



# SEXTANT – STATION EXPLORER FOR X-RAY TIMING AND NAVIGATION TECHNOLOGY\*

\*Funded by NASA STMD/GCD & GSFC/OCT

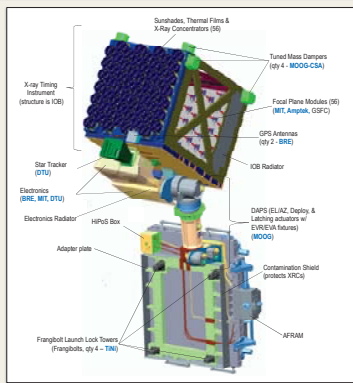
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## DESCRIPTION

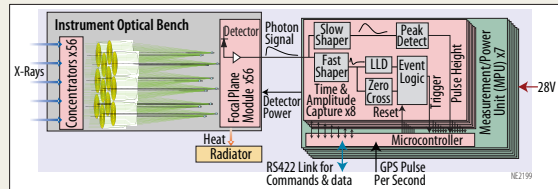
- NICER is a NASA SMD funded, ISS-mounted X-ray observatory that will carry out phase-resolved spectroscopy of rapidly spinning neutron stars.
- SEXTANT, a combined technology demonstrator, will augment NICER avionics with algorithms to demonstrate, for the first time, real-time X-ray Navigation (XNAV) based orbit determination using millisecond pulsars (MSPs).
- This poster describes SEXTANT's architecture with details on each of the main components.

## NICER PAYLOAD AND X-RAY TIMING INSTRUMENT (XTI)

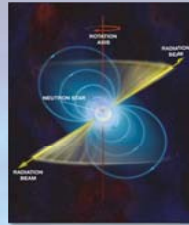


### NICER XTI

- 56 co-aligned X-ray concentrator optics and associated Silicon Drift Detectors (SDDs) in Focal Plane Modules (FPMs)
- 7 Measurement/Power Units The FPMs detect X-rays arriving from the concentrators
- MPUs time-tag and packetize photon events
- < 300 nsec absolute time resolution
- > 2000 cm<sup>2</sup> effective area
- Moderate (CCD-like) energy resolution



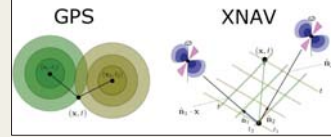
Block diagram of NICER XTI showing main components.



## XNAV CONCEPT

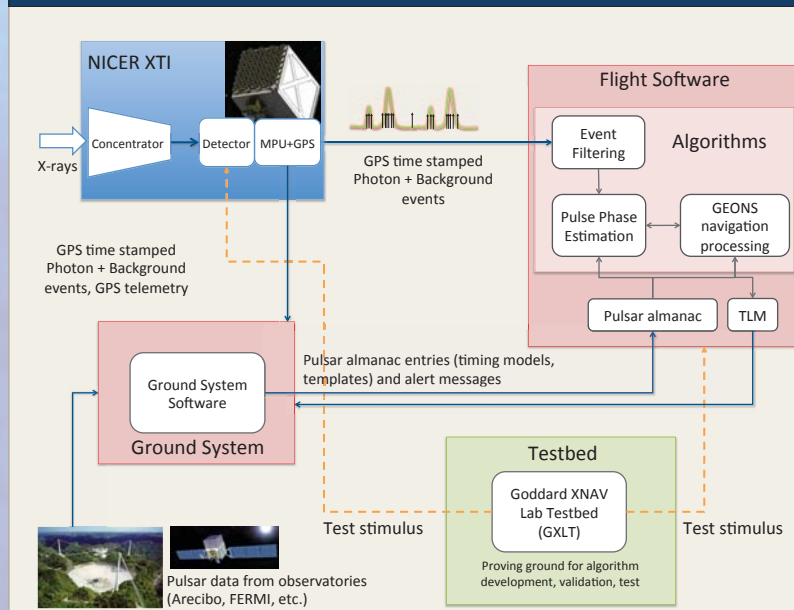
XNAV uses MSPs as stellar lighthouses for navigation. MSPs have the following attractive properties:

- distributed on Galactic scale
- are very stable clocks on long time scales, comparable to or better than atomic clocks
- provide distributed GPS-like timing infrastructure.



GPS & X-ray pulsar navigation basics

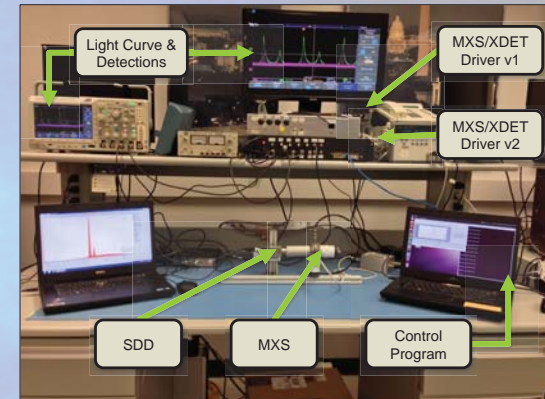
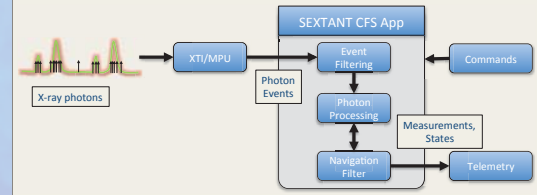
## SEXTANT ARCHITECTURE



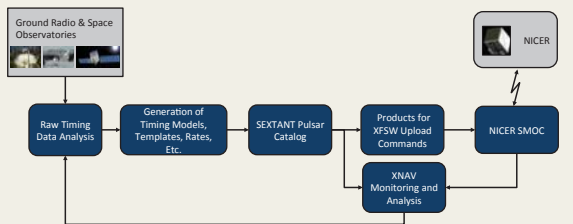
## SEXTANT FLIGHT SOFTWARE APP

XNAV Flight Software (XFSW) sequence flow:

- XTI detects events from sequential pulsar observations, output via MPU
- Pre-processing filters & buffers events until sufficient number from single pulsar collected
- Batch process events to extract single measurement of phase, Doppler, count rates
- Navigation algorithm (GEONS EKF) blends models of dynamics with measurement(s) to update spacecraft state estimate
- Ground system maintains pulsar almanac used by XFSW

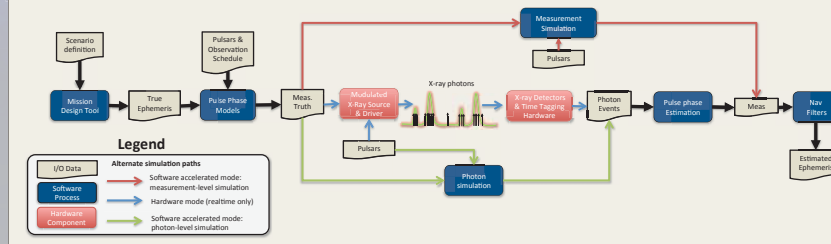


## SEXTANT GROUND SYSTEM



- Generate and maintain the pulsar almanac
  - Timing models
  - Profile templates (light-curves)
- Maintain and update application
- Pulsar upload tables
- GEONS maintenance commands
- Monitor performance
  - Trending
  - Alerts
- Driven initially with radio observations
  - NICER data after sufficient
  - data collected

## GODDARD XNAV LABORATORY TESTBED (GXLT)



- Level 0 simulation**
  - Software only XNAV measurement simulation
- Level 1 simulation**
  - Software only photon event simulation
  - Photon processing algorithm implemented for measurement generation
  - Primary mode of development for SEXTANT
- Level 2 simulation**
  - Hardware-in-the-loop simulation
  - Test-as-you-fly
  - Use the Modulated X-ray source (MXS) to generate the photon events
  - X-ray detector & electronics time-tag the photon events
  - Useful for testing flight hardware

## REFERENCES

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- G. Prigozhin, K. Gendreau, R. Foster, G. Ricker, J. Villaseñor, J. Doty, S. Kenyon, Z. Arzoumanian, R. Redus, and A. Huber, *Characterization of the silicon drift detector for NICER instrument*. In Space Telescopes and Instrumentation: Ultraviolet to Gamma Ray, volume 9443 of Proc. SPIE. International Society for Optics and Photonics, Sep. 2012.
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