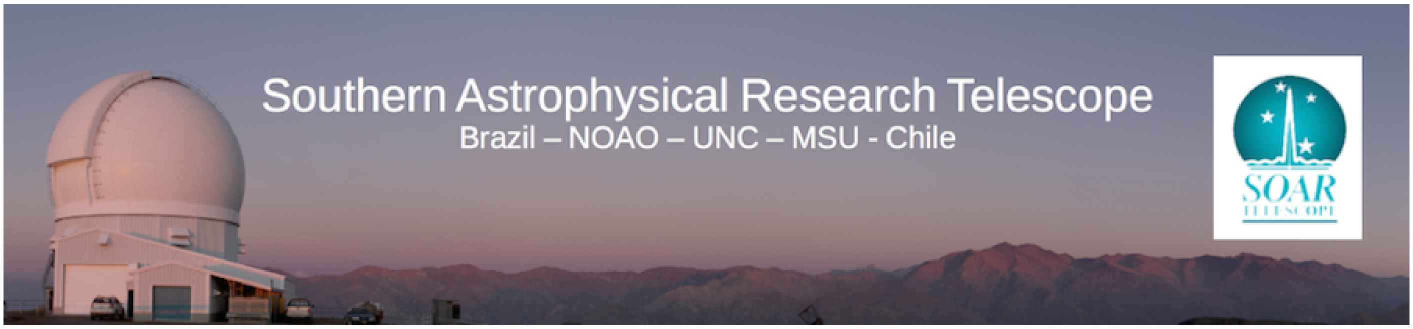


Published on *SOAR* (http://www.ctio.noirlab.edu/soar)

About SAM

Introduction

The **SOAR Adaptive Module** (SAM) is a laser-assisted adaptive optics instrument at the 4.1-m SOAR telescope. By compensating selectively low-altitude turbulence, it improves resolution at visible wavelengths. The instrument contains a 4Kx4K CCD imager covering the 3-arcmin square field. The paper describing the instrument is Tokovinin et al. (2016). [1]

Images as sharp as 0.3″ have been obtained under favorable conditions of weak high-altitude turbulence which happen ~50% of the scheduled SAM nights. Under such conditions, the typical FWHM resolution delivered by SAM is 0.4″ in the I band and 0.5″ in the V band. The compensation quality is uniform over the field (FWHM variation of few percent). On nights with strong high turbulence (which does not necessarily mean poor seeing), SAM brings only a marginal resolution gain in closed loop and delivers V -band FWHM between 0.6″ and 1″.

The first paper using SAM commissioning data on the globular cluster NGC 6496 was published by Fraga et al. (2013, [2] AJ, 145, 165) [2]. It demonstrates that the photometric precision and limiting magnitude in crowded stellar fields are improved by using the SAM AO system and that good-quality photometry can be derived from the SAMI images.

In the figure 1 from Fraga et al. 2013 shown above, we show the full-frame image of NGC 6496 in the I-band taken with the SAM Imager (SAMI; north is up, east to the left). The enlarged fragments of 15 × 12 arcsecond size compare closed-loop (upper) and open-loop (lower) images taken with the same exposure time of 120 s and displayed on the same intensity scale, at the center and near the edge of the field.

SAM in Numbers [3]

Documentation for the SAM User

- SAM Imager (SAMI) Instrument Manual [4]
- SAMI Software manual [5]
- Filters available for SAMI [6]
- Contact SAM support staff [7]

Documentation for the SAM Operator (SAM Support Scientist)

- SAM Operator's Manual [8] (user guide)
- Link to SpaceTrack (for PRM/PAM files. Only authorized users) [9]
- SAM Computers [10]
- SAM LCH Protocol Guide [11]
- ICSoft Manual [12]
- SAM AOM Software Manual [13]
- SLCH Software User Manual [14]
- SAM Instrument documentation [15](login required)

Filters for SAMI

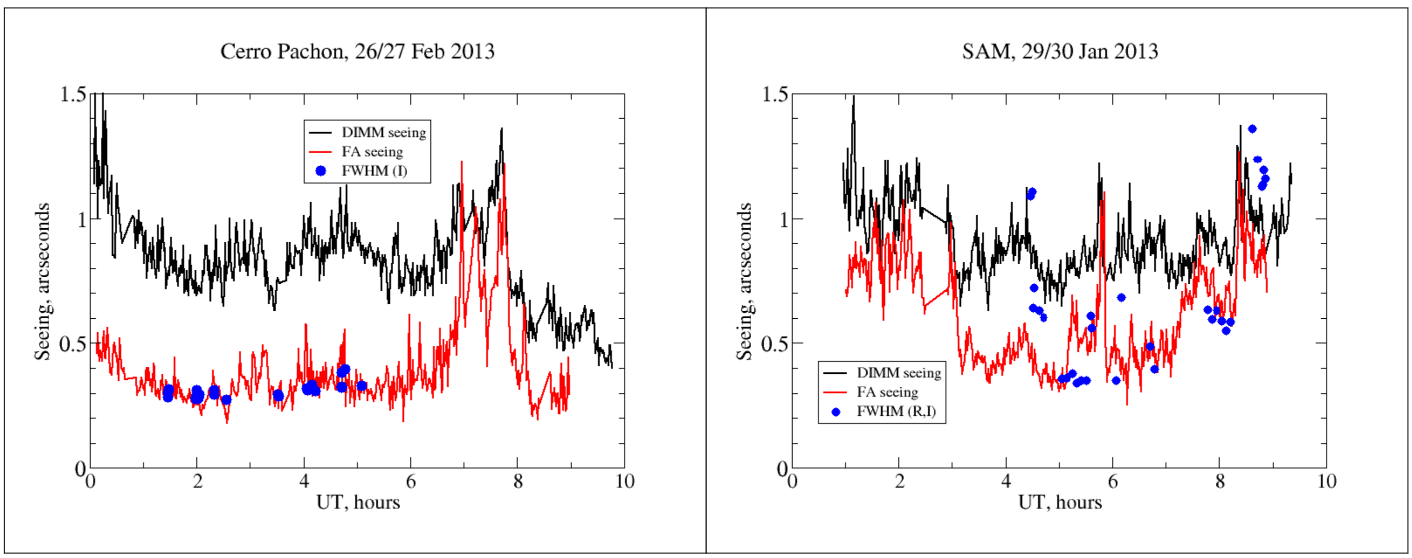
SAMI has one filter wheel with 7 positions for 3 inch square filters. We have acquired two new broadband filter sets for exclusive use with SAMI: a Kron-Cousins BVRI set and a SDSS griz set. We also have new Ha, NI, [NII] and [SII] narrow band filters, in addition to several redshifted Ha filters designed for the Fabry-Perot module (more details in this link [16]). The table below shows the updated list of available filters, with the vendor-supplied transmission curves.

Filter Name	Filter Set	Central wavelength (Å)	FWHM Width (Å)	Transmission Curve
SAMI-B	K-C	4400	1000	Plot [17]
SAMI-V	K-C	5500	800	Plot [18]
SAMI-R	K-C	6550	1800	Plot [19]
SAMI-I	K-C	7800	1050	Plot [20]
SAMI-g	SDSS	4750	735	Plot [21]
SAMI-r	SDSS	6250	735	Plot [22]
SAMI-i	SDSS	7750	765	Plot [23]
SAMI-z	SDSS	9500	2328	Plot [24]
SAMI-Ha	Narrow	6563	75	Plot [25]
SAMI-[NI]	Narrow	5180	55	
SAMI-[NII]6583	Narrow	6583	18	Plot [26]

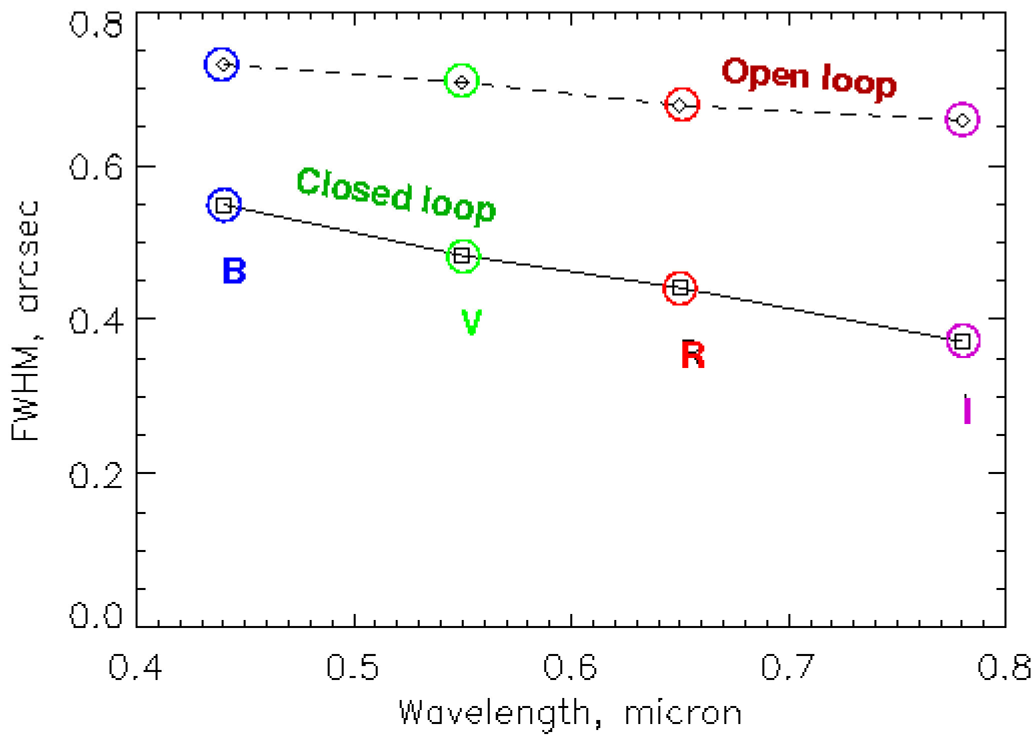
SAMI-[SII]	Narrow	6724	75	Plot [27]
SAMI-[SII]6738	Narrow	6738	27	Plot [28]
BTFI_5021/17	Narrow	5030.9	16.5	
BTFI_6569/20	BTFI	6569.2	18.6	
BTFI_6579/20	BTFI	6578.8	19.9	
BTFI_6600/20	BTFI	6600.5	19.3	
BTFI_6745/38	BTFI	6745	38.5	

Performance

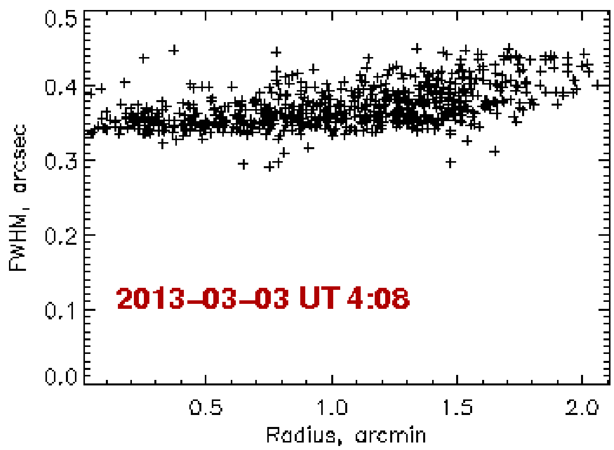
SAM compensates partially turbulence in the atmospheric ground layer and in the telescope dome. The delivered image quality (DIQ) approaches the free-atmosphere seeing produced by turbulence above ~0.5km. When the free atmosphere is calm, SAM provides an appreciable gain in the DIQ, but when the total seeing is dominated by the free atmosphere, the gain from using SAM can be marginal and the DIQ can be mediocre. This is illustrated by the two figures below.

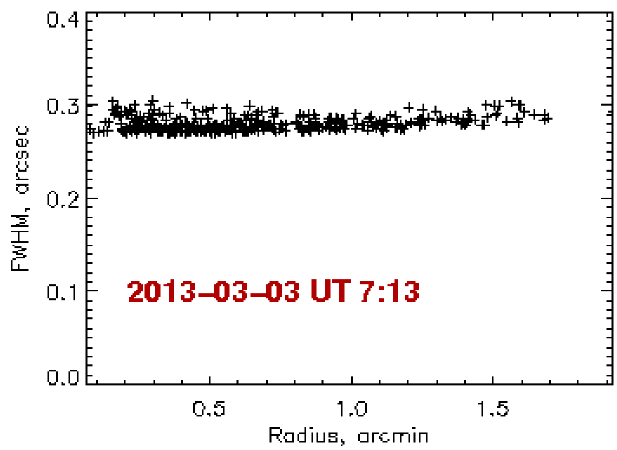


Left plot: on February 26, 2013, the free atmosphere (red line) was calm, the DIQ in the I band (blue dots) was between 0.3 and 0.4 arcsec FWHM - much better than the site seeing (black line). Right plot: one month before that, on January 29, 2013, the seeing was less stable and often dominated by the free atmosphere. In these conditions the DIQ could be worse than 1 arcsecond, and the resolution gain provided by SAM was variable. Note that the site seeing was similar on both nights. The performance of SAM depends on the **free-atmosphere seeing** , not on the total seeing!



Turbulence compensation in SAM is partial, better at longer wavelengths. The DIQ of SAM depends on the wavelength stronger than the natural seeing. The plot above shows the median DIQ for a good night of March 6, 2012, in closed (compensated) and open (uncompensated) loop. Yet another consequence of partial compensation is that the point-spread function is more "peaked" compared to the natural seeing. It can be modeled by a Moffat function with beta~2. With such PSF, the encircled energy is improved, but not as much as the FWHM resolution.





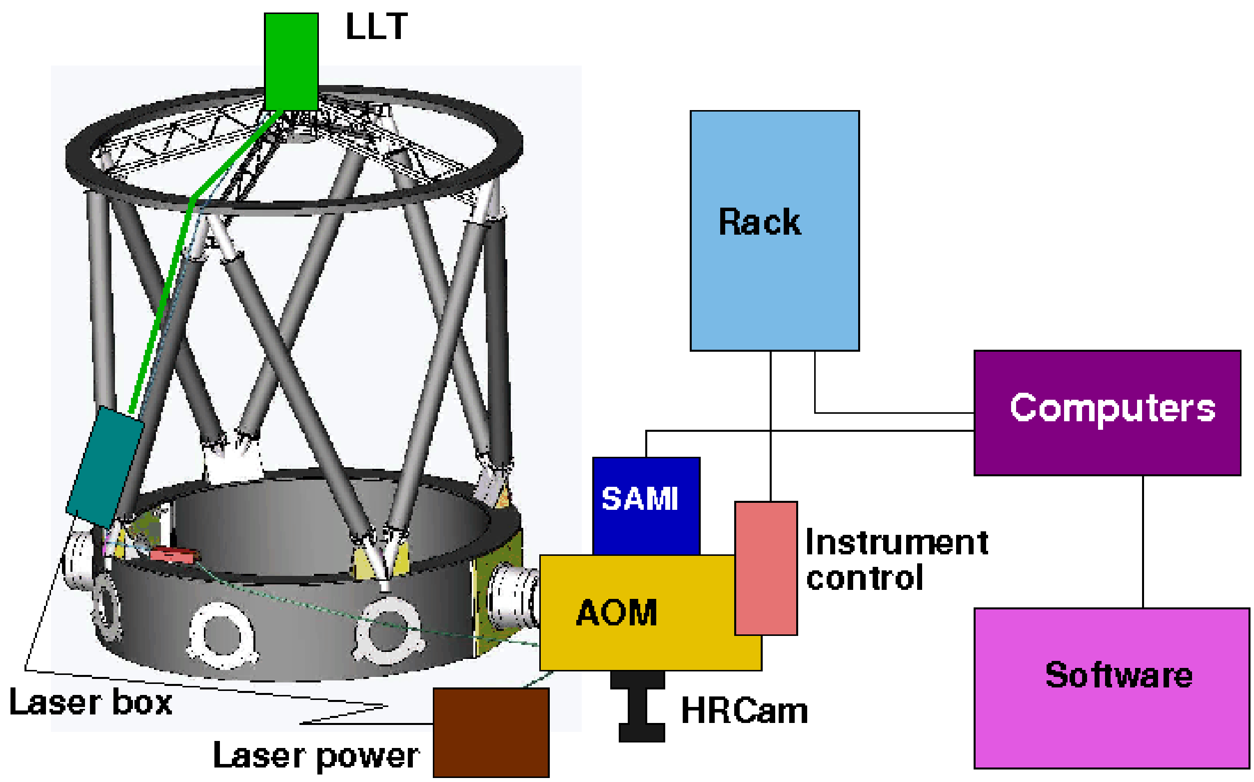
The plots below show FWHM resolution as function of the star position in the field. The data were obtained on a good night of March 3/4, 2013 in the I band, when SAM provided a very good resolution. The uniformity over the field is excellent. However, some degradation towards the field border is seen in the left plot. It is produced by partially compensated turbulrnce at low altitude.

This material is based on the SAM Commissioning report [29].

SAM in Numbers

AOM: optics

- Focus depth w.r.t. flange surface: 150mm
- OAP parameters:



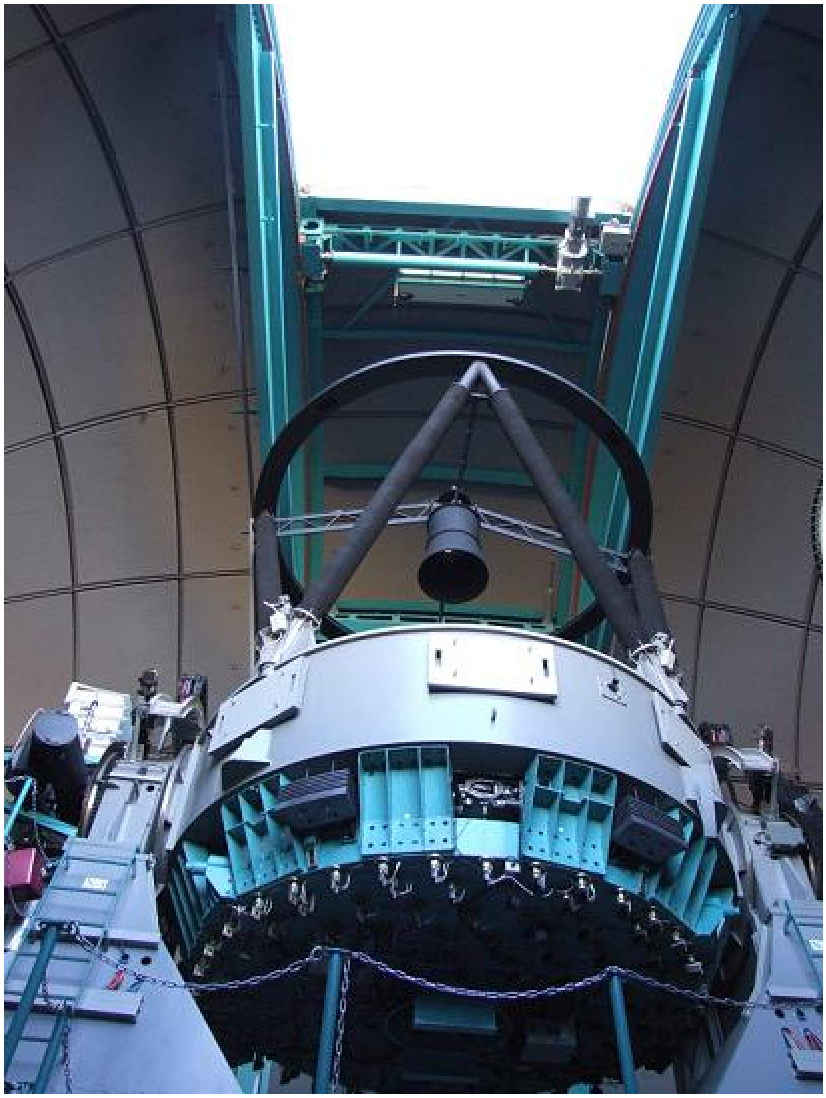
  - Focal length 810mm
  - Off-axis distance 213.277mm
  - Diameter 175mm
- Deformable mirror BIM-60

    - Number of electrodes: 60
    - Pupil diameter: 50mm, incidence angle: 12.5deg
    - Min. curvature radius (400V on all electrodes): 16.7m
- Tip-Tilt guiders
    - Patrol field: 100x100mm (5x5 arcmin)
    - Probe field of view: 3x3arcsec

AOM - mass and dimensions

- Total mass at installation (3-Aug-2009) ~300kg
- Offset towards SOAR w.r.t. the ISB hole: 67.5m

SOAR telescope



- Aperture diameter 4.10m
- Plate scale 0.330mm/arcsec or 3.025arcsec/mm
- M1 curvature radius at vertex: -13.50970m
- M1 conic constant: -1.002667
- M2 curvature radius: -2.03265m
- M1-M2 distance: 5.83922m
- M2-M3 distance: 4.98922m

- M3 to focus: 4250.0m
- Effective focal length: 68.175m (F/16.63)
- Focal surface radius: 0.9656m (convex outside)
- Central obscuration: 0.228 (diameter 936.5mm)

Laser

- Wavelength 355nm
- Nominal power 10W
- Nominal pulse frequency 10kHz, pulse length 34ns
- Laser head size: 813x127x86mm, mass: 14.5kg
- Typical power consumption: 400W laser, 700W chiller
- Power supply size: 427x364x76mm, mass: 8.4kg
- Chiller size: 533x440x264mm, mass 55kg

Electronics

Computers

HR camera

- Pixel size 10 micron or 15.23mas
- Format 658(H)x496(V) or 6.58x4.96mm or 10.0x7.55arcsec

SAMI

- Pixel size 15micron or 45.5mas
- 4Kx4K (3x3 arcmin on the sky)
- Filters: TBD

Back to SAM webpage [30]
Last change: Dec-23-2014, César Briceño

Send comments to: Andrei Tokovinin [31]

SAM: instrument support staff

Instrument support scientists

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Cesar Briceno (cbriceno@ctio.noao.edu [32])

Engineering support

Manuel Martinez (mmartinez@ctio.noao.edu [33]) - electronics, motion control software
Rolando Cantarutti (rcantarutti@ctio.noao.edu [34]) - real-time and instrument control software, HRCAM
Omar Estay (oestay@ctio.noao.edu [35]) - SAMI software
Roberto Tighe (rtighe@ctio.noao.edu [36]) - optics

Source URL: http://www.ctio.noirlab.edu/soar/content/about-sam

Links
[1] http://adsabs.harvard.edu/abs/2016PASP..128l5003T
[2] http://adsabs.harvard.edu/abs/2013AJ....145..165F
[3] http://www.ctio.noirlab.edu/soar/content/sam-numbers
[4] http://www.ctio.noirlab.edu/soar/sites/default/files/SAM/archive/sami-manual.pdf
[5] http://www.ctio.noirlab.edu/soar/sites/default/files/SAM/archive/sami-sw.pdf
[6] http://www.ctio.noirlab.edu/soar/content/filters-sami
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[15] http://www.ctio.noirlab.edu/soar/content/instrument-documentation-0
[16] http://www.ctio.noirlab.edu/soar/content/filters-sam-fp
[17] http://www.ctio.noirlab.edu/soar/sites/default/files/SAM/SAMI_Filters/Kron-Cousins_B.jpg
[18] http://www.ctio.noirlab.edu/soar/sites/default/files/SAM/SAMI_Filters/Kron-Cousins_V.jpg
[19] http://www.ctio.noirlab.edu/soar/sites/default/files/SAM/SAMI_Filters/Kron-Cousins_R.jpg
[20] http://www.ctio.noirlab.edu/soar/sites/default/files/SAM/SAMI_Filters/Kron-Cousins_I.jpg
[21] http://www.ctio.noirlab.edu/soar/sites/default/files/SAM/SAMI_Filters/SDSS_g.jpg
[22] http://www.ctio.noirlab.edu/soar/sites/default/files/SAM/SAMI_Filters/SDSS_r.jpg
[23] http://www.ctio.noirlab.edu/soar/sites/default/files/SAM/SAMI_Filters/SDSS_i.jpg
[24] http://www.ctio.noirlab.edu/soar/sites/default/files/SAM/SAMI_Filters/SDSS_z.jpg
[25] http://www.ctio.noirlab.edu/soar/sites/default/files/SAM/SAMI_Filters/SAMI_filt_Ha_curve.png
[26] http://www.ctio.noirlab.edu/soar/sites/default/files/SAM/SAMI_Filters/SAMI_filt_NII_Narrow_curve.jpg
[27] http://www.ctio.noirlab.edu/soar/sites/default/files/SAM/SAMI_Filters/SAMI_filt_SII_curve.png
[28] http://www.ctio.noirlab.edu/soar/sites/default/files/SAM/SAMI_Filters/SAMI_filt_SII_narrow_curve.png
[29] http://www.ctio.noirlab.edu/soar/sites/default/files/SAM/archive/samrep.pdf
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