Science requirements for an ‘ELT MOS’

Chris Evans (UKATC/STFC)
E-ELT patrol field

~40 sq. arcmin

ELT workshop – Chris Evans – Feb 2013
Resolved stellar populations

Richardson et al. (2008)

Chapman et al. (2006)
Resolved stellar populations

An ELT-MOS is essential for studies of GALAXY EVOLUTION with the E-ELT
MOS requirements

Multi-Object Spectroscopy with the European ELT: Scientific synergies between EAGLE & EVE

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\begin{itemize}
  \item \textbf{‘High definition’}: Observations of tens of channels at fine spatial resolution provided by multi-object adaptive optics (MOAO).
  \item \textbf{‘High multiplex’}: Integrated-light (coarsely resolved) observations of >100 objects corrected by ground-layer adaptive optics (GLAO).
\end{itemize}
**MOS requirements**

- **Workshop in Amsterdam**
- **Assembled a science team**
- **Meetings in UK, Italy, Brazil, NL**
- **New science simulations**

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Multi-object spectroscopy on the European Extremely Large Telescope

25-26th October 2012 - University of Amsterdam

Venue | Accommodation | Programme | Participants | Registration

Turingzaal, NIKHEF, Science Park 105, 1098 XG Amsterdam, The Netherlands

The workhorse instruments of the 8-10m class observatories are their multi-object spectrographs (MOS), providing slit-based and space-borne imaging surveys from, e.g., surveys will be a plethora of compelling case for a MOS as one of the first E-ELT instruments. By exploiting the excellent image quality across the full final class of the telescope, combined with its ability to obtain the outcomes of the key scientific from studies of stellar populations and asymptotic giant branch galaxies.
**MOS requirements**

- Workshop in Amsterdam
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- New science simulations

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**ELT-MOS White Paper**

**Contribution:**
Beatriz Barbuy, Nate Bastian, Piercarlo Bonifacio, Elisabetta Caffau, Jean-Gabriel Cuby, Gavin Dalton, Ben Davies, Jim Dunlop, Chris Evans, Hector Flores, Francois Hammer, Lex Kaper, Bertrand Lemasle, Simon Morris, Laura Pentericci, Patrick Petitjean, Mathieu Puech, Daniel Schaerer, Eduardo Telles, Niraj Welikala, Bodo Ziegler

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ELT-MOS White Paper

- SC1: First light - spectroscopy of the most distant galaxies
- SC2: Spatially-resolved spectroscopy of high-z galaxies
- SC3: Role of high-z dwarf galaxies in galaxy evolution
- SC4: Tomography of the IGM
- SC5: Resolved stellar populations beyond the Local Group
- SC6: Galaxy archaeology with metal-poor stars

& more...
AO correction better in J-band, and stars are intrinsically red (I-J) = 0.5-1.0

See Ben Davies' talk tomorrow

Example trade-off: Opt. vs. nIR?

Davies et al. (2010)
Evans et al. (2011)
## ELT-MOS White Paper

### Table 3: Summary of top-level requirements from each Science Case

<table>
<thead>
<tr>
<th>Case</th>
<th>Target densities</th>
<th>FoV/target</th>
<th>Spatial resolution</th>
<th>λ-coverage (µm)</th>
<th>R</th>
</tr>
</thead>
<tbody>
<tr>
<td>SC1</td>
<td>1-2 arcmin⁻²</td>
<td>2'' × 2''</td>
<td>40-90 mas</td>
<td>1.0-1.8, 1.0-2.45</td>
<td>5,000</td>
</tr>
<tr>
<td></td>
<td>10s arcmin⁻²</td>
<td>–</td>
<td>(GLAO)</td>
<td>1.0-1.8, 1.0-2.45</td>
<td>&gt;3,000</td>
</tr>
<tr>
<td>SC2</td>
<td>1-2 arcmin⁻²</td>
<td>2'' × 2''</td>
<td>50-80 mas</td>
<td>1.0-1.8, 1.0-2.45</td>
<td>5,000</td>
</tr>
<tr>
<td></td>
<td>10s arcmin⁻²</td>
<td>–</td>
<td>(GLAO)</td>
<td>1.0-1.8, 1.0-2.45</td>
<td>&gt; 3,000</td>
</tr>
<tr>
<td>SC3</td>
<td>≥ ~20 arcmin⁻²</td>
<td>–</td>
<td>(GLAO)</td>
<td>0.8-1.7</td>
<td>≥5,000</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>~10,000</td>
</tr>
<tr>
<td>SC4</td>
<td>0.5-1 arcmin⁻²</td>
<td>2'' × 2''</td>
<td>(GLAO)</td>
<td>0.4-1.0, 0.37-1.0</td>
<td>5,000</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>10,000</td>
</tr>
<tr>
<td>SC5</td>
<td>Dense</td>
<td>1'' × 1''</td>
<td>≤75 mas</td>
<td>1.0-1.8, 0.8-1.8</td>
<td>5,000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1.5'' × 1.5''</td>
<td>20-40 mas</td>
<td></td>
<td>≥5,000</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>≥10,000</td>
</tr>
<tr>
<td>SC6</td>
<td>10s arcmin⁻²</td>
<td>–</td>
<td>(GLAO)</td>
<td>0.41-0.46, 0.60-0.68</td>
<td>≥15,000</td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.38-0.46, 0.60-0.68</td>
<td>≥20,000</td>
</tr>
</tbody>
</table>
Next stage: prioritise requirements from the different cases via trade-offs, taking into account technical & operational feasibility
Example trade-off: Spatial sampling?

- Spectral simulations using ‘WEBSIM’ from Puech et al. (2008)
- MOAO PSFs
- $t_{\text{int}} = 10\text{hrs}$
- J-band
- $R \sim 4000$
Example trade-off: Spatial sampling?

- Spectral simulations using ‘WEBSIM’ from Puech et al. (2008)
Spatial sampling vs. survey speed

HST-ACS NGC55
Summary

- Compelling & well-defined cases for an ELT-MOS
- ELT-MOS White Paper presenting top-level cases
- Two modes: ‘high multiplex’ & ‘high definition’
- MOS instruments have become the workhorses of the 8-10m
- MOS instruments early-on in GMT and TMT plans
- An E-ELT MOS will be an essential part of its instrument suite
Synergies with HIRES?