CANADA'S FLAGSHIP X-RAY TELESCOPE

THE COLIBRÌ MISSION

UBC · Université Bishop's University · Western · University of Manitoba · University of Alberta · McGill University · Saint Mary's University Since 1802 · Queen's University

CSA ASC · Stewart Blusson Quantum Matter Institute, The University of British Columbia · TRIUMF · Honeywell · MDA

Colibrì: Take Home Message

High- Time Resolution
High-Spectral Resolution
High-Throughput

Transition Edge Sensor
(TES) Detectors in Space

The Colibrì Team

Jeremy Heyl, UBC

Principle Investigator

Ilaria Caiazzo, UBC

Project Scientist

Kelsey Hoffman, Bishop's

Project Manager

Daryl Haggard, McGill

Mission Planning Lead

Sarah Gallagher, Western

Black Holes WG Lead

Samar Safi-Harb, Manitoba

Neutron Star WG Lead

The Colibrì Team

Gregory Sivakoff, Alberta

Coordinated Observations Lead

Kostis Michelakis, SBQMI, UBC

Detectors

Neil Rowlands, Honeywell

Payload

Piotr Jasiobedzki, MDA

Satellite

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Principal Investigator:

Jeremy Heyl, University of British Columbia

Project Scientist:

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Working Group Leads:

Black Holes - Sarah Gallagher, Western University

Neutron Stars - Samar Safi-Harb, University of Manitoba

Mission Planning Lead:

Daryl Haggard, McGill University

Coordinated Observations Lead:

Gregory Sivakoff, University of Alberta

Detector Technical Lead:

Kostis Michelakis, SBQMI, University of British Columbia

Detector Technical Team members:

Wolfgang Rau, TRIUMF, Queen's University

Josh Folk, SBQMI, University of British Columbia

Jeff Young, SBQMI, University of British Columbia

Pinder Dosanjh, SBQMI, University of British Columbia

Mario Beaudoin, SBQMI, University of British Columbia

Andrea Damascelli, SBQMI Director, University of British Columbia

Karl Jessen, SBQMI, University of British Columbia

Science Payload Technical Lead:

Neil Rowlands, Honeywell Aerospace

Science Payload Mechanical/Thermal Engineering Lead:

Dwight Caldwell, Honeywell Aerospace

Satellite Technical Lead:

Dr. Piotr Jasiobedzki, MacDonald Dettwiler

Satellite Technical Team members:

Dennis Gregoris, MacDonald Dettwiler

Jagannath Kshtriya, MacDonald Dettwiler

Science Working Group Members:

Luigi Gallo, St. Mary's University

Sharon Morsink, University of Alberta

★ Demet Kırmızıbayrak, University of British Columbia

★ Paul Ripoche, University of British Columbia

Andrew Cumming, McGill University

Craig Heinke, University of Alberta

Ingrid Stairs, University of British Columbia

Bob Rutledge, McGill University

★ Benson Guest, University of Manitoba

Colibrì Mission Overview

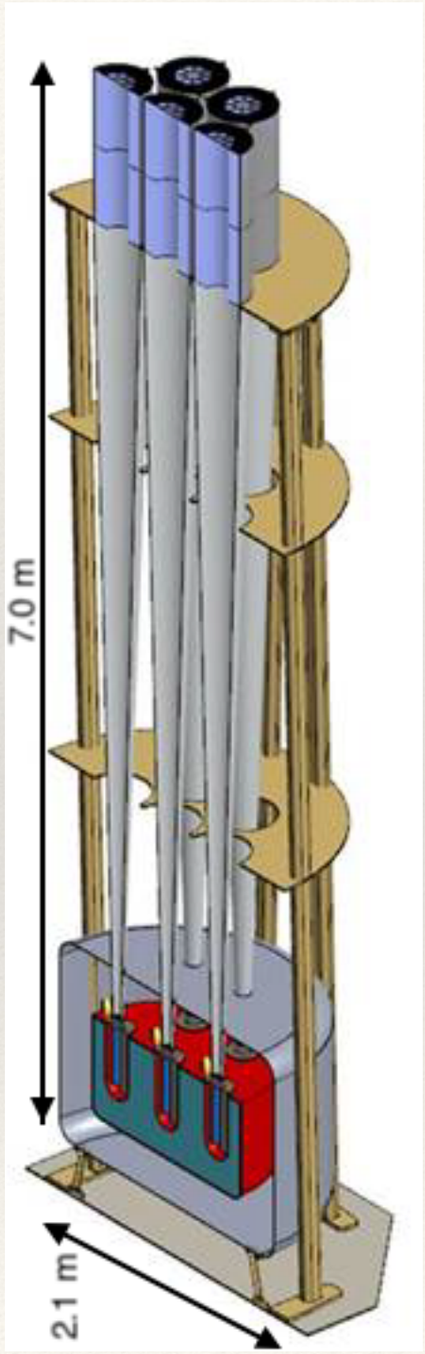
- High-time resolution, high-spectral resolution and high throughput
- Science questions:

    1. Does general relativity apply in the strong gravity regime? Is spacetime around black holes well described by the Kerr metric?
    2. Can we better understand the physics of accretion? How do accretion disks lose angular momentum? What is the mechanism behind winds? How are jets launched?
    3. How does matter behave in extreme environments in terms of density, gravity and magnetic fields? What is the physics of ultra-dense matter? What are the masses, radii and atmospheric composition of neutron stars?

- Current Status: 18-month concept study (September 2018 - February 2020)

Colibrì Mission Specs

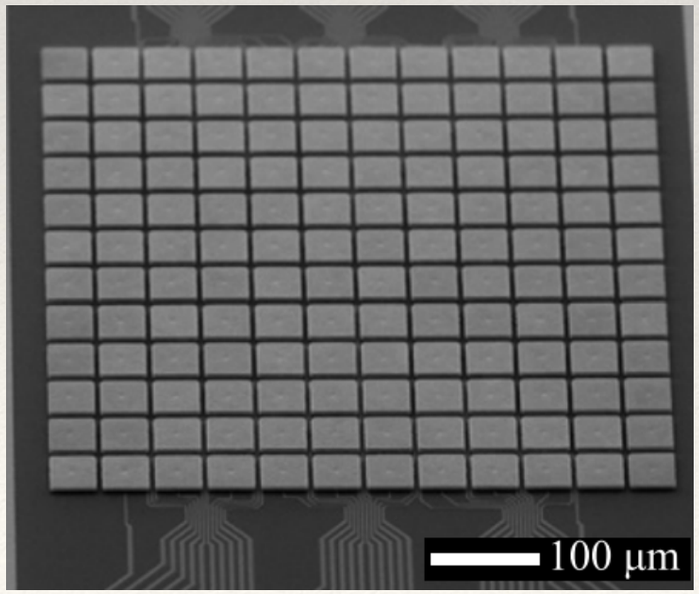
- Energy Range: 0.5 - 20 keV
- Energy Resolution: 2 - 5 eV
- Timing Resolution: 250 ns
- Effective Area: 3000 cm²
- Count Rate: >100 kHz
- Orbit: Sun Synchronous, 500-800km
- Mission Lifetime: 5 years
- Ground Ops: X-band, CSA Sat-Ops/ NRCan



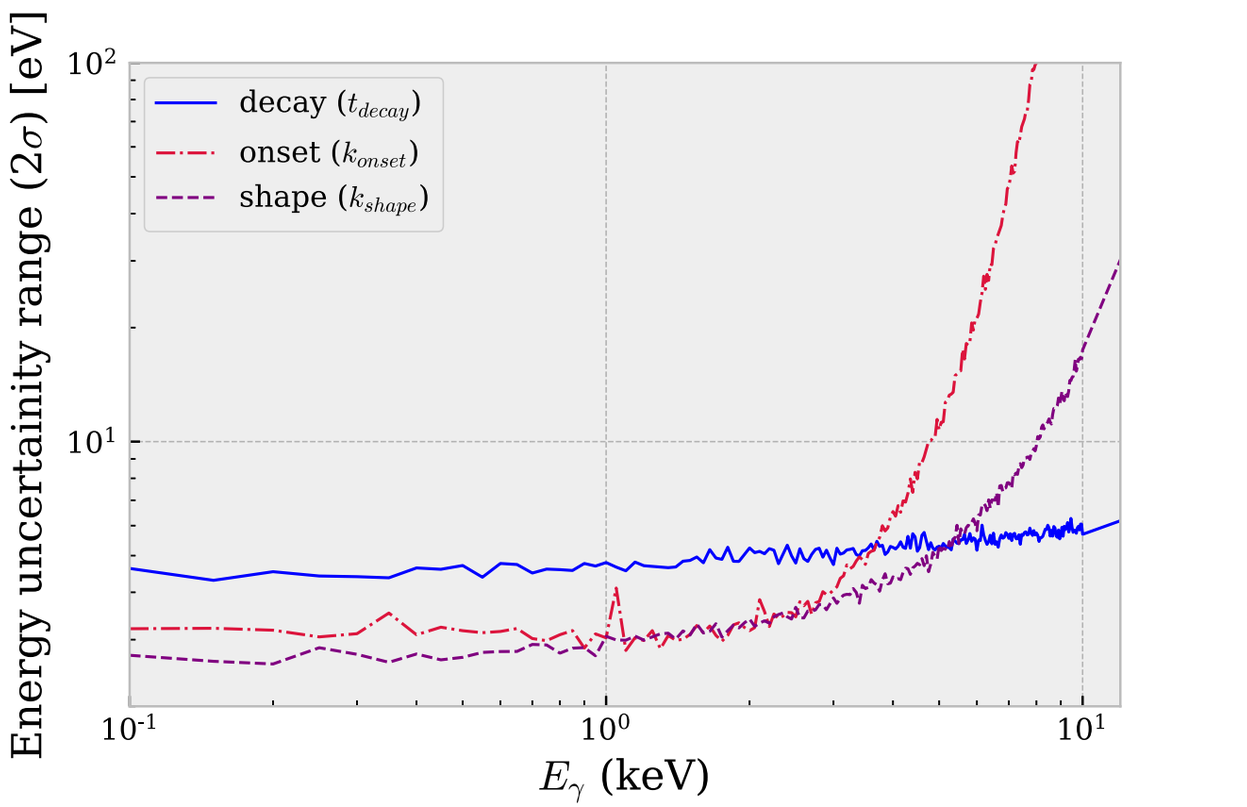
- Focal Length: 4.9 m
- Number of Arrays: 7
- Foils per Array: 30
- Coating: Iridium
- Detectors: TES Bolometers
- Bath Temp: 70 mK
- Tc = 100 mK

Colibrì: TES Detectors

- Transition Edge Sensors: high energy resolution and sensitivity
- Canadian TES detector development to be at Stewart Blusson Quantum Matter Institute at UBC
- On-board pulse processing - Sample every 5 microseconds
- Use of Linear filters (Paul Ripoche, Graduate student at UBC)



TES array for X-ray detection from Lee et al. 2015



Colibrì Science Goals

Black Holes

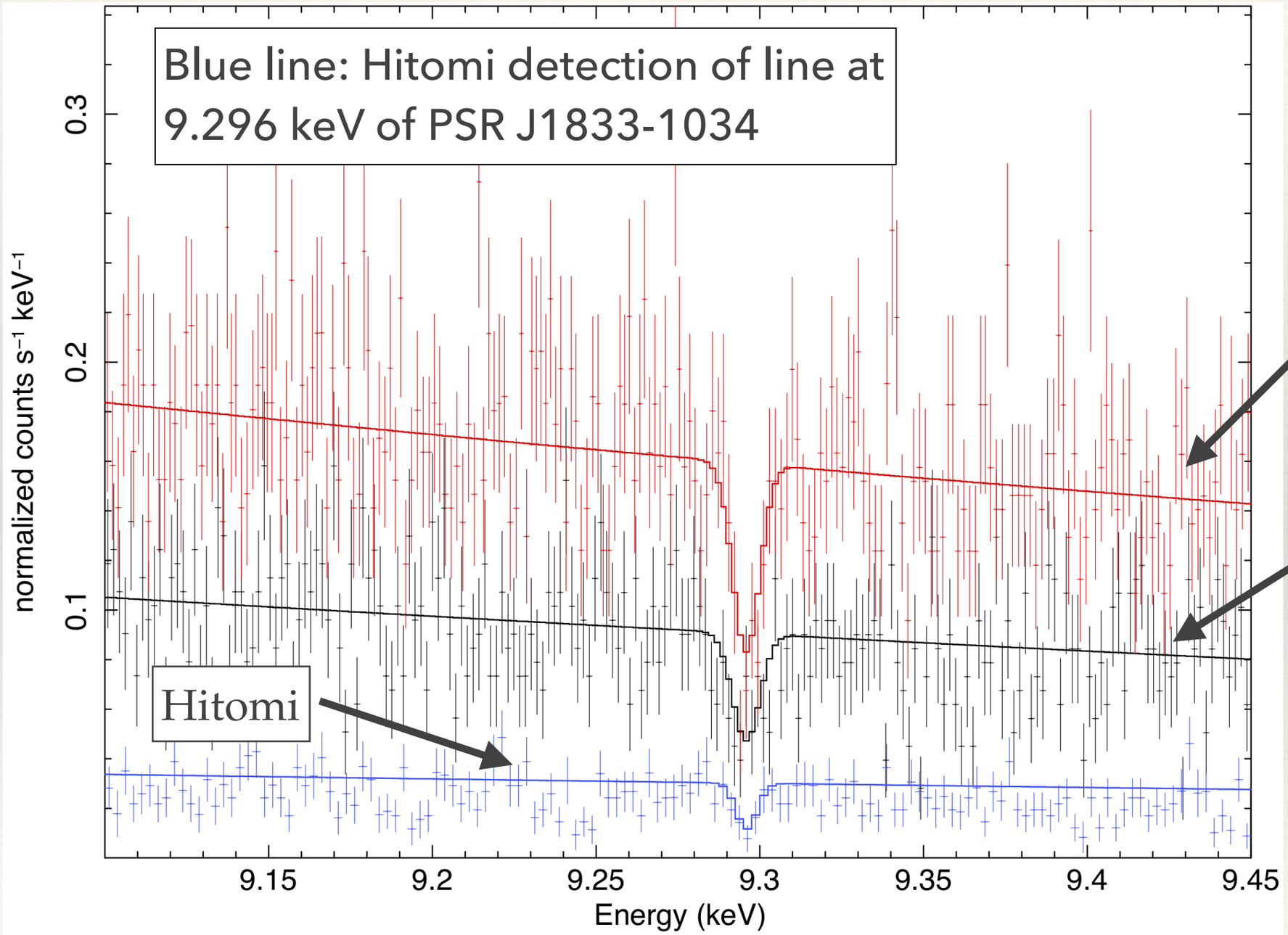
- Reverberation mapping: Test GR, measure BH Mass
- Quasi Periodic Oscillations
- Warm/Hot Intergalactic Medium
- High Velocity Hot Outflows

See WP 036 for more details, Talk by Ilaria Caiazzo at UBC Town Hall (Nov 26)

Neutron Stars

- Lines/Spectroscopy: Isolated and Accreting
- Magnetar Spectral Lines
- Accretion Disk Winds
- Quasi Periodic Oscillations
- Thermonuclear bursts
- Mass & Radius of Neutron Stars

Spectral Features: PSR J1833-1034



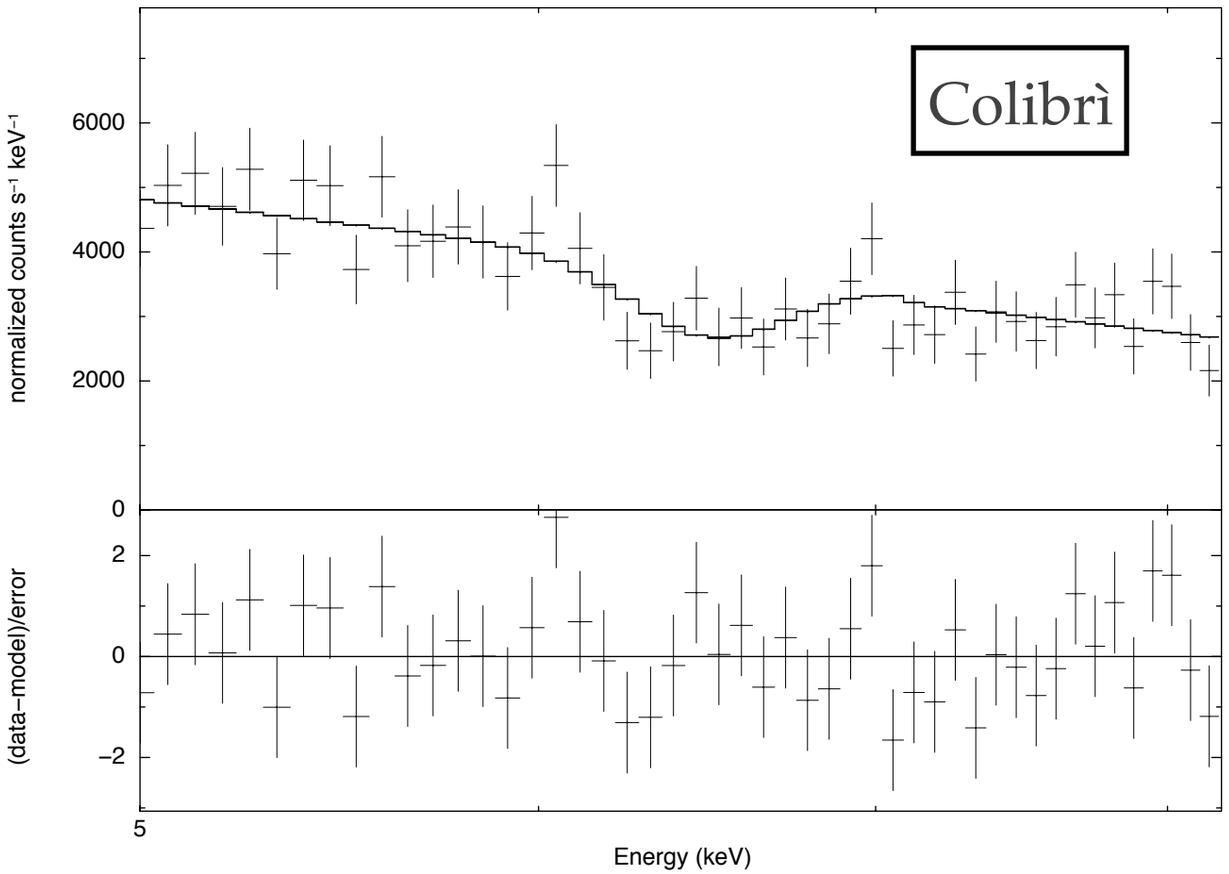
Key mission specs:
High-Spectral Resolution
High Throughput
High-Time Resolution

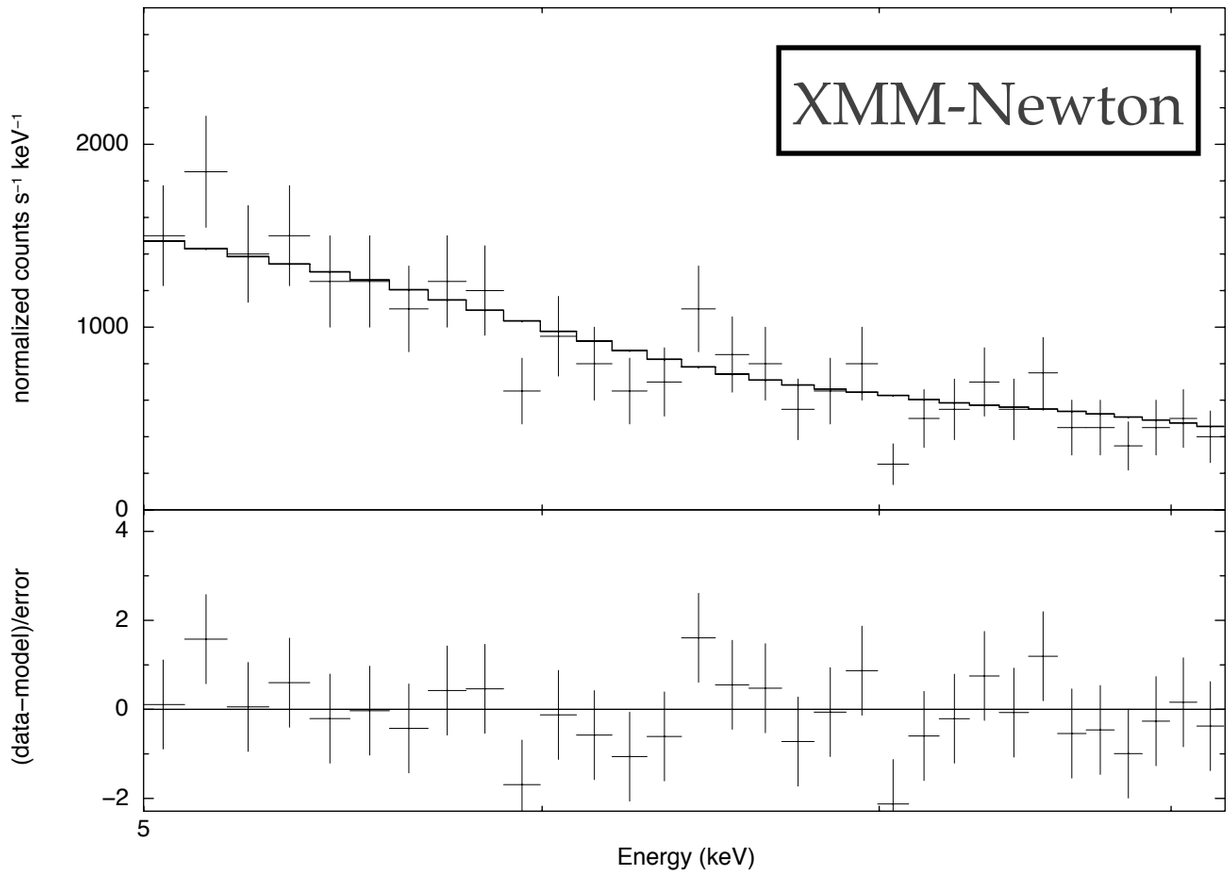
Colibrì Double f/10

Colibrì Single f/10

Simulations by Benson Guest, PhD Student at U Manitoba

Magnetar Outbursts: SGR 1900+14

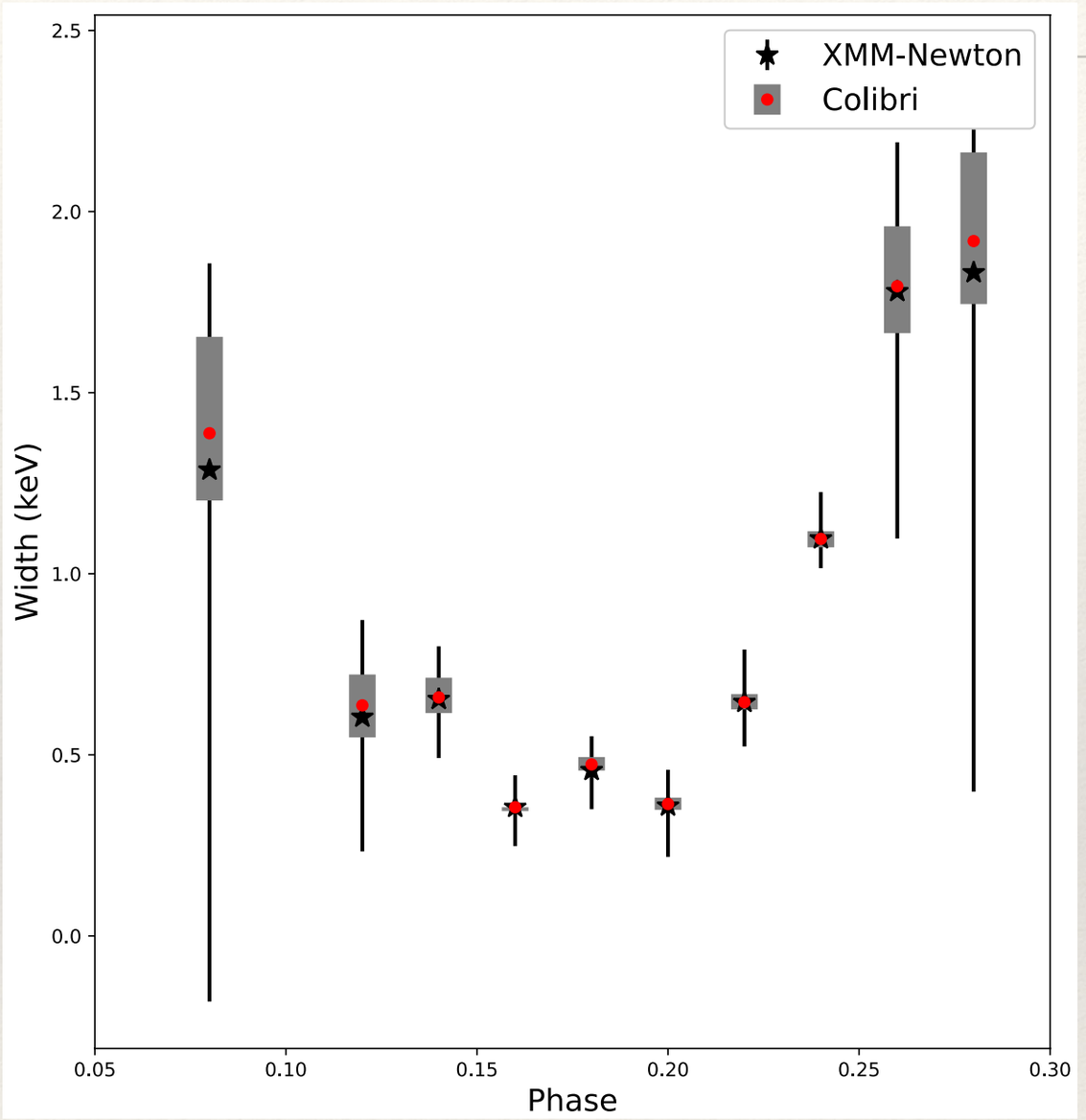


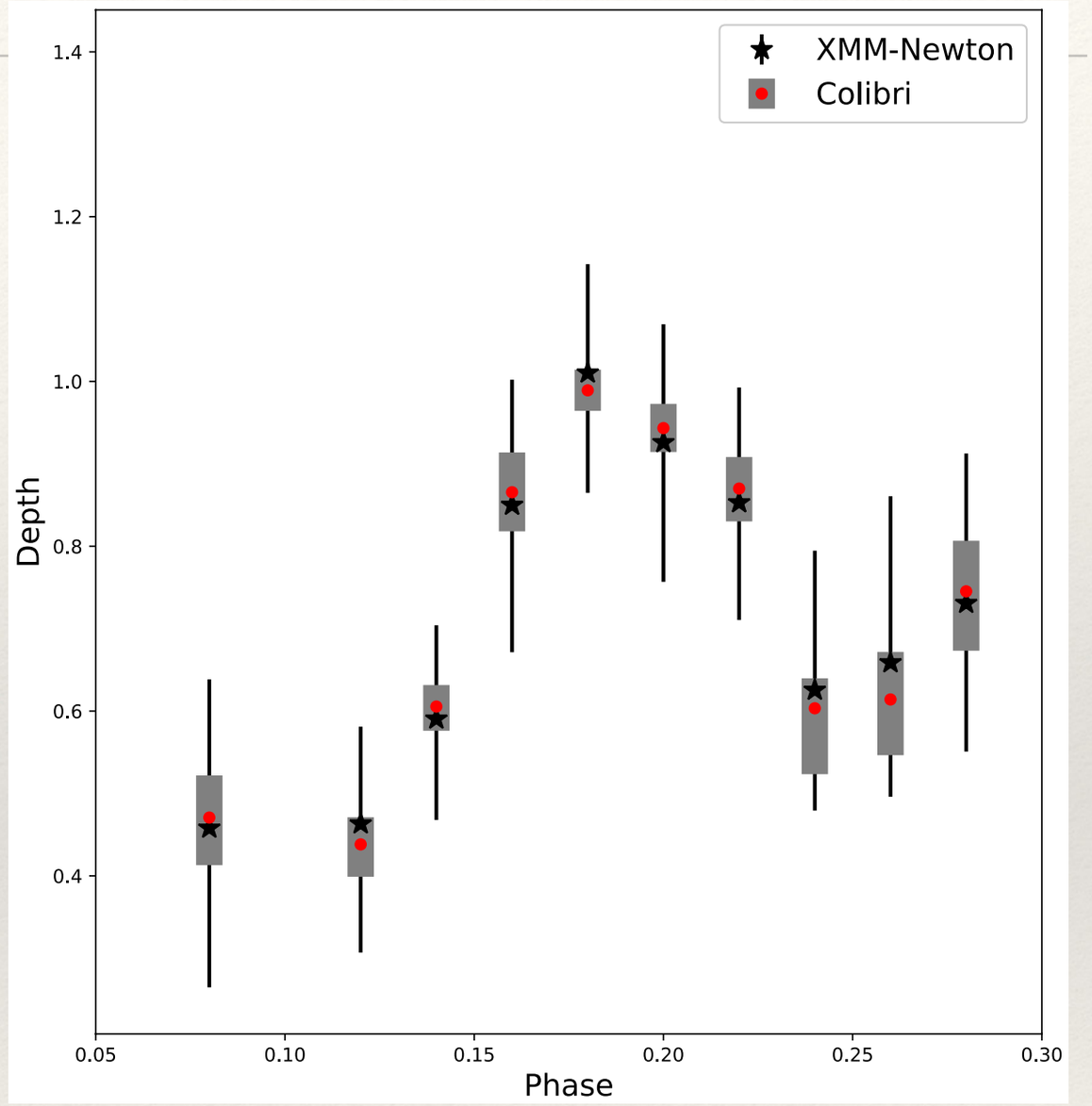


Key mission specs:
High-Spectral Resolution
High-Throughput
No pile up issue for bright bursts

Simulations by Demet Kirmizibayrak, PhD Student at UBC

SGR 0418+5729 Phase Resolved Spectroscopy





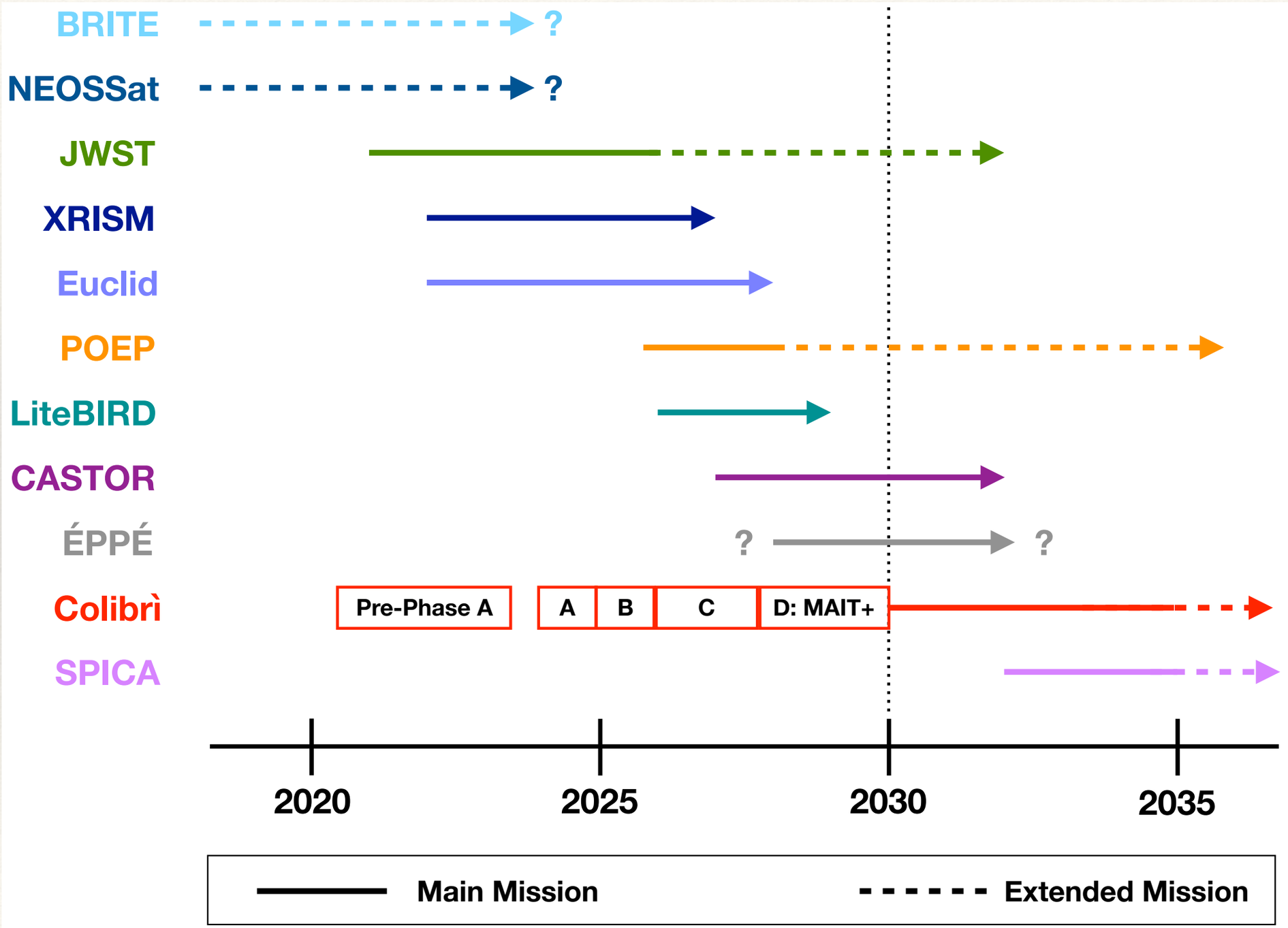
<u>Key mission specs:</u>
High-Time Resolution
High-Spectral Resolution

Simulations by Demet Kirmizibayrak, PhD Student at UBC

Colibrì: Training and Retention

- HQP Training:
  - Student involvement has already been instrumental for the progress of the study
    - Preparation of the next generation of leaders
- HQP Retention:
  - Science office staff positions (R6 of WP: 64)
- Continued mission development also supports the Space Sector

Colibrì and the Canadian Landscape



Colibrì: Next Steps

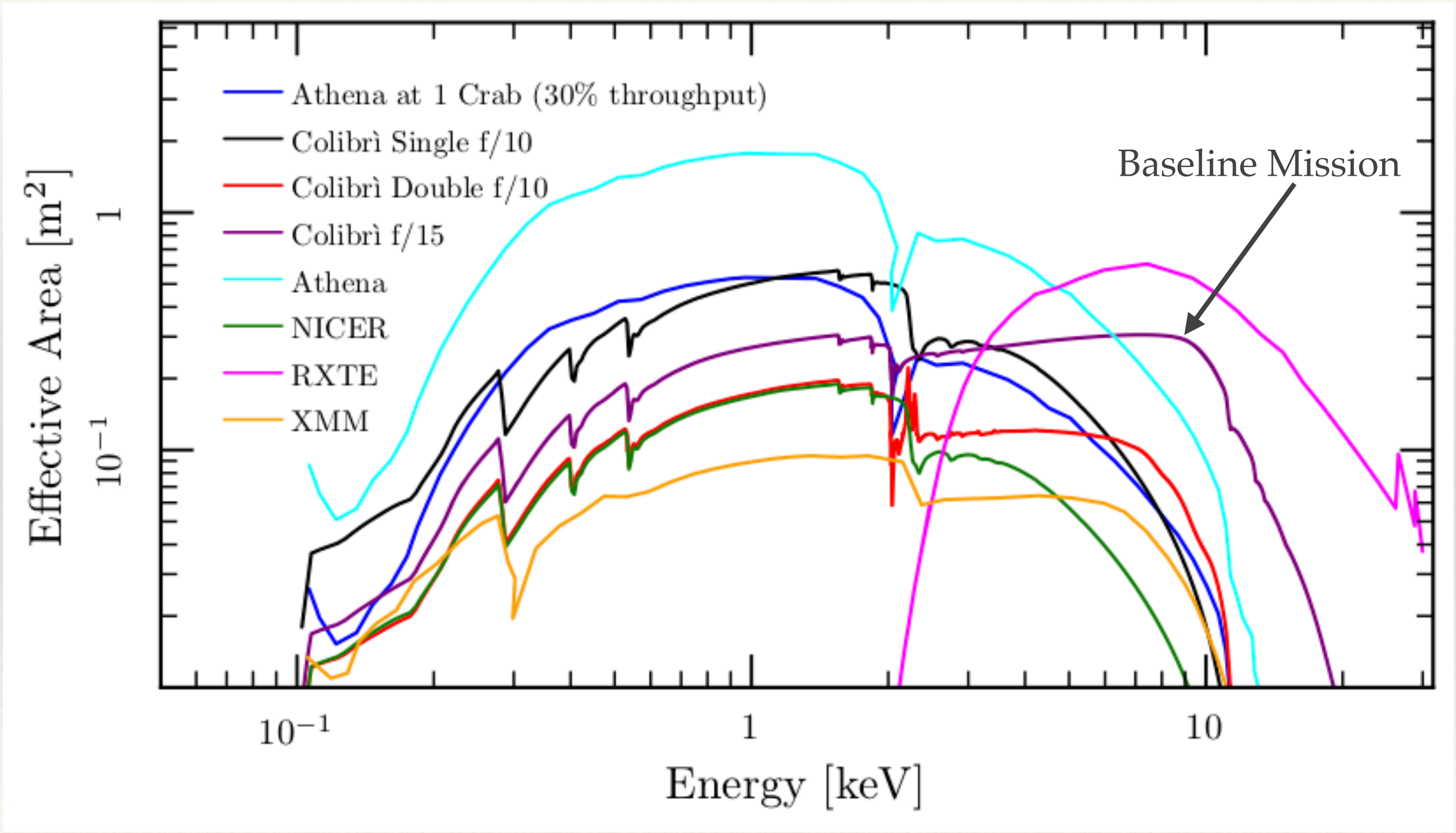
- FAST — Recently submitted, will increase SRL
- SMS — Validate Science requirements, increase SRL
  - Develop secondary science goals
- STDP — Increase TRL of Canadian made TES detectors

The Colibrì Mission

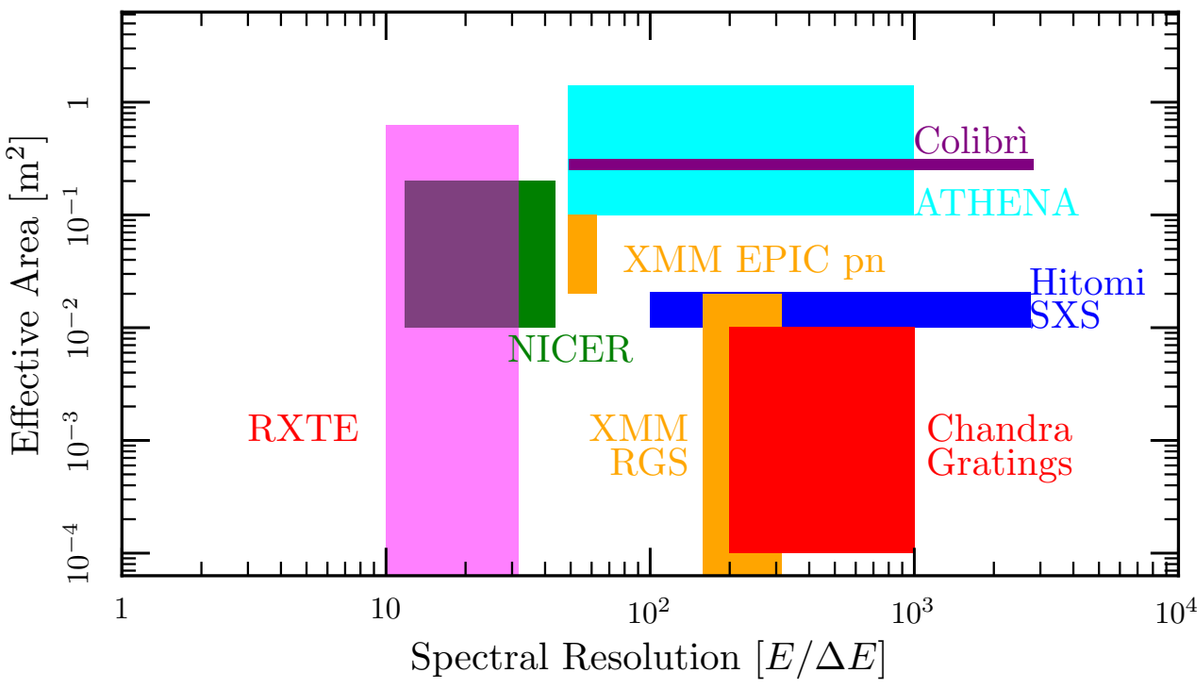
- Canada's First Flagship X-ray telescope
- Builds on CSA's investment in Hitomi and XRISM
- Study the laws of the Physics of the Extreme
- Combination of high-time resolution, high-spectral resolution and high throughput
- Development of TES detectors in Canada
- Opportunities for HQP training throughout development and mission operations
- Job Creation: Through HQP retention via science office, grow the detector industry in Canada, support Canadian space sector — Build a robust and experienced workforce in the Space Sciences
- In order to continue the development through 2020-2030, build capacity through a space program and support in the LRP report is required

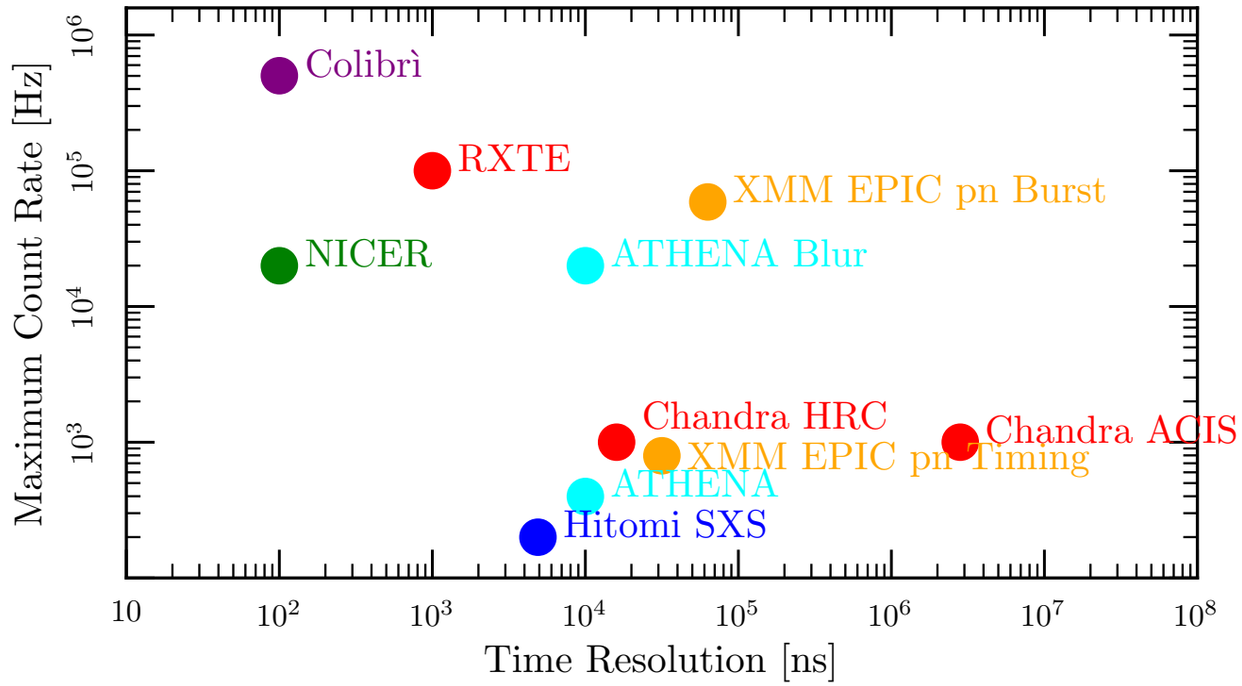
Back up slides

Colibrì Effective Collecting Area



Comparison to other X-ray Missions





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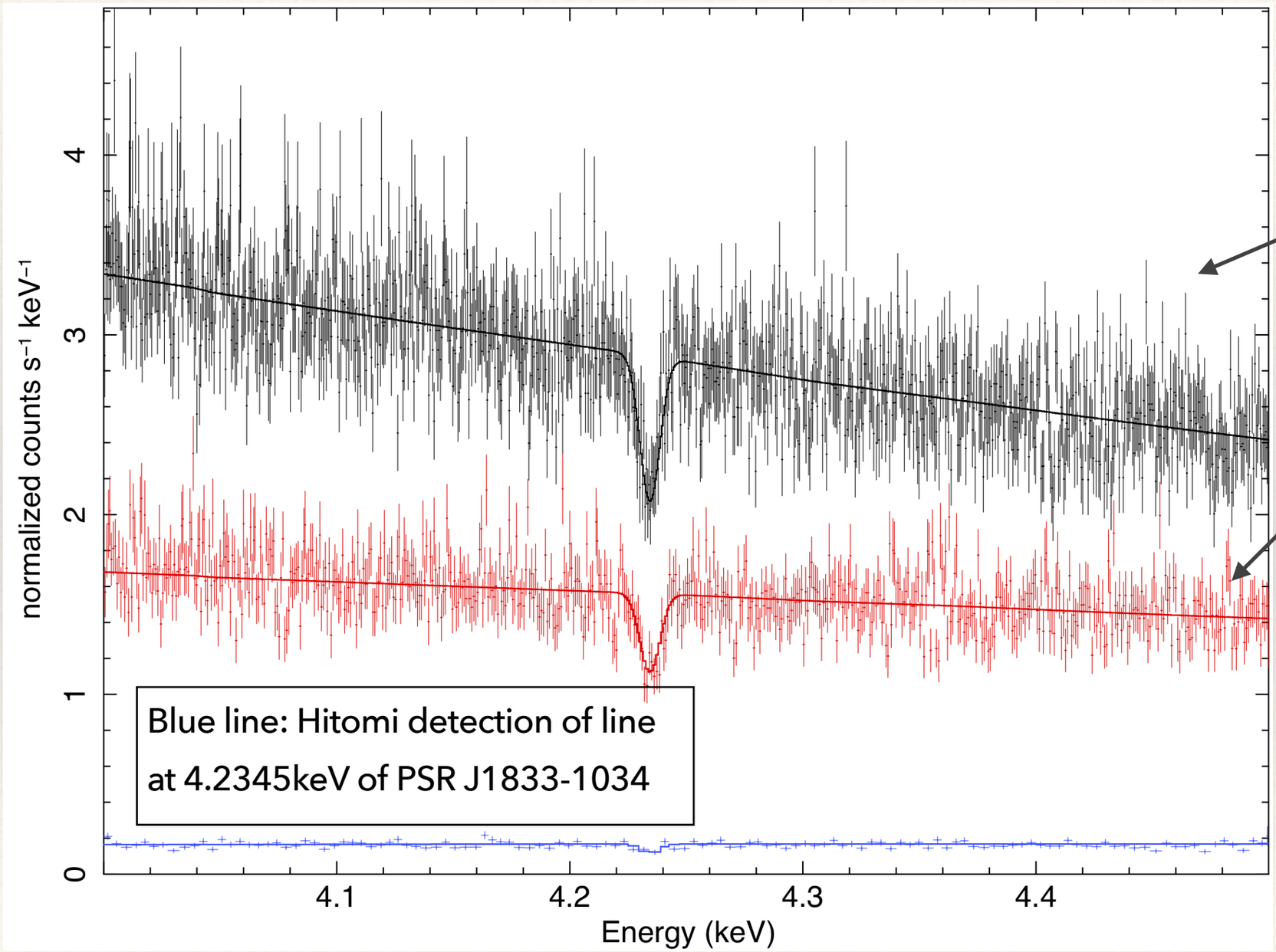

Colibrì Single f/10

Colibrì Double f/10

Calculations by Benson Guest, Phd Student at U Manitoba