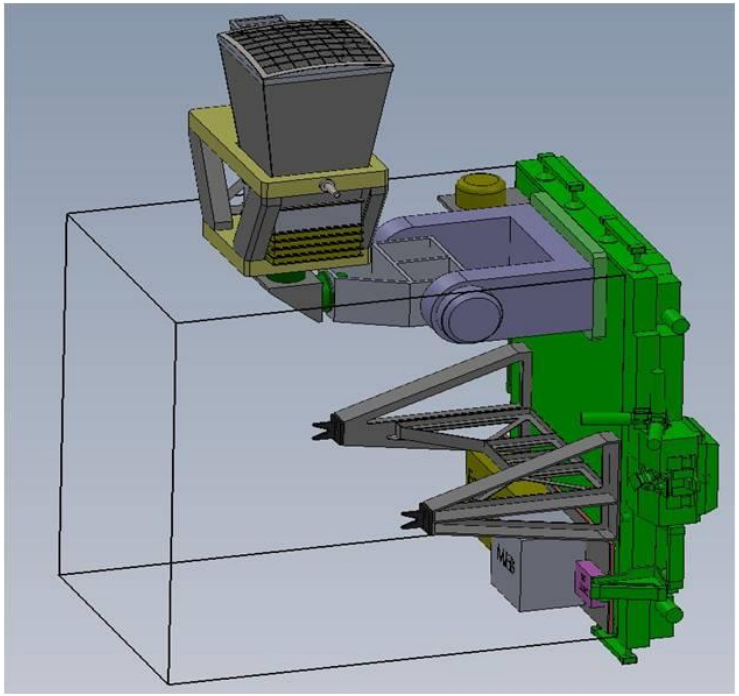


ISS-Lobster on Pointing Platform

ISS-Lobster

A Low-Cost, Wide-Field X-Ray Transient Mission on the ISS

Texas Relativistic Astrophysics Symposium
Dec. 11, 2013

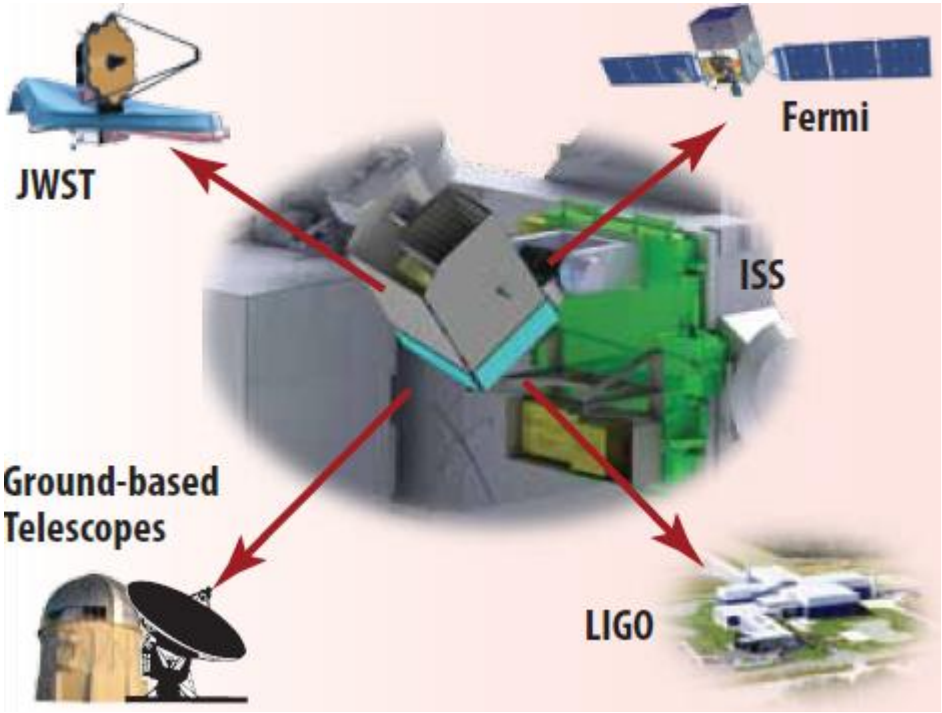
Jordan Camp
Goddard Spaceflight Center

iLobster Objectives

X-Ray Time Domain Astronomy In ISS Era

- 30 x higher sensitivity compared to BAT, ASM, MAXI, for transient study of Black Holes, Neutron Stars, GRBs

- Multiwavelength analysis with LIGO, Fermi, JWST, ground telescopes



ISS-Lobster Mission Proposal

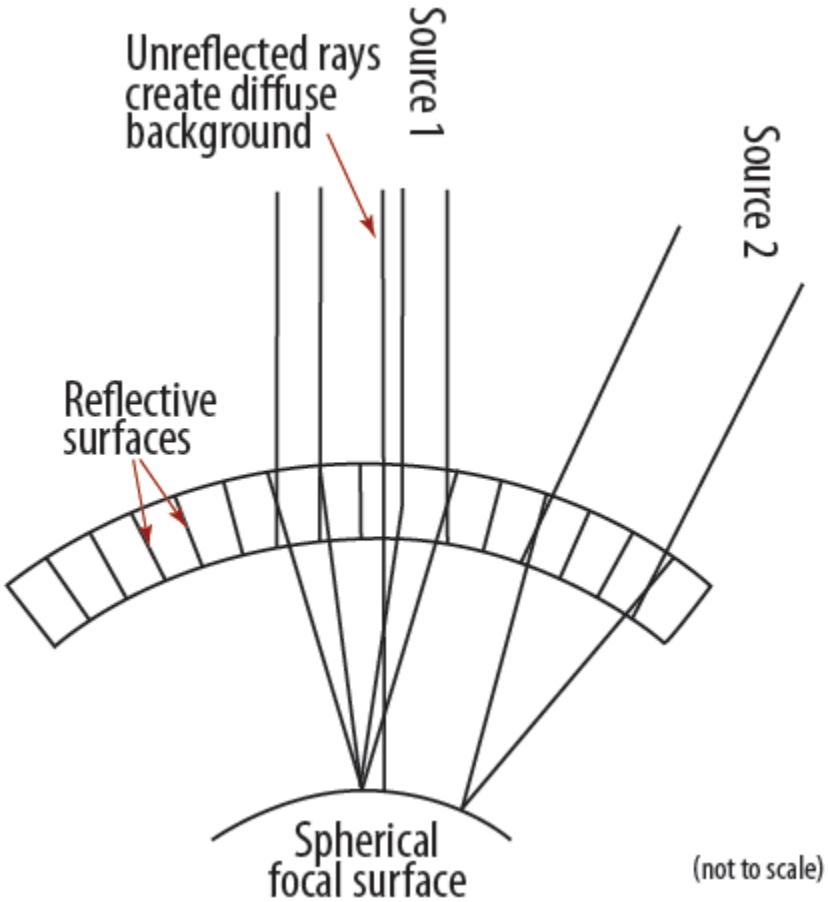
- ISS-Lobster proposed to 2012 NASA Mission of Opportunity
  - $60M
  - Power and communication provided by ISS

- Opportunity cancelled in April 2013 due to lack of funds in FY14 budget

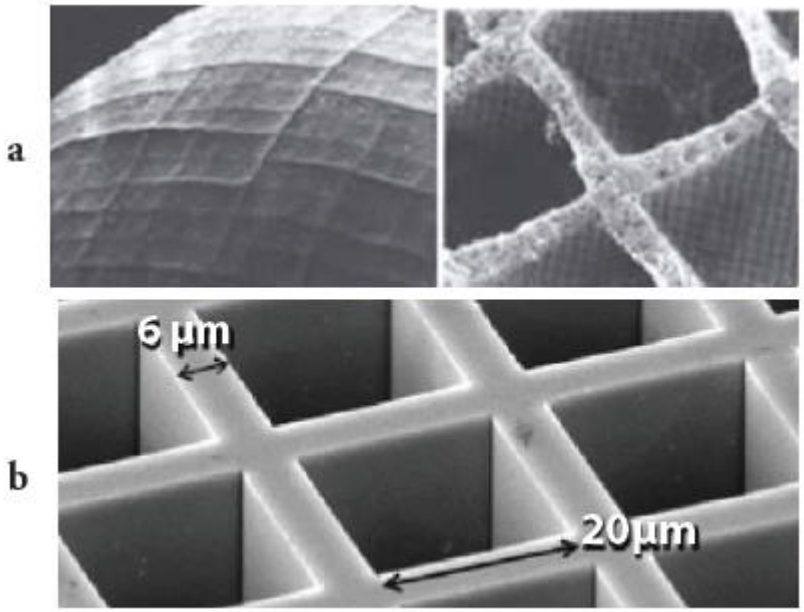
- Received positive review of proposal
  - Strong science
  - Simple and robust implementation
  - Cost fidelity

- Will re-propose in Fall 2014

New Technology → Breakthrough Science



Lobster Eye

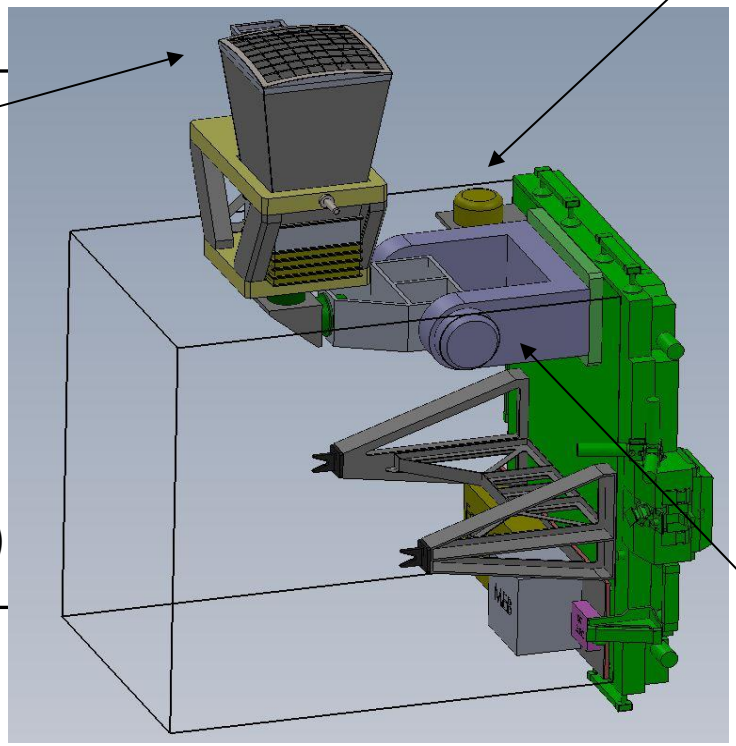


Lobster-Eye geometry provides *simultaneous* large FoV, high position resolution and high sensitivity → Time Domain Astronomy

iLobster and its Instruments

Gamma-Ray Burst Monitor (GBM)
50 keV to 1 MeV
GSFC, MPE

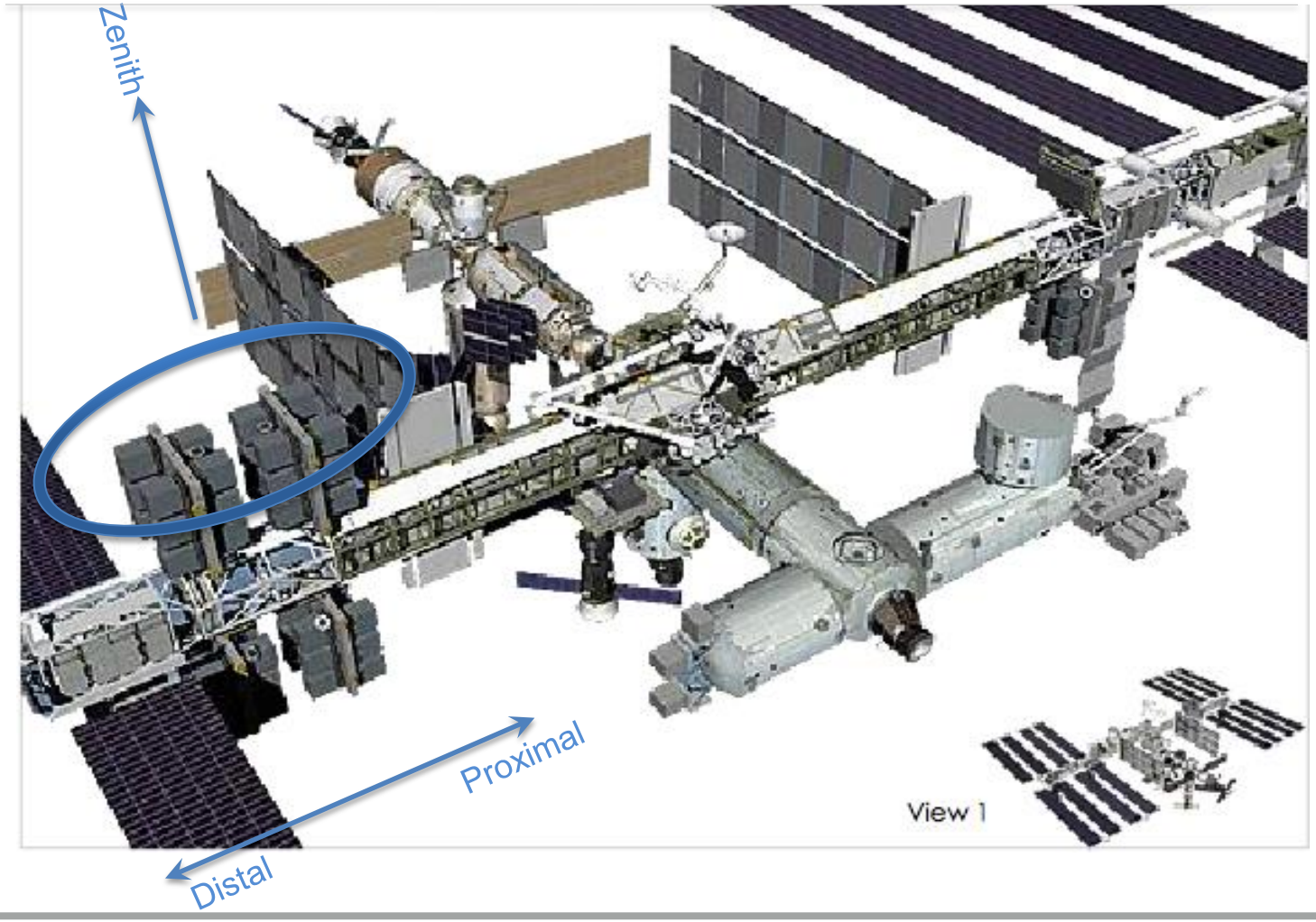
Wide Field Imager (WFI)
GSFC, U. Leicester, MIT
FoV: 0.3 sr = 900 deg^2
Resolution = 1 arc min
Energy Range: 0.3 - 6 keV
Detectors: CCDs
Optics: Microchannel plates
Sens: 10^{-11} erg cm^{-2} s^{-1} (2000 sec)



Pointing Platform
1 arc min stability
2 π FoR
Partner: Moog/CSA

ELC Locations

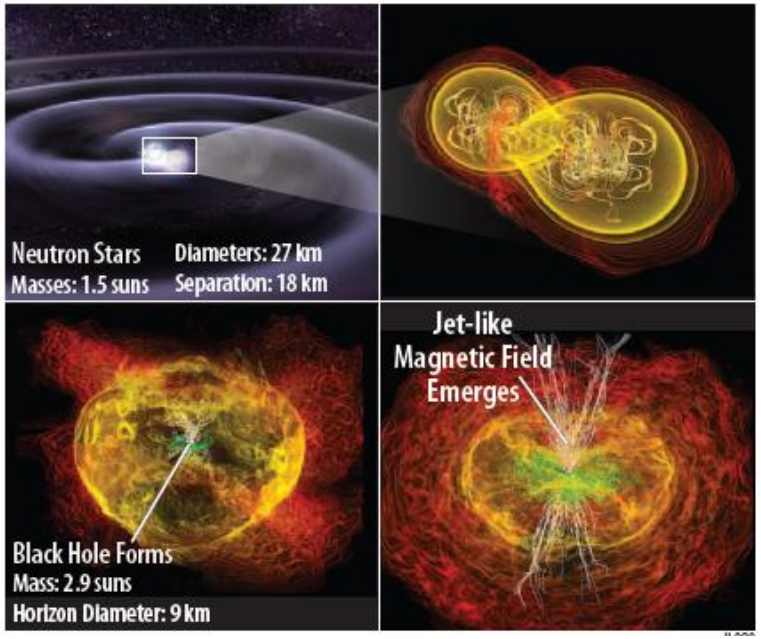
Oval shows the 8 good zenith-looking locations. Initially 2pi FoV.
ISS provides power, telemetry

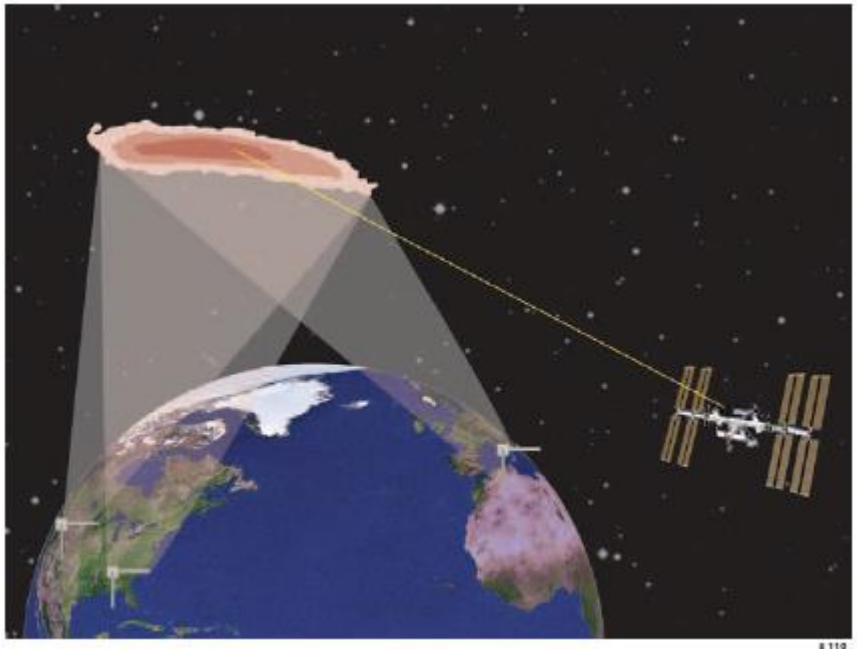


Every New Technology Has Its Day

- Lobster optics proposed by Roger Angel in 1977
- All-Sky X-ray Monitor based on Lobster optics selected by ESA for flight on ISS in 2001 (U. Leicester)
  - Cancelled after Columbia accident
- Lobster-based satellite proposed by Gehrels in 2010
  - Category I but not selected
- Lobster optics now integrated into Beppi-Columbo mission (2015) for X-ray analysis of Mercury surface
- ISS-Lobster proposed for 2012 Mission of Opportunity
  - cancelled in 2013

Science Objective I
X-Ray Followup of Gravitational Wave Detection





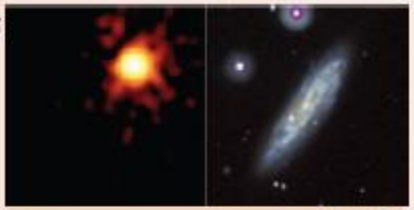
several / yr (NS-BH) or (NS-NS)
Increase range, confidence of LIGO detections
Precise localization of source (redshift)
Energetics of source
Relative speed of graviton and photon (10^{-18})

Science Objective 2
Highest Sensitivity X-Ray Transient Science

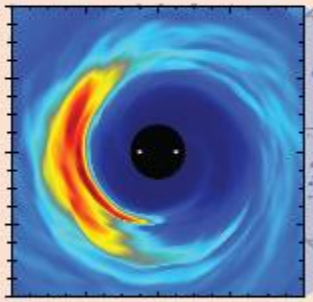
B Highest Sensitivity Time-Domain Survey of the Transient Soft X-ray Sky

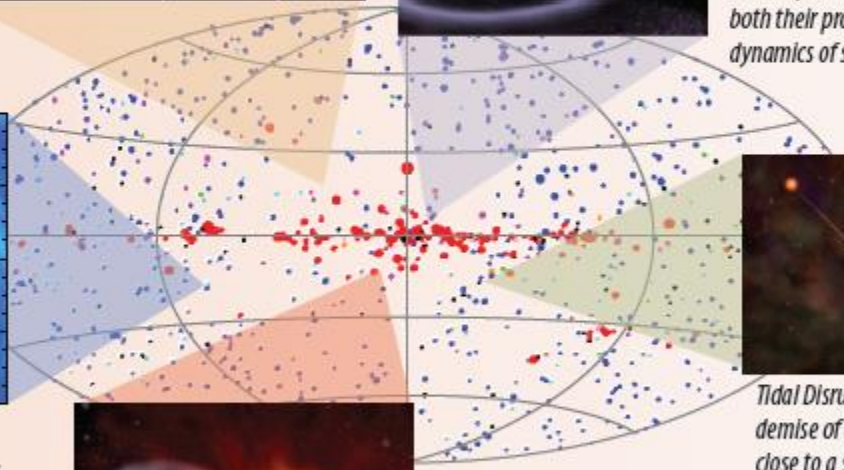
With a 30-fold improvement in sensitivity beyond previous all-sky X-ray telescopes, ISS-Lobster will dramatically extend the discovery space for transient X-ray sources involving black holes and neutron stars. The near continuous ISS-to-ground communications link will allow transient alerts to be rapidly delivered to ground and space observatory networks.

Supernova Shock Breakouts are the elusive short bright X-ray ashes signaling SNe explosions. ISS-Lobster will detect them at a rate of 1-2/yr.



Binary neutron-star and neutron star – black hole mergers are thought to produce both short-lived strong gravity waves and electromagnetic signals. ISS-Lobster will detect these counterparts and provide insight into both their progenitor systems and the dynamics of strong gravity.



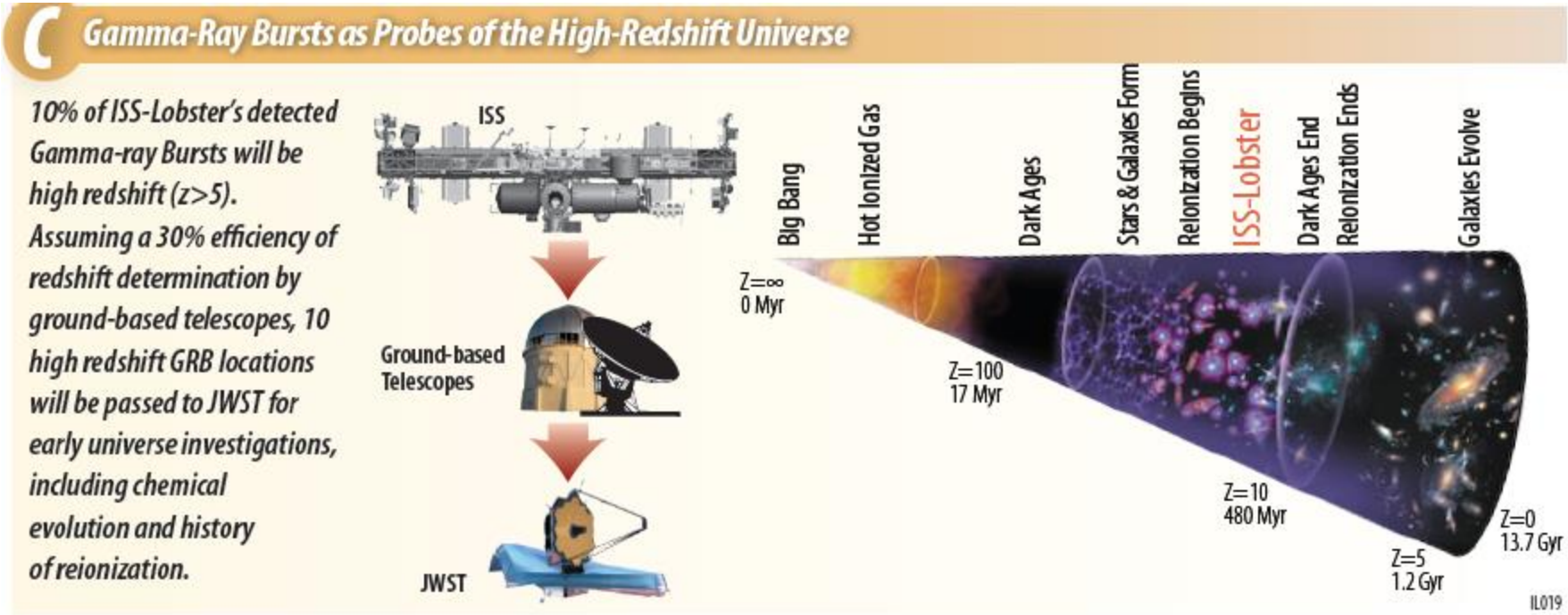


Active Galactic Nuclei will be densely monitored by ISS-Lobster, to detect modulated X-ray flux associated with the circumbinary disc inspiral of supermassive black hole binaries.

Classical and Recurrent Novae are the results of thermonuclear burning on the surface of a white . ISS-Lobster will detect X-rays from their runaway phases.

Tidal Disruption Flares signal the demise of a star when it wanders too close to a super massive black hole in the center of a galaxy. ISS-Lobster will detect ~14 such per year, elucidating stellar dynamics, and providing massive black hole demographics.

Science Objective 3
Gamma-Ray Bursts from early Universe

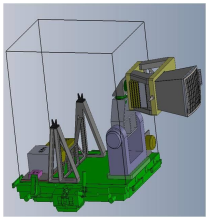


X-Ray Followup of GW Detections by Pulsar Timing Array

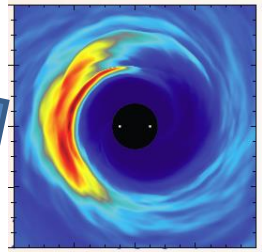
- A PTA may observe stochastic GW background by ~ mid-decade
  - SMBH binaries with mass > 10^8 $\mathbf{M}_\odot$ and periods of 0.5 year or greater

- Discrete SMBH binaries could be seen above background *if* they are close
  - PTA can only localize to ~100 deg^2, but iLobster could find host galaxy

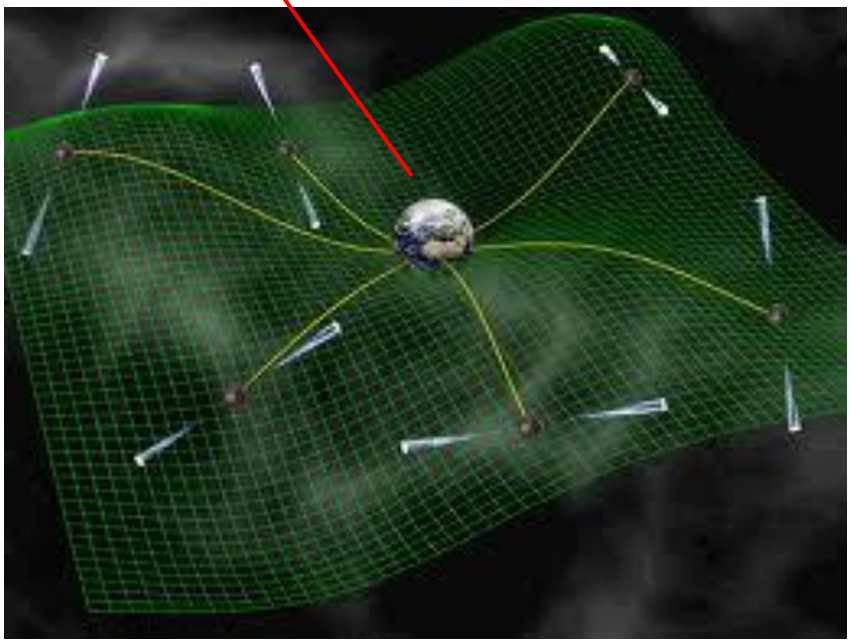
- All-sky iLobster monitor could observe and localize numerous SMBH sources if:
  - X-Ray emission from circumbinary disc modulated at ~ 10% level
  - Period of 1 year or less
  - 10^{-3} SMBH/Mpc^3 and 0.3 galaxy mergers /Gyr/galaxy



ISS-Lobster



10^8 $M_\odot$ SMBH binary



GW will disturb pulsar radio signal arrival times on Earth, observed by PTA

Observational Scenario

- Sky Survey mode (90%)
  - 2% FoV → 1100 sec per observation
  - 5 observations per orbit
  - Full sky coverage in 15 orbits

- Target of Opportunity (10%)
  - 5 min latency for ground pointing command
  - 2700 sec observation (“stare” mode)

Summary

- iLobster science is broad and fundamental
  - Gravitational wave follow-ups (stellar mass BH and SMBH)
  - Tidal disruptions of stars, SN shock breakout, NS bursts
  - High redshift Gamma-Ray Bursts
- Proposed to 2012 Mission of Opportunity
  - Positive review: affirmed science and cost of mission
  - Opportunity cancelled
- Will propose to 2014 Mission of Opportunity