Background Simulations of WXT onboard Einstein Probe mission (EP)

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Scientific Objectives of EP

Approved: 2017,  Launch Time: 2022

Low Earth orbit: 600-650 km,  Energy Range: 0.5-4 keV

1. Detect **quiescent black holes** at almost all astrophysical mass scales by detecting transient X-ray flares.

2. Discover the X-ray photonic **counterparts of gravitational-wave** transients and precisely locate them.

3. Discover **faint X-ray transients**, such as high-z GRBs, supernova shock breakout, and new types of transients.
WXT and MPO

Lobster-eye Optics
Micro Pores

Imaging Principle
Characteristics of WXT

- Focusing telescope
- Largest FOV: >3600 sqr.deg.
- most sensitive all-sky monitor
- Focal length: 375 mm
Background Simulations

- Geant4: Build up WXT model, Set up physical processes
- X-ray background simulations
- Particle background simulations
- Other background sources
WXT model with Geant4
X-ray grazing scattering

- **XRTG4**: Buis and Vacanti 2009.
- **Q software**: Richard Willingale at Leicester Univ.
- Results from Geant4 and Q agree well with each other.

Zhao, et al., 2017

Crucial process to simulate X-ray focusing. Geant4 does not include this process.
X-ray background sources

X rays from the Galaxy

- CXB without absorption
- CXB with absorption
- Soft X rays with absorption

$N_H = 3 \times 10^{20} \text{ cm}^2$
Impact of grazing scattering

<table>
<thead>
<tr>
<th>Physics process</th>
<th>Energy range</th>
<th>X rays</th>
</tr>
</thead>
<tbody>
<tr>
<td>No grazing scattering</td>
<td>0.5–4keV</td>
<td>0.027</td>
</tr>
<tr>
<td>With grazing scattering</td>
<td>0.5–4keV</td>
<td>0.173</td>
</tr>
</tbody>
</table>
Particle background sources

![Graph showing particle flux vs energy](image)

- **Filter**
- **Depletion Si**
- **Substrate Si**
- **CMOS structure**
Impact of detector thickness

<table>
<thead>
<tr>
<th>Thickness</th>
<th>X rays</th>
<th>Particles</th>
<th>Total(cuts/s/cm^2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 um</td>
<td>0.180</td>
<td>0.108 (37%)</td>
<td>0.288</td>
</tr>
<tr>
<td>30 um</td>
<td>0.156</td>
<td>0.001 (0.4%)</td>
<td>0.157</td>
</tr>
</tbody>
</table>
Other background sources

X rays from the Galaxy

Energetic Cosmic rays

\[ N_H = 3 \times 10^{20} \text{ cm}^2 \]
Low-Energy Electrons

High flux, Large fluctuation

![Graph showing electron flux vs. energy](image)

<table>
<thead>
<tr>
<th>Energy Range</th>
<th>1-3 keV</th>
<th>3-300 keV</th>
<th>300-1000 keV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contribution (%)</td>
<td>0</td>
<td>71.3</td>
<td>28.7</td>
</tr>
</tbody>
</table>

20 counts/s/cm²

Magnetic diverter

<0.1 counts/s/cm²

To block 98% of e⁻ in 300-1000 keV

Diverter is optimizing.

Final e⁻ contribution is under studies.
Solar X rays

Scattered solar x-ray spectrum

R.P. Lin 2011

S.L. Snowden 1993
Further Work

- Background changing with satellite orientation and position on the orbit.
- Other sources that may contribute significant background.
- Calibrate the background with simulation data.

Your comments and suggestions are welcome!

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Backup Slide
PSF and effective area of WXT