A repeating fast radio burst source localized to a nearby spiral galaxy

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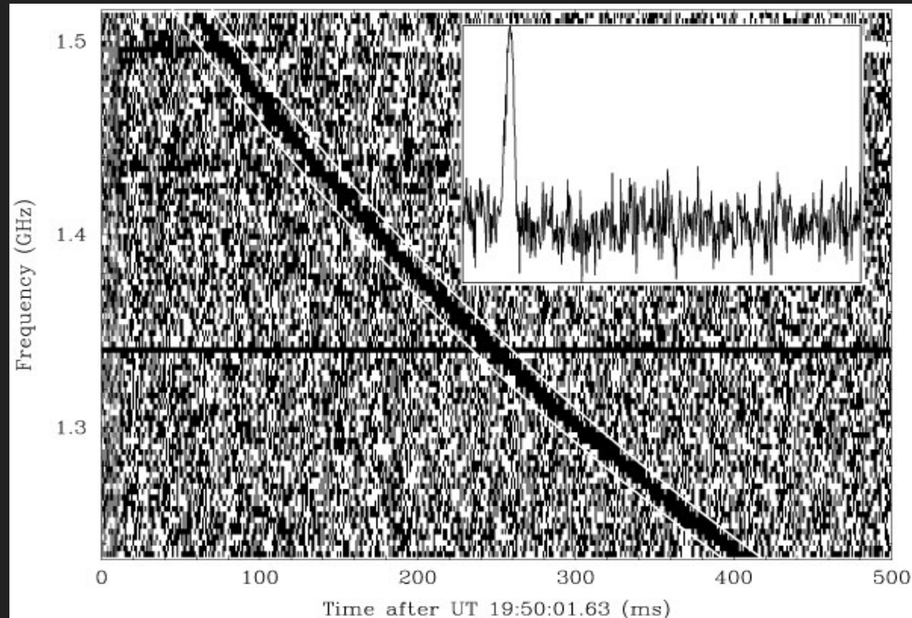
What is a fast radio burst?

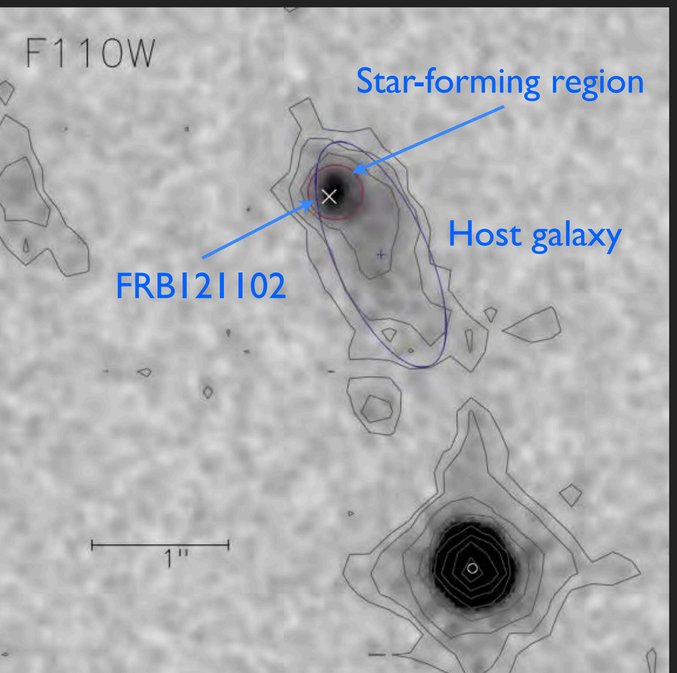
- First FRB discovered in 2007 (Lorimer et al.).
- Short flash of radio light.
- Lasts only for a few milliseconds.
- One FRB happens every ~10 seconds.
- Come from galaxies far-far away.
- Same energy as the Sun emits in one day.
- Some FRBs repeat. Do all?

- **Unknown origin**.



Precise localization is key to unveiling the origin of FRBs

Only four FRBs precisely localized to date.



Repeating FRB

Dwarf Galaxy

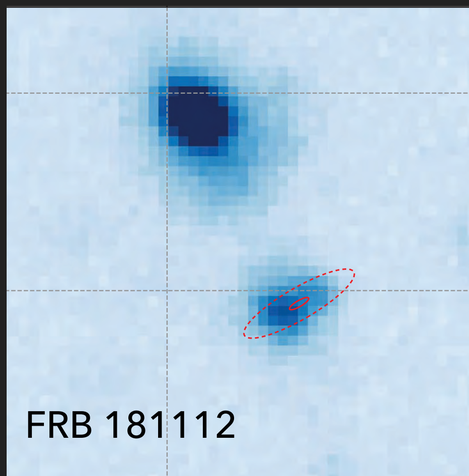
High star formation

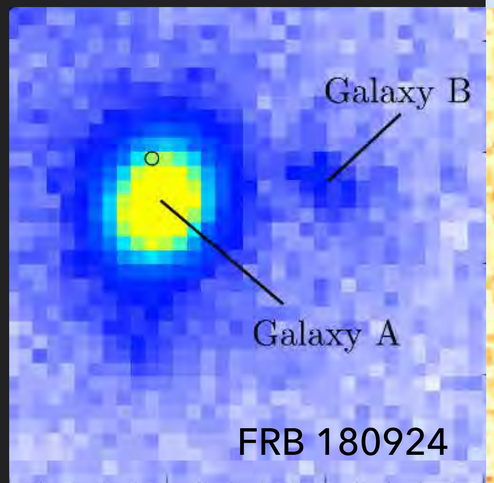
Enigmatic persistent source

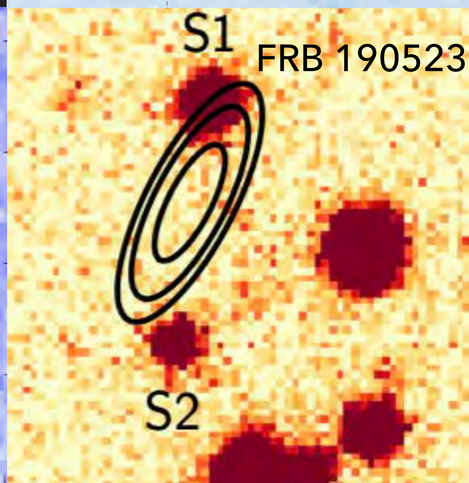
Non-Repeating FRBs

Massive Galaxies

No (or little) star formation







FRB 180916.J0158+65

- World's best FRB finding machine, the **CHIME telescope** (Canada), discovered eight new repeating FRBs (CHIME Coll. et al. 2019).

- FRB 180916.J0158+65 was consistent with being a nearby source or even within the Milky Way.

- CHIME localization insufficient to identify a specific host galaxy.

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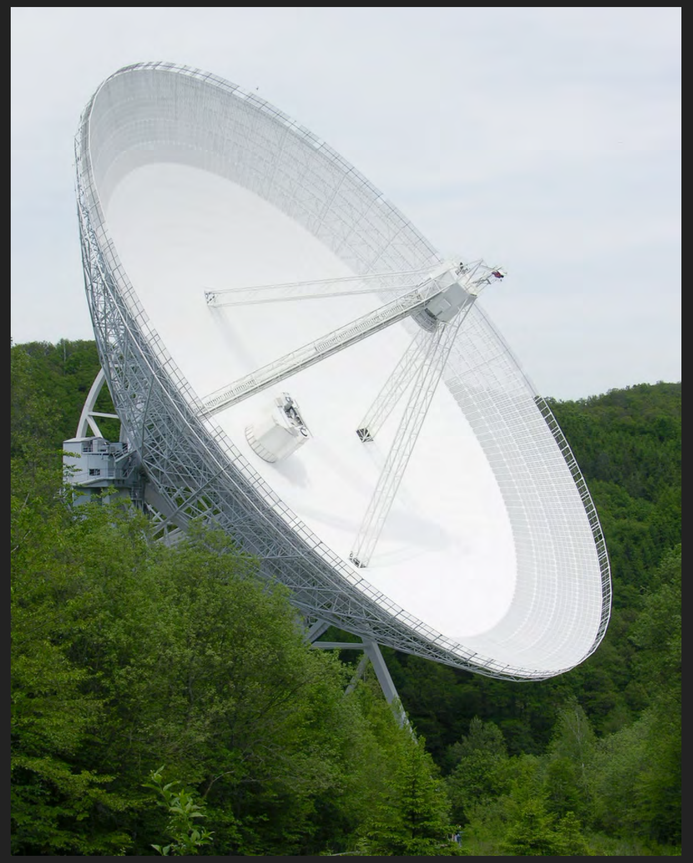
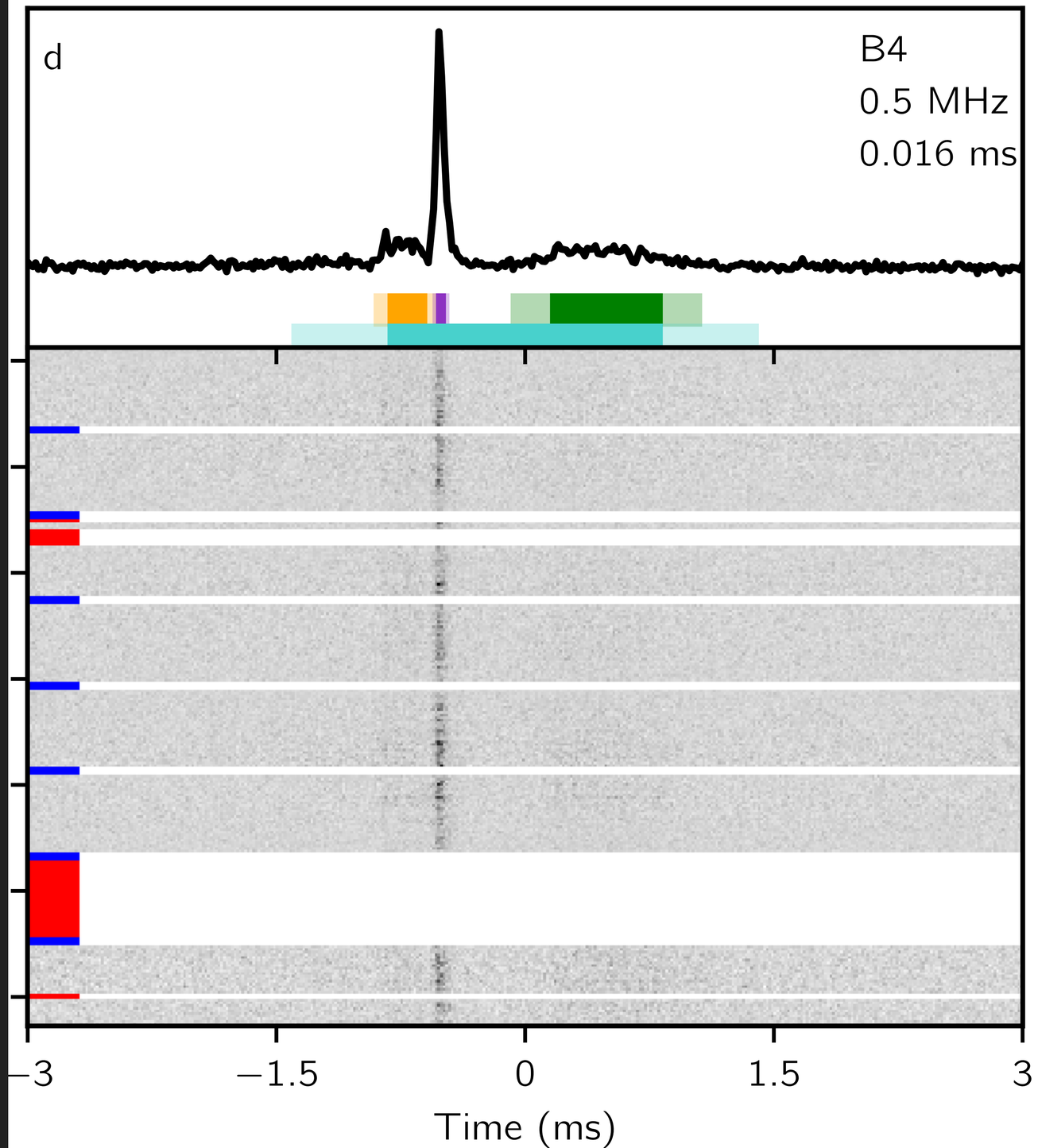
Image by Paul Boven (boven@jive.eu). Satellite image: Blue Marble Next Generation, courtesy of Nasa Visible Earth (visibleearth.nasa.gov).

Finding bursts from FRB 180916.J0158+65

- The100-m Effelsberg Telescope (Germany) was used to search for bursts.
- Four bursts were found.





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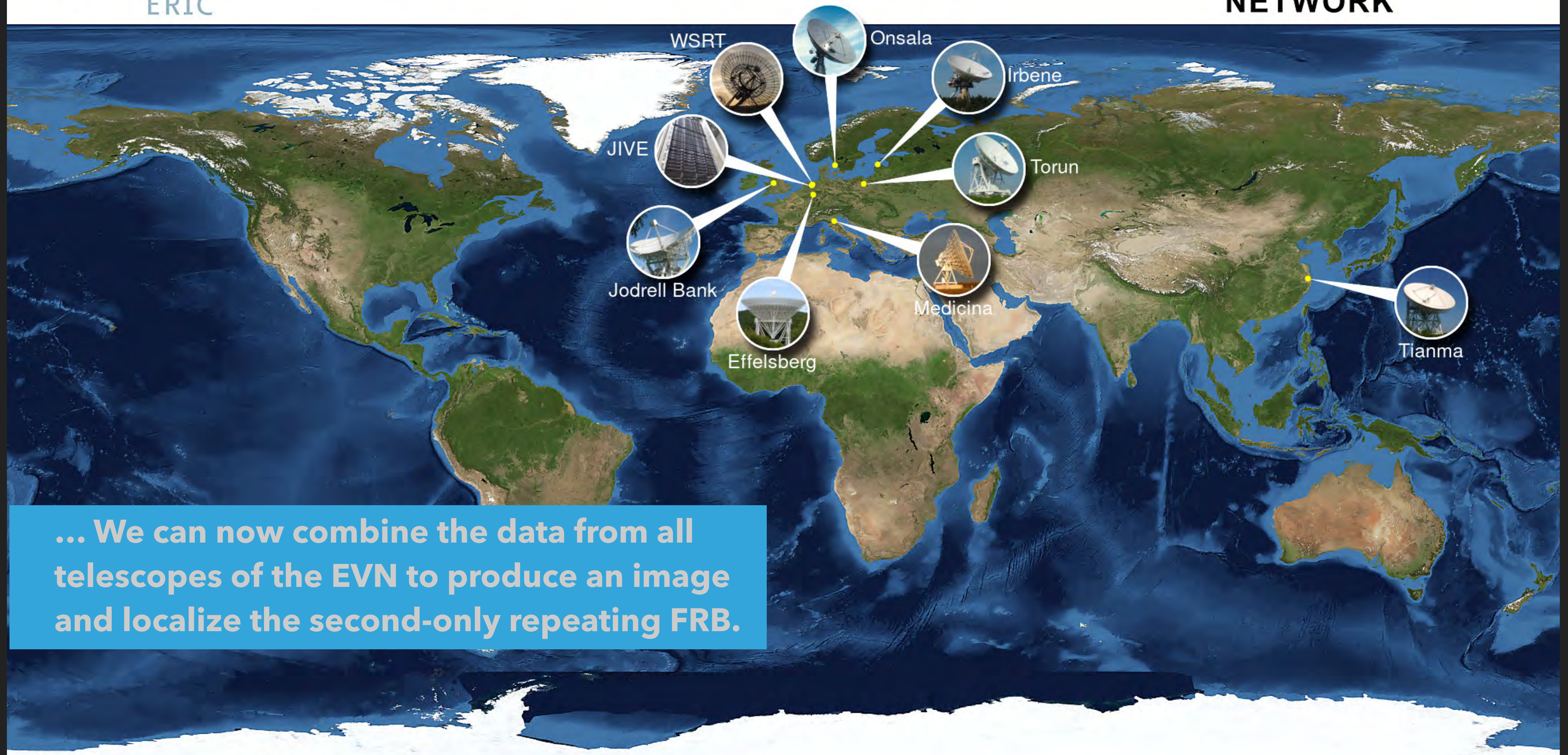
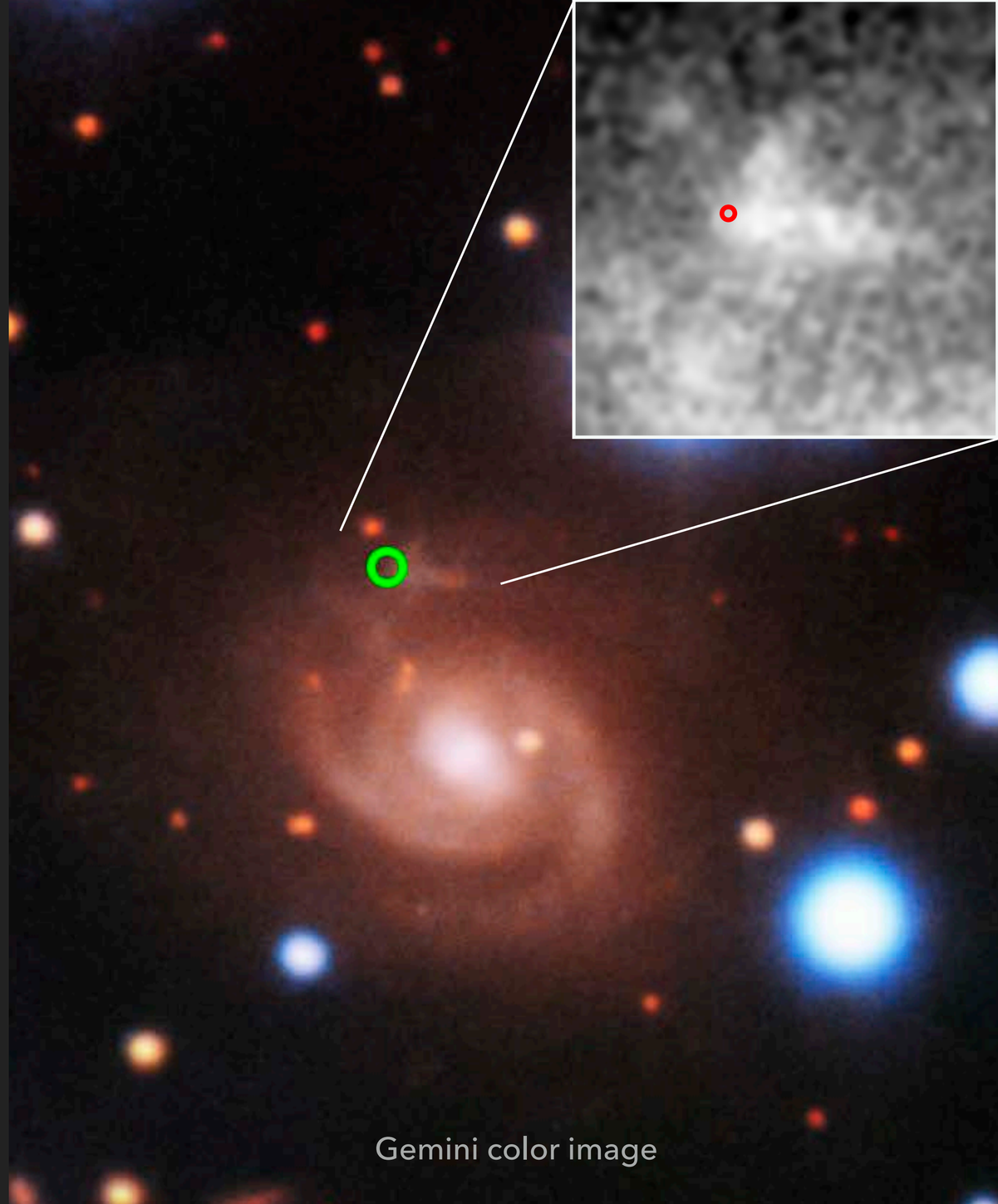


... We can now combine the data from all telescopes of the EVN to produce an image and localize the second-only repeating FRB.

Image by Paul Boven (boven@jive.eu). Satellite image: Blue Marble Next Generation, courtesy of Nasa Visible Earth (visibleearth.nasa.gov).

Localizing FRB 180916.J0158+65

- Using the **EVN** we precisely localized the four bursts.
- Optical follow-up observations with the **Gemini North** Telescope (Hawaii).
- Spiral galaxy at ~149 Mpc (500 million light years).
- FRB localized to a 4-light-year region in the galaxy, inside a star-forming region.



Gemini color image

Take home messages

- Second repeating FRB precisely localized.
- By far the closest FRB localized to date.
- FRBs can be found in Milky Way type galaxies.
- Host and local environment are different compared to the four previously localized FRBs.
- Can a single model incorporate this diversity - or are we seeing that multiple types of sources can produce fast radio bursts?

- Paper: Marcote, Nimmo, Hessels, et al. (Nature, 2020) https://doi.org/10.1038/s41586-019-1866-z

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