Group 4: Alternative Measurement Concepts

RFI Assessment Summary Evaluation Team:

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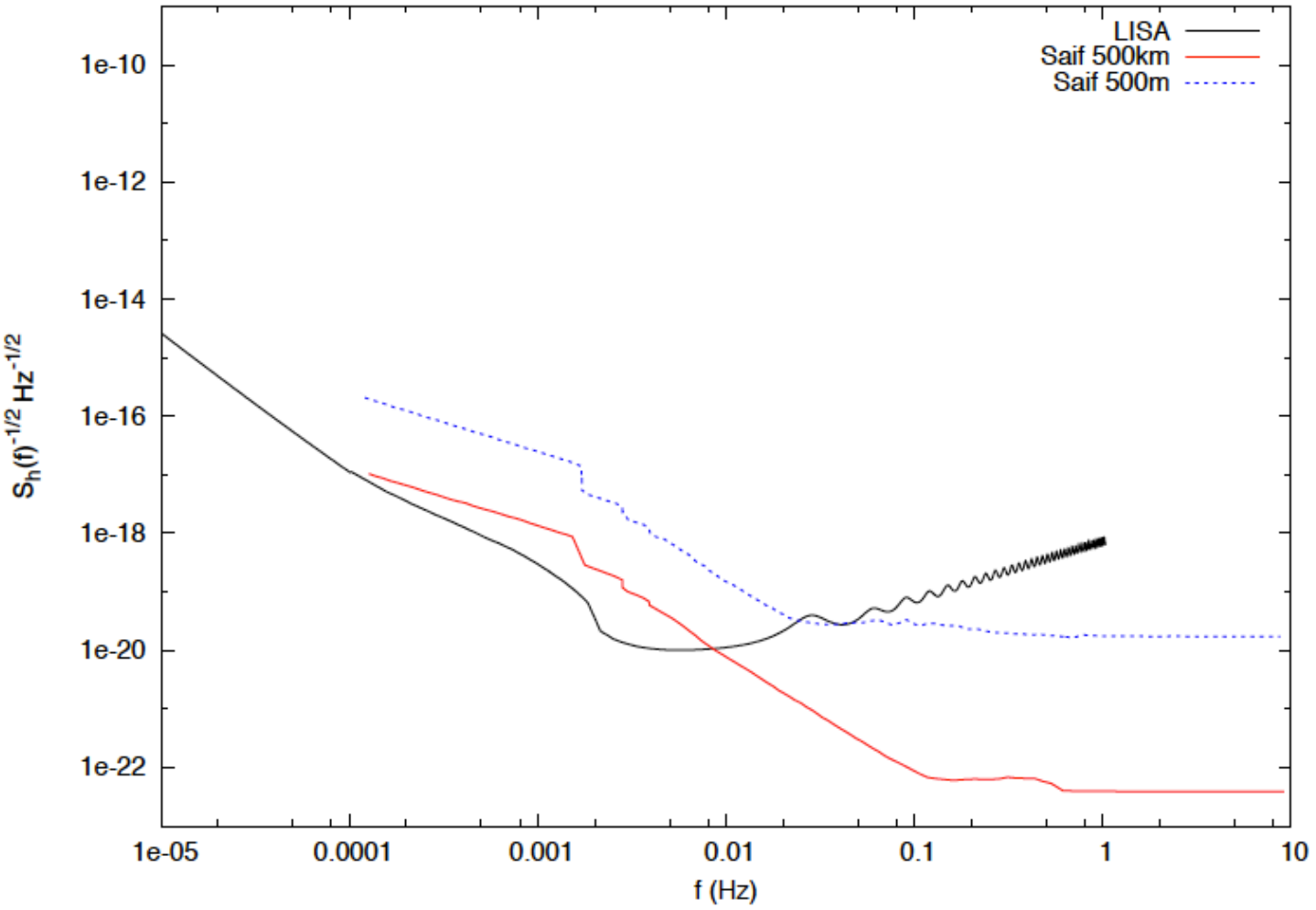
Group 4: High-level Characteristics

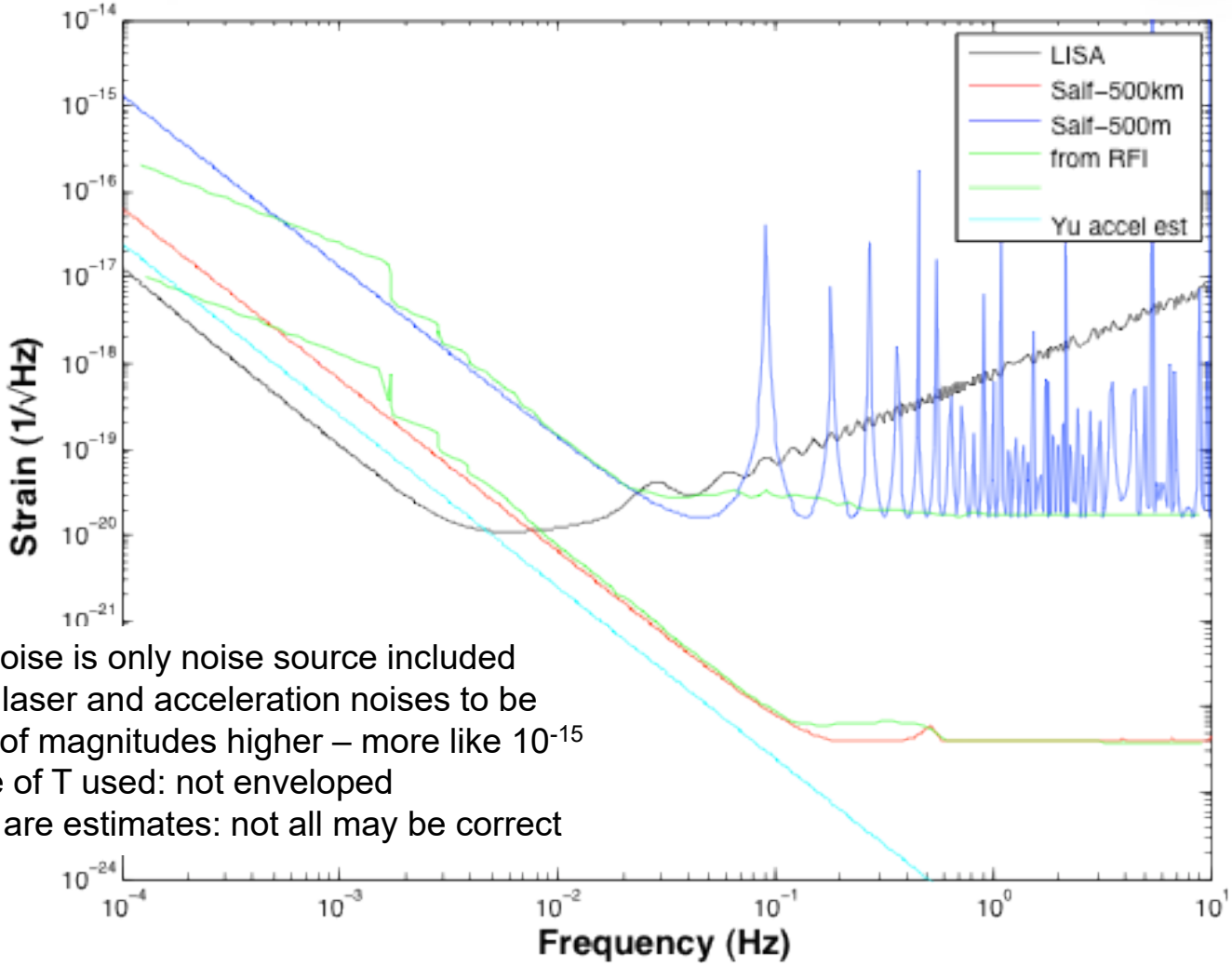
Lead Author	**Saif**	**Gulian**	**Yu**
Acronym	**InSpRL**		
Novel Idea	Atom interferometry	Electrons in superconductor: Crab Pulsar detector?	Atom inteferometer for inertial sensor: apply to any mission
Proposal Type	Concept	Instrument	Instrument
Number of Alternates	2		
Arm length (km)	0.5/500		
Spacecraft/Constellation	1//2/in-line	1	
Orbit	1200 km above geostationary		any
Inertial Reference	Atom interferometers		Atom cloud
Launch vehicle	Falcon		
Baseline/Extended Mission Duration			
Telescope Diameter (cm)	~ 1m for 500 km separation?		
Laser power out of telescope, EOL (W)	10-20		

With the two instruments, we could not do a science analysis

Comparative Sensitivities From the RFI



Group4: (Atom-) Shot noise-limited Sensitivity



- Atom shot noise is only noise source included
- Expect with laser and acceleration noises to be many order of magnitudes higher – more like 10^{-15}
- Single value of T used: not enveloped
- Parameters are estimates: not all may be correct

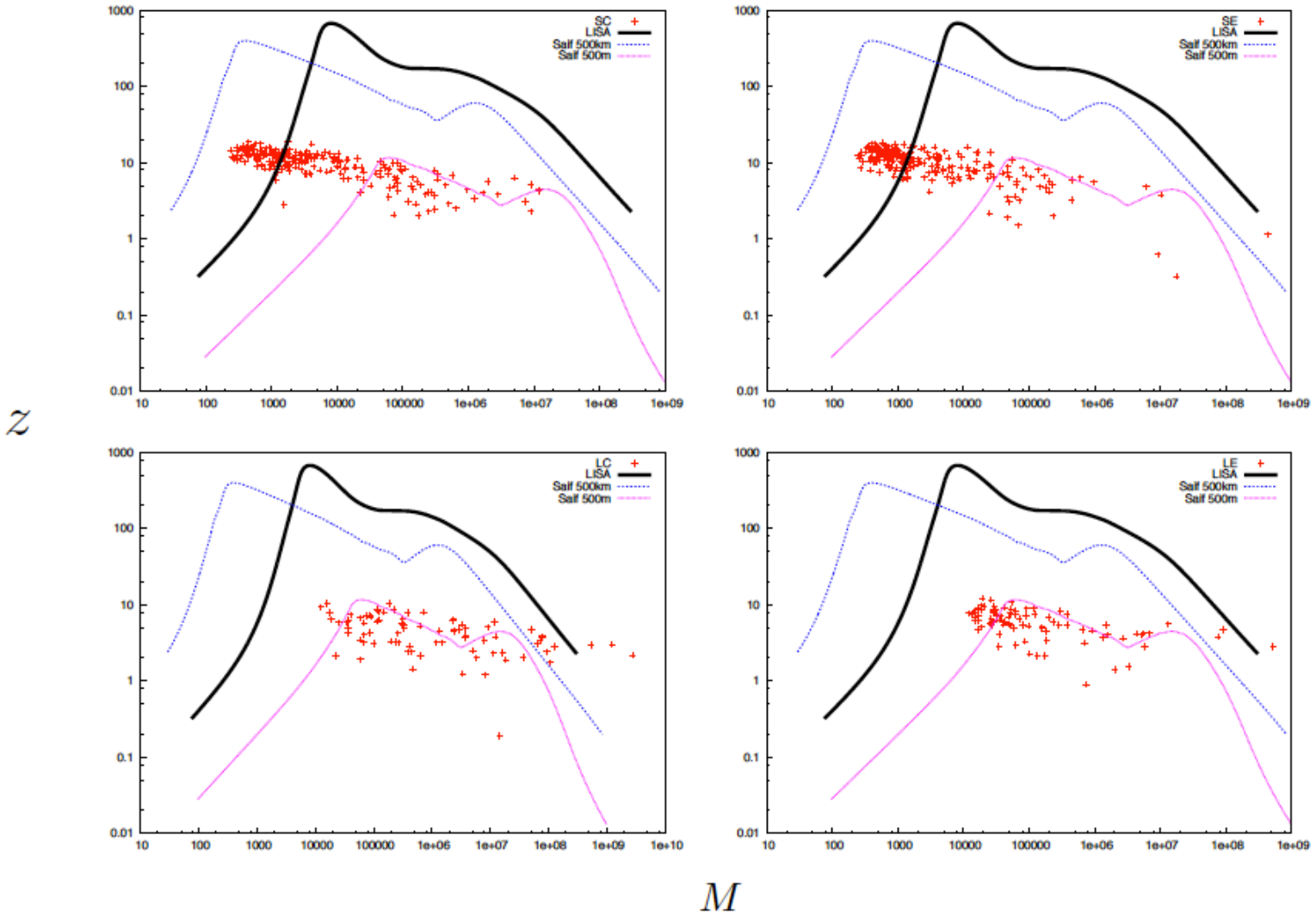
Group 4 Science Assessment Summary

Decadal-endorsed

Category	Units	SGO-High	SAIF 500 km	SAIF 500 m
Massive BH - SS	events/year	42	78	5
Massive BH -LS	events/year	23	22	10
EMRI	events	800	60	0
Discovery Space	SGO-High = 1	1	2.45	0.1
WD-WD Detections		25000	2500	100

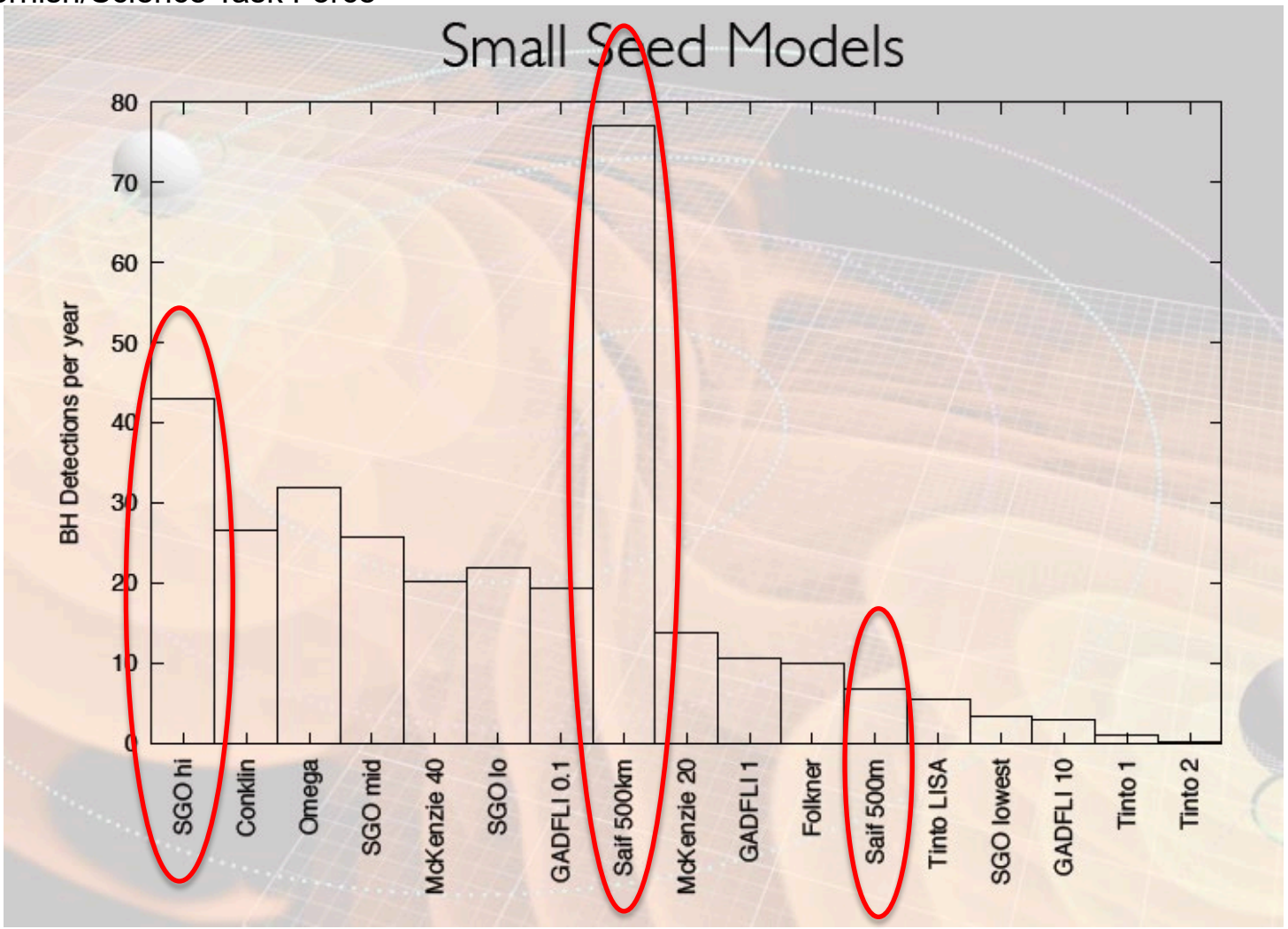
Analysis is based on the RFI sensitivity curves, which do not have all of the noise sources.

Group 4: Massive BH Horizons



Group 4 Massive BH Detections

From N. Cornish/Science Task Force



Group 4 Massive BH Detections

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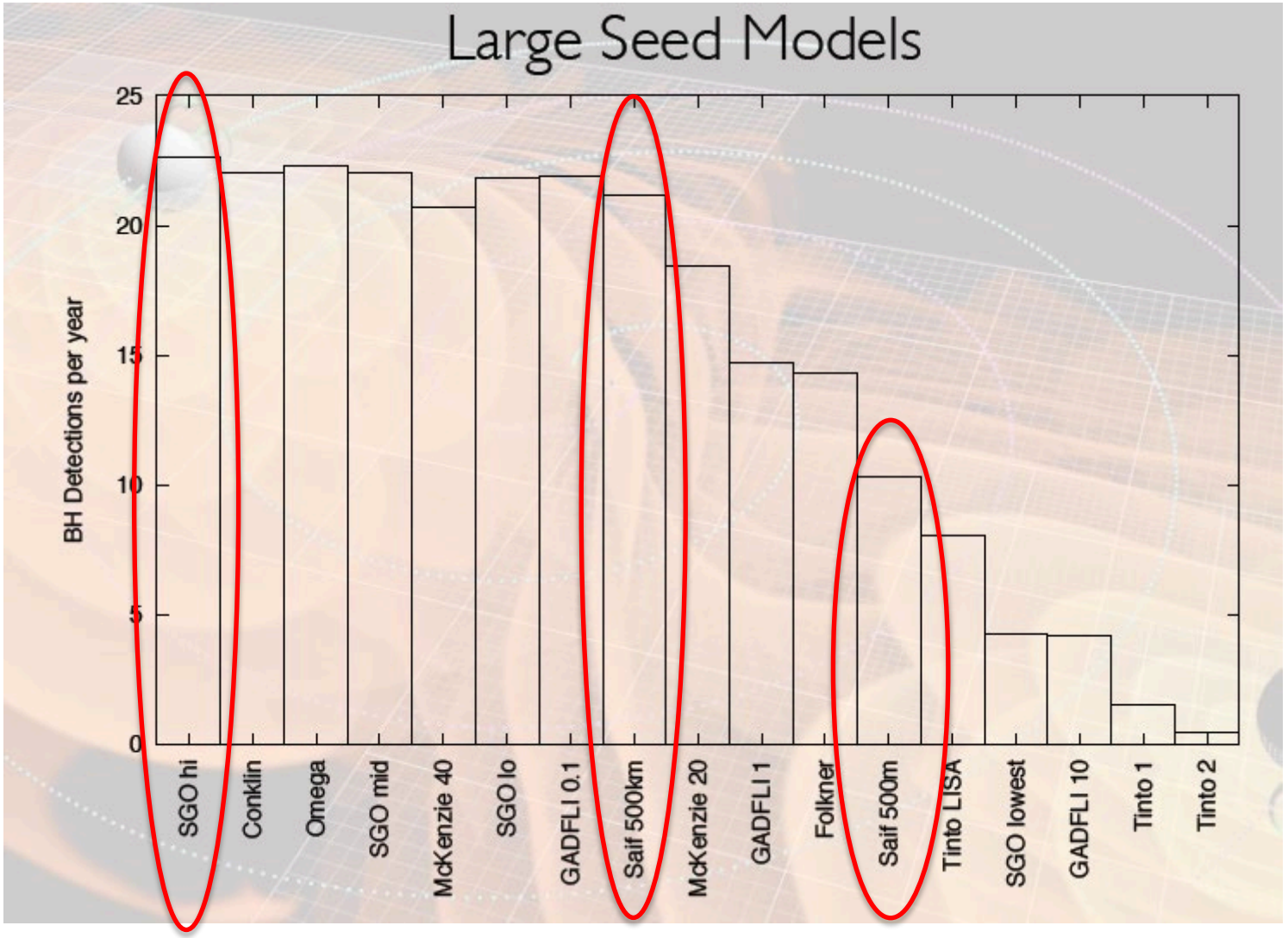

Group 4: EMRI Detections

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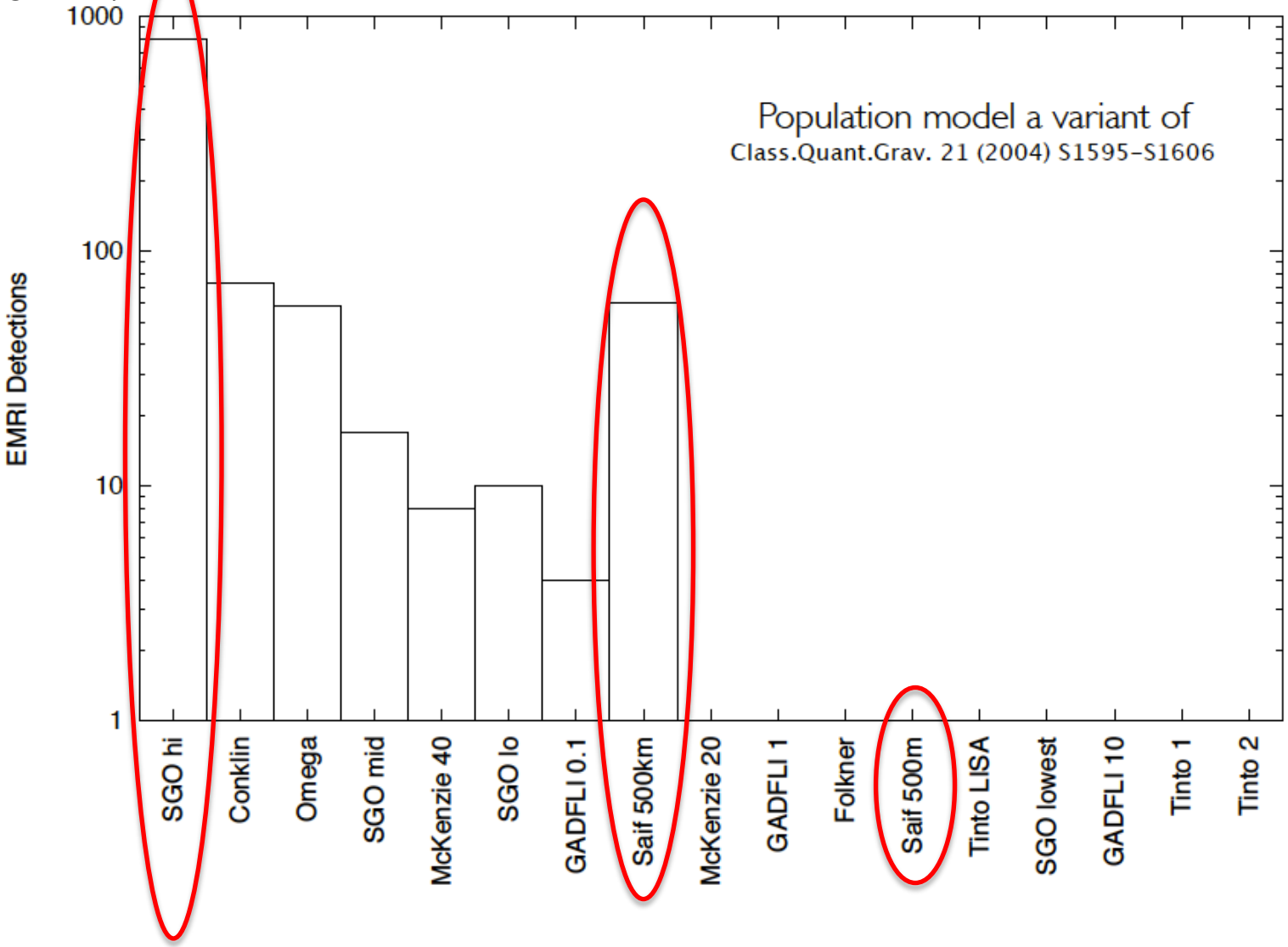

Group 4: Discovery Space

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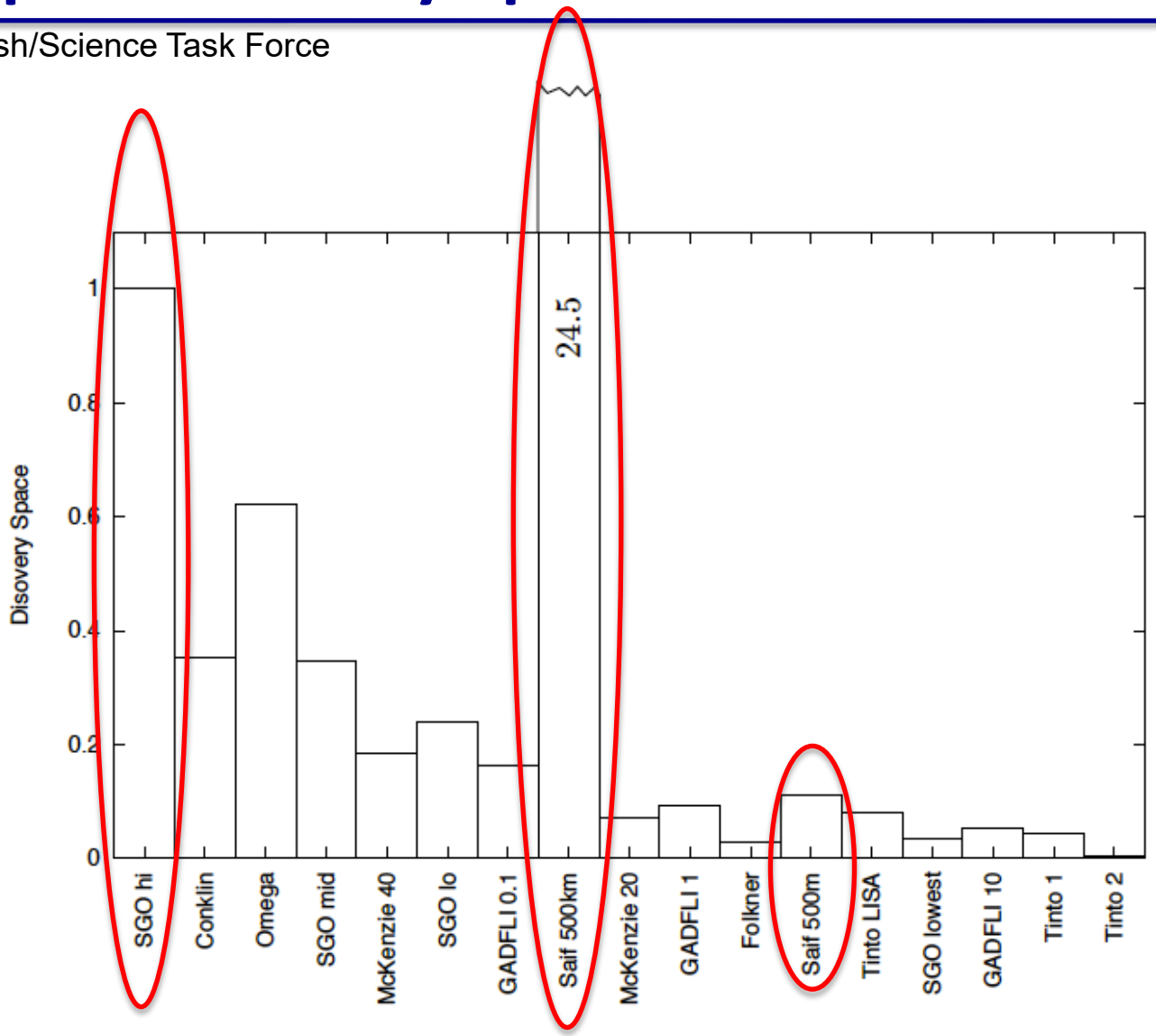

Group 4: WD-WD Detections

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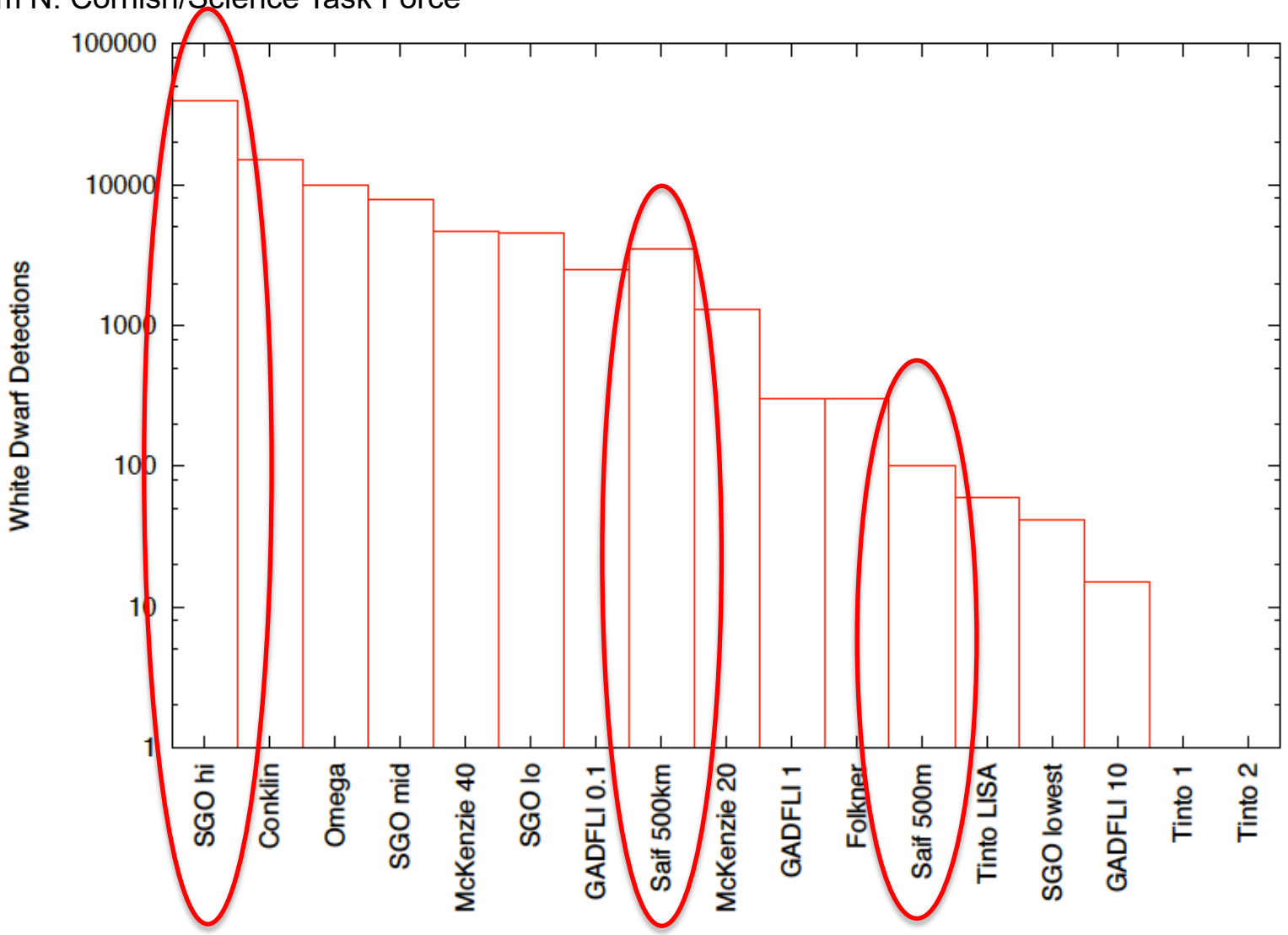

Group 4 Summary

- **Atom interferometer concept as presented suffers from similar limiting noise sources as light interferometers but does not present an adequate solution (noise not included in presented sensitivity curve)**
  - Frequency noise feeds through as GW signals do (same)
  - Acceleration of the "passive" laser also feeds through (new)
    - Acceleration sensitivity required ~10,000X tighter than LISA set by ratio of separation
- **Solving this requires configurations (2 or more arms) and techniques (TDI) similar to LISA - but**
  - Concept not presented in adequate detail to assess
  - Initial look suggests some required capabilities have not been demonstrated as viable analytically, let alone through demonstration – significant readiness risk
- **Best fit, if any, of atomic techniques may be as an inertial reference rather than as a complete instrument**
  - Replace the GRS