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Pierre Bourget\textsuperscript{4}, Damien Jones\textsuperscript{5}, David Lee\textsuperscript{6} + several others

\textbf{1- IAG-USP} Universidade de São Paulo, São Paulo, Brazil
\textbf{2- LNA} Lab. Nacional de Astrofísica, MCT, Itajubá, MG, Brazil
\textbf{3- UFSC} Universidade Federal de Santa Catarina, Brazil
\textbf{4- ON} Observatório Nacional, Rio de Janeiro
\textbf{5- Prime Optics, 17 Crescent Road, EUMUNDI Q 4562 Australia}
\textbf{6- Anglo-Australian Observatory}

\textbf{Angra dos Reis 2003}
The SIFS story

Funds from FAPESP approved in 1998

a prototype was concluded in 2000 - EUCALYPTUS - and tested at LNA (see posters)

Optical design by Damien Jones (Australia) concluded in 2000

PDR in July 2001
general concepts OK, but required better mechanical design

LEG Engenharia re-made mechanical design and is ready for construction

Only slow progress in 2002-2003 since FAPESP first delayed payments waiting for a report from an adviser, and later payments in US$ were forbidden. Recently re-started importations

Angra dos Reis 2003
SIFS prototype: Eucalyptus
a fiber Integral Field Spectrograph in operation at LNA

Fore-optics

Telescope focus
microlens array
fiber bundle

Telescope focus
slit
collimator
ccd
grating

Littrow-type bench spectrograph
Main characteristics of Eucalyptus

- **IFU**: 516 elements (16x32), 1mmx1mm microlens
- **FIBERS**: 50 μm core, 70 μm cladding, “blue” fibers
- **Spectograph**: Littrow, clone of SPIRAL (AAO)
Flat-field
He-Ne
AG Carina
What did we learn with Eucalyptus?

• 50µm fibers is a good choice, it allows to use not too large optics, transmission is still good

• fiber transmission is stable even if we bend or twist the fiber bundle. The flat field corrects fiber-to-fiber transmission differences (< 20%), and good sky subtraction can be achieved

• the use 3 CCD lines only per spectra is not an excessive packing

• An efficient data reduction program was developped by Antonio Kanaan & Cesar Strauss (next talk)
SIFS main characteristics

• 1300 fibers  26x50 microlens array + a 5x5 sky subtraction array
  1mm x 1mm lenses
  50 µm core Polymicro fibers

• Interchangeable fore optics magnification: 2 field sizes
  0.30 arcsec/mm  field  15 x 7.8  arcsec
  0.15 arcsec/mm  field  7.5 x 3.9  arcsec
  room for a third one TBD

• Interchangeable VPH gratings: a set of 6 resolution x ?  choice
  spectral resolution 2000 -40000

• all lenses coated with SolGel

• 4k x 4k CCD mosaic, same CCD camera of other SOAR instruments
Example of a set of 6 VPH gratings

(Militão Figueiredo)

<table>
<thead>
<tr>
<th>Frequency (gr/mm)</th>
<th>Δn (for n=1,5)</th>
<th>d (µm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>500</td>
<td>0,040</td>
<td>9,1</td>
</tr>
<tr>
<td>1300</td>
<td>0,075</td>
<td>4,0</td>
</tr>
<tr>
<td>1800</td>
<td>0,075</td>
<td>4,0</td>
</tr>
<tr>
<td>2200</td>
<td>0,07</td>
<td>5,0</td>
</tr>
<tr>
<td>2600</td>
<td>0,05</td>
<td>5,5</td>
</tr>
<tr>
<td>3600</td>
<td>0,04375</td>
<td>4</td>
</tr>
</tbody>
</table>

(Between two 3-mm BK7 substrates)

Thickness of the gel
ISB (project of Fernando Santoro)
IFU fore-optics ....magnification x 10
+ sky subtraction IFU

2.5 arc min at telescope focus = 50 mm
limitations: size of pick-off mirror
diameter of field lens
Fibras no interior de espaguetis no interior de um tubo
Fiber support block (being constructed by Pierre Bourget - ON)
Collimator + grating + camera

VPH grating between two 3mm thick glass plates
The pupil and exit pupil are *offset* in the y-direction. The near collimated beam from the mirror is designed to clear the slit by nearly 25 mm. Off-axis portions of CCL1, 2, 3 & CCLM are to be utilized.
The camera

- FK5, diam 188 mm
- CaF2, 181 mm
- BaK2, CaF2, Silica, FK5
- diam 181 mm
- CCD camera side

719 mm
SOARS CAMERA: F/3.0, BROADBAND, VERSION 6.05
MON APR 16 2001  UNITS ARE MICRONS.

BOX WIDTH : 100
REFERENCE : CHIEF RAY

C:\ZEMAX\DAMIEN\20-03-2001\CAM605.ZMX
CONFIGURATION 1 OF 1
Efficiency at 350 nm

<table>
<thead>
<tr>
<th>Component</th>
<th>Efficiency</th>
<th>Notes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atmosphere</td>
<td>T 56%</td>
<td>(often not included)</td>
</tr>
<tr>
<td>Telescope+ pick-off mirror</td>
<td>80%</td>
<td></td>
</tr>
<tr>
<td>Fore-optics</td>
<td>90%</td>
<td></td>
</tr>
<tr>
<td>Fiber transmission</td>
<td>75%</td>
<td></td>
</tr>
<tr>
<td>Loss due to FRD</td>
<td>80%</td>
<td>(improving; see poster by A.C. Oliveira)</td>
</tr>
<tr>
<td>Spectrograph transm.</td>
<td>70%</td>
<td></td>
</tr>
<tr>
<td>Grating efficiency</td>
<td>80%</td>
<td>in some cases we reach 85%</td>
</tr>
<tr>
<td>CCD</td>
<td>70%</td>
<td>(possibly better)</td>
</tr>
</tbody>
</table>

We reach 9.5 % overall efficiency at 350 nm (including atmosphere!) This number is dependent on the CCD efficiency (we are not sure, what CCD are we going to have). Loss due to focal ratio degradation (FRD) is an important factor; we are presently studying ways of producing less stress in the fiber, at the slit.

Efficiency increases quickly with ?, about factor 2 better at 400 nm