SARG - The TNG High Resolution Spectrograph

This site contains an adapted version of the main web page of SARG spectrograph. The information contained in this page are enough in order to prepare the observing run.

For more information please visit the Official Padova SARG Website.

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The SARG Exposure Time Calculator (java)

Instrument Status

<table>
<thead>
<tr>
<th>Built by:</th>
<th>OAPD, OACT, OAPA, OATS (P.I.: R. Gratton)</th>
</tr>
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<tbody>
<tr>
<td>Installation:</td>
<td>Nasmyth. Focus B TNG</td>
</tr>
<tr>
<td>Status:</td>
<td>First Visiting Astronomer: January 7th 2001</td>
</tr>
<tr>
<td>Science Team:</td>
<td>R. Pallavicini, P. Molaro, R. Viotti</td>
</tr>
<tr>
<td>Main Contractor:</td>
<td>Contractors and links</td>
</tr>
<tr>
<td>SARG Team Members:</td>
<td>People and Contact</td>
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</table>

Instrument Description

SARG is a cross dispersed echelle spectrograph covering, simultaneously, the wavelength range between 370 -1000 nm. The spectral resolution for a 1 arcsec wide slit is $R=46,000$. The maximum resolution attained with a slit is $R=164,000$ (a selection
of 6 slits is available) while exploiting the Image slicers is R=144,000 (7 slices of 0.314 arcsec that with a pixel size of 13.5 µm provide a projected width on the CCD of 1.92 pixels).

The spectrograph is rigidly connected to the TNG fork under the elevation axe of the telescope. The light feed is provided by an optical train (a lens and a folding mirror) that fold the light beam from the telescope to the spectrograph. The cylinder with the feeding optics is mechanically located within DoLoRes (the TNG low resolution spectrograph) which permanently occupies the Nasmyth B focus.

In order to have a compact design of the optical train (and of the spectrograph) the collimator is a white pupil collimator with a quasi-Littrow configuration providing a 100 mm beam.

The dioptric camera is a F/4.8 providing a correct field of 8.5 degree (in diameter) and a scale of 83.3 µm/arcsec. The detector is a mosaic of 2 2K X 4K thinned and back illuminated CCDs with a 13.5 µm pixel size (0.16 arcsec/pixel).

The cross dispersion is obtained by a selection between four different grisms; the order separation is 6 arcsec minimum.

Auxiliary devices include:

- **Usual Calibration lamps:**
  1. Flat Field lamps: each lamp is equipped with a different colored filter according the selected cross disperser in order to obtain an approximate flat color response on the CCD
  2. Th lamp
  3. Hg lamp to determine the instrumental profile
- **Iodine absorption Cell:** for high precision radial velocity studies.
- **An image derotator.
- A slit viewer** for pointing and tracking.
- **A slide and filter wheel for neutral and rejection filters.** In the filters wheel there are some free position for custom filters (not provided)

The whole spectrograph, but the calibration lamp assembly, is closed inside a cover (included the CCD dewar vessel). A Distributed Active Temperature Control System keeps the inside temperature at the value of (20.0 ± 0.5) C.

**The Polarization Analyzer**

SARG will be equipped with a polarization analyzer that will be mounted (February 2001) on the top of the spectrograph between FM1 and L1. The polarization analyzer will consist of:

- A phase compensator, to correct the linear polarization introduced by the two flat mirror 90° reflections.
- A super achromatic half-wave plane, able to rotate at 22.5° steps and continuously.
- A quarter-wave plate rotating of 90°.
• A beam displacer.
• A depolarizer.

The half-wave and the quarter wave plate will be alternatively used to measure linear or circular polarization respectively. The analyzer is located outside the SARG and its thermal insulated cover, near the focal position created by L1 lens. The scale in this position is 585 μm/arcsec, and therefore the ideal separation of the beams (2-3 arcsec) corresponds to a beam displacement of 1-2 mm. To keep the polarization plane fixed with respect to the polarization component axes, the analyzer at the Nasmyth focus should be accordingly rotated. The two light beams exiting from it would subsequently be derotated by the SARG field derotator, so that they would continue their path in a constant geometry, along the slit.

**The SARG Controls**

SARG controls are basically a VME-system based; the VME-bus directly controls the TNG standard CCD controller by means of an optical fiber link. Spectrograph functions (9 axes) are controlled by RS232 links to standalone motor controllers. All the electronic boards, controllers and VME bus are located in a single rack a couple of meters apart the spectrograph. A high level GUI will be available to control all SARG functions.

The science objectives are listed in Table 1. The predicted observational capabilities and performances are given in Table 2 below and in the figures.

### Table 1: SARG Scientific Drivers

- Detection of Extrasolar Planets (high-precision radial velocity studies over long timescales)
- Asteroseismology of solar type stars (high-precision radial velocity studies over very short timescales)
- Data on the mechanisms of galaxy formation by statistical studies of the absorption lines in QSO spectra
- Data on the mechanisms of galaxy formation by analysis of the chemical composition of fossil remnants of very early stellar populations
- Studies on stellar atmospheres
- Studies on planetary atmospheres
- Studies of interstellar medium

### Table 2: Observational Capabilities and Expected Performance

<table>
<thead>
<tr>
<th></th>
<th>370 - 1000 nm</th>
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<tbody>
<tr>
<td>Wavelength range</td>
<td>370 - 1000 nm</td>
</tr>
<tr>
<td>Resolution-slit product at order center</td>
<td>46,000</td>
</tr>
<tr>
<td>Max. resolution</td>
<td>with slits: 164,000 with Image slicers: 144,000.</td>
</tr>
<tr>
<td></td>
<td>m_v=16 @ R=86,000</td>
</tr>
<tr>
<td>Limiting magnitude (1 hr, S/N ~15 per bin, m$_{sky}$ = 21.8 mag/arcsec$^2$ median seeing)</td>
<td>Overall detective quantum efficiency (DQE) (from top of the telescope, wide slit)</td>
</tr>
<tr>
<td>---</td>
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<tr>
<td>2 % at 370 nm 13.2 % at 540 nm (yellow CD).</td>
<td></td>
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</tbody>
</table>

| Camera | dioptric F/4.8, 82.4 µm/arcsec corrected field: 36.0 mm radius. |

| CCDs and pixel scale | mosaic of two 2K x 4K, EEV 13.5 µm pixels (0.16 arcsec/pix) |

| Echelle | 31.6 g/mm, R4 |

| Crossdispersers0 (g/mm and blaze wavelength) | CD1: 600 g/mm, 484 nm  
CD2: 600 g/mm, 560 nm  
CD3: 300 g/mm, 589 nm  
CD4: 200 g/mm, 752 nm |

| Typical wavelength range/frame | CD1: (360 ; 514) nm (50 Orders)  
CD2: (414 ; 566) nm (40 Orders)  
CD3: (462 ; 792) nm (54 Orders)  
CD4: (496 ; 1011) nm (62 Orders) |

| Order separation (minimum) | CD1: 10.7 arcsec (66.1 pixels)  
CD2: 13.7 arcsec (84.5 pixels)  
CD3: 8.0 arcsec (49.0 pixels)  
CD4: 6.0 arcsec (36.6 pixels) |

For questions related to the use of the instrument and/or for questions on technical aspects of the instrument which are not related to observing programs please contact Gratton R. or Claudi R.

Send comments to claudi@pd.astro.it