The basic outline of SONG

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The SONG science goals are:

1. To study the internal structure and evolution of stars at a level of detail similar to that achieved for the Sun using asteroseismology.

2. to search for and characterize low-mass planets in orbits around other stars.

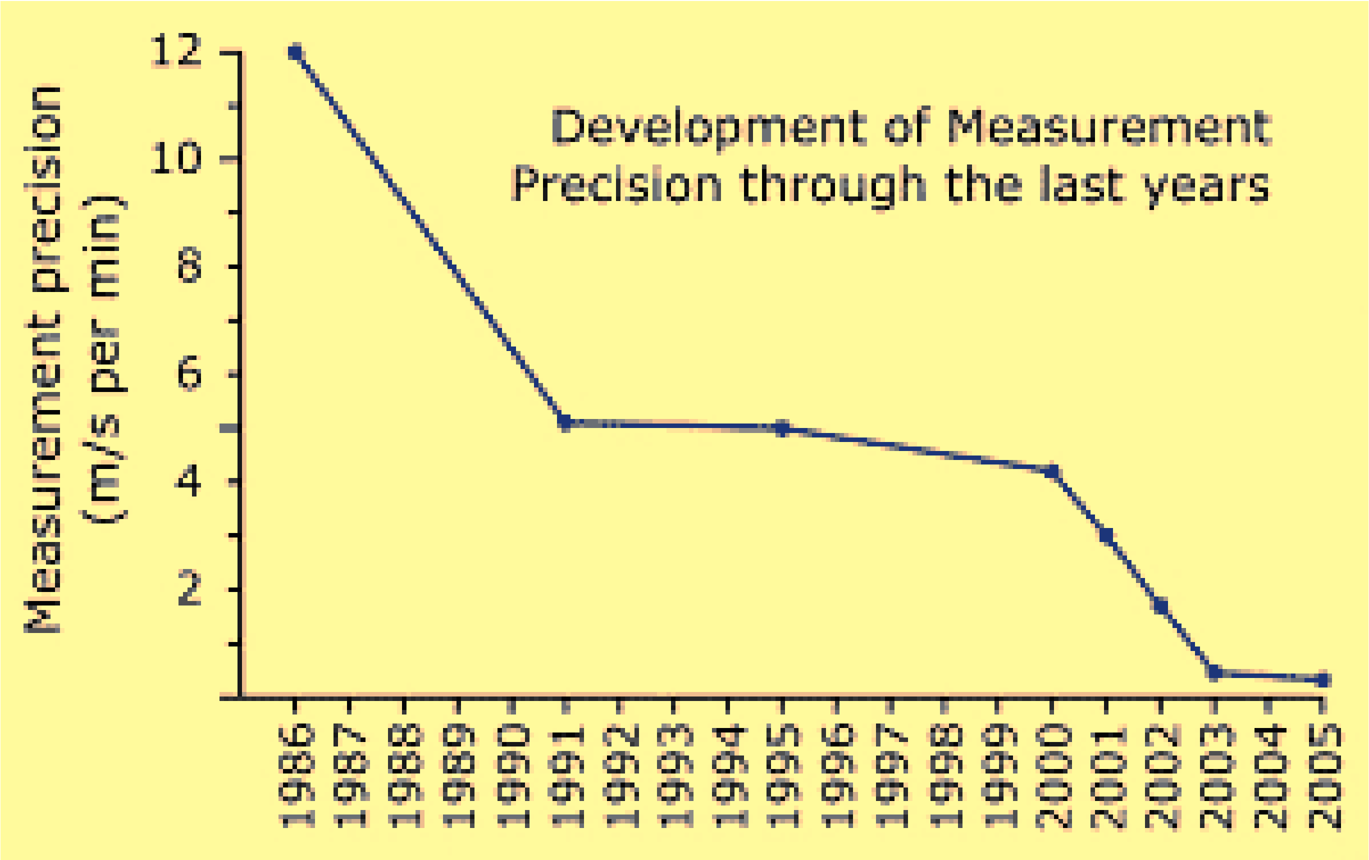
3. carry out daytime velocity measurements of the Sun

Observational limits

- Window function
- Sampling/Cadence
- Length of observing period
- Long term stability

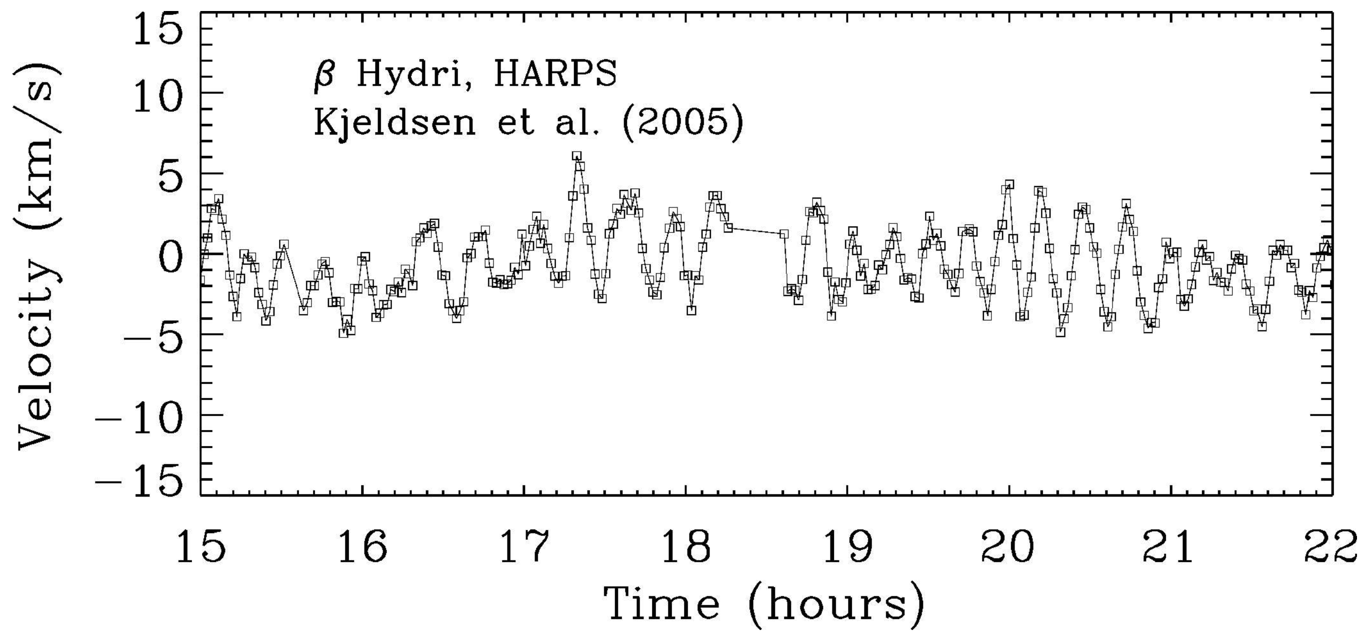
Velocity precision is not the limiting factor

Limits to seismology and planet hunting



For bright stars the limiting factor is NOT measurement precision

We can measure solar-like oscillations directly



UVES, HARPS: Precision better than 50cm/s

So, do we need HARPS (3.6m) and UVES (8m) to do asteroseismology and search for planets ?

NO! - The thought than became a SONG

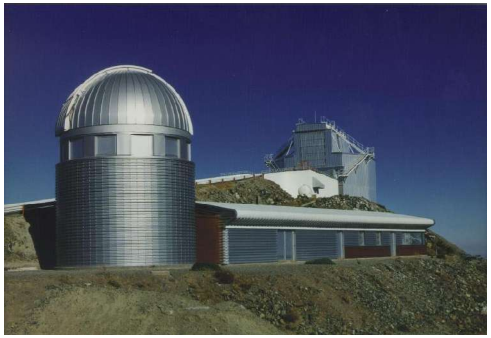
CORALIE at the Euler telescope on La Silla

CORALIE can do asteroseismology

CORALIE has an overall efficiency ~1%

We can build a spectrograph with EFF > 4%

Can use an 0.6m!



SONG basic idea

- optimize network for primary science drivers

  focus on bright stars, long time series

- design for simplicity and robustness

- low maintenance

- reduce running costs

- exploit proven concepts when possible

SONG baseline:

Network baseline:

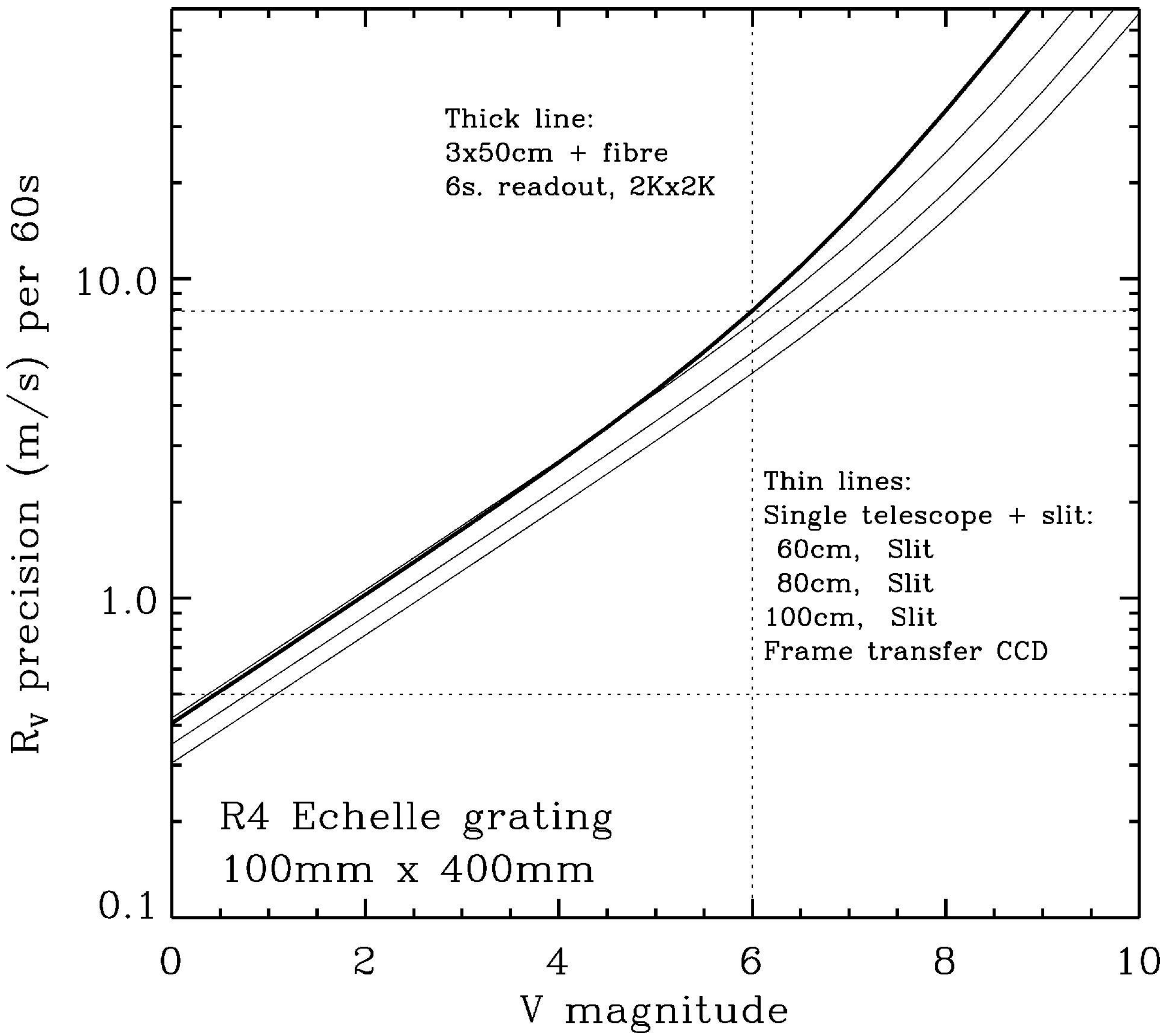
- 8 identical nodes; 4 southern and 4 northern
- Dome with windscreen and possibly window
- Single, ~0.8m telescopes per node.
- State-of-the-art spectrograph, optimized for RV work. Use a slit and iodine reference cell.
- Remote operations.
- On-site, pipeline data reduction.
- Low maintenance requirements is a design goal.

Spectrograph: Slit-feed, Iodine cell,
R4 echelle, UVES like design. -- Proven Performance
"well known" optical design.

Telescope: Alt-az, nasmyth platform, small secondary obstruction
Critical point: can the telescope carry the spectrograph on the Nasmyth platform without excessive vibrations?

- **Why Iodine:** demand on spectrograph stability is less critical than for ThAr method, reduced cost.

- **Why have we abandoned a fibre fed spectrograph ?**
Fibres lead to lower efficiency

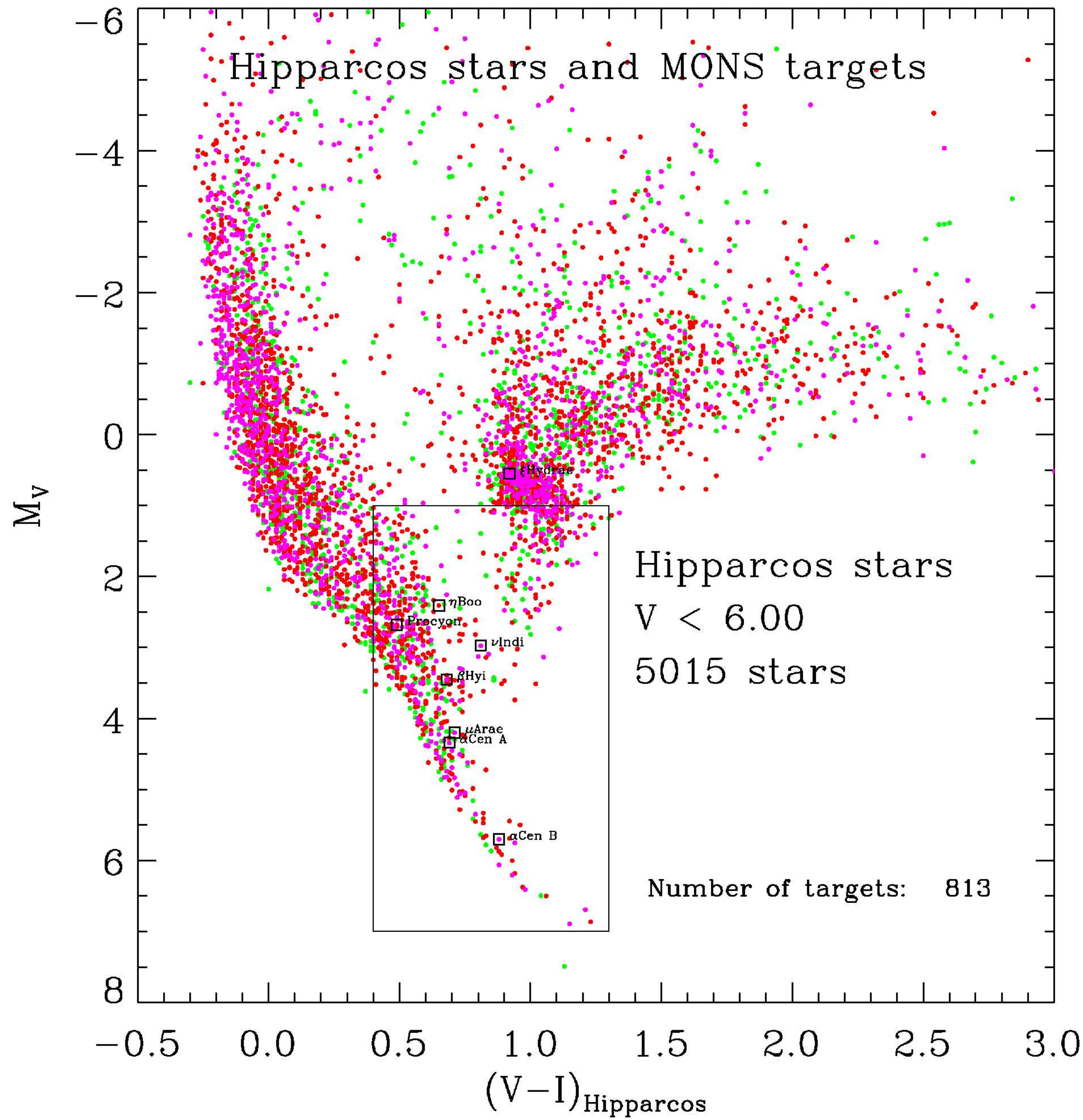


Seeing: 2”

Airmass: 2.0

V-extinction: 0.14

Both telescope/spectrograph combinations full-fill requirements!



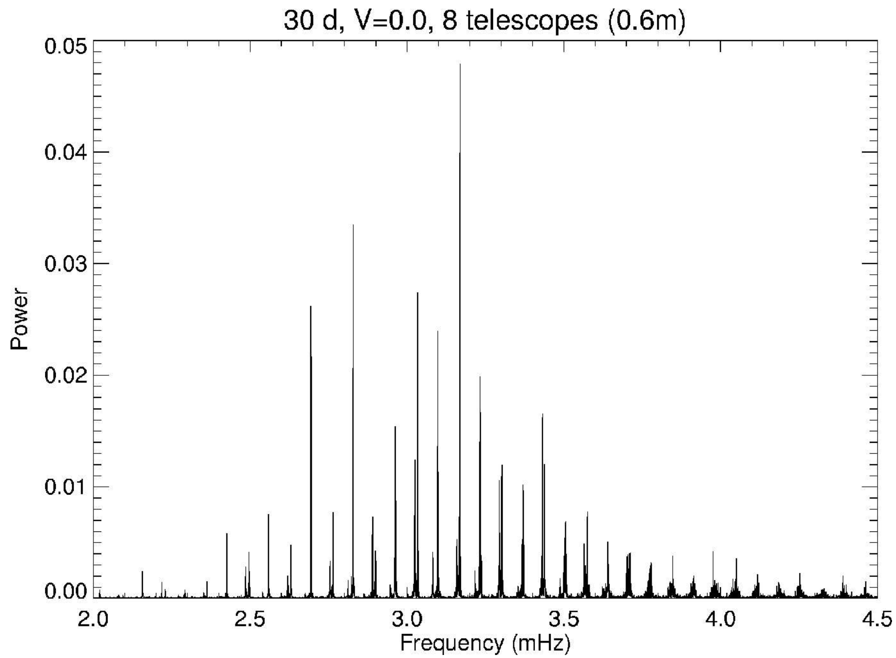
Hipparcos stars and MONS targets
Hipparcos stars
V < 6.00
5015 stars
Number of targets: 813
ηBoo
Procyon
νIndi
βHyi
μArae
αCen A
αCen B
M_V
(V−I)_Hipparcos
−6
−4
−2
0
2
4
6
8
−0.5
0.0
0.5
1.0
1.5
2.0
2.5
3.0

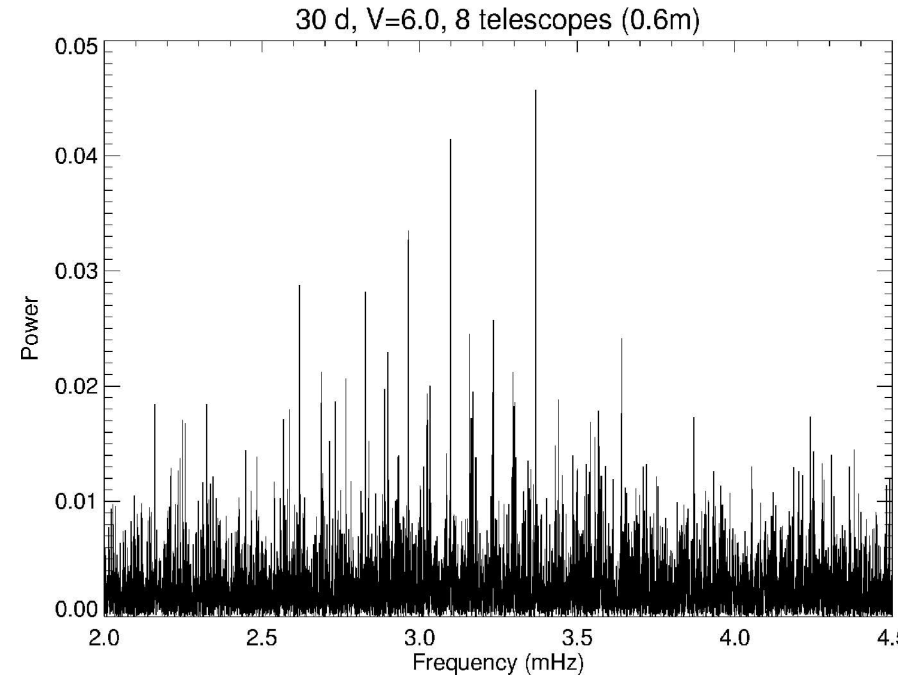
V	-90<?<90		-30<?<30		-90<?<0		0<?<+90	
	No mult	Mult	No mult	Mult	No mult	Mult	No mult	Mult
0.0	0	1	0	0	0	1	0	0
0.5	0	2	0	1	0	1	0	1
1.0	0	2	0	1	0	1	0	1
1.5	1	4	1	2	0	2	1	2
2.0	1	4	1	2	0	2	1	2
2.5	2	5	1	2	0	2	2	3
3.0	4	10	2	5	2	5	2	5
3.5	15	24	9	13	6	9	9	15
4.0	36	59	19	28	17	29	19	30
4.5	78	118	41	59	38	58	40	60
5.0	137	210	64	97	68	104	69	106
5.5	**284**	**417**	**126**	**191**	**146**	**219**	**138**	**198**
6.0	583	817	274	392	299	428	284	389
6.5	1233	1659	596	809	631	868	602	791
7.0	2540	3332	1244	1617	1288	1707	1252	1625
7.5	5063	6481	2541	3216	2542	3265	2521	3216

No mult = Hipparcos multiple flag is NOT set
Mult = Hipparcos multiple flag is IS set

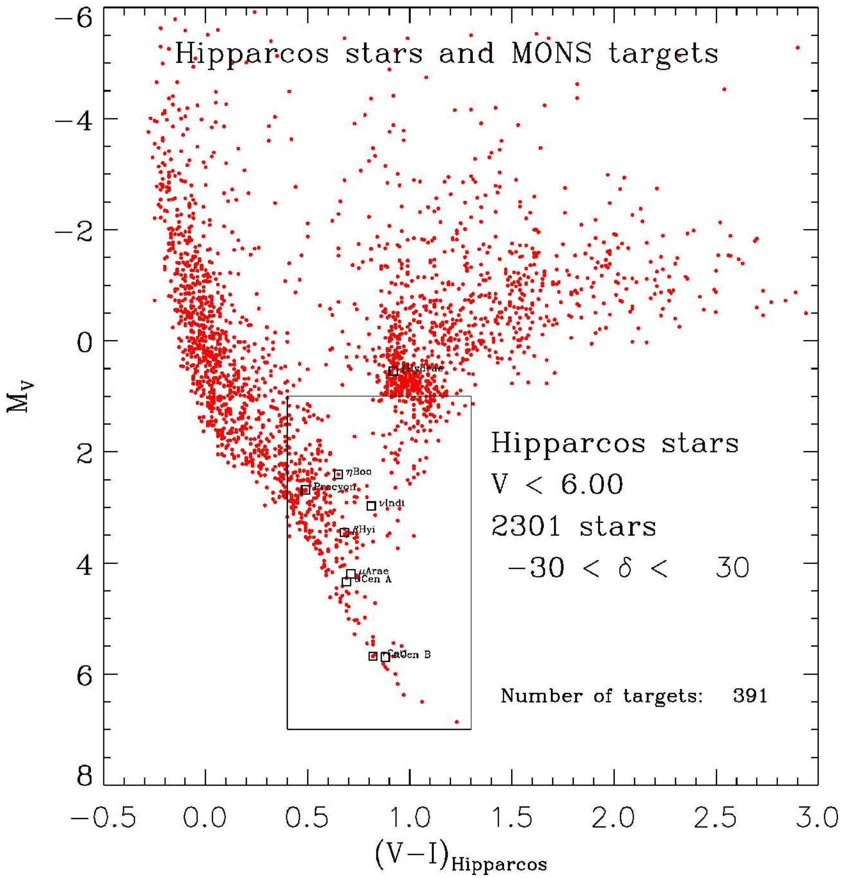
All targets can be "exposed" to interferometry!

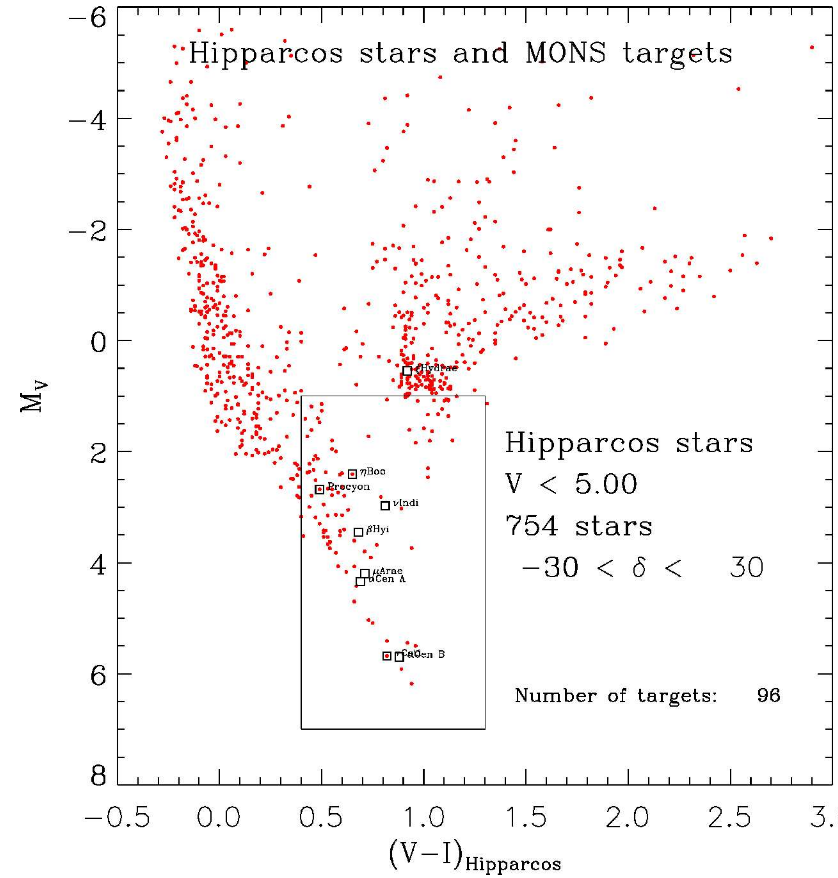
GOLF data + realistic noise





Velocity precision @ V=0 0.5m/s in 60sec.
@V=6 7.8m/s in 60sec.





It makes a big difference for the number of turnoff and main sequence targets if it will be possible to work at V=6

Moving forward.........

Prototyping: Spectrograph,
Telescope,
Data reduction

How you can contribute:

Money, work ideas, hardware,

Timeline:

2006: Concept Design Phase

Mar. 06: First SONG workshop

Apr. 06: Finalize spectrograph requirements and start design work

Aug. 06: Science Design Review: allow science focusing and Science Requirements to be agreed on.
Midterm CDP Review: Status of SONG and focusing of resources .

Sept. 06: Funding applications for next phase(s)

Dec. 06: Preliminary Design Review: ensure readiness for next phases, locate potential problems and showstoppers.

2007: Detailed design and development, including prototype work

Acknowledgements

DASC – Danish AsteroSeismology Centre
IDA – Instrumentcenter for Dansk Astronomi

Implementation and Cost:

Time line:

2006:	Design Study
2007-2008	Development and construction
2009	Deployment, Testing
2010	Operations start

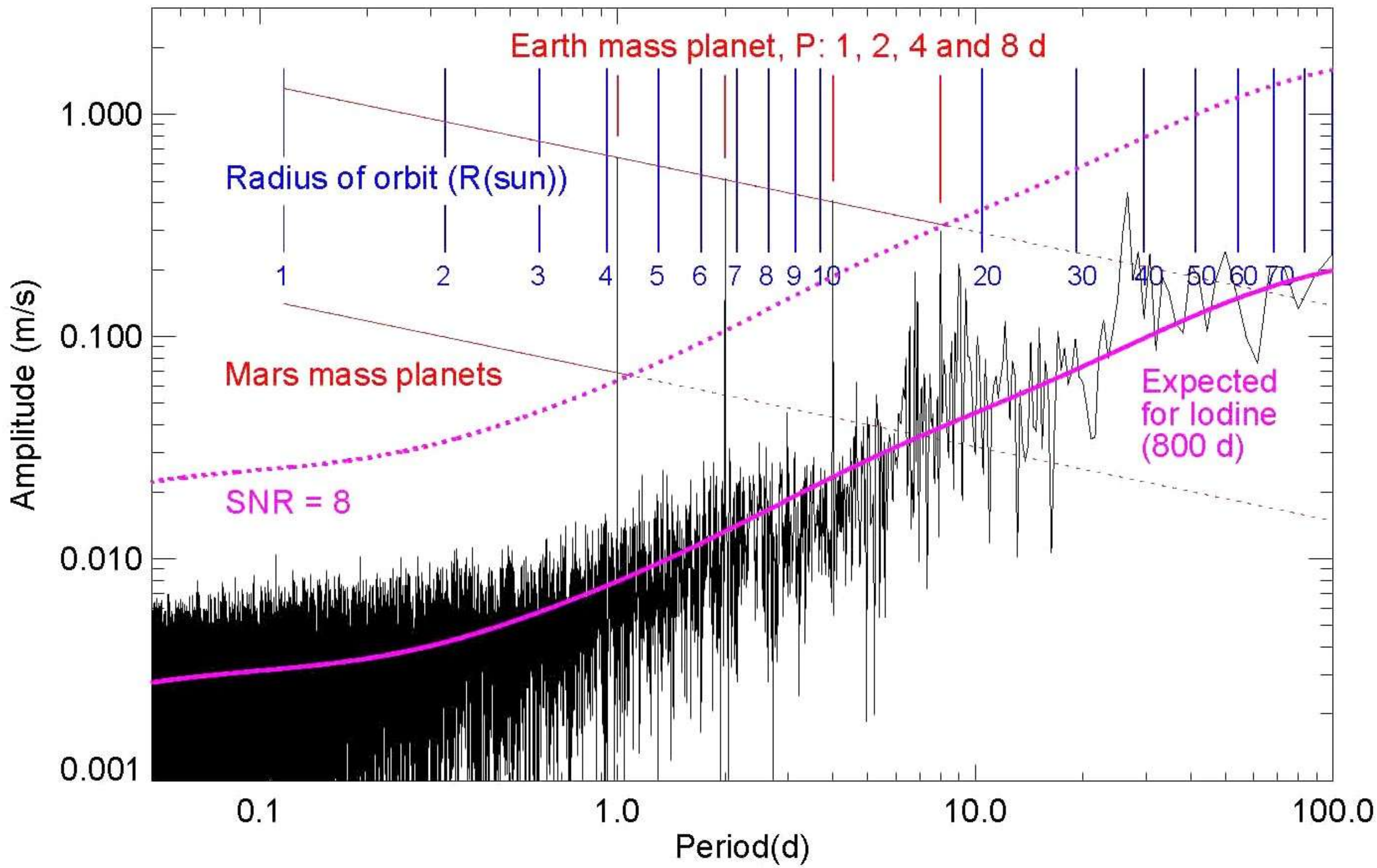
Budget (single site):

Telescopes:	EUR 200.000,-
Spectrograph	EUR 300.000,-
Sites, infrastructure, logistics	EUR 100.000,-
Total	EUR 600.000,-

Simulations of SONG performance by Hans Kjeldsen

Assumptions: 6% total system efficiency, scaled UVES performance.
3 40cm telescopes, 8 sites.

Magnitude	Precision per minute
V = 0.0	0.45 m/s
V = 1.0	0.71 m/s
V = 2.0	1.13 m/s
V = 3.0	1.79 m/s
V = 4.0	2.8 m/s
V = 5.0	4.5 m/s
V = 6.0	7.1 m/s
V = 7.0	11.3 m/s



Earth mass planet, P: 1, 2, 4 and 8 d
Radius of orbit (R(sun))
1
2
3
4
5
6
7
8
9
10
20
30
40
50
60
70
Mars mass planets
Expected
for Iodine
(800 d)
SNR = 8
1.000
0.100
0.010
0.001
Amplitude (m/s)
0.1
1.0
10.0
100.0
Period(d)

Preliminary design of the SONG spectrograph by Sam Barden (AAO)

- Fibre fed, 4 arcsec fibre diameter on the sky (50 micron diameter)
- R ~ 100000, 100mm beam diameter, R4 echelle grating
- 2K x 2K detector with 13.5 micron pixels
- 83% coverage of orders
- Room on detector for four input fibres, cleanly separated
- Nearly diffraction-limited optics
- Size: cylinder of 300mm diameter and 1200mm long.