GROUP 3 CONCEPTS

Discussion

1. Shao
2. SGO Mid
3. SGO Low
4. SGO Lowest
5. SGO High = LISA (not presented)
Group 3:
LISA variants

\[ S_h(f)^{1/2} \text{ Hz}^{-1/2} \]

- LISA
- SGO mid
- SGO lo
- SGO lowest

\( f \text{ (Hz)} \)

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<table>
<thead>
<tr>
<th></th>
<th>High</th>
<th>Mid</th>
<th>Low</th>
<th>Lowest</th>
<th>Shao</th>
</tr>
</thead>
<tbody>
<tr>
<td># S/C</td>
<td>3</td>
<td>3</td>
<td>4</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Distance</td>
<td>5Gm</td>
<td>1Gm</td>
<td>1Gm</td>
<td>2/1Gm</td>
<td>5Gm</td>
</tr>
<tr>
<td># Links</td>
<td>6</td>
<td>6</td>
<td>4</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td>Orbit</td>
<td>22° HC</td>
<td>9° Drift</td>
<td>9° Drift</td>
<td>9° Drift</td>
<td>22° HC</td>
</tr>
<tr>
<td># of PM/SC</td>
<td>2 (LTP)</td>
<td>2 (LTP)</td>
<td>1 (LTP)</td>
<td>1 (LTP)</td>
<td>2 (Torsion)</td>
</tr>
<tr>
<td>Lifetime</td>
<td>5+3.5</td>
<td>2+2</td>
<td>2+2</td>
<td>2+0</td>
<td>5+3.5</td>
</tr>
<tr>
<td>Telescope</td>
<td>40cm</td>
<td>25cm</td>
<td>25cm</td>
<td>25cm</td>
<td>40cm</td>
</tr>
<tr>
<td>Laser power</td>
<td>1.2W</td>
<td>0.7W</td>
<td>0.7W</td>
<td>0.7W</td>
<td>1.2W</td>
</tr>
<tr>
<td>Cost</td>
<td>1,660M</td>
<td>1,440M</td>
<td>1,410M</td>
<td>1,190M</td>
<td>990M*</td>
</tr>
</tbody>
</table>

* Different Costing Method
<table>
<thead>
<tr>
<th>Concept</th>
<th>SGO High</th>
<th>SGO Mid</th>
<th>SGO Low</th>
<th>SGO Lowest</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nominal Lifetime</td>
<td>5 yrs</td>
<td>2 yrs</td>
<td>2 yrs</td>
<td>2 yrs</td>
</tr>
<tr>
<td><strong>MBH mergers</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total # Detections</td>
<td>70 ~ 150</td>
<td>25 ~ 35</td>
<td>25 ~ 35</td>
<td>~ 4</td>
</tr>
<tr>
<td>Median Redshift</td>
<td>$\bar{z} \sim 5$</td>
<td>$\bar{z} \sim 5$</td>
<td>$\bar{z} \sim 5$</td>
<td>$\bar{z} \sim 4$</td>
</tr>
<tr>
<td>Mass Precision @ $z = \bar{z}$</td>
<td>$\frac{\sigma_M}{M} \sim 0.2%$</td>
<td>$\frac{\sigma_M}{M} \sim 1%$</td>
<td>$\frac{\sigma_M}{M} \sim 1%$</td>
<td>$\sim 3%$</td>
</tr>
<tr>
<td>Spin Accuracy @ $z = \bar{z}$</td>
<td>$\sigma_\chi \sim 0.3%$</td>
<td>$\sigma_\chi \sim 2%$</td>
<td>$\sigma_\chi \sim 3%$</td>
<td>-</td>
</tr>
<tr>
<td>Distance Accuracy @ $z = \bar{z}$</td>
<td>$\frac{d_D}{D_L} \sim 3%$ (WL)</td>
<td>$\frac{d_D}{D_L} \sim 3%$ (WL)</td>
<td>$\frac{d_D}{D_L} \sim 20%$</td>
<td>-</td>
</tr>
<tr>
<td>Sky Localization @ $z = \bar{z}$</td>
<td>$\sim 1$ deg$^2$</td>
<td>$\sim 1$ deg$^2$</td>
<td>$\gtrsim 100$ deg$^2$</td>
<td>-</td>
</tr>
<tr>
<td># Detections @ $z &lt; 2$</td>
<td>$\sim 7$</td>
<td>1 ~ 2</td>
<td>1 ~ 2</td>
<td>$&lt; 1$</td>
</tr>
<tr>
<td>Mass Precision @ $z = 1$</td>
<td>$\frac{\sigma_M}{M} \lesssim 0.1%$</td>
<td>$\frac{\sigma_M}{M} \lesssim 0.1%$</td>
<td>$\frac{\sigma_M}{M} \lesssim 0.3%$</td>
<td>-</td>
</tr>
<tr>
<td>Spin Accuracy @ $z = 1$</td>
<td>$\sigma_\chi \lesssim 0.1%$</td>
<td>$\sigma_\chi \lesssim 0.1%$</td>
<td>$\sigma_\chi \lesssim 1%$</td>
<td>-</td>
</tr>
<tr>
<td>Sky Localization @ $z = 1$</td>
<td>$\lesssim 0.1$ deg$^2$</td>
<td>$\lesssim 0.1$ deg$^2$</td>
<td>$\lesssim 10$ deg$^2$</td>
<td>-</td>
</tr>
<tr>
<td><strong>EMRIs</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td># Detections</td>
<td>40 ~ 4000, to $z \sim 1.0$</td>
<td>2 ~ 200, to $z \sim 0.2$</td>
<td>$\lesssim 40$, to $z \sim 0.15$</td>
<td>0</td>
</tr>
<tr>
<td>Mass Accuracy</td>
<td>$\frac{\sigma_M}{M} \sim 0.01%$</td>
<td>$\frac{\sigma_M}{M} \sim 0.01%$</td>
<td>$\frac{\sigma_M}{M} \sim 0.01%$</td>
<td>-</td>
</tr>
<tr>
<td>MBH Spin Accuracy</td>
<td>$\sigma_\chi \sim 0.01%$</td>
<td>$\sigma_\chi \sim 0.01%$</td>
<td>$\sigma_\chi \sim 0.01%$</td>
<td>-</td>
</tr>
<tr>
<td><strong>Compact Binaries</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td># Verification binaries</td>
<td>10</td>
<td>8</td>
<td>7</td>
<td>0</td>
</tr>
<tr>
<td># Resolvable binaries</td>
<td>$\sim 20,000$</td>
<td>$\sim 4,000$</td>
<td>$\sim 2,000$</td>
<td>$\sim 100$</td>
</tr>
<tr>
<td><strong>Discovery Space</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Detects early-universe $\Omega_{gw}$</td>
<td>$\gtrsim 10^{-10}$</td>
<td>$\gtrsim 10^{-9}$</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Can Detect+Verify Bursts?</td>
<td>✓</td>
<td>✓</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
SHORT PRO/CON LIST

• SGO-High:
  Pro: Uniquely strong science
      Never costed as US only
  Con: LISA has been studied extensively

• SGO-Mid:
  Pro: Smallest six-link LISA concept
      LISA-like, but cheaper
  Con: Fairly large drift rate (limits lifetime?)

• SGO-Low:
  Pro: Greater design variation from LISA
      Less science/no cost savings over mid
  Con: Increased risk (4 links vs 6)

• SGO-Lowest:
  Pro: more radical design change;
      lowest cost
  Con: Very limited science left

• Shao:
  Pro: Explores design space
      New concepts applicable to many other designs
  Con: No heritage/no experience with new proof mass concept.
      Additional S/C shield appears to add complexity/cost.
SHORT PRO/CON LIST

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  LISA-like, but cheaper
  Con: Less science than LISA (~Conklin/Hellings)

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• Shao:
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ANY OBJECTIONS?

http://en.wikipedia.org/wiki/Frankenstein
SHORT PRO/CON LIST

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• SGO-Lowest:
  Pro: more radical design change:

Discussion points:
• For HIGH: To compare apples w. apples
  • New situation w/o ESA

• For Shao: New technology, has never been studied
  • Con: Is Team X the right place to study new technology??

• SGO-Lowest:
  Pro: Greater design variation from LISA
  Con: Increased risk (4 links vs 6)
  Less science/no cost savings over mid

  with new proof mass concept.
  Additional S/C shield appears to add complexity/cost.
Massive BH Detection #’s

Small Seed Models

BH Detections per year

- SGO hi
- Corklin
- Omega
- SGO mid
- McKenzie 40
- SGO lo
- GADFL 0.1
- Saif 500km
- McKenzie 20
- GADFL 1
- Folkner
- Saif 500m
- Tinto LISA
- SGO lowest
- GADFL 10
- Tinto 1
- Tinto 2

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EMRI Detections

Population model a variant of
WD-WD Detection #’s

White Dwarf Detections

SGO hi
Conklin
Omega
SGO mid
McKenzie 40
SGO lo
GADFLI 0.1
Salff 500km
McKenzie 20
GADFLI
Folkner
Saif 500m
Tinto LISA
SGO lowest
GADFLI 10
Tinto 1
Tinto 2

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Parameter Estimation

Massive BHs, LISA-like missions

Similar detection numbers, but each descope x 3-10 loss in resolution