Etude des phases précoces de la formation stellaire au-delà de la ceinture de Gould avec ArTéMiS

Frédéric Schuller - AIM, CEA / DAp (Saclay)

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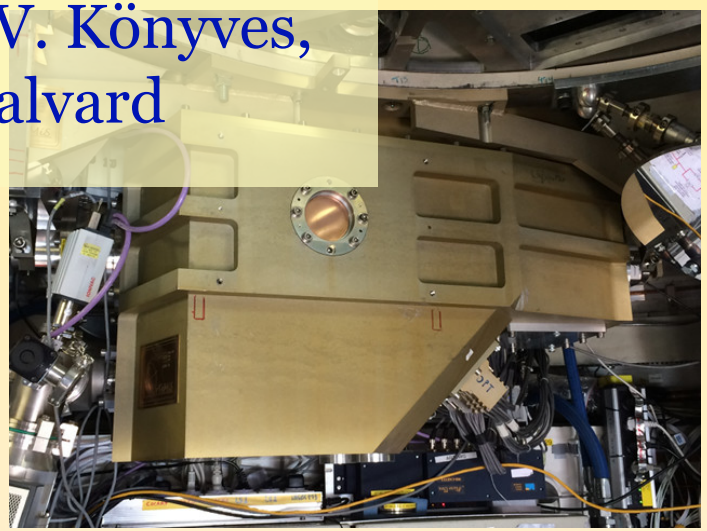
Ph. André, V. Revéret, A. Zavagno, V. Könyves,
H. Roussel, Y. Shimajiri, M. Talvard



Context

- Recent progress for understanding Galactic star formation thanks to large surveys, e.g.:
  - HGBS (André+ 2010, Arzoumanian+ 2011, Könyves+ 2015, …)
  - HOBYS (Motte+ 2010, Hill+ 2011, …)
  - Hi-GAL (Molinari+ 2010, Schisano+ 2014, …)
  - ATLASGAL (Schuller+ 2009, Csengeri+, Urquhart+…)
  - *and many more (Spitzer, BGPS, spectroscopic surveys…)*
- Filament paradigm for (solar-type) star formation

  → large-scale turbulence ⇒ filaments

  → characteristic width ~0.1 pc in nearby clouds (Arzoumanian+ 2011, 2018)

  → most cores form in supercritical filaments

e.g. review André+ 2014, PPVI

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  → most cores form in supercritical filaments

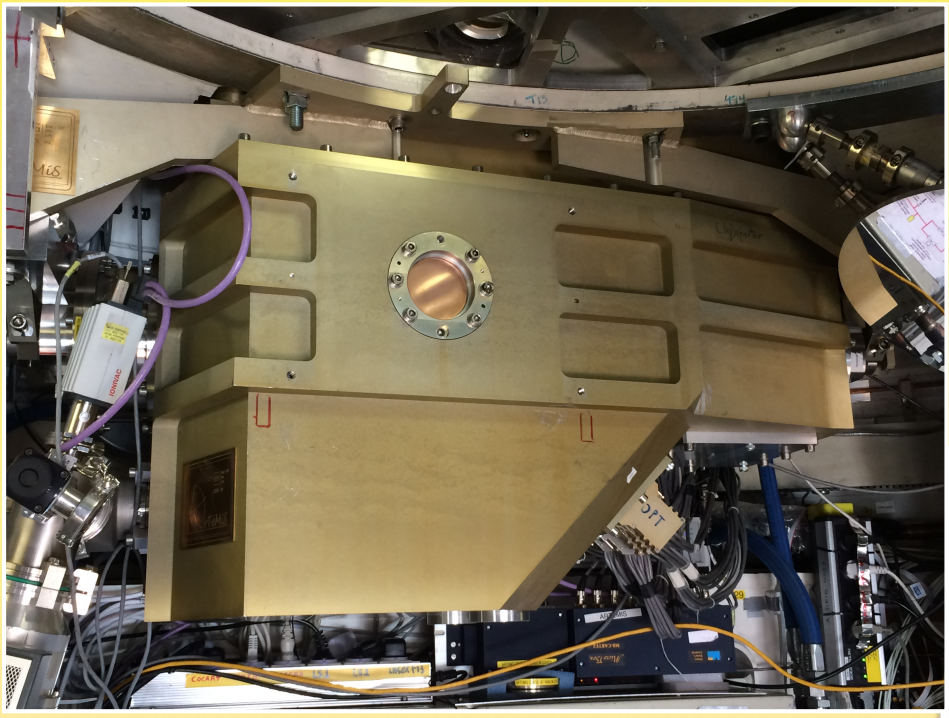
- But *Herschel* resolution <<0.1 pc in Gould Belt

  → forming mostly low-mass stars (< 2 $M_\odot$)

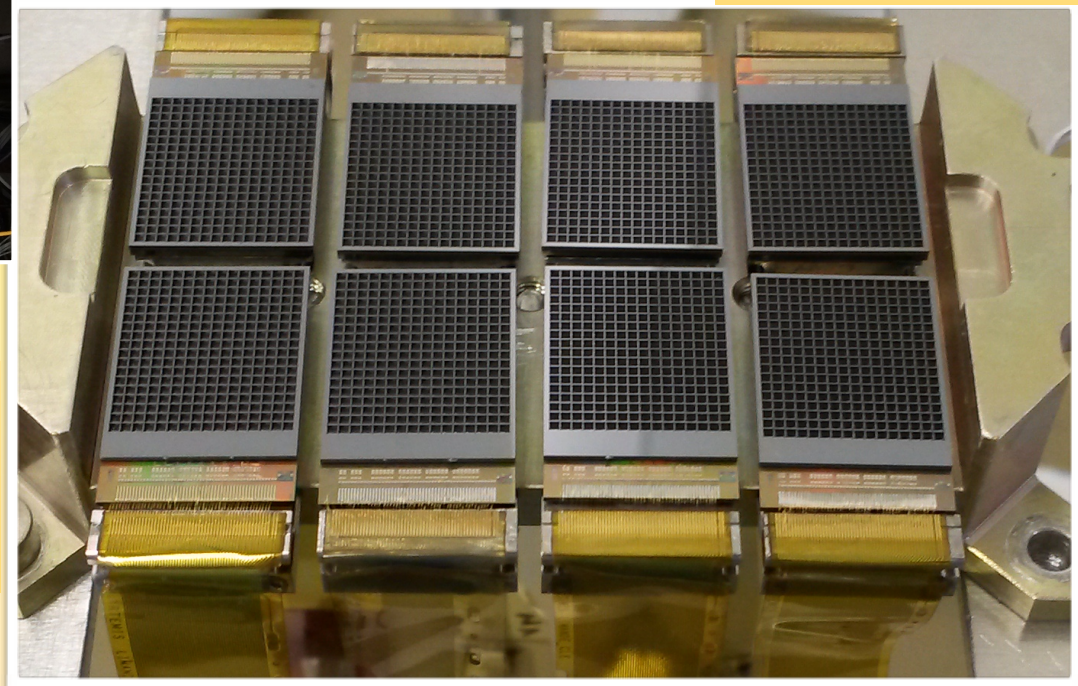
- Need to go to larger distances for high-mass SF

  →**ArTéMiS :** 8" angular resolution @ 350 μm

ArTéMiS: simultaneous continuum mapping at 350 and 450 μm



ArTéMiS @ Cassegrain focus at APEX



Bolometer arrays (semi-conductors) = *Herschel*/PACS blue array

(2006-2009)

ArTéMiS: key facts

- ArTéMiS @ APEX :
  - instrument available through ESO and OSO calls
    (350 μm: since 2013; 350 + 450 μm since 2016)
  - data reduction pipeline (APIS + Scanamorphos, Roussel+2013)

  now available - **www.apex-telescope.org/instruments/pi/artemis/data_reduction/**
  and material for ESO Single Dish 2018 workshop: https://github.com/teuben/sd2018
- On-sky performance:
  - resolution: 8" / 10" @ 350 / 450 μm
  - **3.5 x higher resolution** than *Herschel* / SPIRE
  - 5' x 2.5' field of view
  - >**4 x faster mapping** than SABOCA @ APEX
  - ~same resolution as *Herschel* / PACS @ 70 μm

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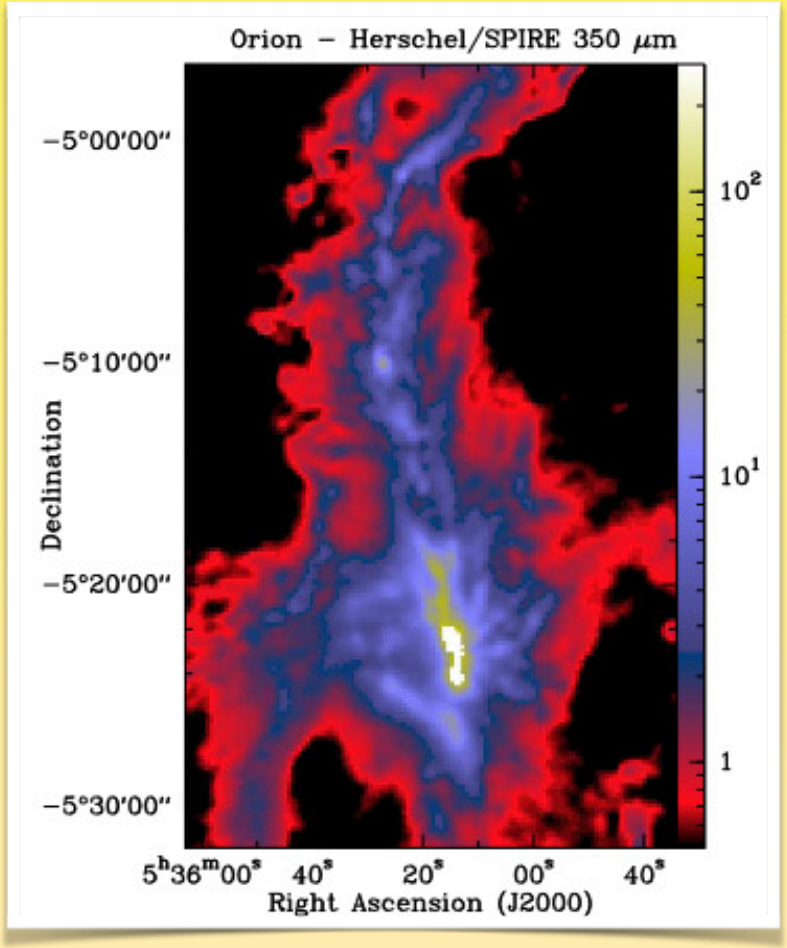
- Fast-scanning OTF maps

  ⇒ high-resolution mapping machine
- BUT: Calibration extremely tricky
  - zenith τ_{350} (PWV = 0.5 mm) ≈ 0.9
  - gain **very** sensitive to dish and sub-ref. surface accuracy

  ⇒ WORK IN PROGRESS…

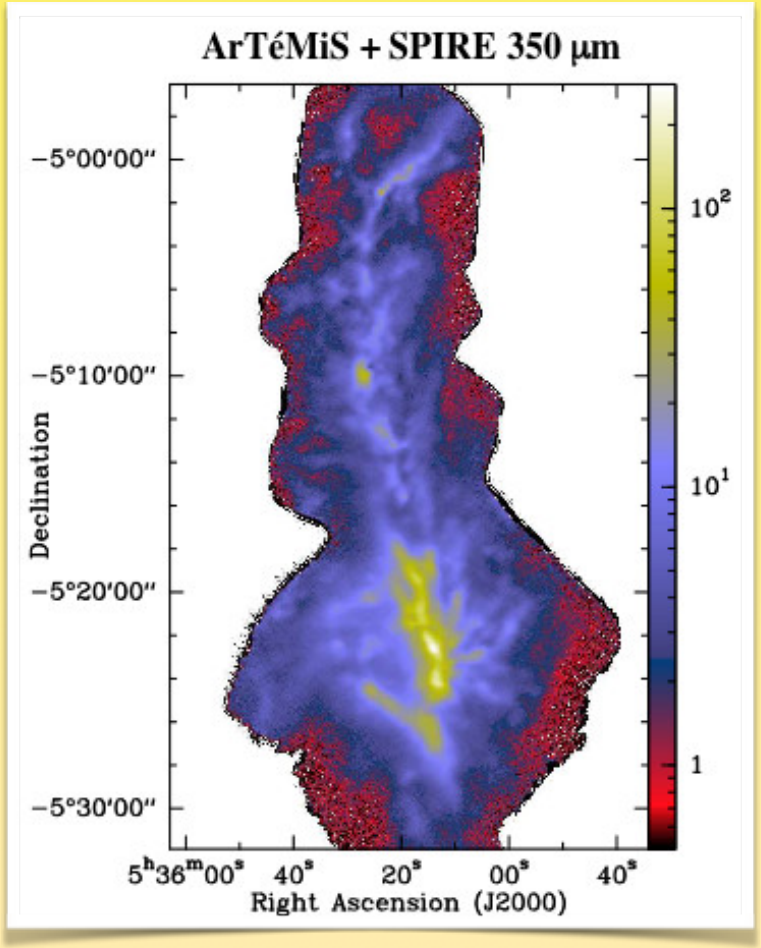
ArTéMiS: 8” resolution @ 350 μm

Herschel: HPBW ~ 25” → ~0.05 pc



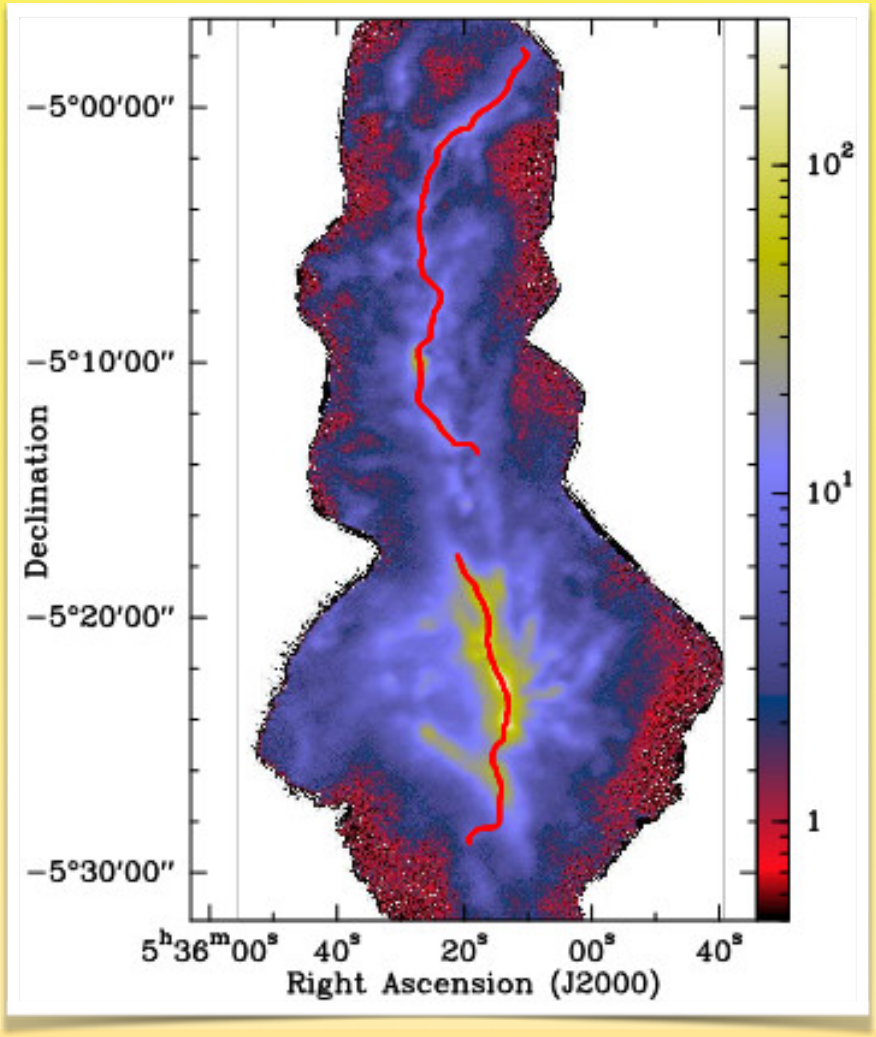
HGBS data
Polychroni, Pezzuto et al., in prep.

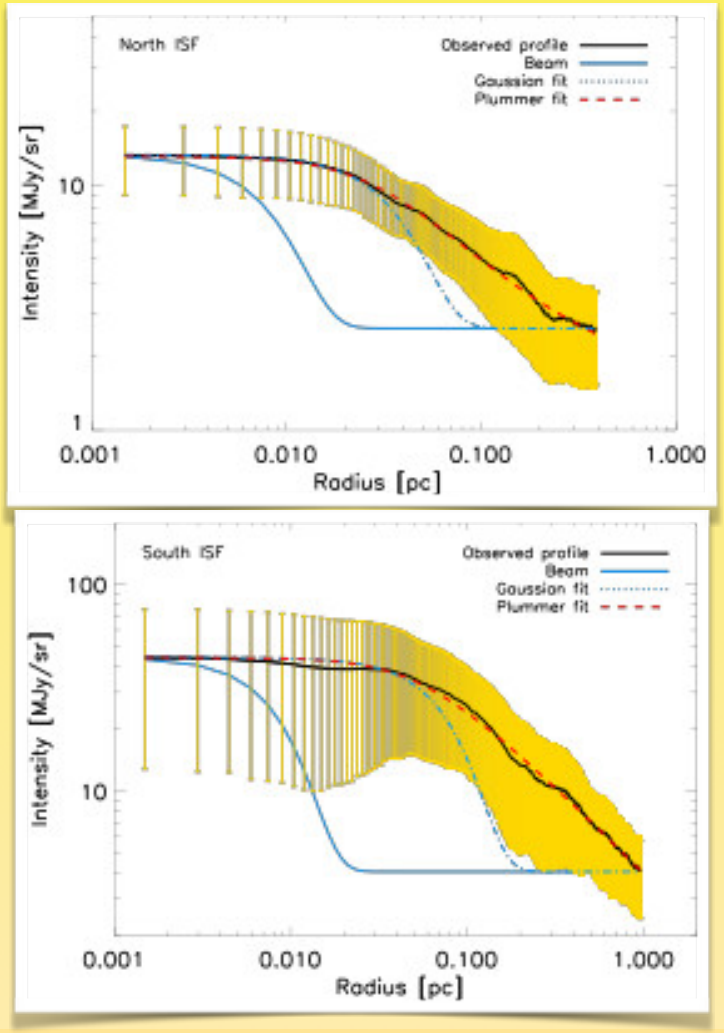
ArTéMiS: HPBW ~ 8” → ~0.016 pc



ArTéMiS (2013+2016) data
Könyves, Shimajiri, Schuller,
André et al., in prep.

Orion integral-shaped filament





Deconvolved FWHM width and diameter of flat inner plateau:

0.06 +- 0.03 pc (N) & 0.14 +- 0.05 pc (S)

(Könyves, Arzoumanian, et al. in prep.)

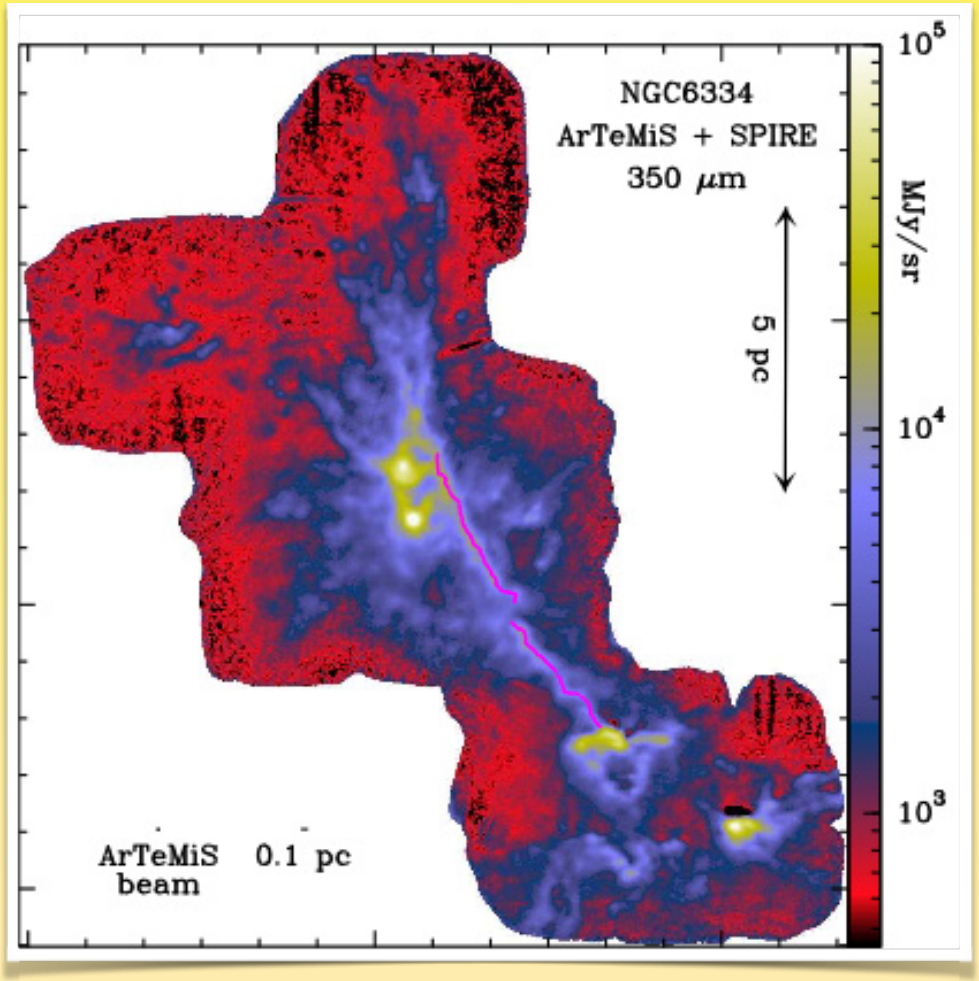
Mapping interstellar filaments

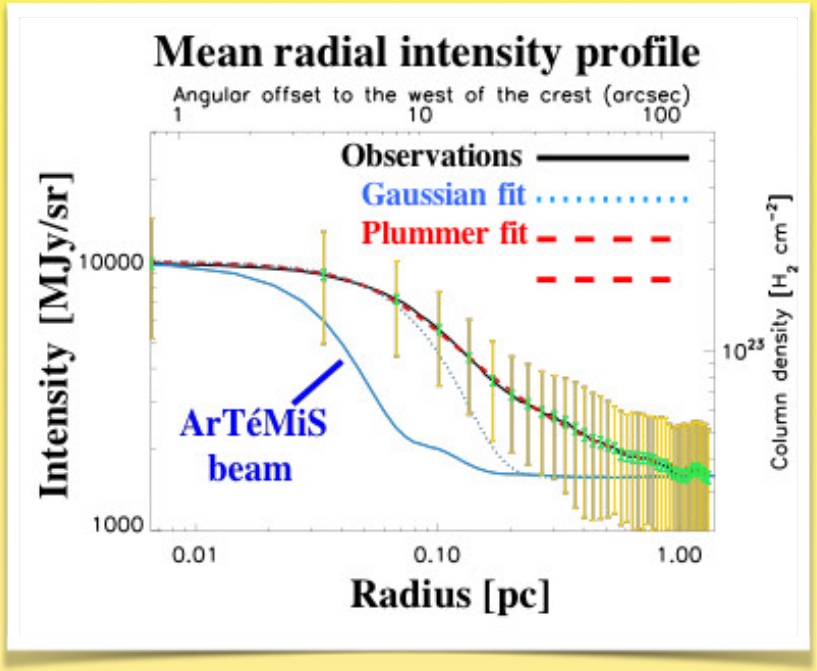
ESO Photo Release ArTéMiS 350 μm + VISTA near-IR

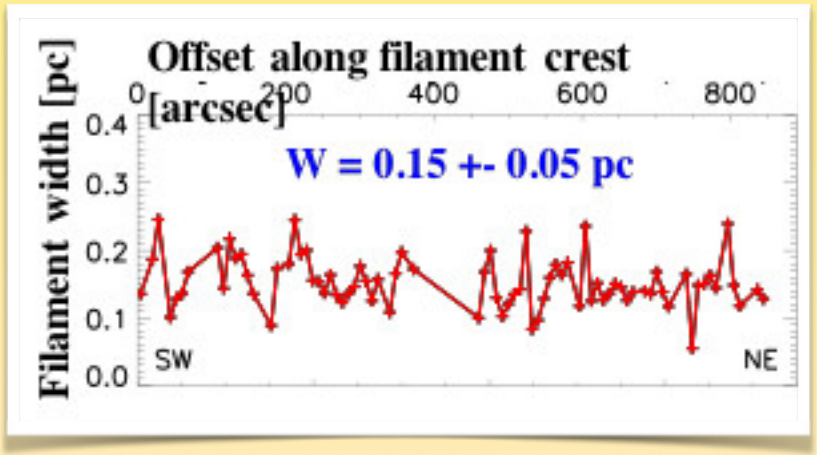
- NGC 6334 (d ~ 1.7 kpc)
- observed 2013 (only 350 μm)
- André et al. 2016, *A&A* 592, A54

Resolving interstellar filaments

NGC6334 main filament: M/L ~ 1500 M$_\odot$/pc







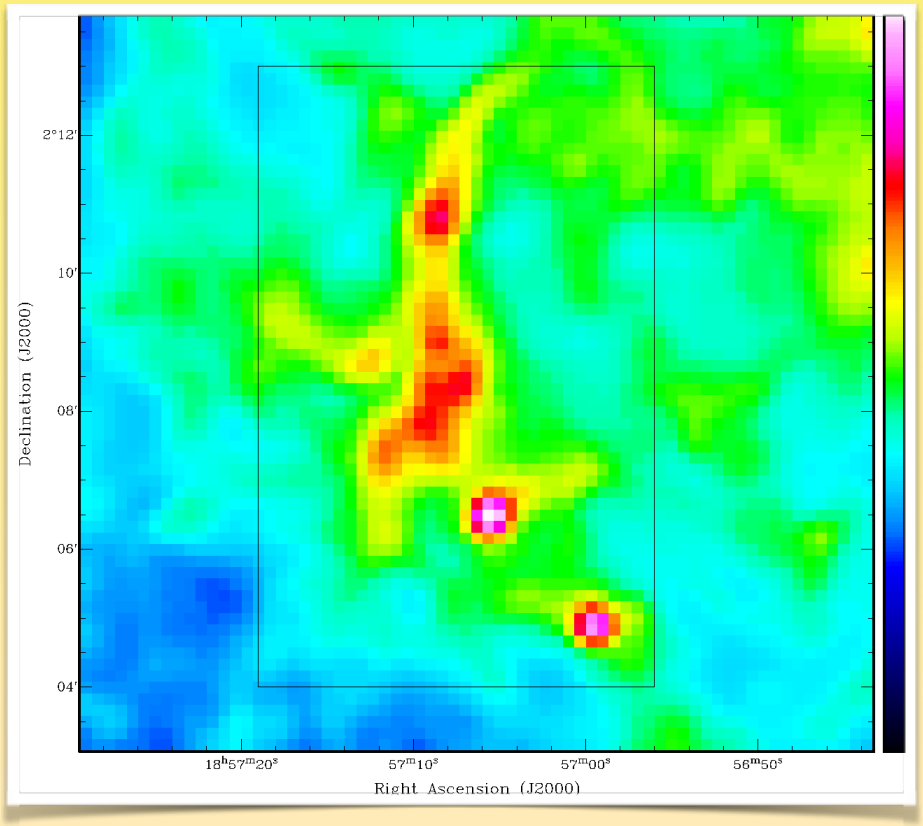
André et al. 2016, A&A 592, A54

See also Russeil+2013, Tigé+2017 for Herschel/HOBYS results on NGC6334

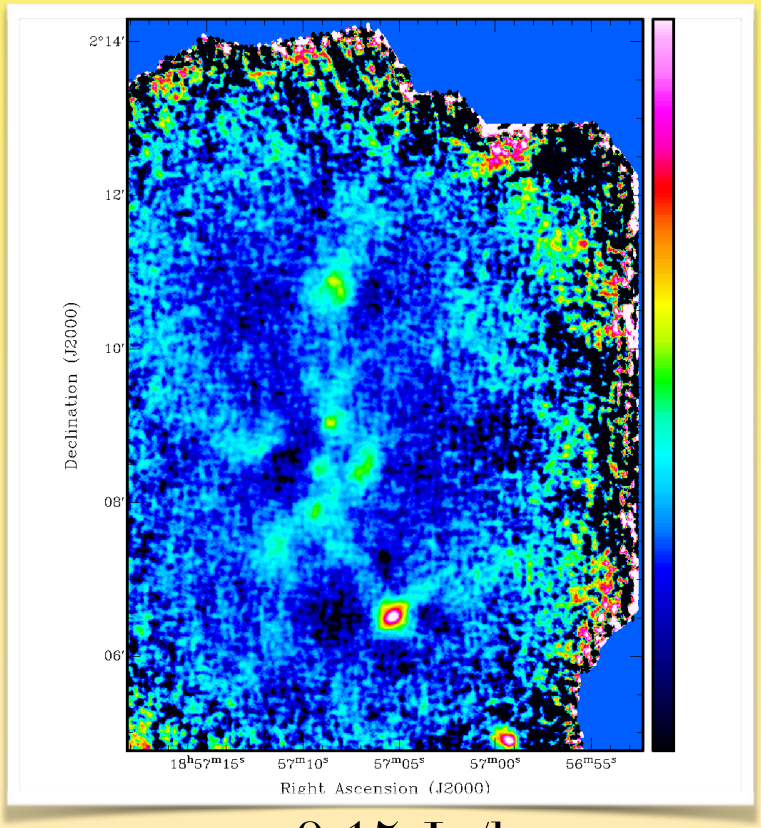
Filaments, clumps and cores

IRDC G035.39-00.33 in the W48 complex (d ~ 3 kpc)

Herschel 350 μm
(Nguyen-Luong+ 2011)



ArTéMiS 350 μm



rms ~ 0.15 Jy/beam

$\Rightarrow$ 5-$\sigma \approx$ 6 M$\odot$ [T = 15K]

Schuller, Pezzuto et al. in prep.

Complementarity ArTéMiS-Herschel

- Combine ArTéMiS + Herschel
  - Herschel @ 350 μm:

    $\Rightarrow$ retrieve (more) extended emission
  - Herschel @ 70 μm: **same resolution as ArTéMiS !**

    $\Rightarrow$ discriminate pre- / proto-stellar cores

    $\Rightarrow$ derive M(env) @ 350 μm and L(proto*) @ 70 μm

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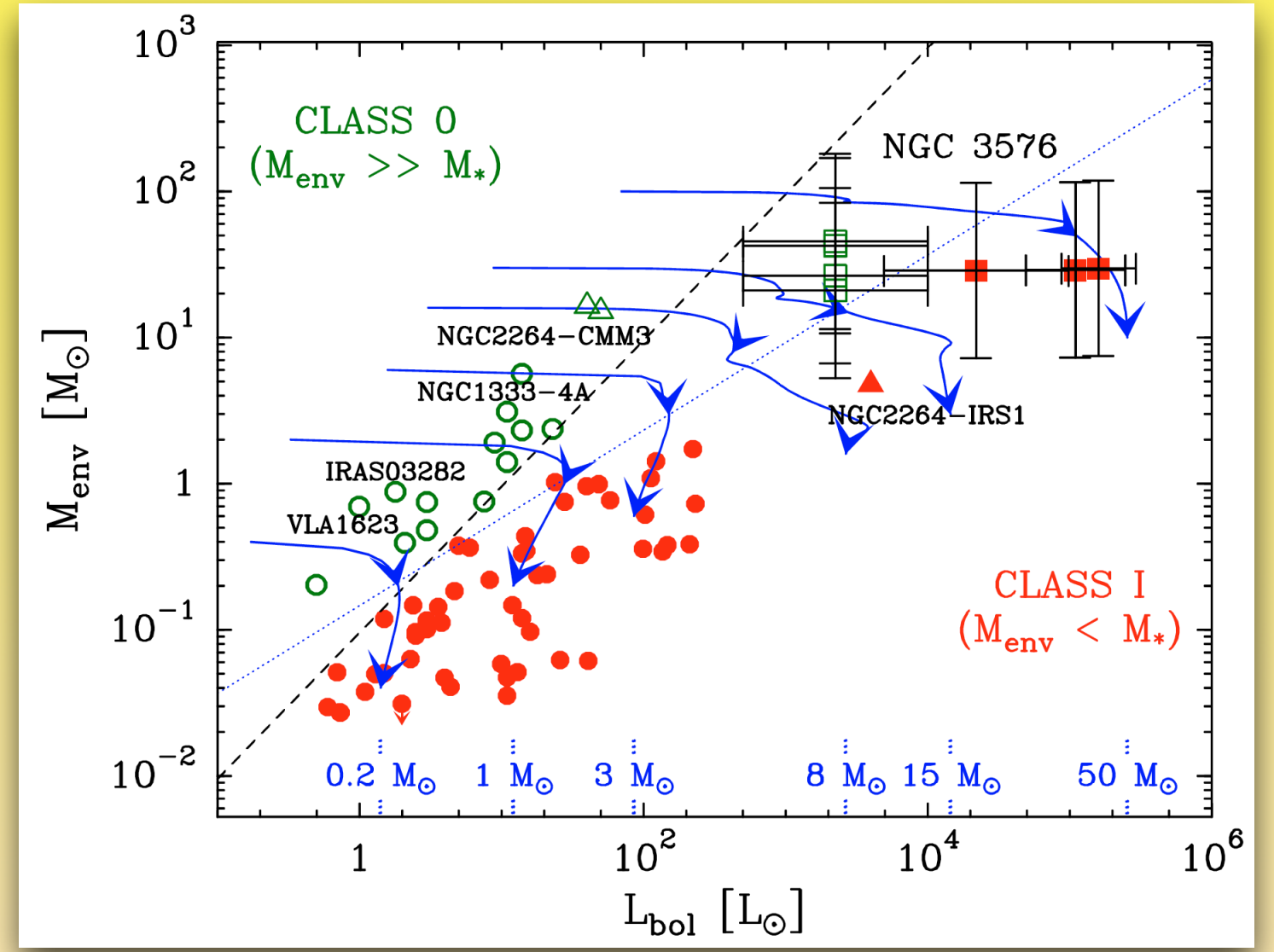

André et al. 2008
A&A 490, L27

Based on p-ArTéMiS 450 μm data

$\Rightarrow$ derive M(env) @ 350 μm and L(proto*) @ 70 μm

Perspectives

- Combine ArTéMiS + Herschel :
  - for NGC6334, Orion: DONE ✓
  - to do: data 2017+ (W48, M17…)

    → ArTéMiS + Herschel/SPIRE @ 350 & 500 μm:

    ⇒ retrieve (more) extended emission

    → Herschel @ 70 μm: **same resolution as ArTéMiS** !

    ⇒ discriminate pre- / proto-stellar cores

    ⇒ derive M(env) @ 350 +450 μm and L(proto*) @ 70 μm

Perspectives

- ArTéMiS: large programme submitted to ESO (P102-105) to map **all** Galactic dense ($A_V > 40$ mag) star-forming clumps up to ~3 kpc
- **ArTéMiS + Herschel :**
  - high spatial dynamic range (8" to degrees)
  - pre- vs. proto-stellar clumps
  - complete diagrams of M_{env} and L_{int} for massive protostars
- New detectors for ArTéMiS sensitive to polarisation (~2020) developed by CEA in the context of SPICA space project

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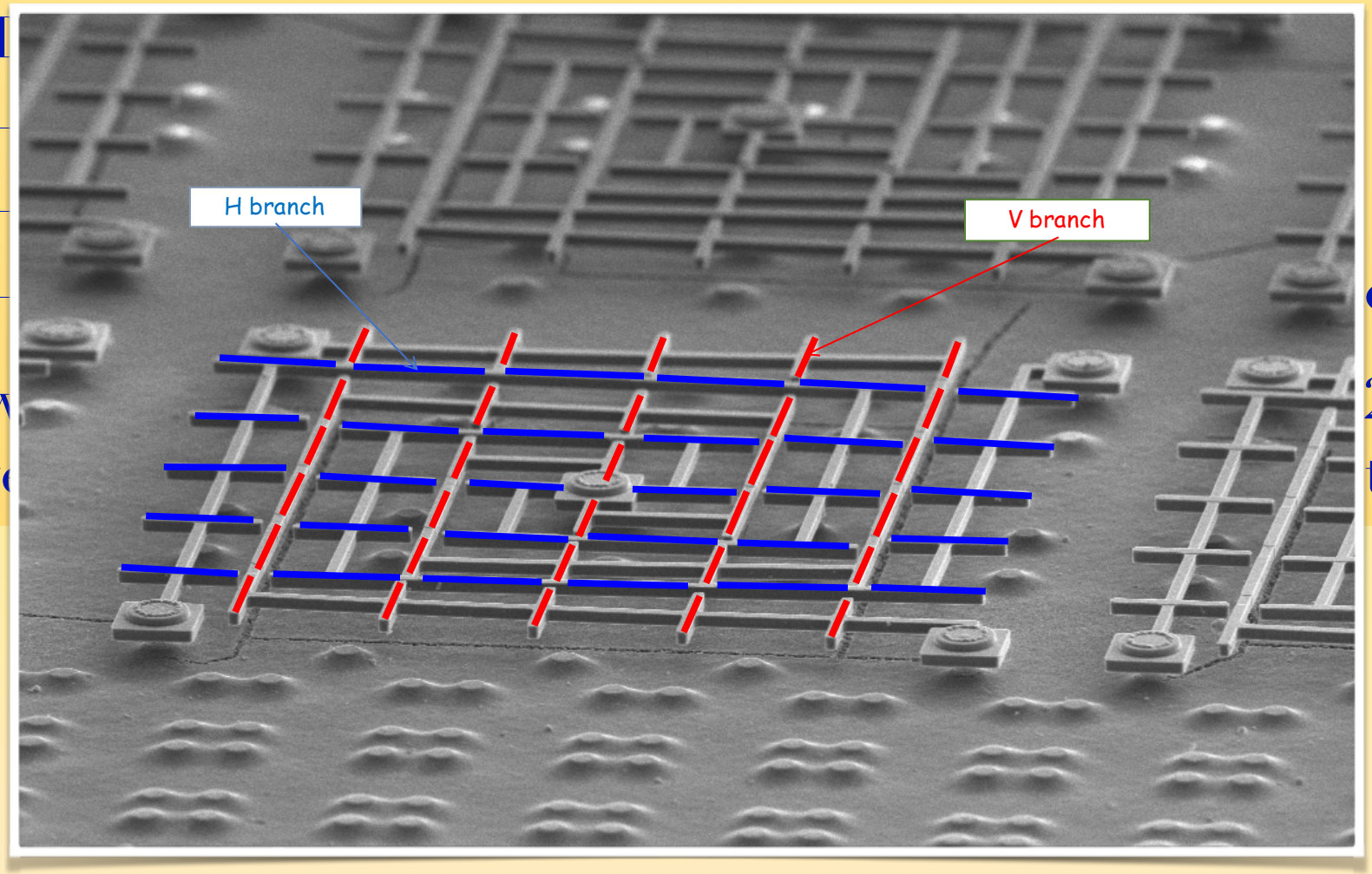

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Thanks to: PNPS + PCMI (p-ArTéMiS, and 2018)
ANR (2006-2009),
and continuous support from ESO and APEX staff