

THE CHANDRA X-RAY OBSERVATORY CALDB

AS A MODEL FOR FUTURE MISSIONS



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Purpose of HEASARC CalDB

- Multi-mission storage for calibration files.
- Standardized file format (FITS).
- Separate cal updates from software updates.
- Searchable index.
- Tools for the above.

Paradigm

- MISSION-TELESCOP-INSTRUME-FILTER-<DETNAME>-CODENAME (product)
- Uses required keywords to construct a single row in index for each extension.
- Delivers pointers to FITS files with extension numbers.

NOTE: CalDB does NOT deliver calibration data directly to software!

Mandatory Keywords, Index Specs

MISSION	Name of mission
TELESCOP	Name of satellite
INSTRUME	Instrument names
FILTER	Filter values allowed
DETNAME	Detector names
CCLS*	BCF or CPF
CDTP*	DATA, TASK, FEF
CCNM*	Cal Product
CDES*	Descriptive summary
CVSD*	Validity start date
CVST*	Validity start time
CBD#*	Boundary conditions (9)

*** indicates a keyword set.

The above keywords translate to fixed column names in the index files, one caldb.indx for each instrument.

- Locations of index files in caldb.config
- Aliasing provided for INSTRUME values, not TELESCOP, MISSION, or DETNAME.
- CALTOOLS "quzcf" routine for calling CalDB from software.

NOTE: This system has been implemented successfully for numerous missions, including: ASCA, ROSAT, EINSTEIN, EXOSAT, SWIFT, SUSAKU, FERMI, NUSTAR!

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Chandra CALDB4 Enhancements

- Key configuration table for each instrument
 - Key.config file stored in parallel with caldb.indx
- Enabled additional **keyword sets** / index entries
- Tools: **calindex** (builder), **calvalid** (checker), **calquiz** (query tool)
 - Library level tooling also, for CIAO and SDP, **ARDLIB**
- Added **DEFAULT** feature for calibration files not associated with any one instrument
 - E.g. HRMA, PIXLIB, PIMMS_EA for Chandra.
 - Queries search DEFAULT index files before searching instrument indexes.
 - Allows consistency with CXC FITS definitions.

Chandra CalDB Branches:

ACIS EPHIN default HRC PCAD PIMMS(default) SIM
(One caldb.indx, key.config file for each branch.)

ACIS key.config

#	colName	dataType	format	hdrKey	queryCol	nullVal
#	-----					
TELESCOP	string	a10	TELESCOP	yes	""	
INSTRUME	string	a10	INSTRUME	yes	"NONE"	
GRATING	string	a4	GRATING	yes	"NONE"	
GRATTYPE	string	a6	GRATTYPE	yes	""	
CAL_DESC	string	a70	CDES*	no	""	
CAL_VSD	string	a10	CVSD*	no	""	
CAL_VST	string	a8	CVST*	no	""	
REF_TIME	double	d	""	no	0.0	
CAL_VED	string	a10	CVED*	no	""	
CAL_VET	string	a8	CVET*	no	""	
END_TIME	double	d	""	no	0.0	
FIDELITY	double	d	FDLT*	no	0.0	

"DEFAULT" key.config

#	colName	dataType	format	hdrKey	queryCol	nullVal
#	-----					
TELESCOP	string	a10	TELESCOP	yes	""	
GRATING	string	a4	GRATING	yes	"NONE"	
GRATTYPE	string	a3	GRATTYPE	yes	""	
CAL_DESC	string	a70	CDES*	no	"NONE"	
CAL_VSD	string	a10	CVSD*	no	""	
CAL_VST	string	a8	CVST*	no	""	
REF_TIME	double	d	""	no	0.0	
CAL_VED	string	a10	CVED*	no	""	
CAL_VET	string	a8	CVET*	no	""	
END_TIME	double	d	""	no	0.0	
FIDELITY	double	d	FDLT*	no	0.0	

CalDB "calquiz" Call Examples

dagny-114: calquiz none chandra acis sc_matrix calfile=CALDB"(cti_app=ppppppbpbpp,date_obs=2024-11-07T00:00:00,data_end=2024-11-07T01:00:00,ccd_id=3,fp_temp=178.15)" echo+
\${CALDB}/data/chandra/acis/p2_resp/acisD2000-01-29p2_respN9969_105-107.fits[4]

dagny-136: calquiz none chandra none prod=pimms_ea calfile=CALDB"(aonumber=AO-27,detnam=HRC-I,grating=none)" echo+
\${CALDB}/data/chandra/pimms/hrc/hrcID2024-11-06pimmsN0027.fits[2]

NOTE As before, one retrieves a file path, filename, and an extension number. No actual data!

CALDB Going Forward...

Pathfinder: A mission with a free-flying mirror with independent station-keeping interchangeable instruments

- Mirror assembly might have transmission gratings.
- Instruments: Microcalorimeter, Bragg Crystal Spectrometer, MCP imager, CCD imaging spectrometer.
- Replaceable instruments; others might be added.

CALDB4 system is compatible with these features!

Remaining CalDB Issues

➤ Related Calibration Data Sets:

- With CHANDRA, related files (related calibration data sets) remains an issue for multi-mission software goals.
- Special keywords have been added (CTI_APP for ACIS, GMAPVER for HRC-S) to select alternative downstream cal files such as QE, QEU, TGMASK.
- This method is not mission-independent, requiring special software to handle.

➤ Calibration data conditioning

- While time-dependence capability exists (CVSD/CVED), it is not smooth.
- Separate files are needed for ranges of variable parameters.(e.g. operating temperatures.)

These issues suggest that a "real" (relational) database might be preferable for complex missions.



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