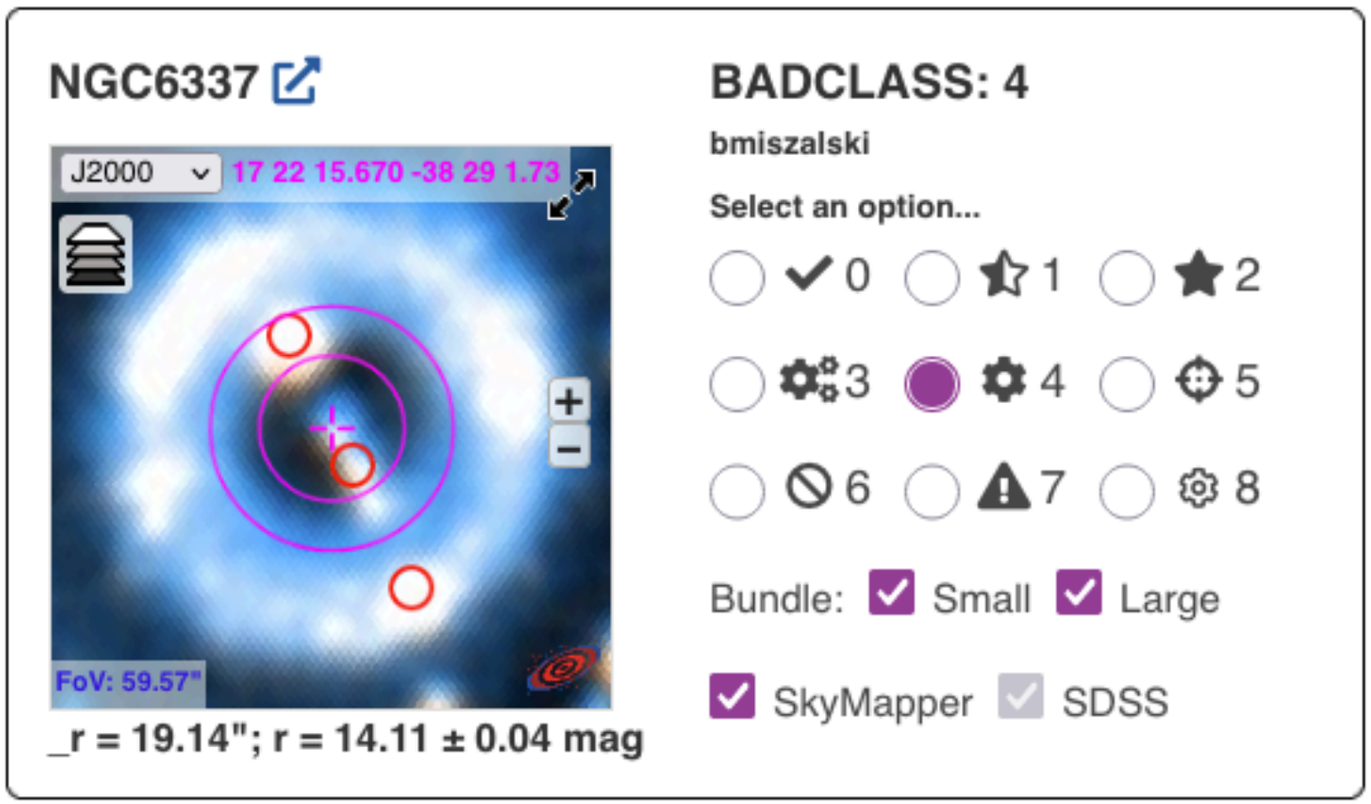
Modernising Target List Visualisation and Classification



Data Aggregation Service

Brent Miszalski

brent.miszalski@mq.edu.au

Simon O'Toole and James Tocknell

(AAO Macquarie)

data central

AAO

MACQUARIE University

Target Visualisation

- **Fundamental task for observational astronomers** often need to visualise large target lists (up to ~few 100k)

- **Planning for observing runs:** Select observing priorities. Instrument configuration and aperture (slit/fibre/IFU position, slit or IFU orientation, etc).

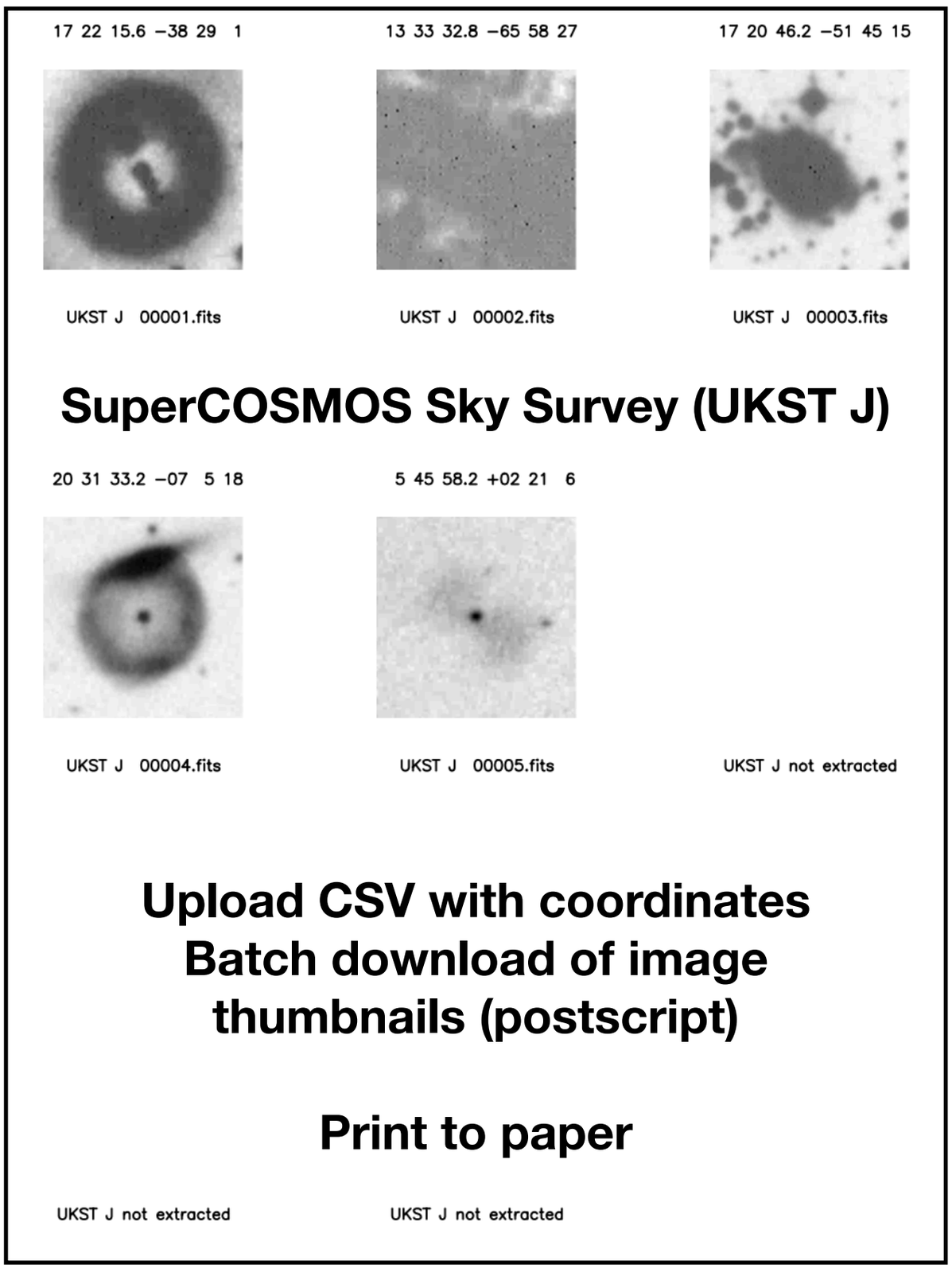
- **Image visualisation:** Identify problems (e.g. bright star, misclassified, coordinates offset). Select targets of interest (**extended sources**). Images may involve multiple wavebands (e.g. colour-composites).

- **Display auxiliary information:** Catalogue magnitudes, radial velocities, abundances, lightcurves, spectra, etc.

- **Embedded in complex workflows:** The above may be part of a data reduction or quality control pipeline. Even a Machine Learning pipeline.

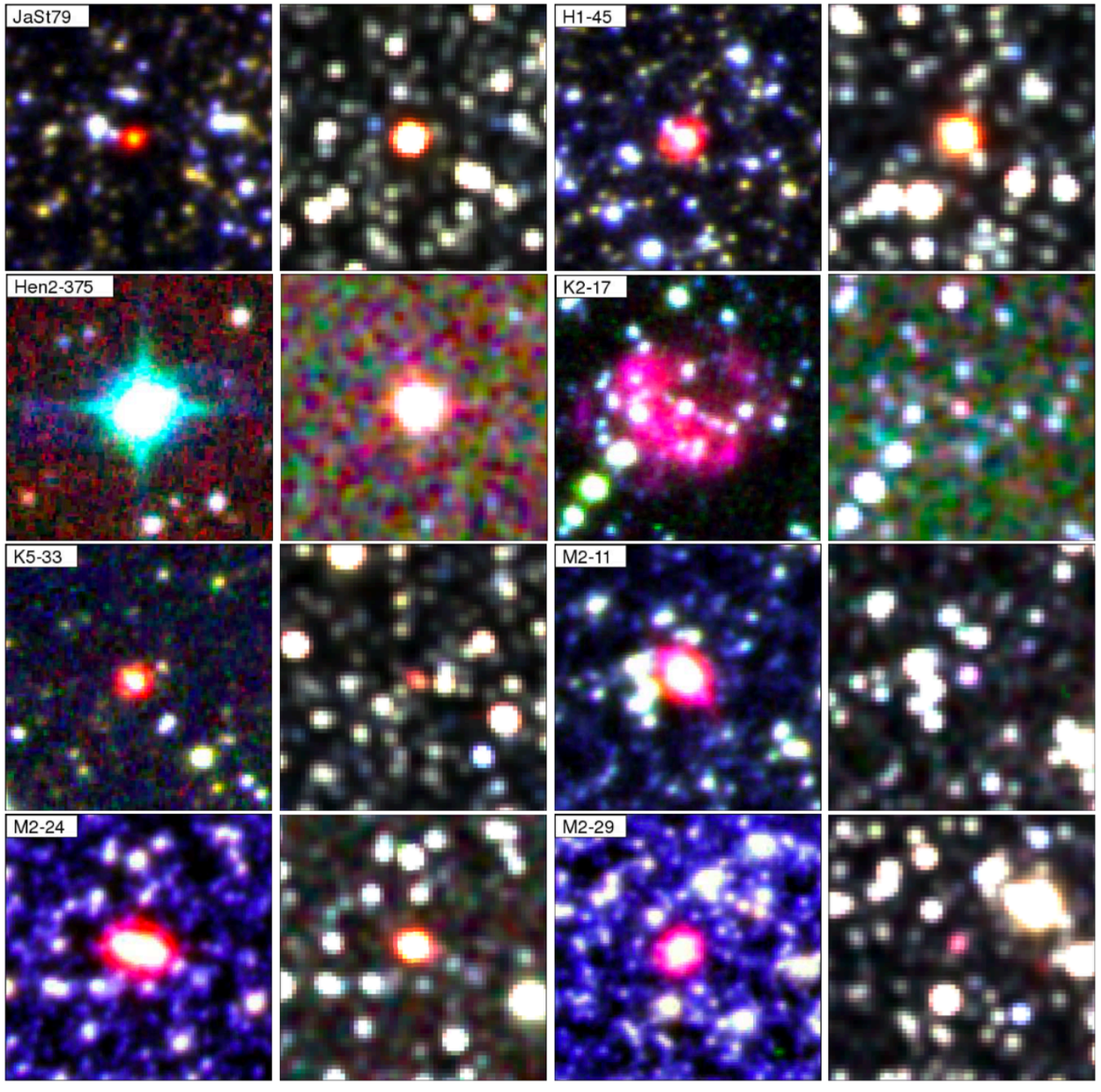
- **Flexible output formats:** CSV, input file for multi-object spectrograph, etc.

Traditional approach



SHS Halpha, SR
SSS Bj

2MASS J, H, Ks



Scripts to download data and create colour-composite thumbnails (Miszalski+2013, MNRAS, 432, 3186)

A static web page, PDF or a simple web application

Data Aggregation Service

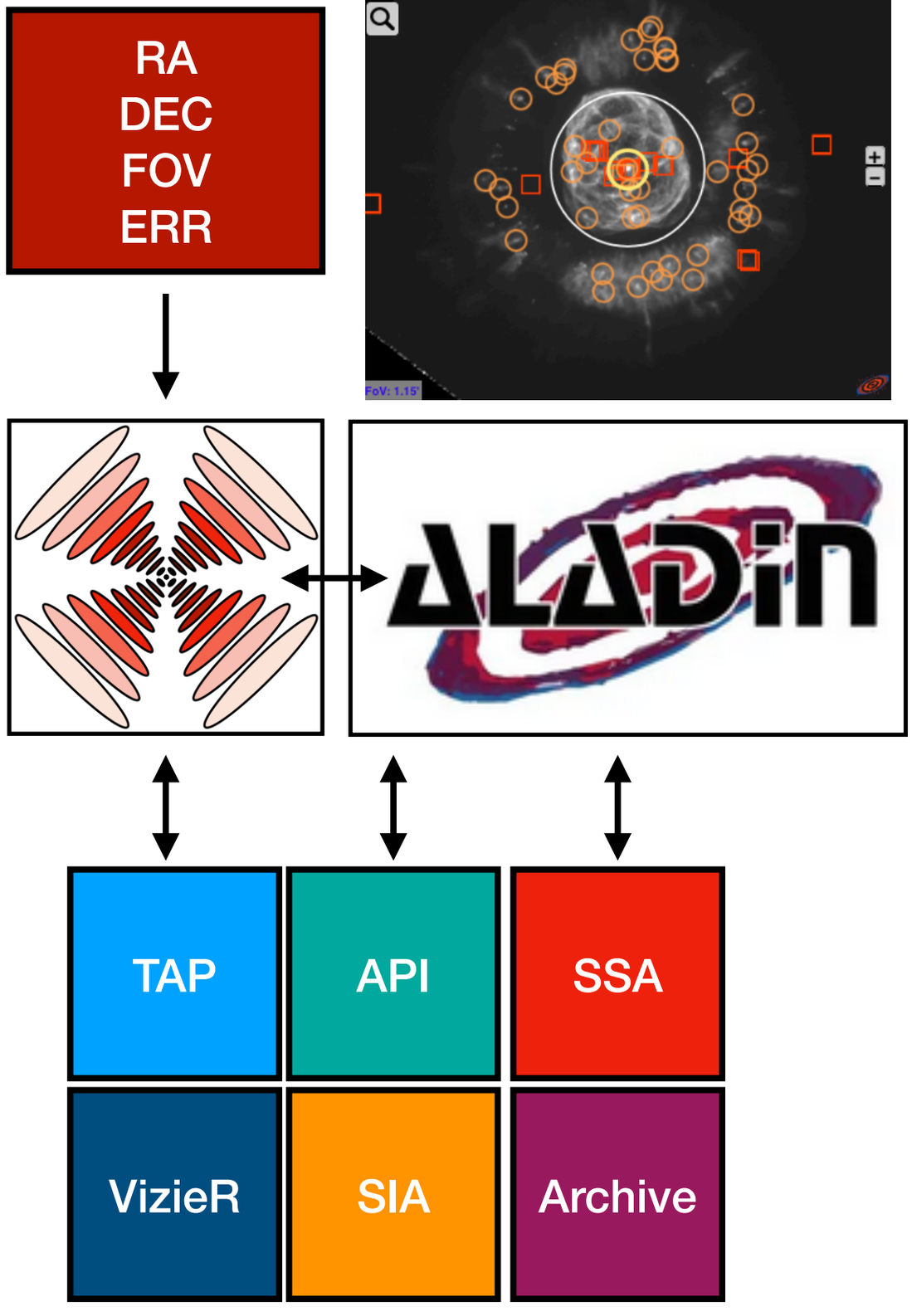
- **A web application** that simultaneously queries multiple online data services. Query results are displayed in browser and may be exported (TOPCAT and Aladin via Web SAMP, .csv, .xls, .vot)

- **Aladin Lite:** interactive visualisation of images and catalogues. Convert FITS to HiPS images on-the-fly.

- **Input GET parameters:** RA, DEC, FOV and ERR (position uncertainty).

- **Innovative features:** Refactored since May interop. Fast and **asynchronous** from the ground up (Starlette/uvicorn/socketio).

- See **ADASS 2021 talk** for more details. das.datacentral.org.au



Data Aggregation Service

data central

Data Aggregation Service

SAMP | Brent Miszalski | Overlay | Transparency: 100%

Enable | Logout | NONE

Catalogues | DCSSA | VizierTables | WISE | ESO | NVSS | SIMBAD | SkyMapper | TIC | DCSCS | GAIA | PS1 | ZTF

Catalogue	Status	SAMP	Excel	CSV	VOTable
LS	265 rows				
ZTF	241 rows				
ESO	139 rows				
PS1	106 rows				
TIC	36 rows				
GAIA	36 rows				
WISE	34 rows				
SkyMapper	32 rows				
DCSSA	3 rows				

Catalogues (Vizier, TAP, SSA, API)

- Toggle on/off
- Mouseover: highlights location in image
- Vizier tables: load on demand

Resolve Name

Resolve

Resolve name with Sesame

Right Ascension

307.888365097

Decimal degrees, "H M S" or "H:M:S"

Declination

-7.08834222636

Decimal degrees, "D M S" or "D:M:S"

FOV

2.0

Width of the field-of-view (arcmin)

Error radius

10.0

Radius of the error circle (arcsec)

Submit

SIMBAD Name resolver

Images | LS | PS1 | SkyMapper | FORS2 | Gemini

Images	Status	SAMP	Excel	CSV	VOTable
SMASH	0 rows				
LS	6 rows				
DES	0 rows				
HLA	0 rows				
PS1	5 rows				
SkyMapper	6 rows				
FORS2	1 row				
Gemini	4 rows				
DCSIA	0 rows				
DECAPS	0 rows				

Images (SIA, API, Custom Pipelines)

- Mouseover: display image
- Trigger downloads: Large images (HST)

das.datacentral.org.au

A more modern approach

- **Data Aggregation Service (DAS):** We can **repurpose** DAS functionality for target visualisation purposes. **Python 3** code: containerised (docker-compose).

- **Web application:** Access **IVOA DAL** and other services for images and catalogues. MongoDB database to manage classifications. API endpoints.

- **Asynchronous:** Leverage async capabilities of DAS to efficiently retrieve data from multiple sources. Results sent via websocket messages.

- **Aladin Lite:** Flexible visualisation of images and catalogues. Use **HiPS** and **MOC** and formats to individualise content of each target (display best images available, rather than display ‘No coverage’).

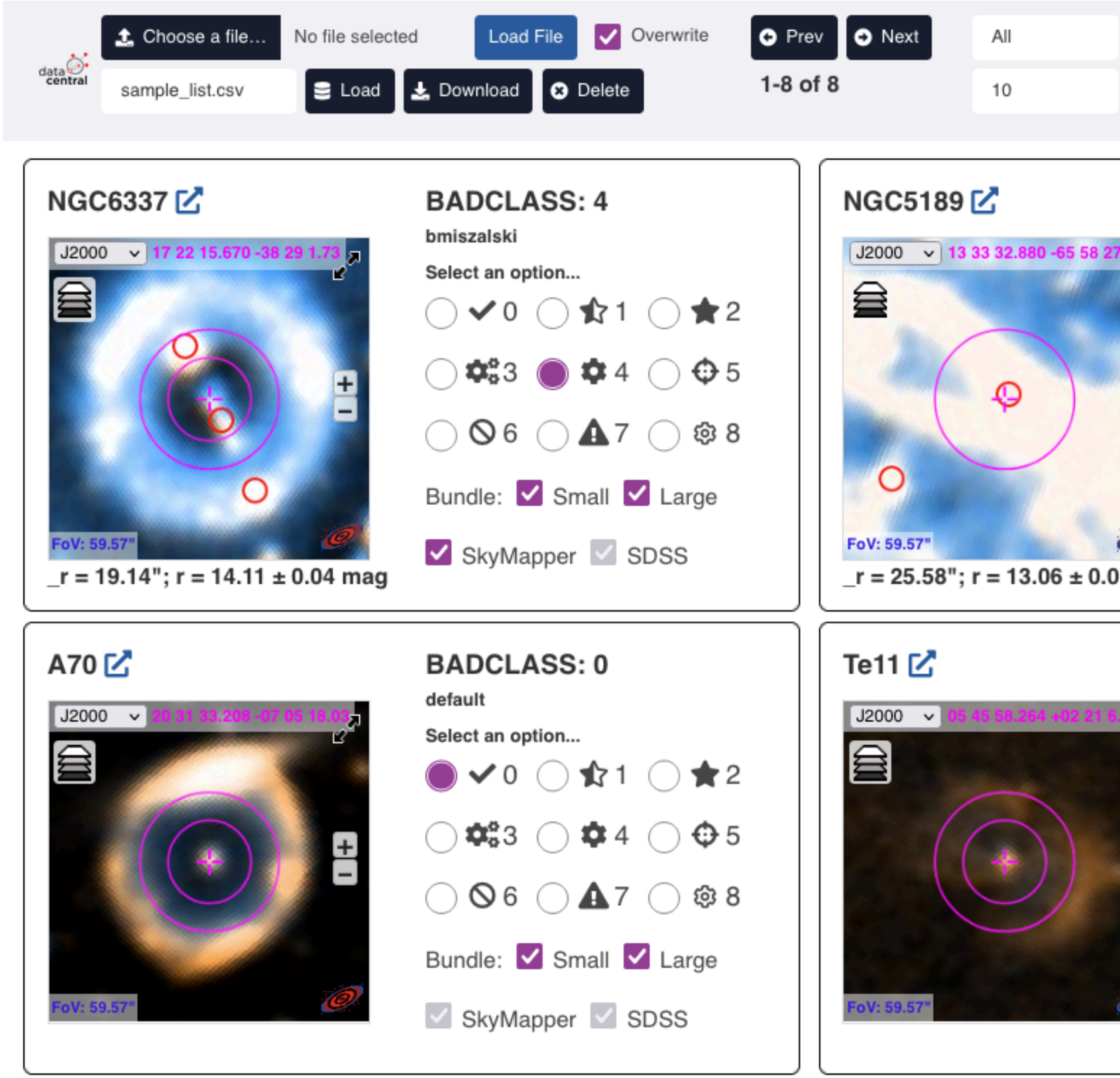
- **Powerful:** Heavy duty jobs handled by async background tasks, e.g. generation of image mosaics, careful analysis/transformation of image pixels (Machine Learning), (re)classification algorithms for whole target list

Overview

- **Target lists:** Import CSV into MongoDB database. User can classify targets and export results.

- **Aladin Lite:** Images and catalogues (**loaded asynchronously**) per target. Display instrument footprints.

- **Filter catalogues:** Radius and magnitude cuts using pandas. Mouseover to view.



Controls

Choose CSV file

Load selected file

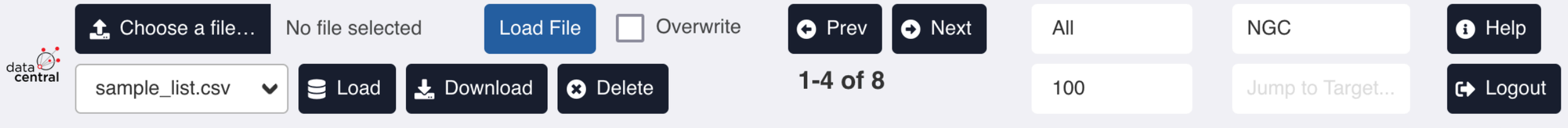
Overwrite file if already in DB

Classification filter (All, Unclassified, > 0, 1, 2, 3, 4, 5, 6, 7, 8)

Target name filter

Online help (modal)

Page Navigation



List of CSV files available in MongoDB database

Load file from database

Download CSV of selected database (includes user classifications)

Delete selected database

Target numbers displayed (Range of N Total)

Targets per page (1, 2, 3, 4, 5, 10, 15, 20, 30, 50, 100, 200)

Jump to target (resume at target of interest)

Logout (Data Central CAS server)

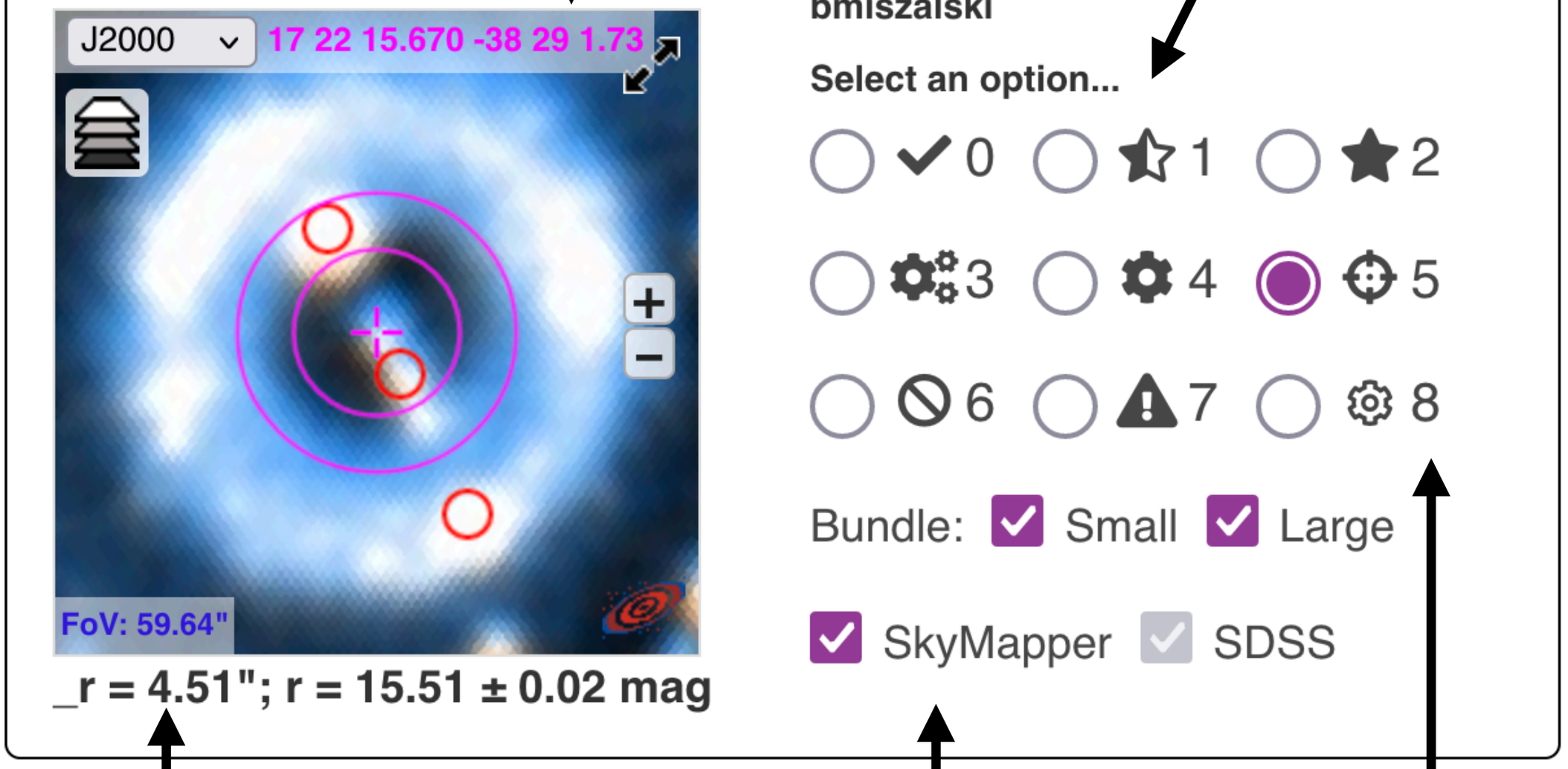
Link to target page (shareable URL)

Target name

Aladin Lite

Current classification and username of classifier

Label to remind user of class meaning (e.g. 4 - Large Galaxy)

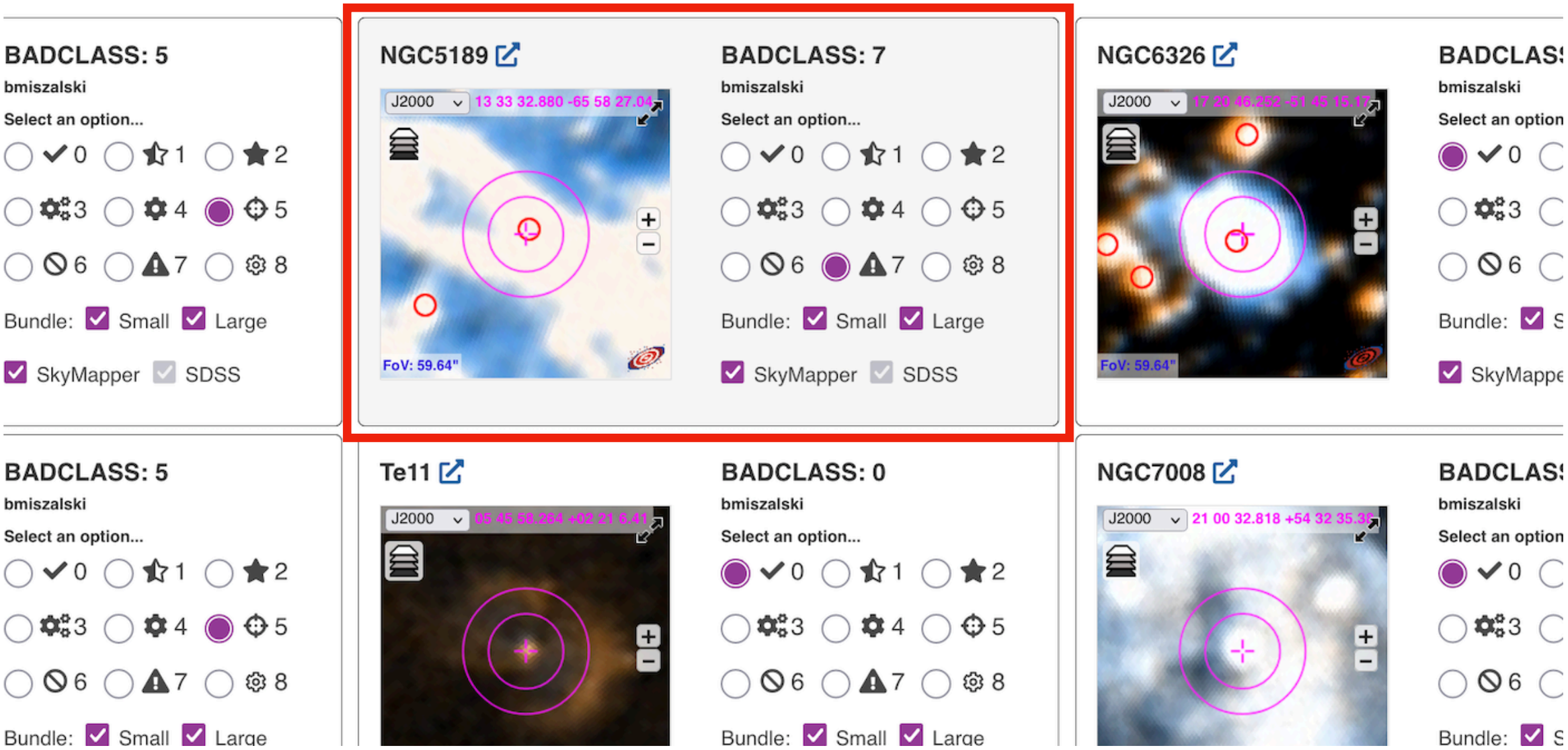


Label to display radial distance (arcsec) and magnitude of catalogued targets (updated on mouseover of target)

Toggle on/off Instrument footprints and loaded catalogues

Radio buttons to classify target

Navigation



- **Mouseover target of interest:** Active target (background shading)
- **Use 0-8 keys:** classification of active target
- **Use Left/Right keys:** Navigate to Prev/Next page of targets.
- **Number of targets per page:** 1 for keyboard only operation, or up to many per page…

Up to a few hundred per page

Targets fill page and adjust when window resized

Choose a file... pne.csv | Load File | Overwrite | Prev | Next | All | Filter Target... | Help

pne.csv | Load | Download | Delete | 101-200 of 200 | 100 | Jump to Target... | Logout

004.1-03.8 | BADCLASS: 0 | default | Select an option... | Bundle: Small Large | SkyMapper SDSS

004.2-03.2 | BADCLASS: 0 | default | Select an option... | Bundle: Small Large | SkyMapper SDSS

004.2-04.3 | BADCLASS: 0 | default | Select an option... | Bundle: Small Large | SkyMapper SDSS

004.2-05.9 | BADCLASS: 0 | default | Select an option... | Bundle: Small Large | SkyMapper SDSS

004.3+01.8 | BADCLASS: 0 | default | Select an option... | Bundle: Small Large | SkyMapper SDSS

004.3-02.6 | BADCLASS: 0 | default | Select an option... | Bundle: Small Large | SkyMapper SDSS

004.6+06.0 | BADCLASS: 0 | default | Select an option... | Bundle: Small Large | SkyMapper SDSS

004.7-11.8 | BADCLASS: 0 | default | Select an option... | Bundle: Small Large | SkyMapper SDSS

004.8+02.0 | BADCLASS: 0 | default | Select an option... | Bundle: Small Large | SkyMapper SDSS

004.8-05.0 | BADCLASS: 0 | default | Select an option... | Bundle: Small Large | SkyMapper SDSS

004.8-22.7 | BADCLASS: 0 | default | Select an option... | Bundle: Small Large | SkyMapper SDSS

004.9+04.9 | BADCLASS: 0 | default | Select an option... | Bundle: Small Large | SkyMapper SDSS

004.9-04.9 | BADCLASS: 0 | default | Select an option... | Bundle: Small Large | SkyMapper SDSS

005.0+03.0 | BADCLASS: 0 | default | Select an option... | Bundle: Small Large | SkyMapper SDSS

005.0+04.4 | BADCLASS: 0 | default | Select an option... | Bundle: Small Large | SkyMapper SDSS

005.0-03.9 | BADCLASS: 0 | default | Select an option... | Bundle: Small Large | SkyMapper SDSS

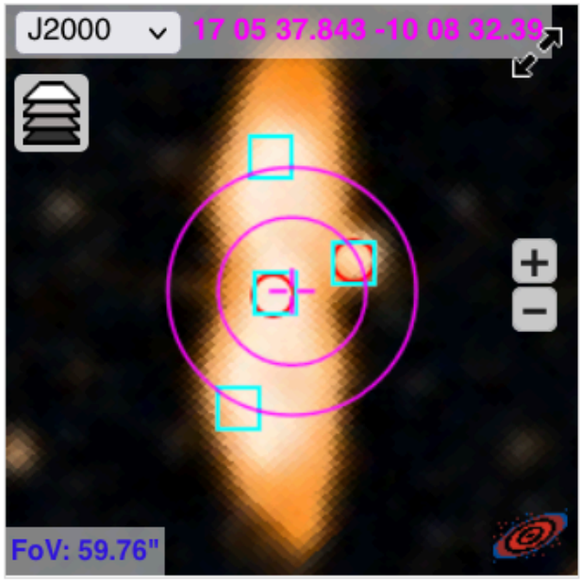
Jump to target

Enter target name
=> Navigate to its position
(resume classification from last target of interest)

Choose a file… | No file selected | Load File | Overwrite | Prev | Next | All | Filter Target... | Help

data central | pne.csv | Load | Download | Delete | 188-200 of 200 | 100 | 010.8+18.0 | Logout

010.8+18.0



BADCLASS: 0

default

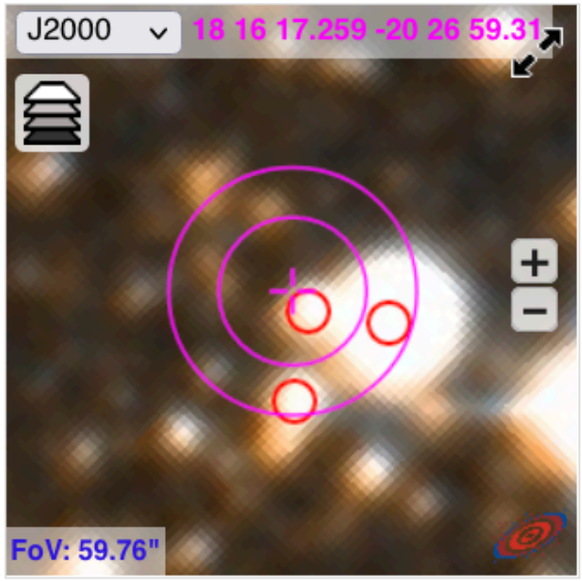
Select an option...

0 1 2
3 4 5
6 7 8

Bundle: Small Large

SkyMapper SDSS

010.8-01.8



BADCLASS: 0

default

Select an option...

0 1
3 4
6 7

Bundle: Small

SkyMapper SD

011.0+06.2

BADCLASS: 0

default

Select an option...

0 1 2
3 4 5
6 7 8

011.0-05.1

BADCLASS: 0

default

Select an option...

0 1
3 4
6 7

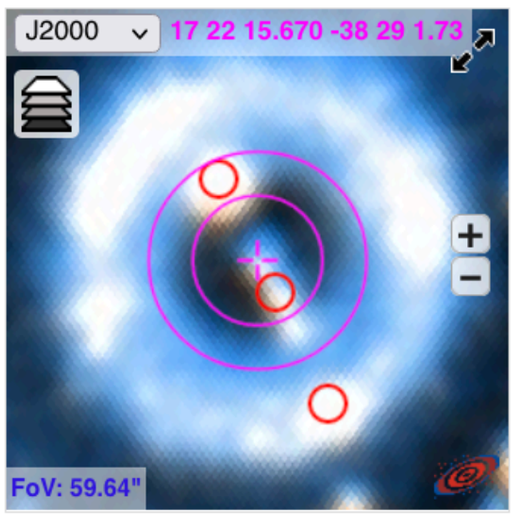
Filtering on target name

Uses pandas.Series.str.contains
(can also support regex, if needed)

Choose a file… | No file selected | Load File | Overwrite | Prev | Next | All | NGC | Help

data central | sample_list.csv | Load | Download | Delete | 1-4 of 8 | 100 | Jump to Target... | Logout

NGC6337



BADCLASS: 4

bmiszalski

Select an option...

○ ✔ 0 ○ ★ 1 ○ ★ 2

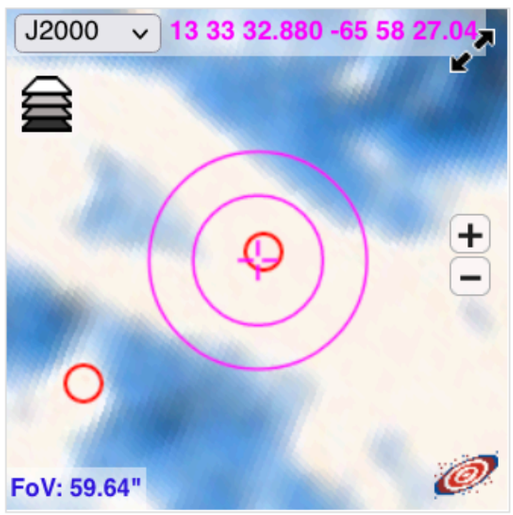
○ 3 ● 4 ○ 5

○ 6 ○ 7 ○ 8

Bundle: ☑ Small ☑ Large

☑ SkyMapper ☑ SDSS

NGC5189



BADCLASS: 7

bmiszalski

Select an option...

○ ✔ 0 ○ ★ 1 ○ ★ 2

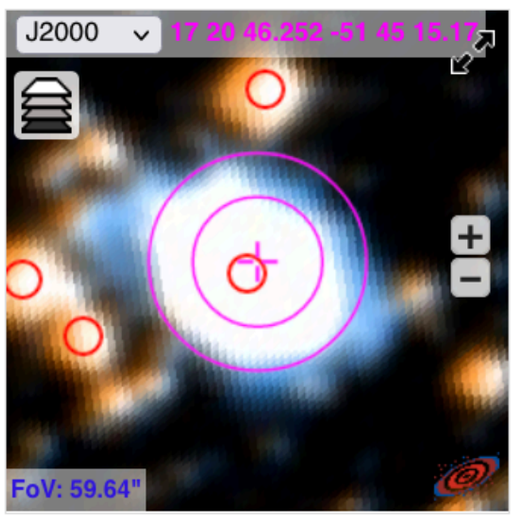
○ 3 ○ 4 ○ 5

○ 6 ● 7 ○ 8

Bundle: ☑ Small ☑ Large

☑ SkyMapper ☑ SDSS

NGC6326



BADCLASS: 0

bmiszalski

Select an option...

● ✔ 0 ○ ★ 1 ○ ★ 2

○ 3 ○ 4 ○ 5

○ 6 ○ 7 ○ 8

Bundle: ☑ Small ☑ Large

☑ SkyMapper ☑ SDSS

NGC7008

BADCLASS: 0

bmiszalski

Select an option...

● ✔ 0 ○ ★ 1 ○ ★ 2

○ 3 ○ 4 ○ 5

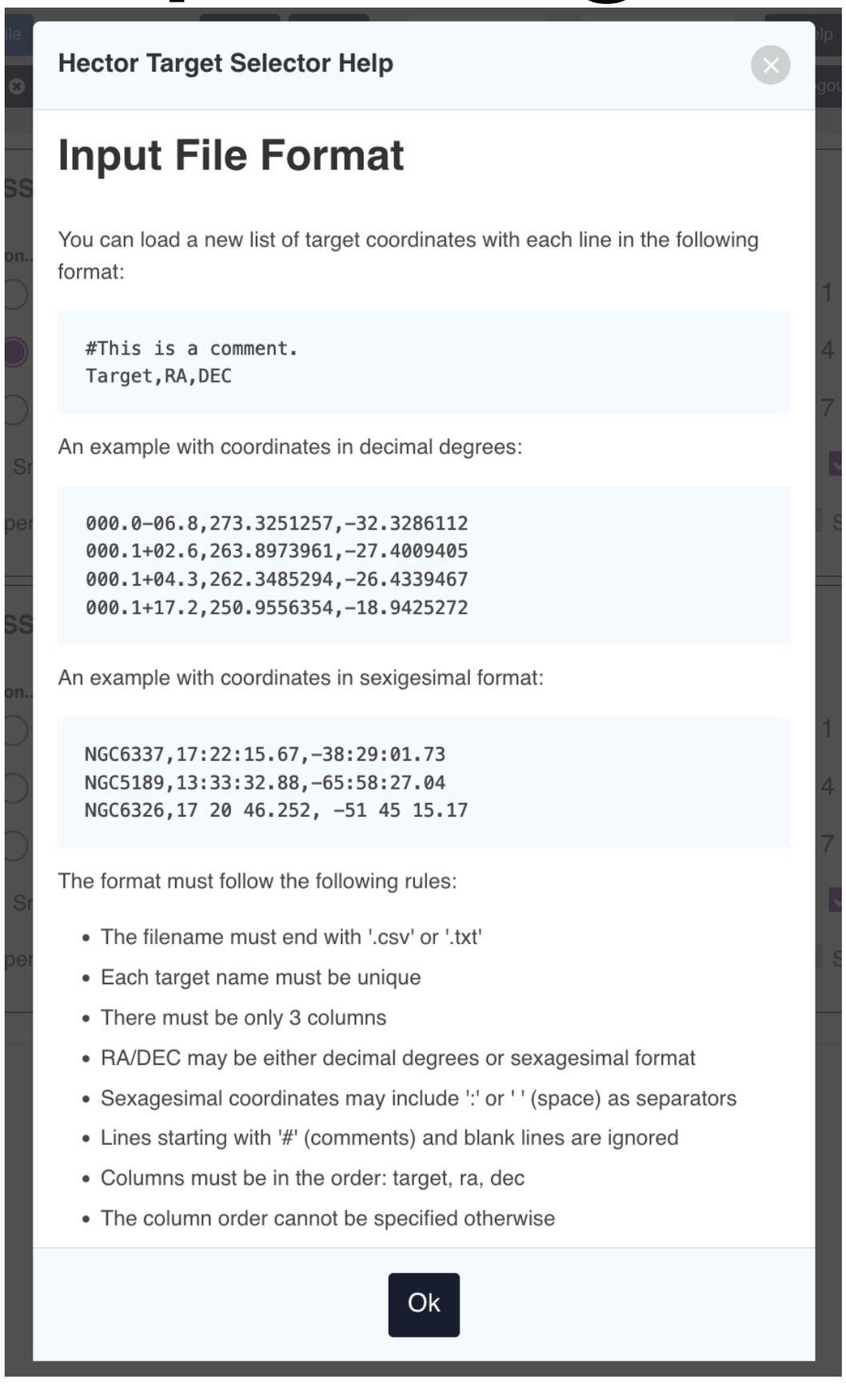
○ 6 ○ 7 ○ 8

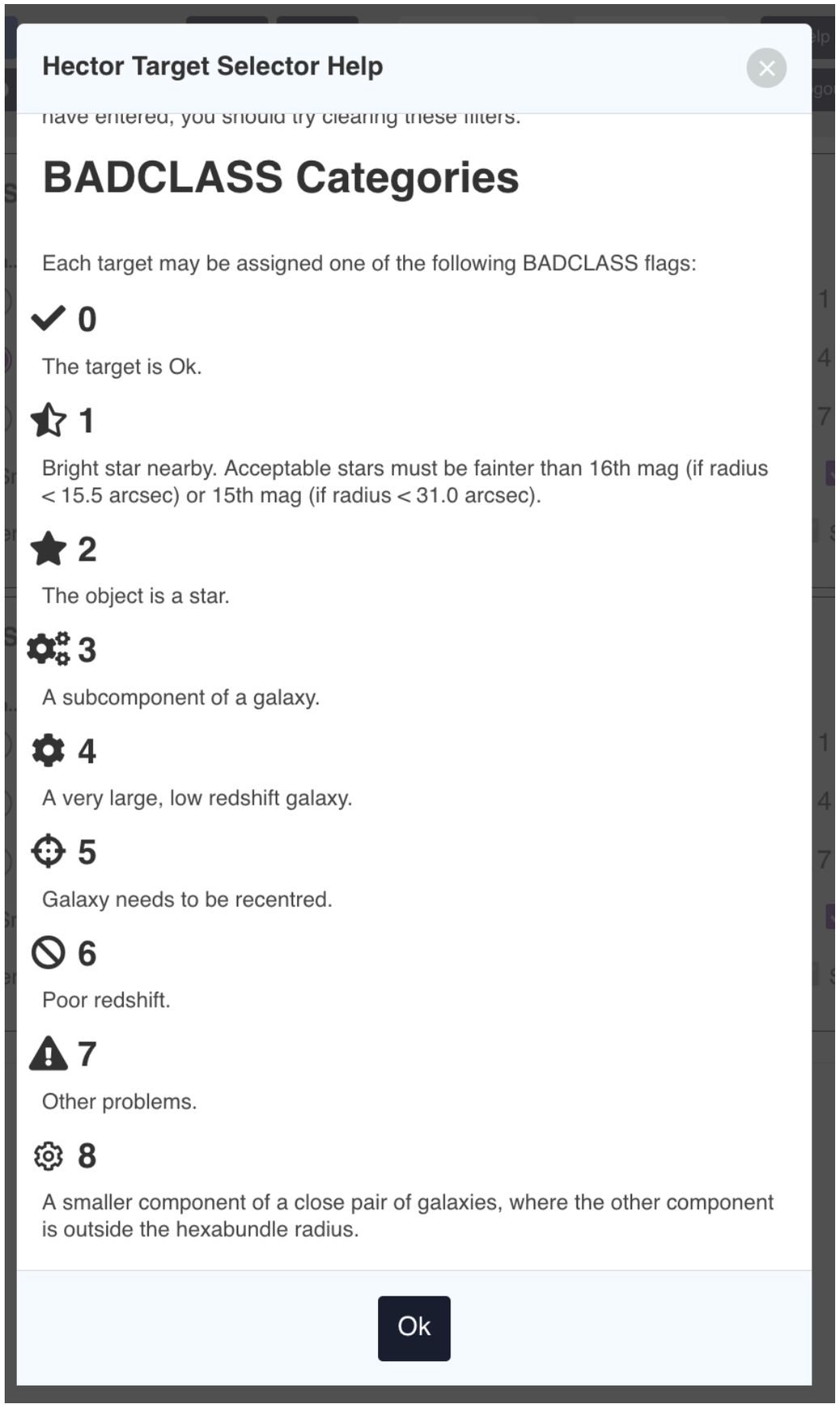
Bundle: ☑ Small ☑ Large

☑ SkyMapper ☑ SDSS

Help dialog

Provides answers to common questions
Reminds users of classification scheme





Future plans

- Used by Hector team to help prepare for upcoming observations (static images instead of Aladin Lite)

- A general Data Central service? Further investigation needed: how to best customise data sources, define classification schemes and other aspects.

- Input catalogue could be sourced differently: e.g. POST to API endpoint, accepting files exported from other applications (e.g. results of TAP query => visualise the list)

- Results of classifications could also be sent elsewhere (e.g. POST to JSON endpoint of an application for training or refining a machine learning model)

- Seeking collaborations to demonstrate neat use cases (machine learning, pipeline integration, etc.)