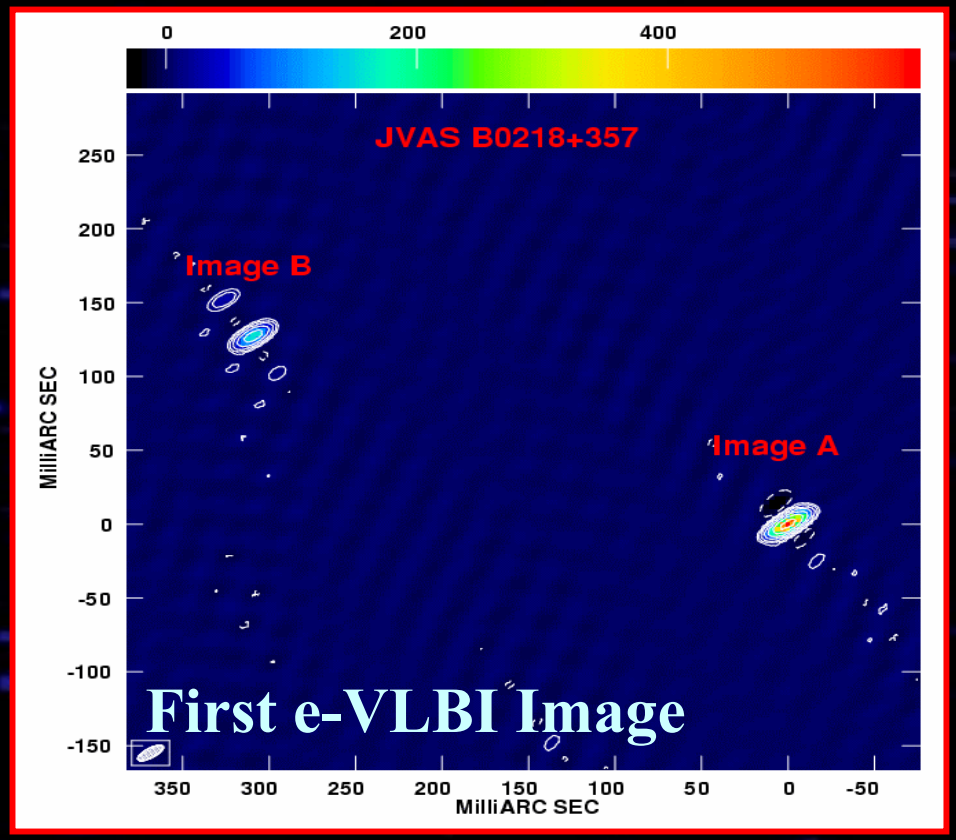
- Seamless co-observations with e-MERLIN of 1-200 milliarcseconds:
  - The e-EVN/e-MERLIN combination will be the most powerful radio imaging instrument on the planet.
- Simultaneous continuum and multi-line spectroscopy.
- Dynamic, central scheduling (telescopes and Correlator) and pipelined imaging.



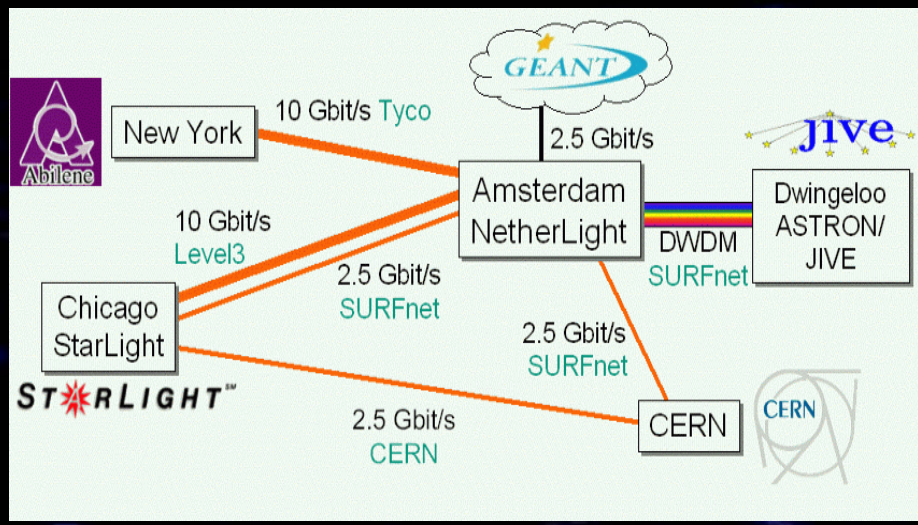
Current *e*-EVN Activity

- EVN is leading an *e*-VLBI proof-of-concept project with GÉANT and NRENs (e.g. SurfNET).
- The first real-time e-EVN image produced April 2004:

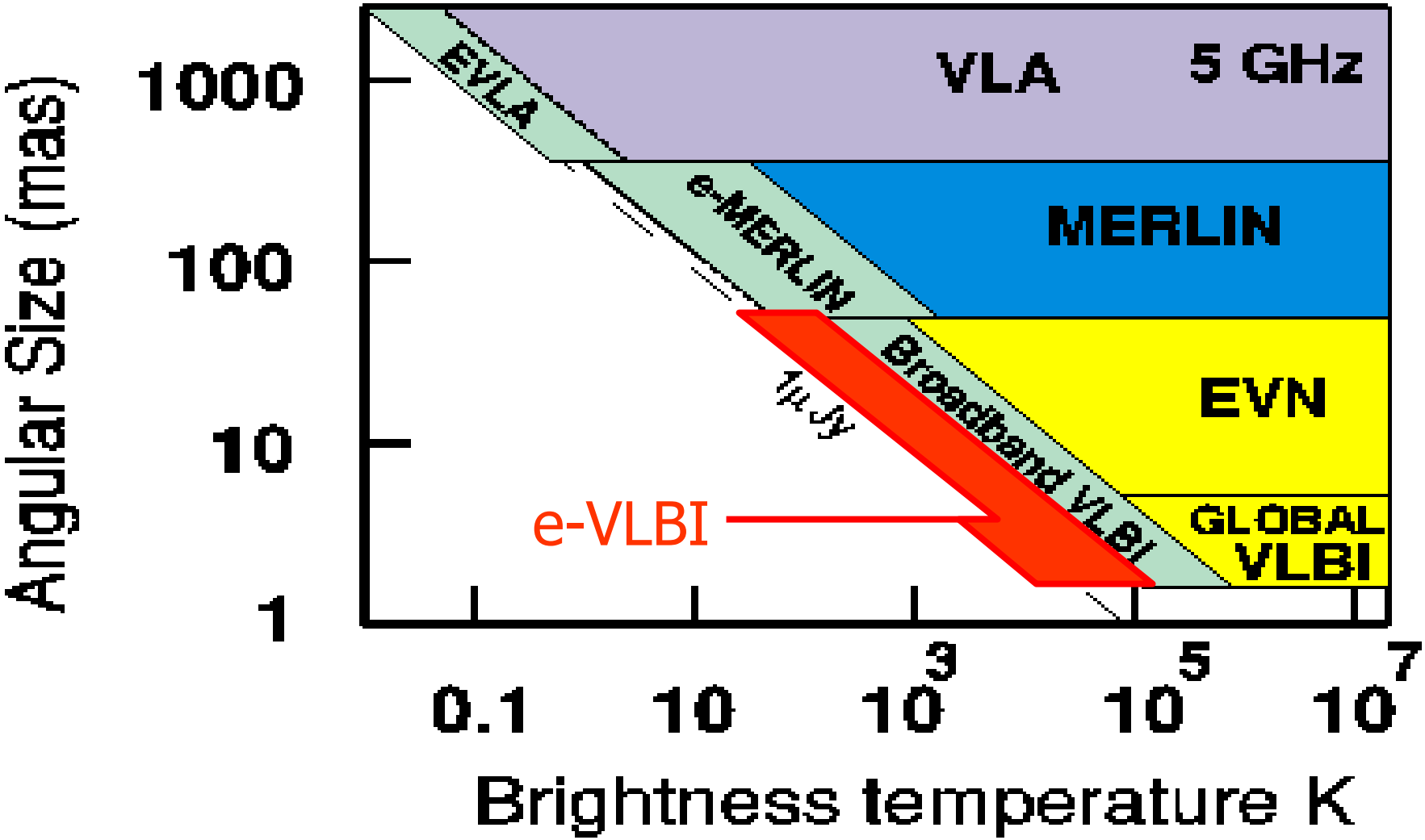




- Current network topology used for tests (right)
  - 340 Mbps recently achieved JIVE (NL) –Torun (PL).
- 6 EVN telescopes on-line by end of 2004,
- Successful transatlantic fringes Onsala (SE) - Westford (USA)
- Tests with worlds largest telescope Arecibo Sep. 2004?
- First Science PoC tests scheduled for later this month.



e-EVN and e-VLBI Science

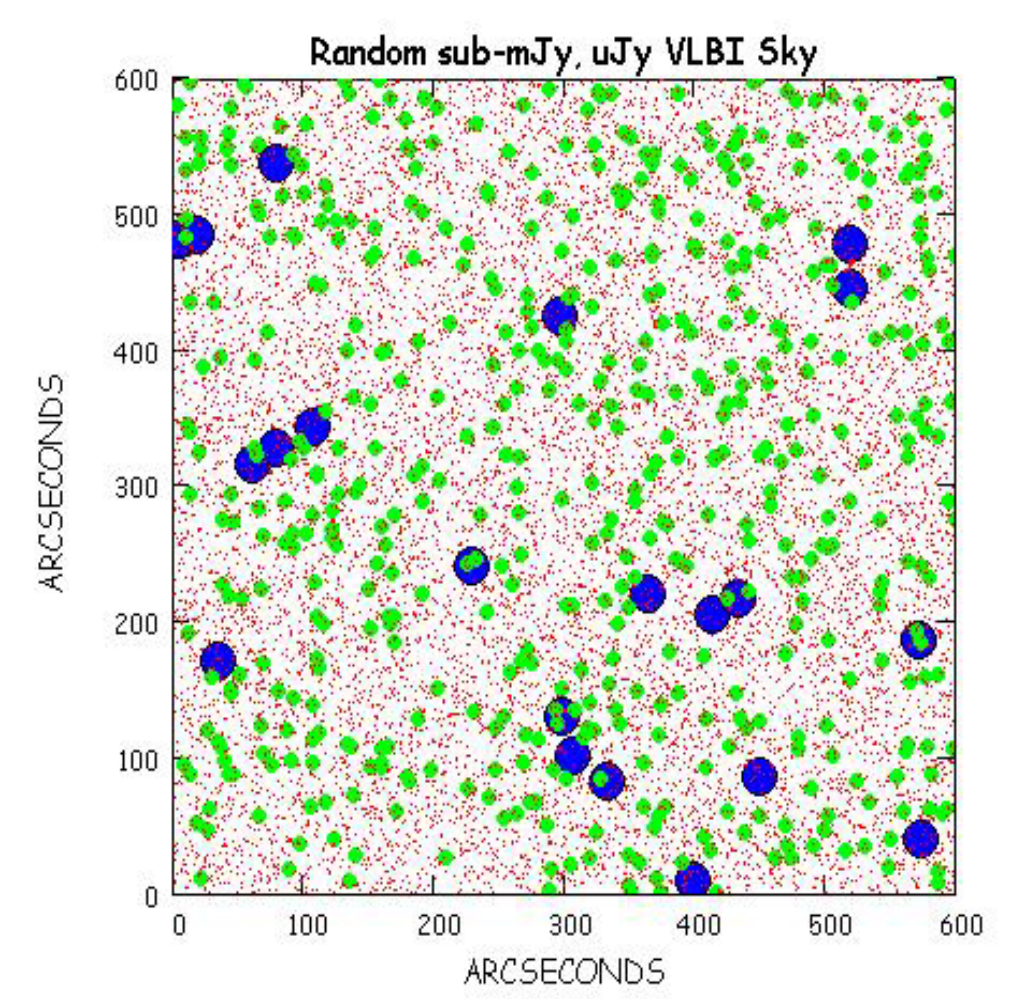


e-EVN Sky

- 10's of thousands of potential targets in e-EVN field-of-view…

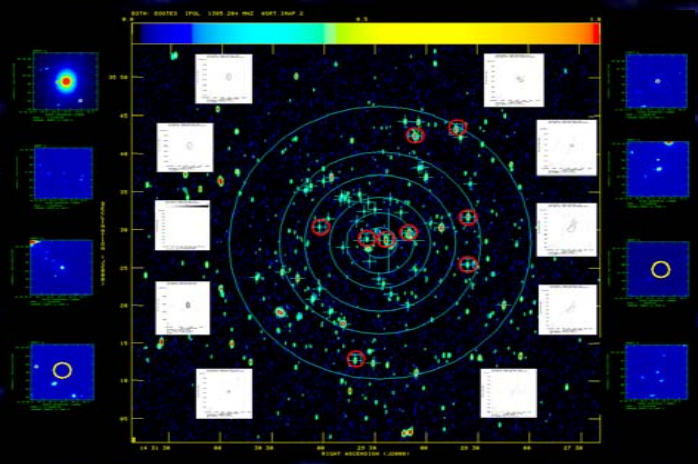
- On-going sub-mJy VLBI Deep Field studies suggest ~ 8% will be compact on milliarsecond scales.

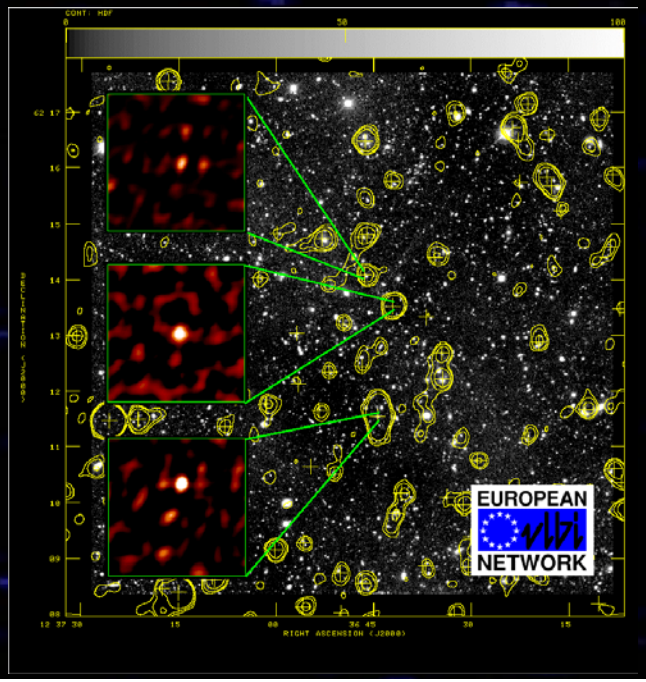
- Figure (right):
  - Blue = > 100uJy
  - Green = 10-100 uJy
  - Red = 1-10 uJy.



e-EVN Key Science Projects (1)

- Ultra-Deep Field VLBI Studies:
  - Combined e-MERLIN/e-EVN can probe the structure of starforming galaxies –locally and at high-z,
  - Establish a cosmic census of AGN & the accretion history of super-massive black holes,
  - Detection of high-z AGN unique to radio-waves and without MIR, optical, x-ray counterparts.

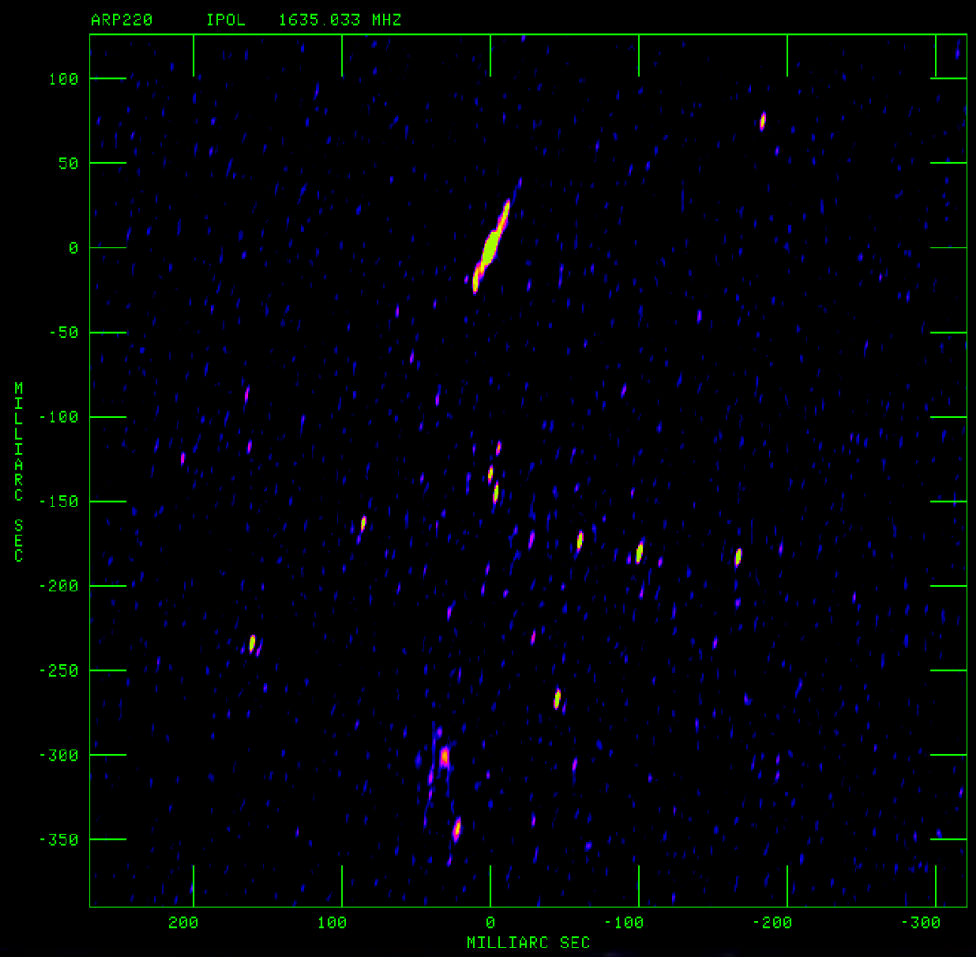




e-EVN Key Science Projects (2)

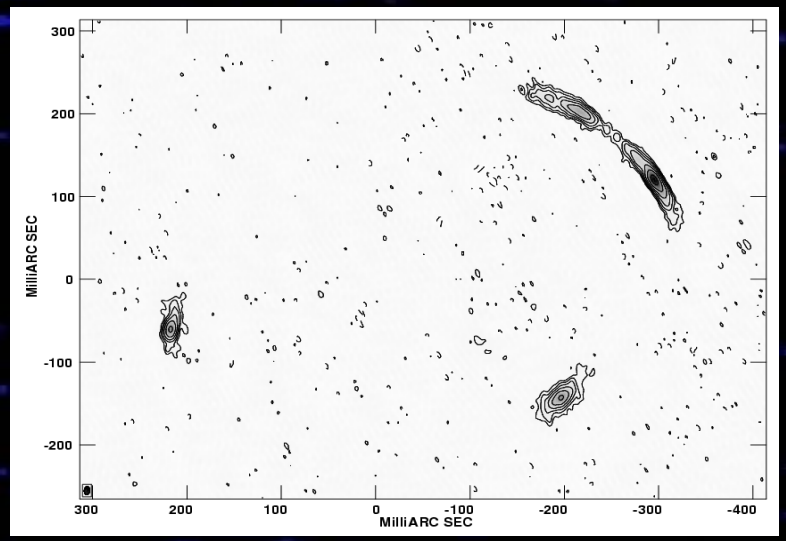
- *e*-EVN sensitivity will permit the detection of individual hypernovae in distant galaxies…
- Distinguish between Starburst and AGN activity in dusty SCUBA SMGs,
- Study the physics of GRB jet formation in nearby galaxies.

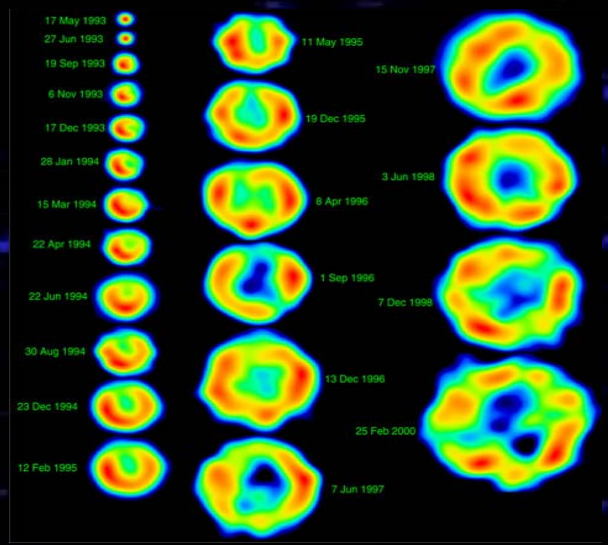
Supernovae in Arp 220



e-EVN Key Science Projects (3)

- Other Key Science Projects include:
  - Cosmology – gravitational lenses – constraining cosmological parameters.
  - Study the physics of GRB jet formation in nearby galaxies.
  - Imaging thermal jets and outflows in YSOs, Sne, SNR
  - Study of micro-quasars, relativistic jets and their local environment.





e-EVN Technical Challenges

- Other technological challenges:
  - Data Processing – new correlator required:
    - Software correlator ?
    - GRID-based solution feasible?
    - Purpose built ?
  - Correlator would produce many tens of Terrabytes per day…
  - Upgrade of EVN Telescope VLBI hardware to > 1Gbps (started in 2004 DBBC project).