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

Edit Share

4 Added by Eric D Miller, last edited by Eric D Miller on Apr 01, 2014 13:50 (view change)

- **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"

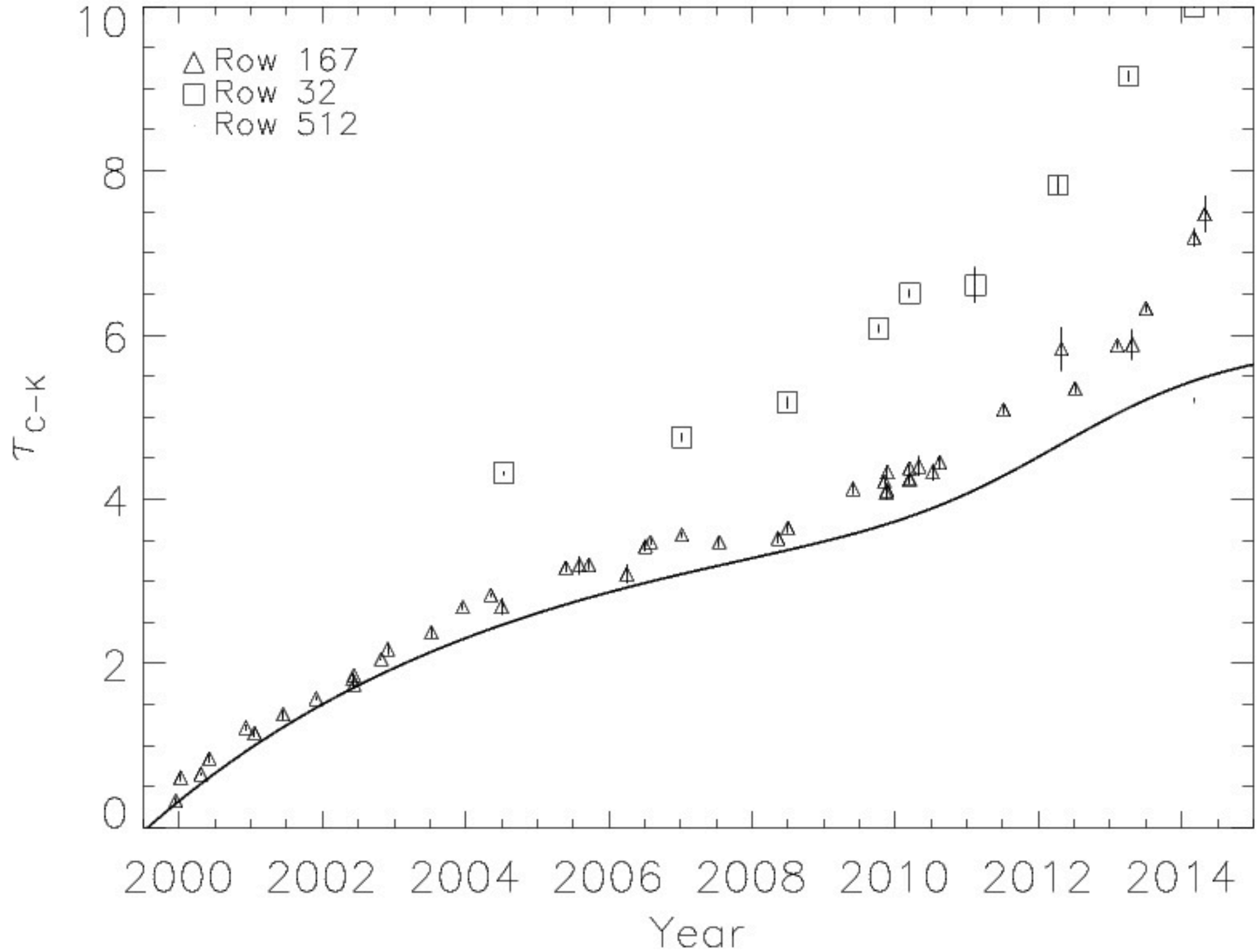
Tuesday, 13 May, afternoon session

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

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

Herman

LETG/ACIS Fit Results



Herman

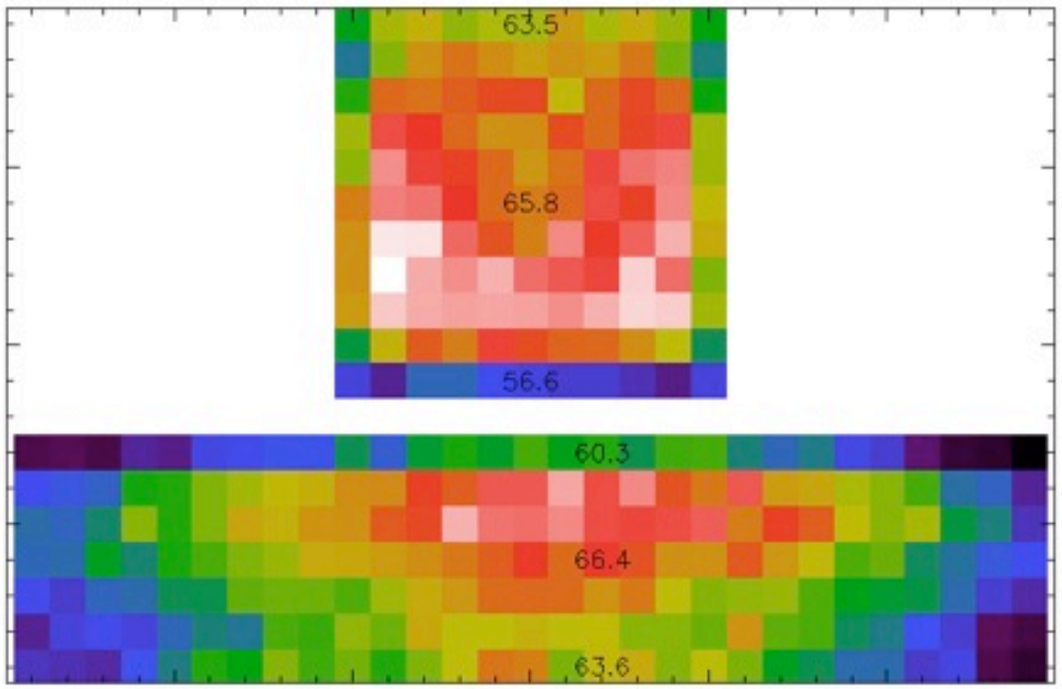
Chandra ACIS Contaminant Summary

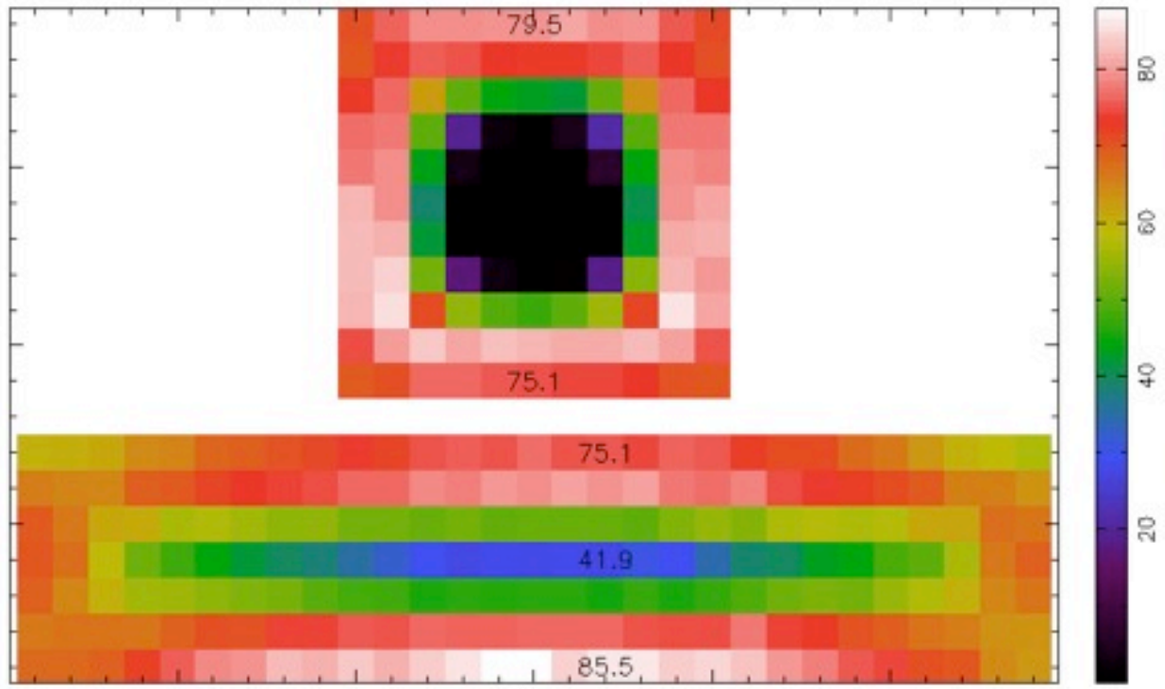
- It's still growing: Why? Filter is colder? S/C hotter?
- Spatial variations are time-dependent
  - CCD/housing temperature difference?
  - N and O don't match C and F
  - S3 matches S2 mostly
- Composition is time-dependent
  - Two components implicated, one is C-rich
  - ECS-LETGS disagreement unresolved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

Doug

Chandra Contaminant Migration Model Results

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





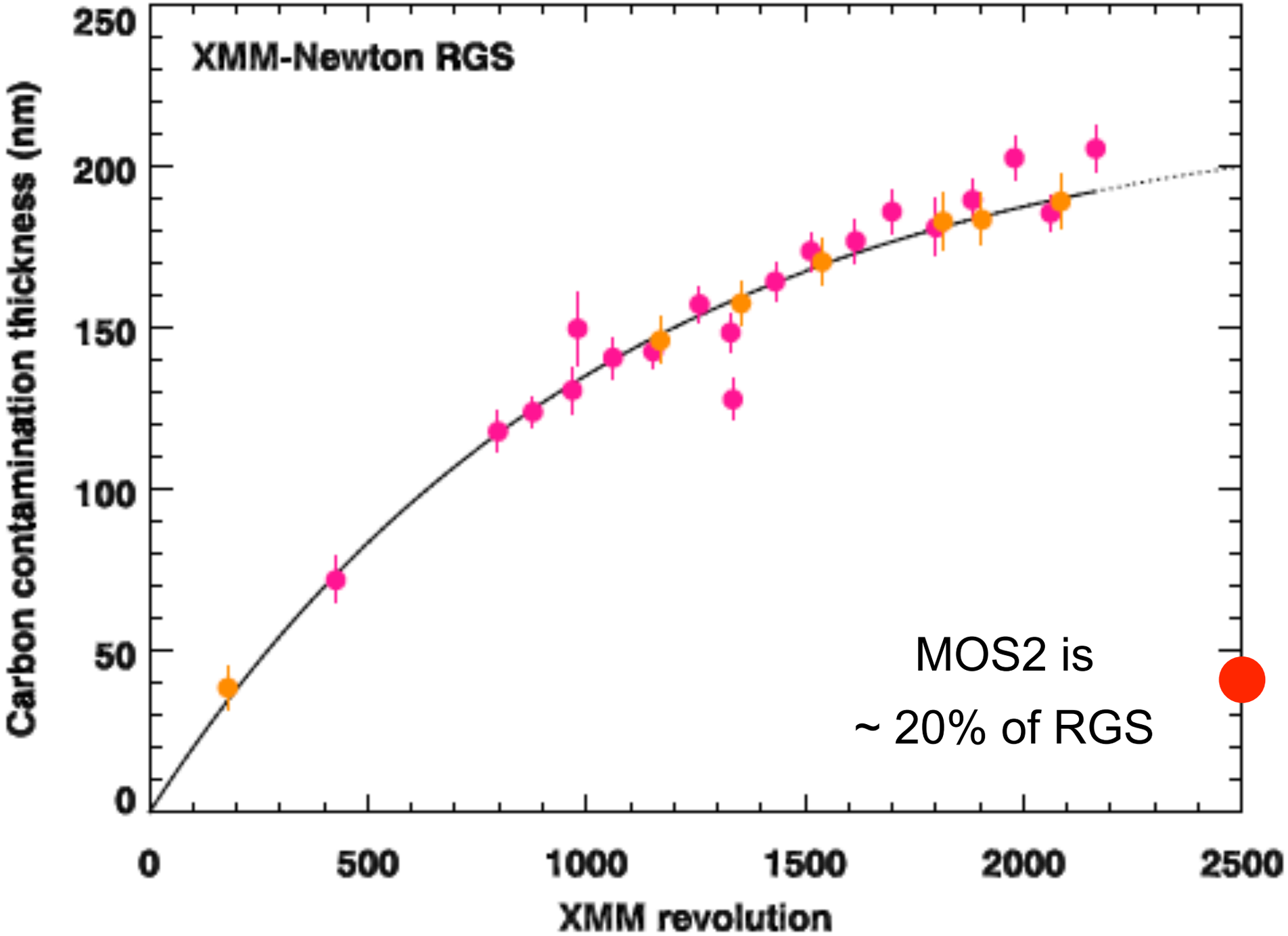
low volatility (0.10)

"deposition" dominated: central regions have highest accumulation because center views more nearby cold surfaces, pattern is asymmetric

high volatility (2.50)

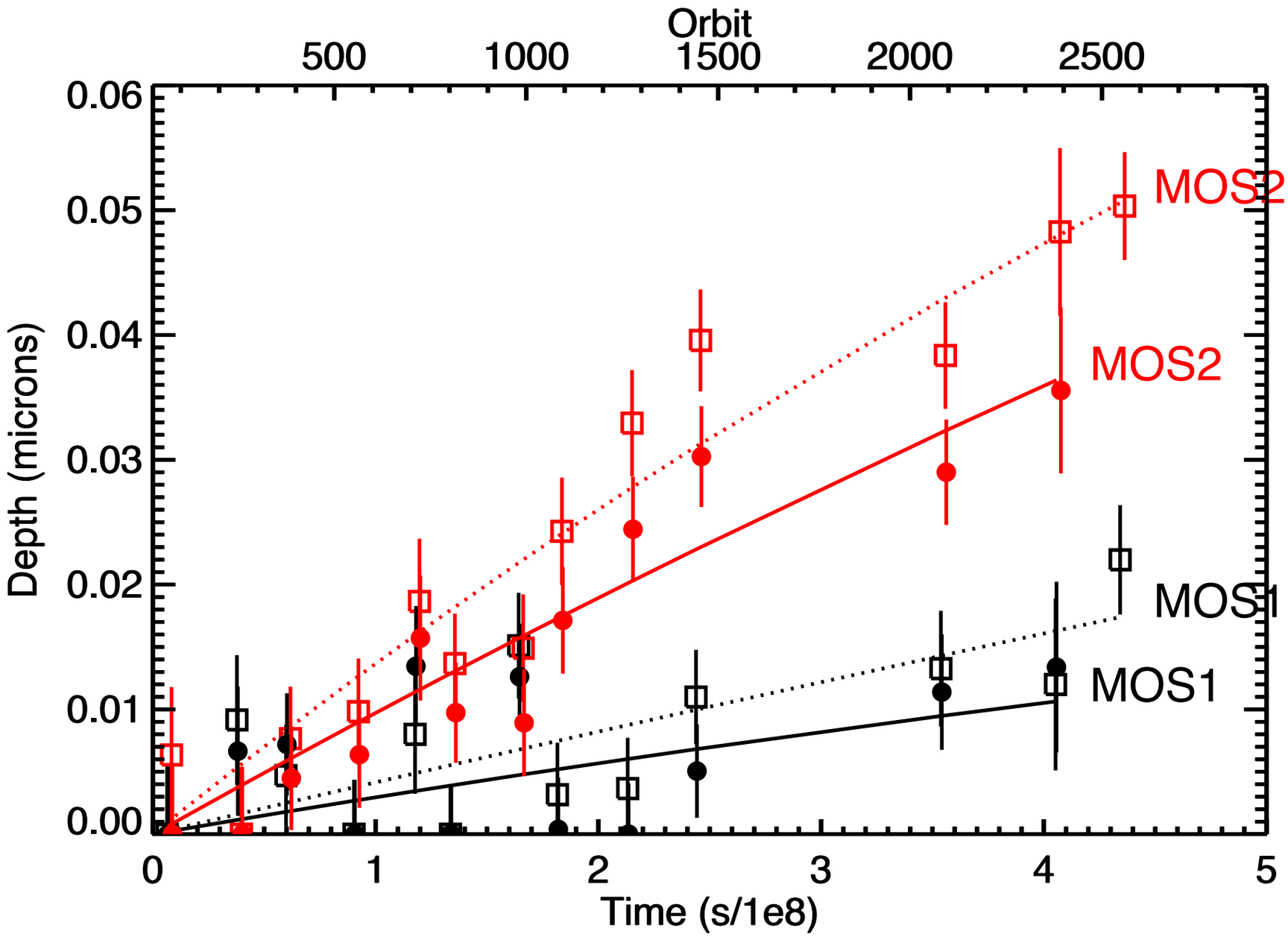
"thermal" (vaporization) dominated: warm central regions begin to clean, pattern follows local temperature distribution with more material near cold edges

Steve Sembay



Steve Sembay

Recalculation of contaminant with sas13.5.0 rmf: plus latest observation

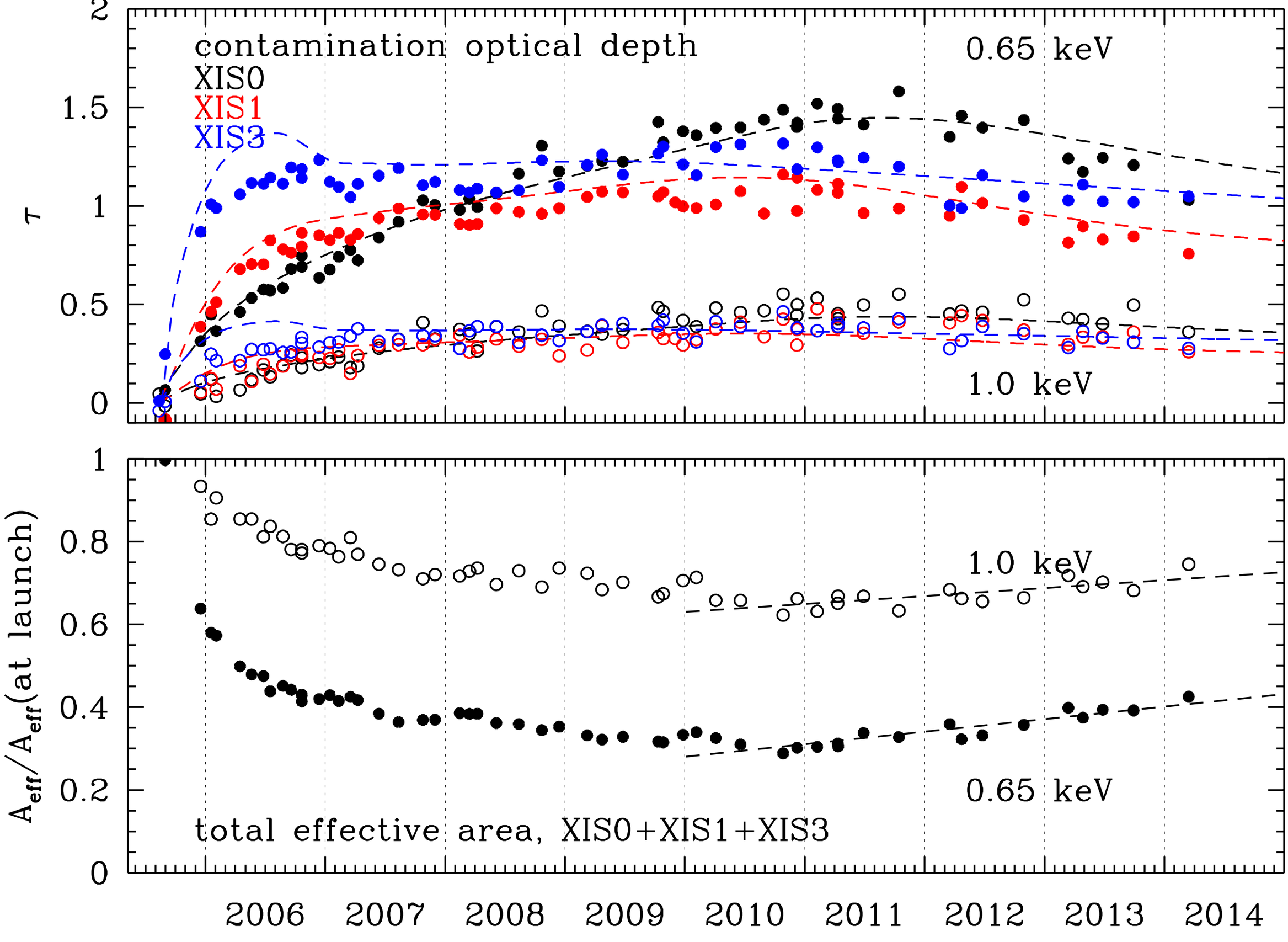


XMM
EPIC
MOS

Steve Sembay (sfs5@le.ac.uk)
IACHEC 12/05/2014

University of Leicester

Eric


contamination optical depth
XIS0
XIS1
XIS3
0.65 keV
1.0 keV
τ
2
1.5
1
0.5
0
total effective area, XIS0+XIS1+XIS3
1.0 keV
0.65 keV
A_{eff}/A_{eff}(at launch)
1
0.8
0.6
0.4
0.2
0
2006
2007
2008
2009
2010
2011
2012
2013
2014

Eric

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

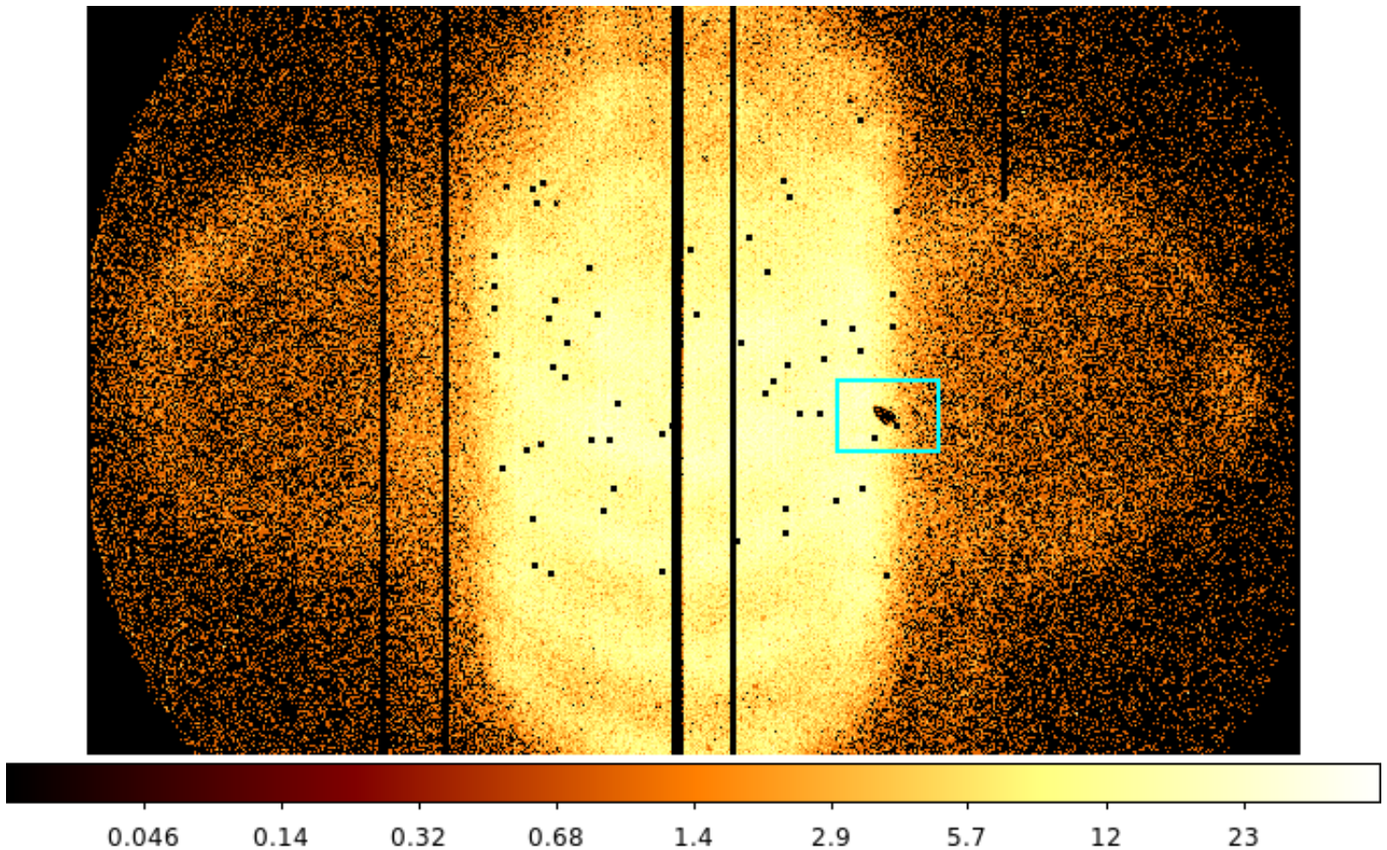
- decrease below C-edge: H? He? something else?

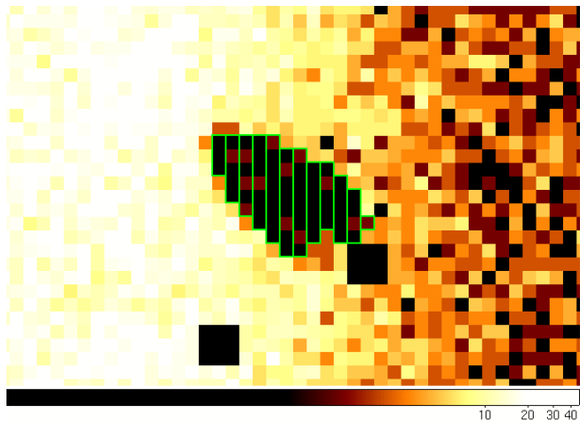
- A_{eff} (E > 0.7 keV) is good to ~5%
  A_{eff} (E < 0.7 keV) is (not) good to 10-50%,
  especially near edges

The ‘Debris’

Andy B.

- 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

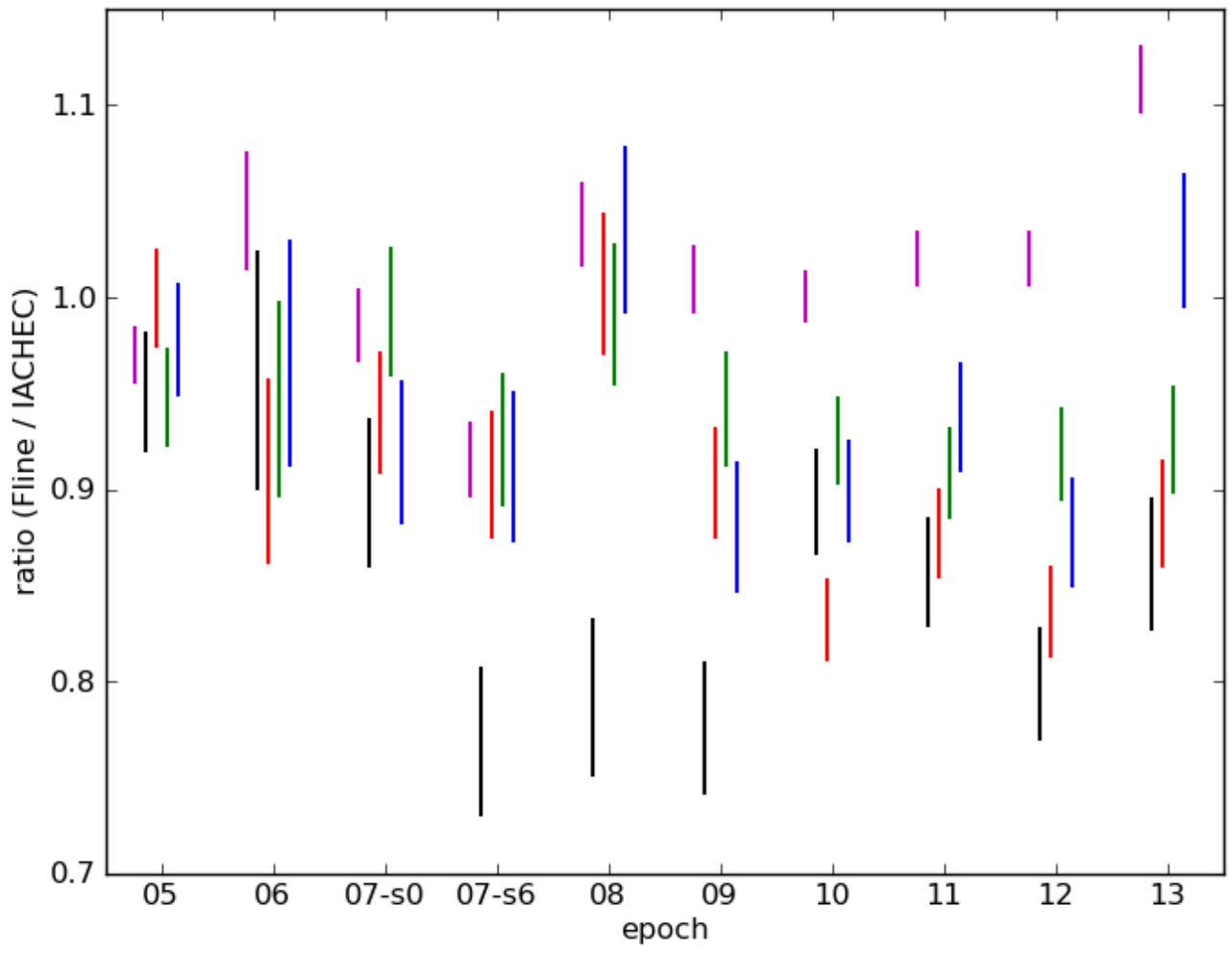




E0102 - line norms evolution

Andy B.

- WT g0 spectra



- Unresolved questions — can observed effects be caused by
  - slight gain variations
  - position of remnant w.r.t. bad-columns

Aperture assembly structure

Baseline plan is to operate DMS heater continuously to prevent sticking of contaminants

Dewar Main Shell **(DMS)**
Temp: 290K

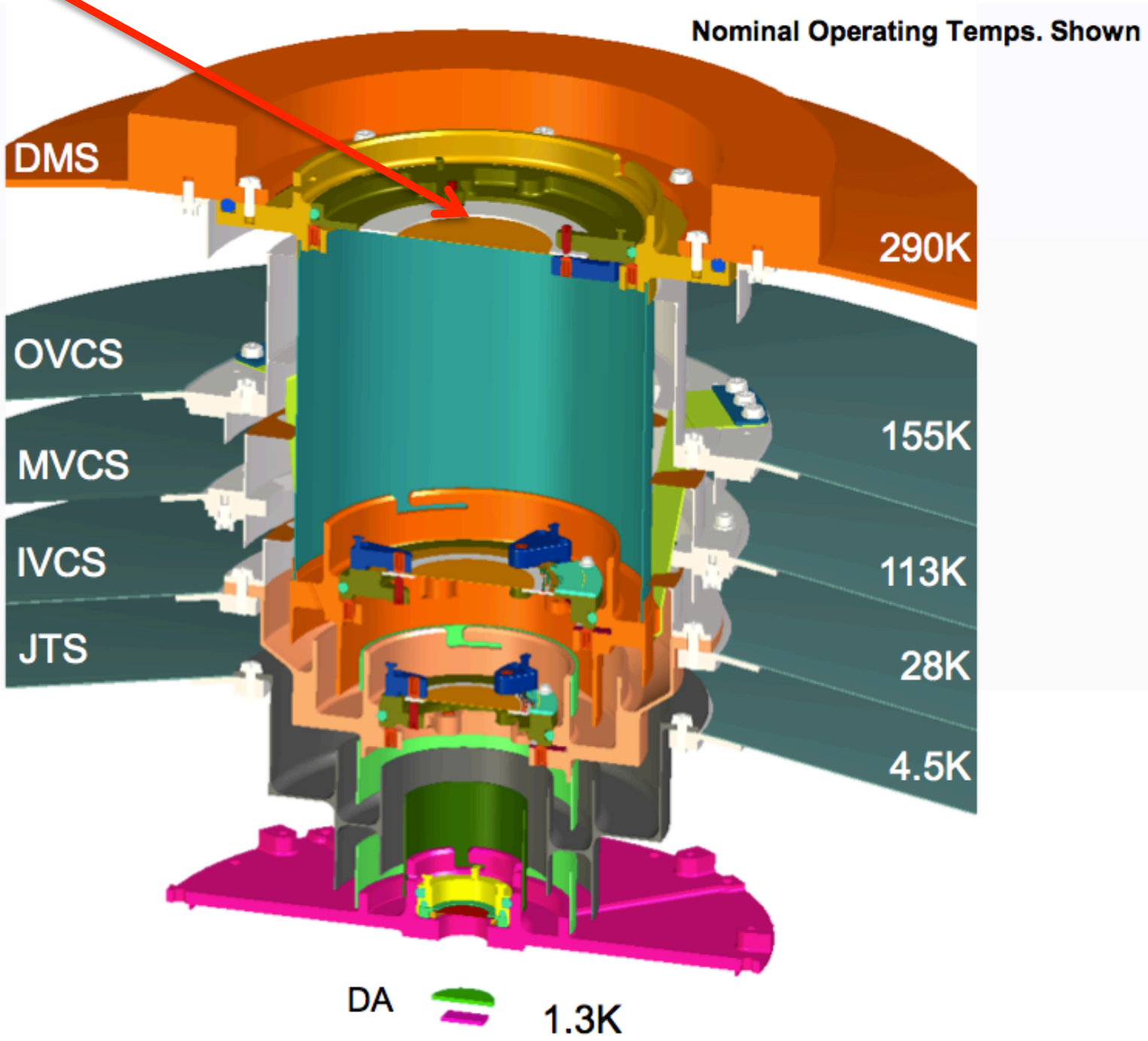
Outer Vapor Cooled Shield **(OVCS)**
Temp: 155K
(80K During Helium Servicing)

* Middle Vapor Cooled Shield (MVCS)
Temp: 113K

Inner Vapor Cooled Shield **(IVCS)**
A Temp: 28K

Joule-Thomson Shield **(JTS)**
Temp 4.5K

Detector Assembly **(DA)**
Temp: 1.3 K



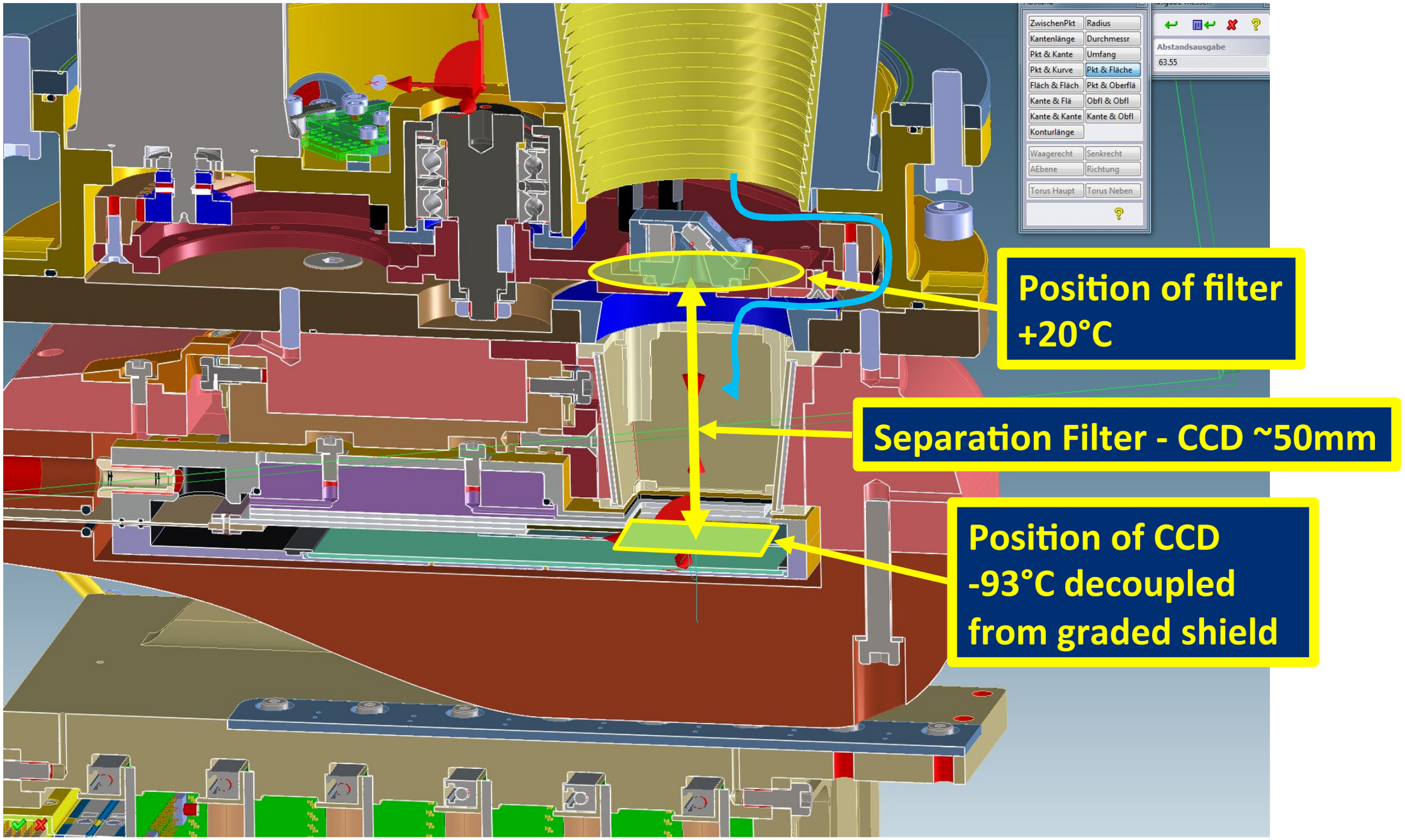
Maurice

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?

Maurice

eROSITA contamination mitigation in Orbit by design



Cleanliness control for eROSITA

MPE	**EROSITA** **VORSCHRIFTEN ZUM REINIGEN, INTEGRIEREN, VERPACKEN, LAGERUNG UND TRANSPORT**	REF. : ERO-MPE-PR-12-10_07 DATE : 2012-03-19 PAGE : 2

CONTENTS

1. ÜBERBLICK 3

2. REFERENCES 4

2.1. APPLICABLE DOCUMENTS 4
2.2. REFERENCE DOCUMENTS 4
2.3. ACRONYMS 4

3. EINLEITUNG 5

3.1. VORAUSSETZUNGEN 5
3.2. ANFORDERUNGEN AN DIE SAUBERKEIT 5
3.3. ANWENDUNG 6
3.4. KONZEPT FÜR DIE REINIGUNG 6
3.5. VISUELLE INSPEKTION DER SAUBERKEIT DER OBERFLÄCHEN 6
3.6. KONTAMINATIONSKONTROLLE WÄHREND DER VERSCHIEDENEN ARBEITSVORGÄNGE 7
3.7. REINRAUMBEKLEIDUNG 7

4. BESCHREIBUNG DER REINIGUNGSVERFAHREN 9

4.1. ÜBERSICHT ÜBER DIE VERSCHIEDENEN REINIGUNGSVERFAHREN 9
4.2. REINIGUNGSVORSCHRIFT A 10
4.3. REINIGUNGSVORSCHRIFT B 11
4.4. REINIGUNGSVORSCHRIFT A* 12
4.5. REINIGUNGSVORSCHRIFT C 14
4.6. REINIGUNGSVORSCHRIFT D 14
4.7. REINIGUNGS- UND INTEGRATIONSVORSCHRIFT FÜR PLATINEN E 15
4.8. REINIGUNGSVORSCHRIFT F 18
4.9. REINIGUNGSVORSCHRIFT A** 19
4.10. REINIGUNGSVORSCHRIFT D** 21
4.11. REINIGUNGSVORSCHRIFT G 21

5. LAGERUNG, VERPACKUNG UND TRANSPORT 23

6. ANNEX 25

6.1. REINIGUNG DES RÖNTGENBAFFLE 25
6.2. REINIGUNGSVORSCHRIFTEN FÜR DEN REINIGUNGSAUTOMATEN IR 6001 MIELE 25
6.3. EMPFOHLENE WISCHTÜCHER 26

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 τ at some energy
    - C, O edges are useful for comparison
    - OVIII and other bright lines are practical
    - ~ contamination model independent
    - τ converts directly into Aeff, 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 τ @ 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!