Optical Monitor data processing & calibration

I) Instrumental corrections

- Astrometry (filters & grisms):
  - Geometric distortion, Boresight
    - \( X,Y \) linearized positions
- Photometry:
  - aperture
  - PSF
  - coincidence losses and dead time
  - time sensitivity degradation
  - cosmetic (bad pixels)
    - count rate (vs. time)
- Spectroscopy:
  - geometry: distortion, rotation
  - spectral extraction
    - spectrum count rate vs. position

II) Calibration

- Astrometry:
  - from \( X,Y \) to R.A. & Dec
- Photometry:
  - from count rate to magnitude,
    standard UBV, color indices,
    AB magnitude
  - light curve
  - from count rate to absolute
    flux at effective wavelength of filter
- Spectroscopy:
  - from position to wavelength
  - from count rate to absolute
    flux vs. wavelength
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**I) Instrumental corrections**

- Astrometry (filters & grisms):
  - Geometric distortion, Boresight:
    - X,Y linearized positions

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  - **Aperture**
  - **PSF**
  - Coincidence losses and dead time
  - **Time sensitivity degradation**
  - Cosmetic (bad pixels)

- Spectroscopy:
  - Geometry: Distortion, Rotation
  - Spectral extraction
  - **Spectrum count rate vs. position**

**II) Calibration**

- Astrometry:
  - From X,Y to R.A. & Dec
- Photometry:
  - From count rate to magnitude, standard UBV, color indices, AB magnitude, light curve
- Spectroscopy:
  - From position to wavelength
  - From count rate to absolute flux vs. wavelength

*All corrections and calibrations are included into OM data processing through corresponding SAS algorithms & CCFs*
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  - From count rate to magnitude, standard UBV, color indices, magnitude
  - Light curve
- Spectroscopy:
  - From position to wavelength
  - From count rate to absolute flux vs. wavelength

All corrections and calibrations are included into OM data processing through corresponding SAS algorithms & CCFs.

SAS RESULTS CAN BE USED DIRECTLY FOR SCIENTIFIC INTERPRETATION.
AB magnitude system for OM

AB magnitudes in the UV: OM versus Galex

Figure 7. Comparison of the XMM-OM UVM2 and GALEX NUV magnitudes. A good linear correlation between magnitudes in the two passbands is evident. The blue line corresponds to a one-to-one relation between UVM2 and NUV.


### OM time sensitivity degradation

#### OM throughput

<table>
<thead>
<tr>
<th>Filter</th>
<th>Current</th>
<th>Expected in 2030</th>
</tr>
</thead>
<tbody>
<tr>
<td>UVW2</td>
<td>0.79</td>
<td>0.73</td>
</tr>
<tr>
<td>UVM2</td>
<td>0.81</td>
<td>0.79</td>
</tr>
<tr>
<td>UVW1</td>
<td>0.87</td>
<td>0.84</td>
</tr>
<tr>
<td>B</td>
<td>0.92</td>
<td>0.86</td>
</tr>
<tr>
<td>V</td>
<td>0.92</td>
<td>0.86</td>
</tr>
<tr>
<td>U</td>
<td>0.85</td>
<td>0.81</td>
</tr>
</tbody>
</table>

*Based on repeated (> 5) observations of sources in the OM Catalogue SUSS.3*
OM data processing in SAS 17

- Repeatability of OM filter photometry: measured mean rates (c/s) of standard stars

<table>
<thead>
<tr>
<th>Star</th>
<th>Nobs</th>
<th>UVW2</th>
<th>UVM2</th>
<th>UVW1</th>
<th>U</th>
<th>B</th>
<th>V</th>
</tr>
</thead>
<tbody>
<tr>
<td>GD 153</td>
<td>15</td>
<td>83.29</td>
<td>161.89</td>
<td>330.03</td>
<td>420.25</td>
<td>283.69</td>
<td>71.57</td>
</tr>
<tr>
<td>error (%)</td>
<td></td>
<td>1.5</td>
<td>1.5</td>
<td>1.0</td>
<td>1.4</td>
<td>1.0</td>
<td>2.4</td>
</tr>
<tr>
<td>Hz 2</td>
<td>18</td>
<td>23.81</td>
<td>48.27</td>
<td>111.78</td>
<td>168.71</td>
<td>148.83</td>
<td>43.84</td>
</tr>
<tr>
<td>error (%)</td>
<td></td>
<td>2.1</td>
<td>1.3</td>
<td>1.3</td>
<td>0.9</td>
<td>0.8</td>
<td>3.0</td>
</tr>
<tr>
<td>BPM 16274</td>
<td>34</td>
<td>14.75</td>
<td>30.34</td>
<td>72.96</td>
<td>112.62</td>
<td>107.81</td>
<td>33.04</td>
</tr>
<tr>
<td>error (%)</td>
<td></td>
<td>1.8</td>
<td>1.2</td>
<td>1.0</td>
<td>0.8</td>
<td>0.9</td>
<td>2.4</td>
</tr>
</tbody>
</table>
To measure the variation, spectra of Standard stars are binned in 250 Å (UV Grism) and 300 Å (V Grism) and normalized:

<table>
<thead>
<tr>
<th>Year</th>
<th>UV_Grism</th>
<th>V_Grism</th>
</tr>
</thead>
<tbody>
<tr>
<td>2000</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>2002</td>
<td>1.01</td>
<td>1.01</td>
</tr>
<tr>
<td>2004</td>
<td>1.02</td>
<td>1.02</td>
</tr>
<tr>
<td>2006</td>
<td>1.04</td>
<td>1.02</td>
</tr>
<tr>
<td>2008</td>
<td>1.05</td>
<td>1.03</td>
</tr>
<tr>
<td>2010</td>
<td>1.07</td>
<td>1.04</td>
</tr>
<tr>
<td>2012</td>
<td>1.08</td>
<td>1.04</td>
</tr>
<tr>
<td>2014</td>
<td>1.10</td>
<td>1.05</td>
</tr>
<tr>
<td>2016</td>
<td>1.12</td>
<td>1.06</td>
</tr>
<tr>
<td>2018</td>
<td>1.13</td>
<td>1.07</td>
</tr>
<tr>
<td>2020</td>
<td>1.15</td>
<td>1.07</td>
</tr>
</tbody>
</table>

Correction factors for OM grism spectra
Jupiter Depletion patch

Jupiter was accidentally observed in July 2017 with the V filter:

- a low sensitivity depletion patch appeared in the OM detector: \(~160 \times 80\) pix$^2$
- RGS boresight is depleted (5% in V filter)
- the depletion level is wavelength dependent
- it is stable (54% in flat field)
- the affected area is flagged in the Bad Pixels CCF
- photometry with SAS: standard star Hz 2 located in the center of the patch:

<table>
<thead>
<tr>
<th>Filter</th>
<th>V</th>
<th>B</th>
<th>U</th>
<th>UVW1</th>
<th>UVM2</th>
<th>UVW2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rate loss</td>
<td>0.73</td>
<td>0.88</td>
<td>0.97</td>
<td>0.91</td>
<td>0.90</td>
<td>0.88</td>
</tr>
<tr>
<td>Sky loss</td>
<td>0.80</td>
<td>0.92</td>
<td>0.95</td>
<td>0.90</td>
<td>0.86</td>
<td>0.87</td>
</tr>
</tbody>
</table>
New Bad pixels map

Bad pixels:

- Dead pixels
- Low sensitivity pixels
- Low sensitivity patches
- "noisy" corners
- Jupiter depletion patch

Are used by SAS to set quality flags on the extracted sources
**XMM-Newton Serendipitous UV Source Survey**
(a.k.a. “the OM Catalogue”)  

- **Version 3: SUSS3**, released in 2017  
- All observations till July 2015  
- 6.88 Msources from 7,886 XMM-Newton pointings (4,8 Msources unique)  
- 3.4 Msources with UV data  
- 3-colour data across the Galex NUV band.  
- simultaneous X-ray and optical data.  
- source variability from multiple exposures and pointings (0.9Msources repeated)  
- Full reprocessing with SAS 15: corrected photometry of sources detected in mosaic and stacked images,…  
- 84 % coincidence with Gaia DR1

- **New Version 4: SUSS4**  
- To be released at end 2018  
- All public observations till mid-2017 + calibration observations: ~10200 XMM-Newton pointings  
- Full reprocessing with SAS 17: new time sensitivity degradation.

- Available through the ESA XSA
- + **Suppl. Bright sources catalogue**