Overall Status of the ACIS Low-Energy Contamination and Future Plans

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Contributors to the Analysis Effort

There is a large group working on these issues. Those contributing directly to the presentation and SPIE papers:

Norbert S. Schulz, Herman L. Marshall, Catherine E. Grant,

George Chartas, Divas Sanwal, Marcus A. Teter

Alexey A. Vikhlinin, Richard J. Edgar, Michael W. Wise,

Glenn E. Allen, Shanil N. Virani, Joseph M. DePasquale,

Michael T. Raley, Allyn Tennant, Steve O'Dell, Ron Elsner

Many others have contributed directly or indirectly:

ACIS MIT and PSU instrument teams, MSFC Project Science, CXC

See astro-ph/0209161 for SPIE paper, new SPIE paper by Marshall this summer

Update on the Decrease in the Low Energy Efficiency

- **The decrease in the low-energy QE is continuing**
- **Grant's analysis of the external cal source argues for a decrease in the accumulation rate of the contaminant; Marshall's analysis of the C-K edge argues for a constant accumulation rate**
- **Marshall's analysis indicates a thickness of** $\approx 50\ \mu\mathrm{gm\ cm}^{-2}$
- **Vikhilin's analysis demonstrates that the layer is not constant over the I and S arrays; perhaps this can still resolve the apparent discrepancy in the accumulation rate.**
- **The chemical composition of the contaminants is better determined, strong C edge, weak O edge, weak F, only upper limits on N .**

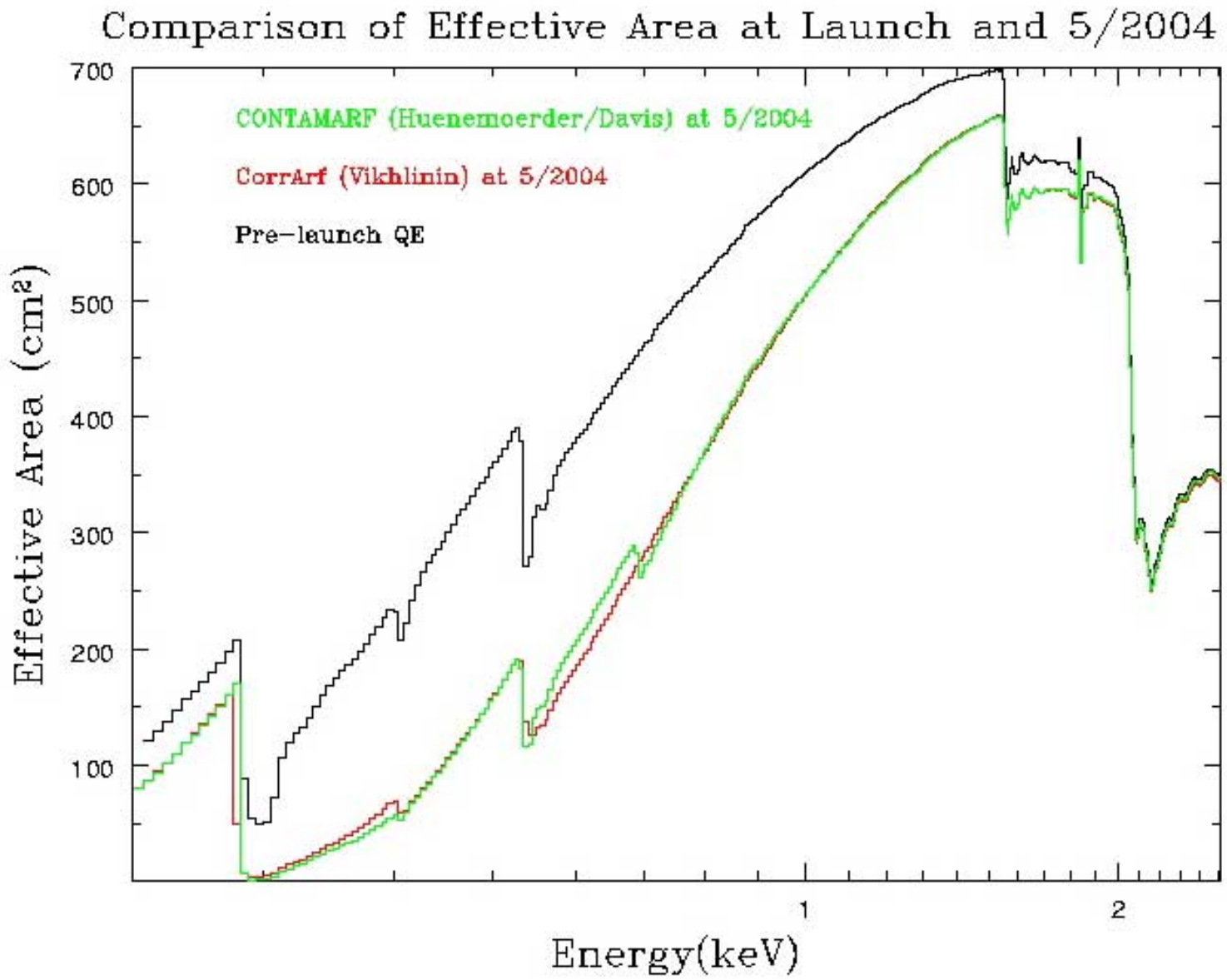
Update on the Evolution of the SW Tools

- **Three SW tools have been developed to correct the effective area for this time-dependent absorption**
- **earlier tools use H:C:N:O == 20:10:1:2 and linear growth in time**

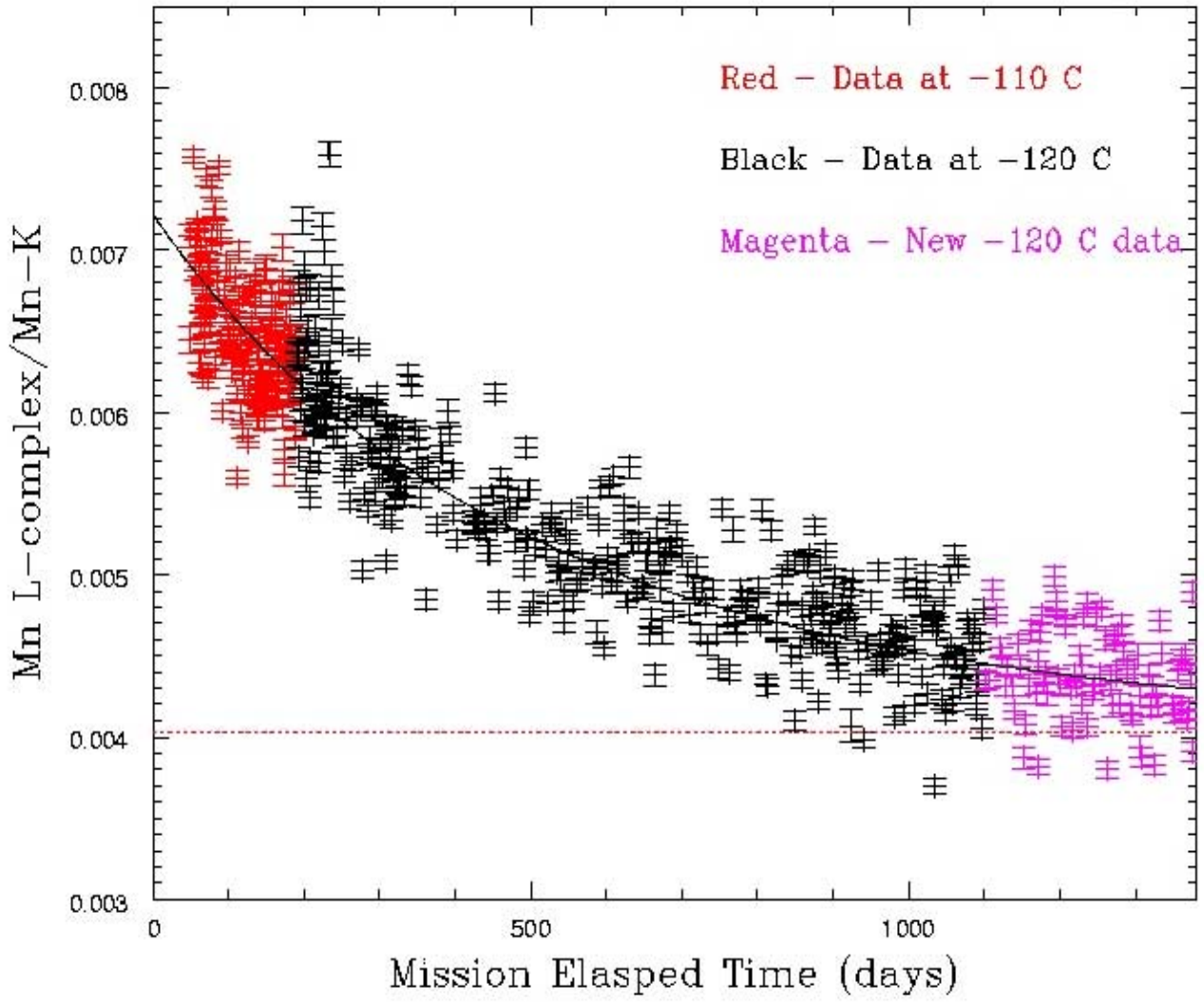
`ACISABS` – XSPEC model of absorption, allows user to adjust the abundances (Chartas PSU)

`corr_arf` – standalone FORTRAN, modifies arf file (Vikhlinin SAO)

- **Available at "cxc.harvard.edu/cal/Links/Acis/acis/Cal_products/qeDeg"**
- **newest tool is `contamarf` (Hunenemorder, Davis MIT), incorporates the C, N, and F determined from Marshall's analysisof Mkn 421 and the modified edge energies and edge structure**
- **available on the contributed SW page "asc.harvard.edu/cont-soft/soft-exchange.html"**
- **the contamination model in `contamarf` will be available in the next CALDB update and can be used by `mkarf` in `CIAO 3.0`**


Comparison of Effective Area at Launch and 5/2004
CONTAMARF (Huenemoerder/Davis) at 5/2004
CorrArf (Vikhlinin) at 5/2004
Pre-launch QE
Effective Area (cm²)
700
600
500
400
300
200
100
1
2
Energy(keV)

Mn-L complex/Mn-K vs Time



Grant (MIT)

Analysis

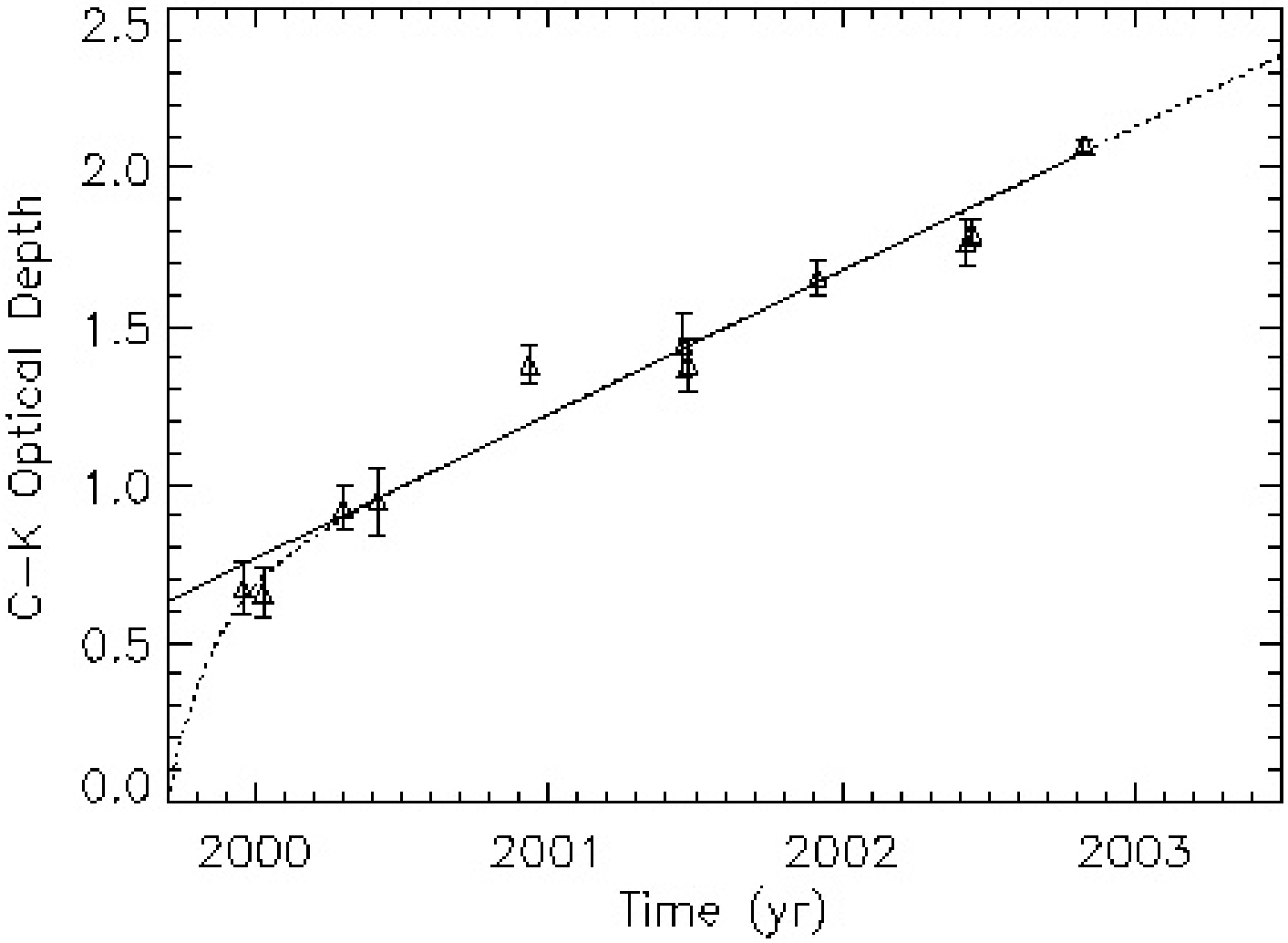
Tennant,

O'Dell (MSFC)

Functional

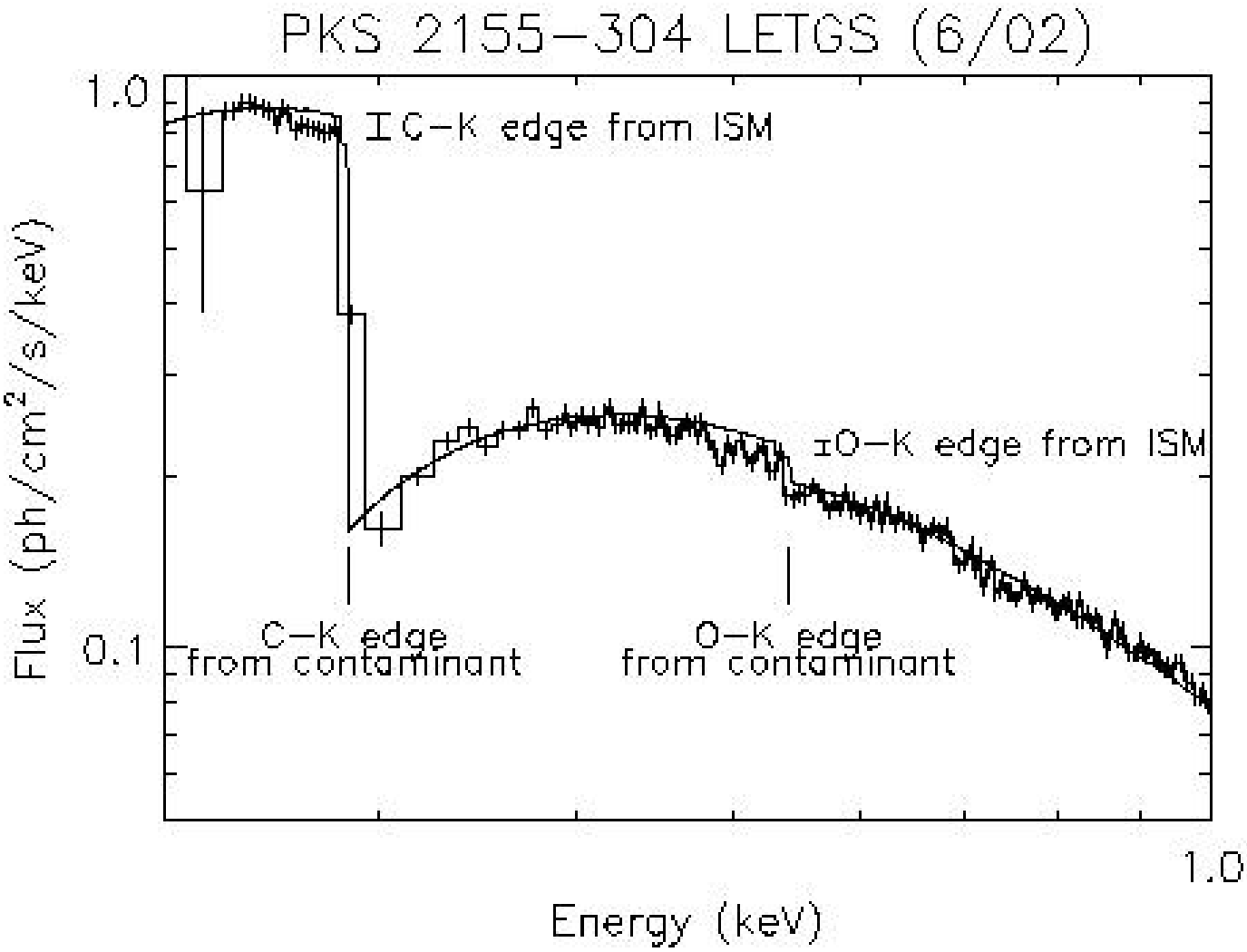
Form

Depth of C-K Edge vs. Time



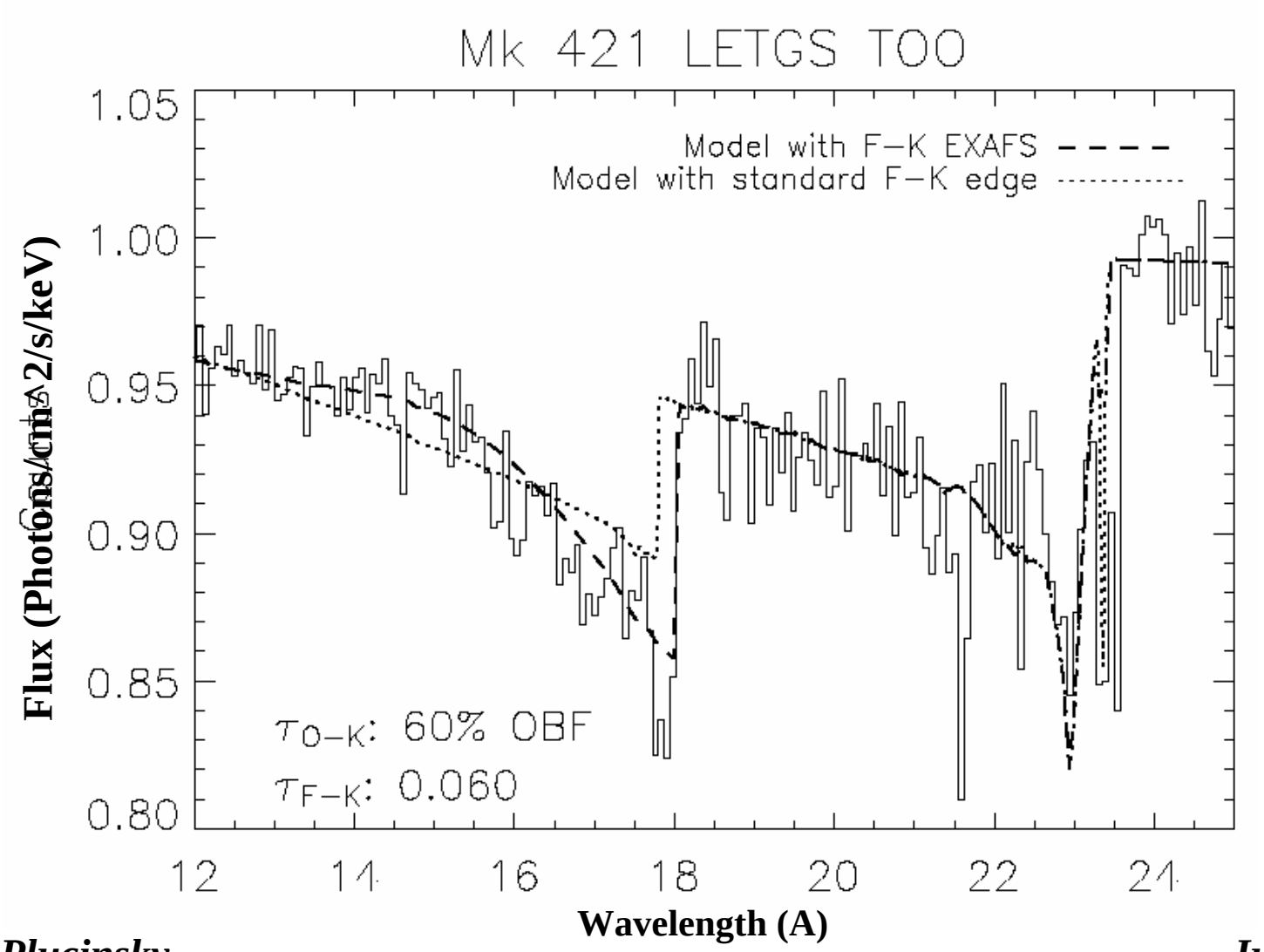
Marshall (MIT)

LETG/ACIS Characterization of the Edges



Marshall (MIT)

LETG/ACIS Characterization of the Edges



Proprietary

Data

Nicastro

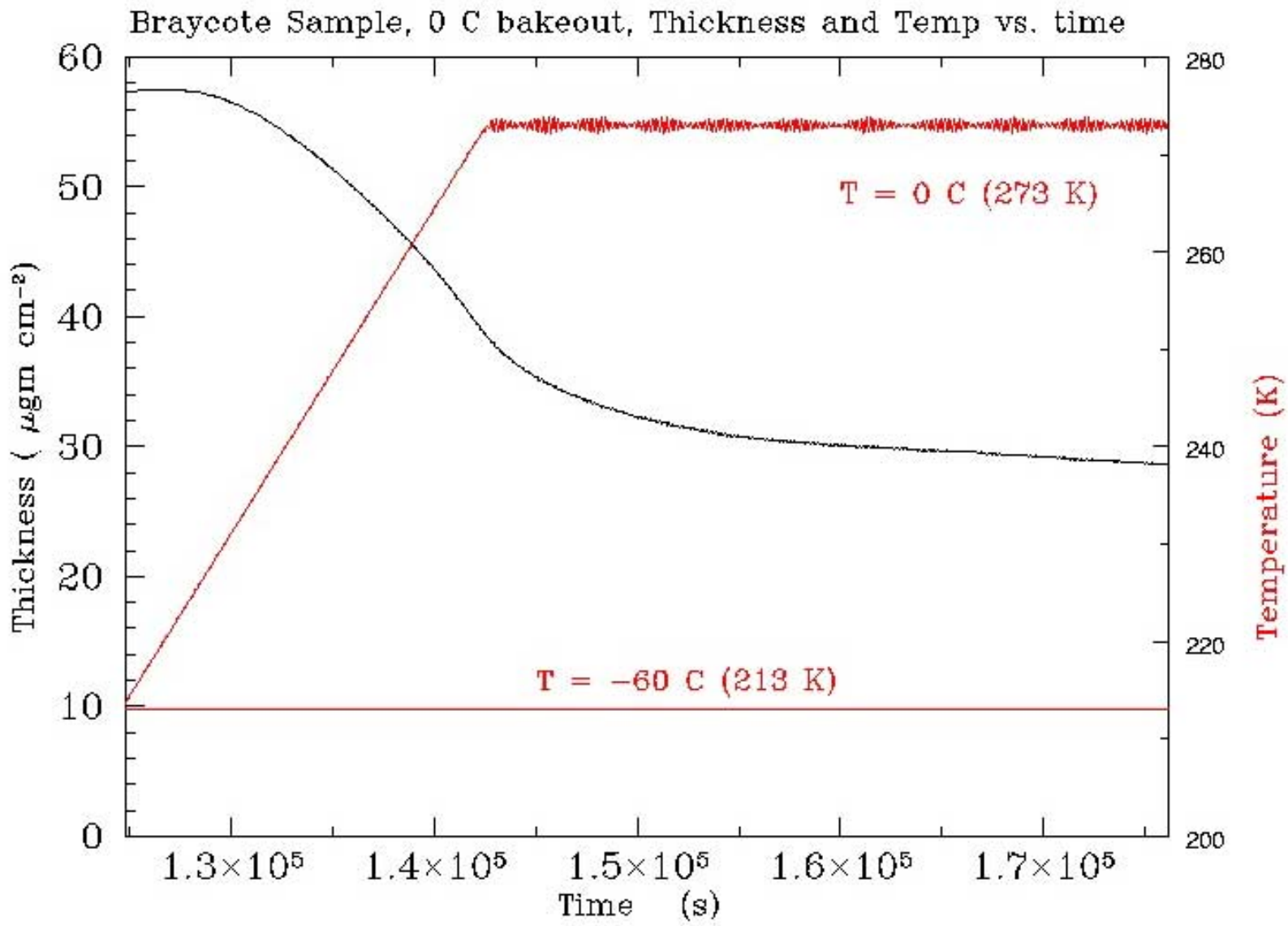
(SAO)

Marshall

(MIT)

Evaluation of a Possible Bakeout

- **Materials testing has proceeded at NGST (the company formerly known as TRW)**
- **Braycote lubricant was identified as a likely source of the F in the contaminant, Braycote does not outgass unless it is exposed to radiation or mechanical stress**
- **Several "Bakeout" tests have been conducted with Braycote, contaminant is collected on a cold surface (-60 C) and then warmed up to a target bakeout temperature**
- **tests on other likely contaminants in the spacecraft have not uncovered any other materials which freeze out at -60 C**
- **considering tests of spare ACIS filters in which the contaminant would be deposited on the filter at -60 C, the filter would be warmed to 0 C, and then cooled back down to -60 C**


Braycote Sample, 0 C bakeout, Thickness and Temp vs. time
Thickness (μgm cm⁻²)
Temperature (K)
Time (s)
T = 0 C (273 K)
T = −60 C (213 K)
0
10
20
30
40
50
60
200
220
240
260
280
1.3×10⁵
1.4×10⁵
1.5×10⁵
1.6×10⁵
1.7×10⁵

Key Tasks for a Bakeout Decision

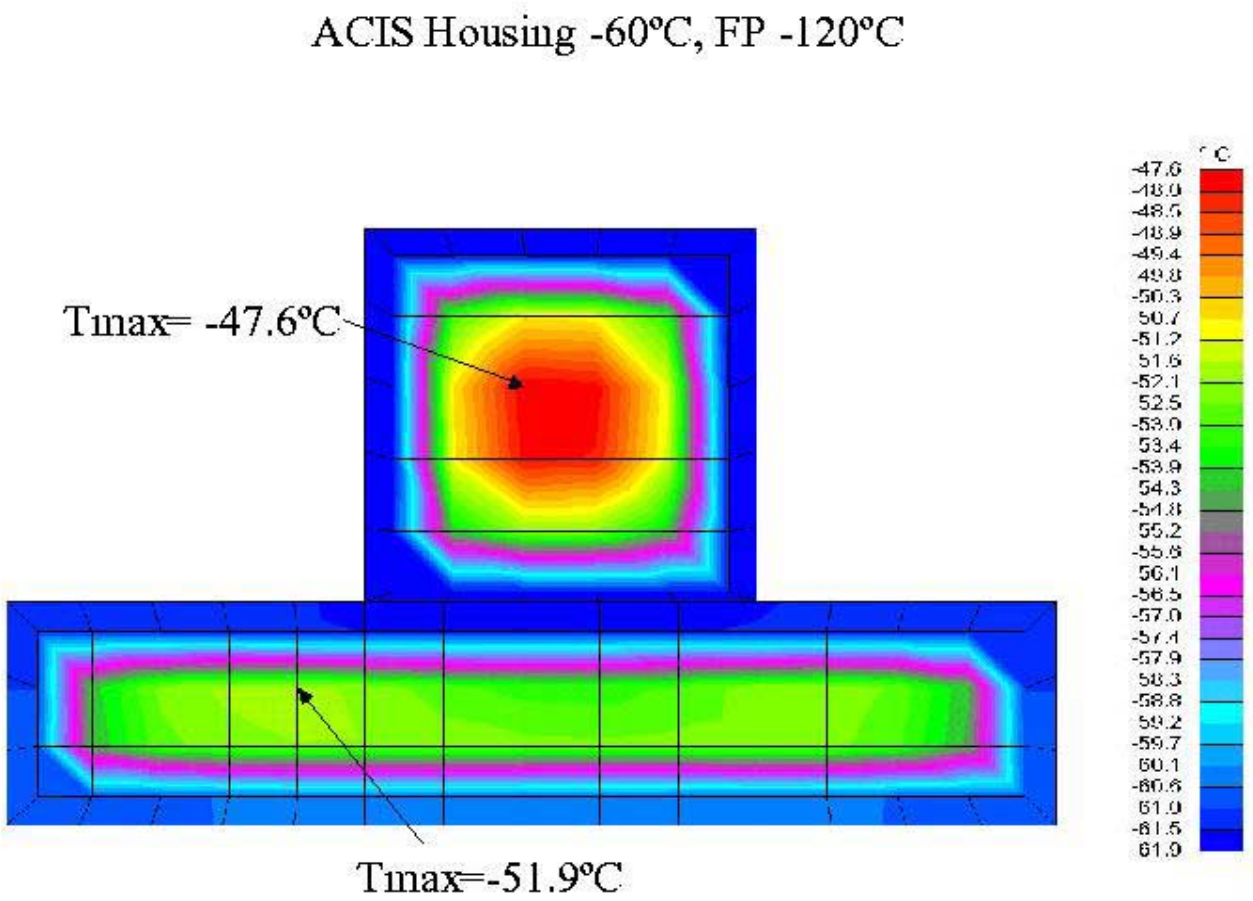
1. **Identify Possible Contaminants (CXC CAL/NGST)**
2. **Determine Release Temperature of the Contaminant (NGST)**
3. **Determine ACIS FP and DH Temperature to Achieve Desired Bakeout Temperature (LMA/ACIS Team)**
4. **Perform Venting Analysis of Release and Redeposition (NGST)**
5. **Conduct Engineering Assessment of Risk to ACIS (ACIS Team/LMA)**
6. **Develop Flight Procedure (SOT & FOT)**
7. **Develop Calibration Plan Before and After Bakeout (CXC CAL)**
8. **Evaulate the impact to the Science Observation Plan (CDO)**
9. **Obtain Final Approval from Project to Execute Bakeout**

ACIS BAKEOUT DECISION TASKS SCHEDULE

6/16/03

ACTIVITY	2002 M	J	J	A	S	O	N	D	2003 J	F	M	A	M	J	J	A	S	O
Identify Possible Contaminants (CXC CAL/NCST)																		
Determine the Release Temperature of the Possible Contaminant (NCST)																		
Determine the ACIS Focal Plane and Detector Housing Temp to Achieve Desired Bakeout Temp (LMA/ACIS Inst. Team)																		
Perform the Venting Analysis (NCST)																		
Model of Contaminant Release																		
Model of Redeposition																		
Conduct the Engineering Assessment of the Risk to the ACIS Instrument (ACIS Inst. Team/LMA)																		
Preliminary Assessment																		
Tests on Spare OBFs																		
Issue Final Report																		
Develop the Flight Procedure (SOT and FOT)																		
SOT Procedure																		
FOT Procedure																		
Develop the Calibration Plan Before and After Bakeout (CXC CAL, MSFC PS, ACIS Inst. Team)																		
Preliminary Plan																		
Final Plan																		
Evaluate the Impact to the Science Observation Plan (CXC DO and MP)																		
Obtain Final Approval from the Project and NASA/HQ to Execute the Bakeout (MSFC PS, CXC, SOT, FOT, ACIS Inst. Team, MSFC PM)																		

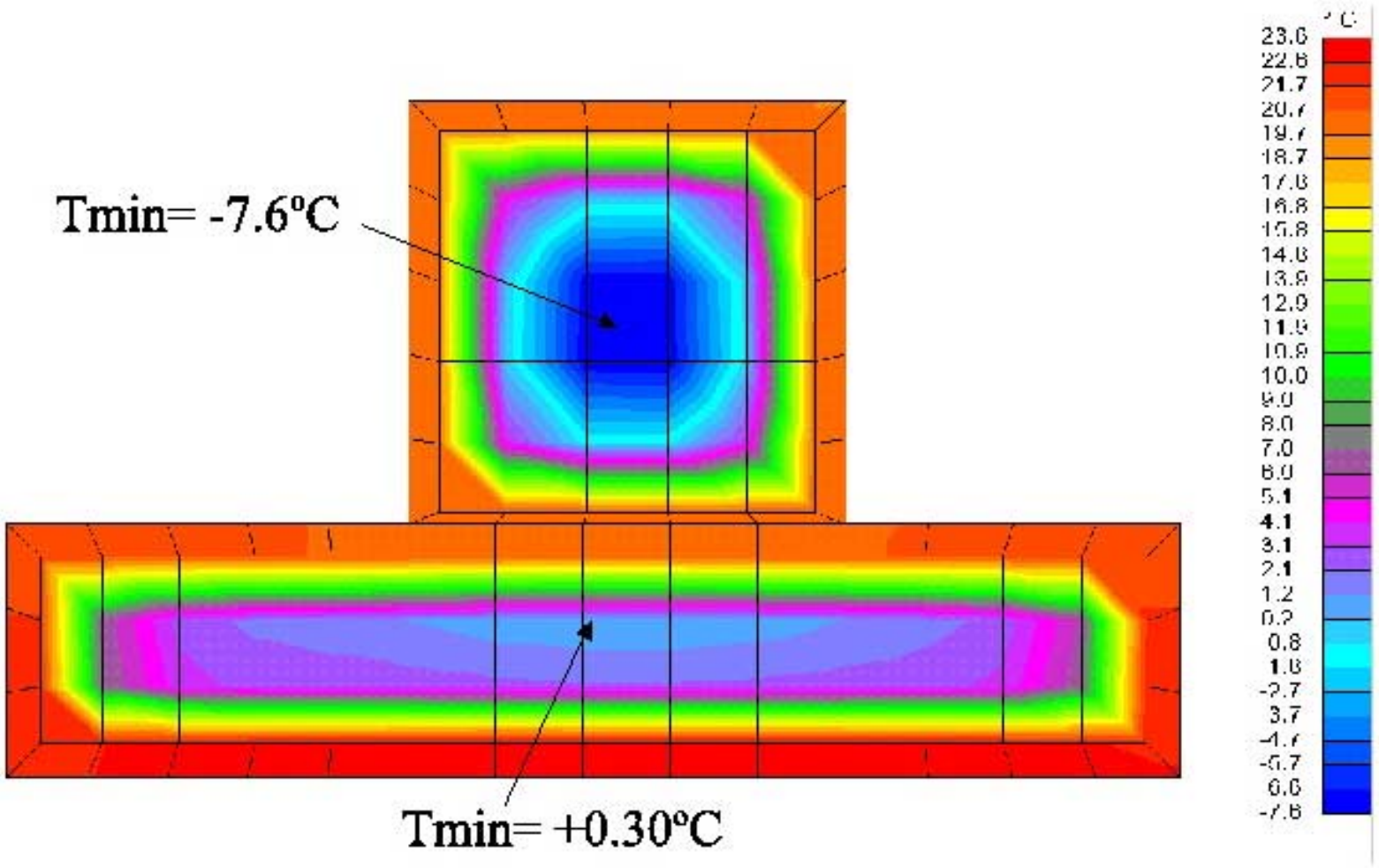
ACIS Filter Temperatures for Standard Conditions

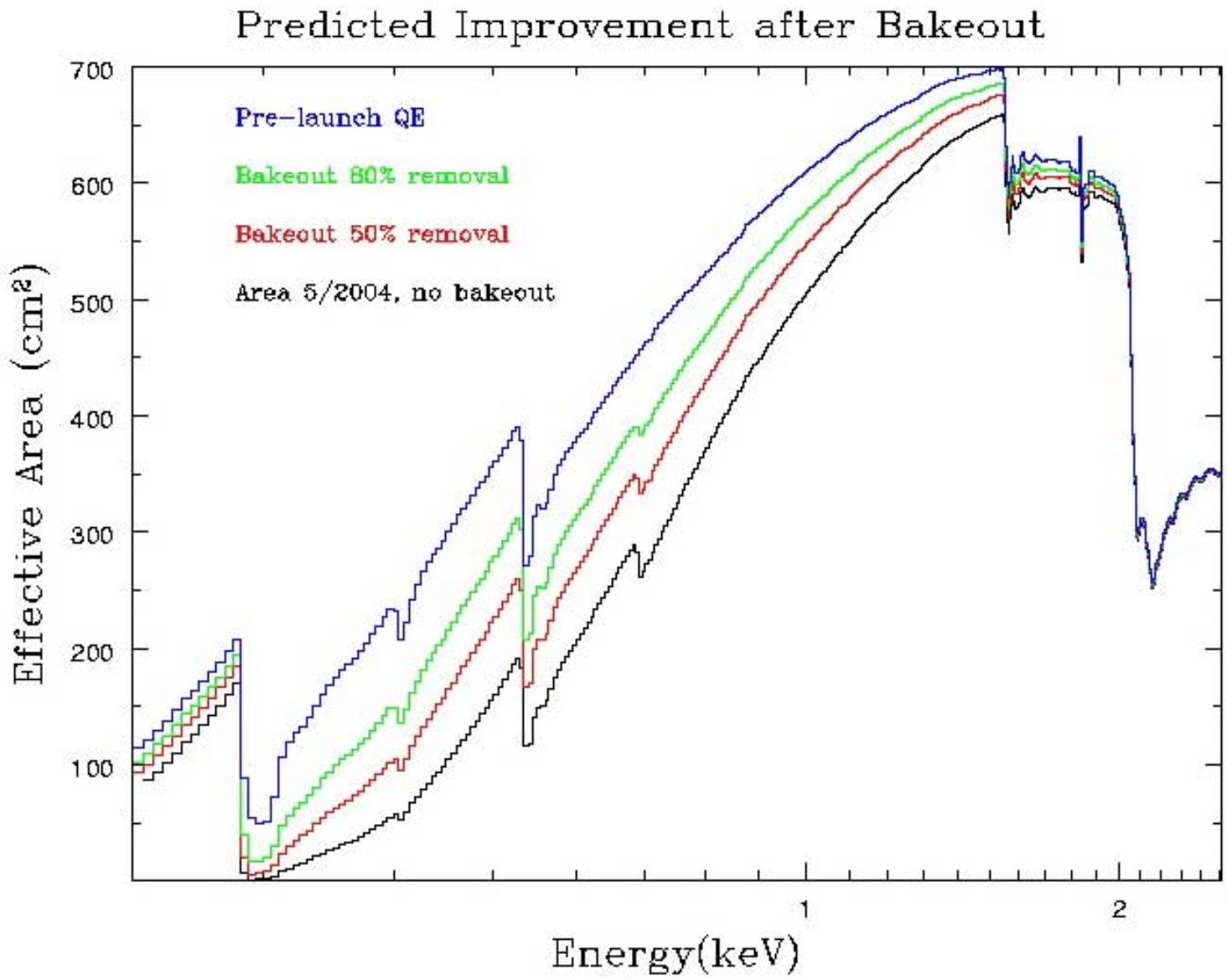


Tice

(LMA)

ACIS Housing 25°C, FP -60°C




Predicted Improvement after Bakeout
Pre-launch QE
Bakeout 80% removal
Bakeout 50% removal
Area 5/2004, no bakeout
Effective Area (cm²)
700
600
500
400
300
200
100
1
2
Energy(keV)

Summary of a Possible Bakeout

- **The flight contaminant has F and Braycote is the most likely source of F on the spacecraft**
- **The C-based material which is the dominant component of the flight contaminant has not been identified**
- **NGST experience on other missions indicates that the C-based materials should evaporate at 0 C**
- **Major tasks to be completed over the summer are the tests of spare ACIS filters at NGST, the SW modeling of the bakeout, and the development of the flight procedure**
- **Aiming for a September decision on a flight bakeout in October or November**