Prospects for an ACIS Bakeout

CXC SOT & FOT, ACIS Instrument Team and MSFC Project Science

Contributors to the Bakeout Effort

The``ACIS Contamination Working Group'' has been studying the ACIS contamination issue for the last two and a half years. Those contributing directly to this presentation:

CXC: P. Plucinsky, A. Vikhilin, H. Marshall, N. Schulz, R. Edgar, D. Schwartz, S. Wolk, H. Tananbaum, J. DePasquale, S. Virani, D. Dewey, L. David

MIT: M. Bautz, C. Grant, W. Mayer, R. Goeke, P. Ford, B. LaMarr, G. Prigozhin, S. Kissel, E. Boughan

PSU: G. Garmire, L. Townsley, G. Chartas, D. Sanwal, M. Teter, G. Pavlov

MSFC: S. O'Dell, D. Swartz, M. Weisskopf, A. Tennant, R. Elsner

NGST: M. Mach, P. Knollenberg, D. Shropshire, L. McKendrick, R. Logan, R. Giordano, T. Trinh, K. Chen, K. Henderson, F. Cottrell, J. Lamb, D. McGregor, H. Tran, D. Lindemann, L. Harper, L. Ryan, A. Tao

LMA: N. Tice

McMaster University: A. Hitchcock

Many others have contributed directly or indirectly.

Status as of Last Year's Calibration Workshop

Characterization of the Contaminant – chemical composition (C:O = 11.5:1, C:F = 14:1), spatial distribution, thickness vs. time

Identification of Contaminant – impossible to identify the exact material since so many materials on the spacecraft contain C. Most likely, the contaminant is a mixture.

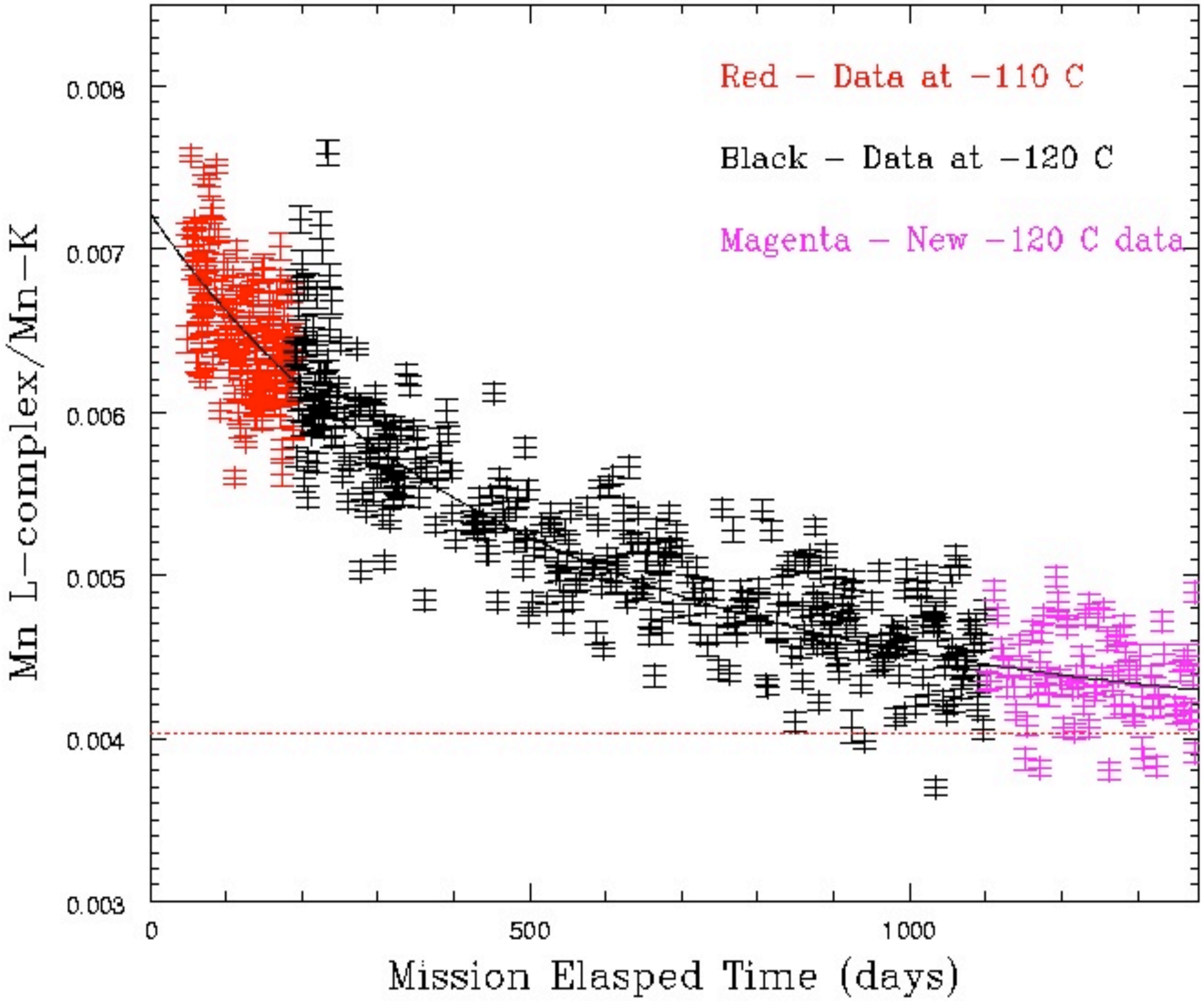
Materials test – determine vaporization properties (thermal desorption) of Braycote and "sticking factor" at relevant temperatures

Thermal Models – model the focal plane and OBF temperatures for various bakeout scenarios. The goal is to get the OBF as warm as possible, with the FP as cold as possible, and still have an effective bakeout

Model Bakeout Scenarios – SW model developed by NGST to predict the effectiveness of different bakeout scenarios

Engineering Assessment of Risk – minimal risk to HW, only concern is the OBF itself, instrument has been thermally-cycled 4 times during the mission.

Mn-L complex/Mn-K vs Time



Grant (MIT)

Analysis

Tennant,

O'Dell (MSFC)

Functional

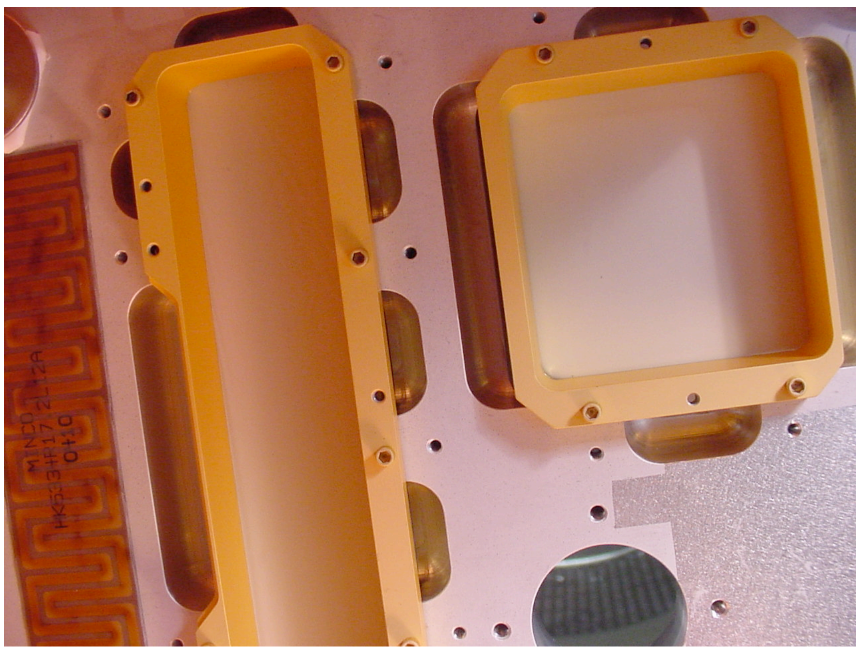
Form

Ground Tests of OBFs' Vulnerability to Thermal Cycling

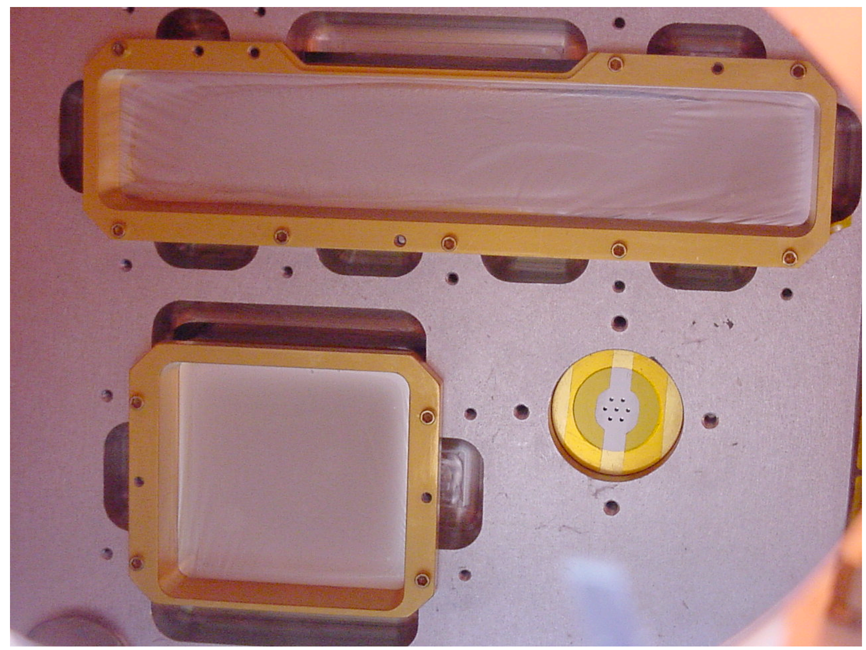
- **one new concern uncovered by the engineering assessment was thermal cycling the OBFs with a layer of contamination**
- **a series of tests were conducted at NGST with flight spare OBFs under different bakeout conditions (FP=-60 C/DH=+20 C and FP=+25C/DH=+20C)**

Before and After Pictures of the OBF Tests

OBFs with thick layer of contaminant



OBFs at the completion of the tests

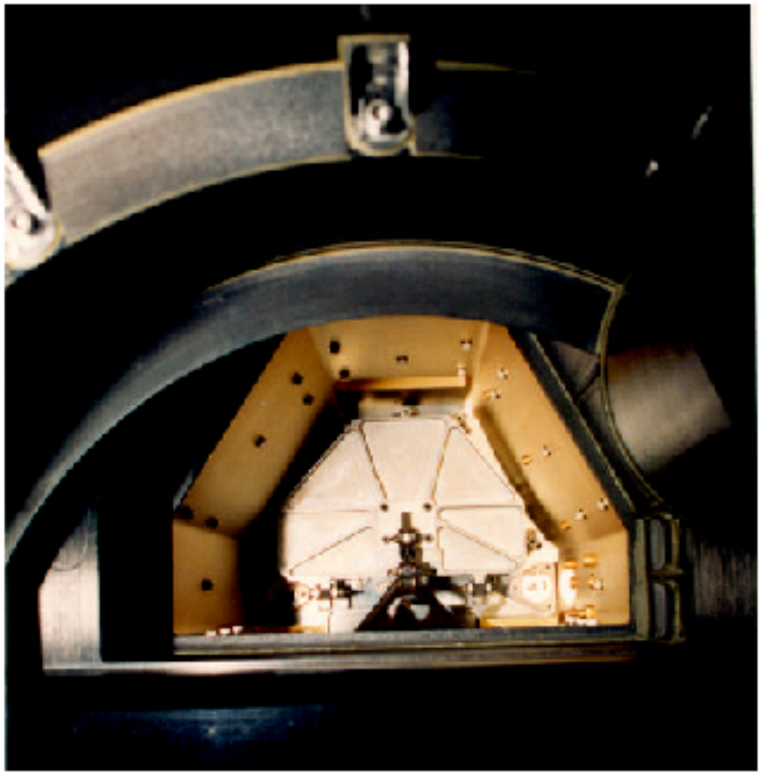


RESULT: There was no damage to the OBFs at any point during these tests.

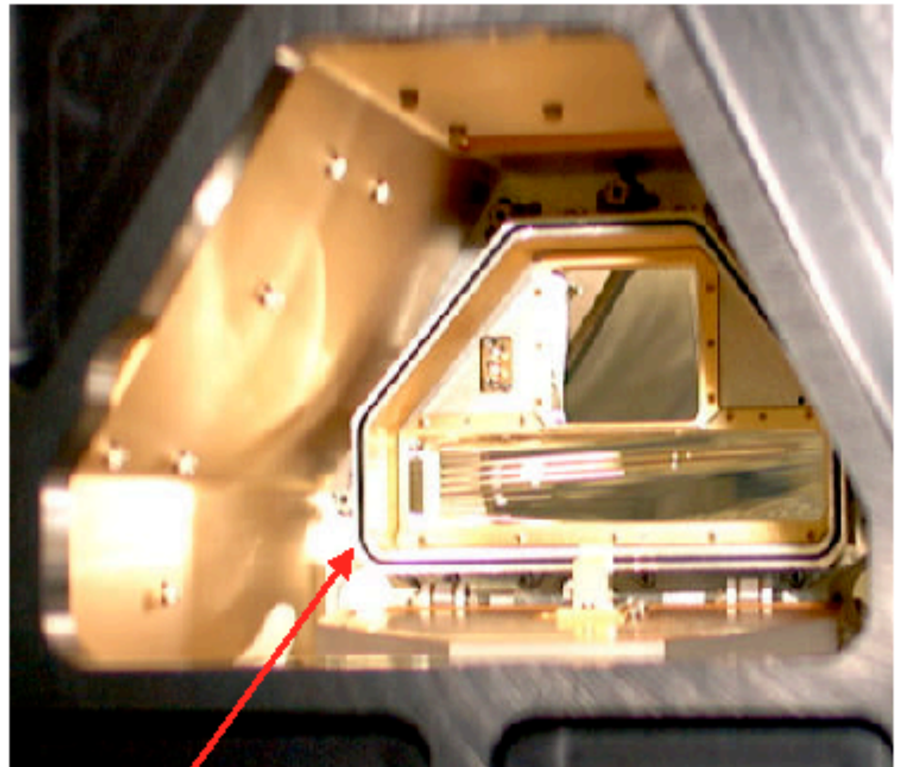
Modeling of the Bakeout

- **initial runs of the NGST model indicated that the centers of the OBFs might accumulate contaminant during the bakeout, since the centers would be the coldest surfaces**
- **a new, more flexible, model was developed by the MSFC Project Science group which allowed us to track the contaminant buildup/decrease on various surfaces and to examine the effects of changing some of the parameters (temperature, time, etc) to optimize the bakeout**
- **conclude that the "cold FP" bakeout scenarios (FP=-60 C/DH=+20 C) are not likely to be successful and the FP must be close to the DH temperature, or warmer than the DH if possible, to have a successful bakeout**
- **the major uncertainty in the simulations is the volatility of the contaminant, the range of volatilities which are consistent with the data is so large that at the low end of the range, the bakeout would have a negligible effect on the contaminant, and at the high end of the range, the bakeout would remove a large fraction of the contaminant**

X-Ray View of ACIS Door and Detector



Door Closed while Mounted to ISIM



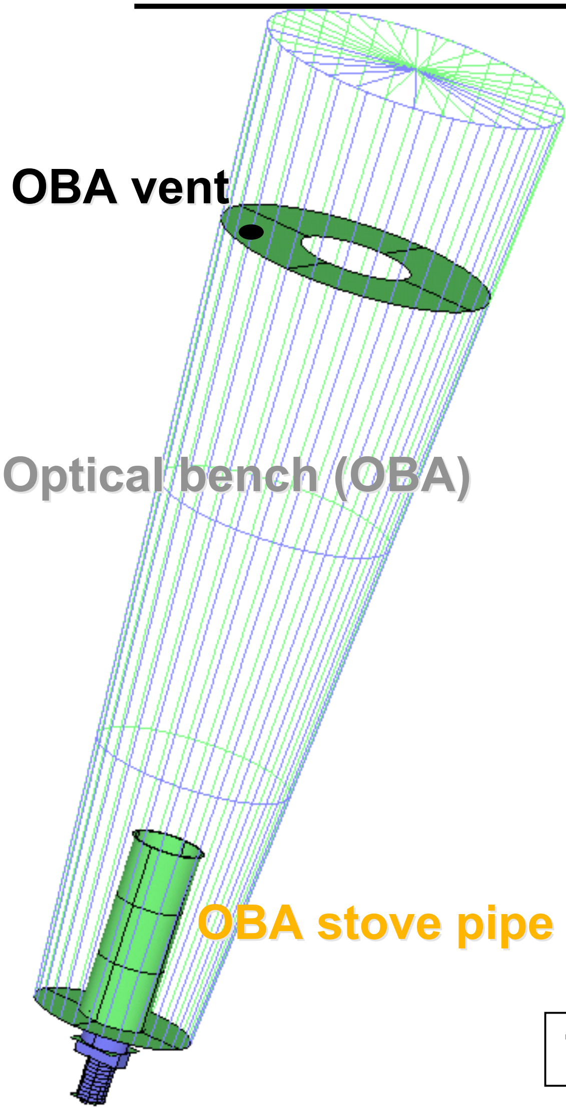
Door Open at LMA

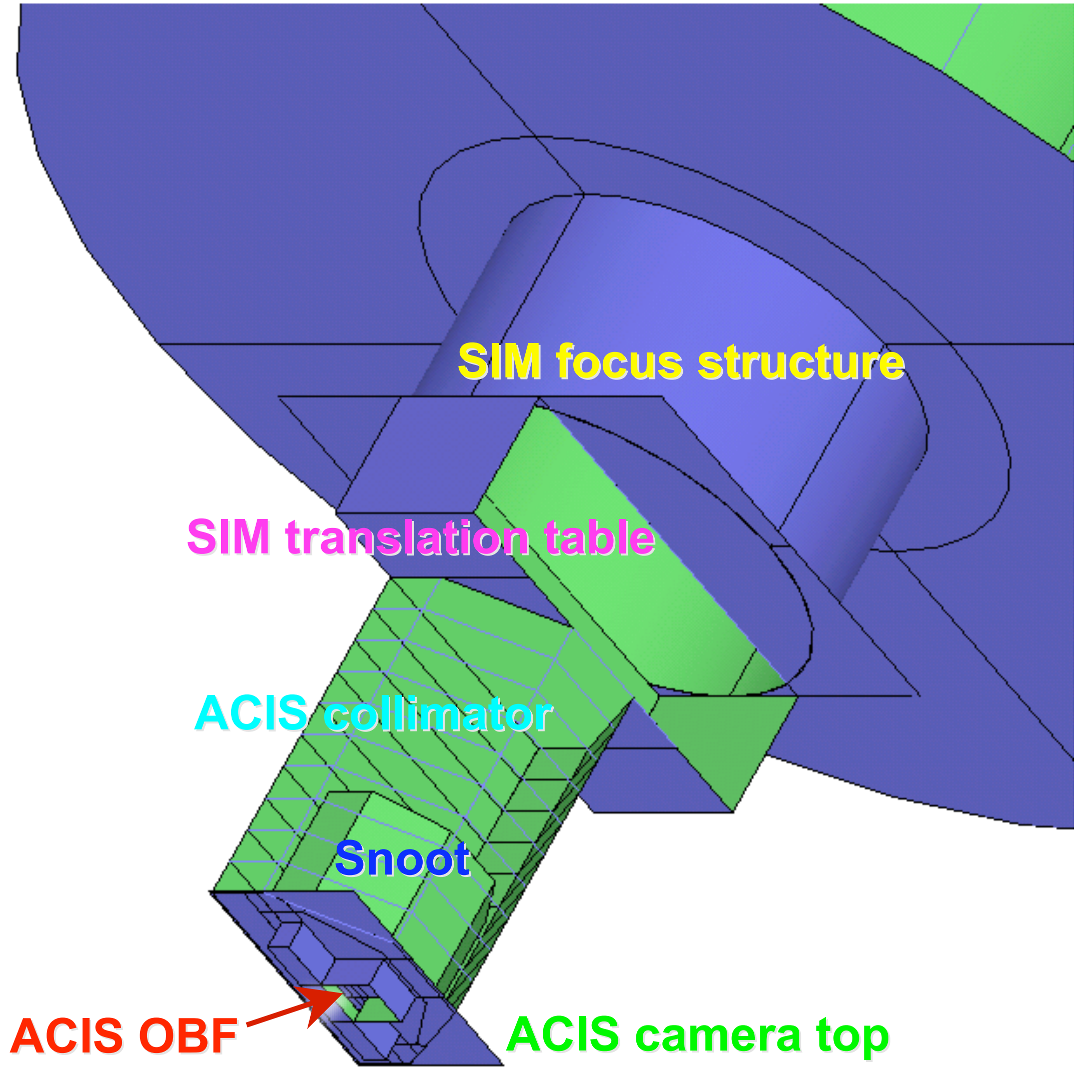
Viton O-ring

1

LOCKHEED MARTIN

Geometric model





TRASYS model by NGST/ H. Tran et al.

Chandra X-Ray Observatory

10.X DOP volatility re-deposition: Mass column

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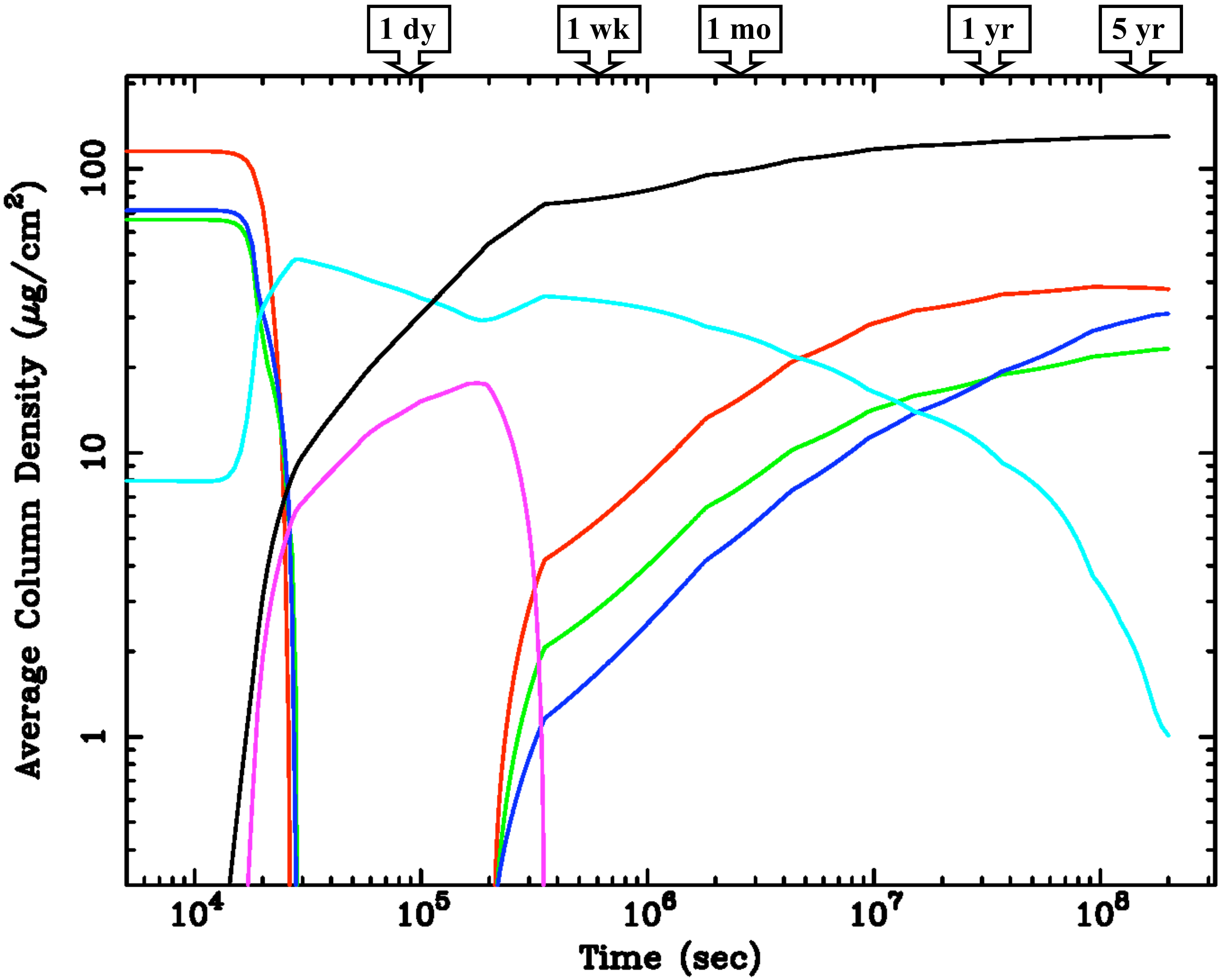

1: ACIS OBF
2: Camera top
3: ACIS snoot
4: ACIS collimator
5: SIM trans table
6: SIM focus struc
7: OBA stove pipe
8: Optical bench
9: OBA vent

1.0X DOP volatiltiy re-deposition: Mass column

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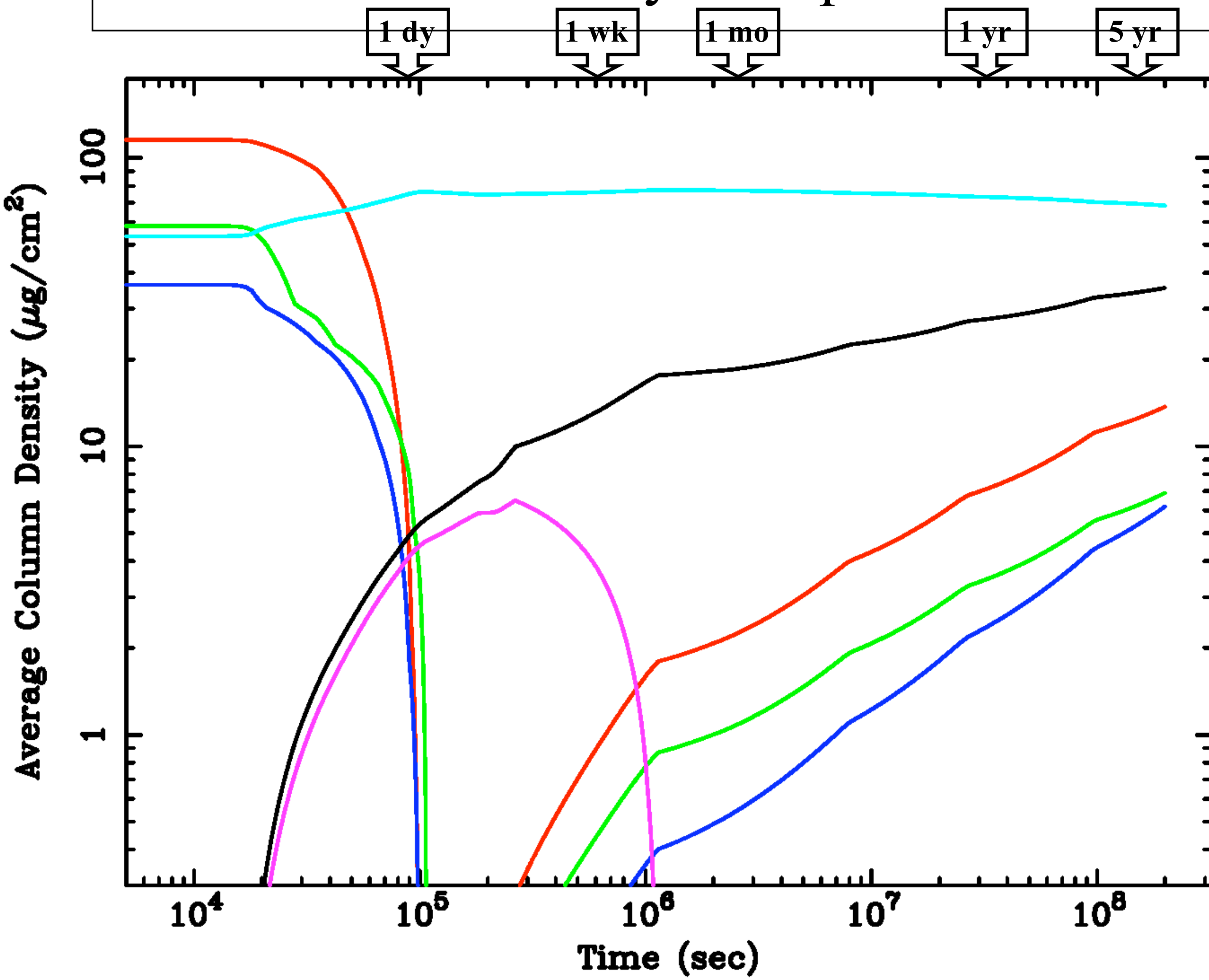

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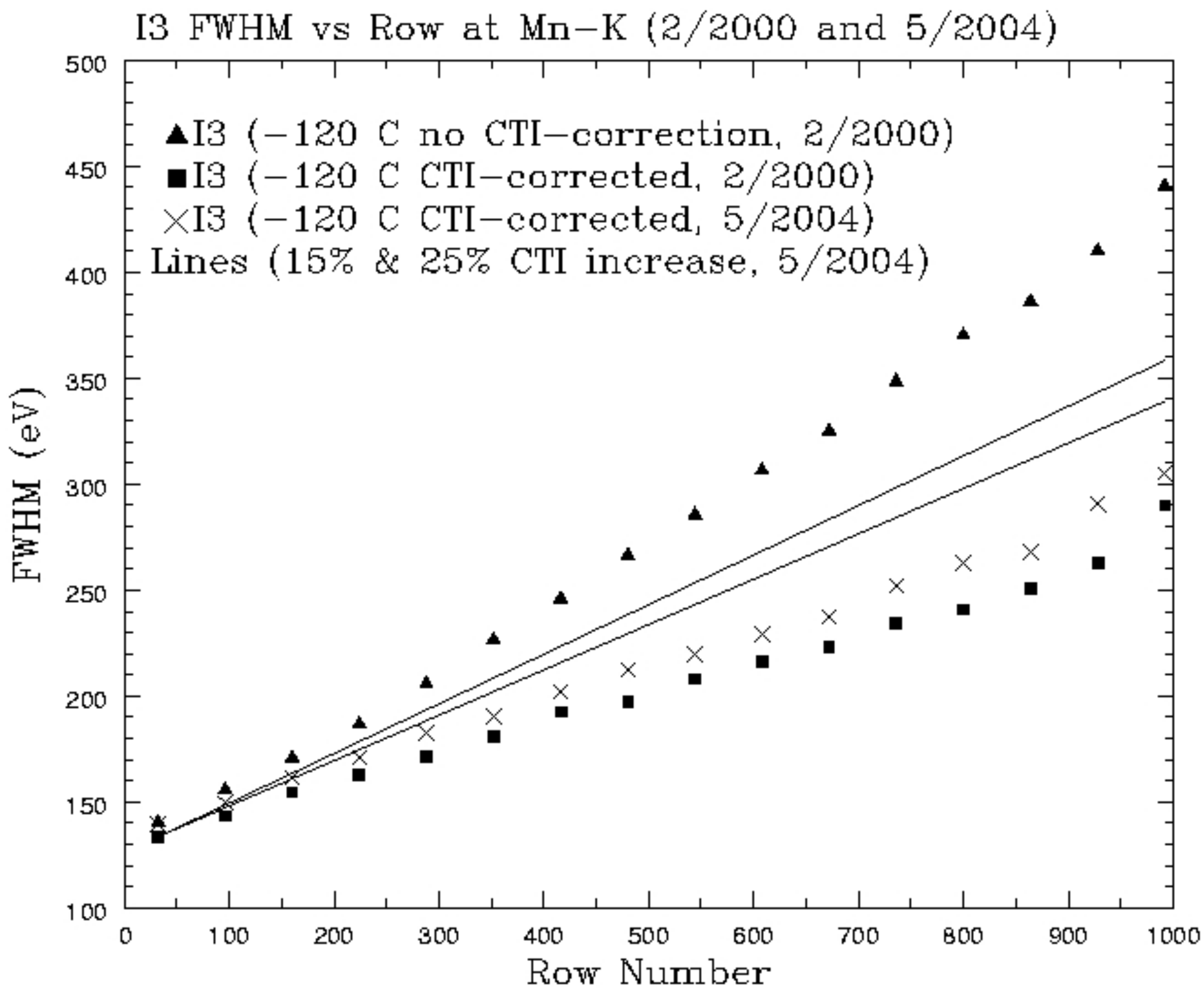
Evaluation of a FP = +30 C and DH = +20 C Bakeout

- It is clear that a large fraction of the contaminant should vaporize at +20 C if the volatility is comparable to or higher than that of DOP. If the volatility is significantly lower than DOP, very little of the contaminant vaporizes at +20 C.
- If the contaminant vaporizes, a large fraction of the material does not get out of the ACIS collimator and SIM/ACIS interface. We explored the possibility of using additional heaters on the spacecraft to heat these surfaces but it was determined the use of these heaters was not safe.
- Some of the material which does not vent out of the spacecraft will eventually make its way back to the ACIS OBF, but the timescale seems to be rather long
- The performance of both the FI and BI CCDs would change if the FP were heated to +30 C. The ACIS team estimates that the FI CTI could increase by 15-30% and the BI CTI could increase by 2-10%.
- The *Chandra* project is currently deciding how to proceed in light of the uncertainties.

FWHM vs. row number for -120 C and -120 C (CTI corrected) and for 15.0 & 25.0 % CTI Increases



Predictions for FWHM include the 10% increase in CTI from 2000 to 2004 and the estimated 15.0% and 25.0% increase due to the bakeout.