ASTRON

Netherlands Institute for Radio Astronomy

The Apertif Survey Program

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HI absorption 2017

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European Research Council
Established by the European Commission

kapteyn astronomical institute

NWO

university of groningen

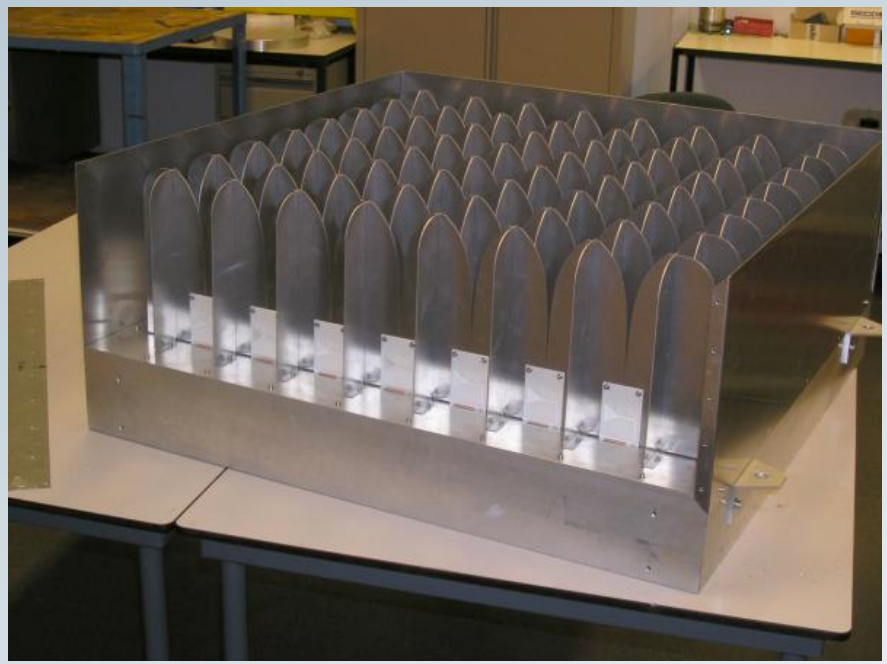
Apertif key points

- A new phased-array feed system for WSRT, greatly increasing field of view and survey speed
- Two imaging surveys: shallow northern sky and medium deep
  - Survey footprints designed to maximize multiwavelength coverage
- Pulsar and transients survey (ARTS)
- Survey commissioning next year with limited Apertif system; surveys start mid-year
- Surveys are managed by Apertif Survey Team

Outline

Apertif:
a phased-array feed for WSRT

- Fill the focal plane with dipole elements and combine to form compound beams



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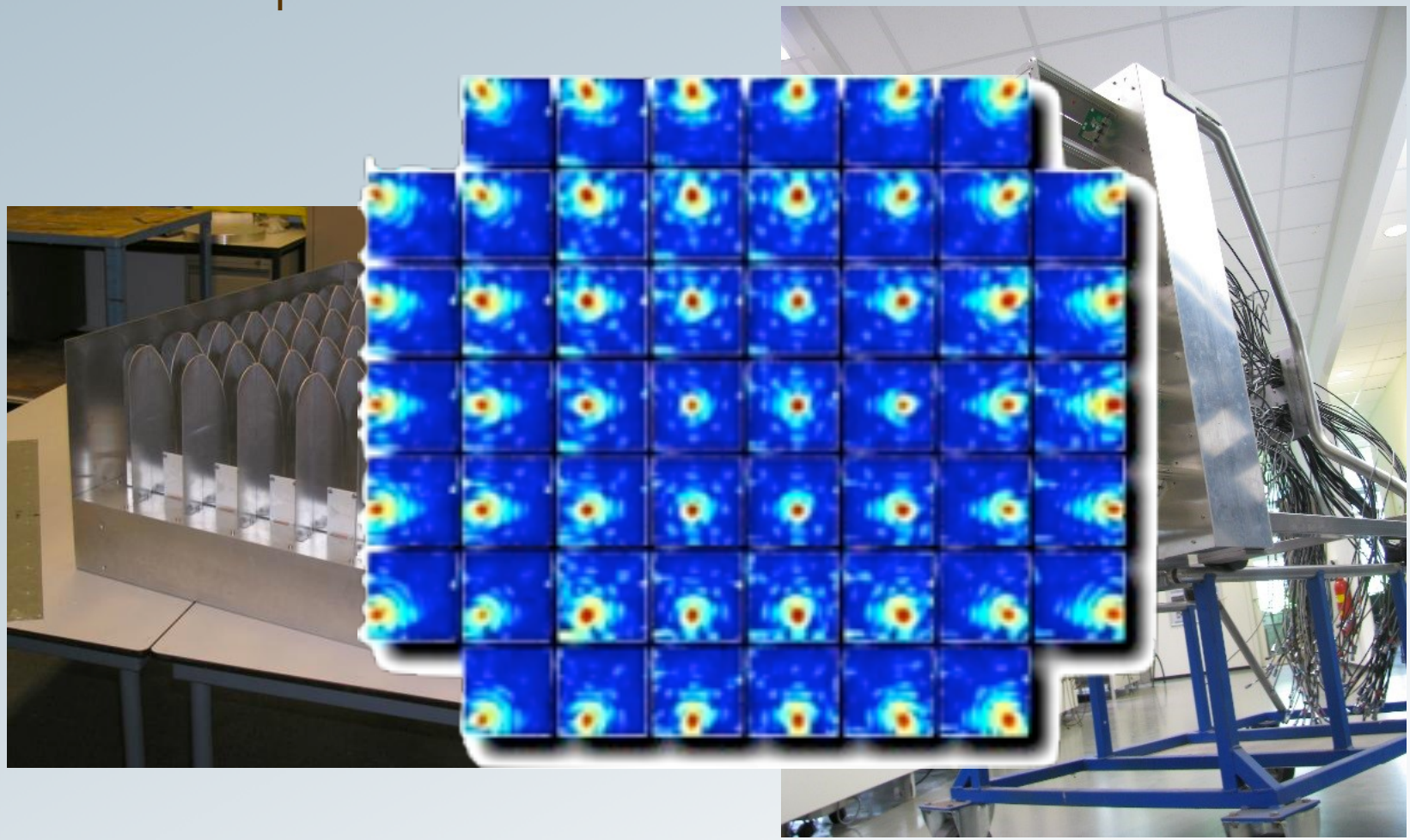


Apertif:
a phased-array feed for WSRT

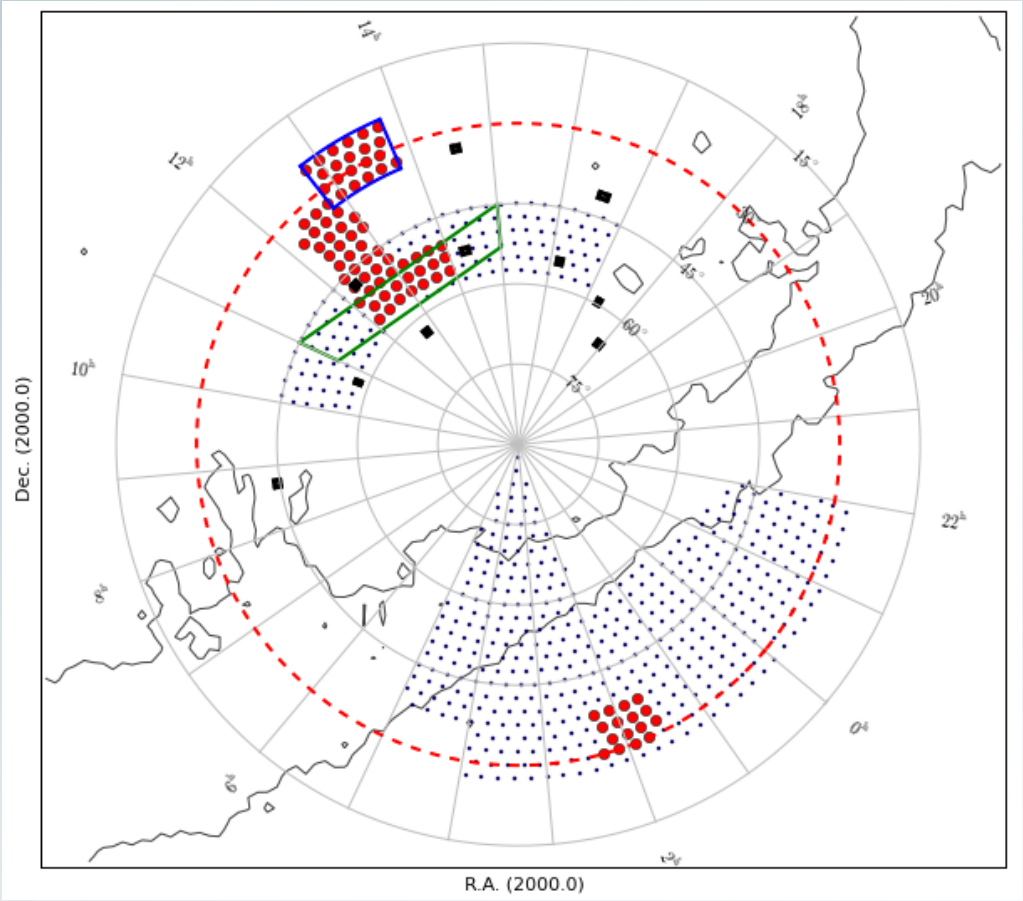
- Multiple compound beams to expand the field of view
- Survey speed increases by 25

Apertif system

The Apertif Survey Program

Apertif Surveys

- Legacy surveys
- Pulsars and transients
- HI and continuum surveys: shallow and medium-deep
  - 300 MHz bandwidth (z~0.26)
  - Δv=2.6-3.2 km/s
  - 15" beam (plus decl.)
- www.apertif.nl



Key science goals

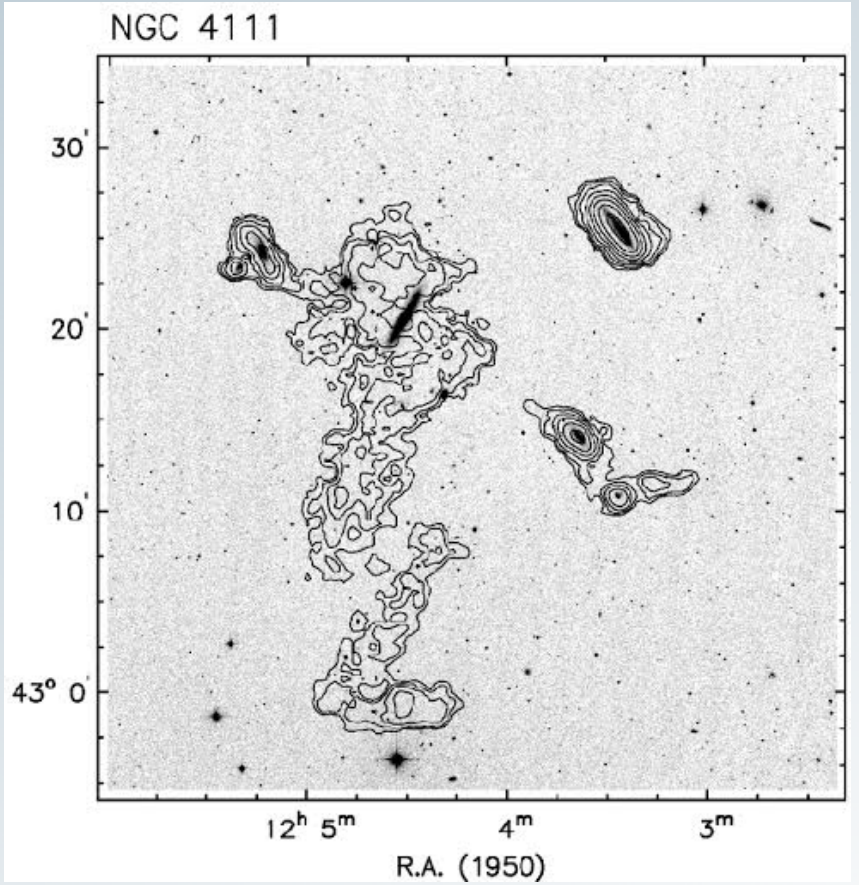
- Resolved HI observations to connect gas and total mass (as function of other galaxy properties)
- Role of environment, including interactions, gas accretion and removal of gas
- Smallest gas-rich galaxies (confront with theory)
- Cold gas in AGN and feedback activity;
- History of star formation and AGN activity of the faint radio continuum population
- Magnetic fields in galaxies and of large-scale structure

Medium-deep survey

- ~400 sq degrees

- 10^5 M_{sun} @4Mpc
- 10^6 M_{sun} @13 Mpc
- N_{HI} <10^{20} atoms cm^{-2} (15")
- continuum noise
  ~6 μJy/beam

- edges of galaxies
- accretion/removal of gas
- smallest HI-rich galaxies



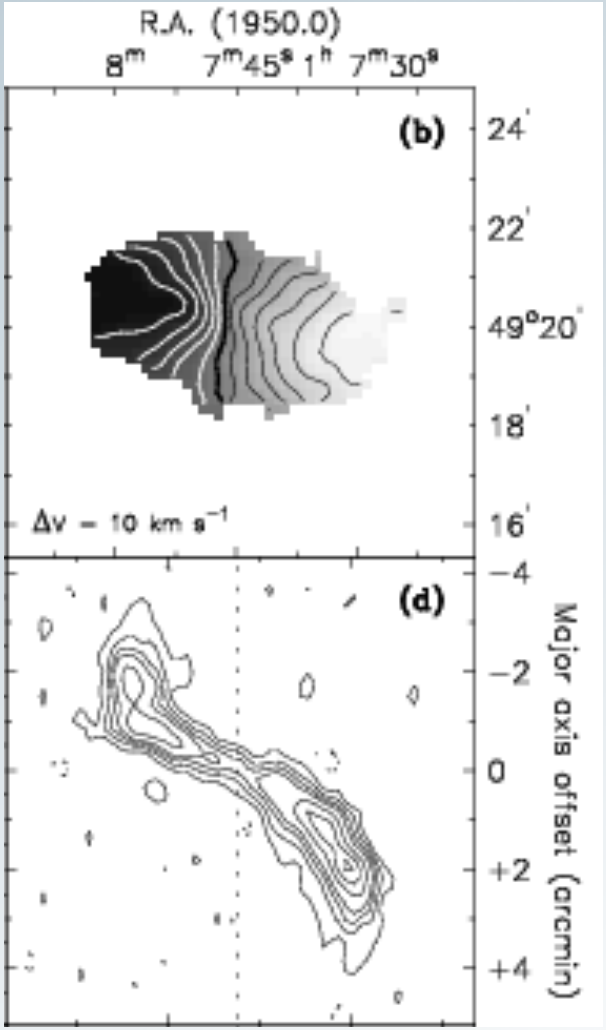
Verheijen & Zwaan 2001

Shallow Northern Sky Survey

- ~3500 sq degrees

- 10^5 M_{sun} @2.5Mpc
- 10^6 M_{sun} @8 Mpc
- N_{HI} <2.5x10^{20} atoms cm^{-2} (15")
- continuum noise
  ~15 μJy/beam

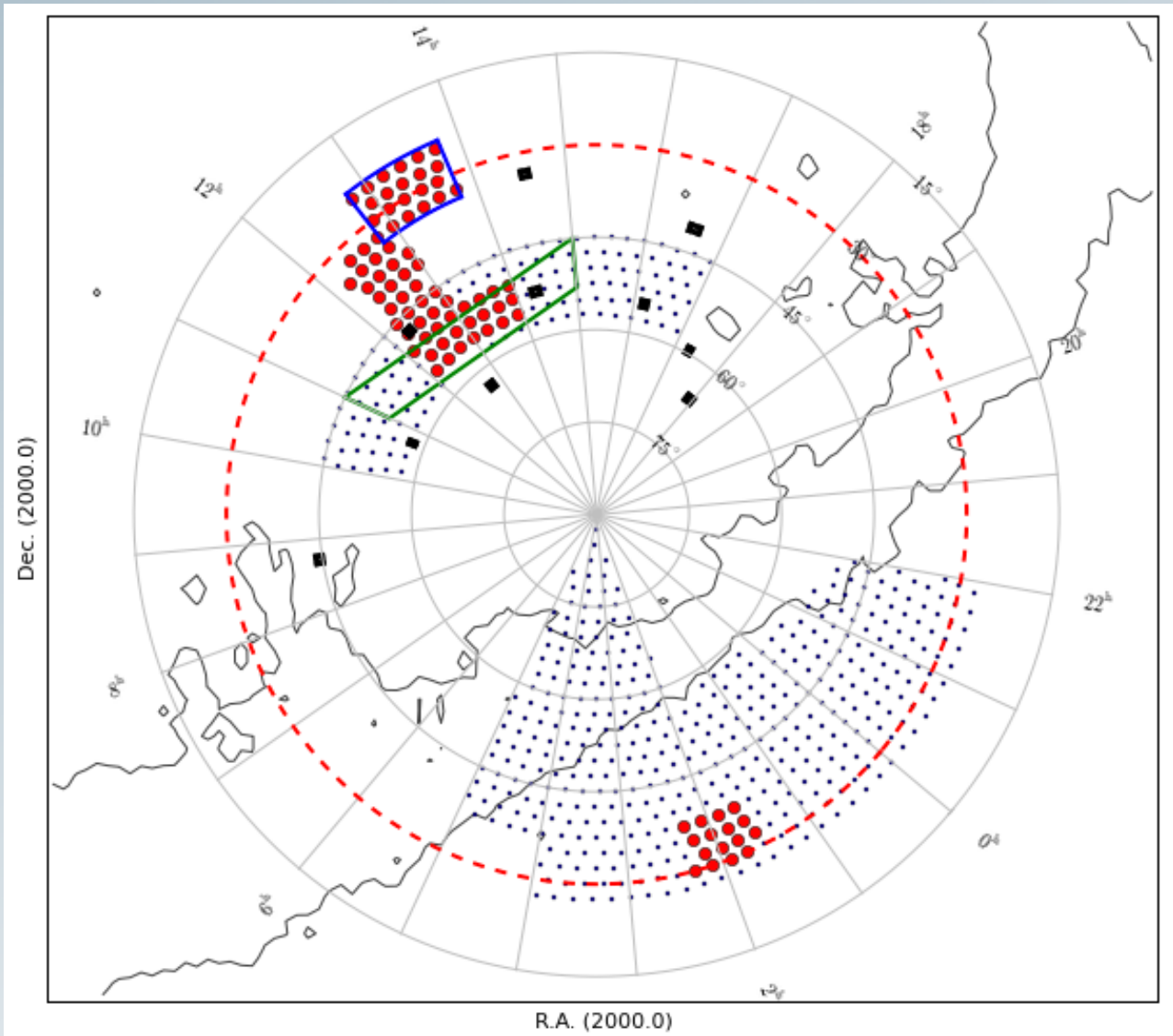
- resolved kinematics
- environment
- large scale structure



Swaters+ 2002

Apertif Surveys

Survey footprints



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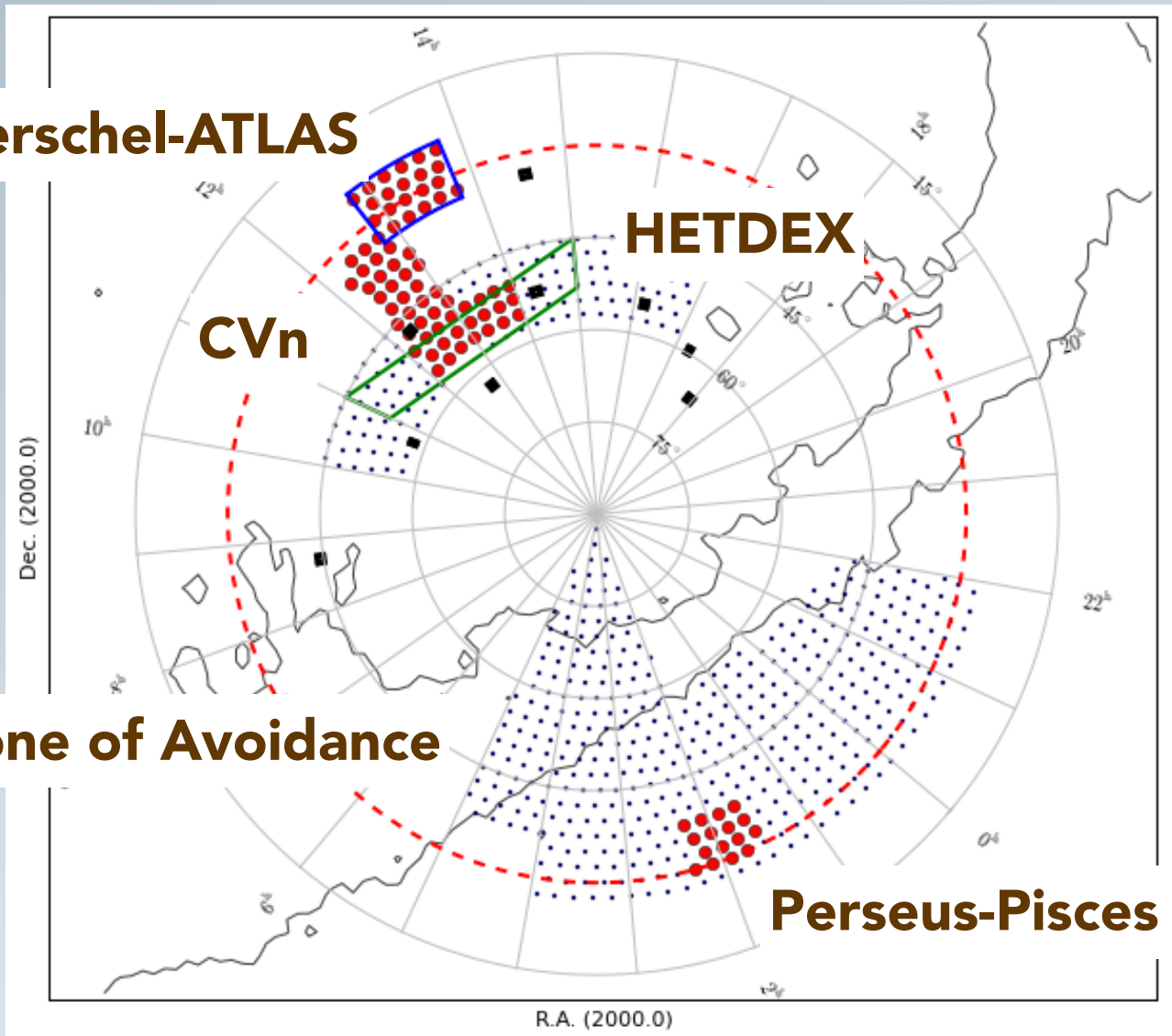

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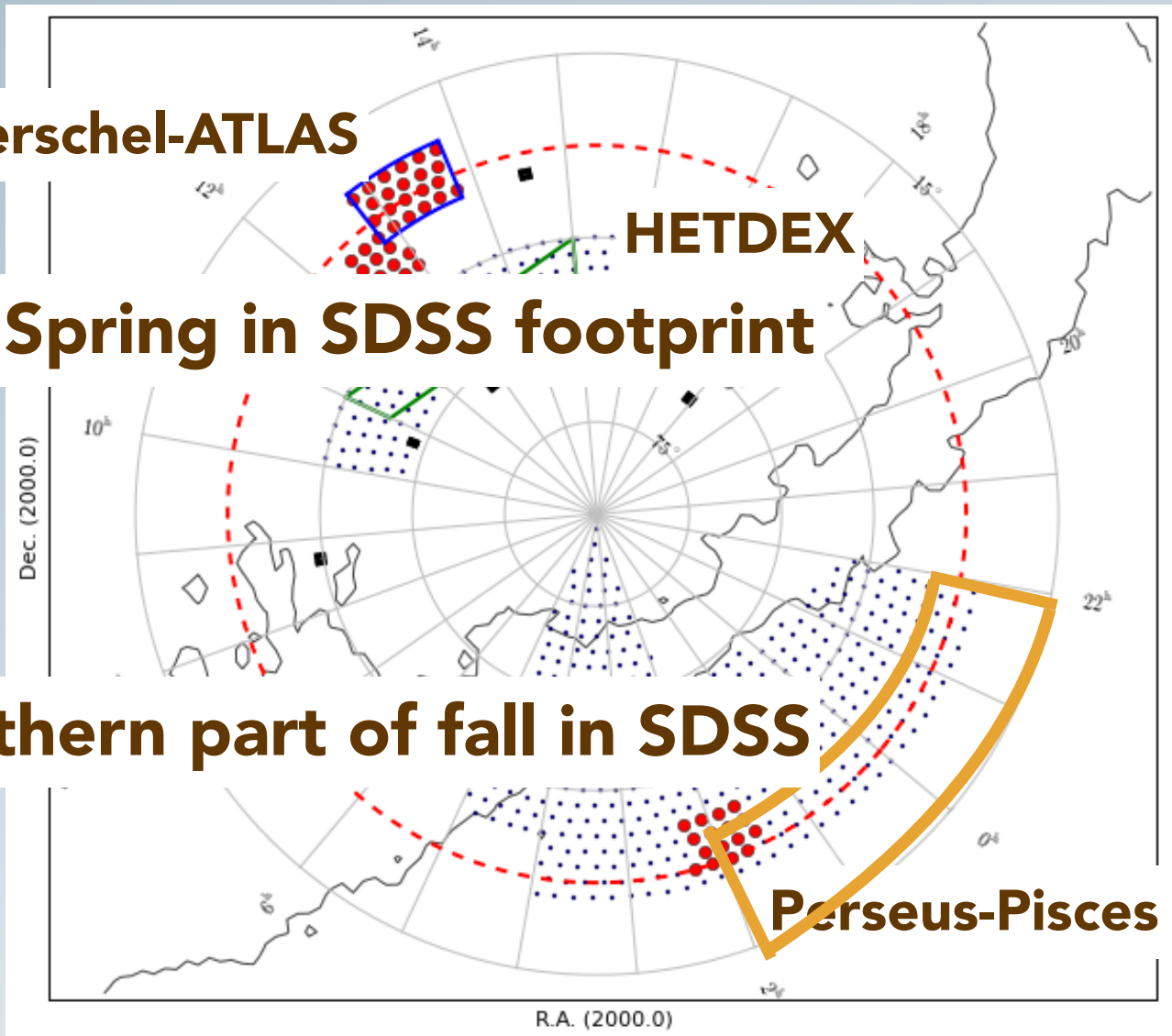
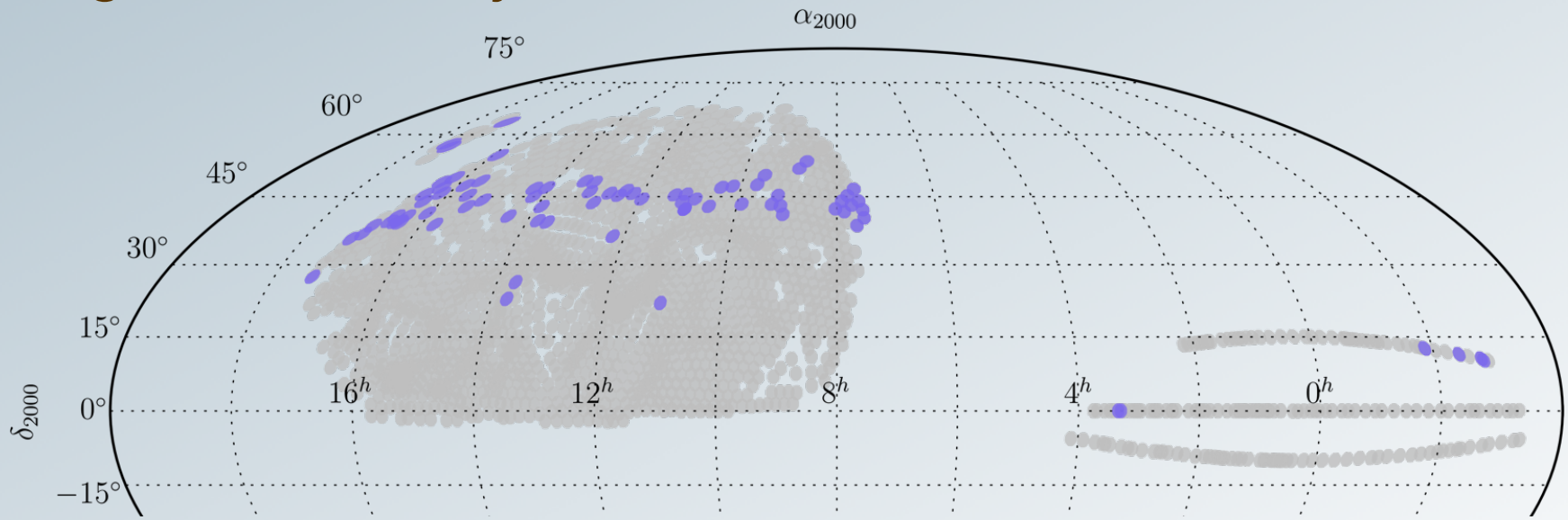


MaNGA

- IFU spectroscopy of SDSS galaxies
- Purple = observed
- Declination ~45deg -> overlap with HETDEX, CVn regions of survey



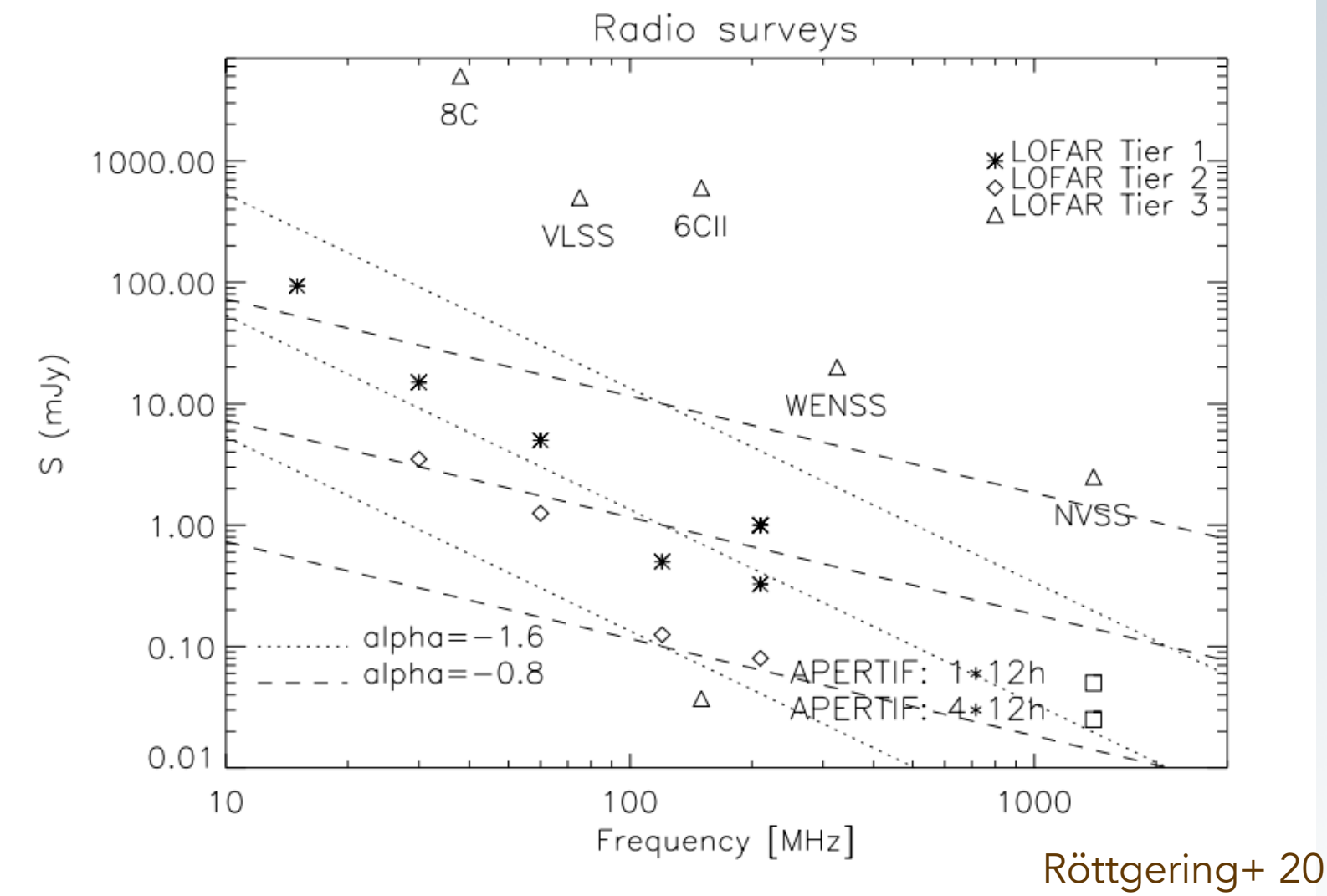
MaNGA DR13 footprint

WEAVE-Apertif

- WEAVE: new IFU instrument for William Herschel Telescope
- WEAVE-Apertif: ~350 nights to target Apertif-selected galaxies
  - Large IFU observations of resolved galaxies
  - mini IFU observations of z~0.25 bright galaxies

- Kelley Hess is coordinating Apertif with MaNGA/WEAVE

Sensitivity match to LOFAR



Röttgering+ 2011

Apertif Early Science

- While waiting on final capabilities
  - Single or dual polarization, lacking full polarization
  - 200 MHz bandwidth (full bandwidth is 300 MHz)
- "Survey commissioning"
  - During the first half of 2018
  - Small prototype surveys to test survey strategy/ logistics
  - First opportunity to address Apertif key science goals
  - Fields outside of planned survey footprint
  - Fields determined by Apertif Survey Team

Apertif Survey Structure

- Radio Observatory (ASTRON)
  - maintains hardware
  - carries out observations
  - deposits raw data into Apertif Long Term Archive

- Apertif Survey Team (AST) is responsible for management of the Apertif Survey Program
  - schedule and track observations
  - data quality assessment
  - calibration and imaging pipelines
  - delivery of legacy data products to community (after proprietary period)

Apertif Management

Apertif Survey Team

- Apertif Survey Team
  - priority access to all survey data products
  - assigns authorship list for joint publications
  - determines the final survey footprint and strategy

- Membership is open but requires a substantial contribution
  - Project is funded through grants
  - All survey support comes from Apertif Survey Team
  - *Apertif Survey Team and Apertif Survey Program Ground Rules* (www.apertif.nl)

Current Apertif Survey Team

- Erwin de Blok
- Raffaella Morganti
- Tom Oosterloo
- Lister Staveley-Smith
- Thijs van der Hulst
- Joeri van Leeuwen
- Marc Verheijen

Apertif Management

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Summary

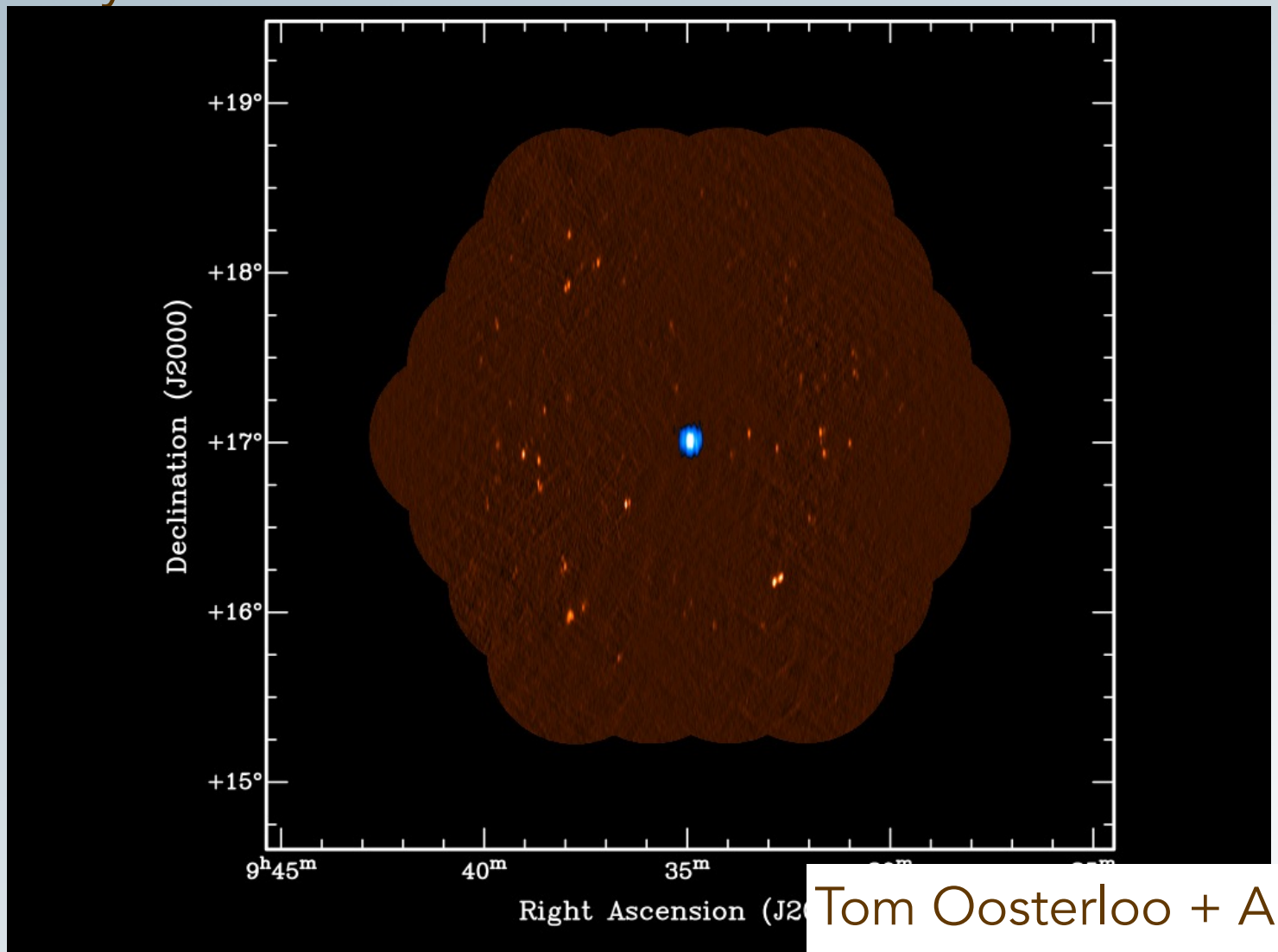
Apertif starts observing: First full field mosaic

ASTRON

APERTIF

Apertif first results

- Easily detect Leo T



Tom Oosterloo + Apertif team