SkyMapper and the Southern Sky Survey

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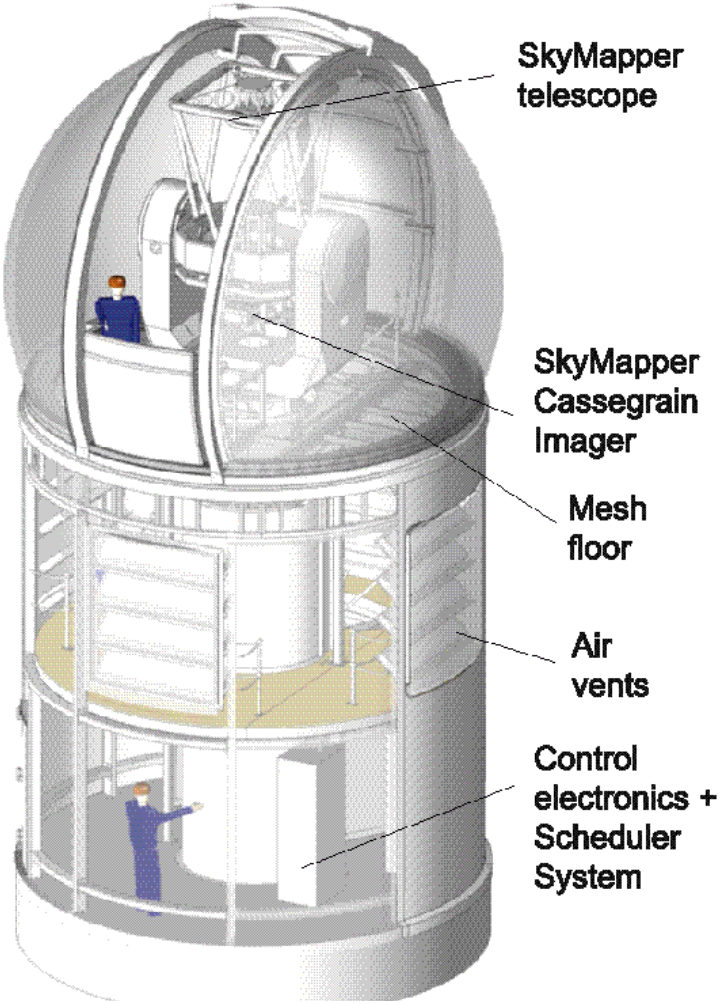
What is SkyMapper?

- 1.35m telescope with a 5.7 sq. degree field of view
- To reside at Siding Spring Observatory, NSW
- To conduct the Southern Sky Survey:
  - Five year
  - Multi-colour (6 filters)
  - Multi-epoch (6 exposures, each filter)
  - 2π steradians
  - Limiting mag. g~23
- First light 2rd quarter 2007
- All-sky photometry $\Rightarrow$ simplify calibration - stds in every VLT, VST field.



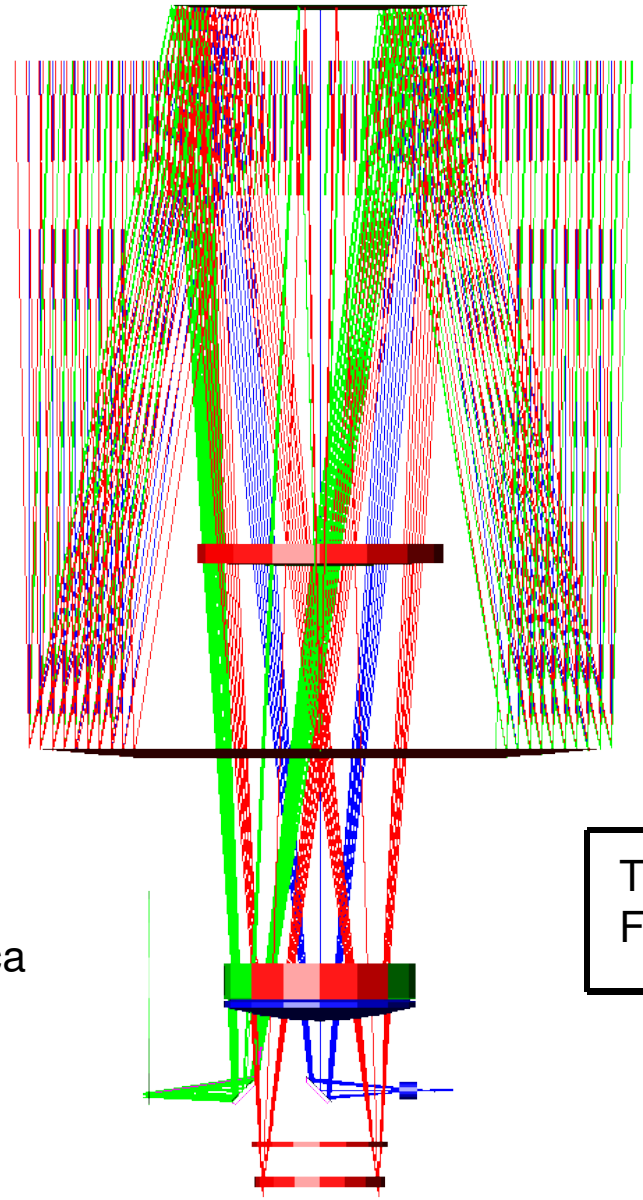
The Rapid Imaging Survey Era

Name	Aperture (m)	FOV (sq deg)	Filter Set	Areal Coverage	Hemi sphere	First Light
SDSS	2.5	Drift scan	ugriz	π (2/3)	N	Operating
CFHT MegaCam	3.6	1	ugriz	<1000	N	Operating
SkyMapper	1.35	5.7	uvgriz	2 π	S	2007
PanStarrs	1.8 (+3x)	7	grizY	3 π	N	2007
VISTA	4	1.65	zYJHK	2π	S	2008
VST	2.6	1	ugriz	~5000	S	2008
Discovery Chn	4	2	?	?	N	2009?
Dark Energy	4	2	?	5000	S	2009?
LSST	6.5	7	ugrizY	3 π	S	2013

- Have a window of opportunity to do the definitive digital southern sky survey, similar to SDSS but with significant improvements:
  - Blue/red sens; areal + temporal coverage; sens to stellar params

Telescope Optics

0.69m secondary



0.6m fused silica asphere

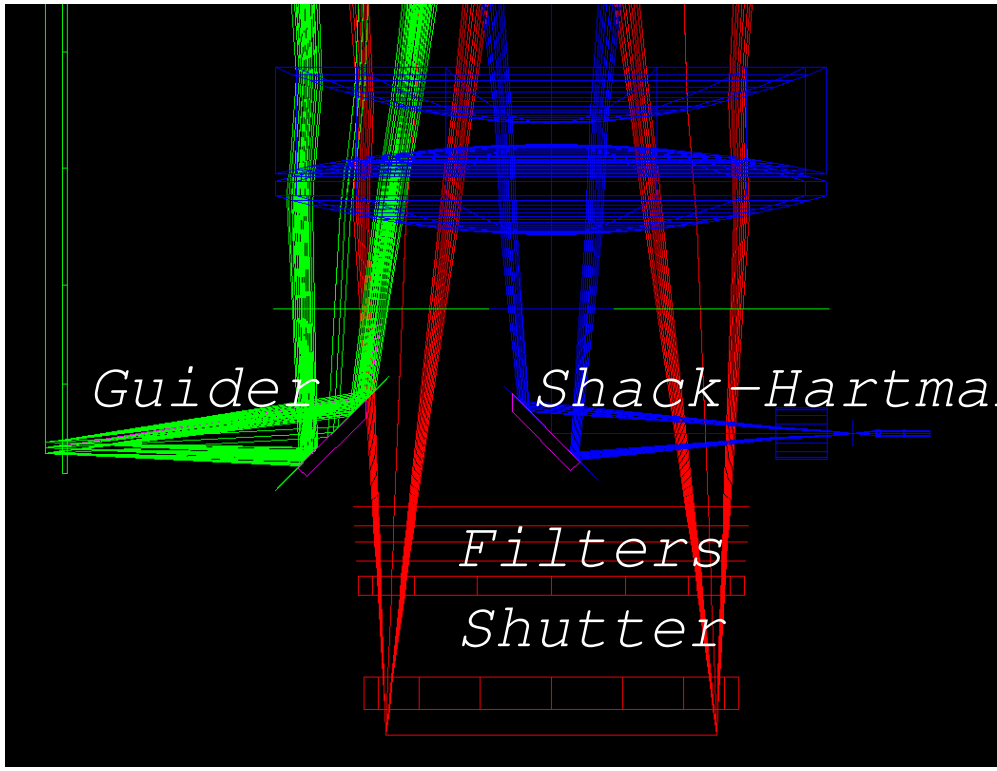
1.35m primary

2 x 0.45m fused silica spherics

Telescope – Focal length & f/ ratio	16224.75mm f/4.78

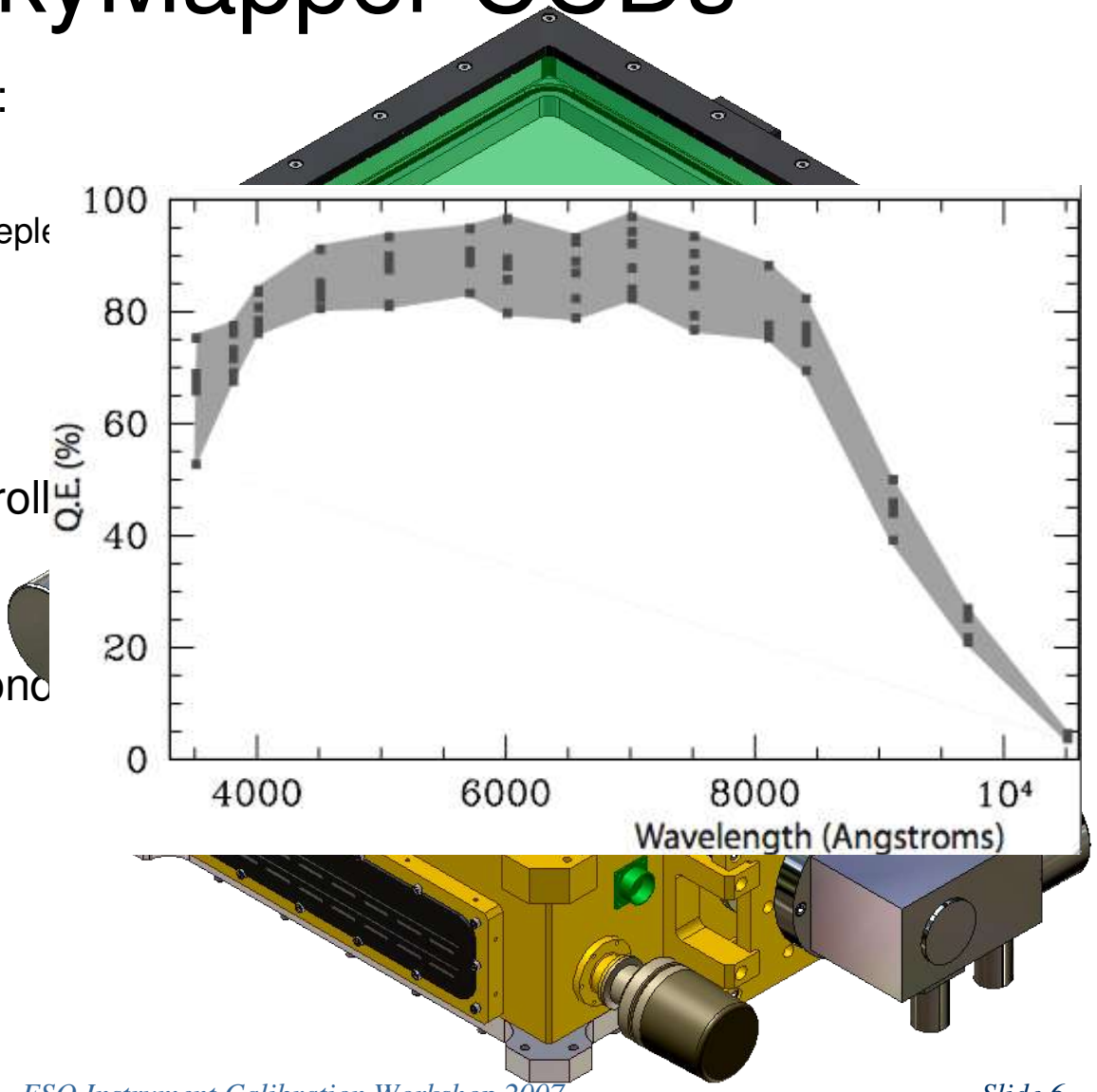
SkyMapper Cassegrain Imager

- Shack-Hartmann system for collimation, etc.
- 6 Filters slots (< 15 second exchange time)
- Bonn shutter (2ms accuracy)



The SkyMapper CCDs

- 32 E2V CCD44-82 devices:
  2048x4096 15 micron pixel CCDs
  - Broadband coated
  - 40 micron (thick) deep depl
    devices
  - Reduced fringing, inc. red response
- 16384x16384 0.5” pixels
- Using new Pan Starrs controll
  (Onaka)
- Readout in ~12seconds
- Readnoise ~5e- @ 12 second



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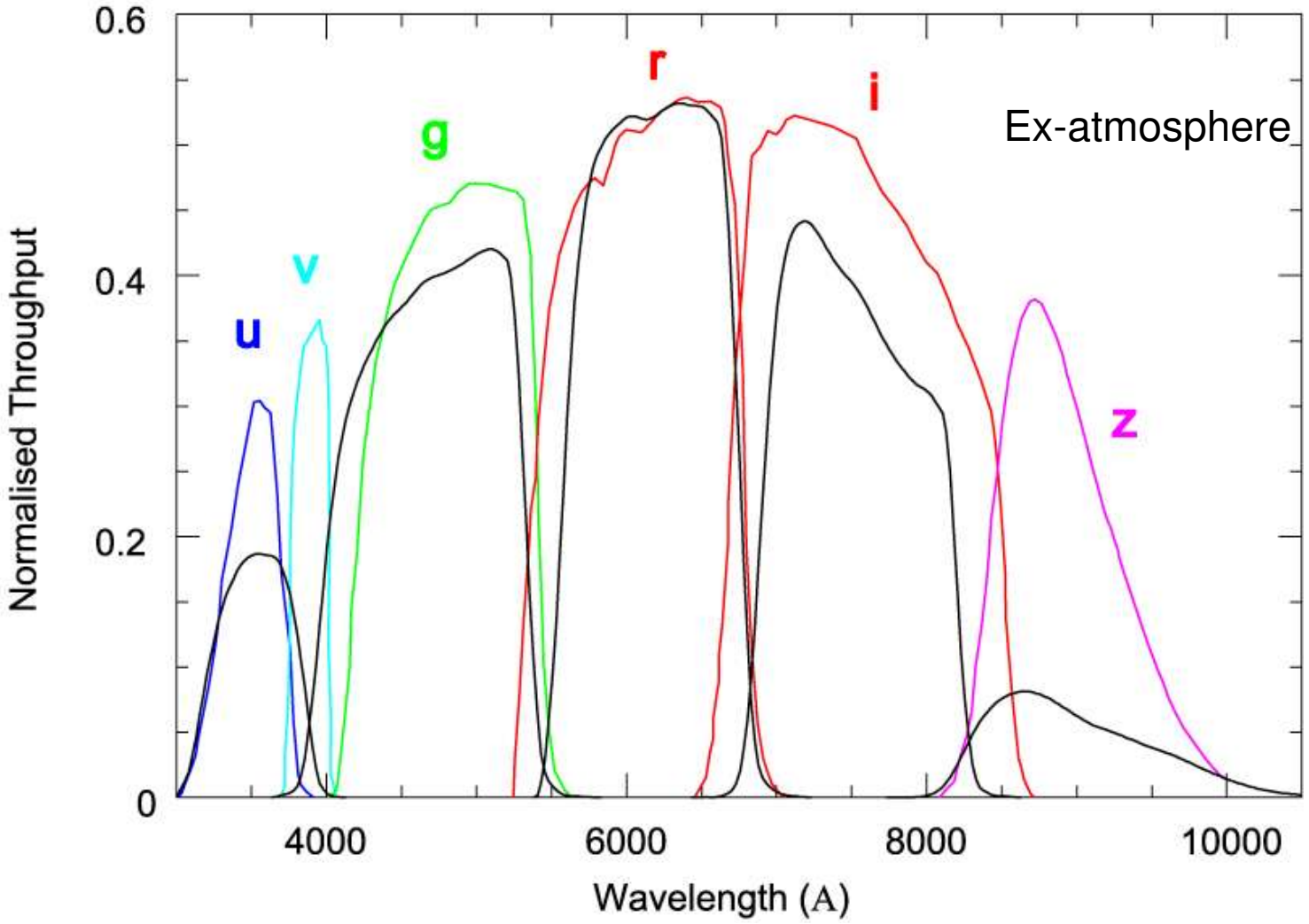
SkyMapper Filter Set



309 x 309 mm filter components

- Russian glasses from MacroOptica, Moscow
- u 8mm yΦC2 + 6.3mm BC4
- v 3 yΦC1 + 6.5 C3C23 + 5 BC7
- g 4 ZhC11 + 5 C3C21 + 5.7 BC4
- r 6.5 OC12 + 8 Schott B270 + SWP coating
- i 6 KC19 + 8.5 Schott B270 + SWP coating
- z 4.5 RG850 + 10.1 Schott B270

- SWP & BBAR coatings from Optical Surface Technologies, Albuquerque

The Southern Sky Survey

- Survey requirements:
  - Large sky coverage - 2π steradians
  - Multi-colour stellar photometry g<18 to 3% global accuracy
  - Astrometry to better than 50 mas ⇒ proper motion to 4mas/yr over five years
  - Multi-epoch: hours, days, months and years.
  - Five years to complete

Expected Survey Limits

	u	*v*	*g*	*r*	*i*	*z*
1 epoch	21.5	21.3	21.9	21.6	21.0	20.6
6 epochs	22.9	22.7	22.9	22.6	22.0	21.5
Sloan Digital Sky Survey comparison	22.0	n/a	22.2	22.2	21.3	20.5

AB mag. for signal-to-noise = 5 from 110s exposures

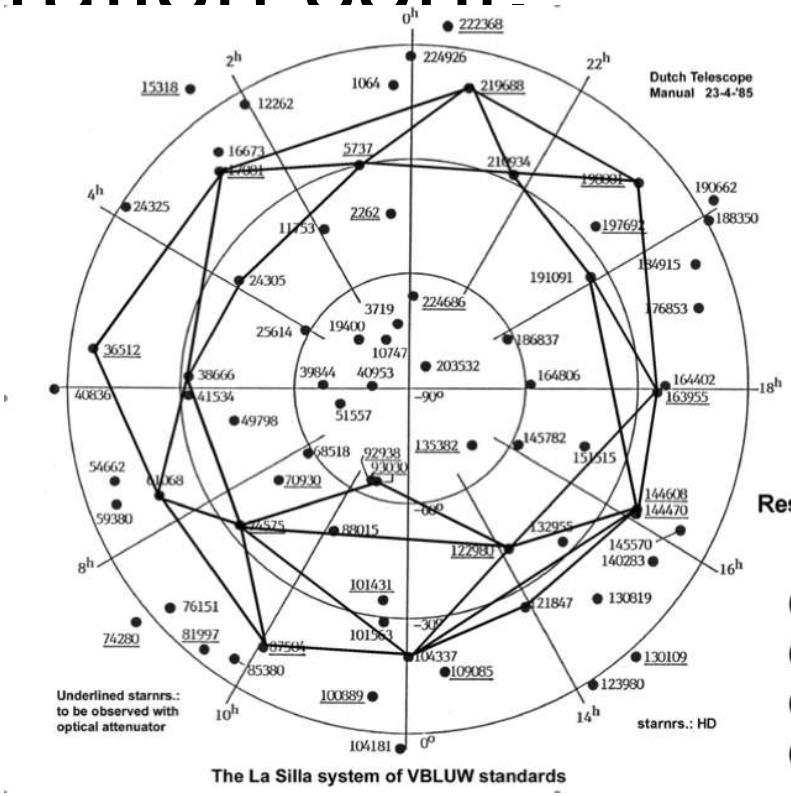
Our Calibration Plans

- Understanding the illumination correction is fundamental
  - In commissioning construct Illum. Corr. Via dithered observations of a field.
  - Then rotate instrument and repeat…
  - Develop 6 reference fields (23 sq. degrees) spaced in RA at dec ~ -20
- Conduct Five-Second Survey
  - In photometric conditions cover the southern sky with 3x5s exposures: 7-16th mag.
  - During 5-S observe the highest two reference fields
- Anchor the deeper Main Survey to the Five-Second photometry and astrometry
  - Enables the Main Survey to proceed under non-photometric conditions

Calibration cont.

- Establish 6 reference fields near Walraven stars
- Individual stars to < 5 millimags
- The stars are also spectrophotometric standards from HST
- Synthetic photometry confirms Walraven colours to 3 millimags

⇒ Absolute flux calibration



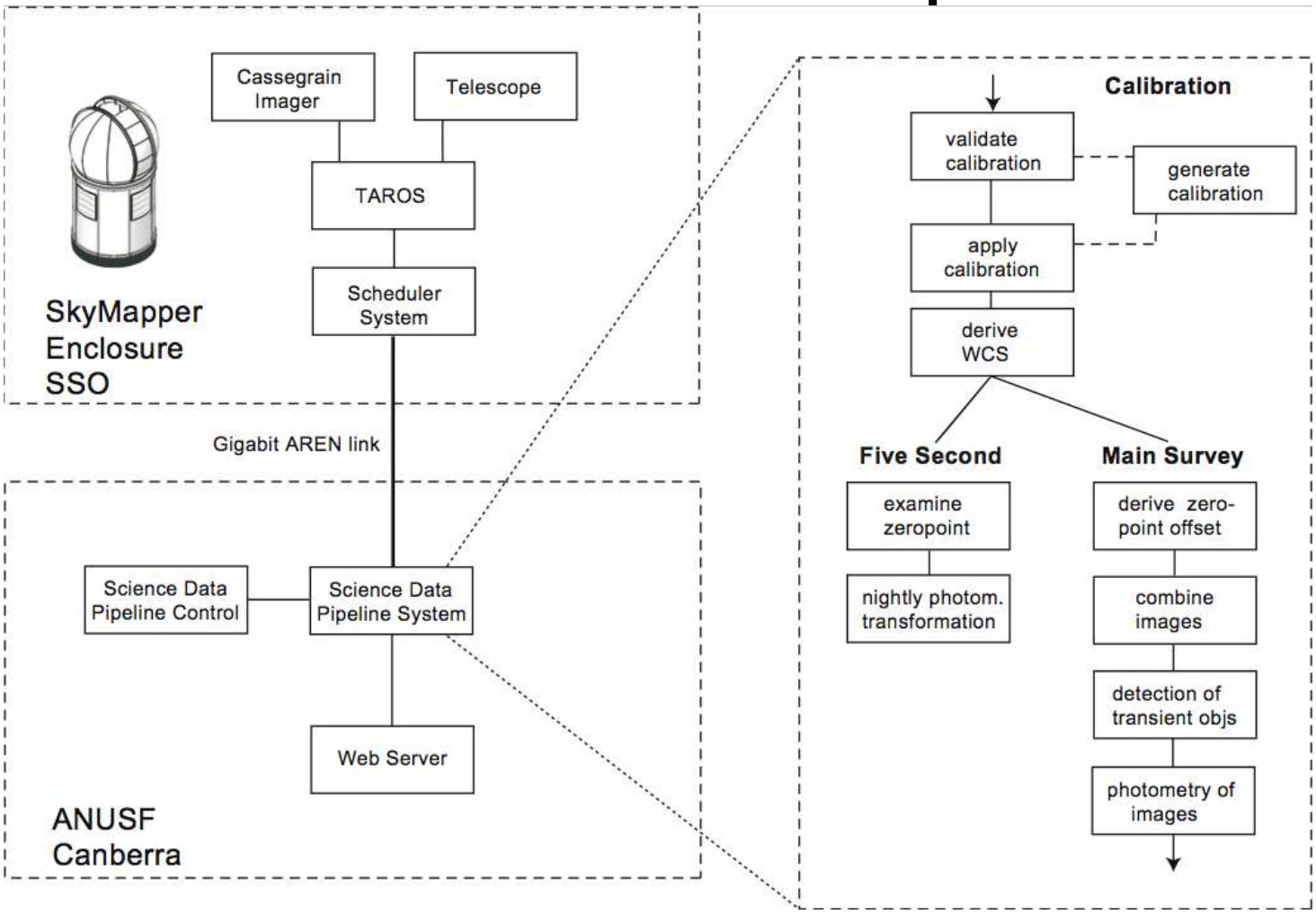
From Pel 2006

Residuals in 'Ring solutions':

V	0.00045 mag
(V-B)	0.00025
(B-L)	0.00031
(B-U)	0.00031
(U-W)	0.00027

5-S contains several thousand stars with Johnson,Geneva, Stromgren and Sloan photometry to provide check on systematic accuracy and define transformations to these systems

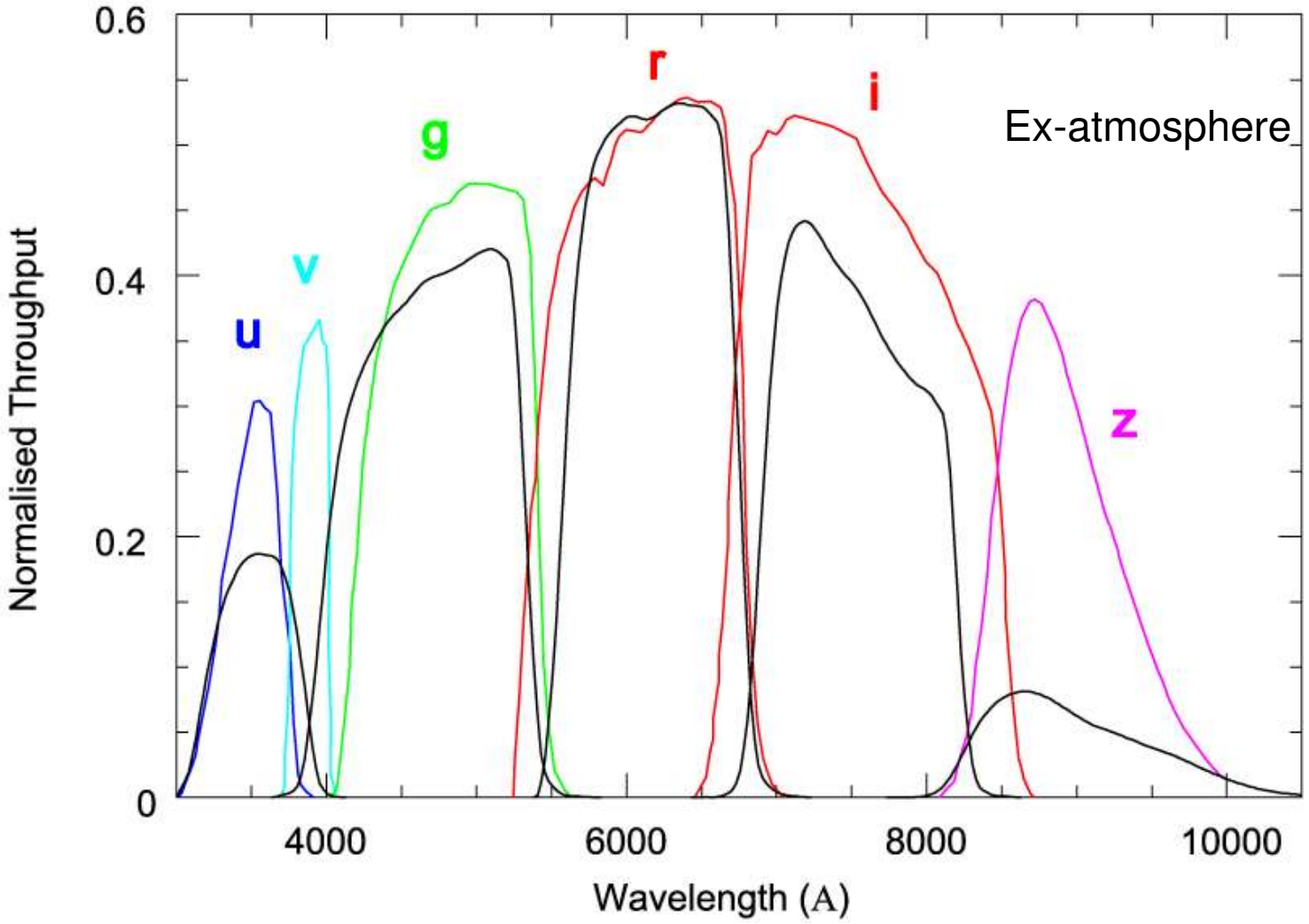
Data Reduction Pipeline



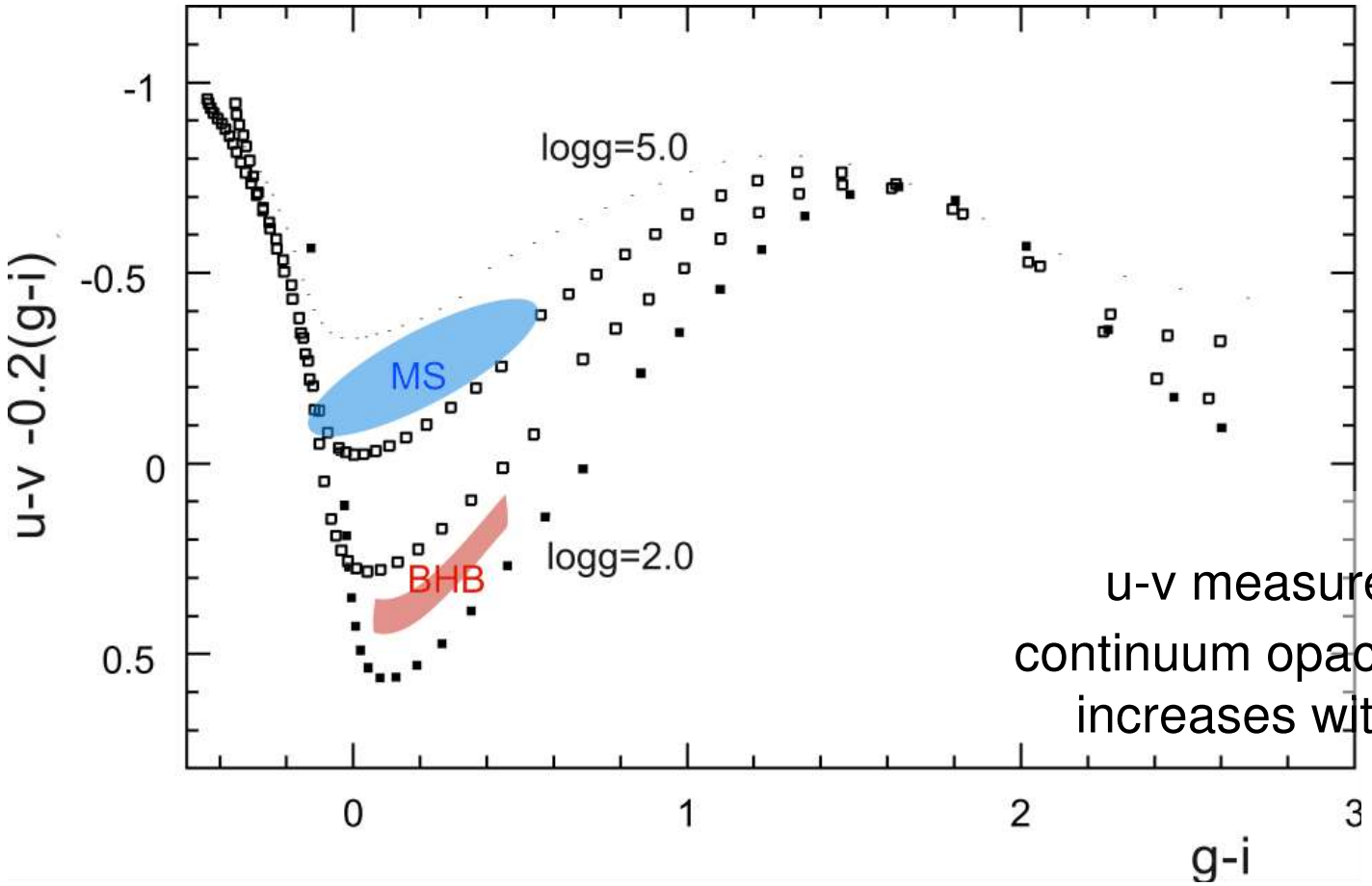
Key Science

- What is the distribution of large Solar-System objects beyond Neptune?
- What is the history of the youngest stars in the Solar neighbourhood?
- How far does the dark matter halo of our galaxy extend and what is its shape?
- Gravity and metallicity for on order of 100 million stars $\Rightarrow$ the assembly and chemical enrichment history of the bulge, thin/thick disk and halo?
- accurate photometric calibration of galaxy redshift surveys: 2dF/6dF.
- Extremely metal poor stars.
- bright z>6 QSOs

SkyMapper Filter Set



Blue Horizontal Branch Stars



u-v measures H^- continuum opacity which increases with logg

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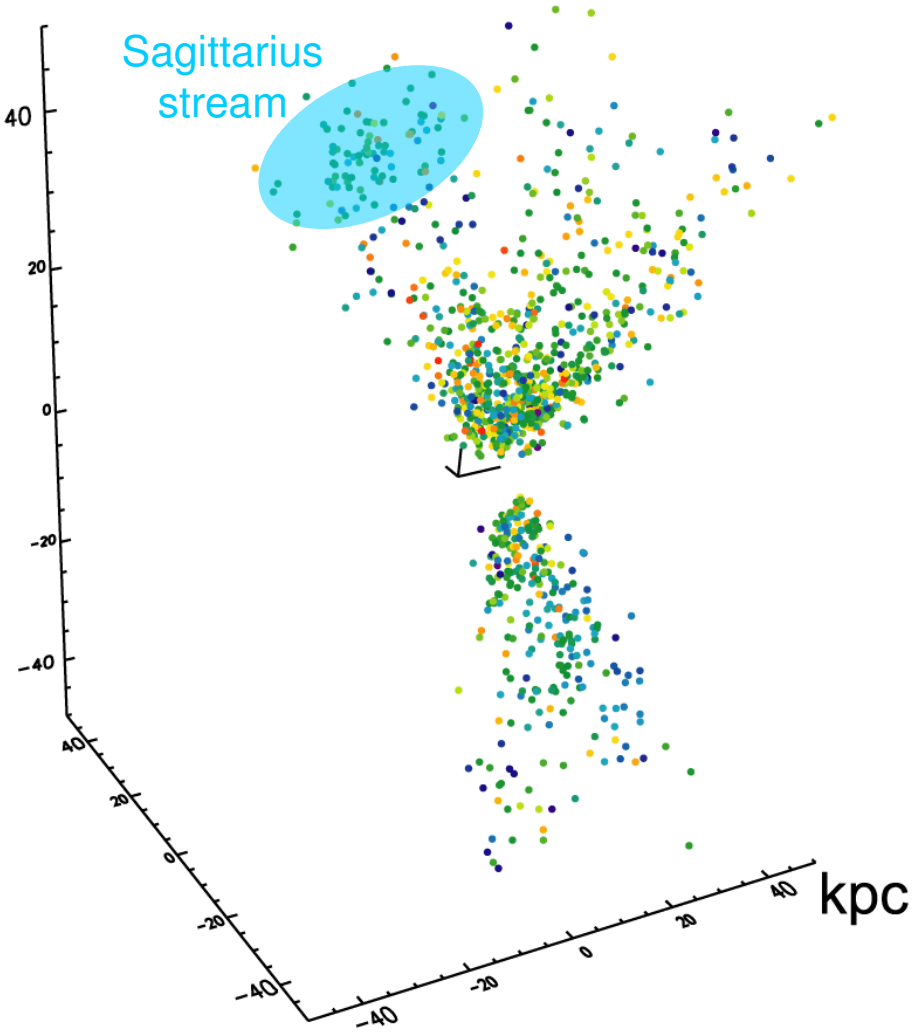


From Sirko et al. 2004

The SDSS view

Use a set of colour and spectroscopic indices to isolate BHBs

Extend to 60kpc

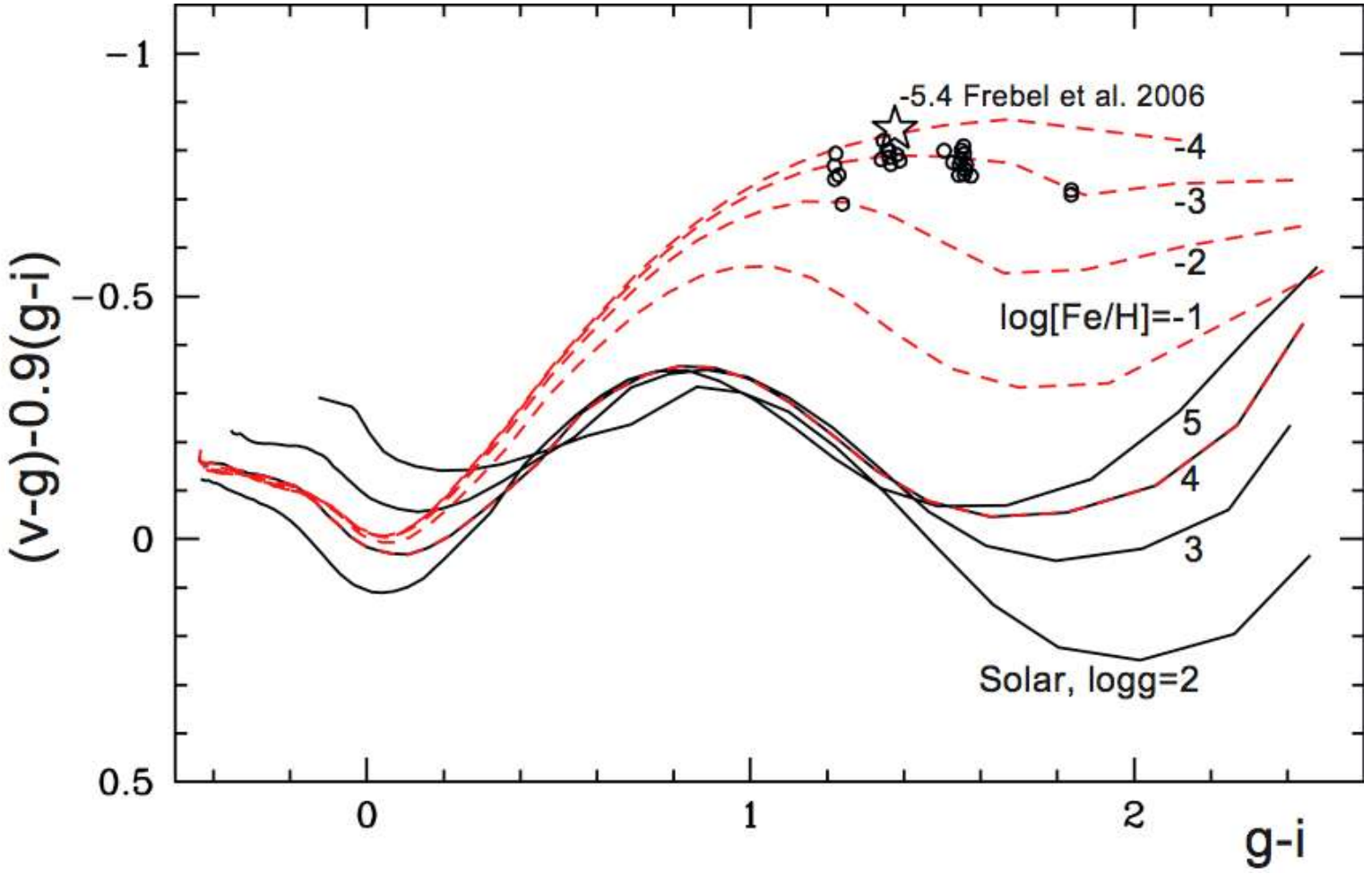
The SkyMapper View

Photometric BHB selection to 130kpc with 5% contamination

+ RRLs obtained from time series

…and lines of sight to HVCs

Metal-poor Stars in the Halo



Data Products

- Deliverables to the Outside User:
  - 5-Second Survey all-sky standards after data validation
  - Main Survey data (epoch, RA, DEC, mags, shape info,…) in two data releases: after 3/6 epochs [2Tb]
    - Main Survey reduced images [150Tb]
    - Released to the world after extensive data verification process

Summary

- SkyMapper and the Southern Sky Survey - a valuable resource for the southern sky
- Commence data acquisition second half of 2007
- Provide accurate photometry for 8-23rd magnitudes
- Photometry that could be used to simplify calibration of imaging data taken by FORS, VST and other ESO imaging assets

http://www.mso.anu.edu.au/skymapper

Passband design criteria

- u like Strömgren u, mostly below Balmer Jump
- v like DDO38, more metallicity sensitive than Strömgren v
- g like SDSS g
- r like SDSS r
- i like SDSS i
- z like SDSS z

-SWP coatings on r, i; CCD cutoff for z.

-SWP coatings remarkably uniform at 0.3%