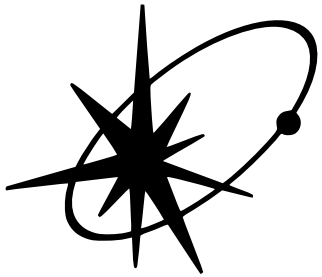
Apparent frequency dependence shift of ultra-compact AGN cores

Petr Voytsik
Astro Space Center of Lebedev Physical Institute



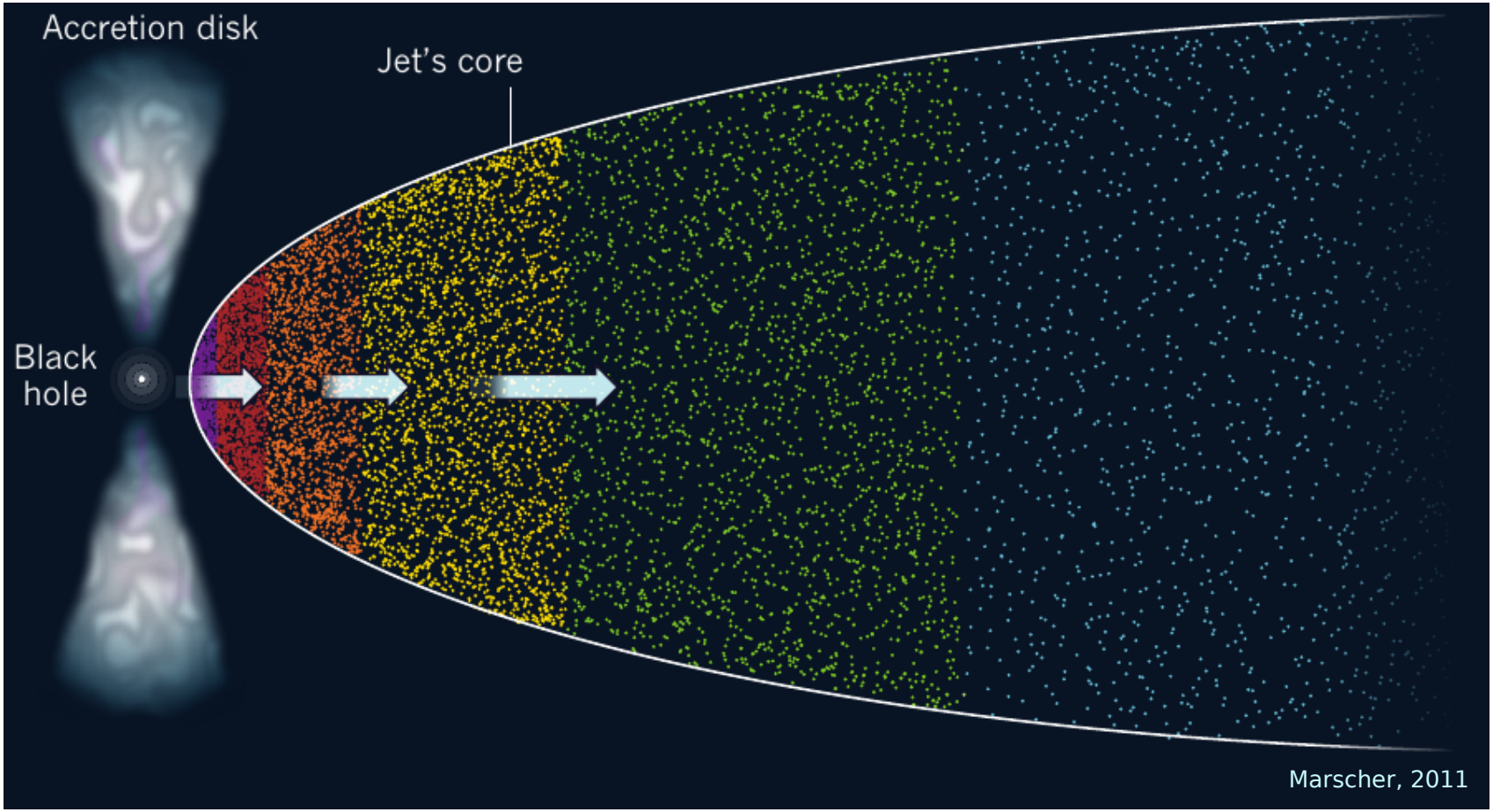
43rd Young European Radio Astronomers Conference
Bielefeld University

2 October 2013

Outline

- Introduction
  - What is the VLBI cores?
  - The «core shift» effect
- Observations
- Data reduction
- Results and plans

Relativistic jet



VLBI core is the most compact feature near the apparent base of the jet

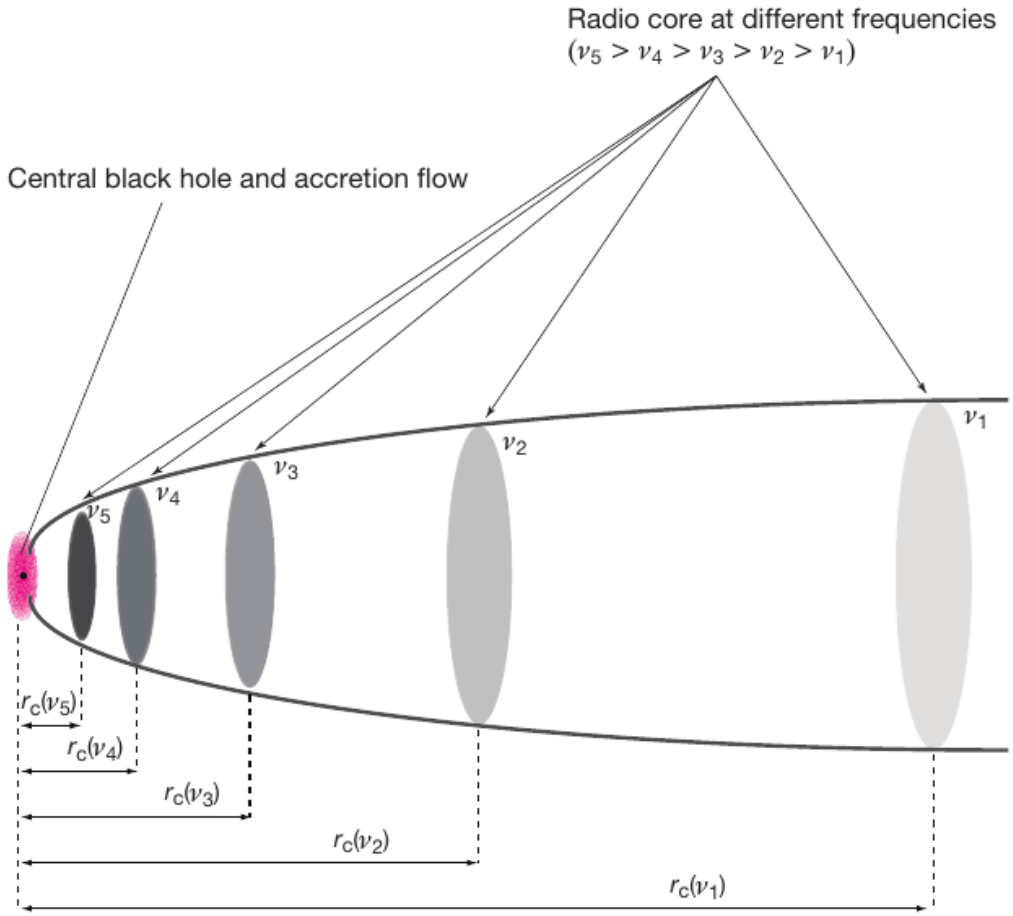
Core shift effect

At any given observing frequency ν, the core is located in the jet region with the optical depth $\tau(\nu) \approx 1$

Blandford & Königl

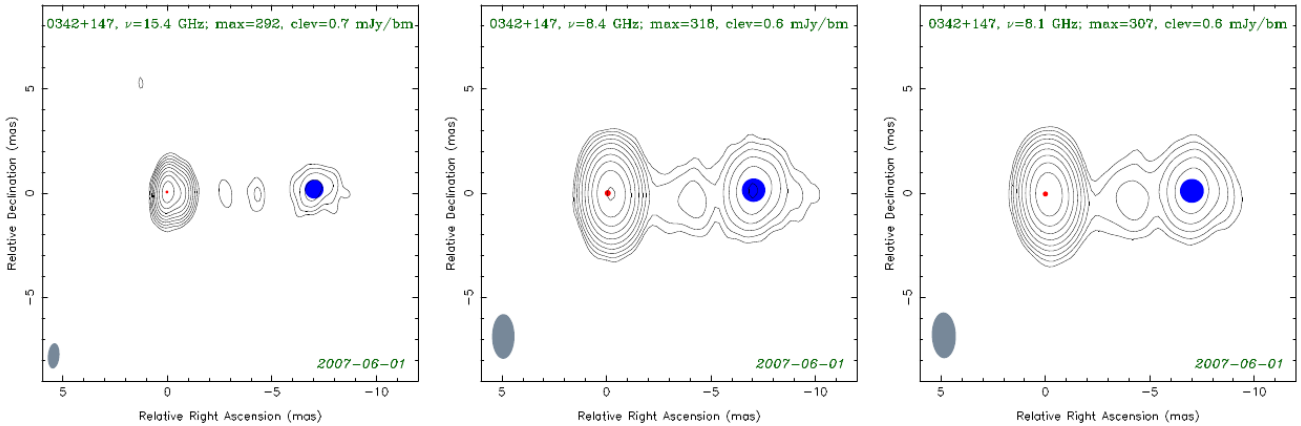
$$r_c \propto \nu^{-1/k_r}$$

If the core is self-absorbed and in equipartition, $k_r = 1$
k_r can be larger in the presence of external absorption or pressure/density gradient in the flow



Methods of the core shift measurement

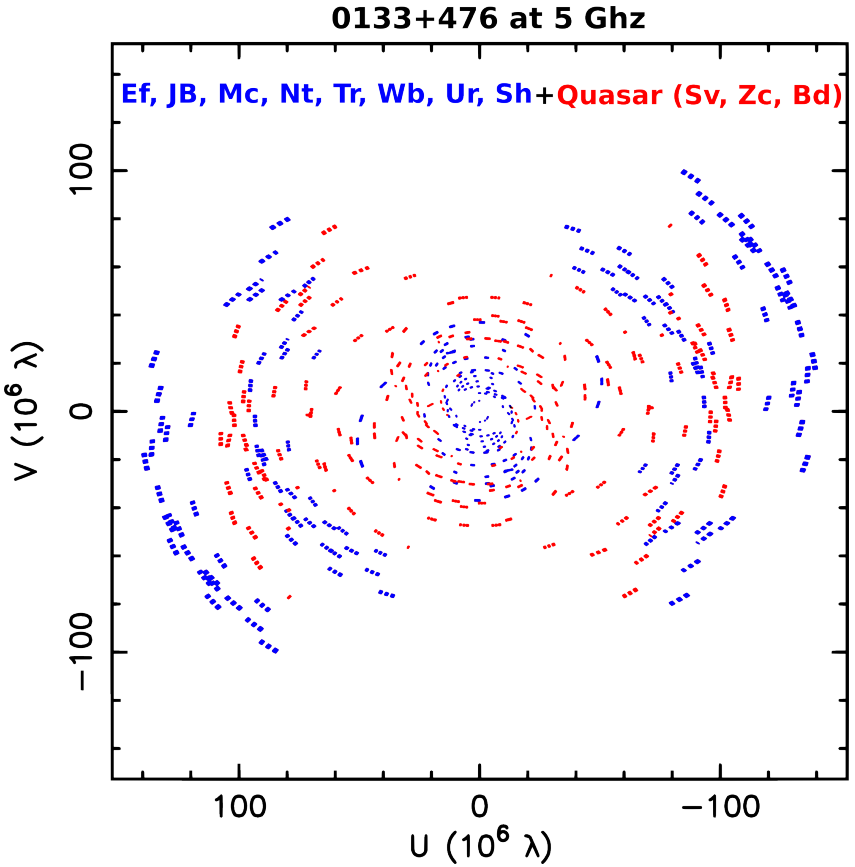
- Core position relative to the optically thin component.



- Cross-correlation method
- **Relative astrometry** is the only tool in case of highly compact objects with weak or no jets.

Observations
Phase-referencing VLBI

- European VLBI network
- This experiment was the first involving three 32-m stations of the Russian VLBI network QUASAR in EVN
- Four frequencies: 1.4, 2.4, 5, and 8.4 GHz to determine the value of k_r
- Observations took place in October 2008 and consisted of three segments:
  - EK028A (19-20 Oct): S/X band
  - EK028B (22-23 Oct): C band
  - EK028C (29-30 Oct): L band



UV-coverage for source 0133+476 at C-band

Source selection

We selected objects that:

a) are *defining* ICRF sources

b) are highly core dominant

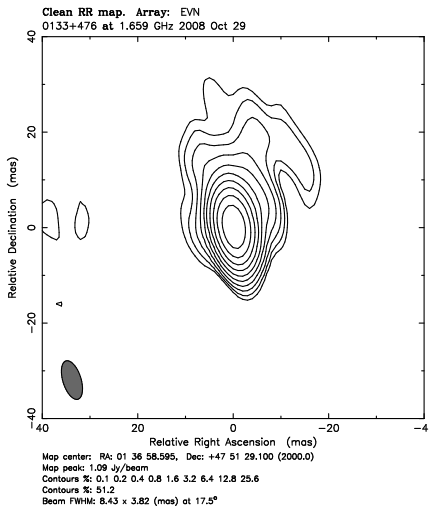
c) have VLBI flux densities at 8 GHz greater than 1.2 Jy

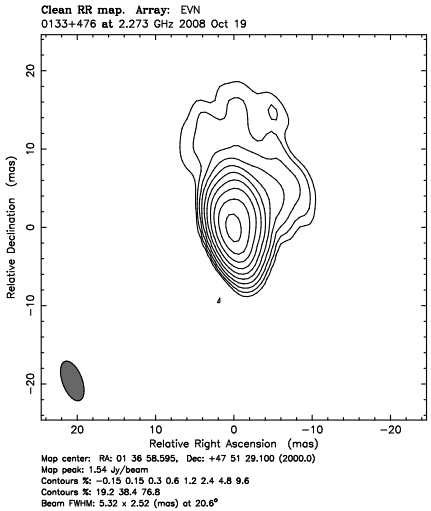
8 target sources were observed. For each target source 2 phase calibrators were selected

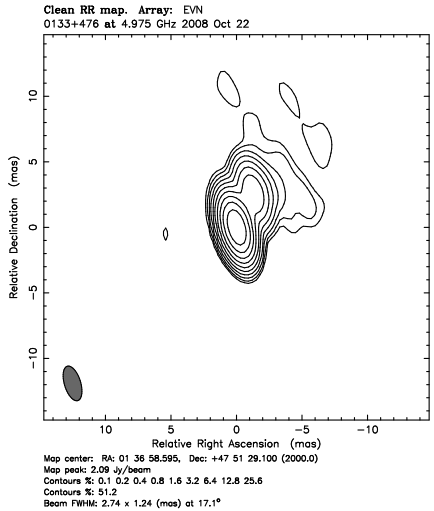
Data reduction

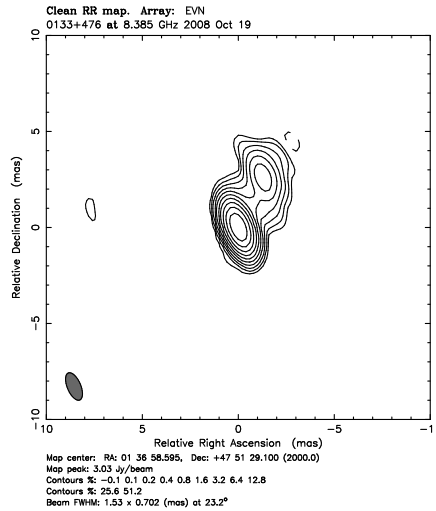
- Standard VLBI data processing in AIPS (Astronomical Image Processing System) including:
  - Amplitude calibration with measured antenna gains and system temperatures
  - Phase (self-)calibration (global fringe fitting)
  - Complex bandpass corrections
- Hybrid mapping and self-calibration in Difmap

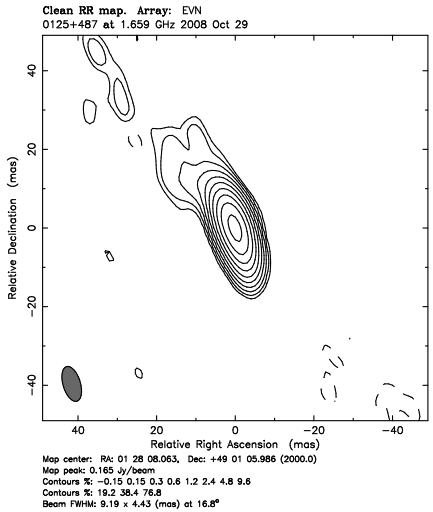
Preliminary results
Naturally weighted CLEAN images

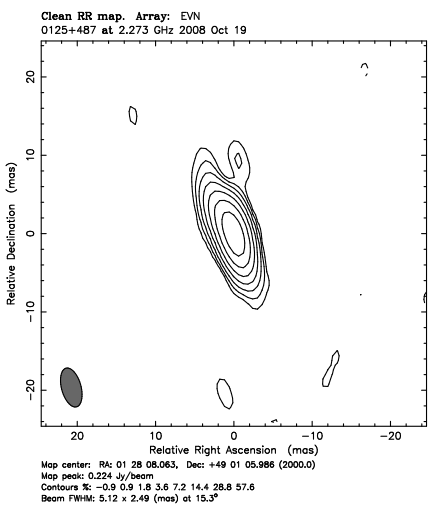


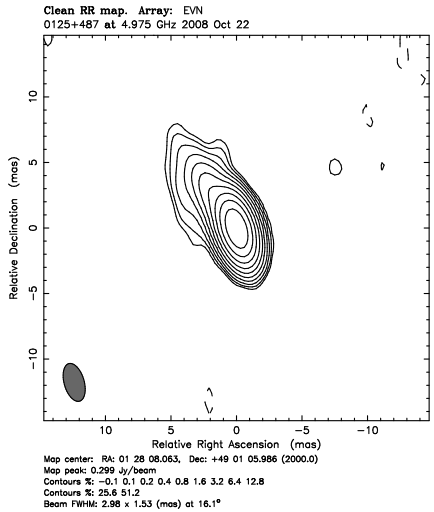


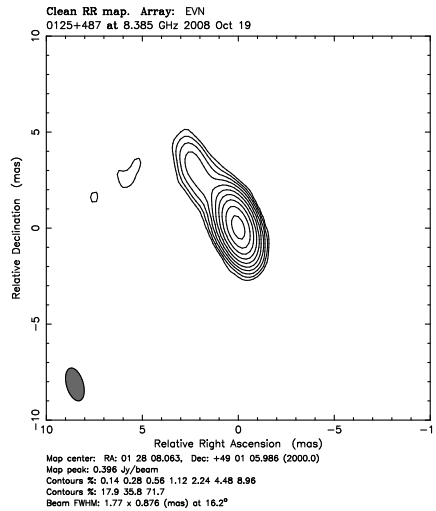












Results and plans

The following is being achived to date:

- Standard initial data processing in AIPS involving a priori amplitude calibration with measured antenna gain curves and system temperatures, global fringe fitting, and complex bandpass corrections for all four frequency bands.
- Hybrid mapping including amplitude and phase self-calibration in Difmap to obtain CLEAN models of the sources for all four frequency bands.

Next steps to be done:

- Image alignment using the source triangles: one target plus two calibrators.
- Core modeling to determine positions of the cores.
- Estimation of the core-shift and its analysis.