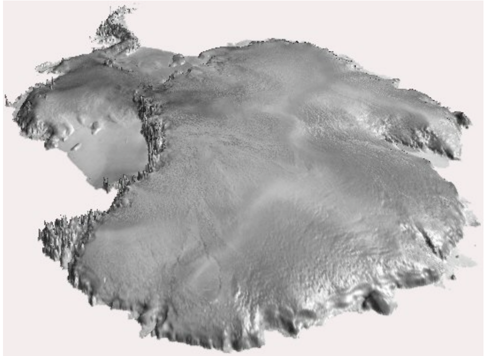

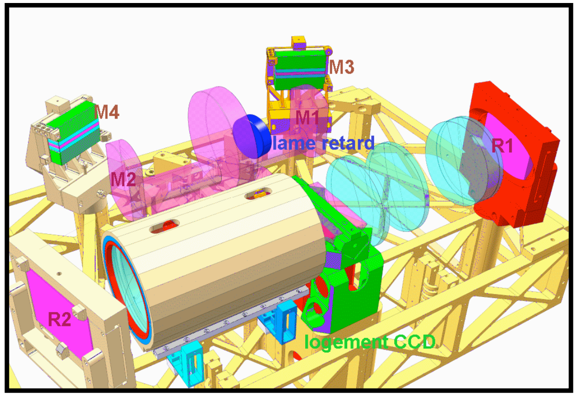

SIAMOIS: science requirements, performances and targets

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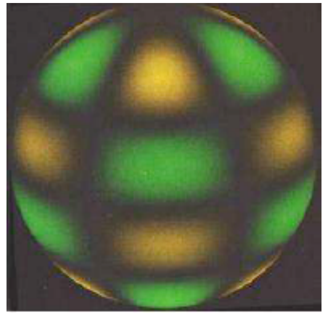
Outline

- Science specifications for asteroseismology
- Photometry -versus- Doppler measurements
- Space -versus- multi-site -versus- Dome C
- *SIAMOIS* at Dome C: main performances
- Potential targets for *SIAMOIS* at Dome C

Science specifications for asteroseismology *(1/4)*



1. detecting oscillations

- ***stellar oscillations of solar type have very small amplitudes: a few ppm in photometry, a few 10 cm/s in Doppler***
- ***typical oscillation modes have lifetimes ranging from 1-10 days***

↓

noise level in Fourier space **≤** ***1 ppm in photometry***
10 cm/s in Doppler
after 5 days of integration

Science specifications for asteroseismology (2/4)

2. measuring frequencies, amplitudes and lifetimes

- *precision on frequencies < 0.2 μHz (inversions, splittings, …)*

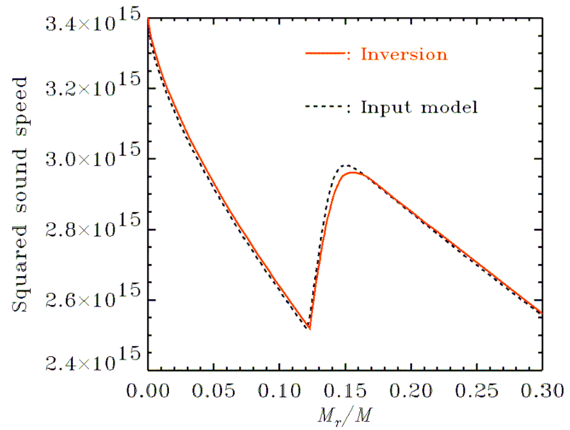
  $\sigma(\nu)^2 = \Delta\nu/(4\pi T)\, f(S/N)$

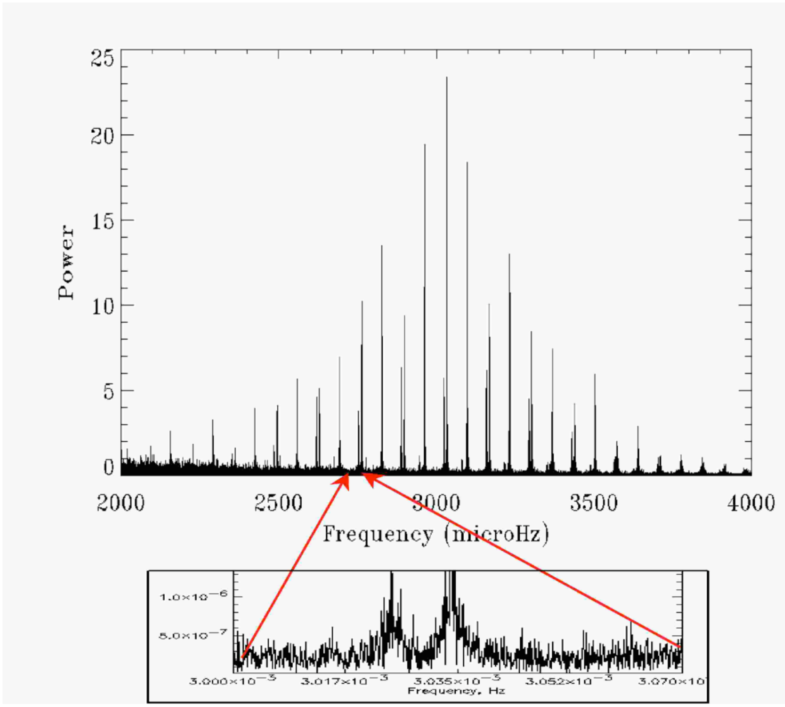
- *determination of mode profiles (mode damping)*

- *measurement of mode amplitudes (mode excitation)*

long uninterrupted monitoring ≥ 3 months

very high duty cycle ≥ 90%





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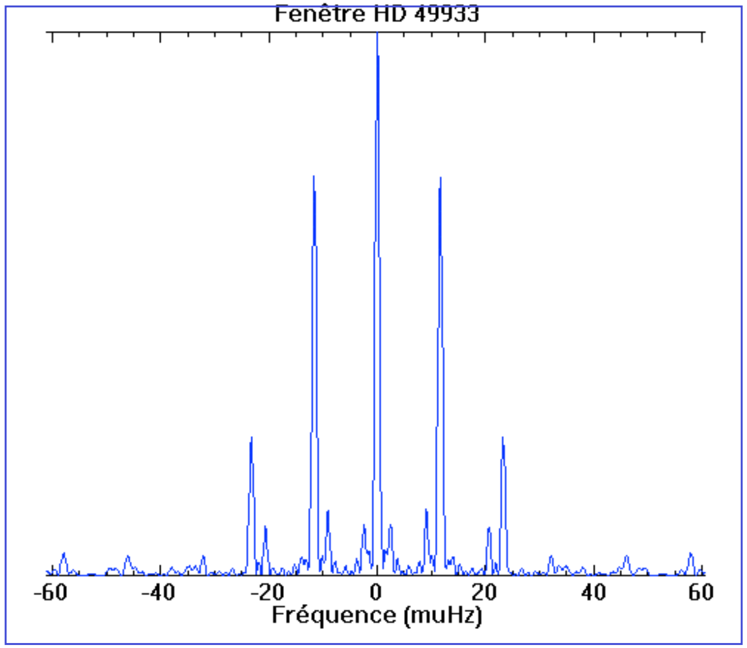
Science specifications for asteroseismology (3/4)

3. avoiding ambiguities in mode detection and identification

avoid side lobes in power spectrum

↓

very high duty cycle ≥ 90%



example of single-site observation window

Science specifications for asteroseismology (4/4)

noise level in Fourier space	≤	1 ppm in photometry 10 cm/s in Doppler	after 5 days of integration

very long monitoring ≥ 3 months

very high duty cycle ≥ 90%

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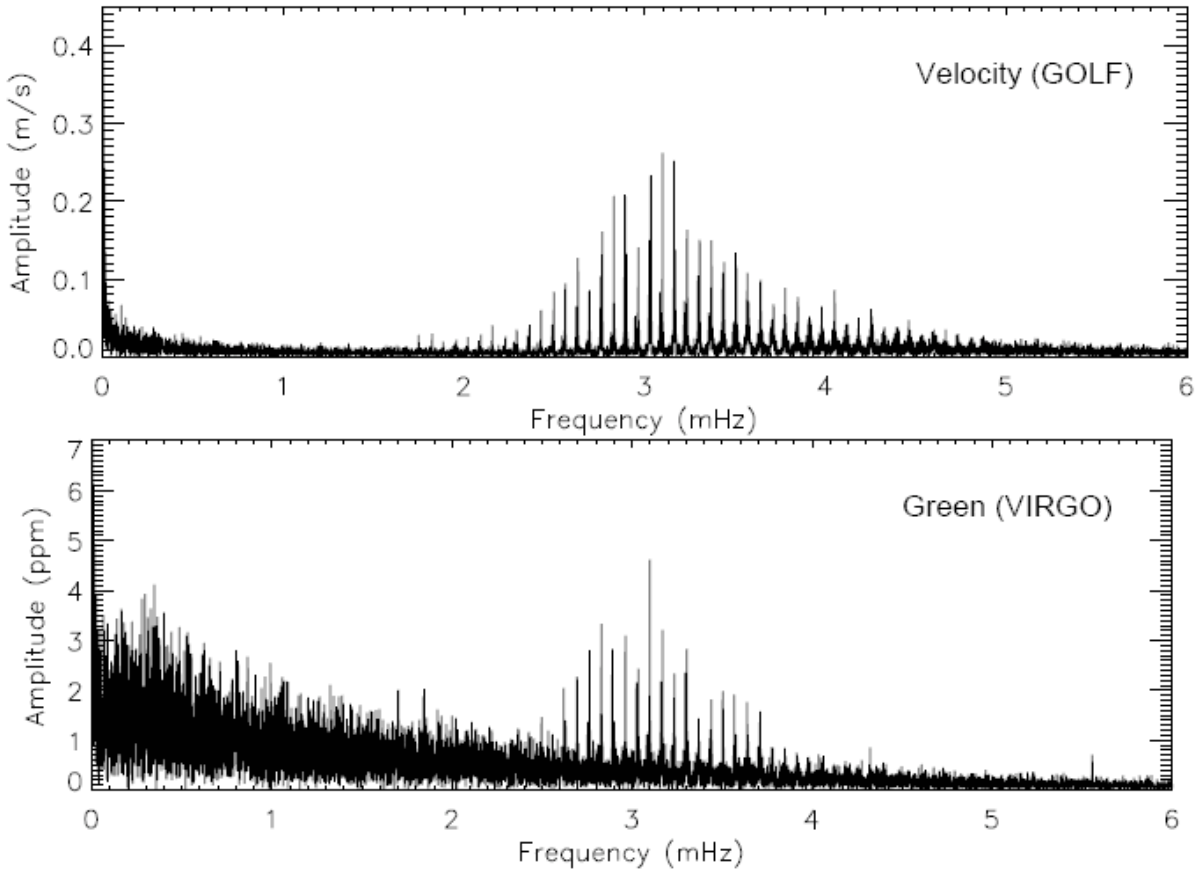
Photometry versus Doppler

photometry is easier BUT:



- Doppler signal is less affected by granulation than photometric signal

- modes with degree $\ell = 3$ are ~ 3 times as visible in Doppler measurements as in photometry

→ measurement of small separation using modes

$\ell = 0-2$ AND $\ell = 1-3$

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Space .versus. groundbased

Photometry:

spec 1 = noise level ≤ 1 ppm in 5 days
= noise level ≤ 8.5 10^{-5} in 1 min → *scintillation*

spec 2 = monitoring ≥ 3 months - - - - →

spec 3 = duty cycle ≥ 90% - - - - →

Doppler:

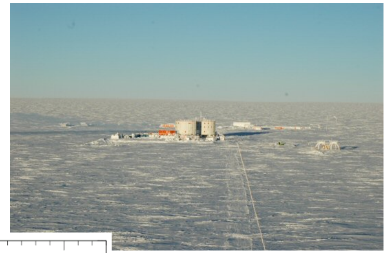
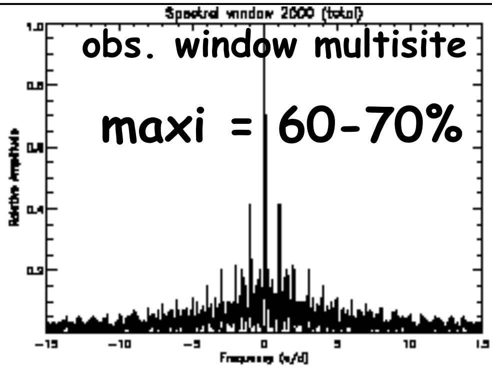
spec 1 = noise level ≤ 10 cm/s in 5 days
= noise level ≤ 8.5 m/s in 1 min → can be achieved from ground
(highly stable spectrometers)

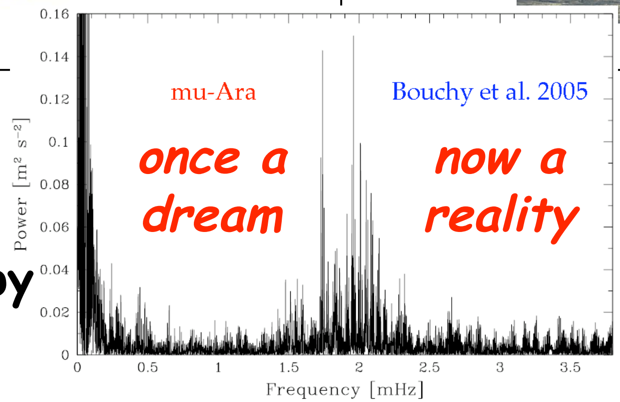
spec 2 = monitoring ≥ 3 months

spec 3 = duty cycle ≥ 90% → very difficult !

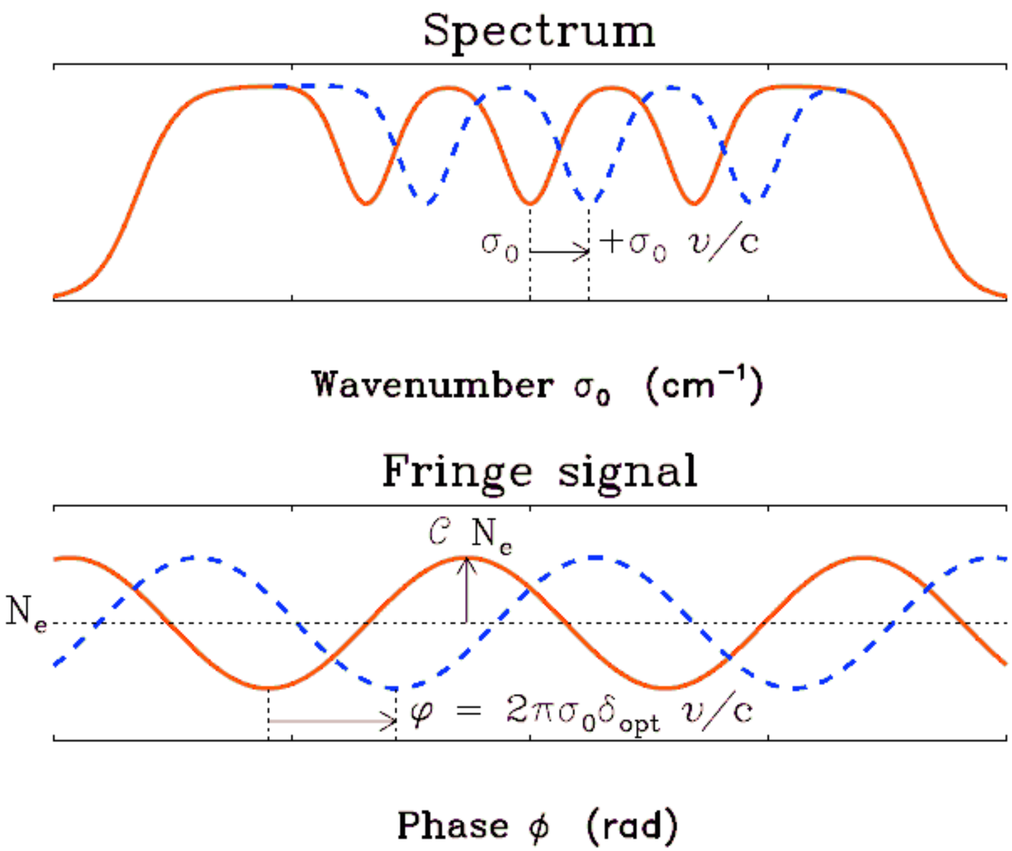
→ multisite networks or observations from Antarctica

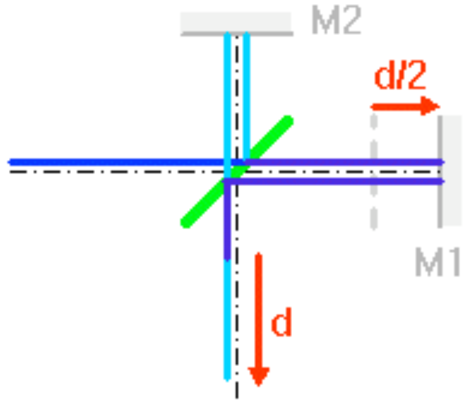
Multisite .versus. Antarctica

Doppler measurements	multisite network 	Antarctica 
noise ≤ 10 cm/s in 5d *8.5 m/s in 1 min*	grating spectroscopy *once a dream*	FT spectroscopy *now a reality*
monitoring ≥ 3 months	very difficult ! (drift of ST wrt UT)	easy (polar night > 3 months)
duty cycle ≥ 90%	obs. window multisite maxi = 60-70% 	maxi = 95% typical = 90% (cf 2005 winter-over)



Performances of SIAMOIS (1/3)



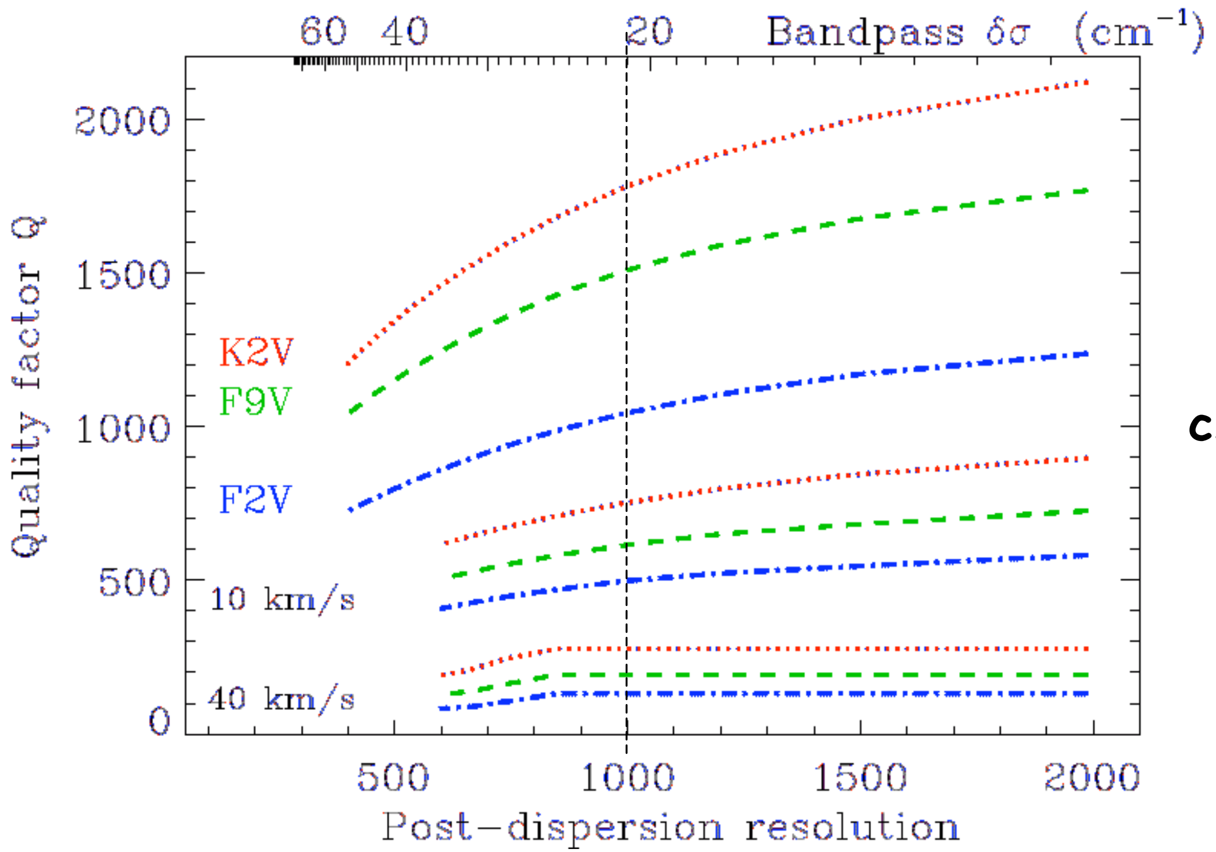


$$\delta v_{\mathrm{rms}} = \frac{c}{Q\sqrt{N_e}}$$

$$Q = \sqrt{2}\pi\ \sigma_0\delta_{\mathrm{opt}}\ \mathcal{C}$$

optimisation δv → maximisation of N_e: high efficiency, large bandwidth
optimisation of δ: depends mainly on line width
maximisation of $\mathcal{C}$ (fringe contrast): post-dispersion

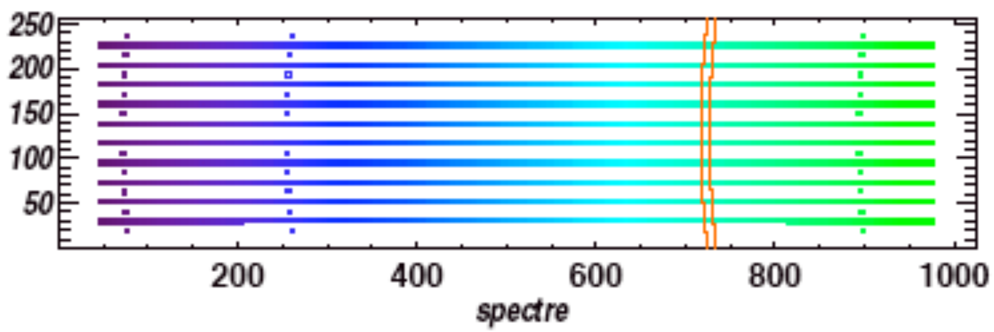
Performances of SIAMOIS (2/3)



$$\delta v_{\mathrm{rms}} = \frac{c}{Q\sqrt{N_{\mathrm{e}}}}$$

$$Q = \sqrt{2}\pi\ \sigma_0 \delta_{\mathrm{opt}}\ \mathcal{C}$$

choice of post-dispersion :
gain in Q
versus
size of detector
R ~ 1000
~ 340 spectral elements



CCD
1024 x 256

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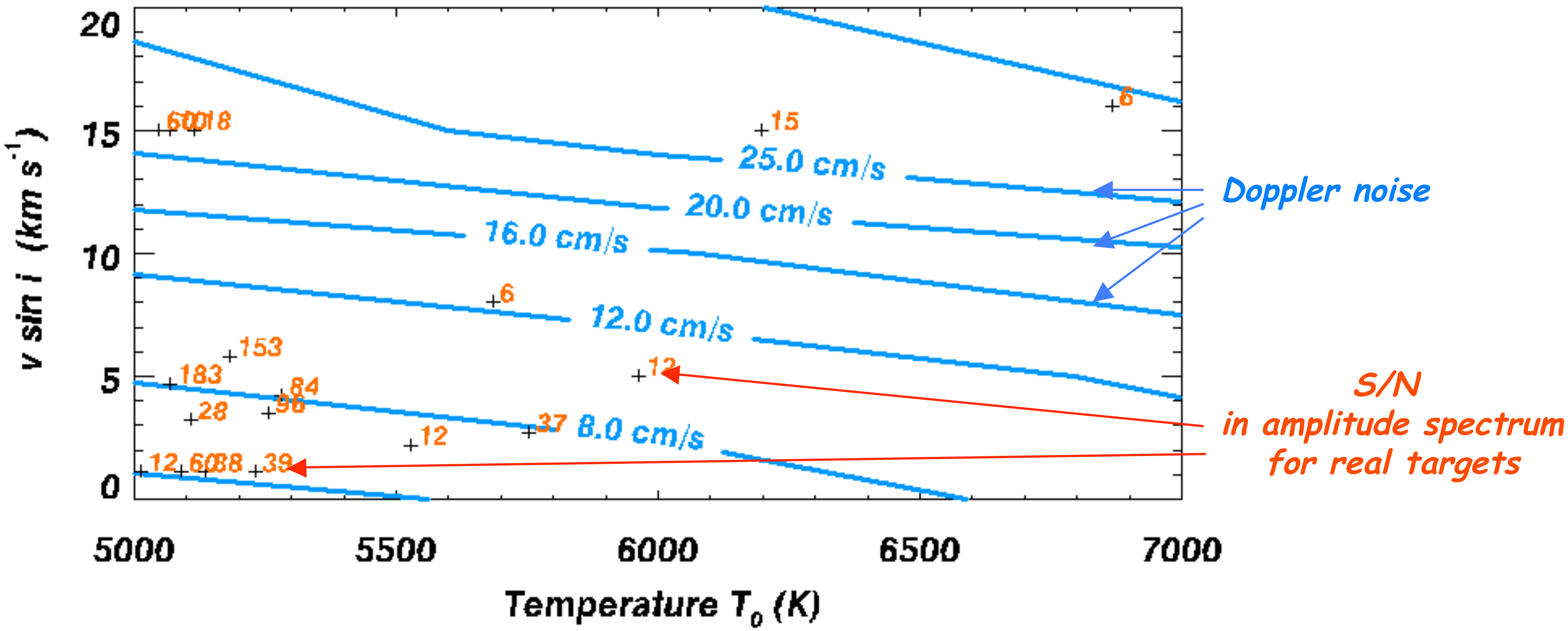
Performances of SIAMOIS (3/3)

δv with 40cm collector, after 5 days, duty cycle 90%, for star m_V=4

based on simulations using synthetic Kurucz spectra + instrument simulation



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Potential targets for SIAMOIS (1/2)

1. stars K to F, IV & V : solar-type oscillations

HD	HIP	nom	type	δ	V	$v \sin i$ (km/s)	A (cm/s)	RSB_{40}
2151	2021	βHyi	G2IV	−77.25	2.79	5.0	59	11
11937	9007	χEri	G5IV	−51.61	3.71	1.1	165	34
92139	51986	p Vel	F4IV	−48.23	3.84	16.0	165	6
114613	64408		G3V	−37.80	4.85	8.0	73	6
128620		αCen A	G2V	−60.83	−0.01	2.7	34	36
128620		αCen B	K1V	−60.84	1.33	1.1	18	12
190248	99240	δPav	G7IV	−66.18	3.56	3.2	111	25

2. red giants
3. δ Sct & γ Dor with vsini ≤ 20 km/s
4. PMS δ Scuti: HD 104237, Herbig Ae stars vsini ~ 17 km/s
5. roAp stars

cf other talks

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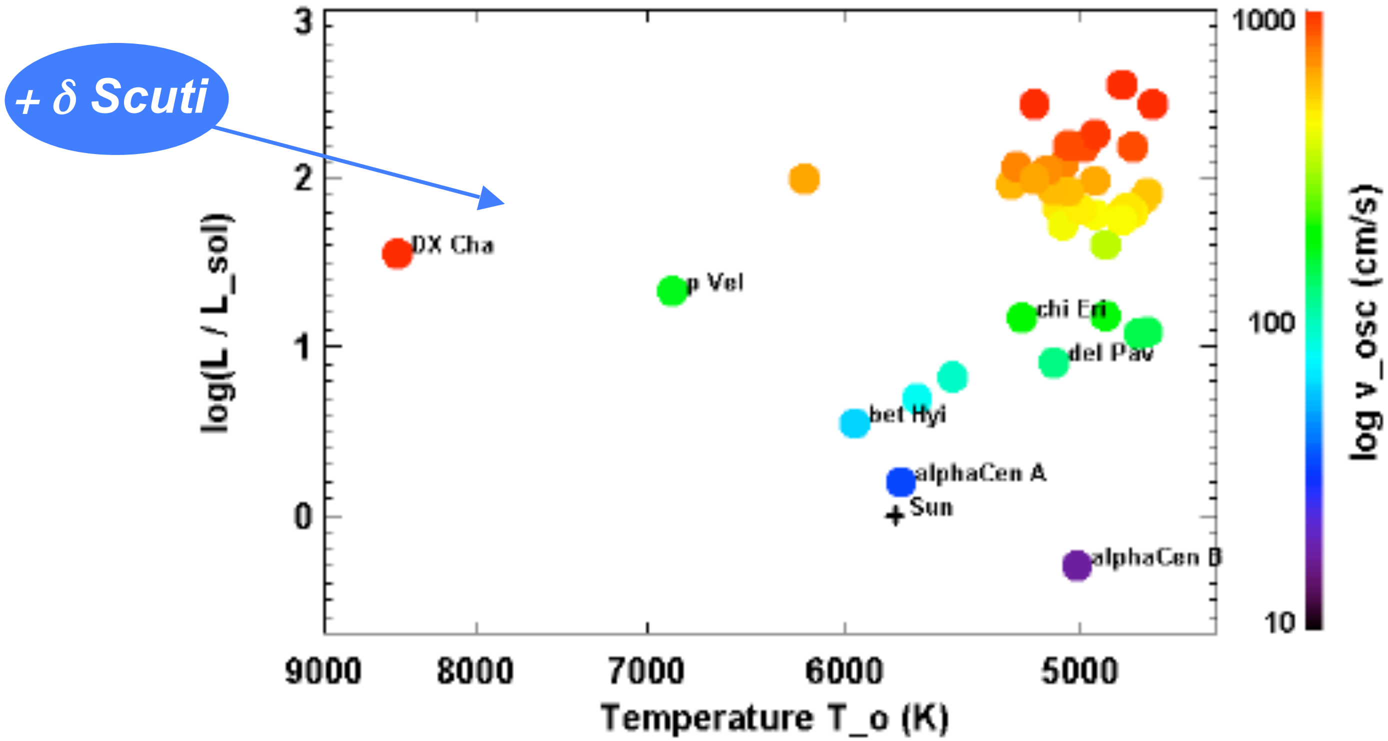
Potential targets for SIAMOIS (2/2)

– **potential targets of SIAMOIS @ Dome C (40 cm collector): circumpolar stars for which oscillations are detected with SNR ≥ 6 in 5 days, duty cycle 90%**



- 7 F, G & K, IV & V targets

- more than 30 red giants **=** *programme for many winter-overs*

- many δ Scuti (v sin i < 20 km/s)

Conclusion

- a FT seismometer installed at Dome C with a 40 cm collector (SIAMOIS) can provide data for the seismic analysis of several classes of stars (solar-type, giants, δ Scuti, PMS), with a wide choice of targets in each class (except PMS) → follow-up of COROT

- the performances of such an instrument on such a site are in principle very well suited to the specifications of asteroseismology

- the analysis presented here assumes that the observations are photon noise limited; a deep analysis of the instrument at system and sub-system levels is necessary to ensure that this is the case - in progress