AGN cores at extreme angular resolutions

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RadioAstron AGN survey team

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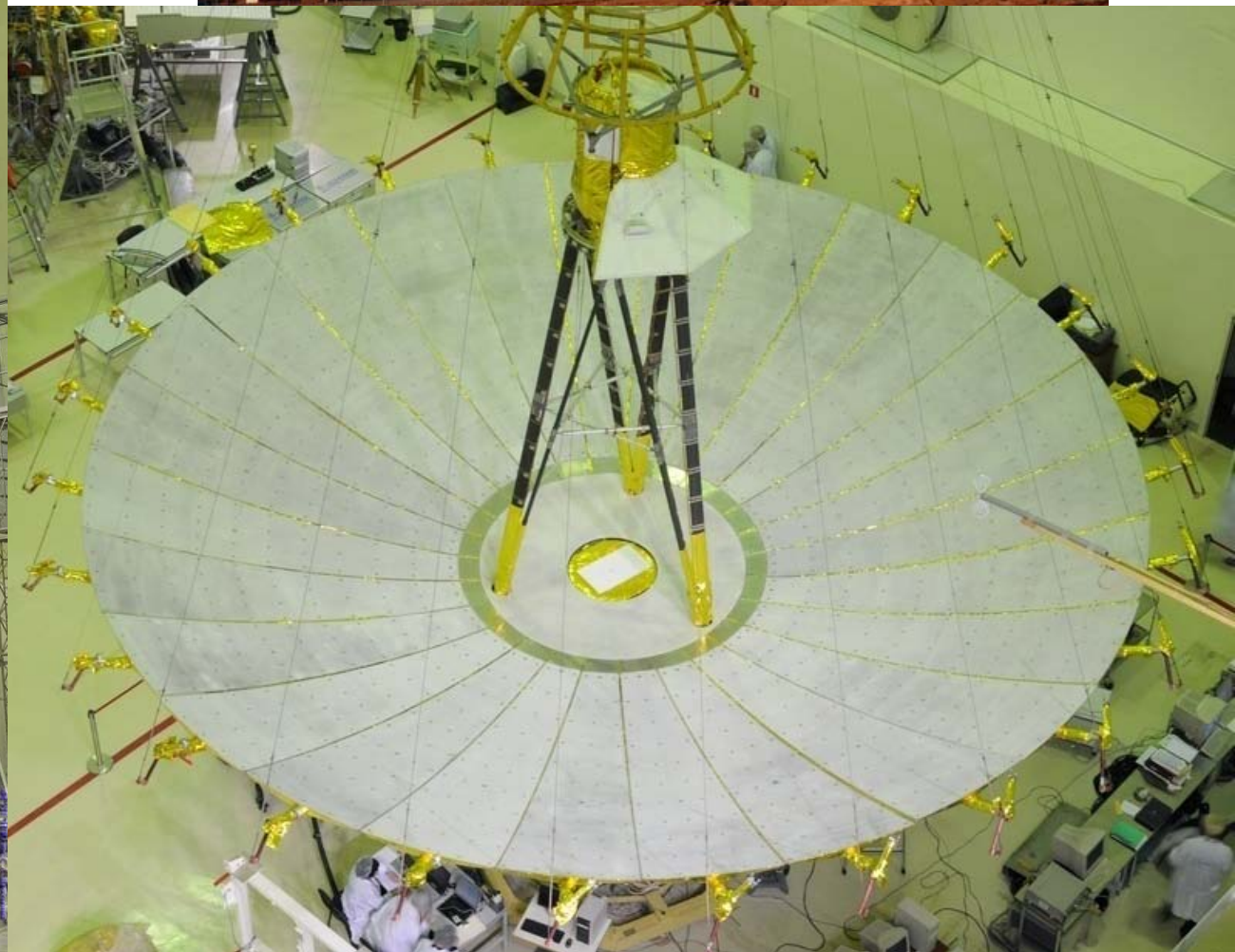
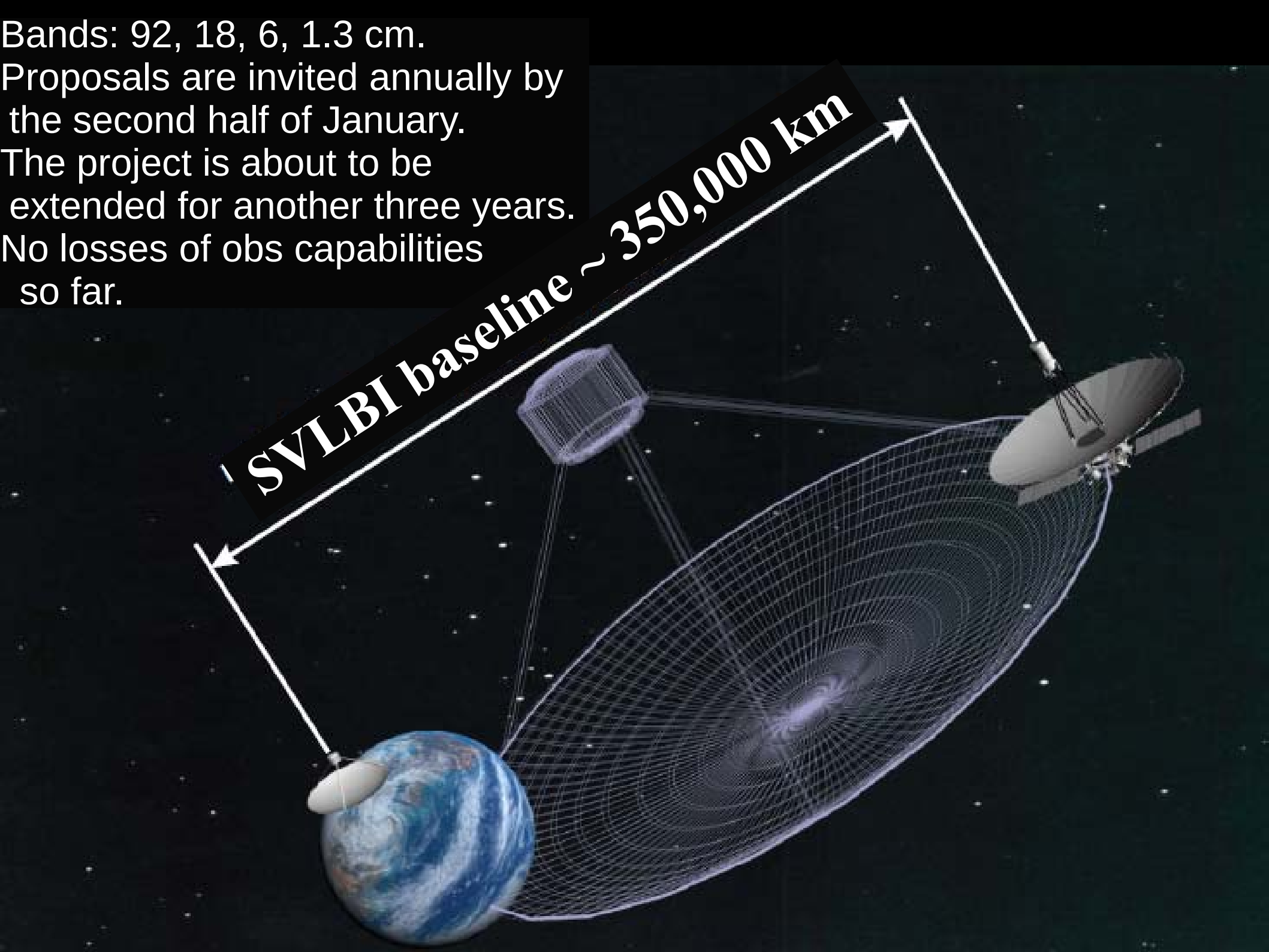
RadioAstron was launched in 2011



Bands: 92, 18, 6, 1.3 cm.
Proposals are invited annually by the second half of January.
The project is about to be extended for another three years.
No losses of obs capabilities so far.



RadioAstron AGN survey

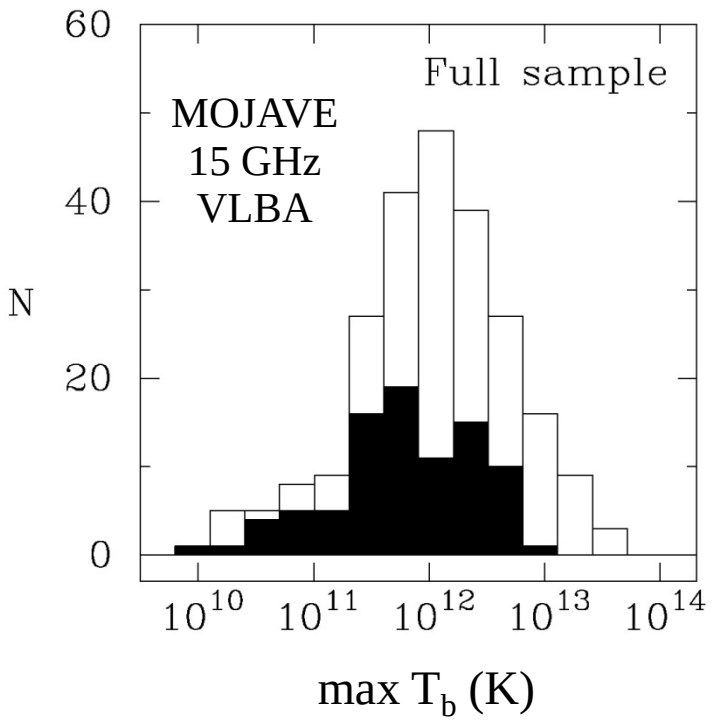
Main goal

The ultimate goal:

Study brightness temperature of AGN cores in order to better understand physics of their emission while taking ISS into consideration.

RadioAstron AGN survey

SVLBI core size, brightness temperature, beaming, ISM



Ground-based VLBI, 2 cm:
median $T_b = 10^{12}$ K,
maxTb (limit) $=5 \cdot 10^{13}$ K.
VSOP 6 cm results are similar.
The inverse-Compton limit of 10^{12} K is confirmed if Doppler boosting is involved.
We know from VLBI kinematics measurements (speed up to 40*c*) and correlations found that jet emission is indeed boosted.
But! Many lower limits on T_b… ISM…

Special role of RA:

Is there anything beyond 5 Earth diameters (ED)?

RadioAstron AGN survey: estimate correlated flux density, size, brightness temperature of most compact structure(s) in the AGN jet base. Test the IC limit boosted by Doppler. Overcome the Earth-based Tb limit. This can not be done by going to higher frequencies on the ground.
Critical to test emission mechanism. Introduce/support or “kill” exotic models.

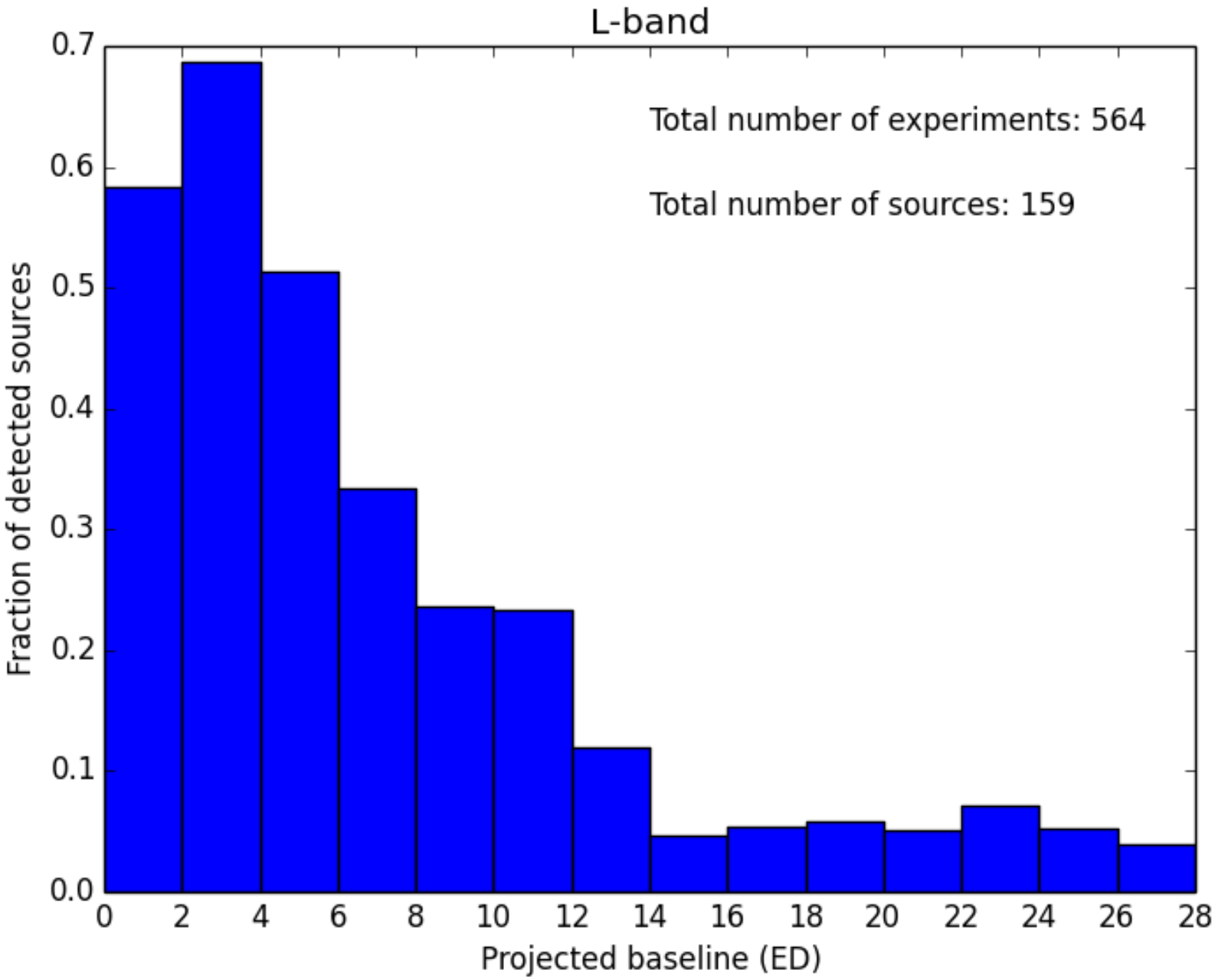
GRTs: SVLBI and IDV measurements

THANK YOU!

VLBI:
Kvazar network: Sv, Bd, Zc (Russia);
Kalyazin (Russia);
Evpatoriya (Ukraine);
Effelsberg (Germany);
WSRT (the Netherlands);
Torun (Poland);
Medicina, Noto, Sardinia (Italy);
Yebes, Robledo (Spain);
Jodrell Bank 1 & 2 (UK);
Usuda (Japan);
Shanghai 25 & 65, Urumqi (China);
VLA, GBT, Arecibo (USA);
HartRAO (South Africa);
LBA+Tid.

Single-dish:
RATAN-600 (Russia);
ATCA (Australia);
WSRT (the Netherlands);
Urumqi (China);
Effelsberg (Germany);
Oven Valley (USA);
GBT (USA).

Some detections statistics



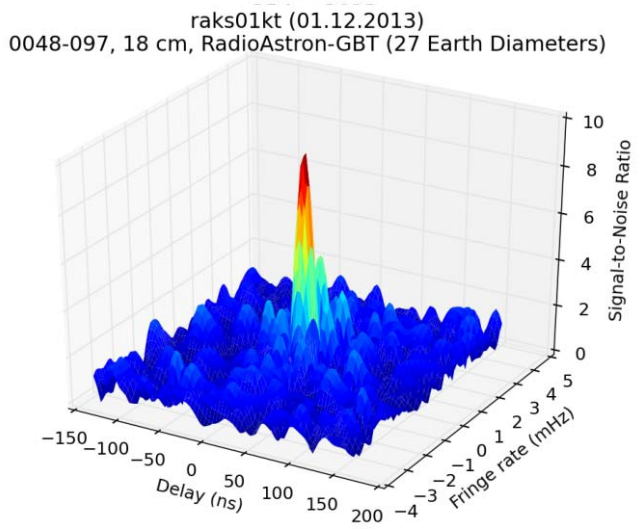
See more details in the poster by Voytsik et al.

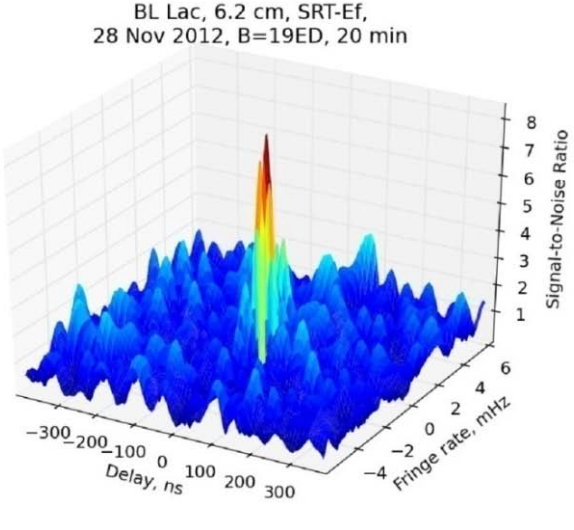
AGN survey: probing jet emission mechanism

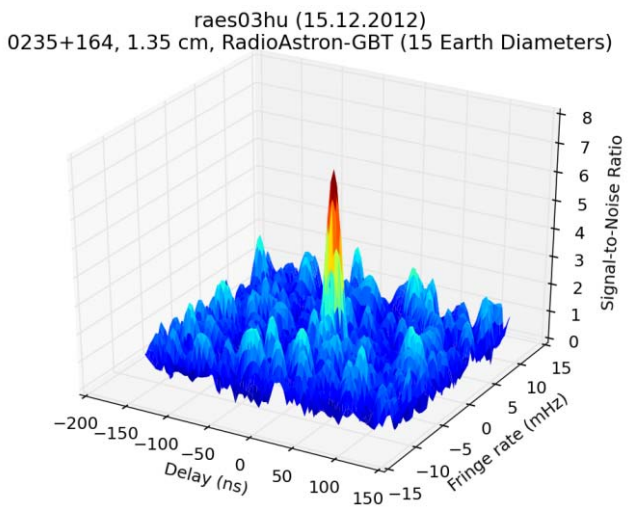
Records: 18 cm: 27 ED 0048-096 (RA-GBT) – 349,000 км;
6 cm: 23 ED 0716+714 (RA-Ef);
1.3 cm: 15 ED 0235+164 (RA-GBT).
The new record of formal angular resolution: 14.5 μas.

Correlated and post-processed to date about 900 segments, significant detections are found for about 80 AGNs in ⅓ of them.
Typical T_b so far are in the range 10^{12} to $\geq 10^{14}$ K.

See more details in the poster by Voytsik et al.







How to generate very high brightness temperature?

- Very high Doppler boosting δ~100 (for equipartition δ~1000 is required), but the 40*c*-max apparent VLBI kinematics does not support it directly.
  In the same time, it clear that Doppler factor *related* to measured VLBI speeds is critical for radio–γ-ray correlations (Lister et al. 2009, Savolainen et al. 2010) and RadioAstron detections.

- Heavy particles – requires very efficient acceleration and very high magnetic field.
- Coherent processes – requires very high magnetic field.
- Continuous re-acceleration in the jet at ~10 pc from the nucleus.
- Unusual core geometry or electron energy distribution.

Summary

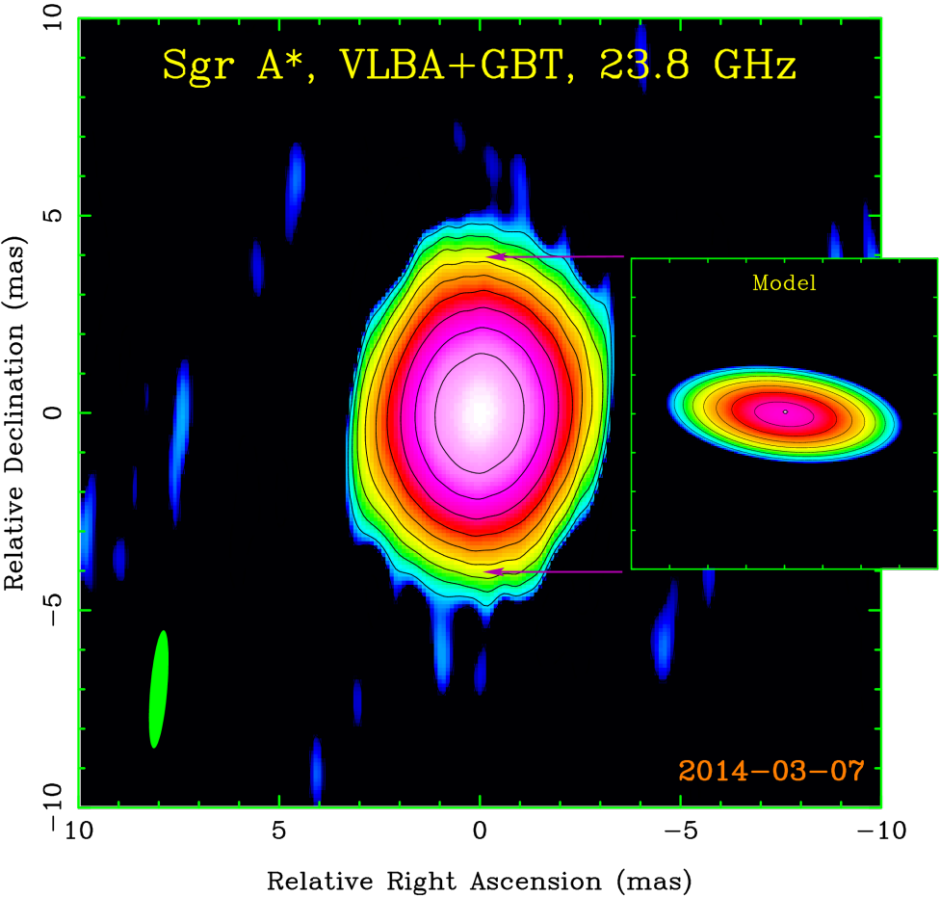
- AGN cores are bright and compact enough to produce positive detections for an interferometer up to at least the Earth-to-Moon distance and up to at least 14.5 μas fringe spacing.

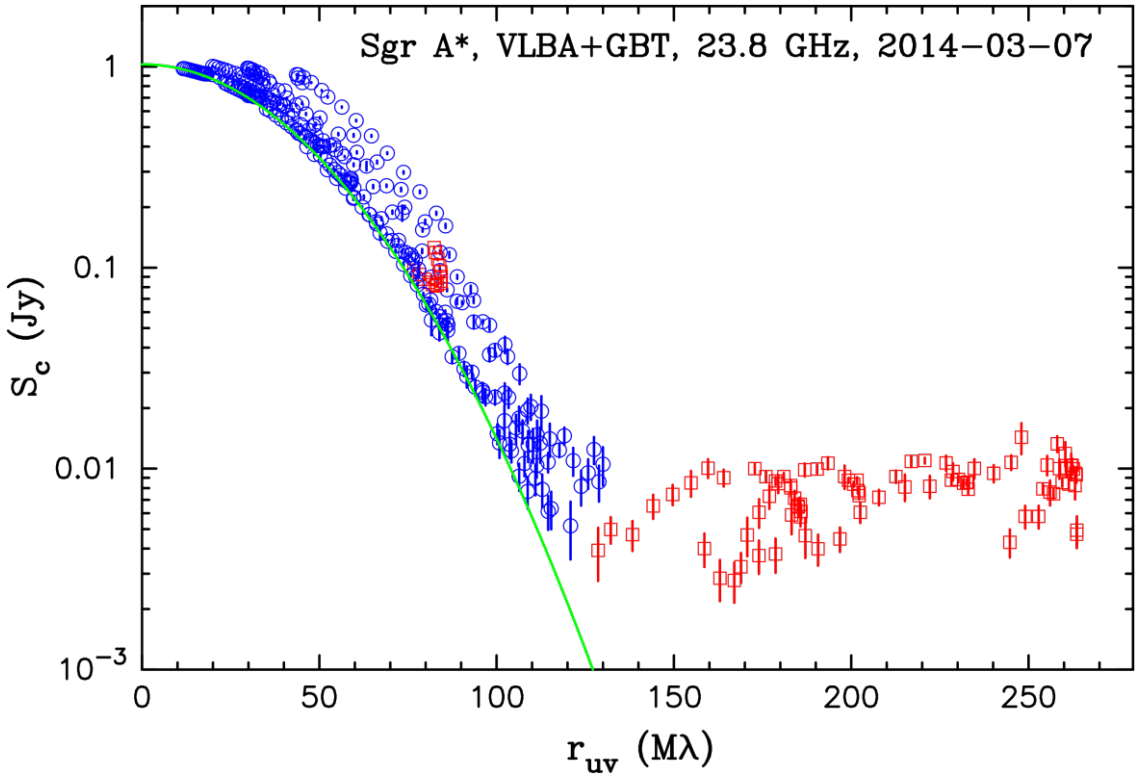
- A typical brightness temperature of AGN cores is found in the RadioAstron survey so far between 10^{12} and 10^{14} K. Requires very high Doppler boosting or other uneasy explanations.

- To do: ISM (RA pulsar talks, SgrA* case by Gwinn et al. 2014).

Thank you

SgrA*: Discovery of a substructure in the scattering disc





Gwinn, Kovalev, Johnson, & Soglasnov (ApJL, 2014)