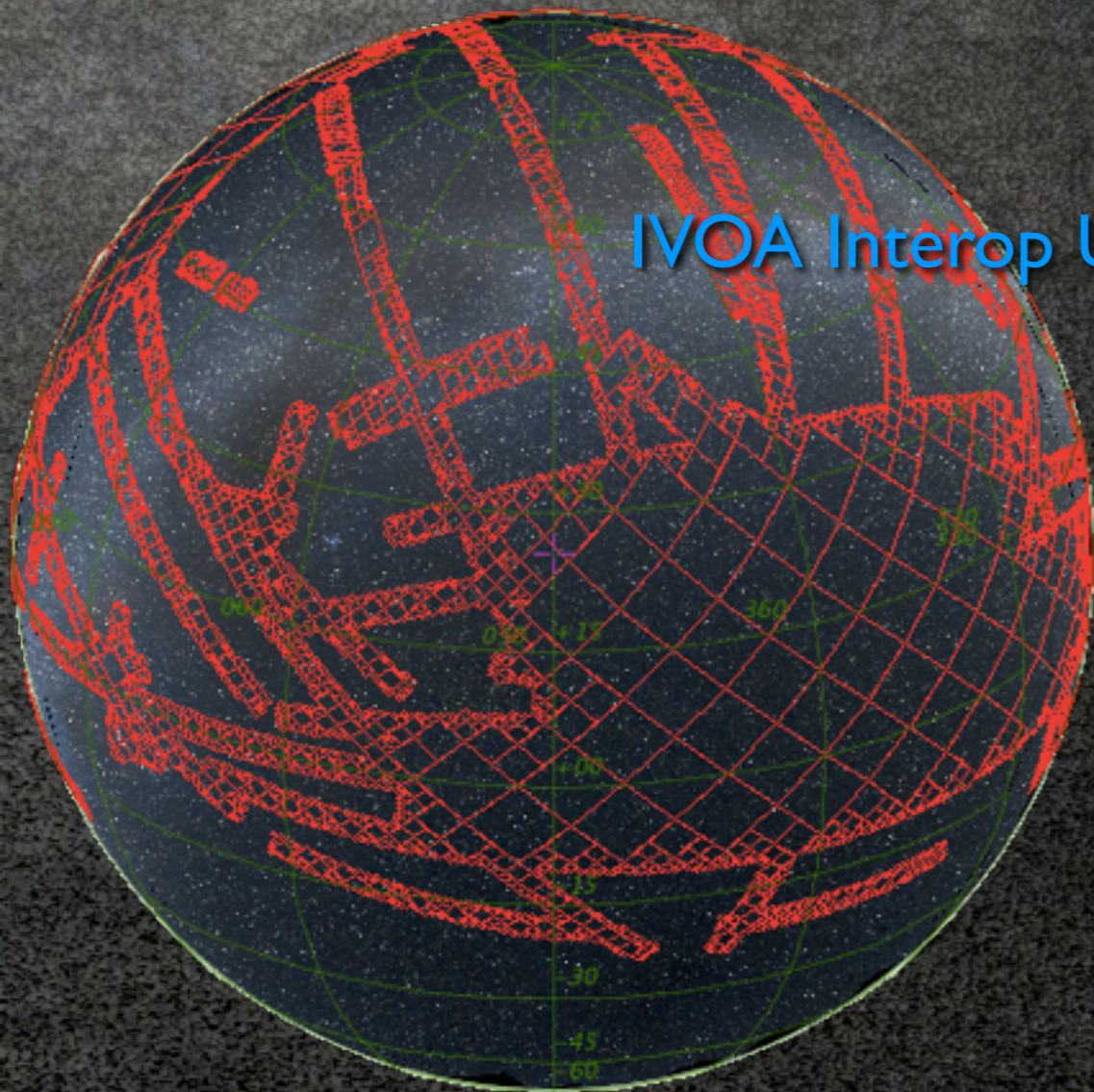


# MOC: Multi Order Coverage maps

*(Thomas Boch, Pierre Fernique, Mark Taylor)*

IVOA Interop Urbana Champaign, May 2012



# Brief reminder

- A **MOC** is a simple and powerful method to specify sky regions (datasets coverage)
- **Goals:** provide visualization, very fast comparisons of coverages, and data access methods
- **How:** based on HEALPix sky tessellation



A sky region  
=  
a list of HEALPix cells,  
grouped hierarchically

# History

*Jan 2011*

- First idea + prototype implementation in Aladin

*May 2011*

- Napoli Interop: presentation in Applications session
- MOC generation for Vizier catalogues

*Nov 2011*

- ADASS 2011: poster and proceedings

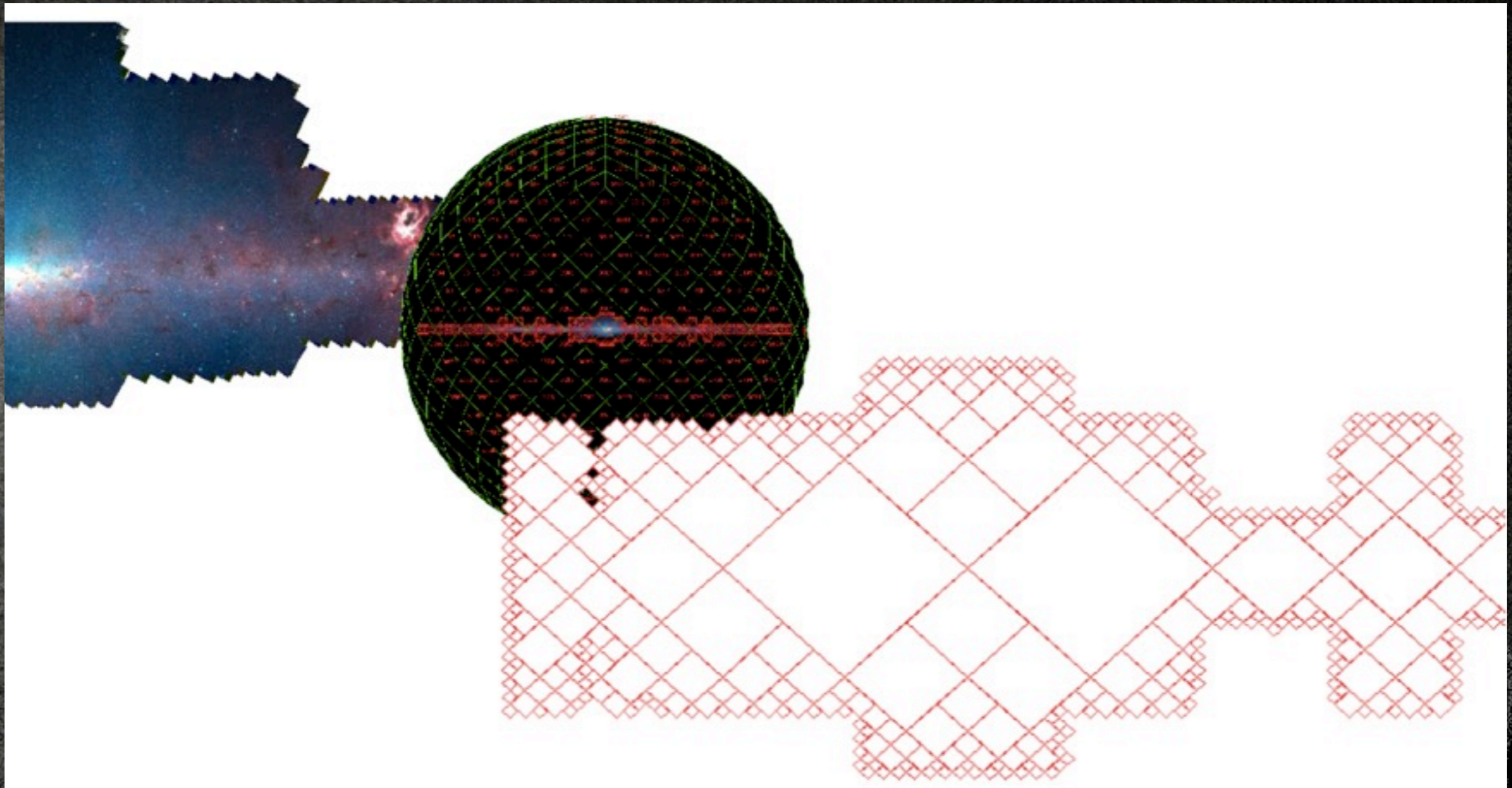
*Dec 2011*

- Implementation in TOPCAT (multiple cone search)

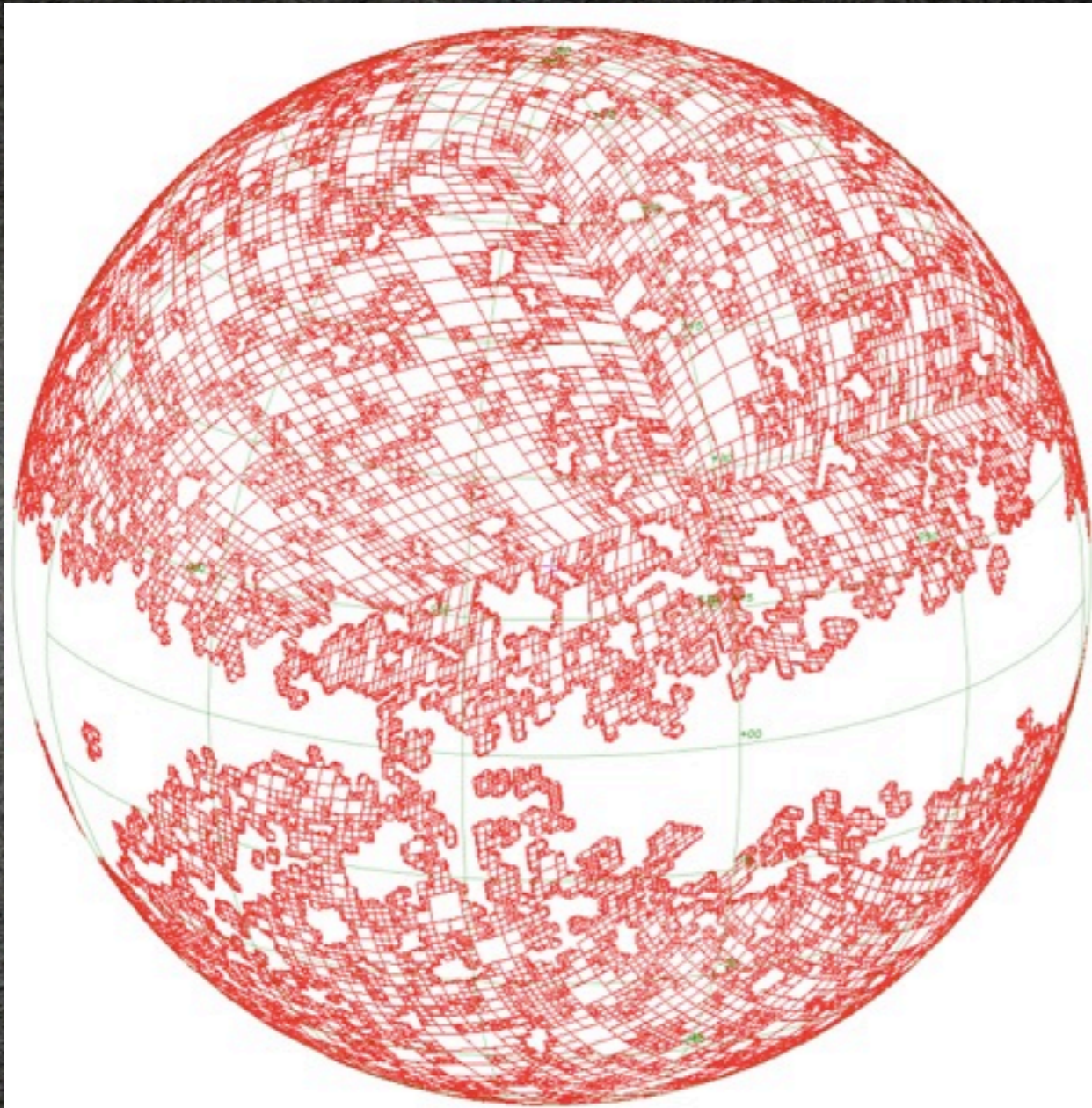
*Apr 2012*

- IVOA note (*Boch, Donaldson, Fernique, O'Mullane, Reinecke, Taylor*)

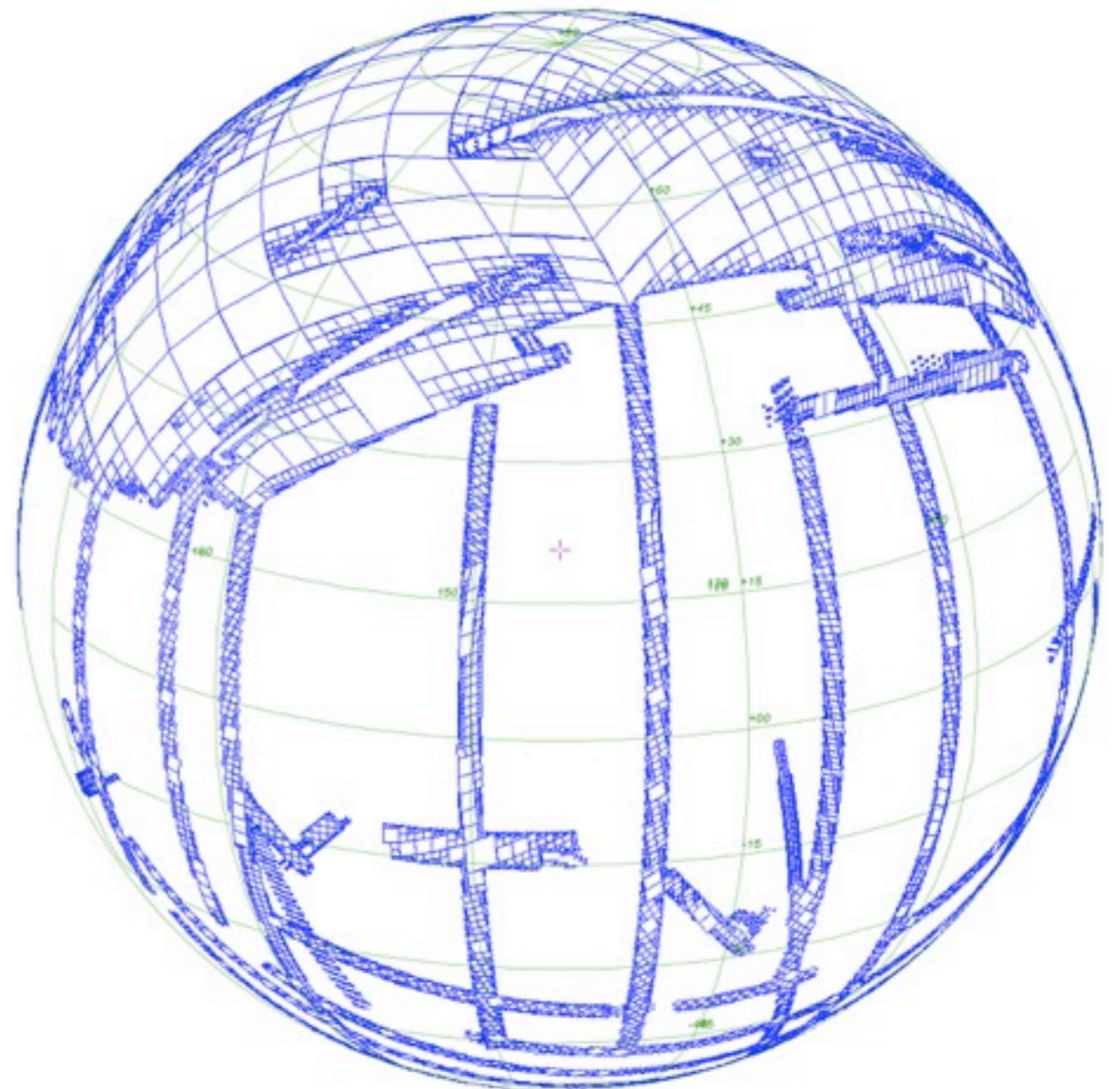
# From data to the MOC ...



*MOC from Spitzer images survey*

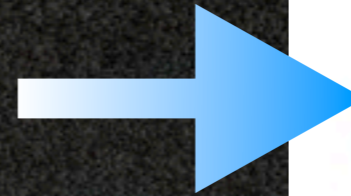


*GALEX AIS MOC (order 8 - 70,000 cells)*



*SDSS DR8 MOC (order 10 - 225,000 cells)*

## Details described in IVOA note



*International  
Virtual  
Observatory  
Alliance*

### MOC – HEALPix Multi-Order Coverage map

Version 1.0

IVOA Note 12<sup>th</sup> April 2012

Previous version(s):  
None

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#### Abstract

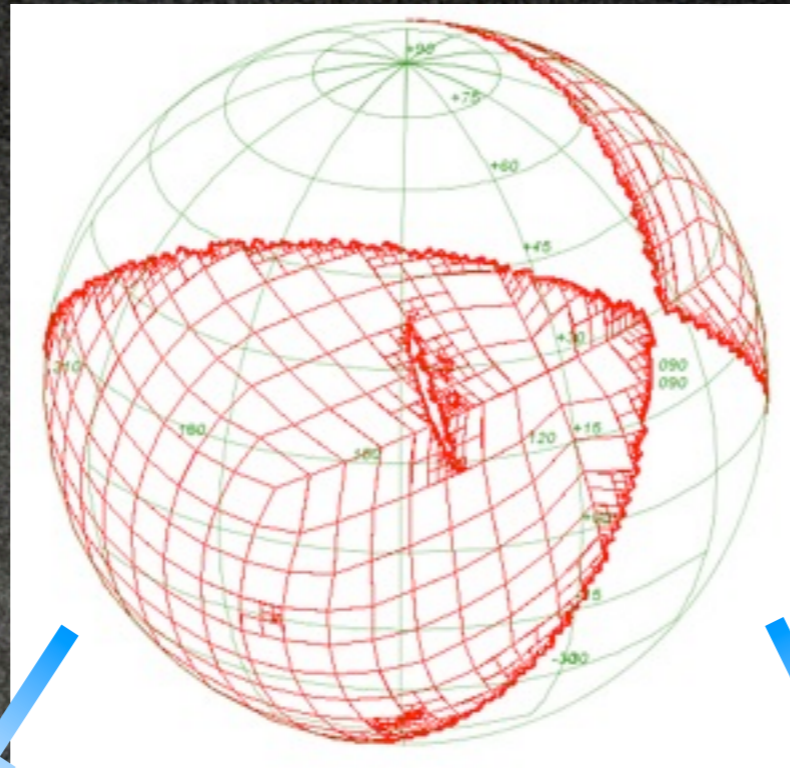
This note describes a simple and powerful method to specify sky regions. The goal is to have a way for providing very fast comparisons and data access methods. The principle is based on HEALPix sky tessellation. It boils down to defining a list of sky cells, grouped hierarchically. This method has been tested and validated in two tools: Aladin and Topcat, and in a front-end tool for Vizier catalogs.

- Why HEALPix ?
- Examples of use cases
- Scope and performances
- MOC encoding
- Libraries

## Java library available at

<http://cds.u-strasbg.fr/resources/lib/exe/fetch.php?media=mocsrc.jar>

# Two encoding formats



*performance*

*versatility*

**FITS MOC:** designed to be processed as fast as possible (serialization/deserialization in one fast step)

**JSON MOC:** easy to write, to read and to parse

`{"1": [1, 2, 4], "2": [12, 13, 14, 21, 23, 25], ...}`

**FITS binary table**

# Demo I

- Visualize in Aladin a VizieR catalogue MOC
- Find VizieR catalogues with a common intersection
- Compute the intersection between 2 VizieR catalogues MOCs

**MultiMoc tester**  
...just to demonstrate MOC potentialities...

This basic form provides an access to a remote server (tomcat+java servlet) containing about 10.000 VizieR table MOCs and a few Aladin image surveys MOCs. Select one catalog/survey (radio button) and you will see appear immediately the list of data set which intersect it. You can also drag & drop one of them into [Aladin \(beta\)](#) for displaying it. Use the two bottom fields for providing by hand a basic MOC, or just a sky position. A MOC (Multi-Order Coverage map) is a way to describe the sky region covered by a data set, such as a source catalog, a pixel survey, or others. A Java API is available [here](#).

**9948 MOCs loaded (190MB)**  
(loaded in 630ms by Tomcat server)

**I/283A/npm2**  
intersects 4898 catalogs/surveys  
(computed in 258ms)

2451)  [J/ApI/658/99/table1](#) (111 obj)  
2452)  [J/A+A/466/137/w2phot](#) (1 obj)  
2453)  [J/PASP/111/685/table1](#) (14 obj)  
2454)  [J/A+A/524/A25/planets](#) (8 obj)  
2455)  [J/A+A/377/945/table3](#) (12 obj)  
2456)  [J/AJ/127/2002/table1](#) (96 obj)  
2457)  [J/A+A/431/565/table3](#) (214 obj)  
2458)  [I/261/fennac](#) (865402 obj)  
2459)  [J/PAZh/34/21/table2](#) (394 obj)  
2460)  [J/ApI/715/429/table5](#) (28 obj)  
2461)  [J/AZh/84/387/table5](#) (487 obj)  
2462)  [J/A+A/444/79/table8](#) (13 obj)  
2463)  [J/AJ/134/411/y808](#) (13 obj)  
2464)  [J/ApI/671/1624/table2](#) (2 obj)  
2465)  [J/AJ/132/2409/table6](#) (128 obj)  
2466)  [J/ApIS/176/262/m6701](#) (12 obj)  
2467)  [J/MNRAS/360/782/table2](#) (27 obj)  
2468)  [J/A+A/454/171/table8](#) (7 obj)  
2469)  [J/ApIS/123/377/table5](#) (125 obj)

700)  [J/ApIS/145/329/sources](#) (71 obj)  
701)  [J/MNRAS/402/1380/table3](#) (15 obj)  
702)  [J/AJ/136/2070/tables](#) (124 obj)  
703)  [J/ApIS/191/232/table1](#) (16 obj)  
704)  [J/A+A/429/235/table3](#) (119 obj)  
705)  [VIII/68/catalog](#) (993 obj)  
706)  [J/ApI/622/129/table3](#) (14 obj)  
707)  [J/ApIS/190/100/table3](#) (17 obj)  
708)  [J/A+A/459/199/table1](#) (38 obj)  
709)  [J/ApI/593/1093/bf](#) (13 obj)  
710)  [J/AZh/72/493/table8](#) (27 obj)  
711)  [V/114/mx6/ir](#) (4889 obj)  
712)  [I/113A/catalog](#) (12237 obj)  
713)  [J/MNRAS/396/964/stars](#) (13 obj)  
714)  [J/A+AS/135/273/table2](#) (98 obj)  
715)  [J/ApIS/45/97/table2](#) (535 obj)  
716)  [III/195/objects](#) (77 obj)  
717)  [J/MNRAS/292/419/table6](#) (38 obj)  
718)  [J/AJ/123/873/table1](#) (197 obj)

→ **Intersection:**  
[I/283A\\_npm2](#)  
[J/VIII\\_23\\_6c4](#)





# A few figures

2.5 sec	Load the 7,000 VizieR MOCs at level 8
7 ms	Query by HEALPix cell: <i>amongst 7,000 VizieR tables, which tables have data in a given cell ?</i>
90 ms	Query by MOC: <i>which VizieR tables intersect a given MOC ?</i>
30 ms	Generation of MOC intersection <i>(between SDSS level 10 and GALEX level 8)</i>

# MOC and Multicone in TOPCAT

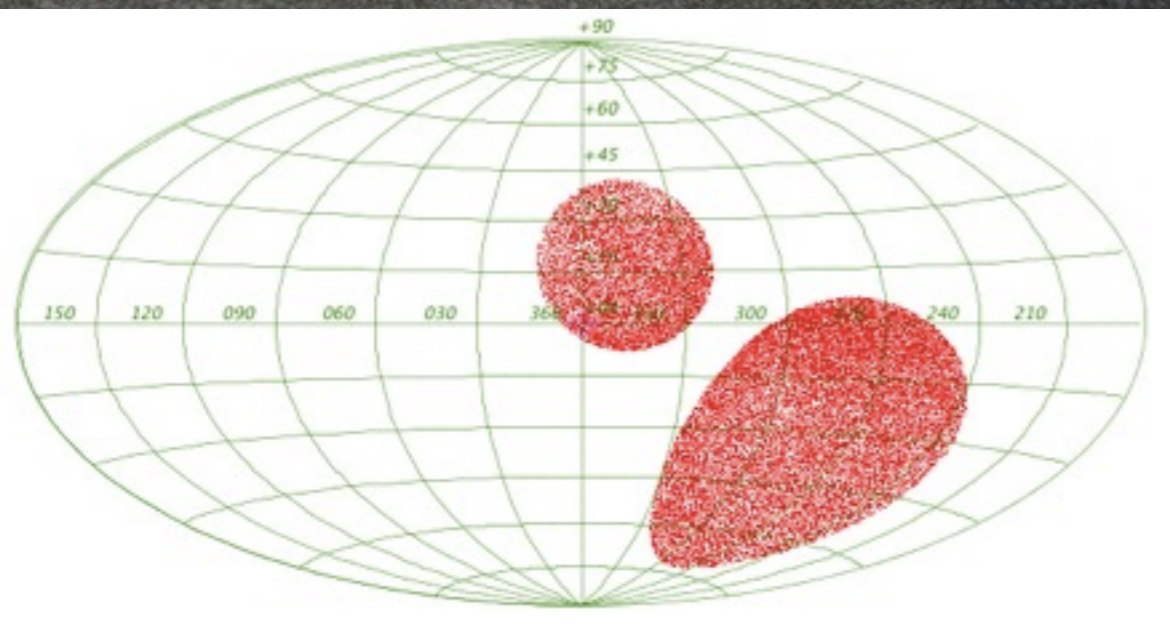


 Multicone

- Popular feature
  - Positional cross-match between a local table and a remote one
  - Multiple cone search queries
- Naive approach:
  - one query per row of the local table
  - in some cases, many unnecessary queries

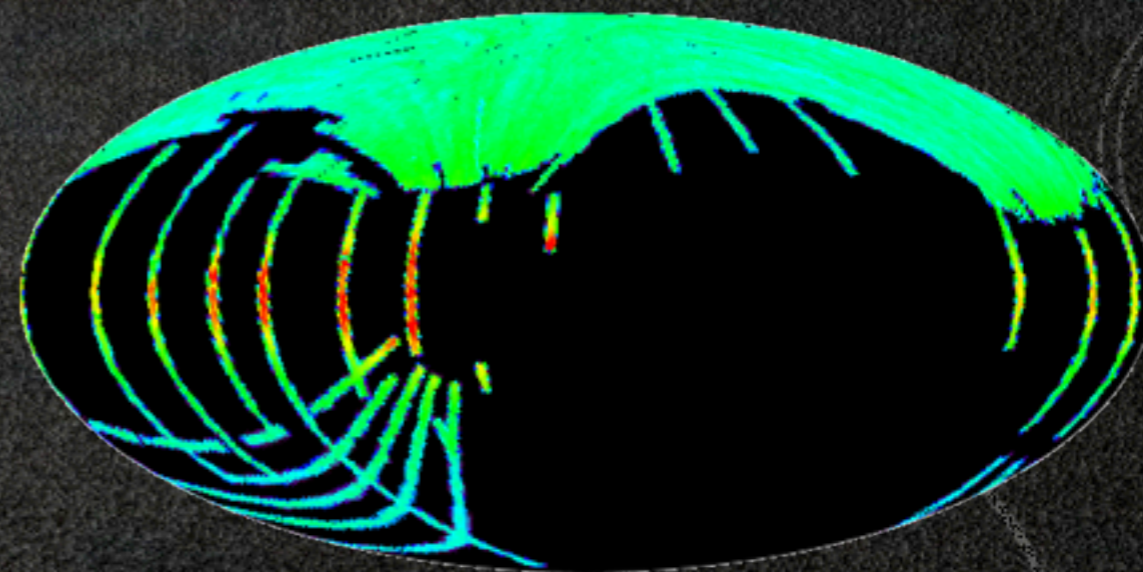
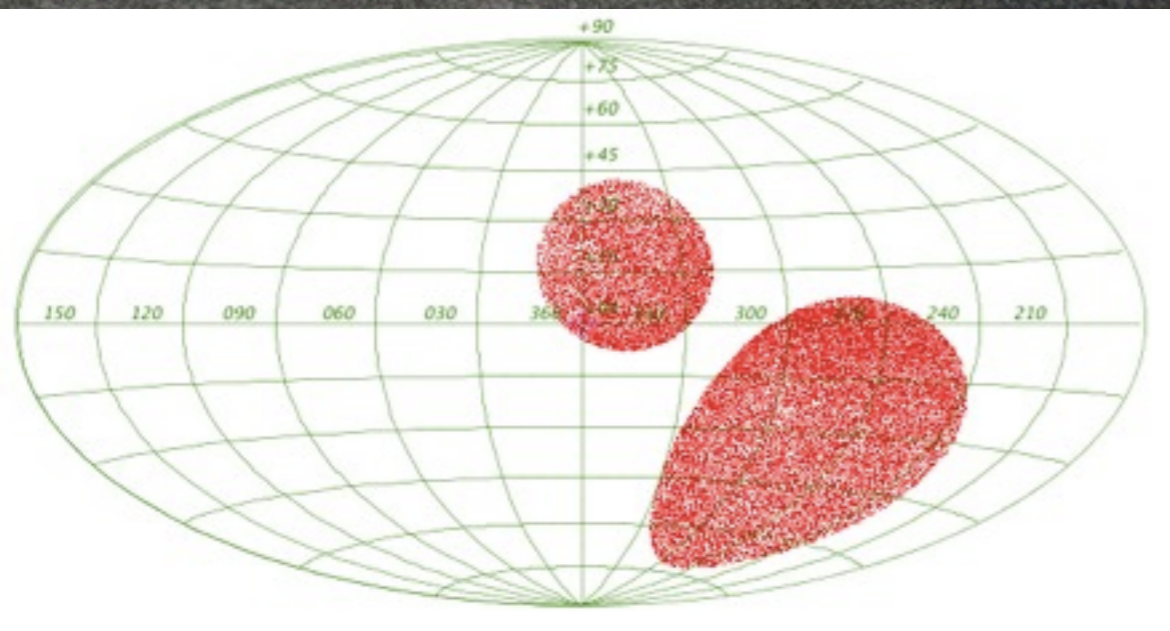
IVOA Interop Urbana Campaign  
May 2012 - T. Boch

Local table  
(22k rows)



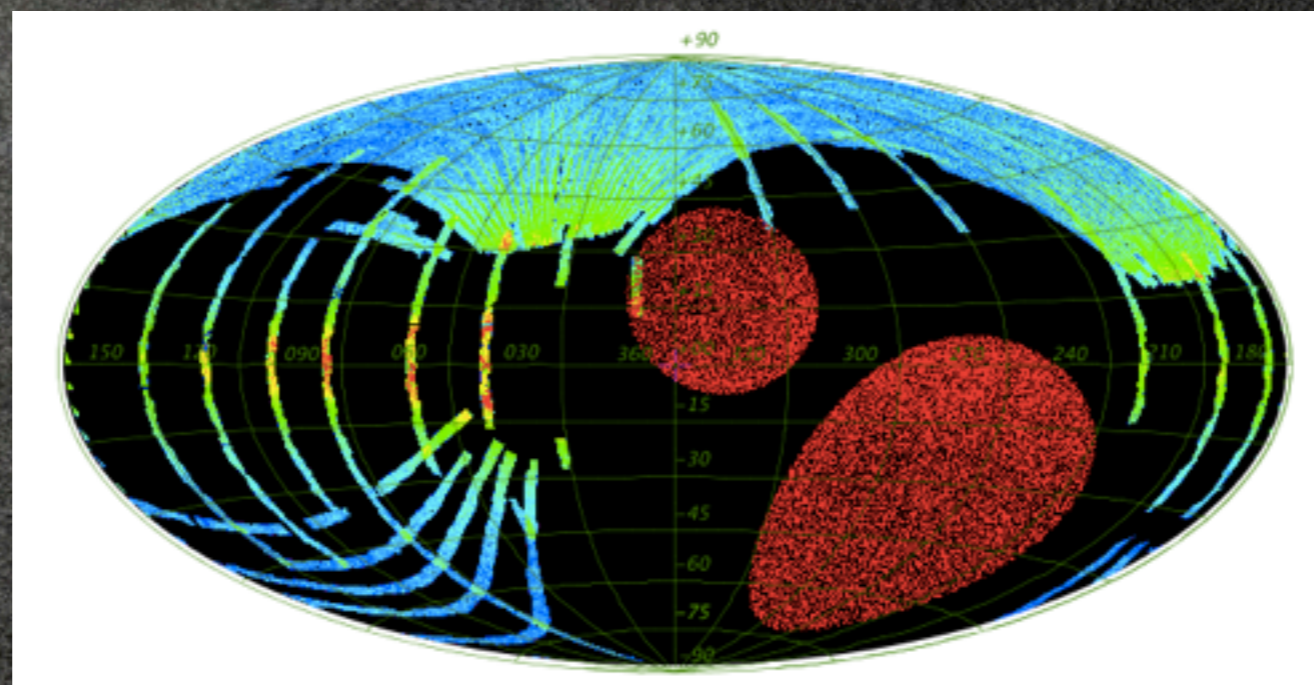
Local table  
(22k rows)

Cone search service  
(SDSS DR7)



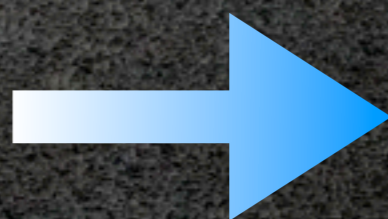
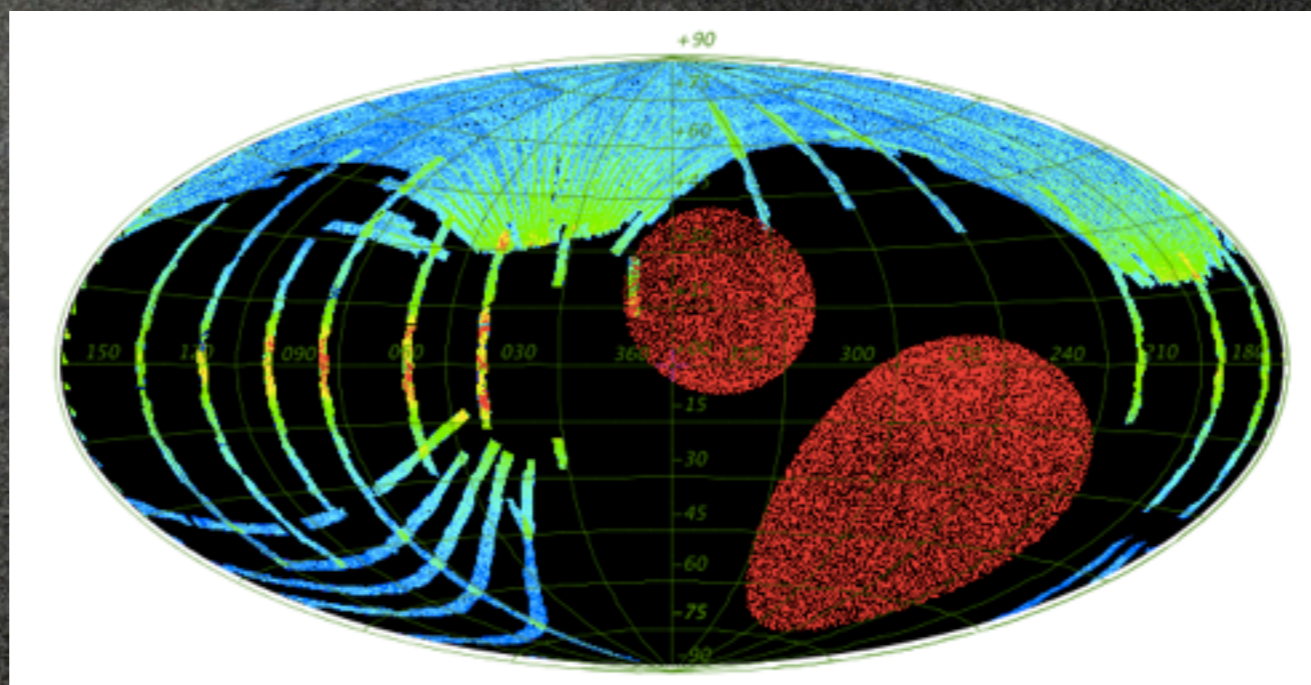
Local table  
(22k rows)

Cone search service  
(SDSS DR7)



Local table  
(22k rows)

Cone search service  
(SDSS DR7)



**Need knowledge of coverage  
for CS services**

# getMoc service

- Provides the global sky coverage (MOC) for a cone search resource
  - *Input:* cone search base url (+ nside)  
eg: <http://alasky.u-strasbg.fr/footprints/getMoc?baseUrl=http%3A%2F%2Fvizier.u-strasbg.fr%2Fviz-bin%2Fvotable%2F-A%3F-source%3DIII%2FI05%26>
  - *Output:* required MOC (serialized in FITS) or 404 error
- Available MOCs :
  - All 7,000+ registered VizieR cone search services (<http://alasky.u-strasbg.fr/footprints/tables/vizier/> )
  - Some cone search services managed by ROE (MOCs computed and provided by Mark Holliman) :  
UKIDSS, SDSS DR8, VISTA VHS



# Demo

Multiple Cone Search Parameters

Cone Search URL:

Input Table:

RA column:   (J2000)

Dec column:   (J2000)

Search Radius column:

Verbosity:

Output Mode:

Parallelism:  Error Handling:

- Feature available in TOPCAT pre-release  
( <ftp://andromeda.star.bris.ac.uk/pub/star/topcat/pre/> )
- makes use of VizieR tables MOC, in order to discard positions without potential counterparts
- Collaboration between CDS and Mark Taylor

# Perspectives

- In VizieR: provide access to catalogue data for a given MOC (*"give me the sources intersecting this MOC"*)
- Gather MOCs of non-VizieR cone search services (we provide with a Java tool to generate a MOC from a list of positions)
- MOCs to describe coverage of S\*AP/TAP services ?
- Replace the getMoc service with a link to the MOC at the registry level ?

# Links

- IVOA note : <http://ivoa.net/Documents/Notes/MOC/>
- MOC demonstrator : <http://alasky.u-strasbg.fr/MocServer/>
- MOC for VizieR tables :  
<http://alasky.u-strasbg.fr/footprints/tables/vizier/>