

## LOTAAS team

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# First Batch of Discoveries from the LOFAR High-Time-Resolution LOTAAS Survey

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## LOTAAS: survey for radio pulsars and fast transients

- **LOFAR**: Next generation radio telescope
- **Tied-Array**: Beam-forming mode
- **All-Sky**: The entire Northern Hemisphere will be mapped

### Scientific goals

- Complete census of local population of pulsars  
Neutron-star Galactic population and supernova rate
- Discovery of exotic pulsar systems  
Testing GR, physics of dense matter and pulsar emission mechanism
- Discovery of pulsars well-suited for timing arrays  
GW detection
- **Characterization of the low-frequency transient sky**  
Discovery of RRATs, FRBs, intermittent pulsars and new transient phenomena

## Fast Radio Bursts [Lorimer et al. 2006]

### Non-repeating extragalactic radio bursts

#### Possible uses:

- “Missing baryons” weight
- Dark energy equation of state
- Intergalactic medium
- Intergalactic magnetic field

LOTAAS can detect 1 FRB / 10hrs

- Long dwelling time
- Large FoV

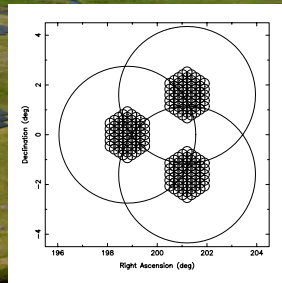
LOTAAS sensitivity  $\sim$  5 times LOFAR FRB limits in literature

## LOTAAS survey

- $t_{obs} = 1$  hour
- $Res = 0.5$  ms
- $\nu_{obs} \sim 120 - 150$  MHz
- 3 incoherent beams:
  - Total FoV  $\sim 60$  sq deg
  - Single-beam Fov  $\sim 5$  deg
- $3 \times 61$  coherent beams:
  - $\sim 3.5$  times higher sensitivity
  - Total FoV  $\sim 10$  sq deg
  - Single-beam Fov  $\sim 0.5$  deg
- Beams nyquist sampled

$\sim 4$  TB/hour

[www.astron.nl/lotaas](http://www.astron.nl/lotaas)







LOFAR Superterp  
- Signal acquisition

Cobalt  
- Beam forming



Cartesius  
- Data processing



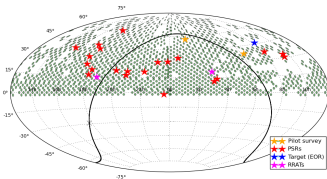
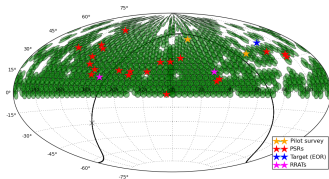
## LOTAAS survey

- $\sim 25\%$  observed and  $\sim 20\%$  processed (Sep 1st)
- 26 new pulsars discovered (1 every 16hrs!)
- Expected  $\sim 200$  new pulsars in total

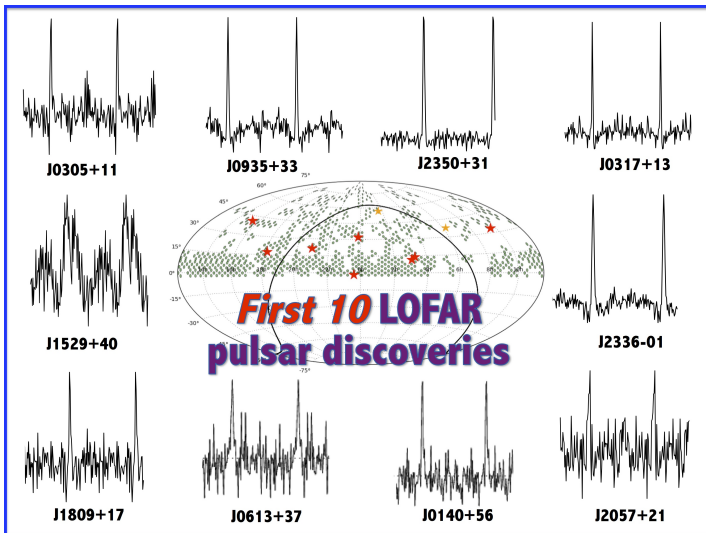
First pulsars discovered with a next-generation telescope!

Already the most successful timing very-low-frequency survey since 70s

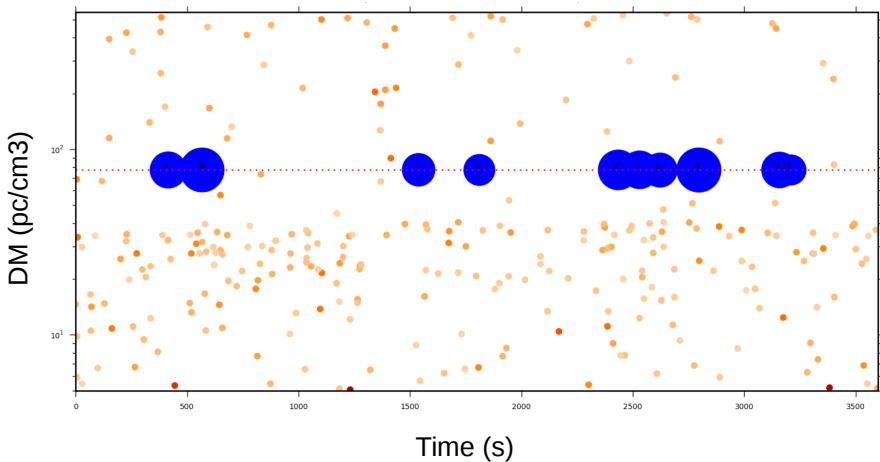
Essential precursor for SKA-low



Periodicity search: 24 new regular pulsars discovered  
(among the nearest and lowest luminosity pulsars known)



## Single-pulse search: 2 RRATs discovered



## Pipeline Version 2.0

- Acceleration search (for binary pulsars)
- Improved data digital processing
- Refined candidate selection scheme
- Drastically improved single-pulse
  - Better discrimination of astrophysical events
  - New selection algorithms for candidates

## FRBs search:

If Kolmogorov spectrum:

$$\tau_s(1.4\text{GHz}) \sim 1\text{ms}$$



$$\tau_s(135\text{MHz}) \sim 30\text{s}$$

Lowering time resolution of timing analysis

Never done before, challenging for RFI and system stability

# DRAGNET



# DRAGNET

GPU cluster for high-speed analysis  
Backend system connected to COBALT

- Real time searching for Fast Transients
- Simultaneous observation and timing of pulsars
- Off-line search for millisecond pulsars
- Expansion of LOTAAS characteristics (e.g. time resolution)



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**Sotiris' poster!**

