A (very) Chandra-centric path to Multi-Order Coverage maps

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Chandra Data Archive

We decided to produce MOCs for Chandra archival data for very **selfish reasons** that have little to do with sharing our data and everything to do with our **Chandra ecosystem**

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Chandra Data Archive

Single
Chandra
Obs

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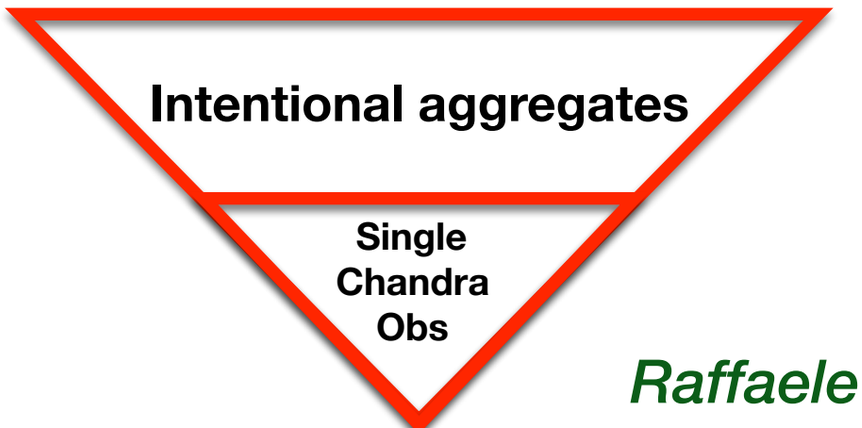
Chandra Data Archive



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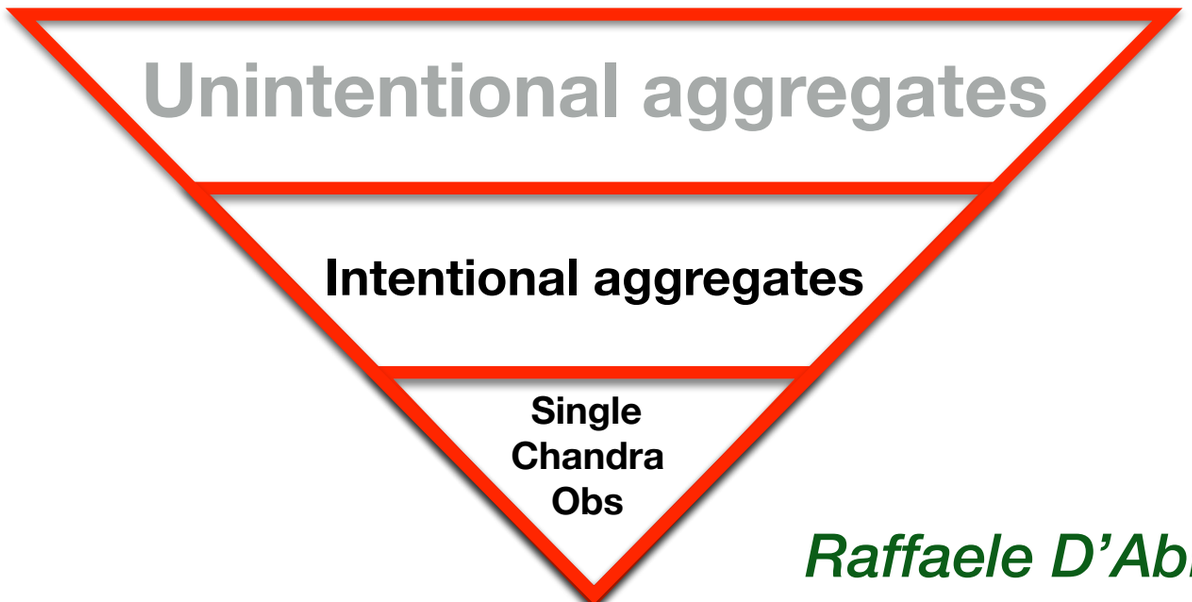

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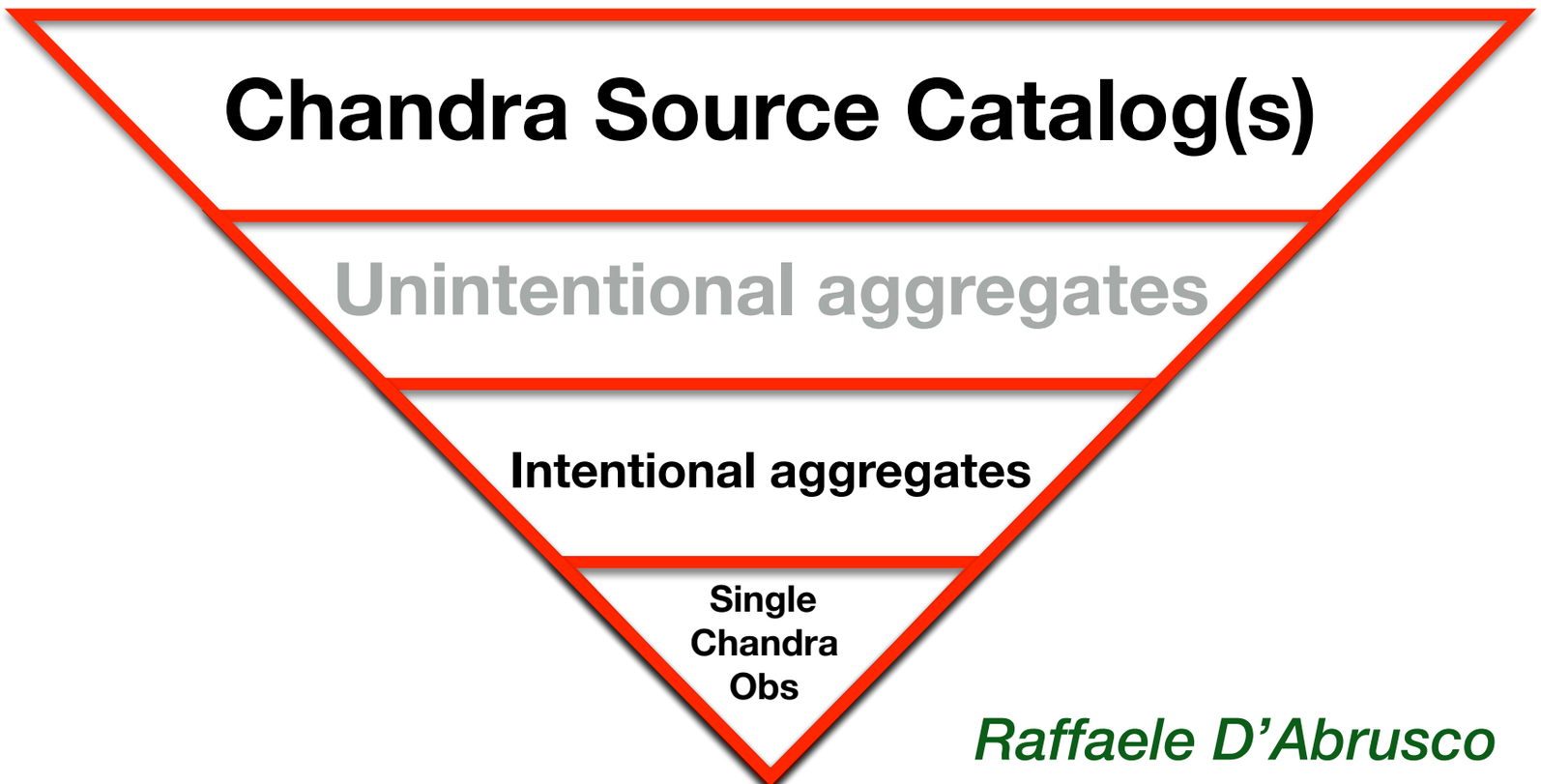

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Chandra Data Archive

Chandra observers

Chandra astronomers

X-ray astronomers

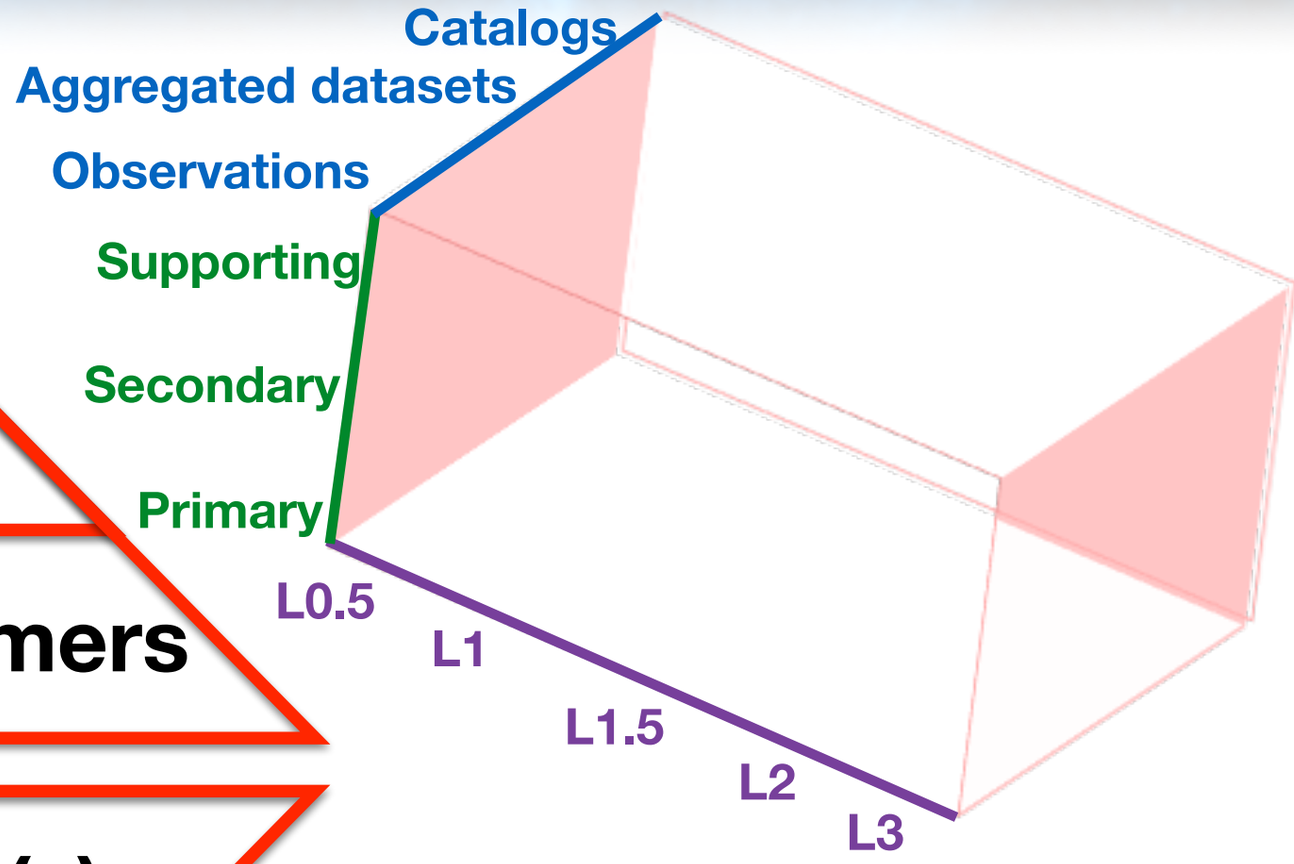
Multi-wavelength astronomers

Chandra Source Catalog(s)

Unintentional aggregates

Intentional aggregates

Single Chandra Obs



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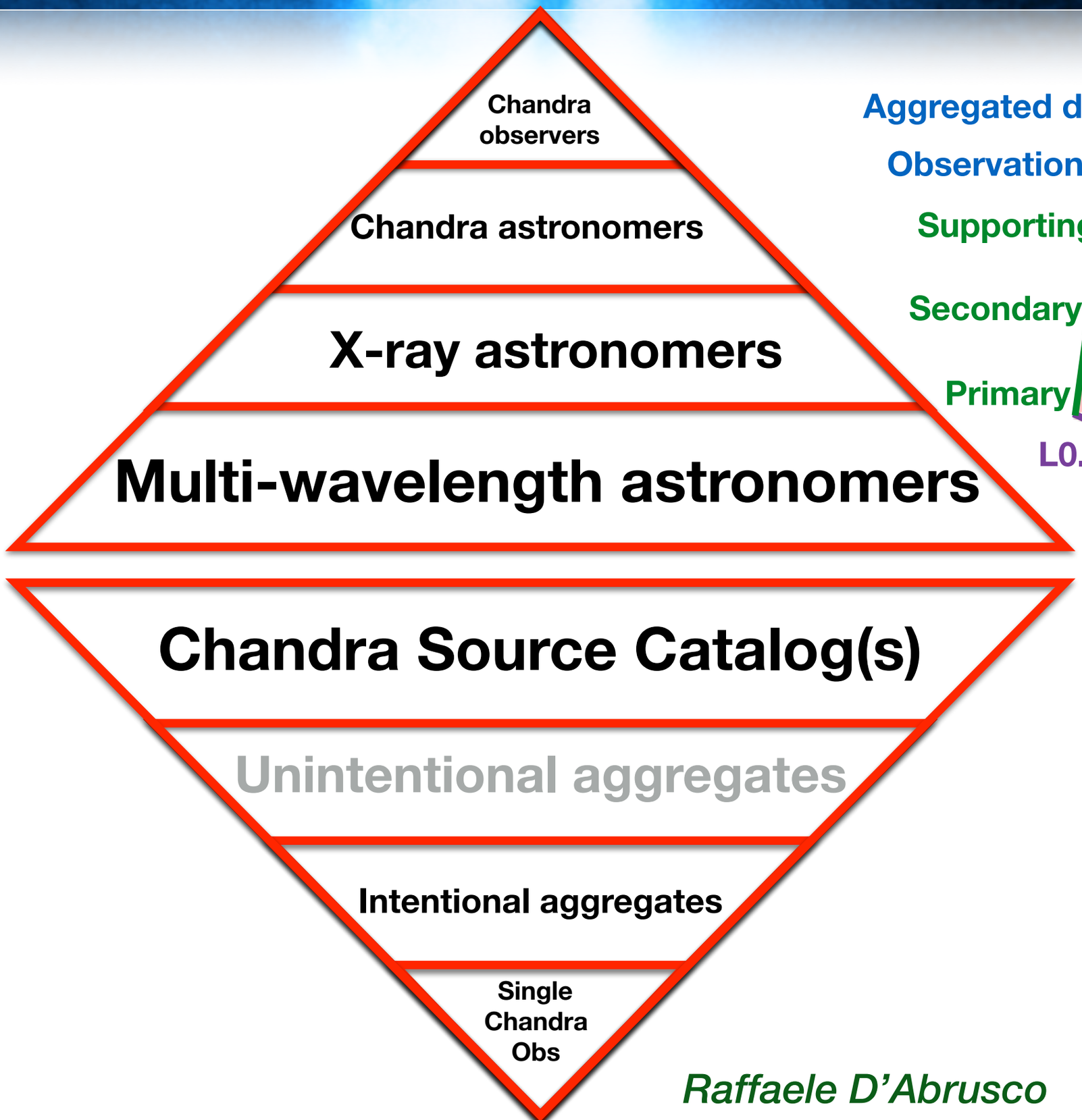

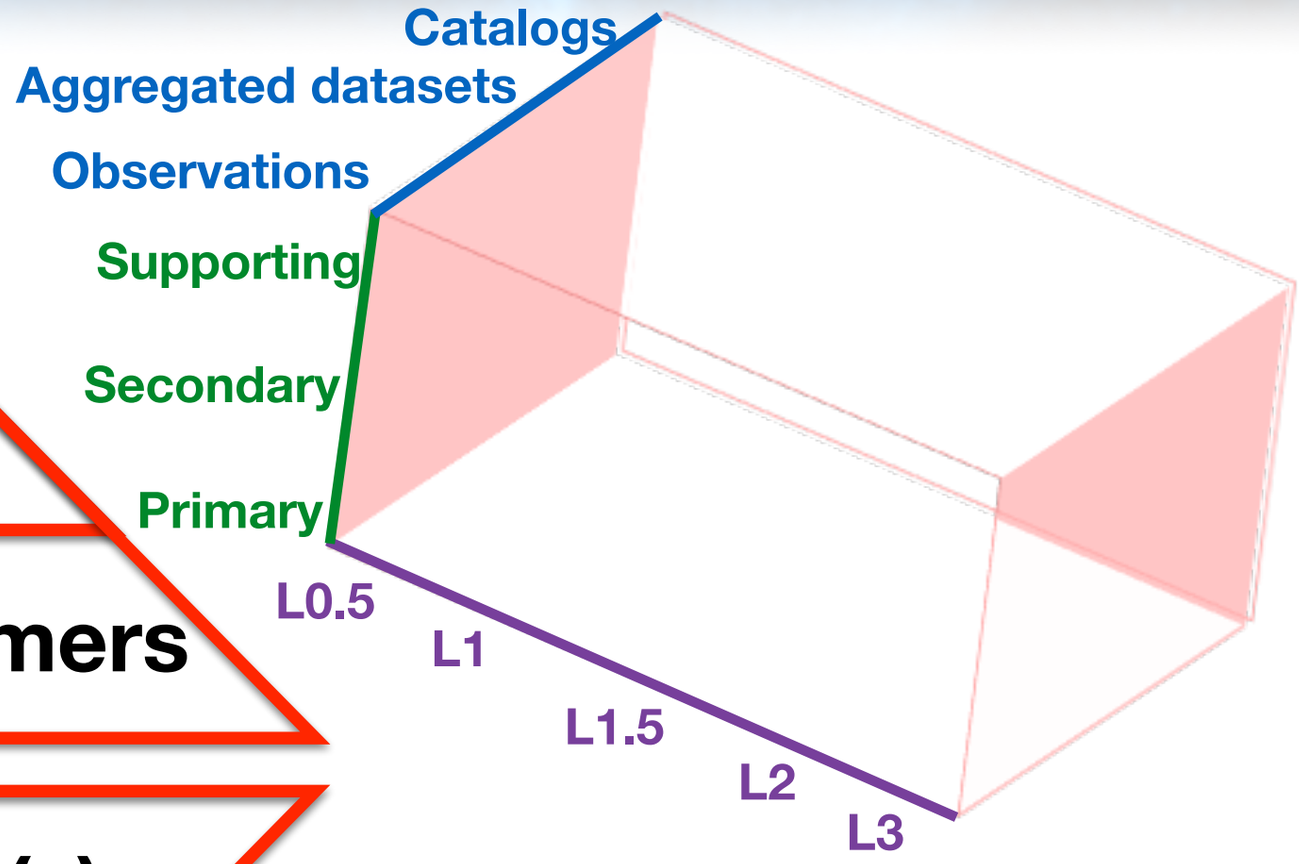

Growing archive

Changing demographics

New tools

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The growth in **size** and **complexity** of **Chandra archival data** calls for new ways to provide descriptions of the global properties of the data in the archive at all levels of aggregation

Chandra Data Archive

Goals

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- Facilitate comparison with coverage of other missions (XMM, HST, Spitzer)

- Provide a global representation of the **Chandra coverage**
  - Small total footprint (< 2.2 square degrees)
  - Complex, sparse, inhomogeneous collection of irregular patches

- Avoid inefficient usage of other Chandra interfaces

- "Experimental" project
  - Small scale, quick (?), minimal impact
  - Gauge community response for future plan
  - Lightweight precursor to **Chandra HiPS,** currently in production

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Chandra X-ray Center

Observation Search

New Search

Search

File Upload | Coordinates | Choose File | No file chosen

Cone Search

Target Name | NGC1399 | Resolve Name | RA/Long/l

Name Resolver | SIMBAD/NED | Coord System

Observation ID | Sequence Number

Proposal Title | PI Name

Start Date | Public Release Date

Exposure Time (ks) | Approved Time (ks)

Status: Archived, Observed, Scheduled, Unobserved, Untriggered

Science Category: Solar System, Stars and WD, WD Binaries and CV, BH and NS Binaries, SN, SNR and Isolated NS

Instrume

Customize Out

Sort Order

Display

Coord System

Chandra X-ray Center

Chandra Biblio

Search

You may enter multiple objects, obsids or bibcodes. Separate each with a comma.

Object

Resolve Object with SIMBAD | Resolve Name

ADS Bibcode

This option performs a cone search. Coordinates should be entered in decimal degrees or in the format HH

Coordinate Search | RA: | Dec:

Keyword Search | and | or

Type each keyword on a new line

Select 'yes' to include in selection, 'no' to exclude from selection, or 'N/A' to ignore in selection.

Instrument	Publication Form	Publication Type	Category
and / or	erratum	multimedia	1
ACIS	article	circular	2
HRC	data	thesis	3
HETG	memo	on-line data catalogue	
LETG	abstract	review	
HRMA		government publication	4
PCAD		proceedings	

CSCview

Search | Stop | New | Open | Save | Send | Download | Script

Chandra Source Catalog Release 1.1

Catalog | Query | Results | Products

Standard Queries:

- Standard Queries
  - Master Source Basic Summary
  - Master Source Summary
  - Master Source Photometry
  - Master Source Variability
  - Source Observation Summary
  - Source Observation Photometry
  - Source Observation Variability
- Standard Search Criteria

Select: all | distinct rows | Save results to file

Result Set: c.usrid, c.separation, c.probability, d.dataset_id, name, ra, dec

Sort Order: c.usrid ascending; c.separation ascending; name ascending

Source Pro

Master

Table

Cross Matc

Search compl

Chandra Footprint Service

Sag A* | Search | Reset | Search Options

Examples: Eta Carinae, 10 45 03.591 -59 41 04.26 r=0.2d, 122,22,1741-1743,1739

Requires Firefox 3, Safari 4, or compatible browser

Footprints | Image Inventory | Preview Images/Download Data | Help | FAQ

*Sag A** RA =266.416826 Dec = -29.007797 r = 0.200000 [17:45:40.038 -29:00:28.07]

Instrument:

- ACIS-I
- ACIS-S
- HRC-I
- HRC-S

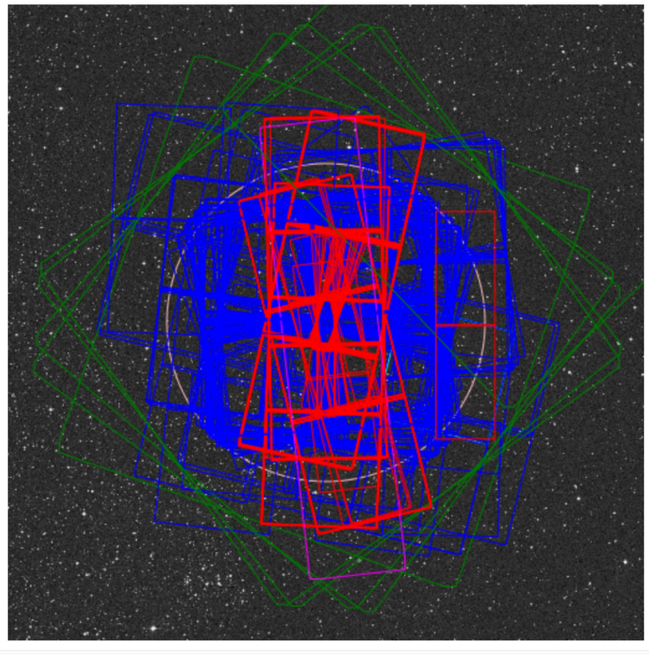
Footprints to display:

- All Public Observations
- CSC Coverage ?

Show DSS Image:

Get VOTable ?

RA 266.8656 DEC -28.6594 Search Radius (deg): 0.2



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Secure | https://cxcfps.cfa.harvard.edu/cda/footprint/#Footprints|filterText%3D%24filterTypes%3D|query_string=NGC...

Apps | Preferiti Raffaele | choresandpleasures | List of oldest living... | List of the verified... | Arcops_Wiki | Personal

Chandra Footprint Service

NGC 4649 Search Reset Search Options

Examples: Eta Carinae, 10 45 03.591 -59 41 04.26 r=0.2d, 122,22,1741-1743,1739

Requires Firefox 3, Safari 4, or compatible browser

Footprints | Image Inventory | Preview Images/Download Data | Help | FAQ

NGC 4649 RA =190.916700 Dec = 11.552611 r = 0.200000 [12:43:40.008 +11:33:09.40]

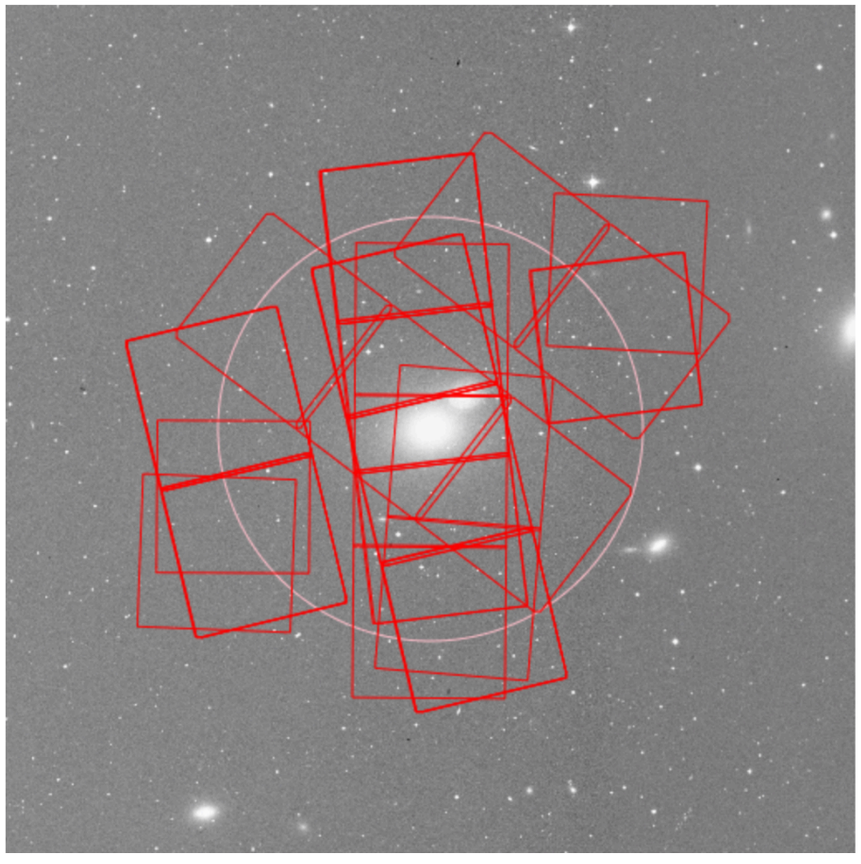
Instrument:
- ACIS-I
- ACIS-S
- HRC-I
- HRC-S

Footprints to display:
- All Public Observations
- CSC Coverage ?

Show DSS Image:

Get VOTable ?

RA 0 DEC 0 Search Radius (deg): 0.2



Results 1- 9 Show 20 results per page

- Anomalous spikes of heavy usage of SIA service installed on the FPS server
  - Very similar to DoS attacks
  - “Culprits” were identified
  - **Legitimate massive spatial queries**
  - Millions of positions searched, few hundreds returned data
  - Very **inefficient usage** of interfaces

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Chandra Data Archive

How we produce MOCs

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- Input from STC polygon descriptions of single chips used for each Chandra observations
  - Easily accessible information from our databases
  - **Aladin** in command line mode to create/update the MOCs
  - STILTS used to validate the new MOCs

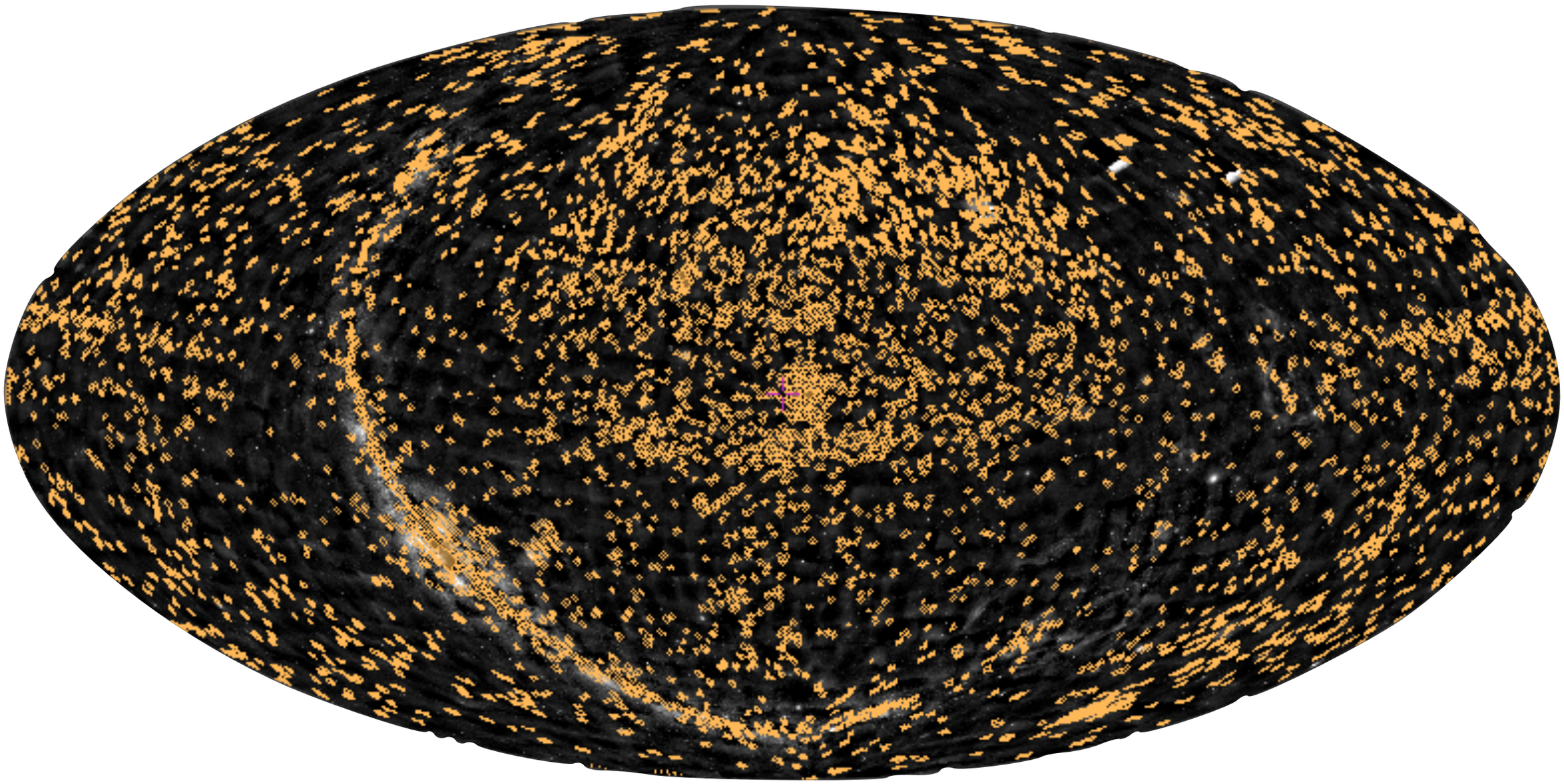
- Distinct MOCs for imaging (HRC & ACIS) and gratings (HETG & LETG) observations
  - Footprint information for grating observations still useful for reference

- MOCs for Chandra Source Catalog (1.1 and soon 2)
  - Static (one time-off) MOCs
  - Observations included are selected based on more complex set of criteria

- Weekly updates to the MOCs
  - newly public Chandra observations are incorporated every week
  - additional coverage can vary between 0 and ~0.3 square degrees per week

- Same MOC at different max spatial resolutions
  - MOC orders 10 (smallest cell resolution ~3.4') to 13 (~25.7")
  - Choice based to roughly approximate Chandra spatial resolution
  - Rethinking some of our choices based on users' feedback (see later)

Chandra Data Archive



http://cxc.cfa.harvard.edu/cda/cda_moc.html

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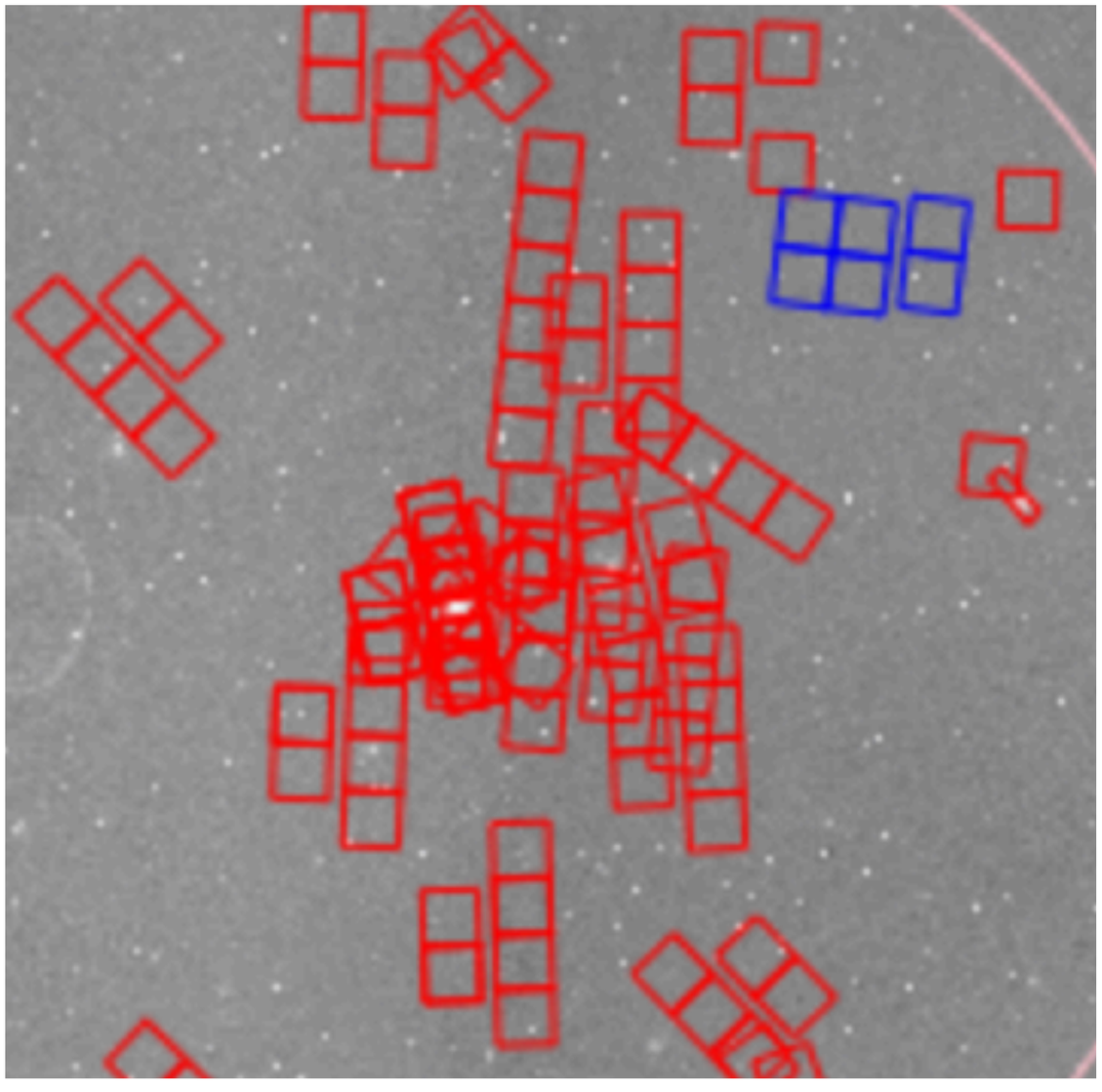
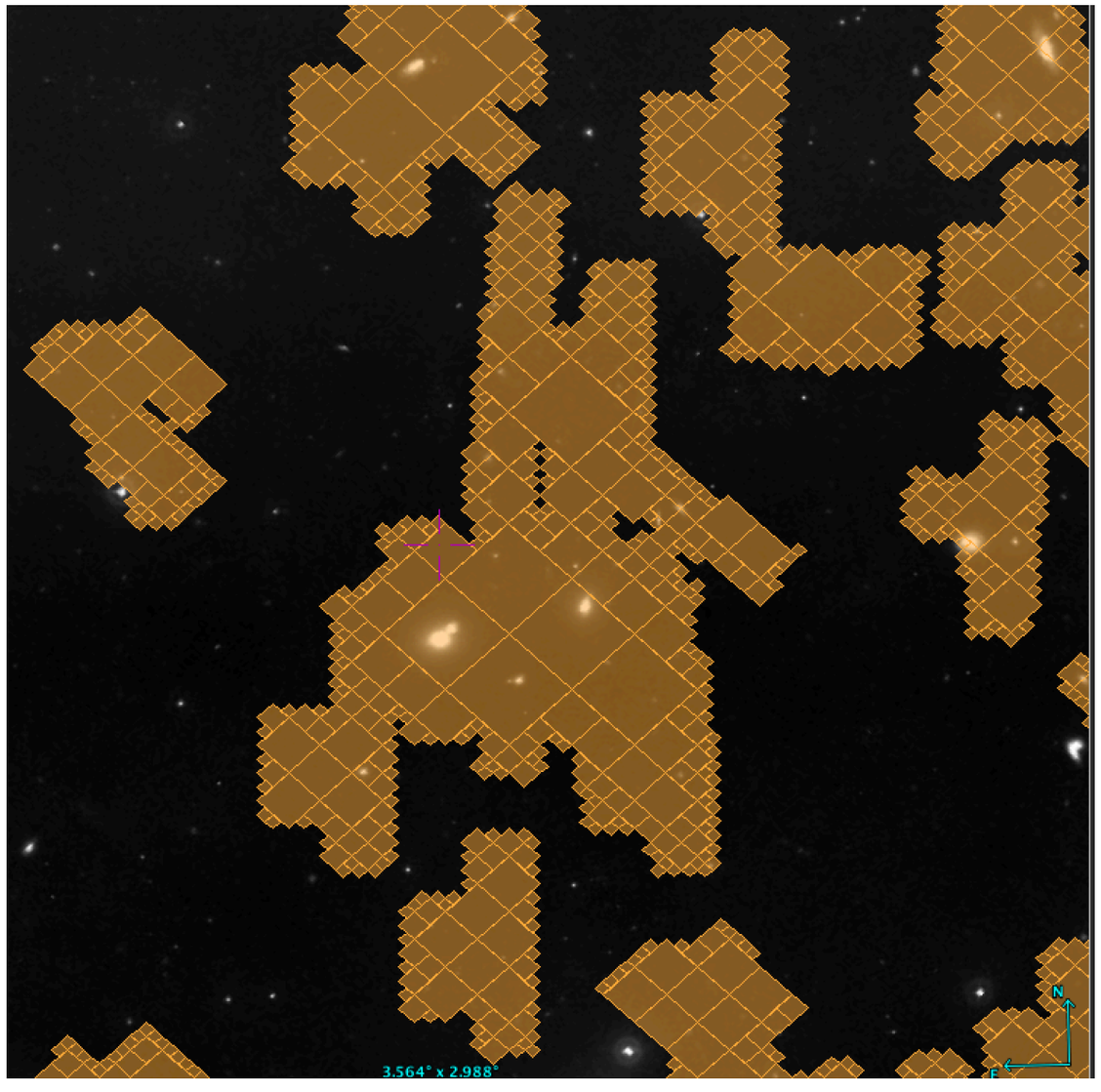
Chandra Data Archive





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Chandra Data Archive

Chandra MOCs webpage

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Chandra Data Archive

cxc.cfa.harvard.edu/cda/cda_moc.html

Apps | Preferiti Raffaele | choresandpleasures | List of oldest living... | List of the verified... | Arcops_Wiki | Personal | Level 3 QA Login | Ferrovie e Trasporti...

CHANDRA X-RAY OBSERVATORY

CXC Home | Proposer | Archive | Data Analysis | Instruments & Calibration | For the Public

Chandra Data Archive

ChaSeR
Chandra Source Catalog ♦ CSCview
Chandra Footprint Service
Request for Acknowledgement

Search cxc.harvard.edu

Google Custom Search | Search

- The Archive
- Search and Retrieve Data
- Advanced Data Services
- Archive User Services
- Chandra Aggregated Datasets
- Publishing Chandra Results

Data Analysis Links

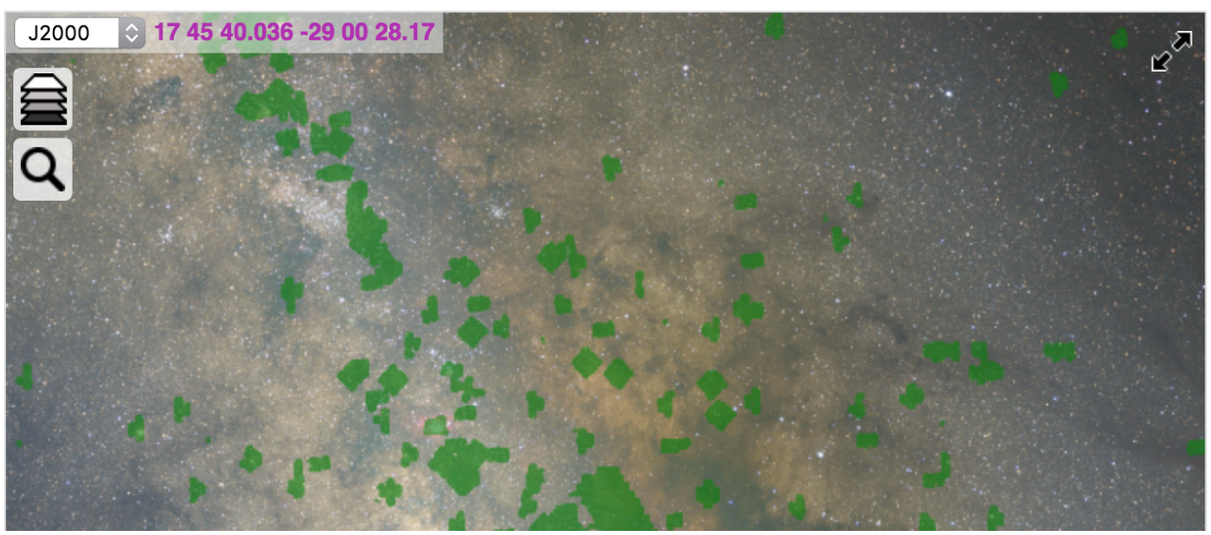
CXC → CDA → The Archive → Chandra MOCs

Introducing the *Chandra* MOCs

The CDA produces Multi-Order Coverage maps based on *Chandra* observations:

- What is a MOC?
- How can I use the *Chandra* MOCs?
- MOC-compatible software
- *Chandra* MOCs download

Sky coverage of all public *Chandra* observations (see description) is displayed in the Aladin Lite window below using a **Multi-Order Coverage** map (**MOC**) derived from public *Chandra* observations with MOC order 13 (see later). Users may pan across this projection and zoom in and out using a mouse. The visualization allows a choice of coordinate systems (drop-down menu, upper left corner), a range of background images (stacked layers icon), and jumping to specific locations on the sky using coordinates or an object name (magnifying glass icon). More advanced uses of MOC maps are described below.



CDA Status

The archive is fully functional.

Reprocessing Status

Reprocessing has been completed for
Phase I: 2005-11-13 to 2011-12-31
Phase II: 2000-01-30 to 2005-11-13

Current Software Releases

ASCDSVER: 10.6
CALDBVER: 4.7.8

What's New

Chandra Footprint Service
2018-05-14
The new secure Footprint Service can be found here

Global Chandra Coverage
2018-02-14
Check out the new Chandra MOC page.

Browsers security warnings
2017-12-22
Are Chandra Data Archive pages safe? See full announcement.

Past Notices

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- **What are MOCs**?

- **Visualization** catches the eye…
  - Aladin Lite Javascript widget (thanks Thomas!) embedded in the webpage

- …but MOCs are useful in multiple ways
  - 2 step-by-step write-ups of usage scenarios that makes sense for Chandra community
  - providing some details on how to **filter lists of coordinates** with MOCs (*inMOC()*, *nearMOC()* STILTS functions) or perform l**ogical operations on multiple MOCs** (Aladin)

- Introducing MOC-compatible tools
  - promote tools and libraries that work with MOCs (**Aladin**, **Topcat**, **MOCpy**, **PyMOC**)

Chandra Data Archive

Early users' feedback

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- **Overall positive reception**
  - Most first time users found **MOCs useful** and "**cool**"
  - Correlation with seniority: younger researchers tend to know MOCs and/or are willing to use them more often than experienced researchers
  - Rethinking MOCs orders based on feedback
  - Requests for deeper integration with Chandra public interfaces
  - Users would love if MOCs carried additional information (i.e., list of observations contributing to each cell)

- Specific questions
  - "Can MOCs be read in DS9?"
  - **"Where are the Chandra HiPS?!?!!!"**
  - "Can you get me a special MOC based on a collection of observations of my choice?"

Chandra Data Archive

What's next

- Making Chandra MOCs available everywhere

- Chandra HiPS

- Pursuing deeper integration of Chandra MOCs/HiPS into our Chandra public interfaces

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