

Observing supergiants with VLT/PIONIER

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S.T. Ridgway⁵

1 : LESIA - Observatoire de Paris

2 : IPAG - OSUG

3 : Lagrange - Observatoire de la Côte d'Azur

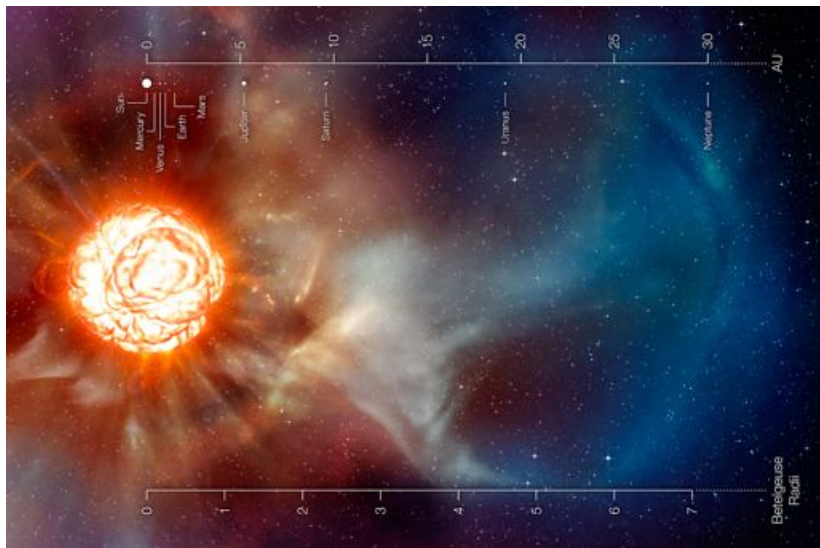
4 : ESO

5 : NOAO



PIONIER Science Meeting - Grenoble - January 14th 2014

RSG overview



Crédits : ESO

RSG mass loss

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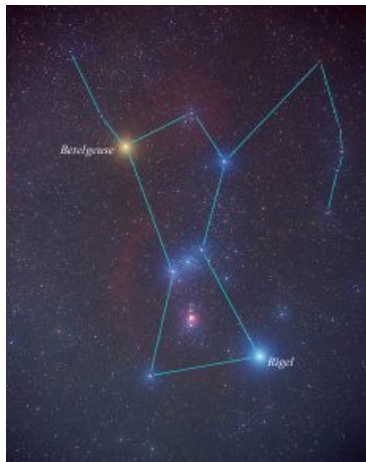
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- Study of the CSE

ID card



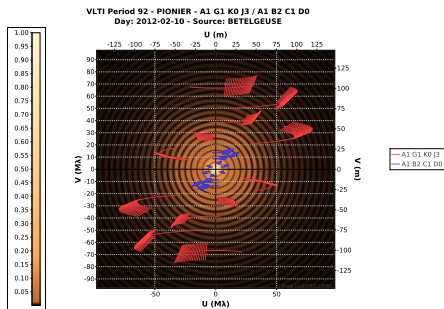
Some figures

- m (visible) = 0.45
- m (IR) = -4.01
- $L = 10^5 L_{\odot}$
- $M = 21 \pm 2 M_{\odot}$
- $R = 645 \pm 129 R_{\odot}$
- $d = 197 \pm 45$ pc
- $v_{\text{rad}} \sim 22 \text{ km.s}^{-1}$
- Spectral type : M2Ib

Purpose of observations

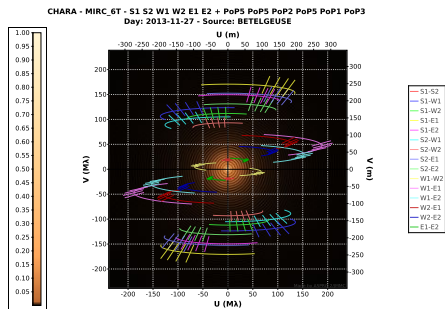
- 3 epochs of observations (2012, 2013 and 2014)
 - Diameter monitoring
 - Image reconstruction
 - Convection statistics (with CHARA/MIRC data → lost to bad weather in 2012 and 2013)

Configuration, (u,v) coverage



PIONIER

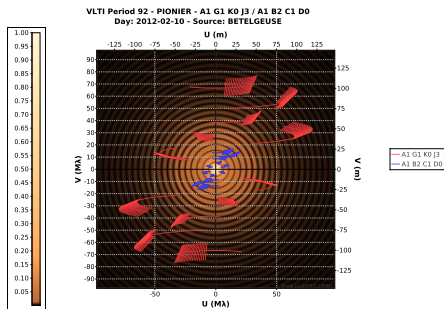
- Compact configuration : 2012, 2013, 2014
- Up to 5th lobe
- Medium configuration : not observable
- Large configuration : Lost to bad weather
- Up to 19th lobe



MIRC - 6T

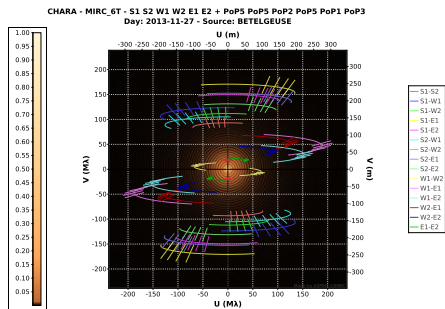
- 6 telescopes : lost to bad weather (2012, 2013)
- Up to ~ 40th lobe (!)

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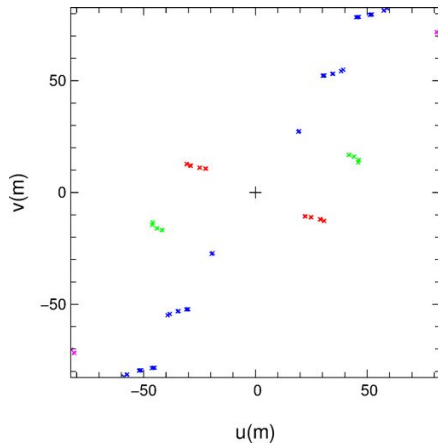
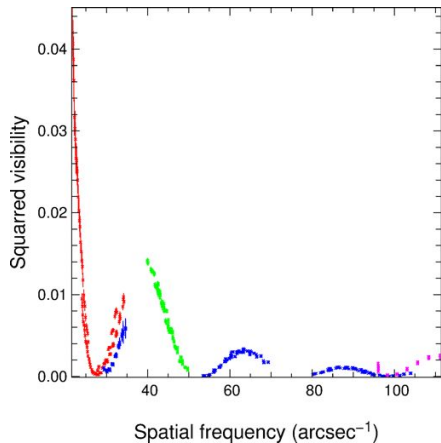
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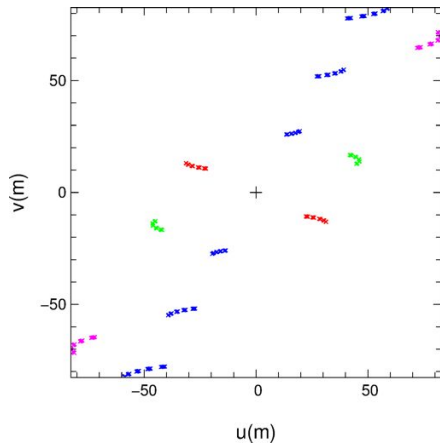
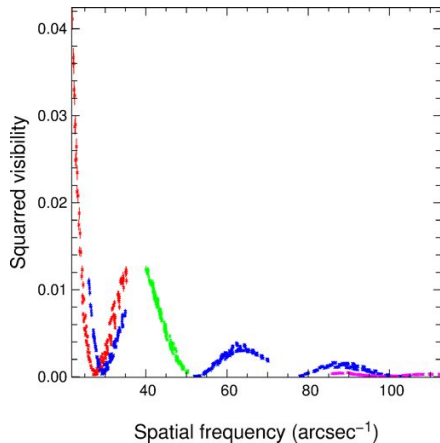
PIONIER visibilities overview

P88 - January 2012



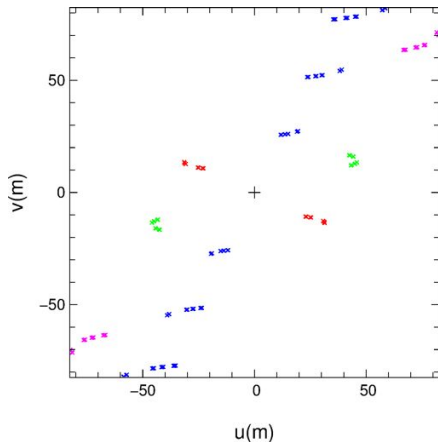
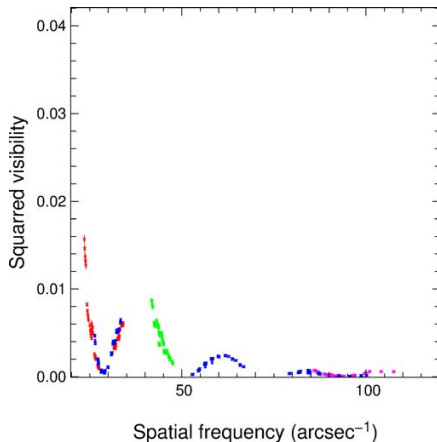
PIONIER visibilities overview

P90 - February 2013

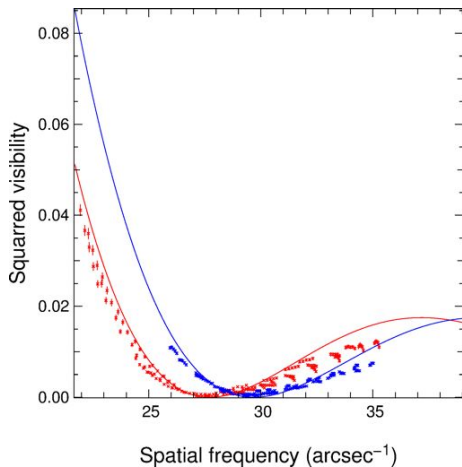


PIONIER visibilities overview

P92 - January 2014 (11th)



PIONIER : 1st zeros



UD :

$$\theta_{UD} = 43,99 \pm 0,06 \text{ mas}$$

$$\theta_{UD} = 41,1 \pm 0,11 \text{ mas}$$

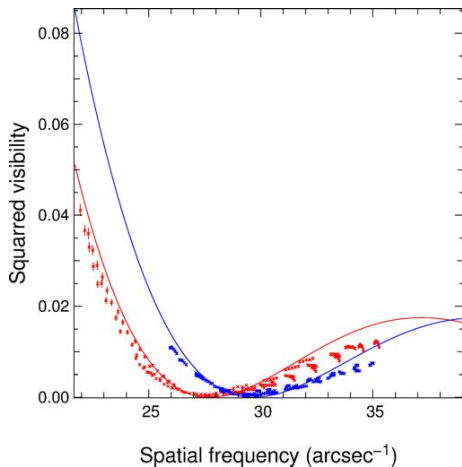
LDD :

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Elongated star ?

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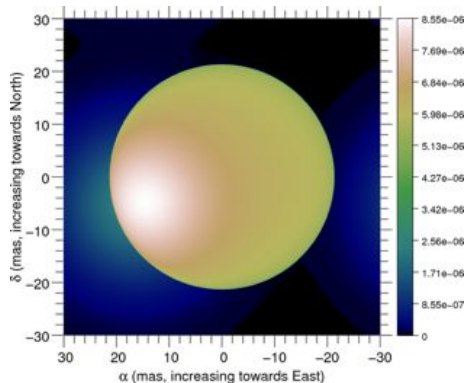
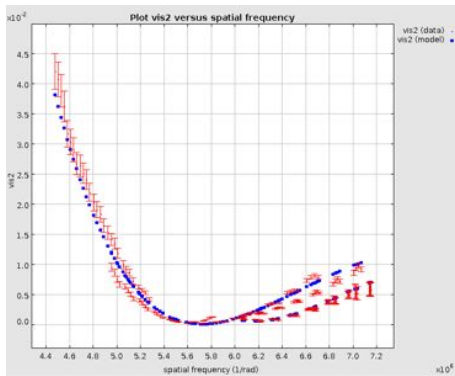
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Elongated star ?

→ But Betelgeuse's rotation
period ~ 30 years

Signature of hot spots ?

P88 - January 2012

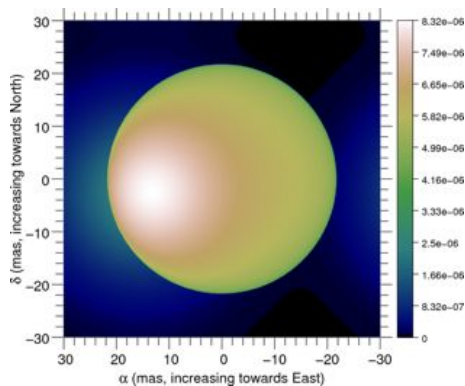
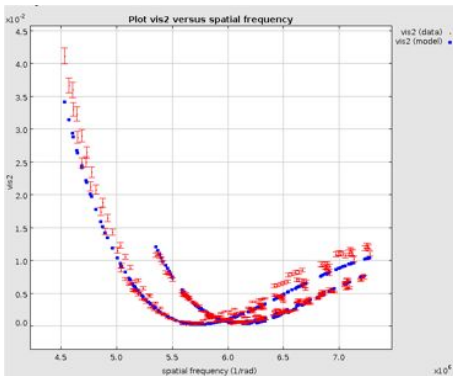


(This time, data are in red and best fit model in blue)

$$\chi_r^2 = 66$$

Signature of hot spots ?

P90 - February 2013

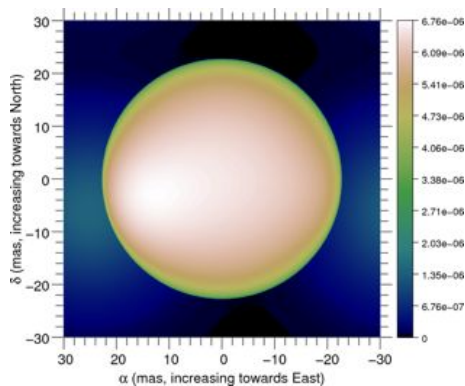
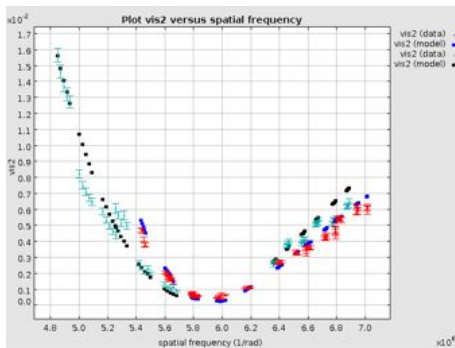


(This time, data are in red and best fit model in blue)

$$\chi_r^2 = 86$$

Signature of hot spots ?

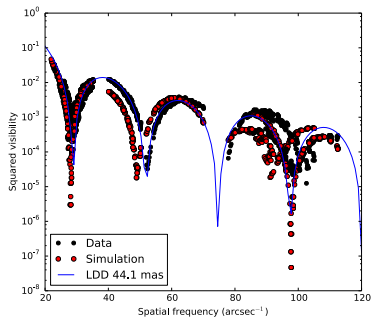
P92 - January 2014



(This time, data are in red and best fit model in blue)

$$\chi_r^2 = 100$$

RHD simulations



$$\chi_{r,LDD}^2 = 350$$

$$\chi_{r,Simu}^2 = 604$$

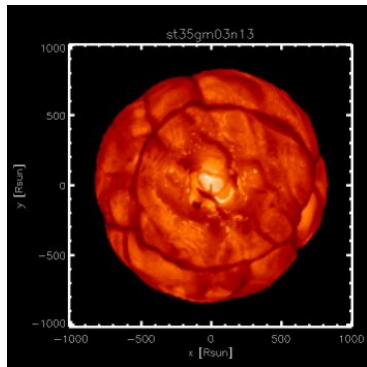
Model st35gm03n13
(Chiavassa et al. 2011, A&A, 535, A22)

- Non-gray model
- $M = 12 M_{\odot}$
- $L = 89477 \pm 857 L_{\odot}$
- $T = 3430 \pm 8$ K
- $\log(g) = -0.354 \pm 0.001$
- $R = 846.0 \pm 1.1 R_{\odot}$
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Current work, going to be improved

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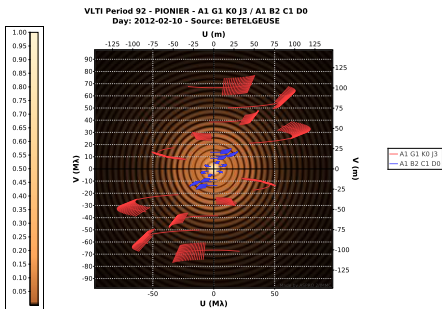


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On Betelgeuse...

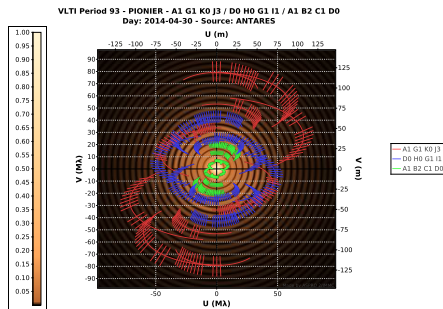
- ✓ VLT/AMBER : chemical composition of the MOLsphere in K band
- HST/STIS : chromosphere
 - VLT/NACO : cold molecules (co-existing with chromosphere)
 - ALMA : extended dust and molecules envelope

Extension of the sample : Antares (α Sco)



Betelgeuse

- $\theta_{UD} \sim 43$ mas
- 2 configurations



Antares

- $\theta_{UD} \sim 41$ mas
- 3 configurations
- Better supersynthesis

Conclusion

- Characterization of RSG mass loss from the photosphere to the ISM
- Multi- λ , multi-scale monitoring of RSGs

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Thank you for your attention