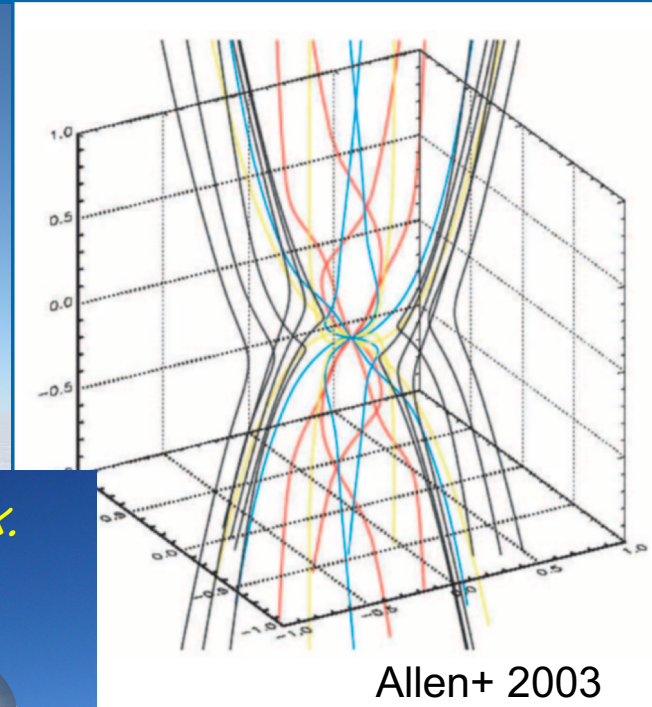


# Tracing B-fields in protostellar targets across spatial scales with ALMA, SOFIA, BLAST, and APEX

Giles Novak,  
Northwestern  
University



“mag. braking  
catastrophe”  
Z. Li + 2014

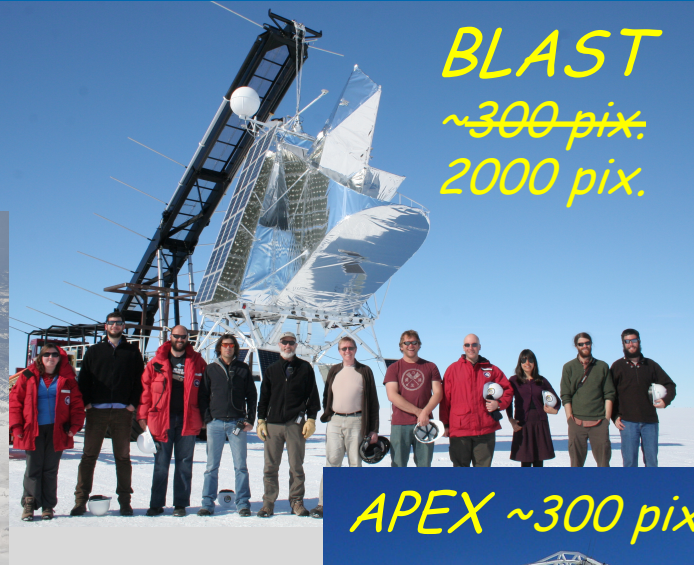
**ALMA**



# Tracing B-fields in protostellar targets across spatial scales with ALMA, SOFIA, BLAST, and APEX

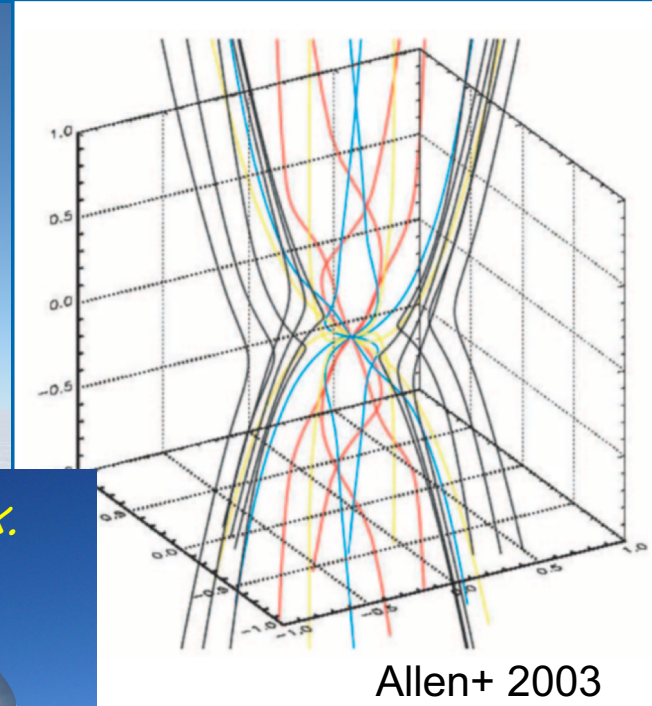
Giles Novak,  
Northwestern  
University

*HAWC+ / SOFIA*  
~ 5000 pix.



*BLAST*  
~300 pix.  
2000 pix.

*APEX* ~300 pix.

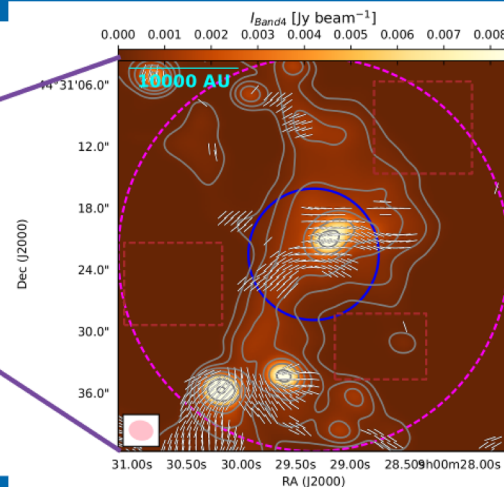
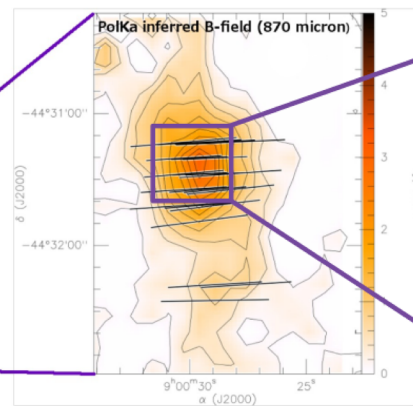
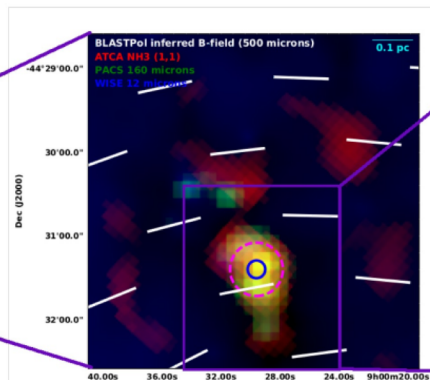
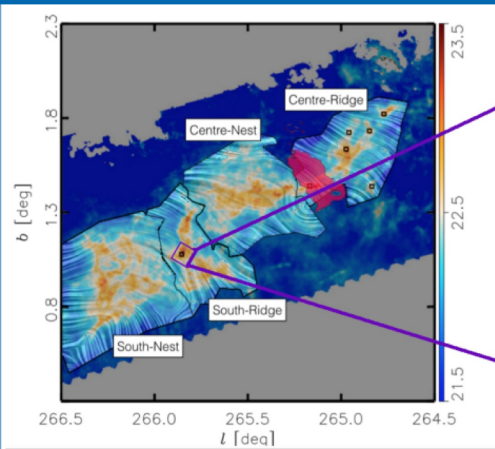


“mag. braking  
catastrophe”  
Z. Li + 2014

*ALMA*



# Tracing B-fields in Vela C South Ridge from "entire cloud scales" down to 2000 au (Williams+ in prep.)



**BLAST 2012 flight – 250-500  $\mu\text{m}$**   
(Fissel+ '16, '19, Soler+ '17, Gandilo+ '16,  
Santos+ '17, Ashton+ '18)

**Polka / APEX  
870  $\mu\text{m}$**   
preliminary  
result

**ALMA Band 4**  
(P.I.: Fissel)  
prelim. result



L. Fissel,  
Queen's University  
Canada

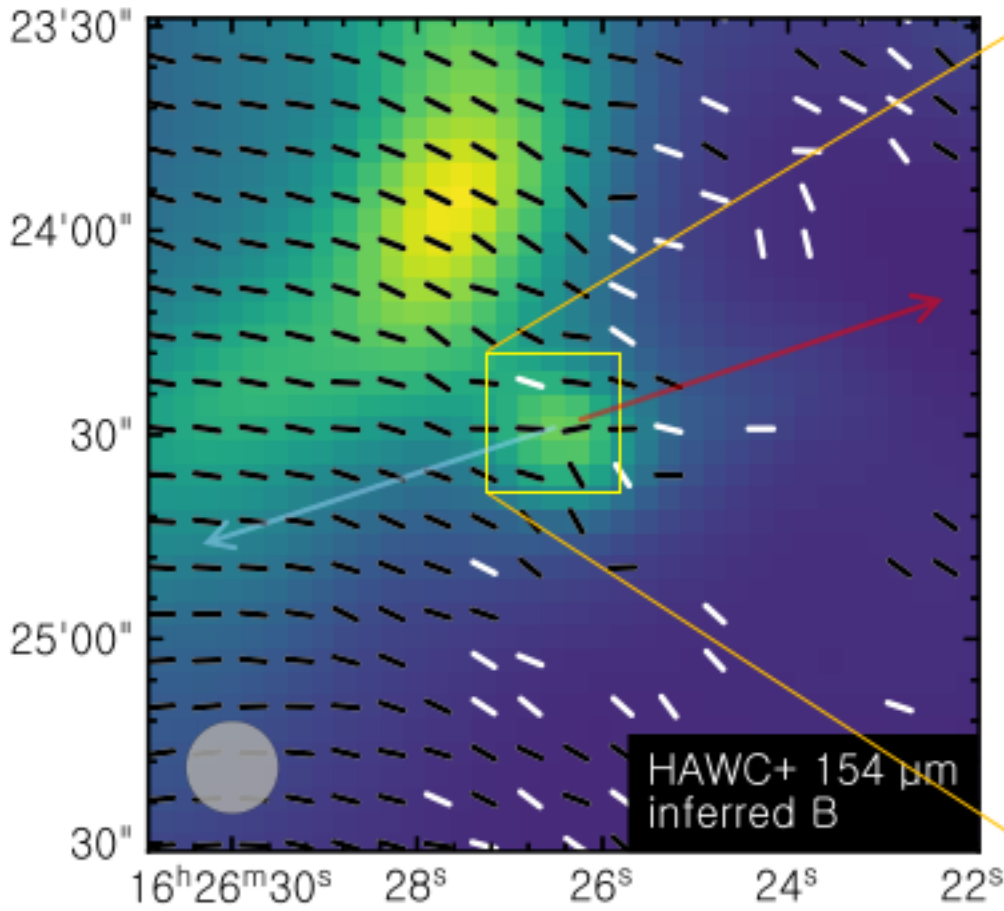


P. Williams  
Northwestern U.

other collaborators: C.-Y. Chen, P. Cortes, M. Cunningham, P. Jones, Z.-Y. Li, L. Looney, G. Novak, **T. Pillai**, J. Soler, **H. Weisemeyer**

*Six times closer - a protostellar triplet in Ophiuchus*  
(Sadavoy+ in prep.)

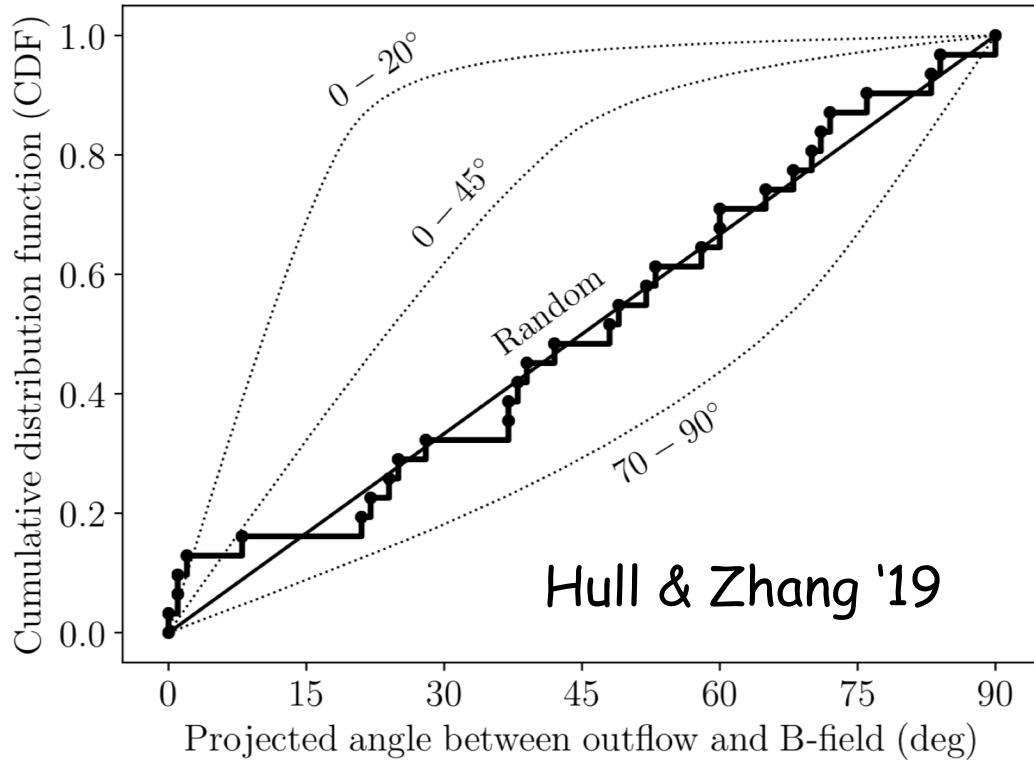
VLA 1623-AB in L1688  $\rho$  Oph A



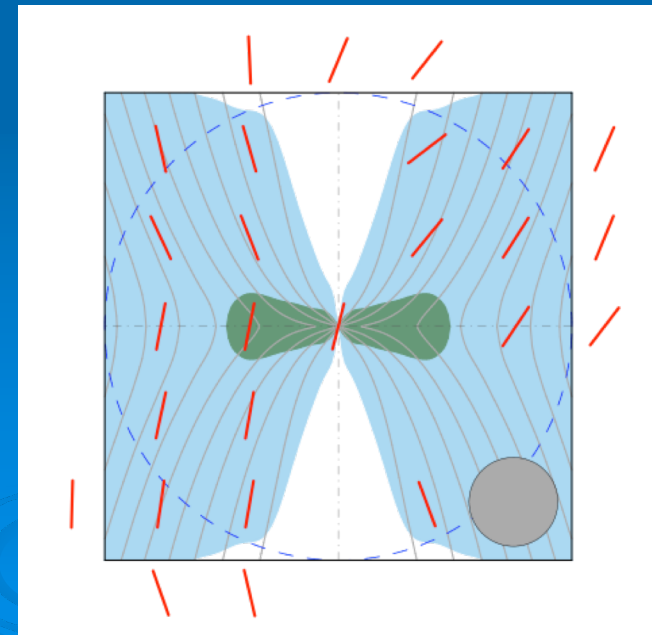
ALMA image of VLA 1623-AB polarization is **not** included in on-line version of this presentation, due to preliminary nature of the analysis. Please stay tuned!

# *previous work on relative alignment of B-field & ang. mom.*

**Figure 4.** The thick, stepped curve shows the cumulative distribution function (CDF) of the (projected) angles between the bipolar outflows and the mean magnetic-field orientations in the full sample of low-mass protostellar cores observed to date in full polarization with BIMA, the SMA, CARMA, and ALMA.



Chapman+ '13



*hints of trends in B vs. J*: Galametz+ '18;  
Segura-Cox+ '18; H.-W. Yen+ '15;

*similar, for simulations*: Offner & Chaban '17

# *ToI TEC at LMT*

*a 7000-pixel mm-wave polarimeter  
with 5" resolution*



P.I.:

G. Wilson (U. Mass.)

Project Scientists:

I. Aretxaga (INAOE)

A. Pope (U. Mass.)

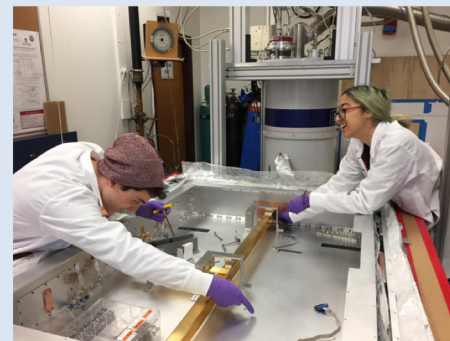
funded by NSF MSIP

## Specifications and Timeline: ToI TEC /LMT



### **Large Millimeter Telescope (LMT)**

- world's largest millimeter telescope
- 50 m primary mirror with active surface
- binational project between Mexico & USA
- located at 15,000 ft. summit of Volcan Sierra Negra, central Mexico



### **ToI TEC**

Observes simultaneously in three bands centered at ...

- 1.1 mm (5" resolution, 3600 detectors)
- 1.4 mm (6.5" resolution, 1800 detectors)
- 2.1 mm (10" resolution, 900 detectors)

**Schedule:** cooldown of complete cryostat underway (see above); commissioning at LMT in Dec. 2019; Four Public Legacy Surveys (2 galactic, 2 extragalactic) start 2020; interim data release early 2021; final data release late 2021



# ToI TEC at LMT

a 7000-pixel mm-wave polarimeter  
with 5" resolution

Example targets – for both C2C and FiF surveys

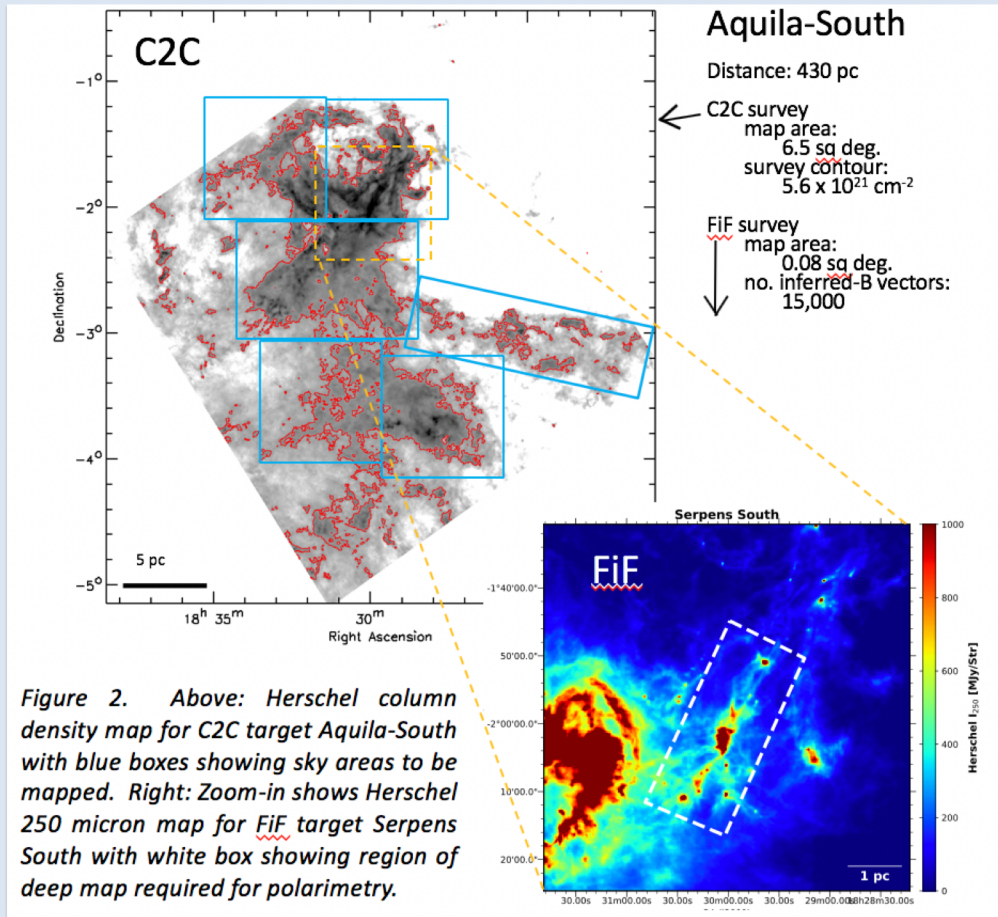


Figure 2. Above: Herschel column density map for C2C target Aquila-South with blue boxes showing sky areas to be mapped. Right: Zoom-in shows Herschel 250 micron map for FiF target Serpens South with white box showing region of deep map required for polarimetry.



## Fields-in-Filaments (FiF) Survey:

- Total observing time: 100 hours
- Resolution (1.1 mm band): 5 arcseconds
- Total No. of independent inferred B-vectors: 70,000

target clouds: B1 in Perseus; B211/213 in Taurus; Serpens South; Rho Oph C, E, F; OMC 2, 3 (also two IRDCs)

# *Tracing B-fields in protostellar targets across spatial scales*

## *SUMMARY*

- 1. Comparing cloud B-fields with protostellar B-fields may show how nature determines stellar multiplicity and architecture of planetary systems*
- 2. Initial attempts to link large-scale B-fields to ALMA B-fields show hints of continuity, especially in Vela C South Ridge (Williams+, in prep), but maybe even to 100 au scales in VLA 1623-AB (Sadavoy+ in prep)*
- 3. The ToI TEC Fields-in-Filaments Survey (Fissel, Novak, co-coordinators) complements ALMA with good u-v plane overlap at similar wavelengths for a statistically significant sample of protostellar systems*





