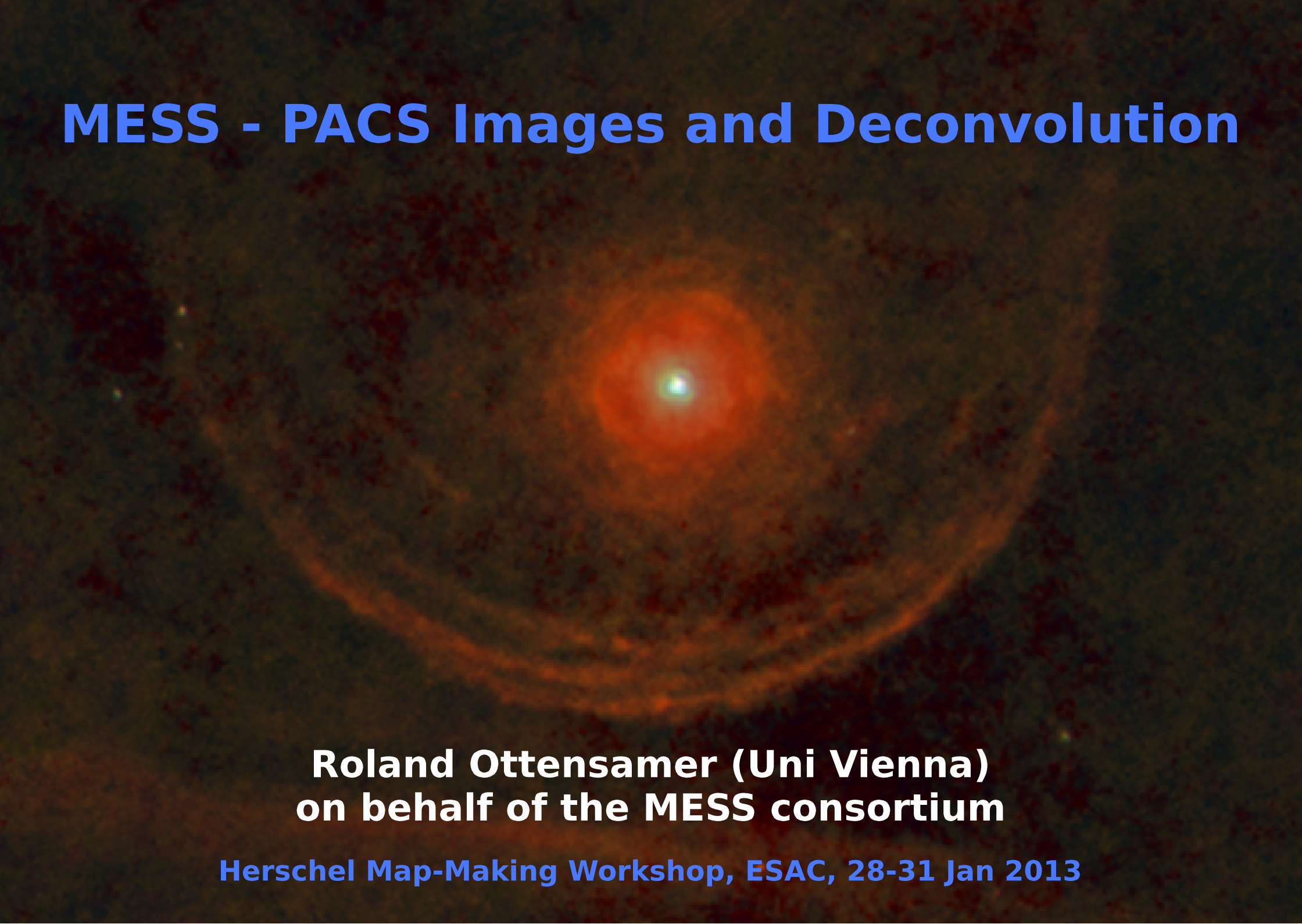


MESS - PACS Images and Deconvolution

Roland Ottensamer (Uni Vienna)
on behalf of the MESS consortium

Herschel Map-Making Workshop, ESAC, 28-31 Jan 2013

MESS - Mass loss of Evolved StarS

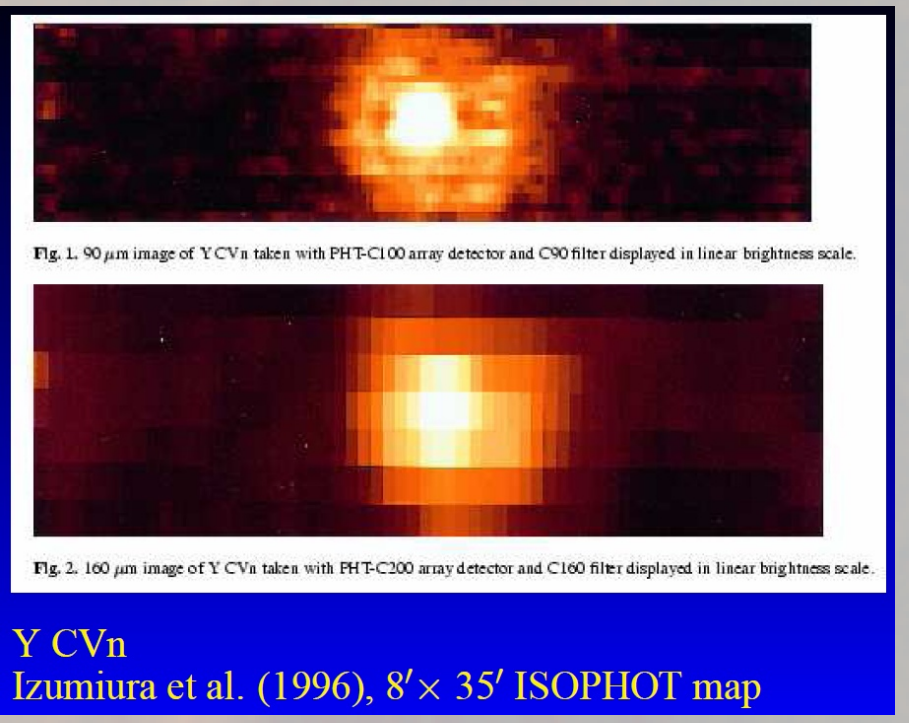
KP to study the circumstellar matter in evolved objects

PI: Martin Groenewegen, OMA

Groenewegen et al. 2011

AGB, Post-AGB, PNe, RSG, WR, LBV, SN
focusing on nearby objects

Mass-loss dominates the evolution
How? How much? Time evolution? Geometry? Dust species? Influence on PN shape? ISM interaction?
...



Y CVn
Izumiura et al. (1996), 8′× 35′ ISOPHOT map

PACS+SPIRE, Phot+Spec

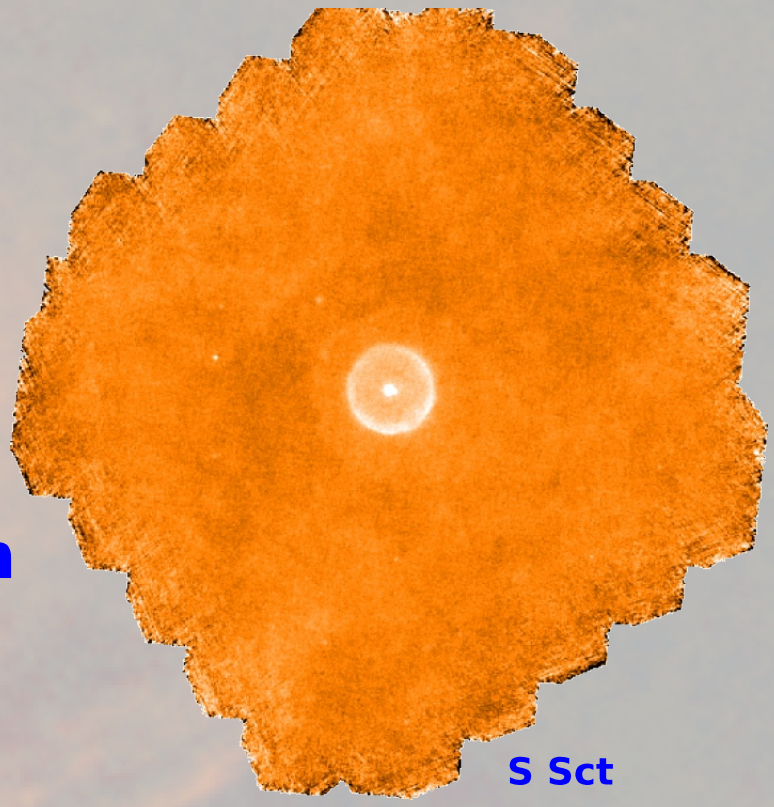
using GT from: Belgium, SPIRE SAG-6, Vienna, Heidelberg, HSC, MS

SDP_mgroen01_3: 20.8 h
KPGT_mgroen01_1: 286 h
GT2_mgroen01_6: 5.1 h

Implementation (Photometry)

~2/3 of the observation time are devoted to imaging.

~3/4 of the imaging is done with PACS



PACS: "Scan Maps" at 70 + 160 µm

- medium (20"/s) speed
- 30' map size
- scan + cross-scan, 3-8 repetitions

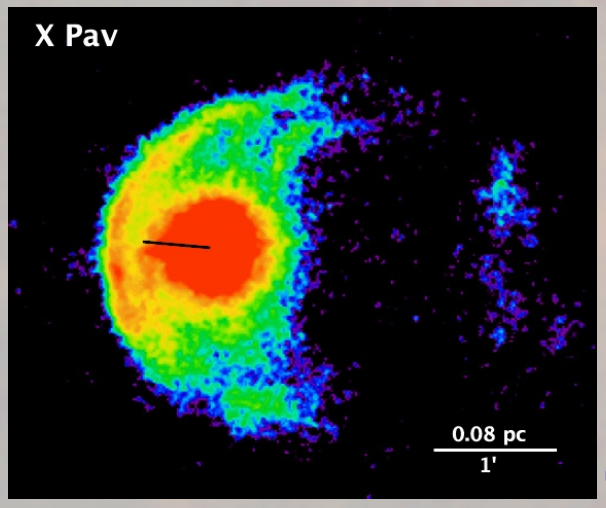
SPIRE: "Large Maps" at 250, 350, 500 µm

plus a few observations in parallel mode / other configurations.

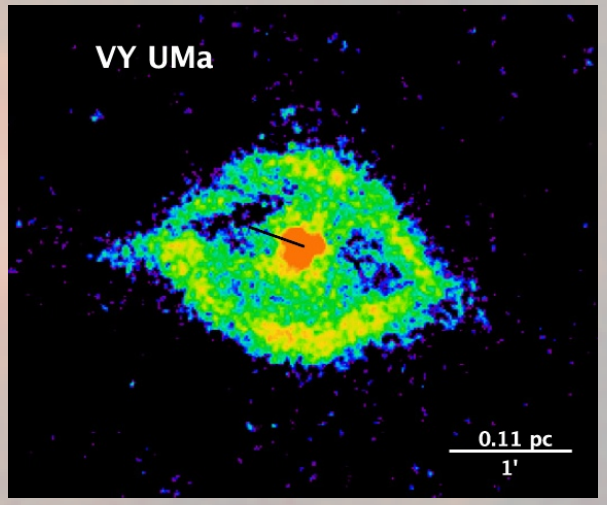
PACS Photometry

78 observations of AGB and RSG stars, allowing a first classification into four distinct classes:

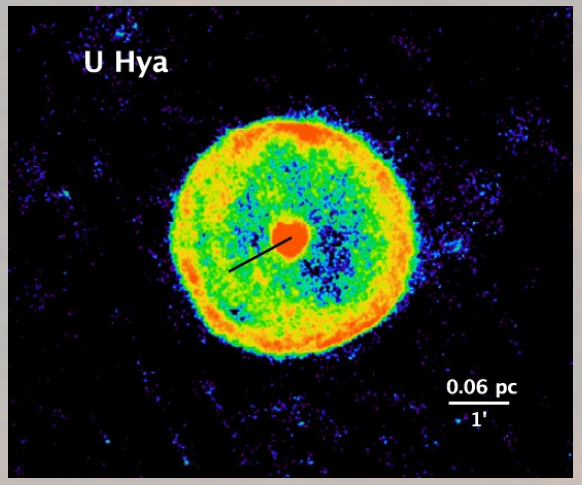
Cox et al. 2012



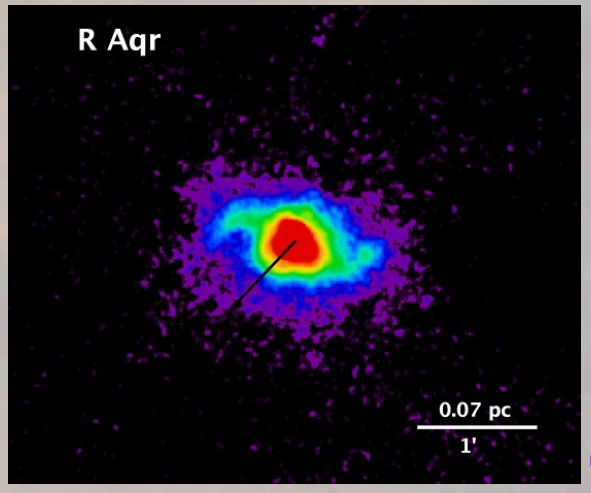
"fermata"



"eyes"

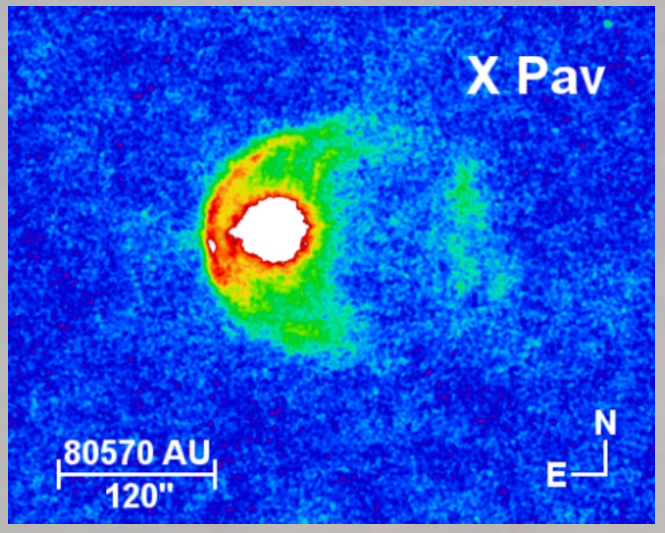


"rings"



"irregular"

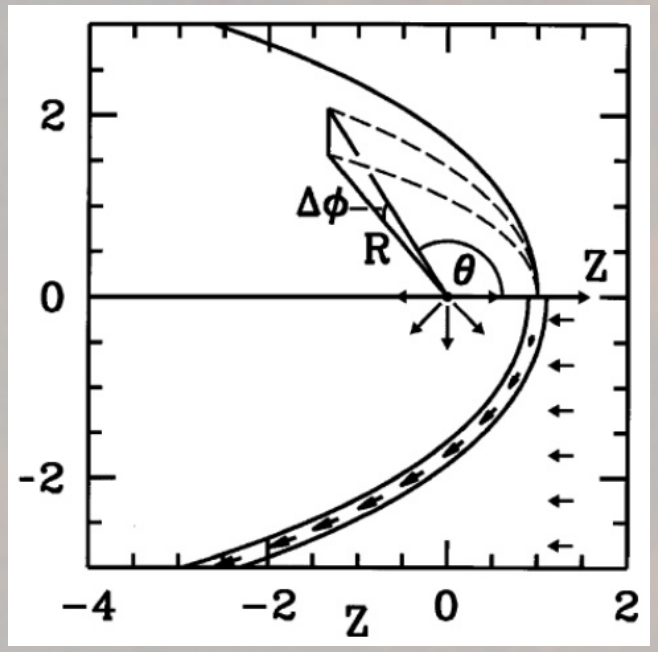
Wind-ISM Interaction



Bow shocks

Mayer et al. 2012

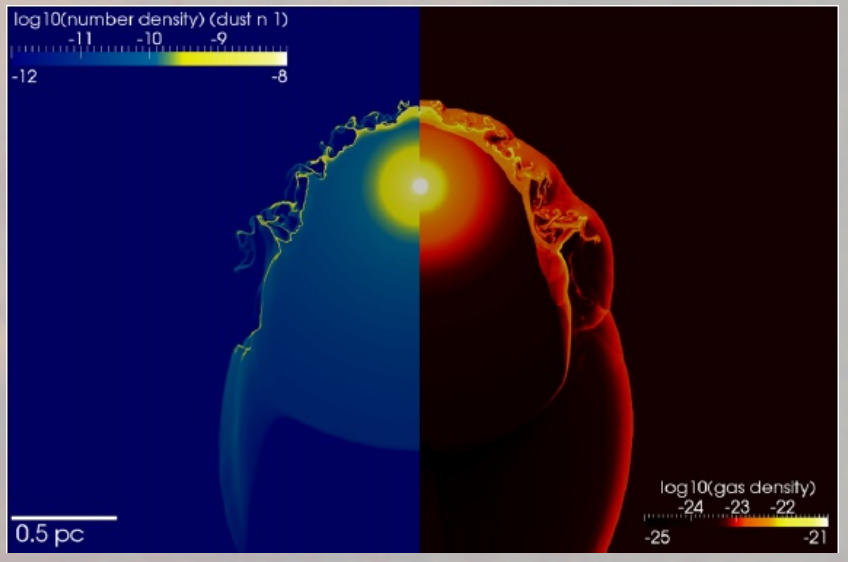
- feature is shock front & tail structure
- Wind hits ISM highly supersonic
- only AGB stars with high proper motion from bow shocks (vLSR > 40 km/s)
- most common morphology in MESS sample, ~1/3



Wilkin 1996

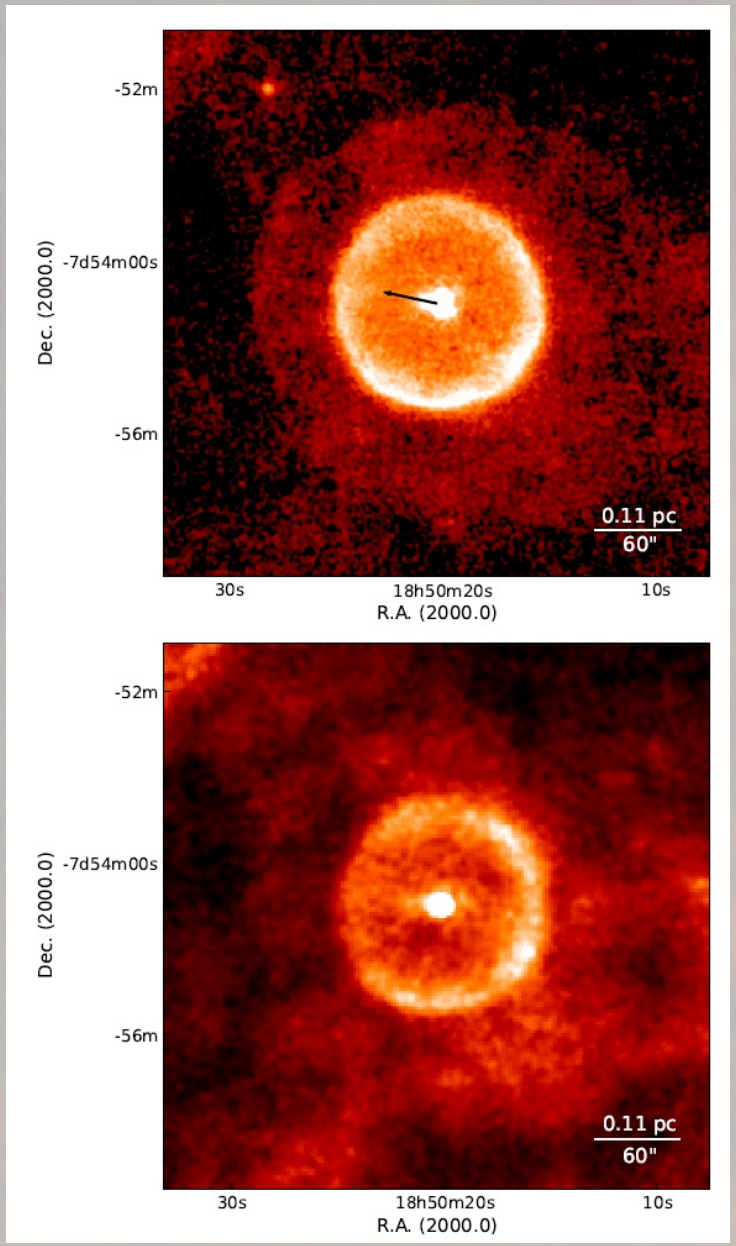
$$R(\theta) = R_0 \csc\theta\sqrt{3(1-\theta\cot\theta)}.$$

$$R_0 = \sqrt{\frac{\dot{m}_w V_w}{4\pi\rho_a V_*^2}}$$



Gas vs dust density, van Marle et al. 2011

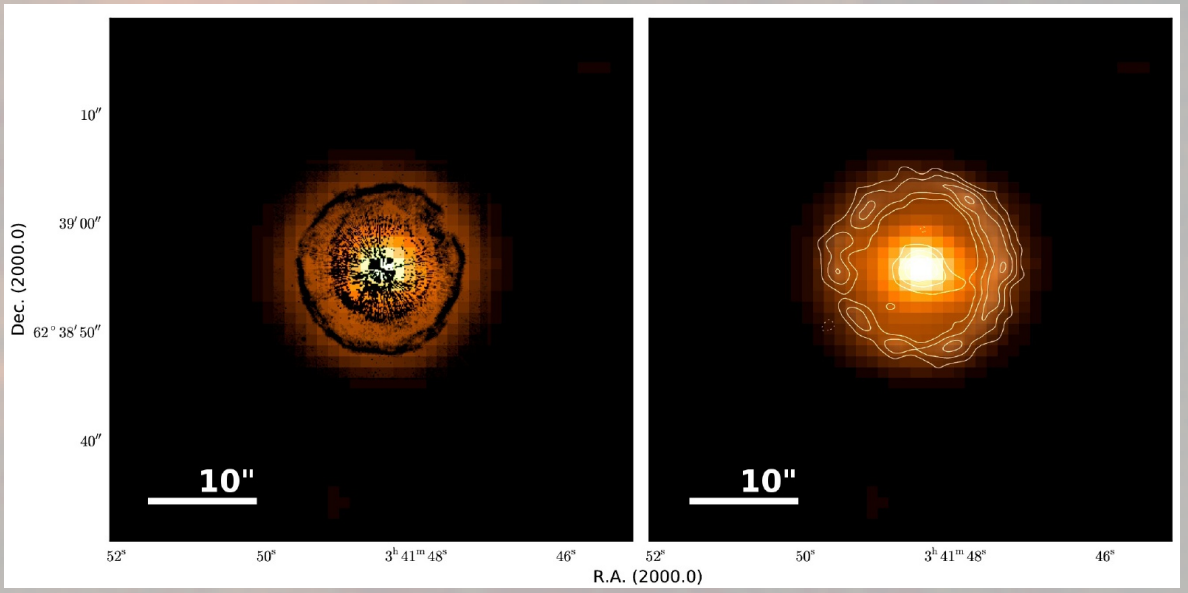
Detached Shells



S Sct

Fit radial profiles and spectra with synthetic models to derive Temp, C/O, Mass, Dust composition
Mecina et al. 2013

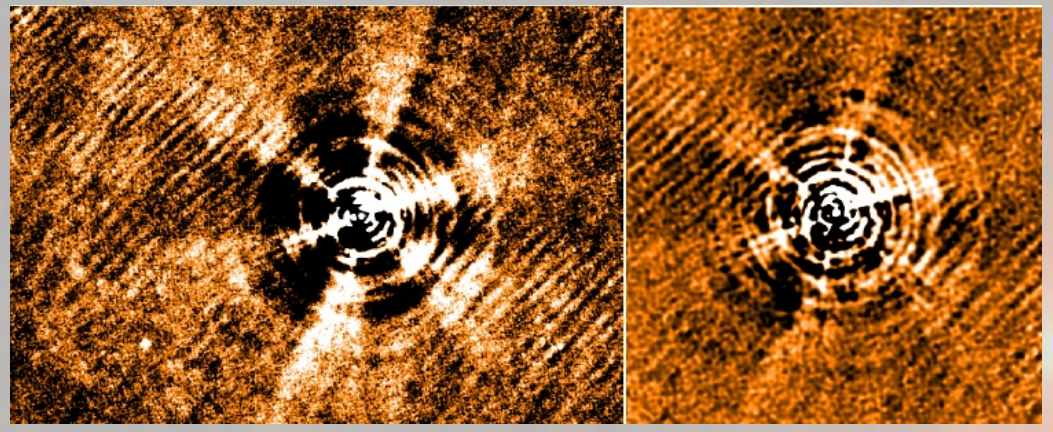
Dust observations from Herschel are very well aligned with CO observations!
Kerschbaum et al. 2011, Mecina et al. 2011



U Cam

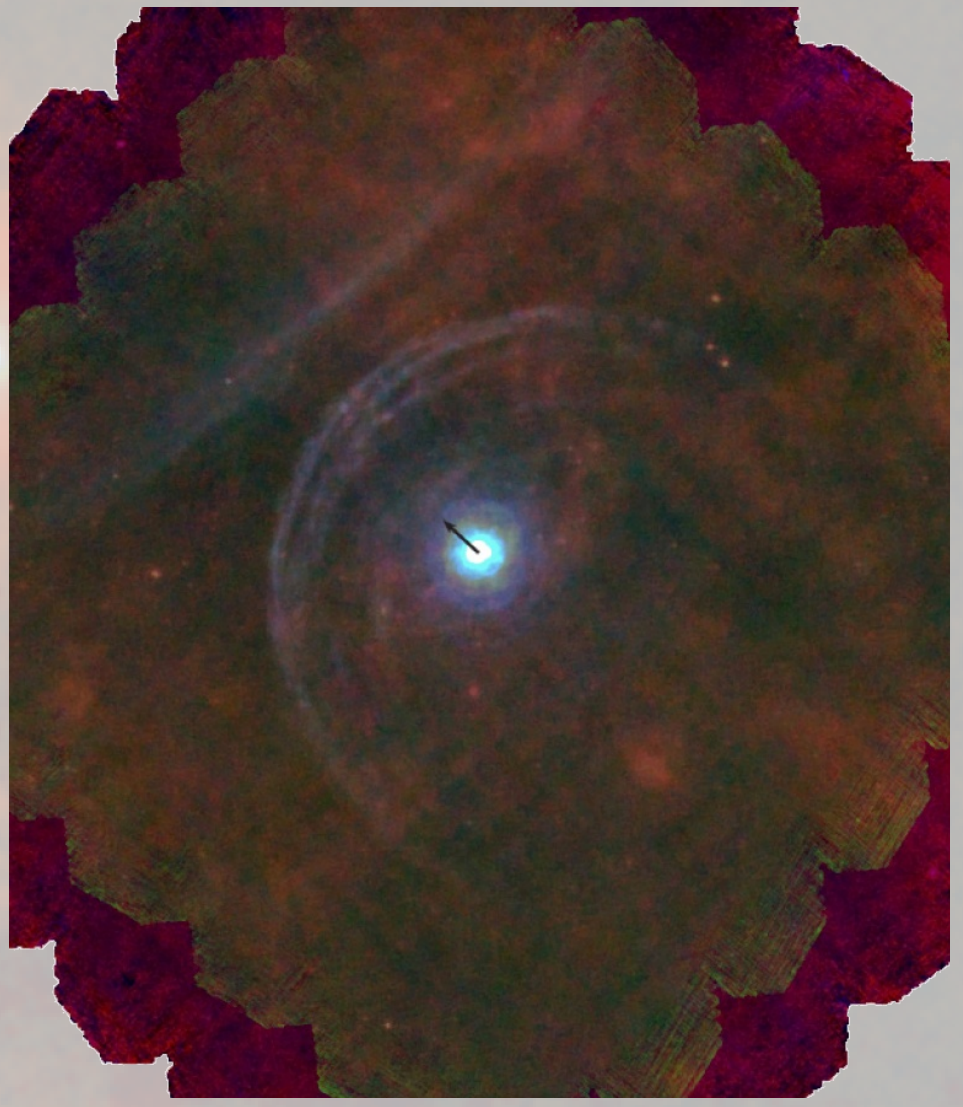
Imaging Highlights

CW Leo, Decin et al. 2012

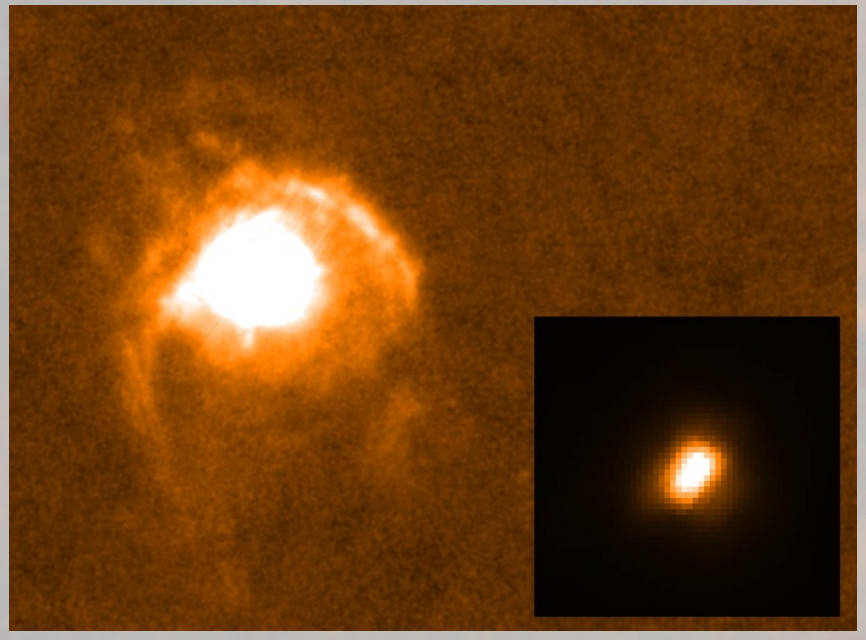


not deconvolved deconvolved

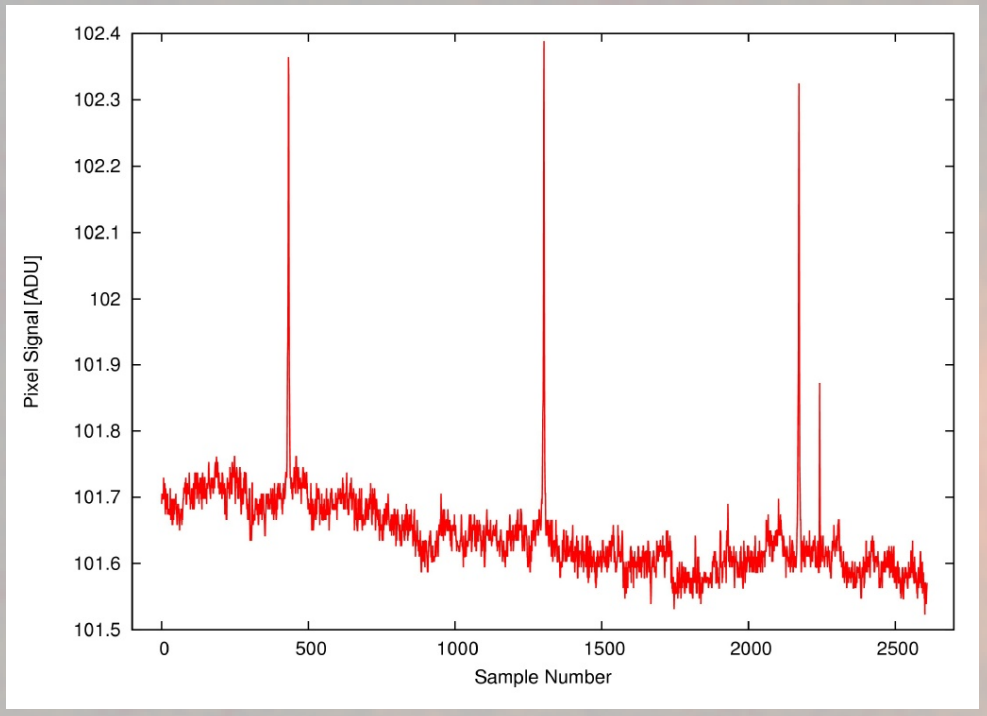
Betelgeuse, Decin et al. 2012



Mira, Mayer et al. 2011



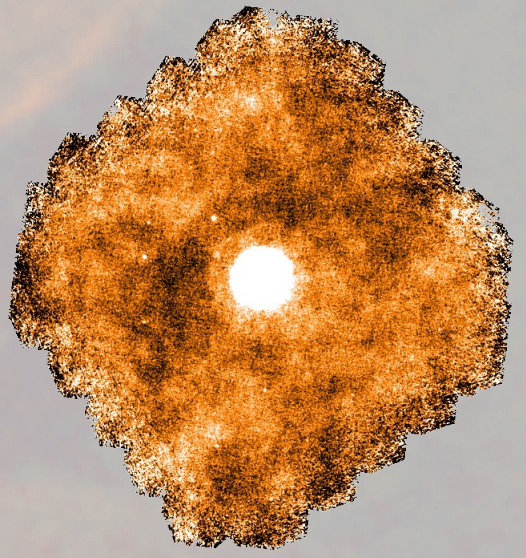
Typical Dataset



1-20 min per scan
3-8 repetitions per scan
Maps at 1" resolution

Photometry of:

- very bright Star (1-1000 Jy)
- faint features close to the star
- ISM BG

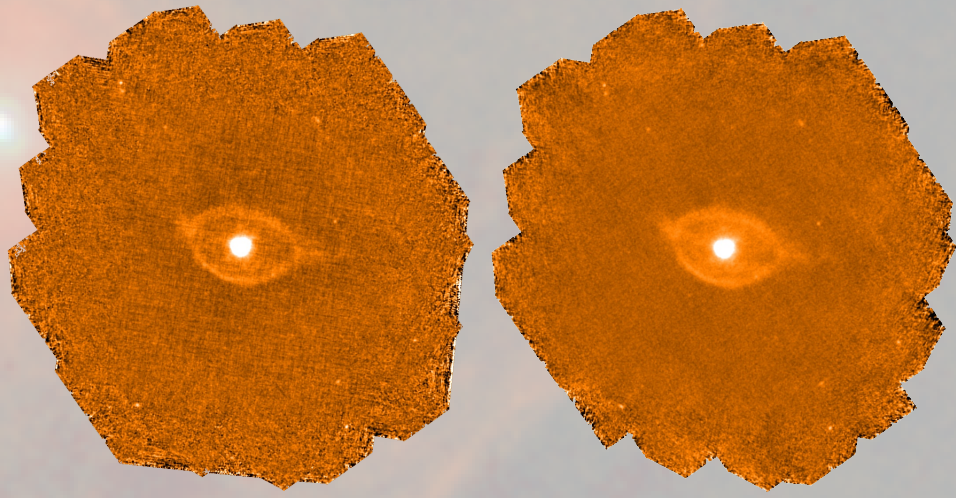


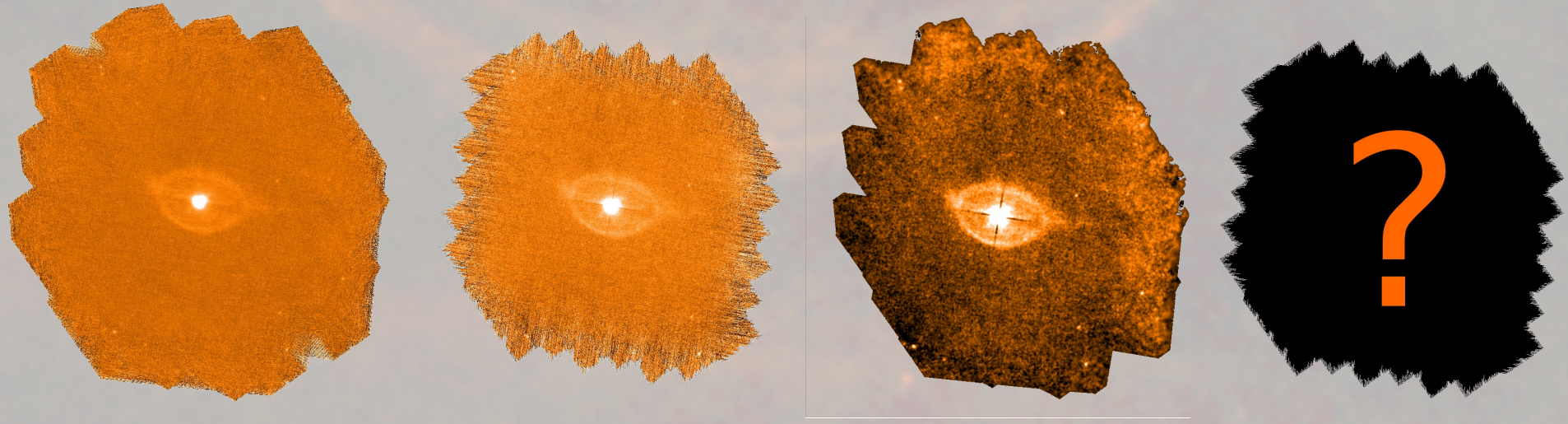
Comparison of Methods

PACS B observation processed *by users* with different mappers.

U Cam, 1342229979, 1342229980
1" map resolution

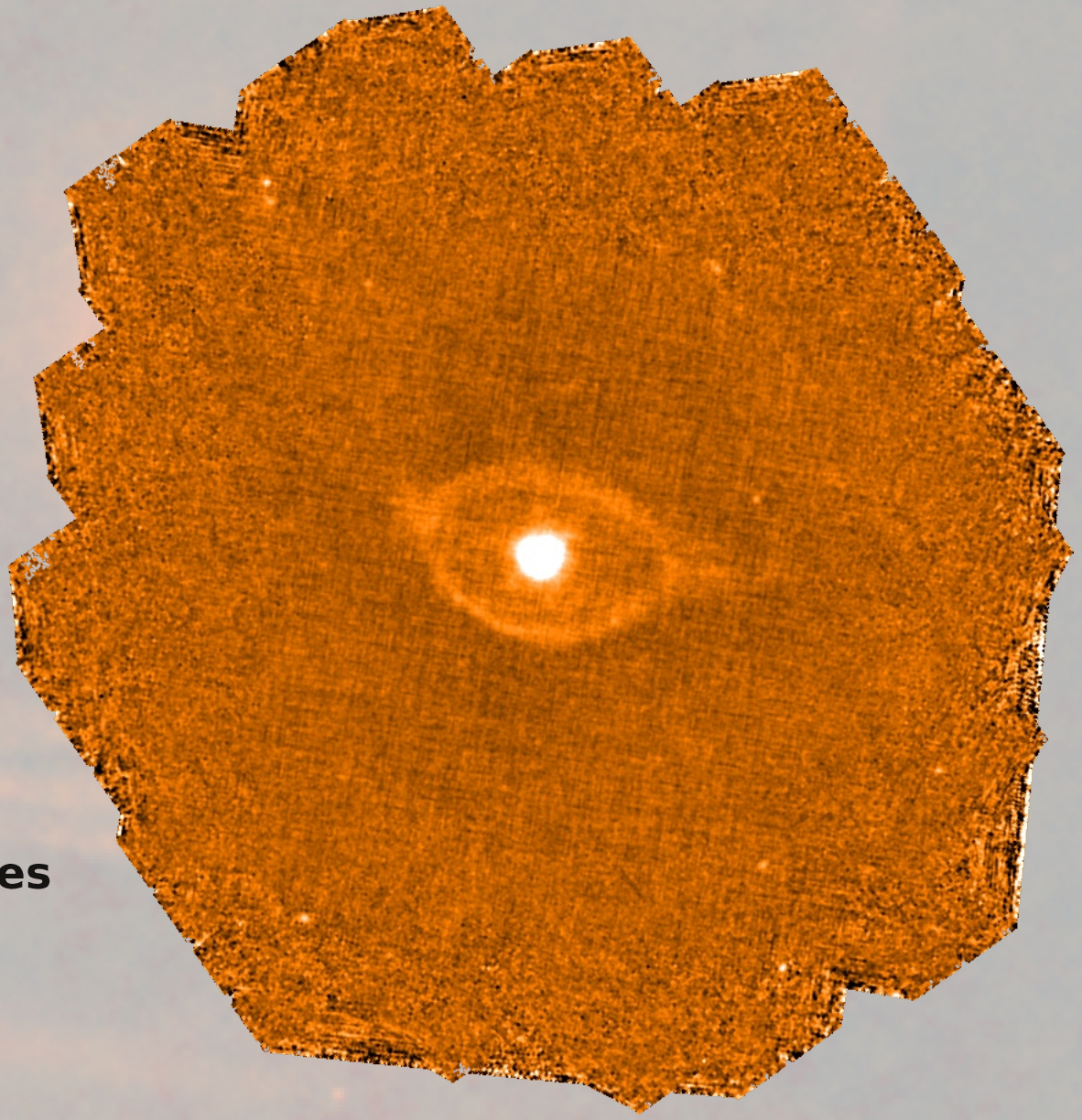
2 weeks time and some technical support given.





Comparison of Methods

Phot Project with masked HP filter



PROS:

- comes with HIPE
- easily customizable

CONS:

- very basic method
- single threaded
- memory limited
- very sensitive to filter width
- shadows around bright sources
- removes extended emission

Comparison of Methods

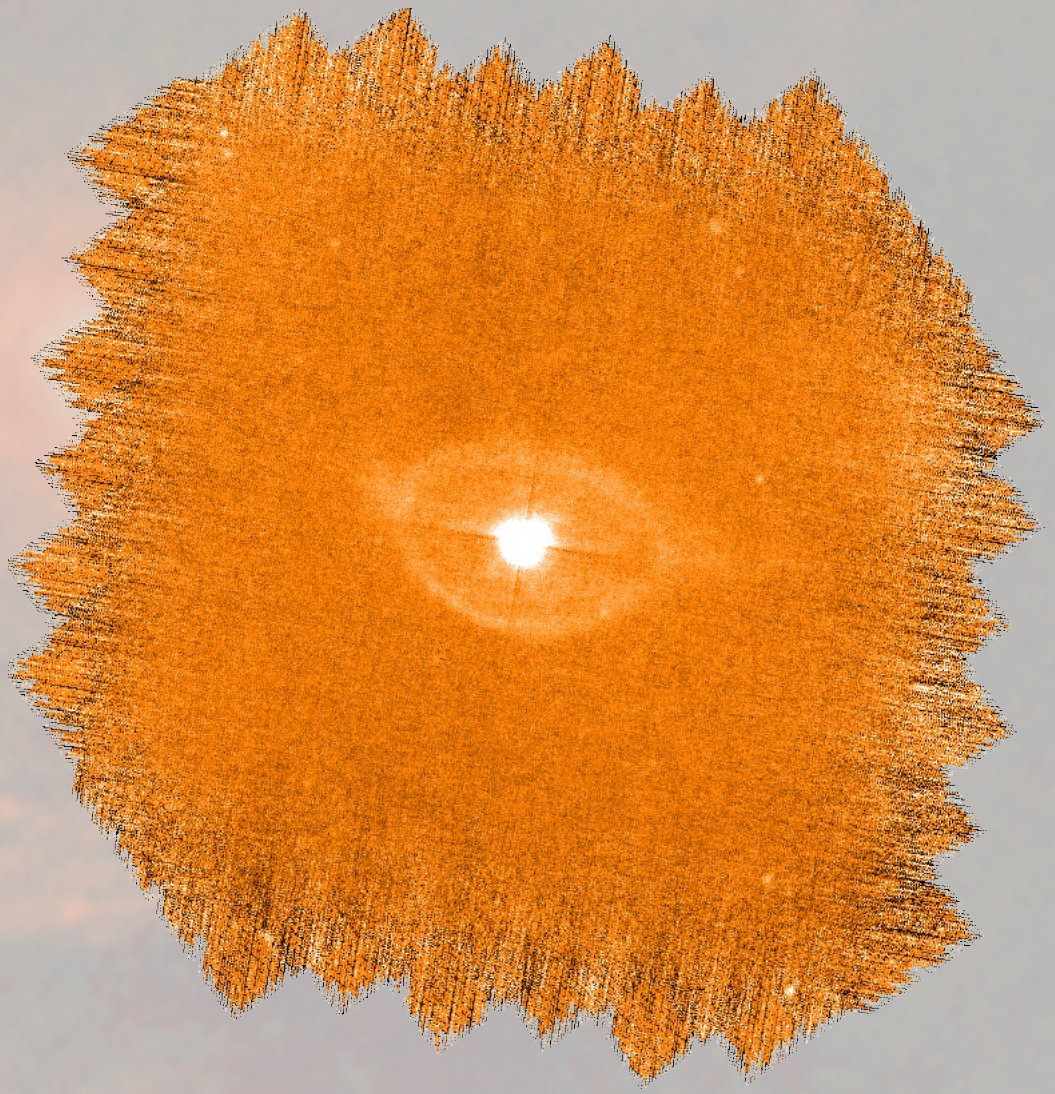
HIPE: MADMap

PROS:

- comes with HIPE
- customizeable
- visually better than PhotProject (especially BG at lower res.)

CONS:

- X-artefact
- signals fade for high resolution
- border influeces the image
- single-threaded
- memory limited



Comparison of Methods

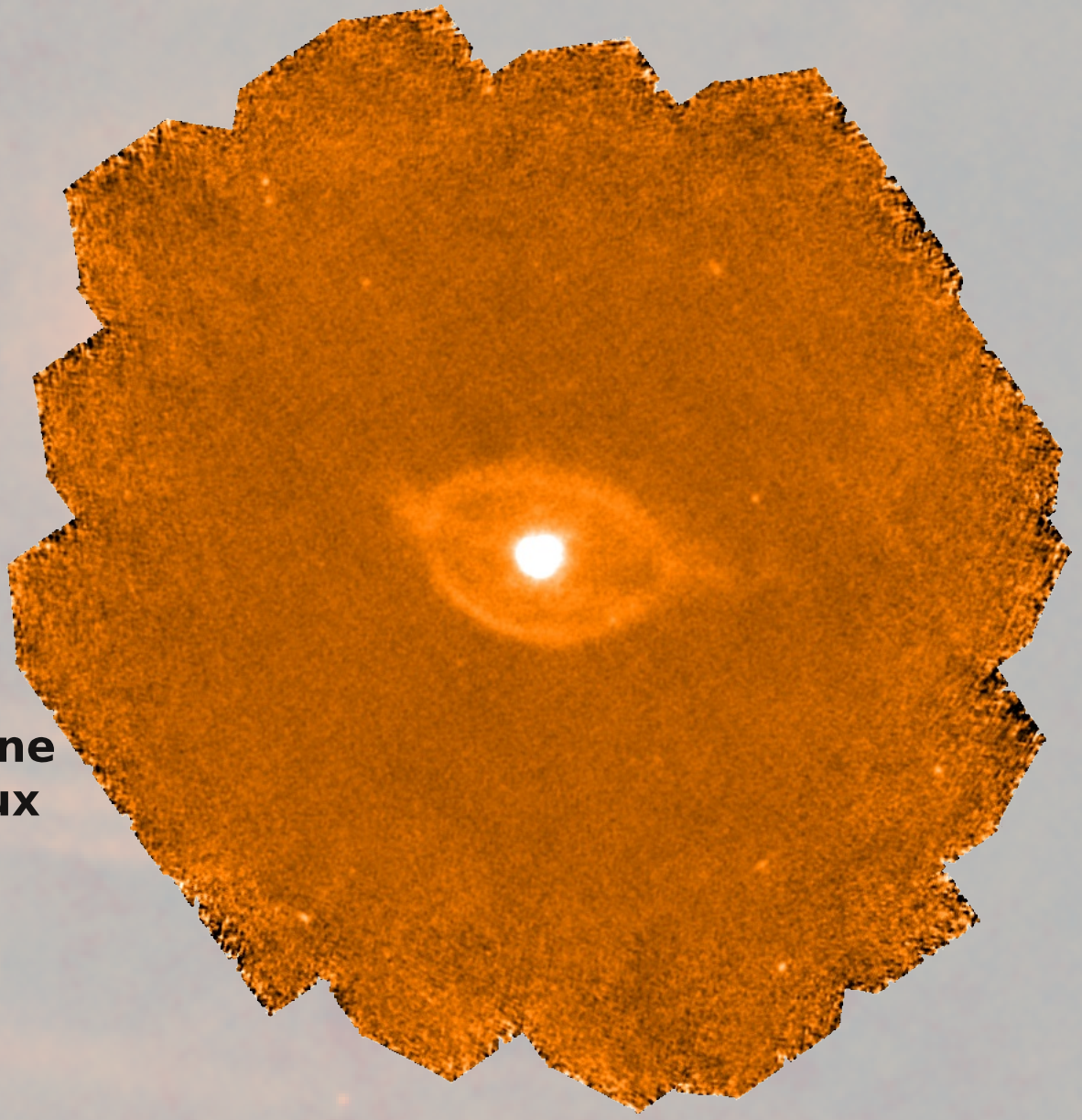
Scanamorphos:

PROS:

- no artefacts
- handles bright point sources
- works at high resolution
- smooth background
- fast and uses little resources

CONS:

- a bit of a black-box
- virtually no parameters to tune
- takes away too much faint flux
- single-threaded
- memory limited
- IDL? We are not amused!

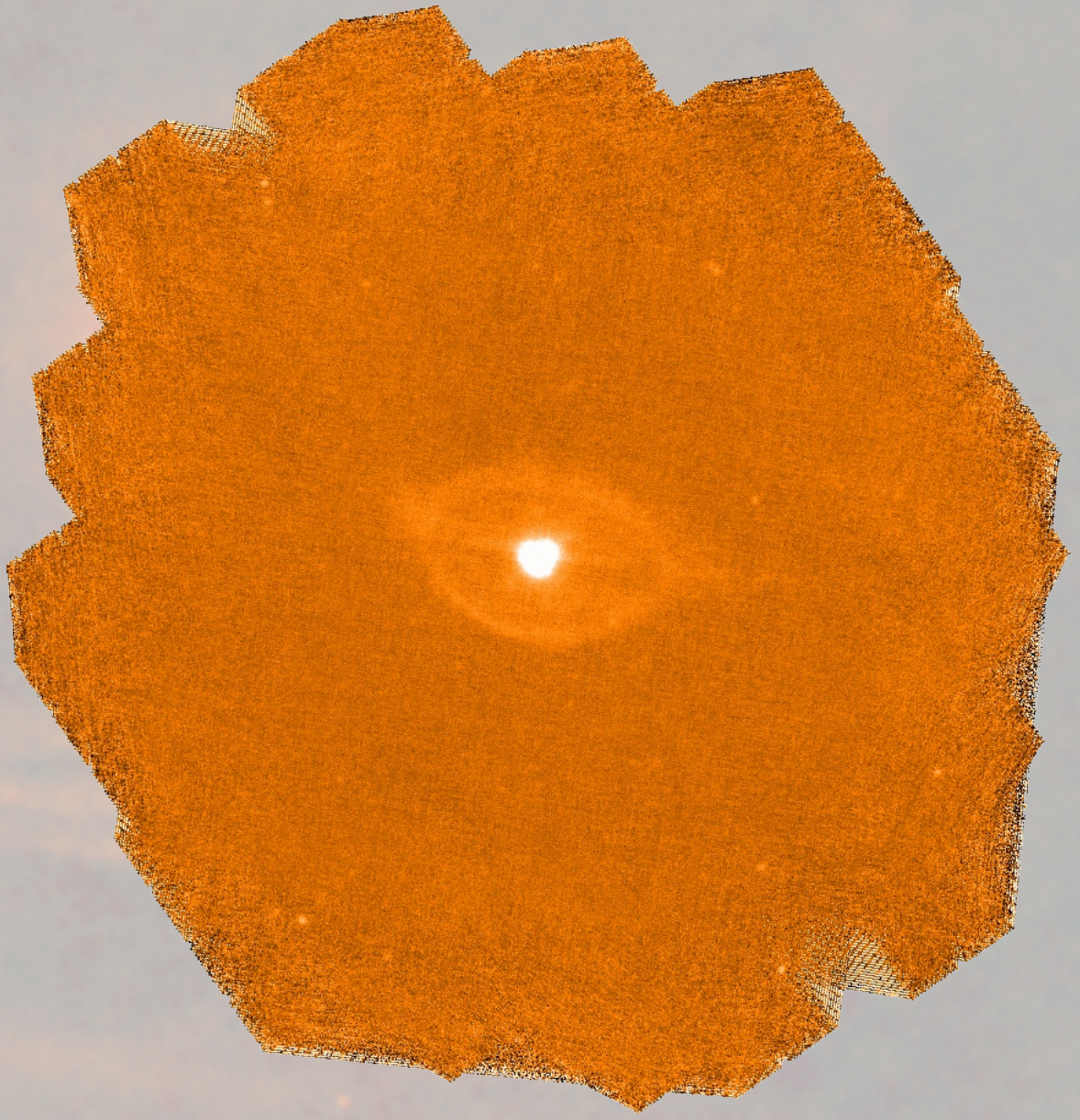


Comparison of Methods

Unimap:

PROS:
- very smooth backgrounds
- no X-artefacts
- good borders

CONS:
- loses weak signals
- single-threaded
- memory limited



Comparison of Methods

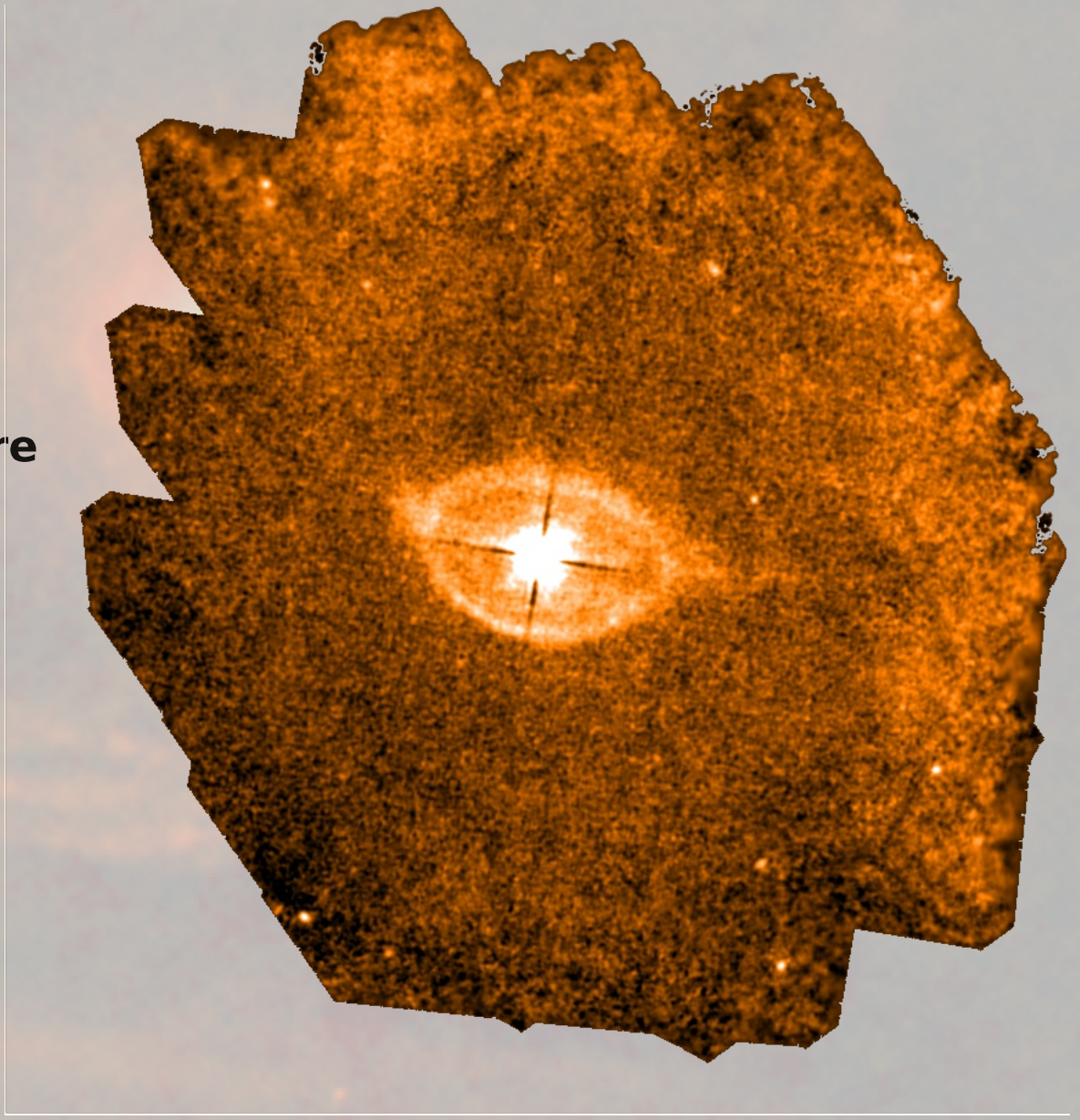
Tamasis:

PROS:

- supreme approach
- very fast P^TP
- computationally extremely well implemented
- makes use of cluster hardware
- very modular
- measurement model customizable
- works with high resolution
- good BG flux

CONS:

- single-threaded bottlenecks, e.g. InvNTT convolution
- X-artefact



Comparison of Methods

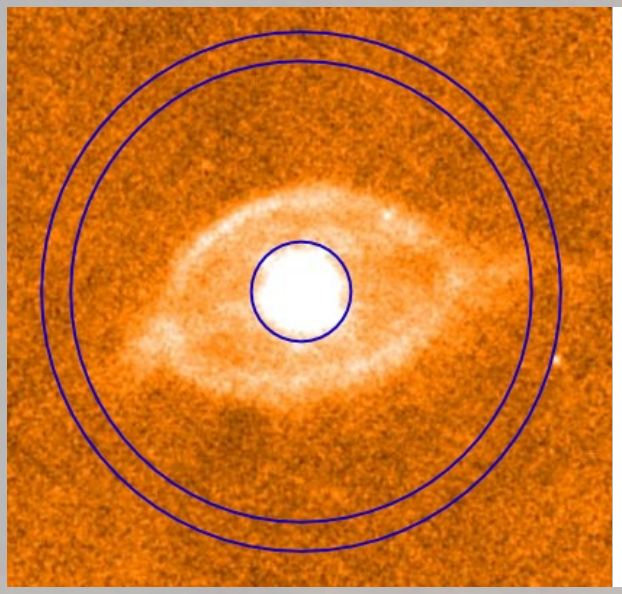
Sanepic:

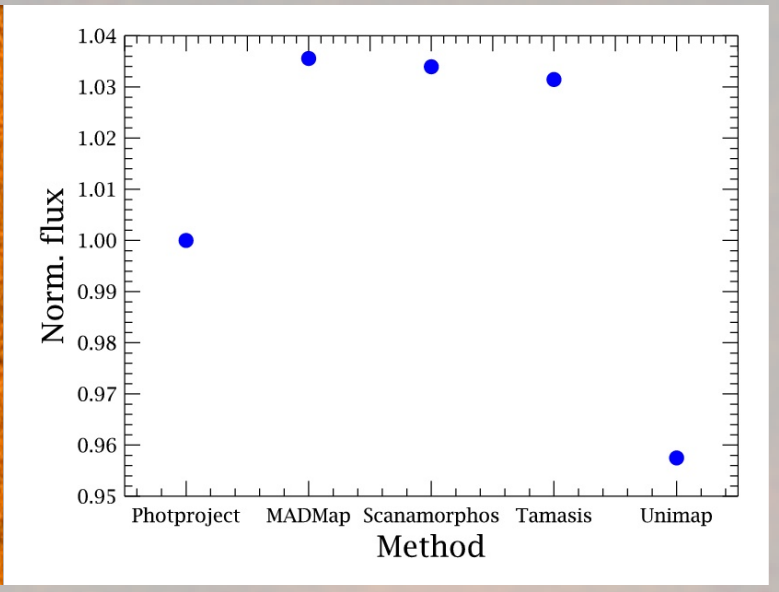
PROS/CONS: can't tell...

... image from above would take 5 months to calculate!

- makes use of cluster hardware
- still, noise correlation matrix inversion takes forever
- 2048 pixels are simply too much
- number of file descriptors per bolometer per process exceeds normal kernel limit

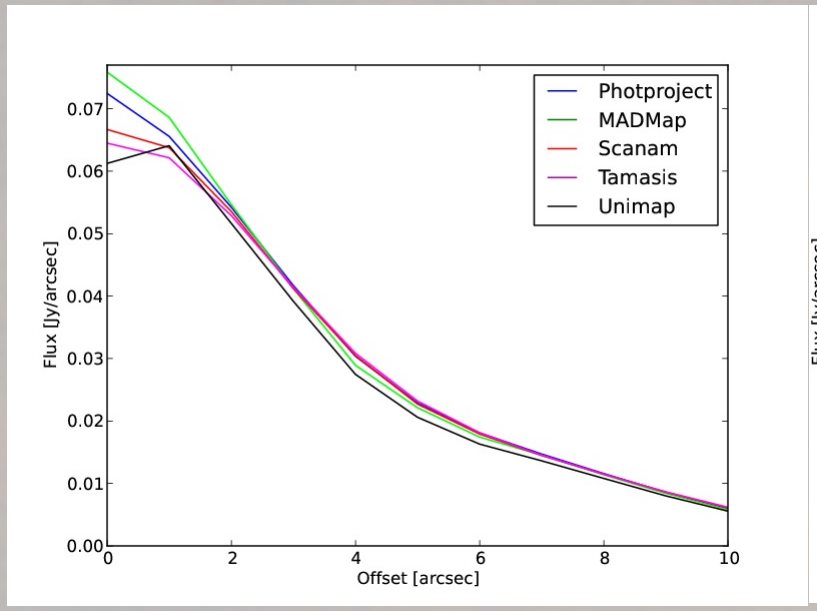
Comparison of Methods

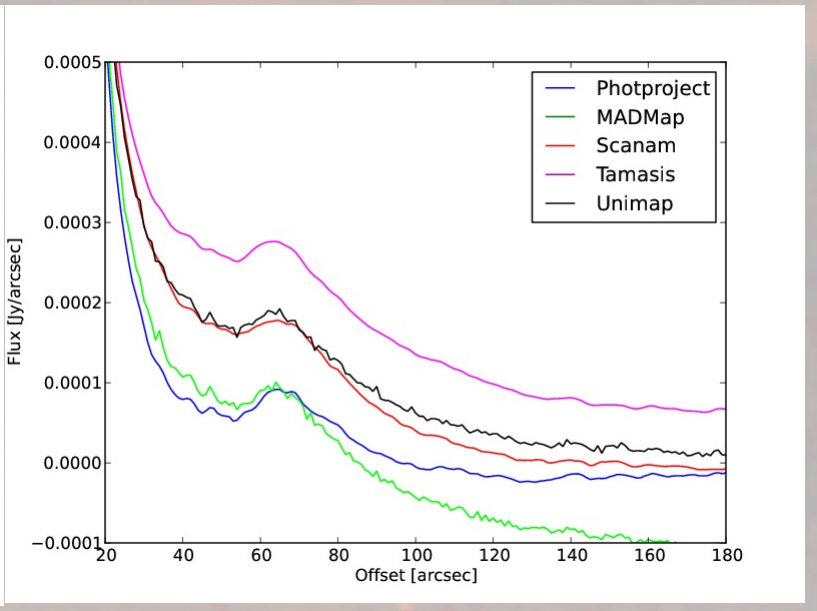




Aperture photometry agrees within few %

Radial profiles diverge on the star as well as in the field





MESS Data Reduction

Current baseline: use Scanamorphos

Bulk data processing on the Shell:

- **Scripts for archive access**
  invoking HIPE scripts through jylaunch

- **Scripts for L1 generation**
  controlling a tuned pipeline script

- **Scripts for running Scanamorphos (IDL)**
  invoking frame preparation and Scanamorphos

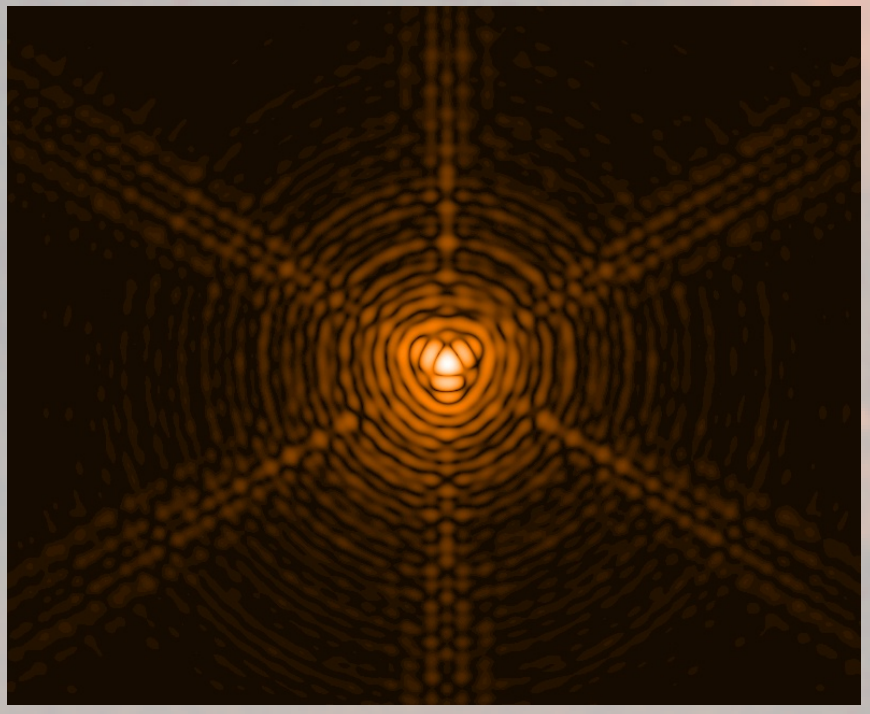
Herschel/PACS PSF

Some observed MESS targets are scientific misses:

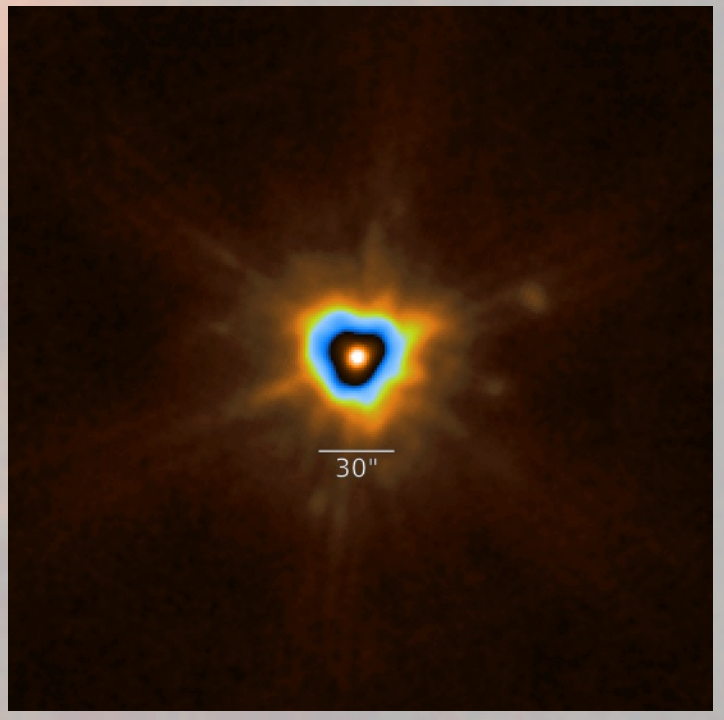
No resolved dust features: perfect PSFs!

AFGL190, AFGL618, AFGL3068, OH127.8+0.0, IRAS 11385-5517 ...

for PACS G channel use: Ceres and Vesta observations



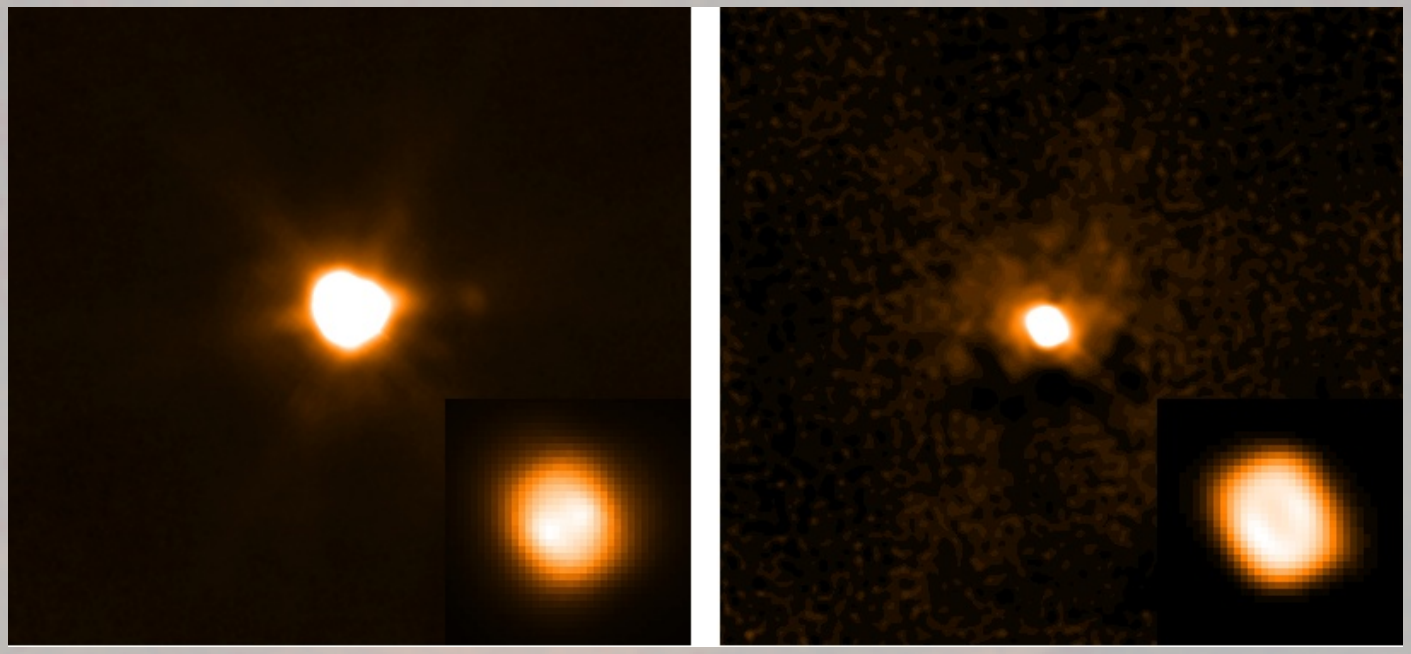
PACS 70µm synthetic PSF
N.Geis, D.Lutz



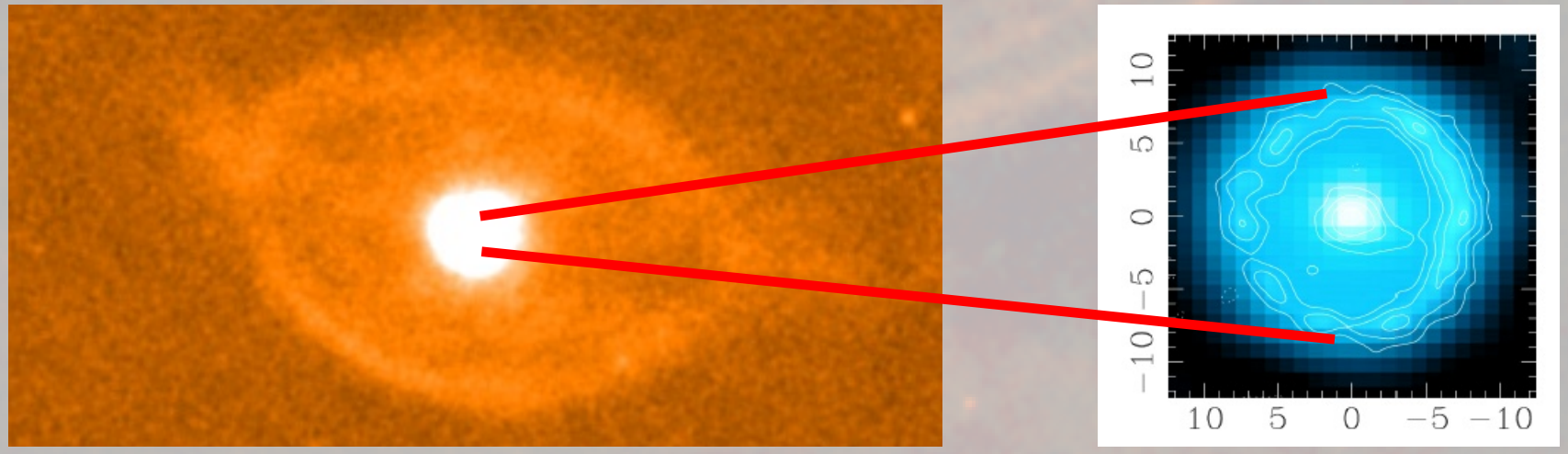
measured PACS B PSF

2 Problems with the PSF

NGC 7027:
Exter et al. 2012
need to lift the "haze" by PSF



U Cam central part: need high resolution
Mecina et al. 2011



Deconvolution in HIPE

Generation of PSF

- selection of PSF source to match in intensity

- PSF ideally comes from the same mapper as the observation

- align rotation according to position angle

- too little PSFs available to cover colour (SED)

Deconvolution

We already have many algorithms implemented in HIPE

Output datasets

generated PSF, Re-convolved image and residuals
to help decide on features/artefacts

Conclusion

3 ways to further improve the MESS imagery:

Astrometry -- PSF -- X-artefact

Pointing correction, field distortion

- improve map resolution and SNR
- big influence on deconvolution artefacts

We will never have "ideal" PSFs!

- need to take care of that fact in deconvolution algorithm

Alternative to a-posteriori deconvolution:

- implement PSF in Tamasis measurement model

Mappers

- find a way to get rid of the X-artefact!
- apply Unimap stategy to Tamasis?