

National Aeronautics and
Space Administration



NASA Involvement in Athena

X-ray SIG Meeting

AAS HEAD Meeting | Monterey, CA March 19, 2019

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Advanced Telescope for High-Energy Astrophysics (Athena)

ESA-led X-ray mission with NASA contributions;
Launch date 2031

Currently in phase A/B bridge, Phase B1 starts Nov
2019

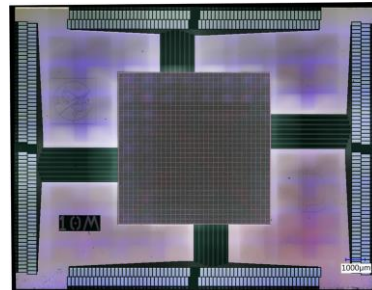
NASA wants to provide unique, scientifically valuable,
US expertise to Athena

NASA wants to be an enabling junior partner

During this study phase, pre-adoption, NASA is
participating in studies of possible contributions via a
Letter of Agreement

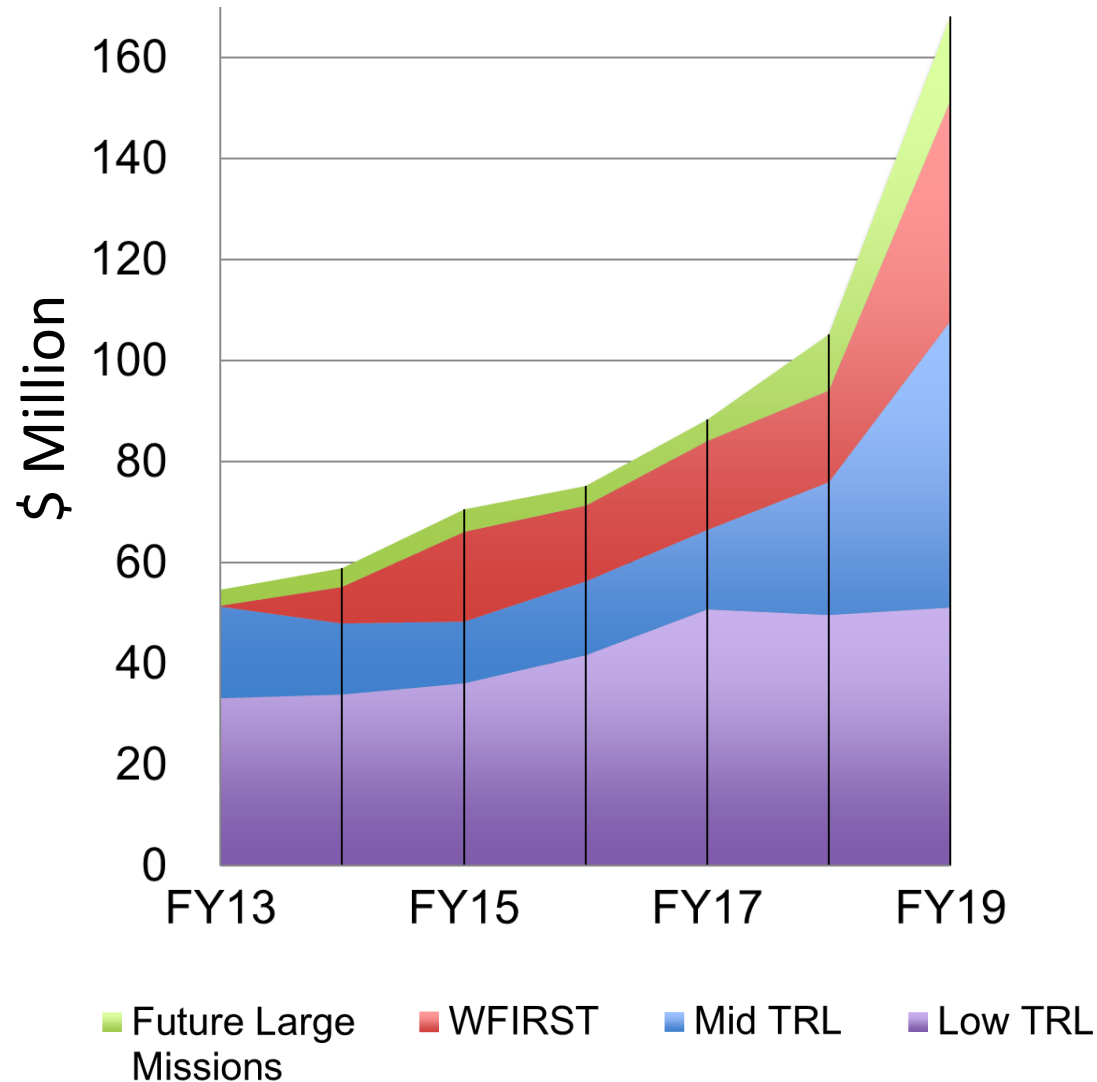
At adoption (2021), NASA contributions will be
specified via a Memorandum of Understanding

Advanced Telescope for High-Energy Astrophysics (Athena)



- NASA providing hardware (\$100M to \$150M), plus a U.S. GO program and a U.S. data center. Currently studying the following potential contributions:
 - X-ray Integral Field Unit (X-IFU) μ -calorimeter main sensor array (GSFC)
 - Wide Field Imager (WFI) ASIC design, heat pipes & radiators, Science Products Module (SPM) (Penn State, MIT, SAO, Stanford & GSFC)
 - Soft-Ride system (GSFC)
 - X-ray and Cryogenic Facility (XRCF) for possible calibration (MSFC)
- Athena Study Office (“proto-project”) at GSFC is responsible for managing technology investments and science contributions. US scientists Co-Is on instrument teams, represented on Athena Science Study Team, and Science Working Groups

Athena funding is currently part of the Astrophysics Technology Investment FY13-FY19

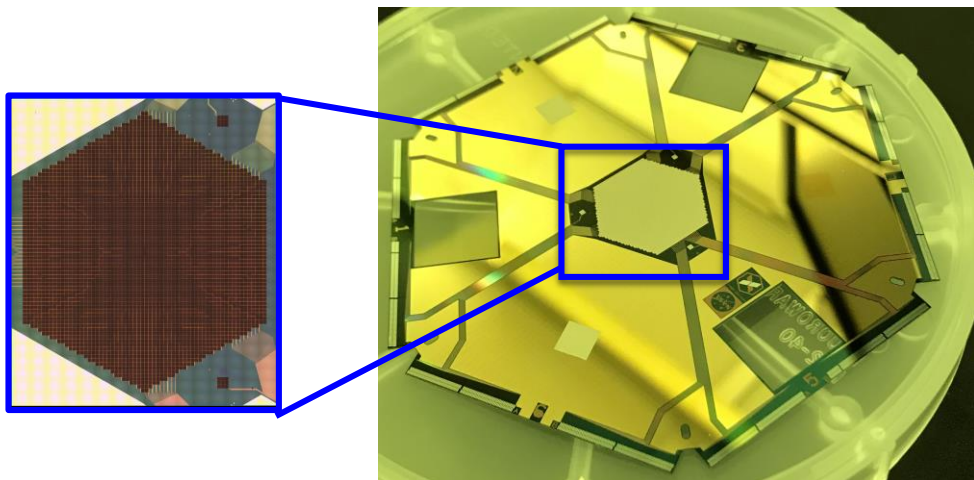


Robust, responsive, forward- leaning, and balanced investment strategy:

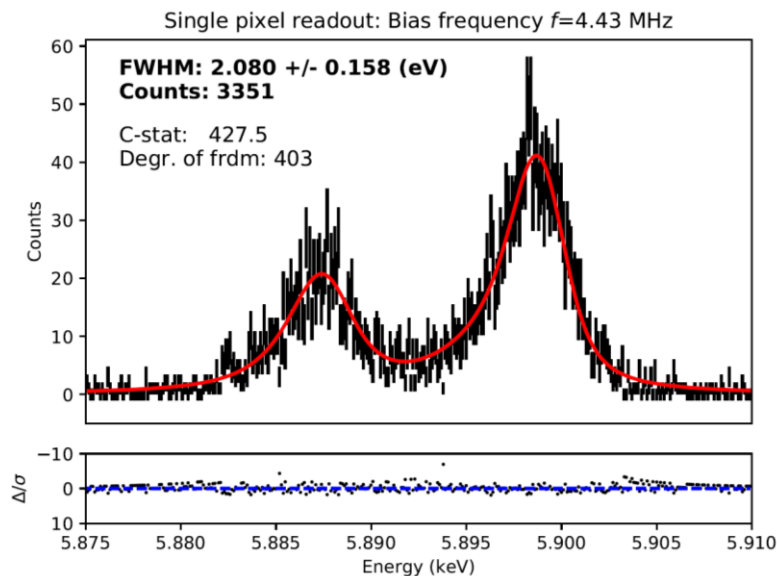
- More than 300% growth over 6 years in technology development (FY13-FY19); over \$600M invested
- Investing in technology innovations across a wide TRL range
- Balanced among low-TRL and **mid-TRL (Athena)** technology investments
- Investing in future missions' technology requirements

Athena X-IFU (X-ray Integral Field Unit)

- X-IFU is led by IRAP, managed by CNES, and includes SRON and a large multi-national team.
- GSFC team is providing the main sensor array, plus technical expertise
- The effort is a logical extension of the work on XRISM (formerly XARM), the successor to ASTRO-H/Hitomi.
- Rather than a 6x6 array on XRISM, the Athena X-IFU will be ~56x56 pixels in a hexagonal shape
- Small arrays have been delivered to SRON for testing, the first full-sized prototypes have been made
- Test arrays have already met the required energy resolution of 2.5 eV
- The US team will participate in the GTO program



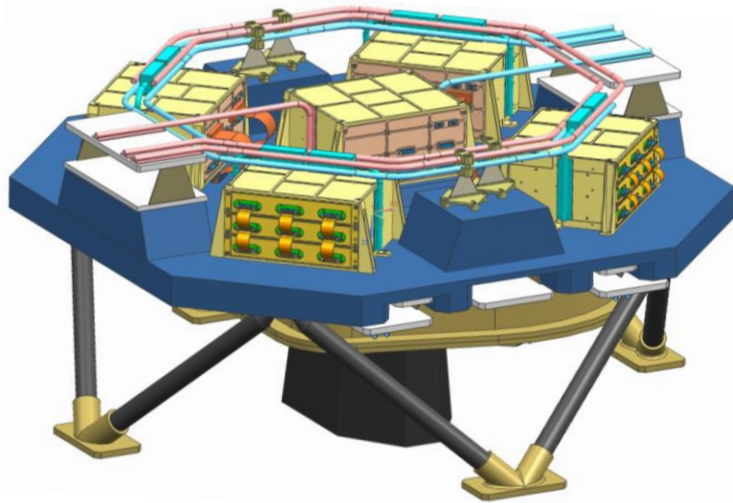
Single-pixel, $\delta E = 2.08$ eV @ 4.4 MHz





Athena WFI (Wide Field Imager)

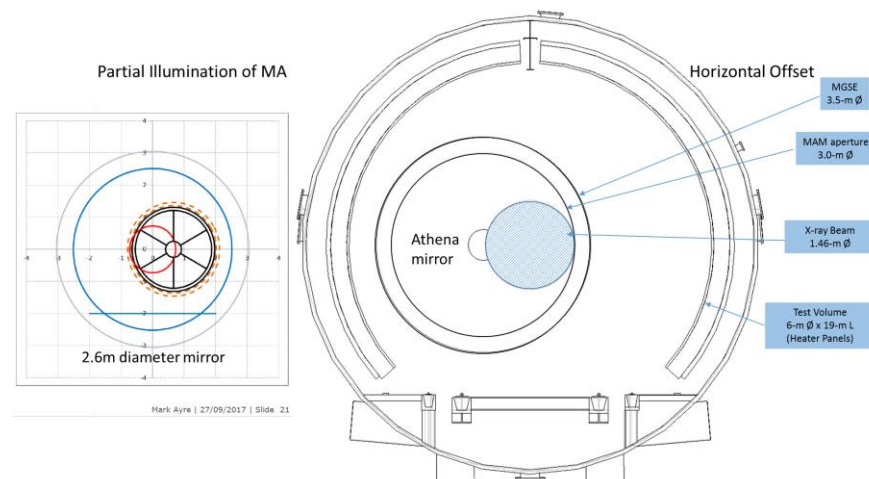
- WFI is lead by MPE and includes a large multinational team.
- Penn State is leading the US contribution, which includes Co-Is from Stanford, MIT, and SAO.
- US contributions include the ASIC (readout) design, a possible Science Products Module (SPM), possibly heat pipes and radiators.
- SPM on-board processor would allow reduction in background and detection of transient sources.
- The US team will participate in the GTO program.





X-Ray and Cryogenic Facility (XRCF) for Athena Calibration

- Largest X-ray Beam line in world
- Built for Chandra Calibration
- Used for JWST Cryo Testing
- Could uniformly illuminate ~1/3 of Athena mirror for calibration



NASA Athena Study Team

- Formalized in Feb 2019
- Co-Chaired by Esra Bulbul (SAO) and Jon Miller (U Mich)
- Includes previously appointed NASA members of the AWG (Athena Working Groups), funded for travel, jointly appointed by ESA ASST, and US Instrument Team members
- Meeting here Wed 7:30AM
- Organized Science White papers input to the Decadal on Athena science
- Will be community focal point for Athena related Decadal input.
- 'Athena-nast@lists.nasa.gov'

Last	First	Organization	Science Working Group	Email
Allen	Steve	Stanford University	1.1 Evolution of galaxy groups and clusters	swa@stanford.edu
Badenes	Carlos	University of Pittsburgh	3.4 Astrophysics of Supernova Remnants and the Interstellar Medium	badenes@pitt.edu
Ballantyne	David	Georgia Institute of Technology	2.2 Understanding the build-up of SMBH and galaxies	david.ballantyne@physics.gatech.edu
Bandler	Simon	NASA GSFC	5.4 End-to-end simulations (X-IFU team)	simon.r.bandler@nasa.gov
Bautz	Mark	MIT	US WFI Co-I	mwb@space.mit.edu
Brandt	Niel	Penn State University	2.1 Formation and growth of the earliest SMGH	niel@astro.psu.edu
Bregman	Joel	Univ of Michigan	1.1 Evolution of galaxy groups and clusters	jrbregman@umich.edu
Brenneman	Laura	Smithsonian	2.4 Close Environments of Supermassive Black Holes	lbrenneman@cfa.harvard.edu
Bulbul	Esra	Smithsonian	Co-Chair NASA Athena Science Team	ebulbul@cfa.harvard.edu
Burrows	David	Penn State University	US WFI Co-I	burrows@astro.psu.edu
Donahue	Megan	Michigan State University	1.2 Astrophysics of galaxy groups and clusters	donahue@pa.msu.edu
Galeazzi	Massimiliano	University of Miami	1.4 The missing baryons and the warm-hot intergalactic medium	galeazzi@miami.edu
Griffiths	Richard	University of Hawaii	3.5 Multiwavelength working group	griff2@hawaii.edu
Heinz	Sebastian	University of Wisconsin	1.3 AGN feedback in Galaxy clusters and groups	heinzs@astro.wisc.edu
Hornschemeier	Ann	NASA GSFC	3.2 Star formation and evolution	ann.h.cardiff@nasa.gov
Foster	Karl	Cal Tech	5.1 Ground Segment	krl@srl.caltech.edu
Kallman	Timothy	NASA GSFC	5.5 Advanced Analysis Tools	timothy.r.kallman@nasa.gov
Kelley	Richard	NASA GSFC	US XIFU Co-I	richard.j.kelley@nasa.gov
Kilbourne	Caroline	NASA GSFC	US XIFU Co-I	caroline.a.kilbourne@nasa.gov
Kouveliotou	Chryssa	George Washington Univ	2.5 Luminous Extragalactic Transients	caroline.a.kilbourne@nasa.gov
Kraft	Ralph	Smithsonian	US WFI Co-I	rkraft@cfa.harvard.edu
Miller	Jon	University of Michigan	Co-Chair NASA Athena Science Team, 3.3 End points of stellar evolution	jonmm@umich.edu
Plucinsky	Paul	Smithsonian	5.3 Inter-Calibration sub-group of Mission Working Group	pplucinsky@cfa.harvard.edu
Porter	Scott	NASA GSFC	US XIFU Co-I	Frederick.S.Porter@gscf.nasa.gov
Ptak	Andrew	NASA GSFC	2.3 Astrophysics of feedback in local AGN	andrew.ptak@nasa.gov
Reynolds	Christopher	University of Maryland	2.4 Close Environments of Supermassive Black Holes	chrisreyn@googlemail.com
Smith	Randall	Smithsonian	US ASST Member, 3.0 Observatory Science	rsmith@cfa.harvard.edu
Troja	Elenora	UMUC / GSFC	5.6 GRB external triggers and TOOs	eleonora.troja@nasa.gov
Wolk	Scott	Smithsonian	3.1 Solar System and exoplanets	swolk@cfa.harvard.edu
Zhang	William	NASA GSFC	4 Telescope Working Group	william.w.zhang@nasa.gov



Athena in the US, going forward

- NASA will provide requested Decadal input on Athena
- NASA will transition its Athena involvement to formal 'project' status (no longer technology development, in 'pre-Phase-A) in 2019, leading to Phase A and B gates in coordination with ESA schedule.
- NASA anticipates an opportunity to expand US community involvement in Athena around time of Adoption in 2021, and will do so in coordination with ESA and the Instrument Teams.
- NASA is planning for a US Athena Data Center and a US GO program.
- NASA anticipates great US involvement in fabulous Athena science !