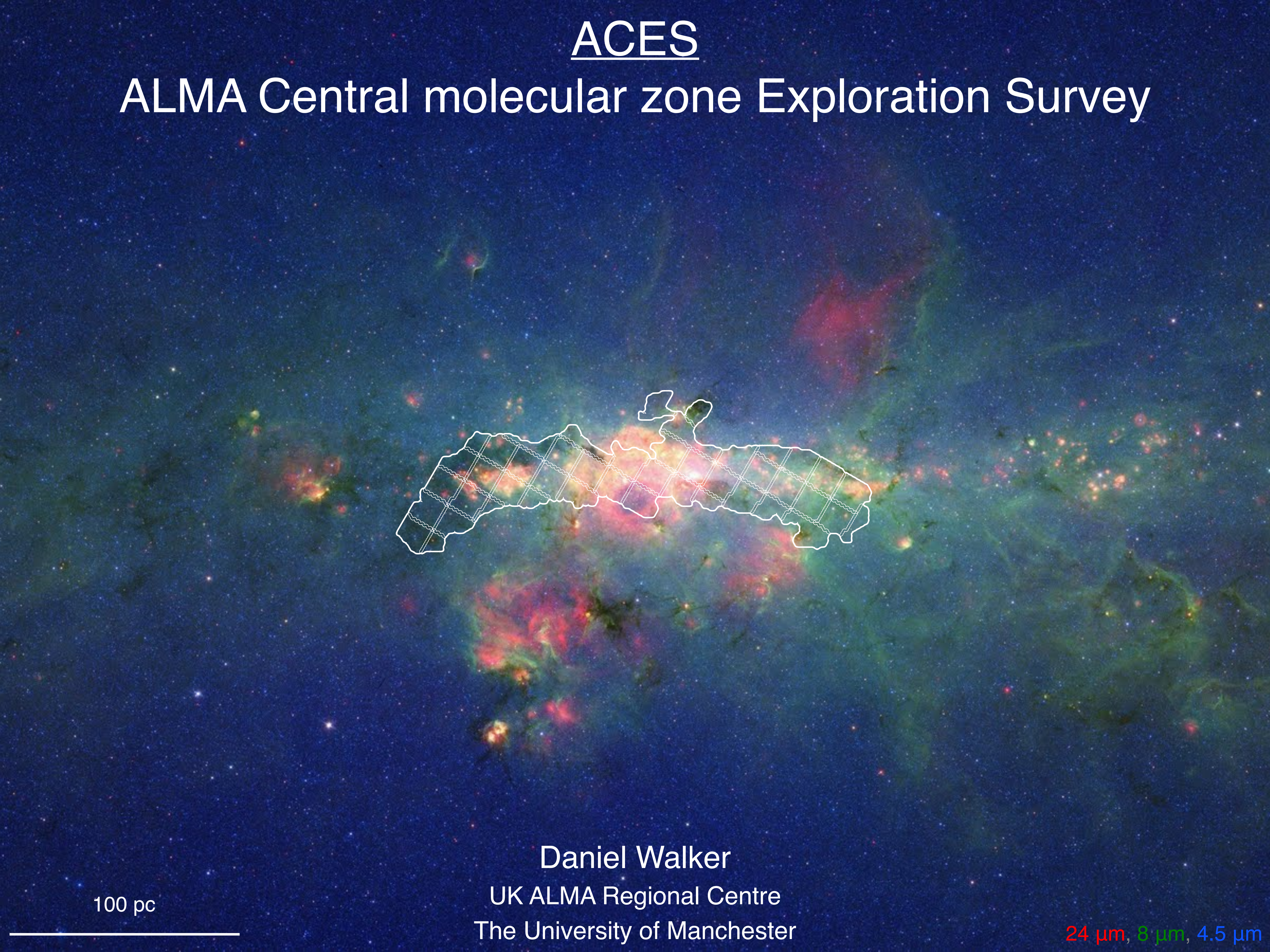
ACES

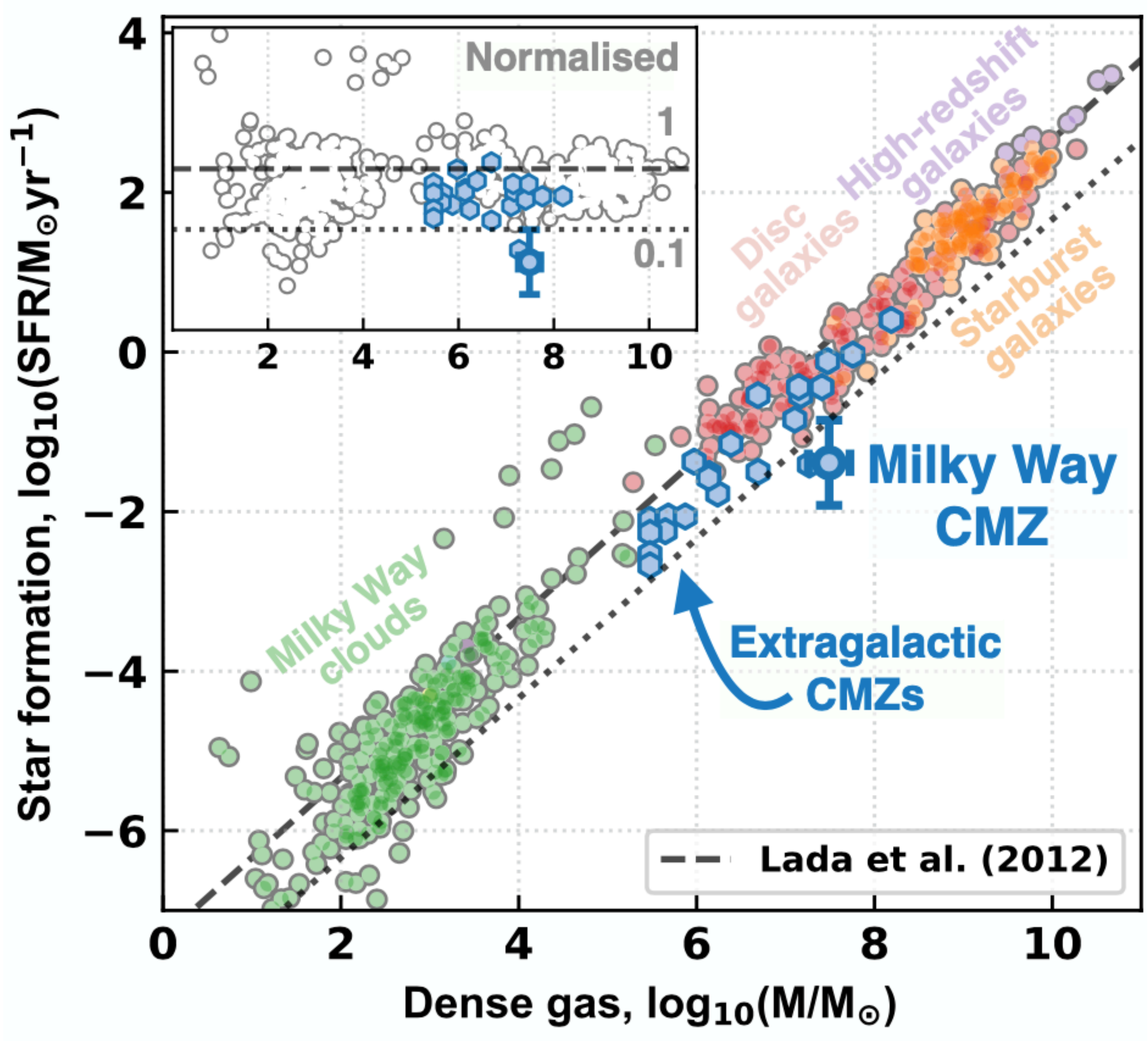
ALMA Central molecular zone Exploration Survey



Daniel Walker
UK ALMA Regional Centre
The University of Manchester

The SFR in the CMZ is ~ an order of magnitude lower than expected given the huge reservoir (>10^7 $M_\odot$) of dense (>10^4 cm^{-3}) gas.

Why?



Henshaw et al. 2023 PPVII review

ALMA Central molecular zone Exploration Survey (ACES)

Motivation

- What are the physical mechanisms driving mass flows as a function of size and location?
- What is the 3D distribution of gas in the CMZ?
- How is star formation regulated by environmental conditions?

Answering these questions requires uniform measurements of the physical, kinematic, and chemical properties of the gas from global to core scales

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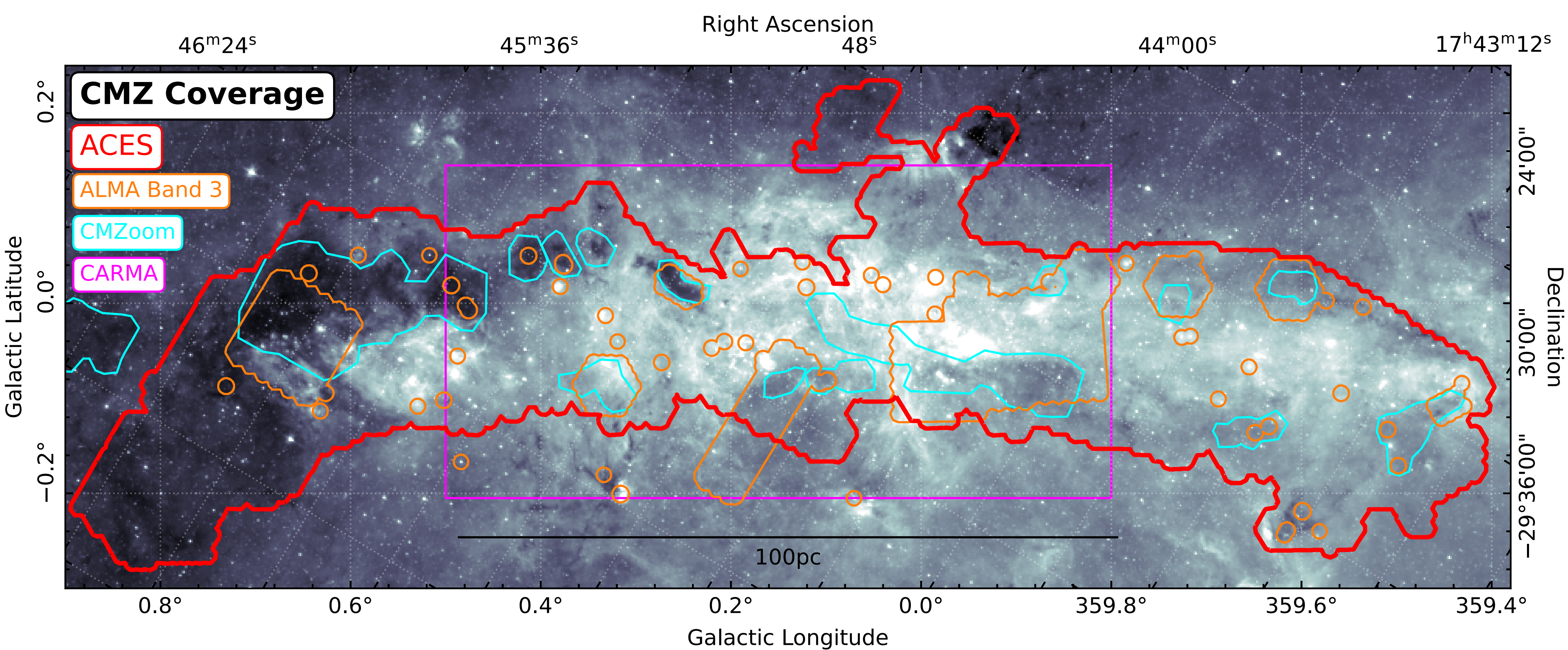
Aim

To build a complete, multi-scale picture of the mechanisms shaping the CMZ from global (100 pc) down to individual star-forming (0.1 pc) scales

Strategy

Observe a uniform, contiguous mosaic of molecular lines and dust continuum covering all gas above $N(H_2) \sim 10^{22}\ cm^{-2}$ in Band 3 at ~ 2" resolution

Combine with state-of-the-art simulations



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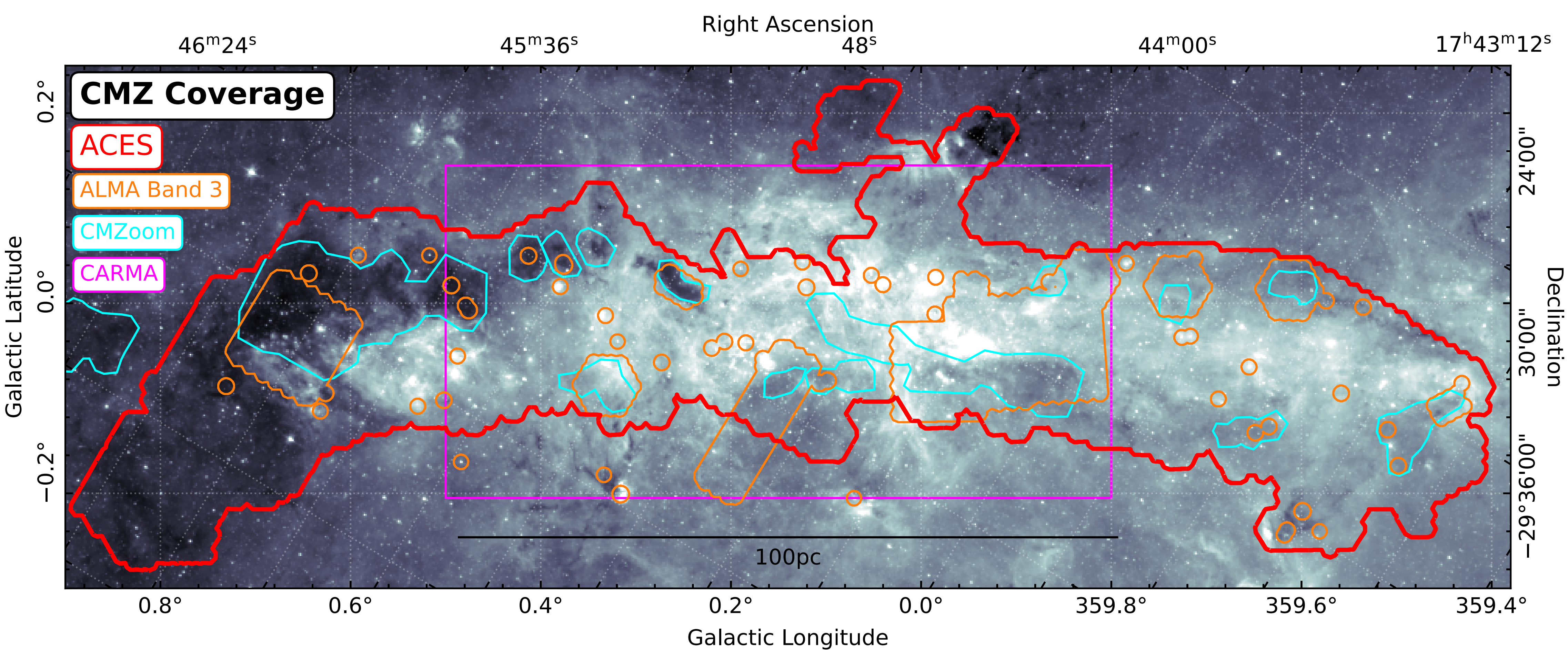
- Narrow SPWs: HNCO & HCO^+ (0.2 km/s)
- Med. SPWs: SiO, $H^{13}CO^+$, $HN^{13}C$, etc. (1.7 km/s)
- Broad SPWs: CS, HC_3N, H40α, SO, etc. (3 km/s)
- + GBT MUSTANG data for single-dish continuum

- 120 hrs (12m)
- 360 hrs (7m)
- 700 hrs (TP)
- > 5000 pointings



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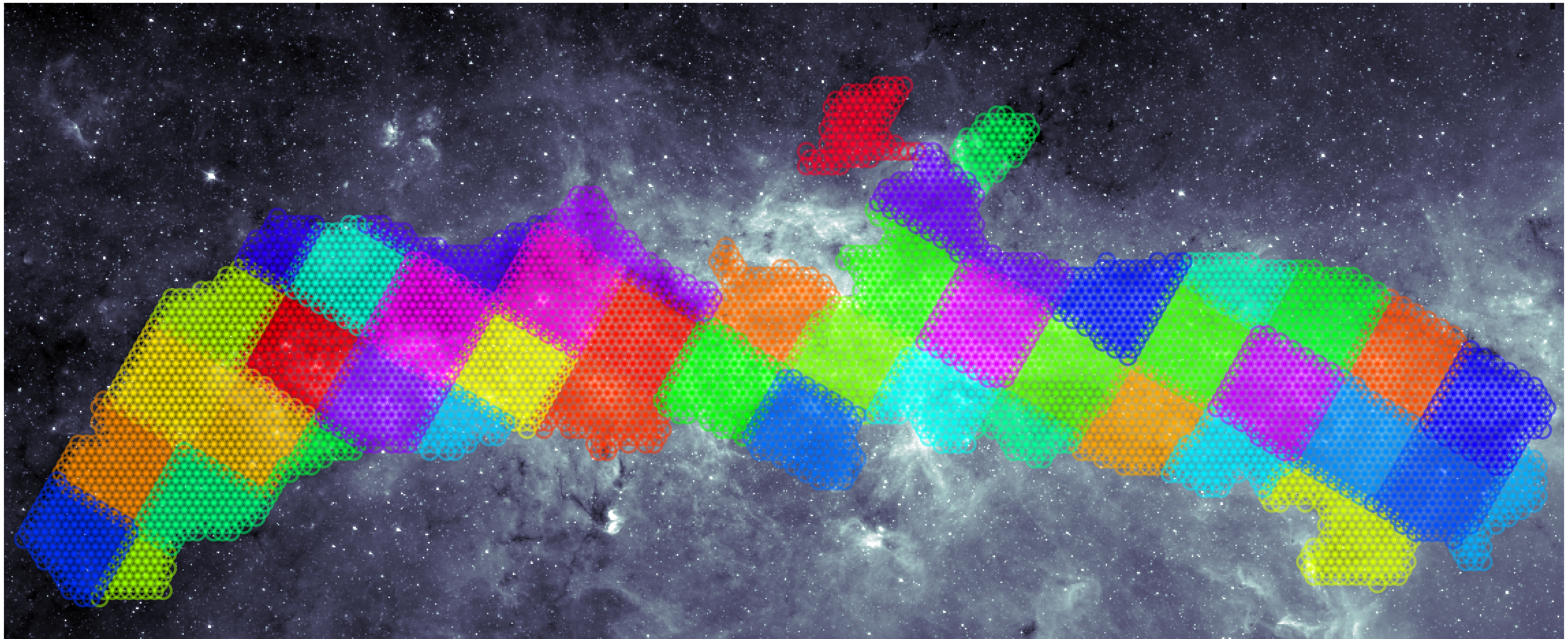
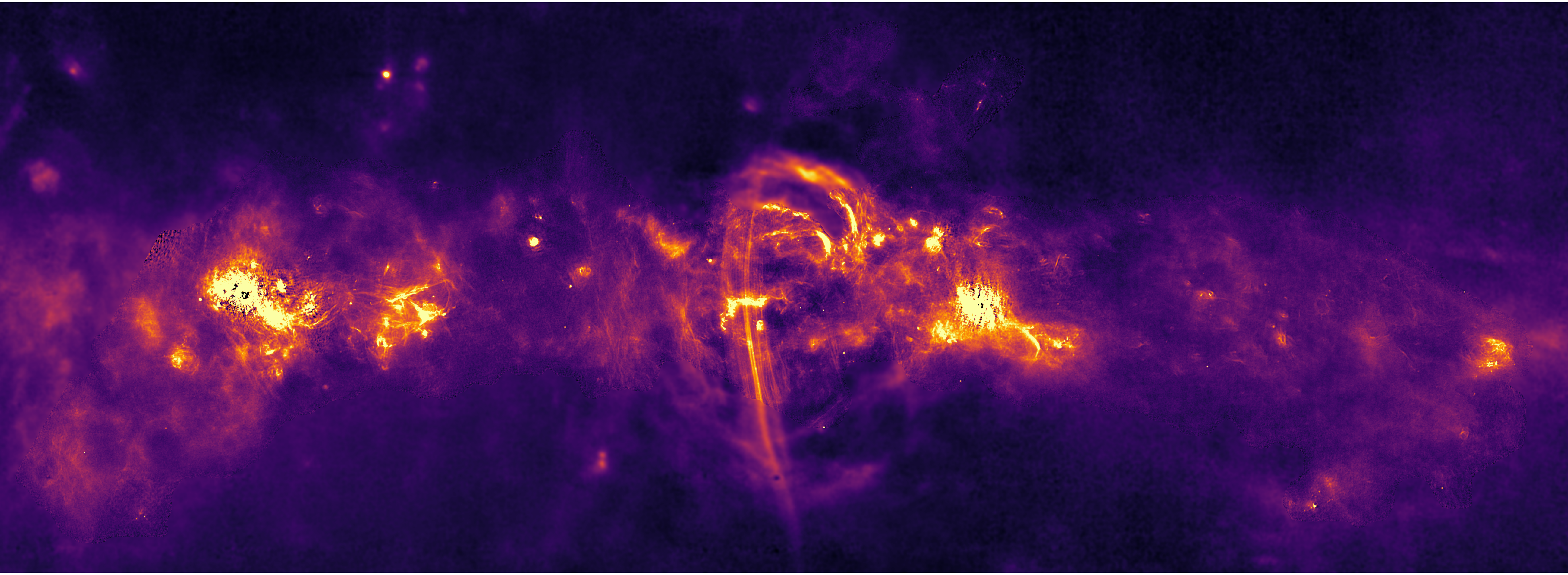
Largest ALMA mosaic ever observed



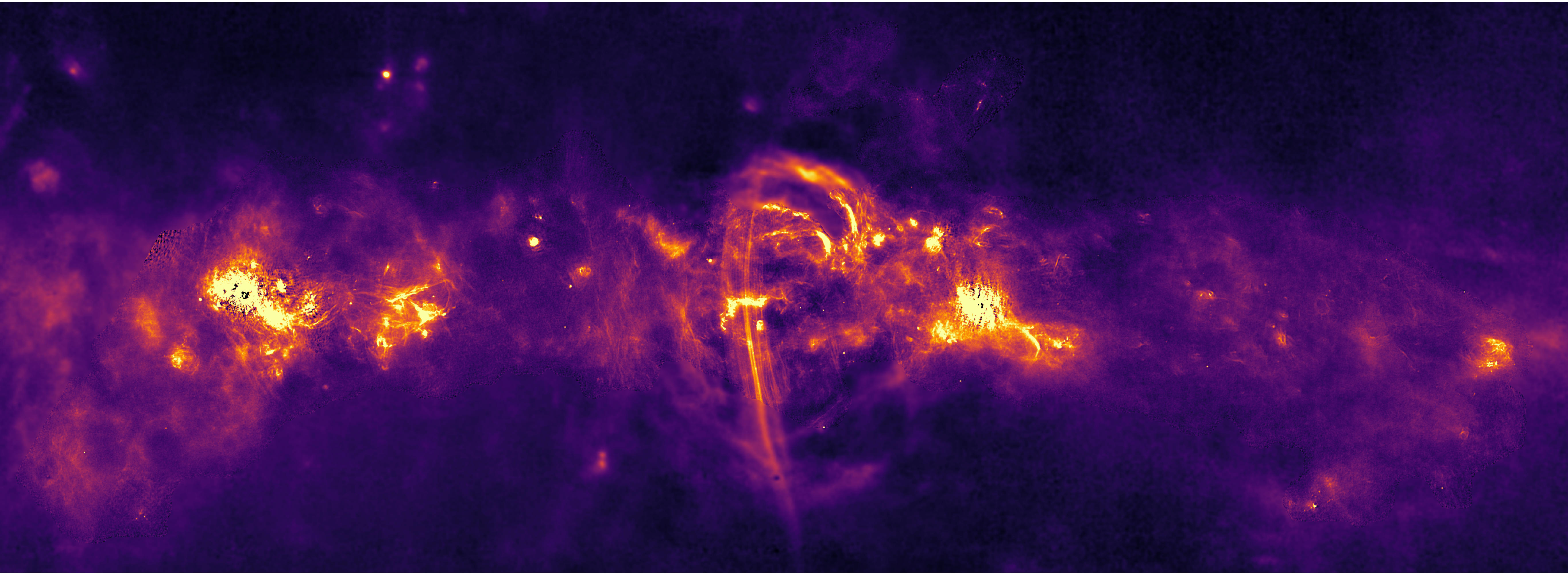
ACES + GBT MUSTANG 3 mm continuum



Mix of thermal, ionised, and non-thermal emission

Ginsburg et al. (in prep.)

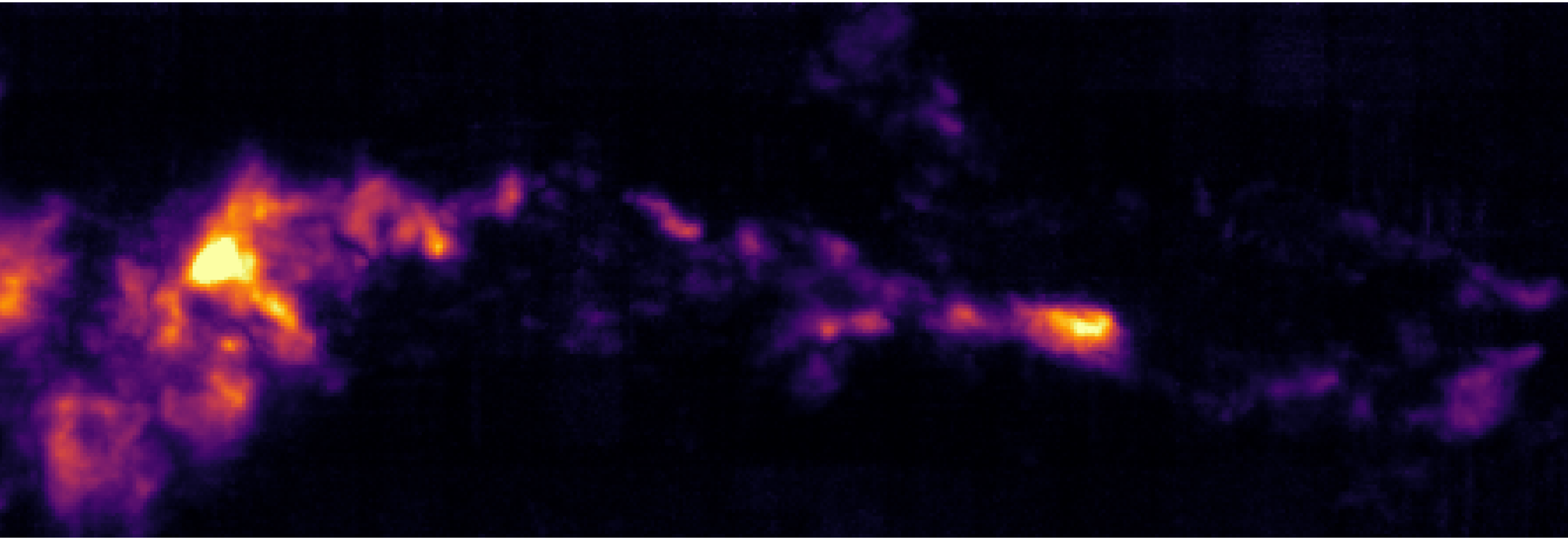
ACES + GBT MUSTANG 3 mm continuum



Compact source catalogue has been produced with 1000s of candidate sources

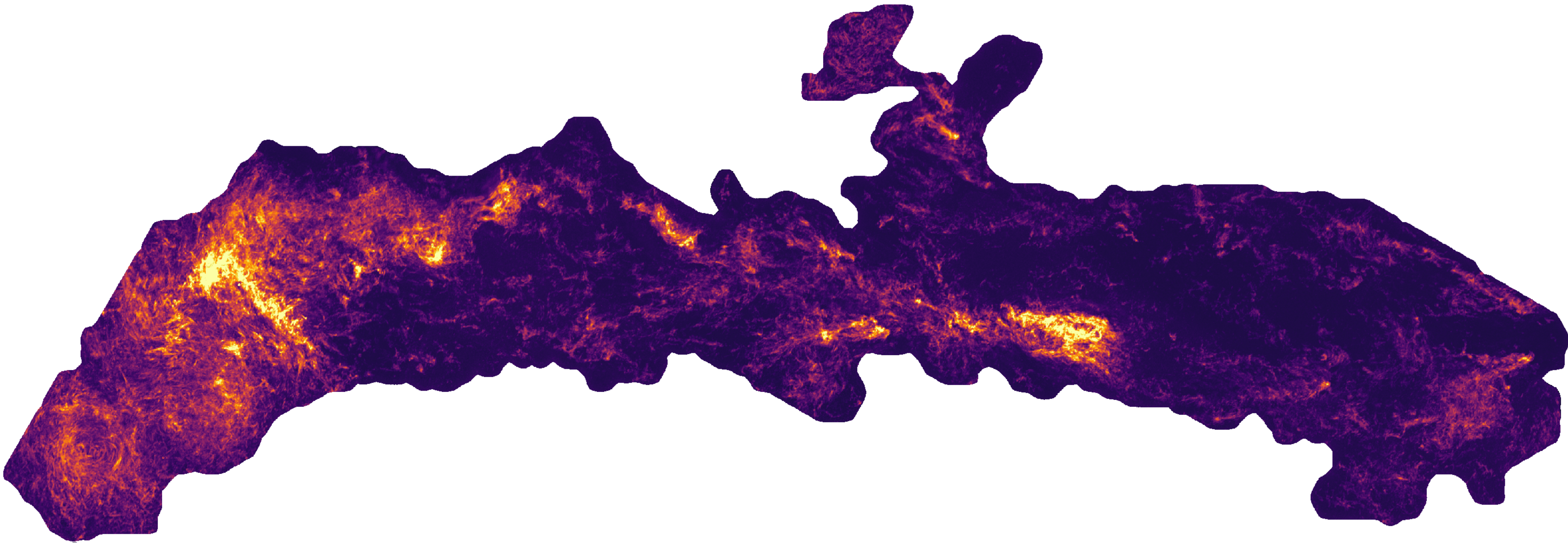
Jen Wallace et al. (in prep.)

HNCO peak intensity (Mopra CMZ survey)



Jones et al. (2012)

HNCO peak intensity (ACES)



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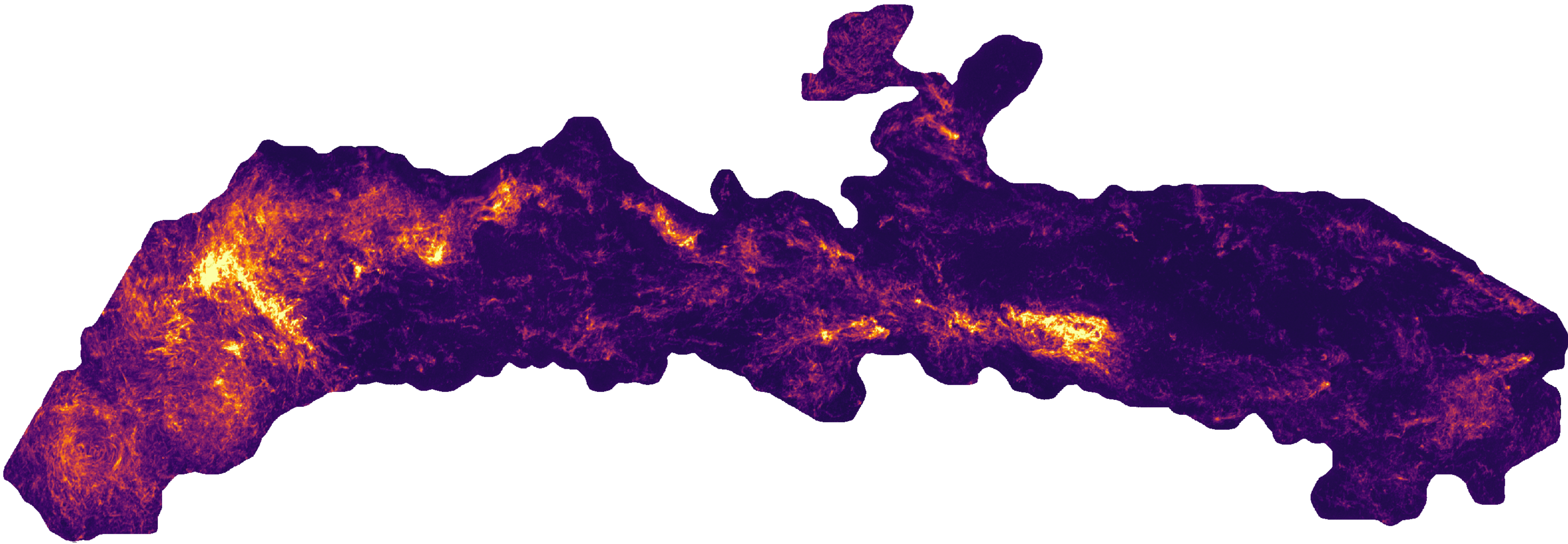
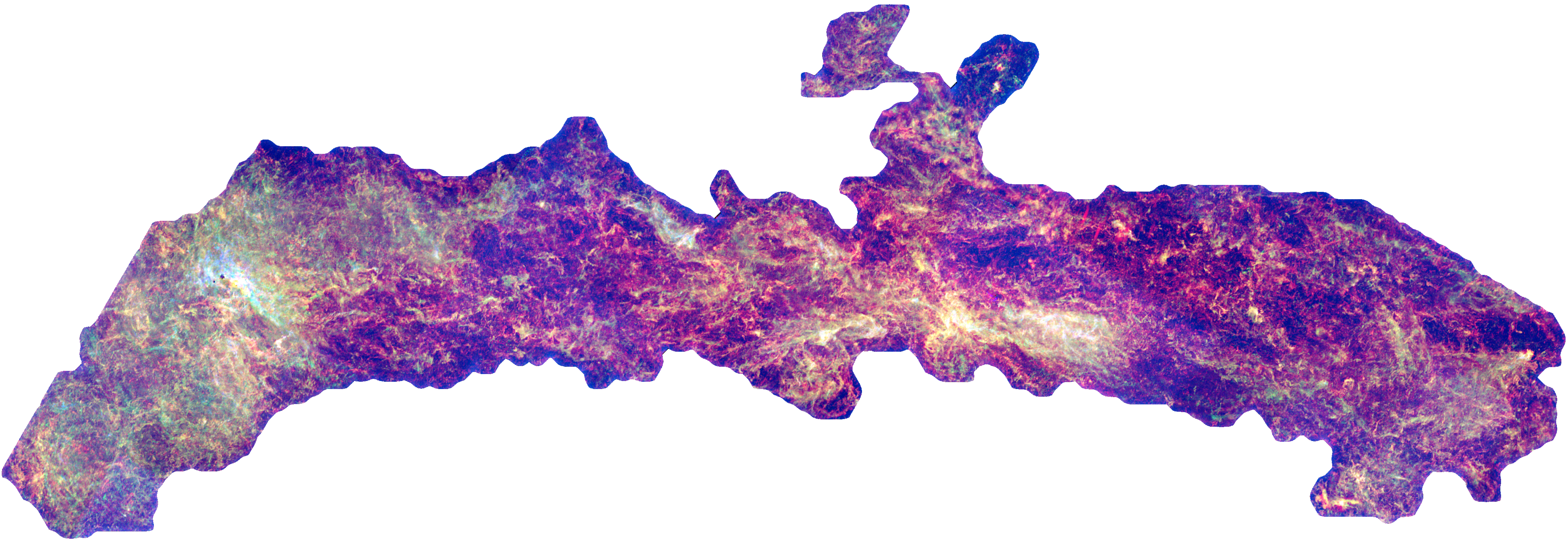
HNCO peak intensity (ACES)



Eventual goal is to decompose HNCO emission to obtain a full description of the PPV structure of the dense gas in the CMZ

(but this is very challenging! See talk by Rojita)

CS/SO/CH_3CHO peak intensity (ACES)

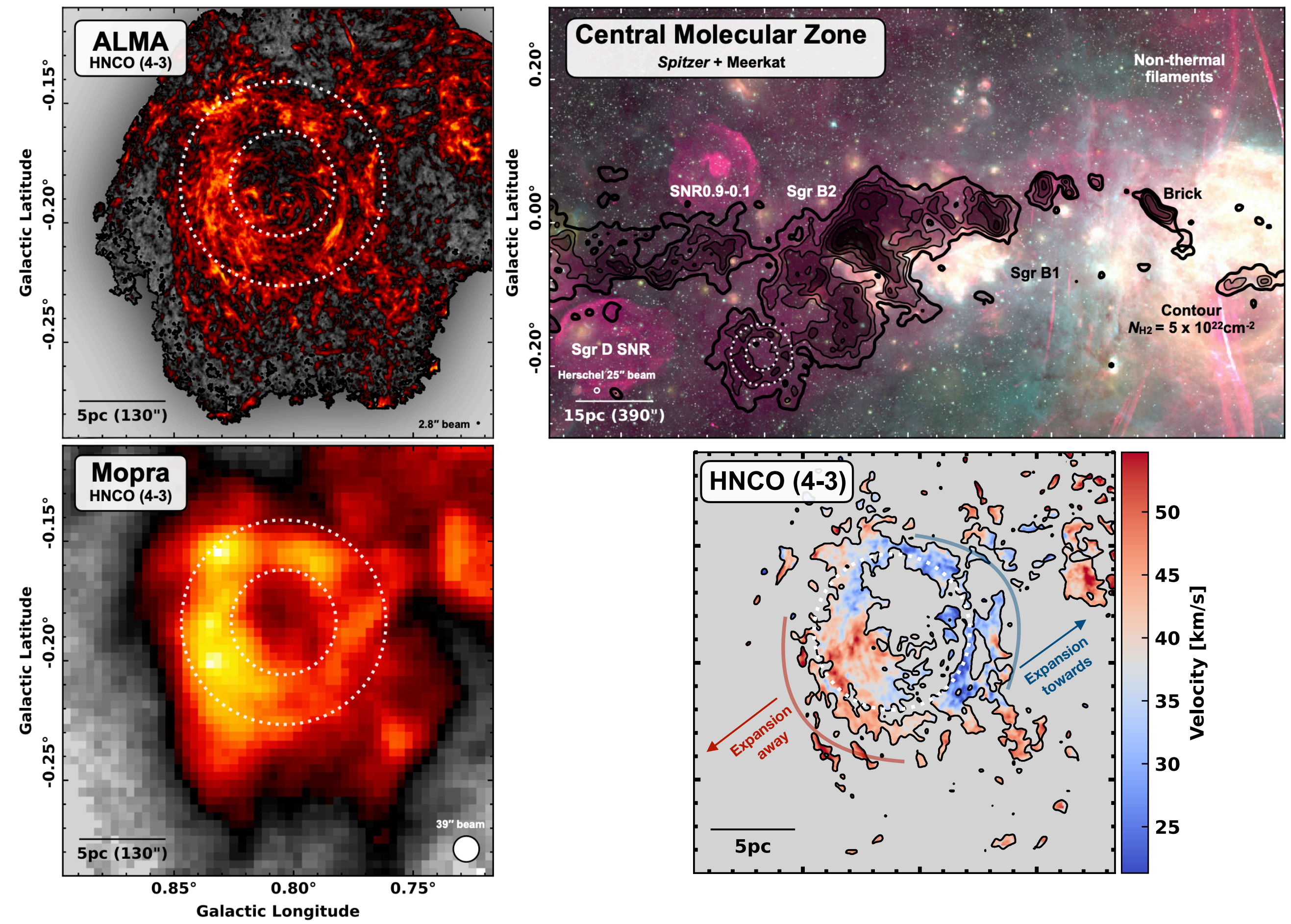


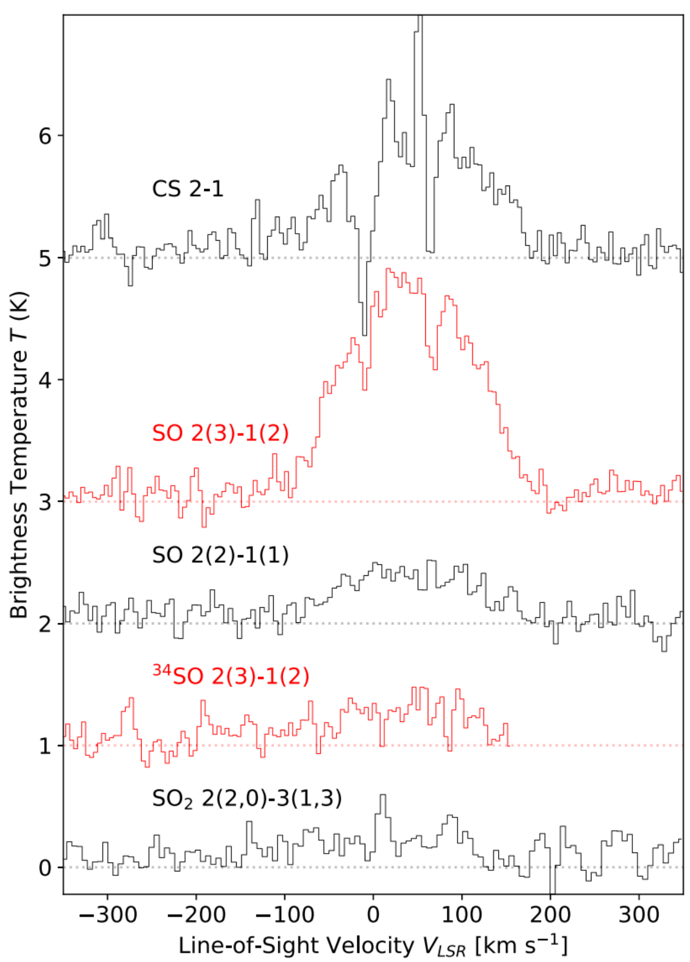
Hsieh et al. (in prep.)

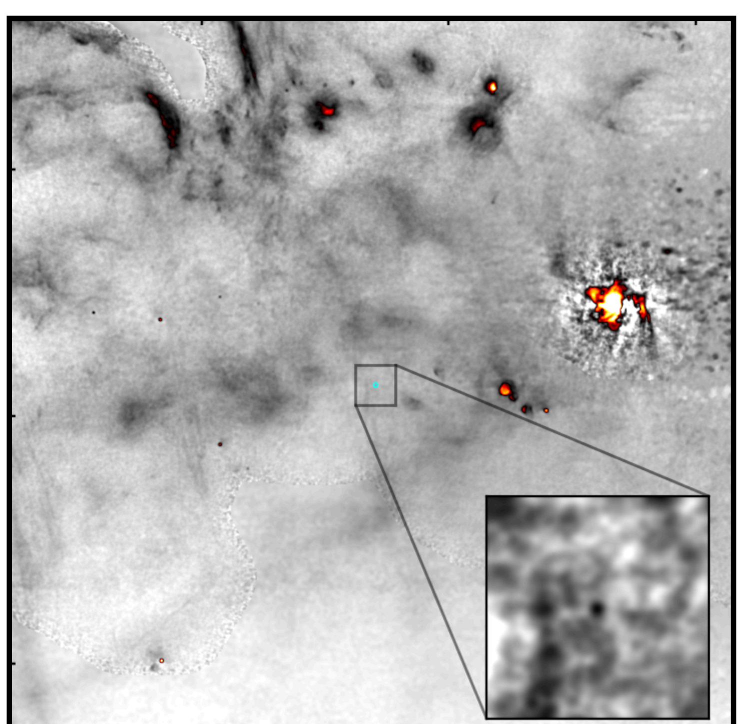
ACES Early Science Results

‘M0.8-0.2 ring’
Nonhebel et al. (2024)

- Large (~ 10 pc) ring like structure
- Mass ~ $10^6\,M_\odot$
- Kinetic energy ~ 10^{51} erg
- Origin? Potentially a hypernova in a dense molecular cloud







The ‘MUBLO’
Ginsburg et al. (2024)

- **M**illimeter **U**ltra-**B**road-**L**ine **O**bject
- Compact (< 1”) dust continuum source
- FWHM ~ 160 km/s
- Cold (~ 15 K)
- No detection at other wavelengths
- Origin? … unknown.
- Potentially stellar merger or intermediate mass black hole, but not fully consistent

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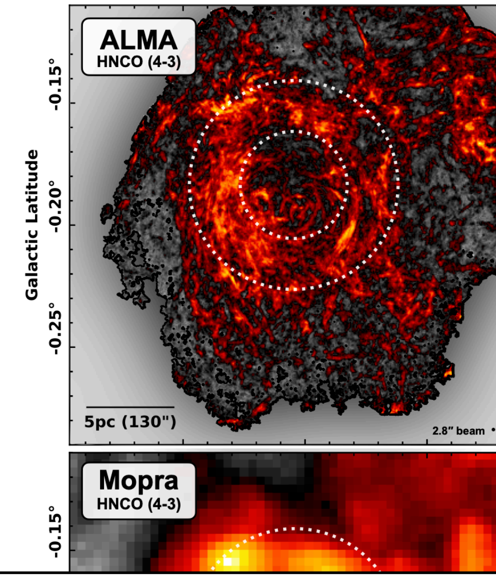
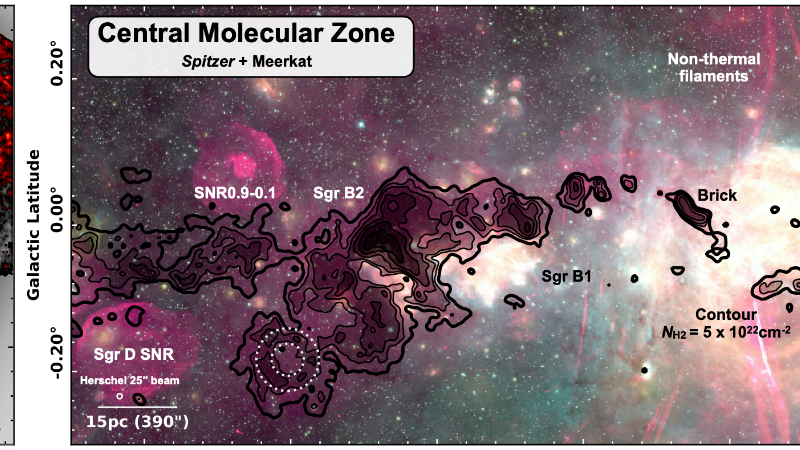
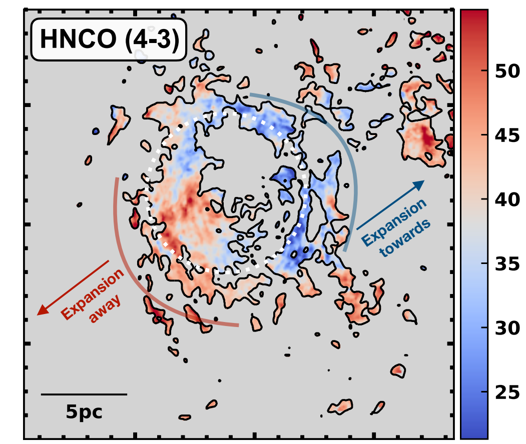
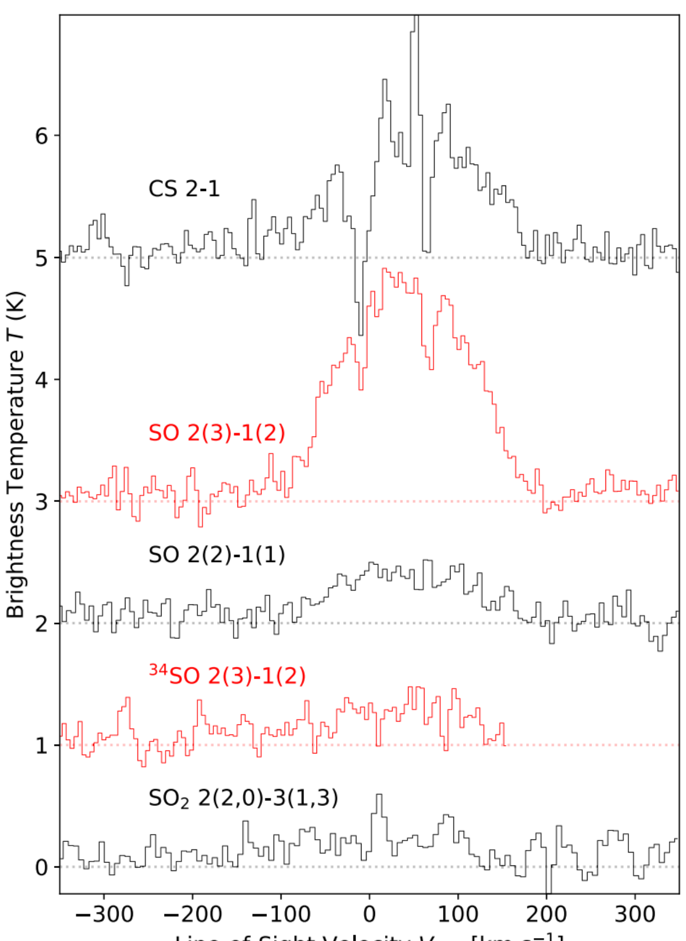


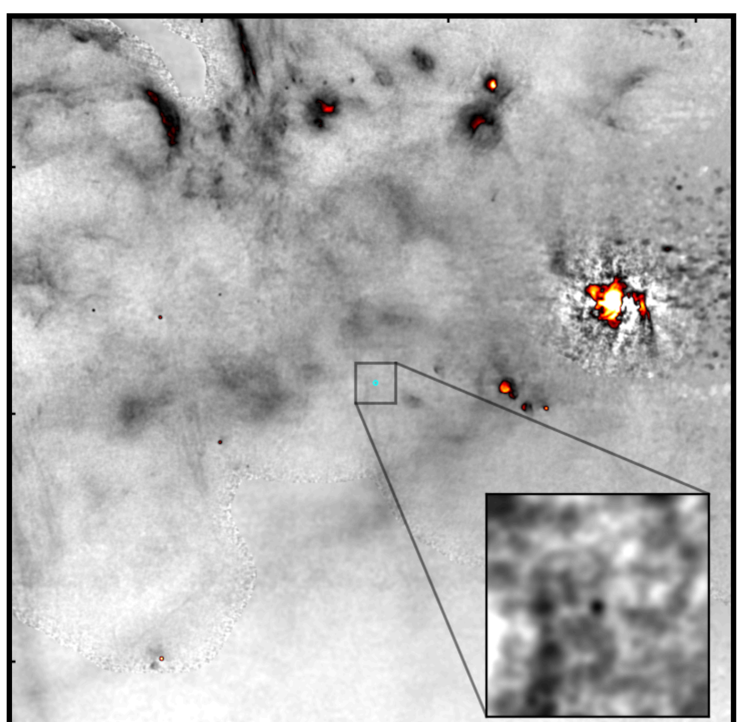




Many other ongoing ACES science projects!

See e.g. talks by:
Rojita Buddhacharya
Bijas Najimudeen





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ACES Data Release

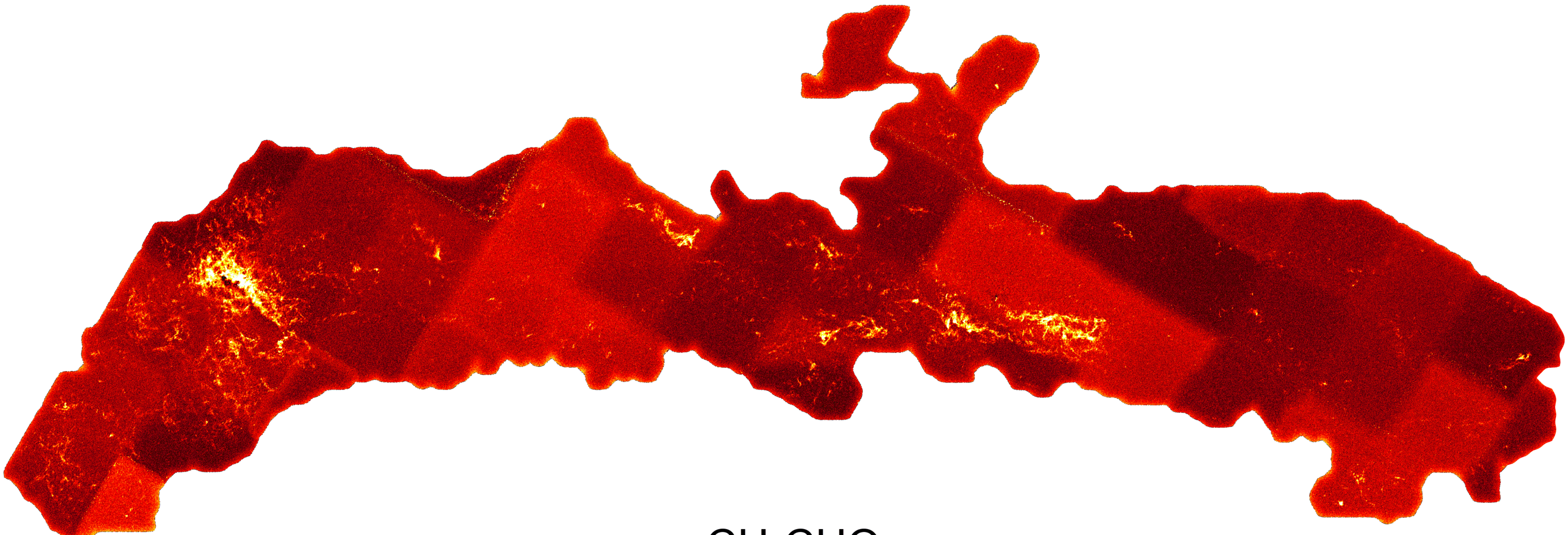
- Release of ACES data is imminent (~ Autumn 2025) and will include:
  - Cubes for all 6 SPWs and 45 fields
  - Cubes of entire CMZ mosaic for ~ 15 molecular lines
  - 3mm continuum mosaic of entire CMZ
  - Advanced products (e.g. moment maps, PV maps, etc.)
- Will be accompanied by 5 papers (survey overview + 4 data papers)
- All code, issue tracking, etc., is publicly available at github.com/ACES-CMZ

ACES data reduction team

Adam Ginsburg, Ash Barnes, Dan Walker, Alyssa Bulatek, Nazar Budaiev, Claire Cook, Savannah Gramze, Pei-Ying Hsieh, Katharina Immer, Desmond Jeff, Eric Liang, Xunchuan Liu, Steve Longmore, Xing Lu, Xinyu Mai, Sergio Martin, Betsy Mills, Jaime Pineda, Marc Pound, Alvaro Sanchez-Monge, Qizhou Zhang

ACES is a completely open collaboration

Get in touch if you're interested in joining!



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