

# The Black Hole Explorer (BHEX)

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on behalf of the BHEX team



# The Black Hole Explorer

**BHEX will achieve the highest angular resolution in history and reveal a black hole's "photon ring" for the first time**

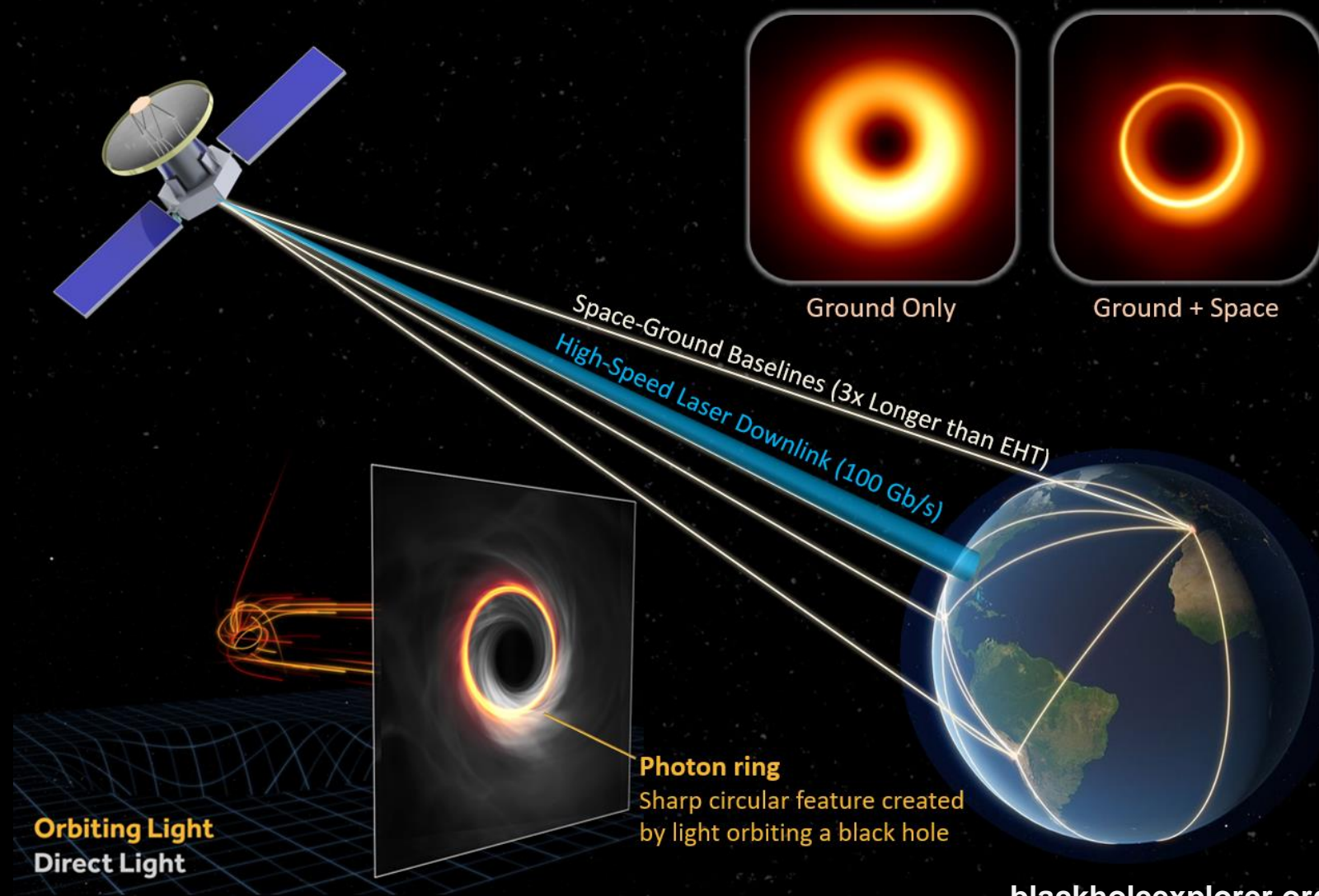
- First *direct* measurement of a black hole's spin
- Opportunity to study *dozens* of black holes
- Leverages existing ground infrastructure
- Targeting a 2025 SMEX proposal

## Science Goals

- Discover a black hole's photon ring
- Make direct measurements of a black hole's mass and spin
- Reveal the shadows of *dozens* of supermassive black holes

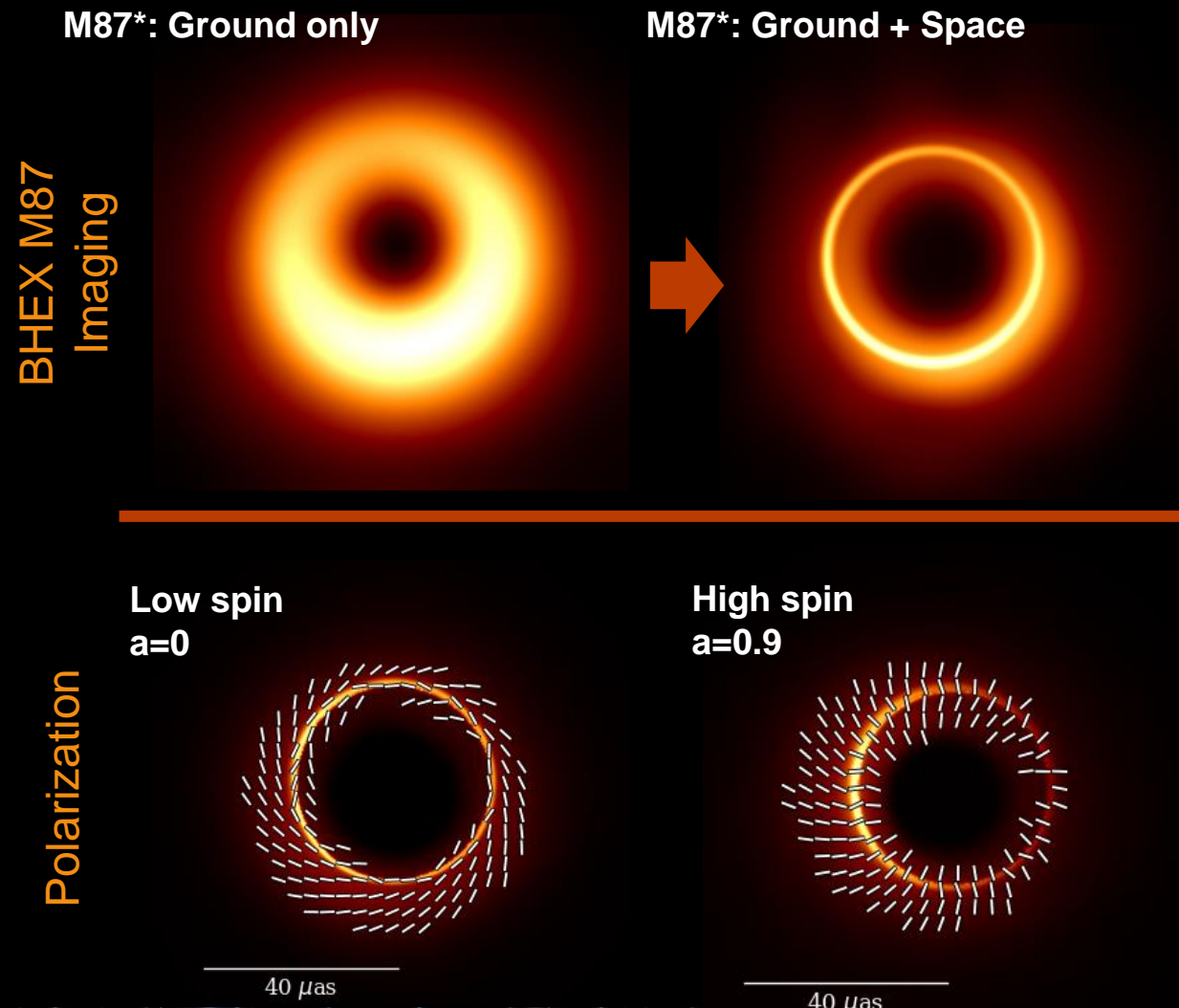
## Necessary Parameters for Space-VLBI

- High radio frequencies (>100 GHz)
- Orbits of at least ~20,000 km
- High-speed (~100 Gb/s) downlink



# BHEX Science Area 1: Detect Black Hole Photon Rings and Directly Measure BH Spin

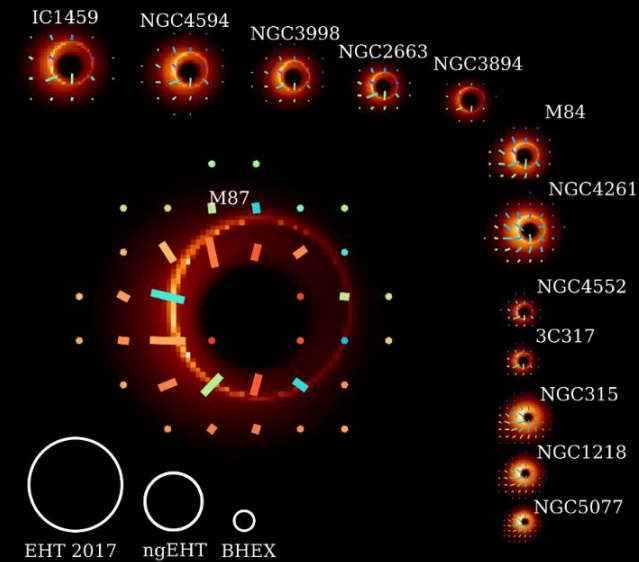
- BHEX will detect and image the photon rings formed by **light deflected >180 degrees** in Sgr A\* and M87\*
- BHEX will measure the **size and asymmetry** of the photon rings in Sgr A\* and M87\* to ~1% accuracy
- BHEX will use these measurements to infer Sgr A\* and M87\*'s mass and spin **directly from strong gravity**
- BHEX will compare spin measured from the photon ring to spin inferred from near-horizon magnetic fields (Palumbo+ 2020, Chael+ 2024)



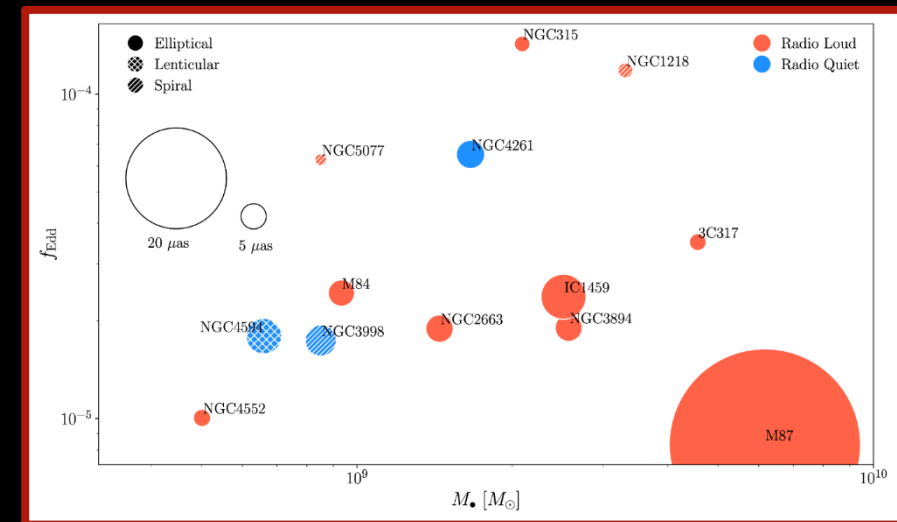
# BHEX Science Area 2: Survey Low-Luminosity AGN with Horizon-scale Resolution

- BHEX will **increase the sample size** of resolved black hole horizons from 2 to >10
- BHEX will make >10 horizon-scale measurements of mass (from the size of the emission region) and spin (from magnetic field helicity)
- BHEX will observe how horizon-scale accretion changes with **mass, spin, accretion rate, radio-loudness, and host galaxy properties**
- BHEX will probe nearby AGN with sufficient angular resolution to detect SMBH **binaries at sub-pc separations**

Event Horizon Targets



LLAGN properties

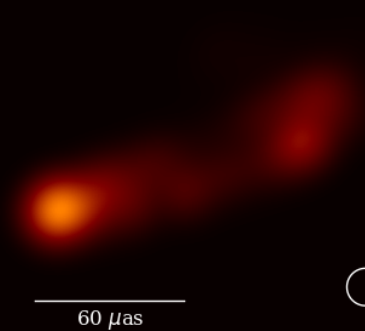


# BHEX Science Area 3: Resolving Extragalactic Jet Launching and Collimation

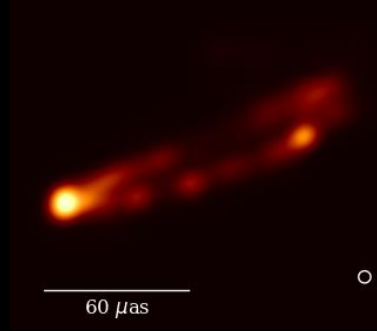
- BHEX will resolve longitudinal and *transverse* structure in jets from scales of 10-10,000 GM/c<sup>2</sup>
- BHEX will determine if BH jets are **universally edge brightened** and probe their magnetic fields, structure, and composition on sub-pc scales
- BHEX will investigate **magnetic fields at the jet light cylinder** (10-500 GM/c<sup>2</sup>), which may encode BH spin (Gelles, Chael & Quataert 2024)
- BHEX will make rapid follow-up images of jets associated with high-energy **neutrinos**

Jet Imaging

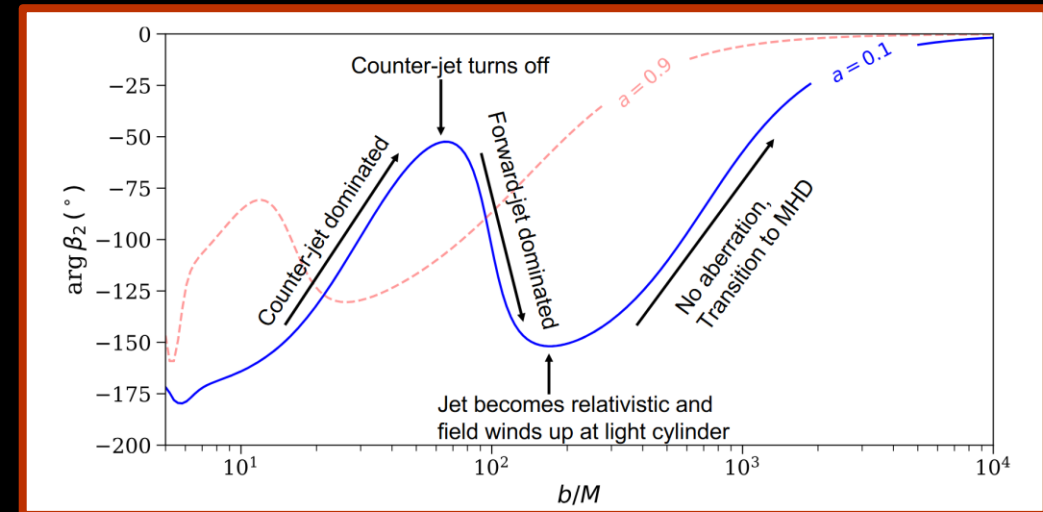
EHT simulation



BHEX simulation

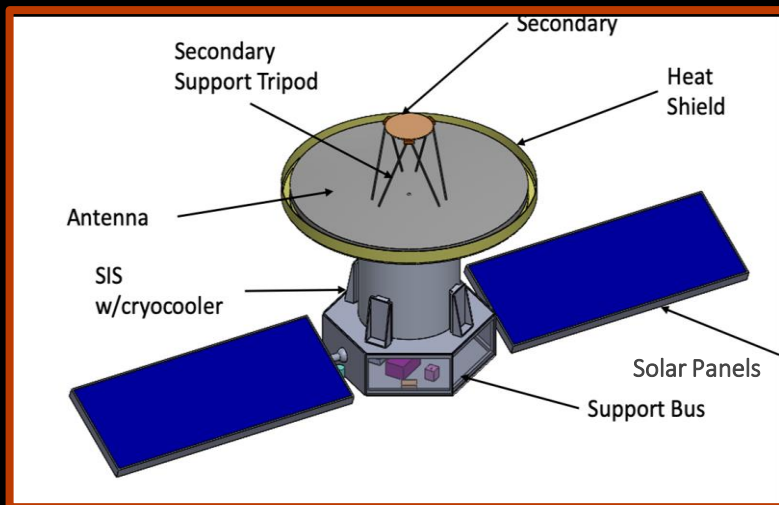


Jet Polarization



# The BHEX Mission

Spacecraft



## Mission Parameters

- 3.5m Antenna, 30um surface, shaded
- Simultaneous dual-band observations (80 + 240/320 GHz)
- 48 GHz of sampled bandwidth (64 Gb/s)
- Orbit: ~20,000 km altitude
- Lifetime: 2+ years
- Telemetry: 100 Gbps using laser communications

## Targeting 2025 SMEX call

Strong contributions from Japanese astronomy community

Potential non-VLBI science case studying O<sub>2</sub> emission at 50-70 GHz

Series of SPIE papers published this summer: see arXiv [2406.12917](https://arxiv.org/abs/2406.12917)

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Please get in touch if you have questions or want to get involved!

M87 u-v coverage

