IACHEC
Contamination WG
Summary

Eric D. Miller (MIT)

IACHEC 2014
Membership

Eric Miller (chair, Suzaku, Astro-H)
Andy Beardmore (Swift)
Vadim Burwitz (eROSITA)
Larry David (Chandra)
Tadayasu Dotani (Astro-H)
Megan Eckart (Astro-H SXS)
Michael Freyberg (eROSITA)
Terry Gaetz (Chandra)
Catherine Grant (Chandra)
Kenji Hamaguchi (Suzaku)

Maurice Leutenegger (Astro-H SXS)
Herman Marshall (Chandra)
Steve O'Dell (Chandra)
Paul Pluncinsky (Chandra)
Steve Sembay (XMM-Newton EPIC)
Doug Swartz (Chandra)
Masahiro Tsujimoto (Suzaku, Astro-H)
Cor de Vries (XMM-Newton RGS)
Qazuya Wada (Suzaku)

12 out of 19 members present
Topics

• comparison among instruments and missions
  • chemical composition
  • time dependence
  • spatial dependence (micron to cm scales)
  • temperature dependence (where is the coldest surface?)
  • environmental dependence (orbit)
• mitigation for current instruments
  • celestial monitoring targets
  • effects on calibration and science results
  • "bake-out" procedures
• mitigation for future instruments
  • design (cold traps, contamination blocking filters)
  • procurement
  • ground procedures
  • ground testing and calibration
  • on-orbit monitoring
Contamination WG Telecon 2014-03-31

- Agenda
  - short (5 minute) summaries from participants about:
    - contamination status of current instruments
      - Steve O. – Chandra ACIS
      - Herman – Chandra ACIS
      - Steve S. – XMM EPIC-MOS and pn
      - Eric – Suzaku XIS
      - Andy – Swift XRT
      - anyone else?
  - plans for future instruments
    - Michael – eROSITA
    - Astro-H?
    - anyone else?
  - discussion about how to structure the 2 x 1.75 hour WG sessions at upcoming IACHEC, which could include:
    - several longer (20 min) presentations for current and future instruments
    - more from Steve S. about combining contamination and response calibration
    - best methods to monitor time, spatial, chemical variations
    - best references for absorption data
    - hands-on cross-calibration? (e.g. real time spectral fitting)
Monday, 12 May, afternoon session

14:00-15:45: Contamination WG: *Foxes Den*

- H. Marshall, "Chandra ACIS contamination monitoring"
- D. Swartz, "Simulations of Chandra ACIS contamination migration"
- S. Sembay, "Contamination on the EPIC-MOS detectors"
- E. Miller, "Contamination on the Suzaku XIS"
- A. Beardmore, "Constraints on contamination on the Swift XRT"

Tuesday, 13 May, afternoon session

16:15-18:00: Contamination WG *Foxes Den Room*

- M. Leutenegger, "Contamination mitigation on the Astro-H SXS"
- V. Burwitz, "Contamination mitigation on eROSITA"
Contaminant Summary

- It’s still growing: Why? Filter is colder? S/C hotter?
- Spatial variations are time-dependent
  - CCD/housing temperature difference?
  - N and O don’t match C and F
  - S3 matches S2 mostly
- Composition is time-dependent
  - Two components implicated, one is C-rich
  - ECS-LETGS disagreement unresolved
- Origin is unknown — not in original form
  - No on-board substance has contaminant’s CFO ratios
  - Radiation-induced organic fracturing?
Chandra Contaminant Migration Model
Results

Mass Column of Octadecane ($C_{18}H_{38}$) at $t=9$ years

low volatility (0.10)
“deposition” dominated: central regions have highest accumulation because center views more nearby cold surfaces, pattern is asymmetric

high volatility (2.50)
“thermal” (vaporization) dominated: warm central regions begin to clean, pattern follows local temperature distribution with more material near cold edges

Thursday, May 8, 2014
MOS2 is ~ 20% of RGS
Recalculation of contaminant with sas13.5.0 rmf: plus latest observation
Suzaku XIS Summary

• contamination level increased quickly (XIS after 3 months ~ ACIS after 6 years) now decreasing at 10% per year

• C:N:O changes with time started out C:O ~ 6 ~ DEHP, but not now

• decrease below C-edge: H? He? something else?

• $A_{\text{eff}} (E > 0.7 \text{ keV})$ is good to ~5%
  $A_{\text{eff}} (E < 0.7 \text{ keV})$ is (not) good to 10-50%, especially near edges
Pre-launch vibration testing caused a small patch of ‘debris’ to appear on CCD – e.g. visible in Tycho trap-mapping observations

- $\sim 12 \times 5$ pixels or $\sim 28 \times 12$ microns in size
- WT g0 spectra

- Unresolved questions — can observed effects be caused by
  - slight gain variations
  - position of remnant w.r.t. bad-columns
Baseline plan is to operate DMS heater continuously to prevent sticking of contaminants.
Contamination Monitoring

• Most likely contaminants are hydrocarbons from spacecraft
• Best targets for monitoring would have stable flux of C, N, O K shell lines, fill SXS field of view, provide ~ few counts/s/pixel – Galactic SNR?
eROSITA contamination mitigation in Orbit by design

Position of filter +20°C

Separation Filter - CCD ~50mm

Position of CCD -93°C decoupled from graded shield

IACHEC #9, May 13, 2014, Airlie Center, Warrenton, Virginia, USA
Cleanliness control for eROSITA

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Summary eROSITA contamination mitigation on ground

• Goal:
  – To avoid contamination building up on CCD in orbit

• Detailed Documentation available:
  – for contamination mitigation
  – planning clean hardware activities

• Continuous:
  – Documentation of all activities needed
  – particle and molecular contamination monitoring

• Important: Outgassing / Baking ...
  ... of all components 110hrs at 60°C
Contamination WG Plan (1/3)

• standardize how we tabulate contamination
  • C,N,O,F, etc. in column density units ($10^{18}$ cm$^{-2}$)
    • useful for composition modeling
  • optical depth $\tau$ at some energy
    • C, O edges are useful for comparison
    • OVIII and other bright lines are practical
    • $\sim$ contamination model independent
    • $\tau$ converts directly into $A_{\text{eff}}$, useful for observers
Contamination WG Plan (2/3)

- A/I for all instruments (due 31 July 2014)
  - estimates of C,N,O,F, etc. columns (multiple epochs are fine)
  - estimates of $\tau$ @ C edge, O edge, 1 keV

- ACIS: Herman Marshall
- XMM EPIC MOS: Steve Sembay
- XMM EPIC pn: Steve Sembay
- XMM RGS: Michael Smith
- Suzaku XIS: Eric Miller
- Swift XRT: Andy Beardmore
Contamination WG Plan (3/3)

• legacy/heritage WG white paper
• lessons learned for design and ground mitigation cf. eROSITA
• lessons learned for first light targets, “zero-contamination” baseline
• targets and observing strategies to detect and monitor contamination
• primary role of this working group!