

ixpeobssim: a simulation
and analysis framework for IXPE

Michela Negro — Louisiana State University
Niccolò Di Lalla — Stanford University
Stefano Silvestri — INFN Pisa

Based on work done by a larger group
(see L. Baldidni et al., 2022, SoftwareX, Volume 19, id. 101194)

Simulation and Analysis

- ▷ Simulation and analysis framework:
 - ▷ Based on `python` programming language and the associated scientific ecosystem
 - ▷ Designed to produce **fast and realistic simulated IXPE observations**
 - ▷ Complemented by a **suite of post-processing applications** to select, bin and analyze simulated and real IXPE data
- ▷ Output data are:
 - ▷ Event lists in FITS format, containing a strict superset of the information included in the publicly released IXPE data products
 - ▷ Fully compliant with the visualization and analysis tools commonly used by the X-ray community (XSPEC, Sherpa, 3ML, DS9, HENDRICS).

Simulation – Several example provided

Installation, overview, documentation and tutorials are available:



If you download the package, you'll find examples of simulations at

`ixpeobssim/ixpeobssim/examples/`

- `cena.py`
- `instrumental_bkg.py`
- `ngc1068.py`
- `opp_sequence.py`
- `sgra.py`
- `toy_binary.py`
- `toy_casa.py`
- `toy_disk.py`
- `toy_gauss_disk.py`
- `toy_livetime_phase.py`
- `toy_livetime_time.py`
- `toy_magnetar.py`
- `toy_ms_pulsar.py`
- `toy_multiple_sources.py`
- `toy_offaxis.py`
- `toy_periodic_source.py`
- `toy_point_source_bkg.py`
- `toy_point_source_grayfilter.py`
- `toy_point_source.py`
- `toy_pollin.py`
- `toy_radial_disk.py`
- `toy_softwarex.py`
- `toy_tangential_disk.py`
- `toy_xspec_point_source.py`
- `tycho_3d.py`

Simulations with ixpeobssim

When is it recommended to use ixpeobssim simulations?

- Your source is **faint**
- Your source is **extended**
- your source is **variable** (or flux decaying in time) during the observation

Otherwise, webPIMMs should give a good enough MDP estimate

New release of ixpeobssim

Current version: ixpeobssim (33.2.1) - Fri, 26 Jun 2026 16:57:34 +0200

New IRFs

Adding new response files for calendar years 2025 and 2026, that should match precisely what is available on the HEASARC CALDB for the same time intervals (modulo the fact that ixpeobssim uses the arf files, while ixpecalcarf recalculates everything starting from the modulation factor and the quantum efficiency).

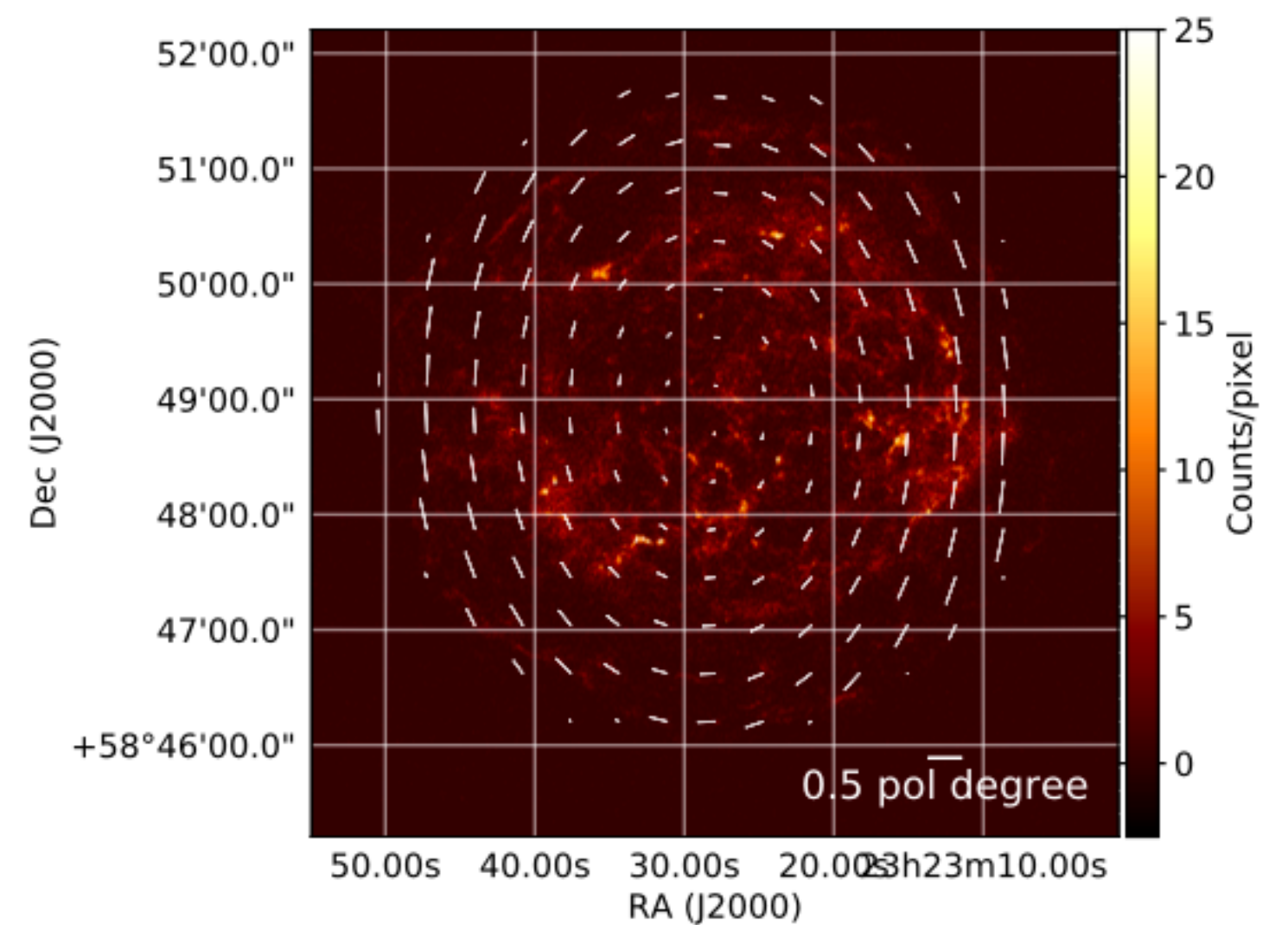
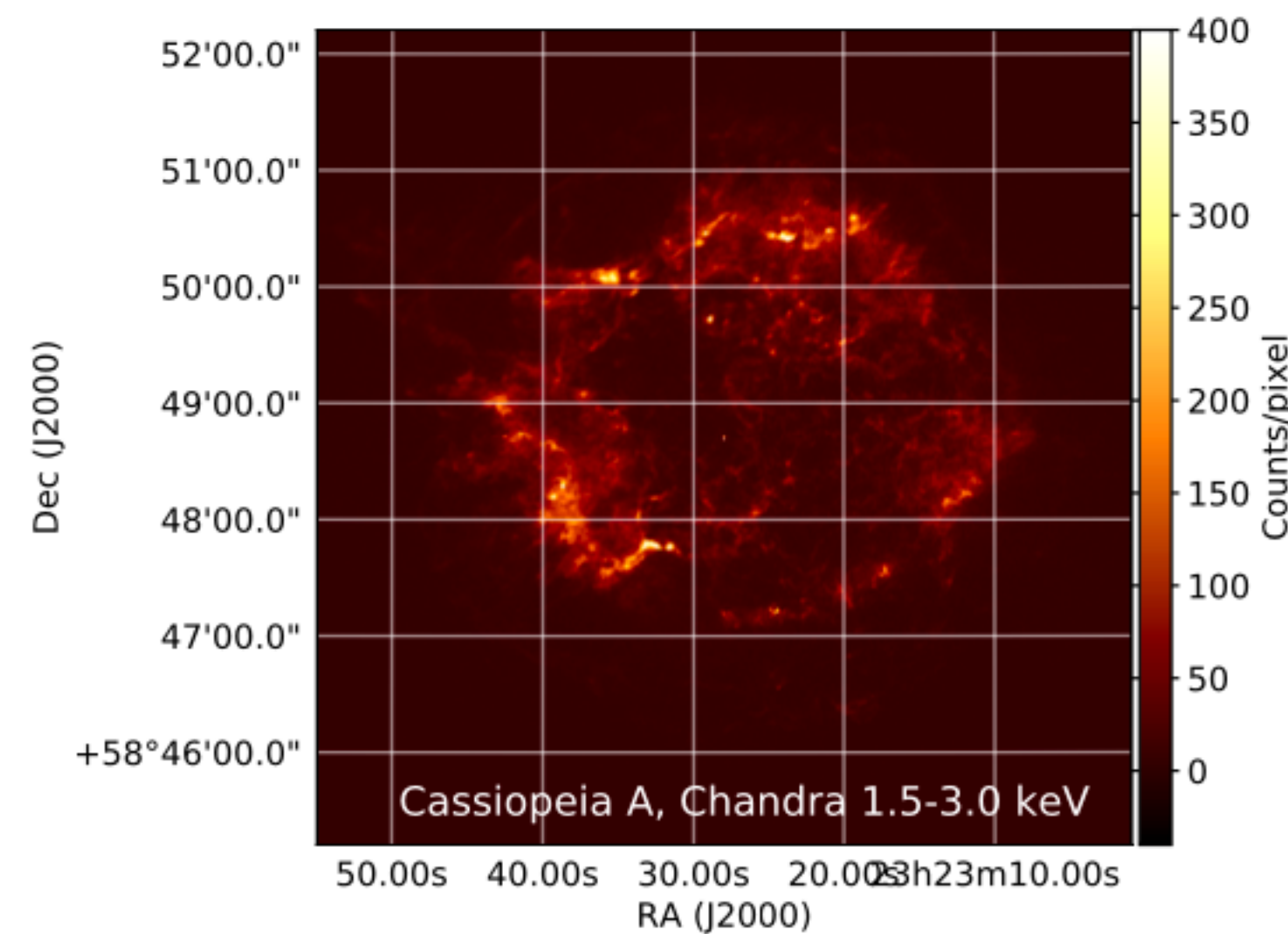
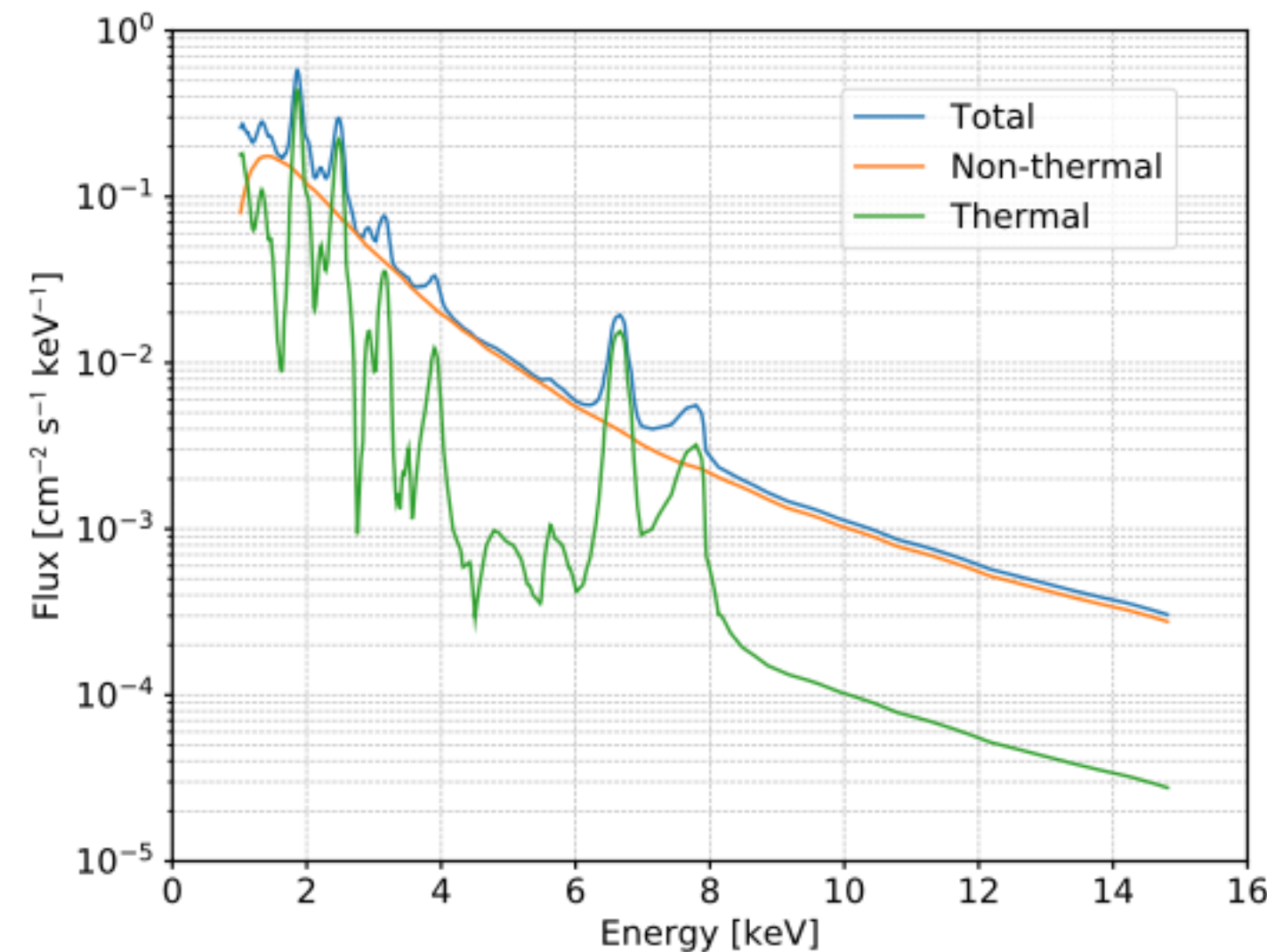
User has to select the appropriate set of IRFs (e.g. `irfname=ixpe:obssim20260701:v13`)

New background

All examples pointing to the new background template that only uses in-eclipse data.

Simulation – Source Model definition

- ▷ Need to define essentially three properties:
 - ▷ Morphology (point sources, disks, annuli, generic extended sources from FITS images)
 - ▷ Energy spectrum in units of $[\text{cm}^{-2} \text{s}^{-1} \text{keV}^{-1}]$
 - ▷ Polarization model (degree and angle, or Stokes parameters Q and U)
- ▷ Can use a Chandra photon list in lieu of defining morphology and spectrum
- ▷ Can overlay several components in the same model
- ▷ Support for time-dependent transient and periodic sources



Simulation – Configuration file example

Example of a point source with background

```
24 import numpy
25
26 from ixpeobssim.config import file_path_to_model_name, bootstrap_display
27 from ixpeobssim.srcmodel.bkg import xTemplateInstrumentalBkg
28 from ixpeobssim.srcmodel.polarization import constant
29 from ixpeobssim.srcmodel.roi import xPointSource, xROIModel
30 from ixpeobssim.srcmodel.spectrum import power_law
31 from ixpeobssim.utils.fmtaxis import fmtaxis
32 from ixpeobssim.utils.matplotlib import plt, setup_gca
33
34
35 __model__ = file_path_to_model_name(__file__)
36
37
38 # Source coordinates, in decimal degrees.
39 SRC_NAME = 'EX Hydrae'
40 SRC_RA, SRC_DEC = 193.101, -29.2489
41
42 # Pointing coordinates
43 PNT_RA, PNT_DEC = SRC_RA, SRC_DEC
44
45 # Spectral and polarimetric parameters
46 PL_NORM = 1.8e-2
47 PL_INDEX = 1.65
48 PD = 0.08
49 PA = -30.
50 SPEC = power_law(PL_NORM, PL_INDEX)
51 POL_DEG = constant(PD)
52 POL_ANG = constant(numpy.radians(PA))
53
54 # Definition of the sources and the region of interest.
55 SRC = xPointSource('EX_Hydrae', SRC_RA, SRC_DEC, SPEC, POL_DEG, POL_ANG)
56 BKG = xTemplateInstrumentalBkg()
57 ROI_MODEL = xROIModel(PNT_RA, PNT_DEC, SRC, BKG)
58
```

Define Source name and coordinates

Define the spectral and polarization parameters

Define the Region of Interest (RoI): Source + background

Simulation – Configuration file example

Example of a point source with background

```
def run():  
    """Run all.  
    """  
    simulate()  
    select()  
    bin_  
  
if __name__ == '__main__':  
    pipeline.bootstrap_pipeline('toy_point_source_bkg')
```

This simulated the fits files

This runs basic analyses to see the results

Simulation – Run script

Example of a point source with background

```
import numpy

import ixpeobssim.core.pipeline as pipeline
import ixpeobssim.config.toy_point_source_bkg as input_model
from ixpeobssim.binning.polarization import xBinnedPolarizationCube

DURATION = 500000.

def simulate():
    """Run the simulation.
    """
    pipeline.xpobssim(duration=DURATION, saa=False, occult=False)
```

- ▷ Simulate an observation starting from an arbitrary source model:
 - ▷ Calculate the expected number of events by convolving the source spectrum with the effective area and extract the event times based on the light curve
 - ▷ Extract the true energies and sky positions and smear them with energy dispersion and PSF
 - ▷ Generate the angular distribution of the photoelectrons according to the polarization model
- ▷ With more components the simulation is separately performed for each one and the resulting photon lists are then merged together.

Simulation – Analyze

Example of a point source with background

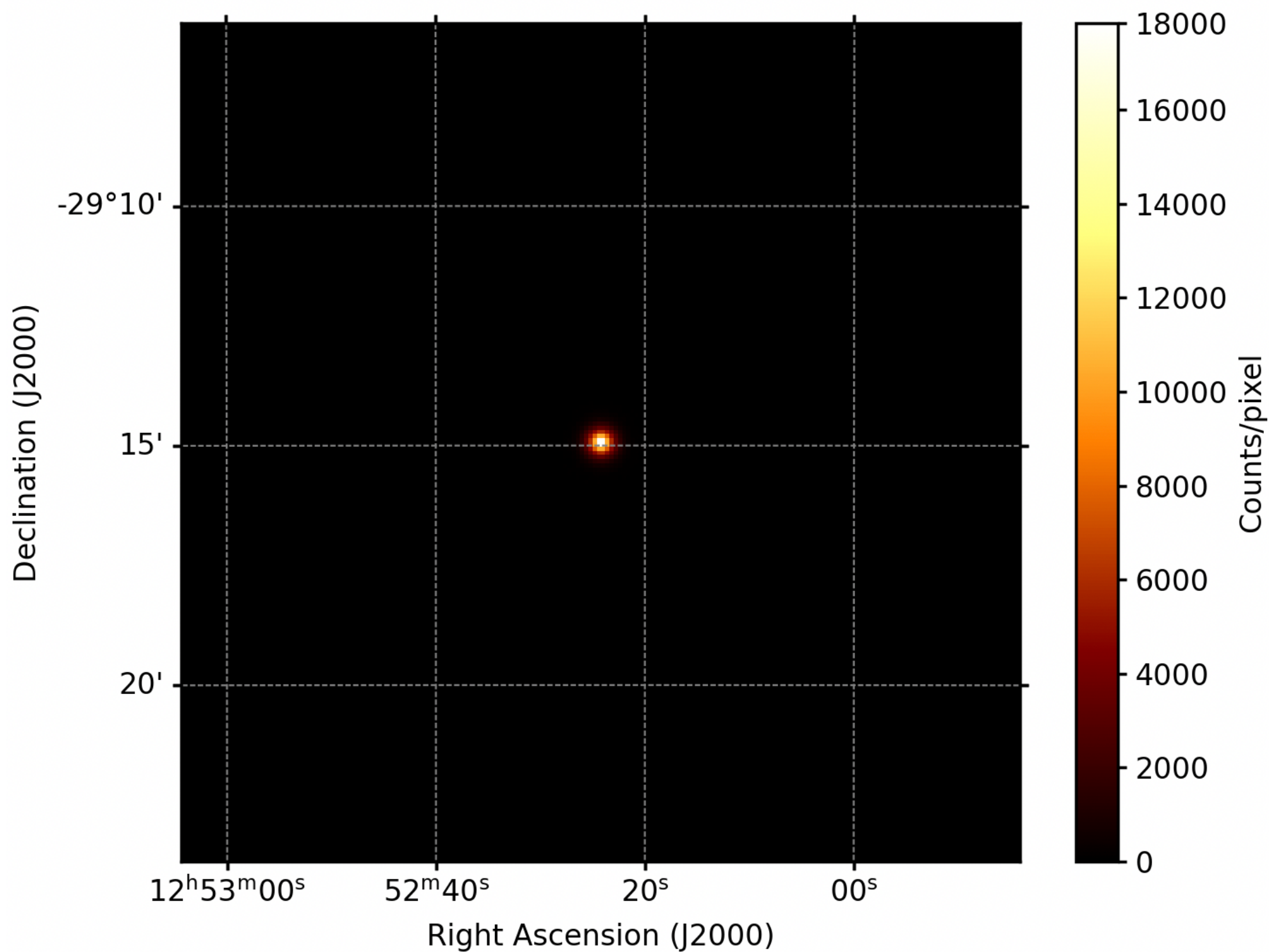
```
def select(src_rad=0.75, bkg_inner_rad=1.5, bkg_outer_rad=3.):
    """Select the photon lists.
    """
    file_list = pipeline.file_list()
    pipeline.xpselect(*file_list, rad=src_rad, suffix='src')
    pipeline.xpselect(*file_list, innerrad=bkg_inner_rad, rad=bkg_outer_rad, suffix='bkg')

ENERGY_BINNING = numpy.array([2., 3., 4., 5.5, 8.])

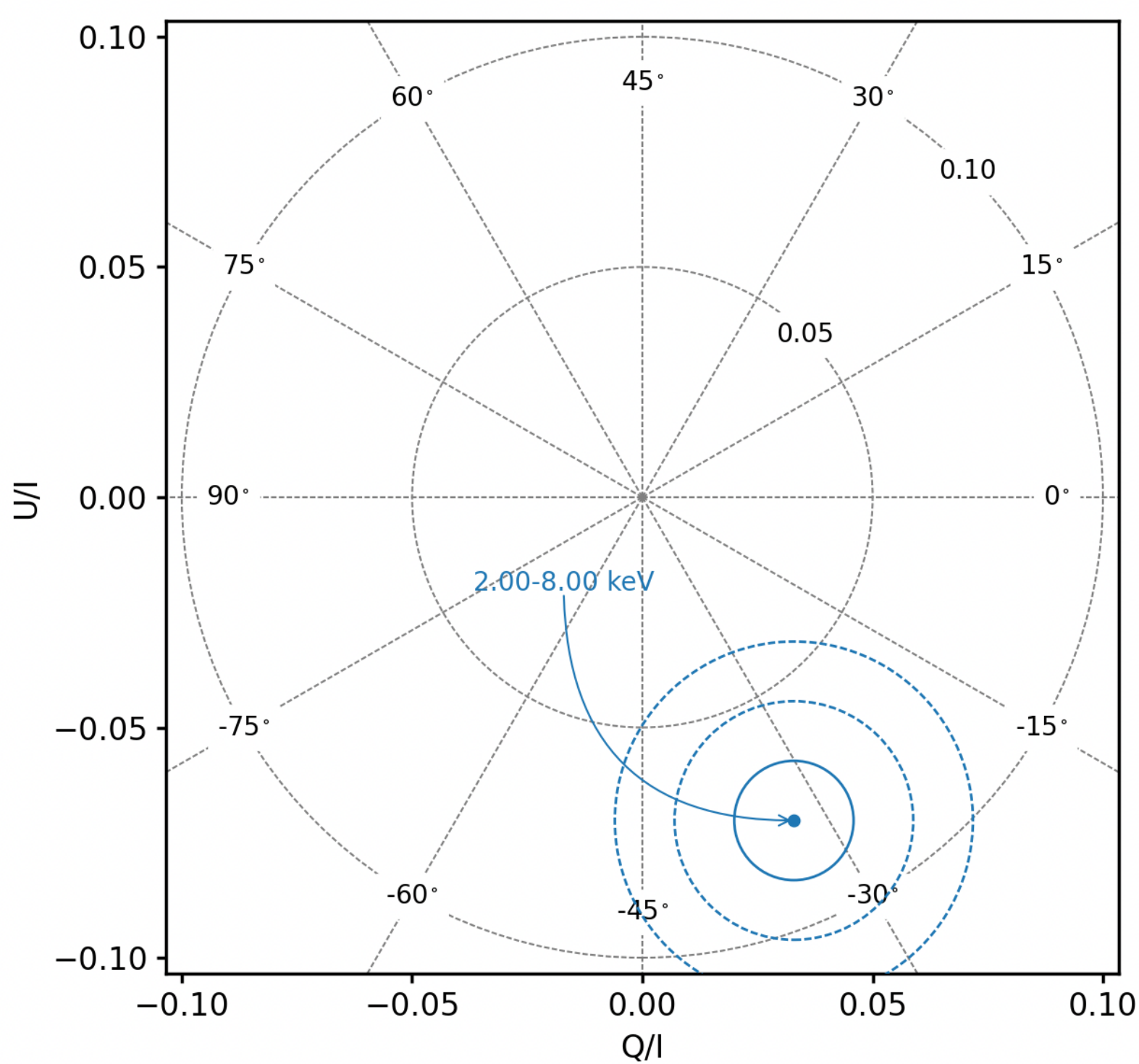
def bin_():
    """Create the necessary binned files.
    """
    pipeline.xpbin(*pipeline.file_list(), algorithm='CMAP')
    pipeline.xpbin(*pipeline.file_list('src'), algorithm='CMAP')
    pipeline.xpbin(*pipeline.file_list('bkg'), algorithm='CMAP')
    kwargs = dict(algorithm='PCUBE', ebinalg='LIST', ebinning=ENERGY_BINNING)
    pipeline.xpbin(*pipeline.file_list('src'), **kwargs)
    pipeline.xpbin(*pipeline.file_list('bkg'), **kwargs)
```

Results of the simulations

CMAP



PCUBE



Smulated: PD = 8%, PA = -30 deg

Quantity	2.00--8.00 keV
E_MEAN	3.8810063644059603
COUNTS	254479.0
MU	0.336022381301422
W2	2626.732421875
N_EFF	105470.5859375
FRAC_W	0.4144569333324164
MDP_99	0.03931184263898911
I	16644.609375
I_ERR	51.25165939331055
Q	547.6119384765625
Q_ERR	215.69568516734992
U	-1168.50732421875
U_ERR	215.67226517942316
QN	0.032900258898735046
QN_ERR	0.012958891392868745
UN	-0.07020334899425507
UN_ERR	0.012957484331435273
QUN_COV	2.1899076509449324e-08
PD	0.07753023505210876
PD_ERR	0.012957476699416206
PA	-32.44511293504224
PA_ERR	4.788678605149939
P_VALUE	1.6831174953030958e-08
CONFID	0.9999999831688251
SIGNIF	5.641769071481441

New Instrumental background based on data

instrumental_bkg_template.py 8

Users > mnegro > opt > anaconda3 > envs > threeML > lib > python3.9 > site-packages > ixpeobssim > config > instrumental_bkg_template.py > ...

```
29
30 from ixpeobssim import IXPEOBSSIM_SRCMODEL
31 from ixpeobssim.utils.fmtaxis import fmtaxis
32 from ixpeobssim.config import file_path_to_model_name
33 from ixpeobssim.utils.matplotlib import plt, setup_gca
34 from ixpeobssim.srcmodel.roi import xROIModel
35 from ixpeobssim.srcmodel.bkg import xTemplateInstrumentalBkg
36
37
38 __model__ = file_path_to_model_name(__file__)
39
40 RA = 45.
41 DEC = 45.
42 file_path = os.path.join(IXPEOBSSIM_SRCMODEL, 'ascii', 'instrumental_bkg_template.txt')
43
44 bkg = xTemplateInstrumentalBkg(file_path = file_path)
45
46 ROI_MODEL = xROIModel(RA, DEC, bkg)
47
48
49 def display(emin=0., emax=15.):
50     """Display the source model.
51     """
52     energy = numpy.linspace(emin, emax, 250)
53     # Energy spectrum
54     plt.figure('%s spectrum' % __model__)
55     plt.plot(energy, bkg.photon_spectrum(energy))
56     setup_gca(xmin=emin, xmax=emax, ymin=bkg.photon_spectrum(emax),
57             logy=True, grids=True, **fmtaxis.spec)
58
59
60
61 if __name__ == '__main__':
62     from ixpeobssim.config import bootstrap_display
63     bootstrap_display()
```

1

- **New method:** average counts (full IXPE band) from years of occultation data, filtered for in-eclipse, plus particle cut (Di Marco et al. 2023)

2

3

4

- Background appears stable, unpolarized; slight rate decline over years possible
- Always check it doesn't overshoot the data

credits: Stefano Silvestri

Simulation – Configuration file example

Example of an extended source

```
# Coordinates of the pointing.
RA_PNT = 350.8664167
DEC_PNT = 58.8117778
# Maximum polarization degree, and corresponding radius.
MAX_POL_DEG = 0.5
MAX_RADIUS = arcmin_to_degrees(2.8)

def _load_spec(file_name, emin=1., emax=15.):
    """Convenience function to load a spectral csv file.
    """
    file_path = os.path.join(IXPEOBSSIM_CONFIG_ASCII, file_name)
    return load_spectral_spline(file_path, emin=emin, emax=emax, delimiter=',')

# Read in the spectral models from the proper files.
total_spec_spline = _load_spec('casa_total_spectrum.csv')
non_therm_spec_spline = _load_spec('casa_nonthermal_spectrum.csv')
therm_spec_spline = total_spec_spline - non_therm_spec_spline

def therm_spec(E, t):
    """Definition of the photon spectrum for the thermal component.
    """
    return therm_spec_spline(E)

def non_therm_spec(E, t):
    """Definition of the photon spectrum for the non-thermal component.
    """
    return non_therm_spec_spline(E)
```

you can build your own spectrum ascii file

1.0154972516429583	0.2600210491838398
1.0283397977608348	0.2654538391443833
1.0305009791403983	0.27100013994125344
1.0435302195220733	0.27381659612225306
1.0501049510845077	0.27381659612225306
1.0611457106148563	0.2654538391443833
1.0678220611554607	0.25734649292415696
1.076795545992024	0.2520796282683438
1.0835798647688821	0.2520796282683438
1.097270588027409	0.2469205554964901
1.1041806806012615	0.2443807498945191
1.1134629622683097	0.2418670685351525
1.127537843733924	0.2418670685351525
1.1346335687298978	0.23569540207102993
1.1417772864645506	0.23206825257419877
1.151372256955922	0.22731873349845377
1.1586196685366936	0.22266641828924652
1.1732584983632384	0.21810931756796426
1.1855975557948553	0.21364548267070463
1.198069885144096	0.21144794187612884
1.2157639696064315	0.2158658621153093
1.2285644224762402	0.22037608885351068
1.2389068246423216	0.22731873349845377
1.2519582638043738	0.23691700646048355
1.2704556458483907	0.2469205554964901
1.2838394405293694	0.25734649292415696
1.294650948929021	0.26821265360916674

Simulation – Configuration file example

Example of an extended source

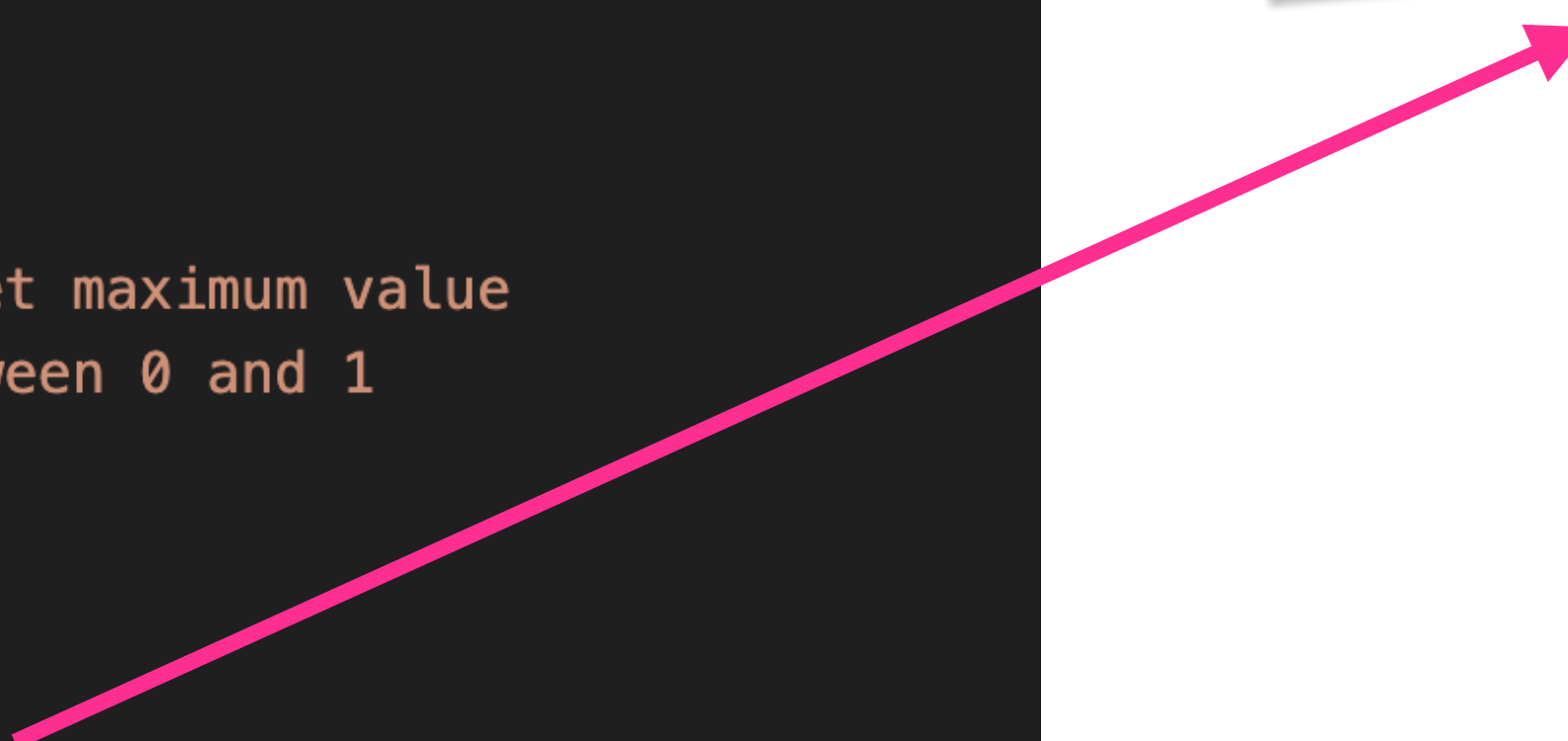
```
# The thermal component is unpolarized.
therm_pol_ang = constant(0.)
therm_pol_deg = constant(0.)

def non_therm_radial_profile(r, E=None, t=None):
    """Radial profile of the polarization degree.

    This is going from zero at the center of the field to the target maximum value
    at the specified radius. (Note the return value is clipped between 0 and 1
    to avoid unphysical values.)
    """
    return numpy.clip((MAX_POL_DEG * r / MAX_RADIUS), 0., 1.)

non_therm_pol_field = xTangentialPolarizationField(RA_PNT, DEC_PNT, non_therm_radial_profile)
non_therm_pol_deg = non_therm_pol_field.polarization_degree_model()
non_therm_pol_ang = non_therm_pol_field.polarization_angle_model()
```

you can use your own
extended polarization model



Simulation – Configuration file example

Example of an extended source

```
# Finally, the Chandra images for the thermal and non thermal components.
le_img_file_path = os.path.join(IXPEOBSSIM_CONFIG_FITS, 'casa_1p5_3p0_keV.fits')
he_img_file_path = os.path.join(IXPEOBSSIM_CONFIG_FITS, 'casa_4p0_6p0_keV.fits')

# Create the model components.
therm_comp = xExtendedSource('Cas A thermal', le_img_file_path, therm_spec,
    therm_pol_deg, therm_pol_ang)
non_therm_comp = xExtendedSource('Cas A non-thermal', he_img_file_path, non_therm_spec,
    non_therm_pol_deg, non_therm_pol_ang)
instrumental_bkg = xTemplateInstrumentalBkg()

# Create the actual ROI object.
ROI_MODEL = xROIModel(RA_PNT, DEC_PNT)
ROI_MODEL.add_sources(therm_comp, non_therm_comp, instrumental_bkg)
```

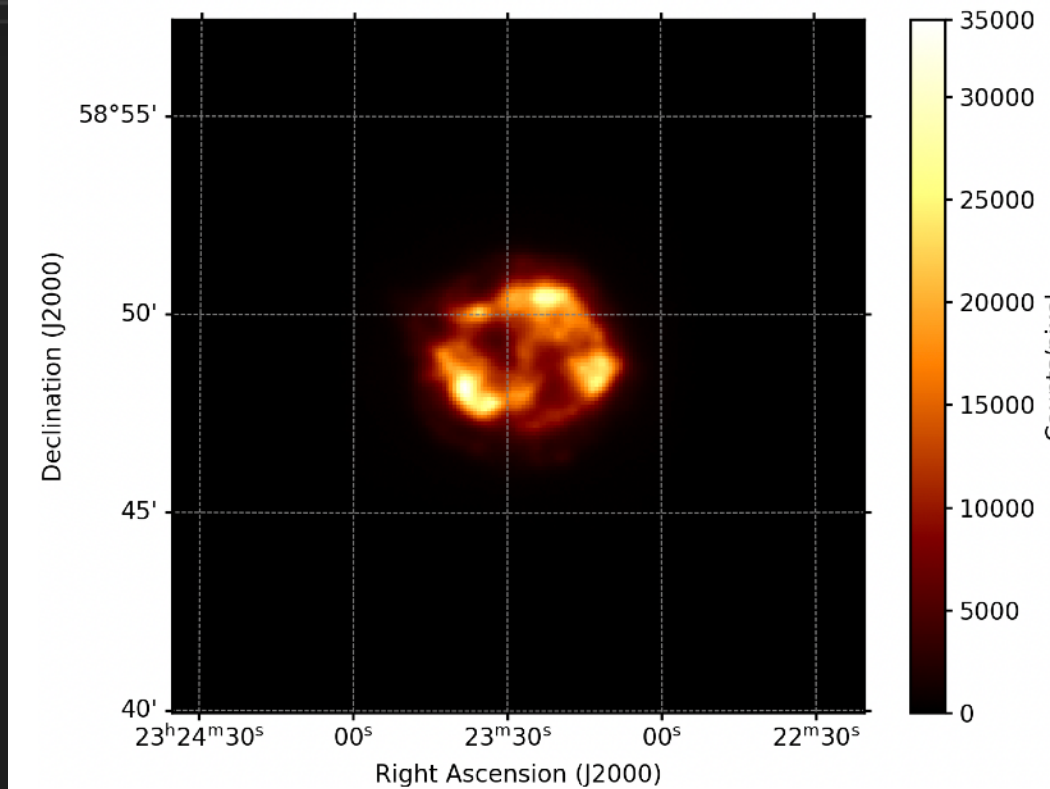
Use Chandra images
for Stokes-I

Build your ROI:
thermal comp +
non-thermal comp +
background

Simulation – run file + analysis

Example of an extended source

```
DURATION = 1500000.  
ENERGY_BINNING = [2., 4., 8.]  
  
def simulate():  
    """Run the simulation and align the stokes parameters tangentially.  
    """  
    file_list = pipeline.xpobssim(duration=DURATION)  
    pipeline.xpstokesalign(*file_list, mode='TAN')  
  
def bin_():  
    """Create the counts map and the polarization map cubes, in both the original  
    and the rotated (via xpstokealign) flavors.  
    """  
    kwargs = dict(npix=50, ebinalg='LIST', ebinning=ENERGY_BINNING)  
    file_list = pipeline.file_list()  
    pipeline.xpbin(*file_list, algorithm='CMAP')  
    pipeline.xpbin(*file_list, algorithm='PMAPCUBE', **kwargs)  
    file_list = pipeline.file_list('stokesalign')  
    pipeline.xpbin(*file_list, algorithm='PMAPCUBE', **kwargs)
```

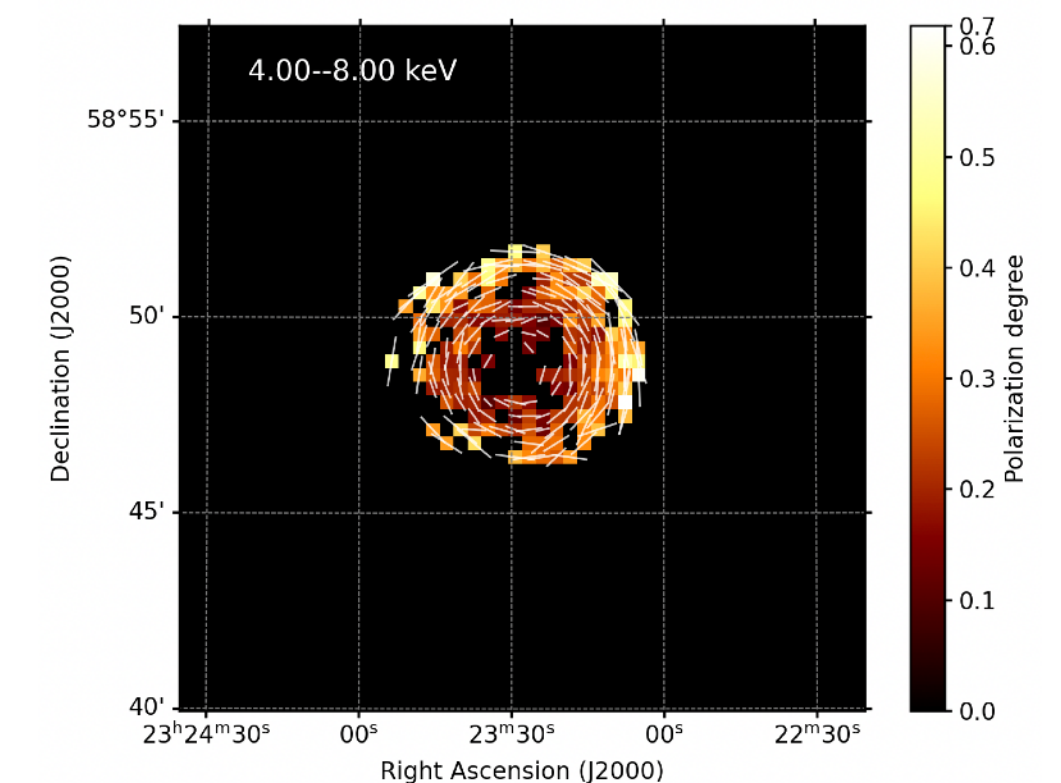
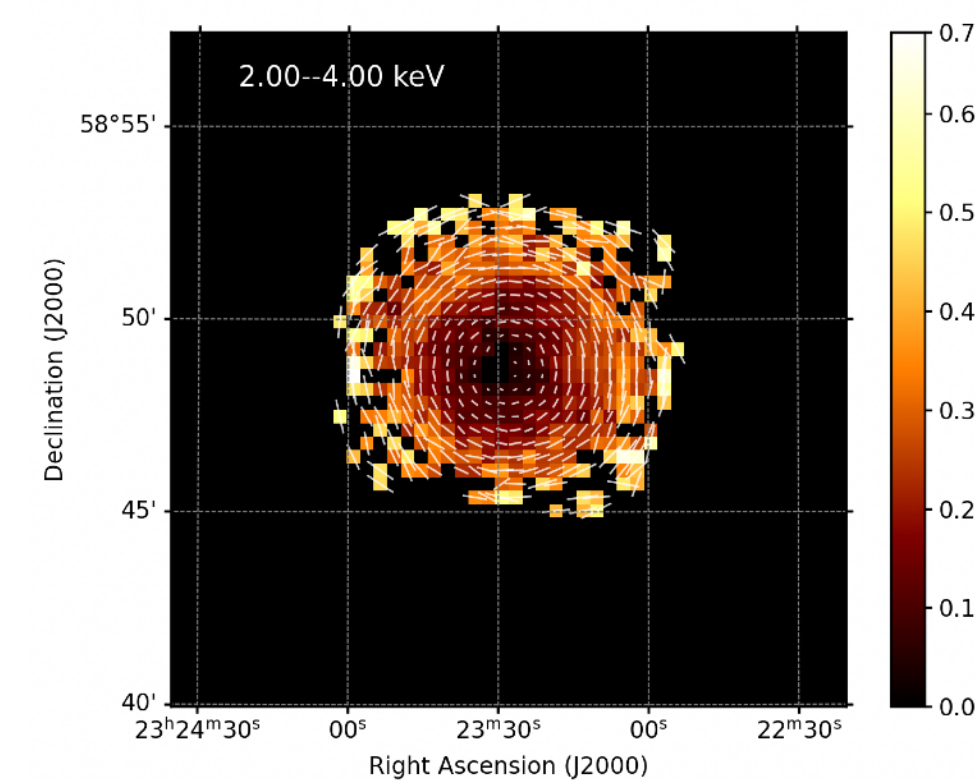


>>> Reading (in memory) /Users/mnegro/ixpeobssimdata/toy_casa_du3_stokesalign_pmapcube.fits...

Filename: (No file associated with this HDUList) 37/1865

No.	Name	Class	Ver	Type	Cards	Dimensions	Format
0	PRIMARY	1	PrimaryHDU		53	()	
1	E_MEAN	1	ImageHDU		24	(50, 50, 2)	float64
2	COUNTS	1	ImageHDU		24	(50, 50, 2)	float64
3	MU	1	ImageHDU		24	(50, 50, 2)	float64
4	W2	1	ImageHDU		24	(50, 50, 2)	float64
5	N_EFF	1	ImageHDU		24	(50, 50, 2)	float64
6	FRAC_W	1	ImageHDU		24	(50, 50, 2)	float64
7	MDP_99	1	ImageHDU		24	(50, 50, 2)	float64
8	I	1	ImageHDU		24	(50, 50, 2)	float64
9	I_ERR	1	ImageHDU		24	(50, 50, 2)	float64
10	Q	1	ImageHDU		24	(50, 50, 2)	float64
11	Q_ERR	1	ImageHDU		24	(50, 50, 2)	float64
12	U	1	ImageHDU		24	(50, 50, 2)	float64
13	U_ERR	1	ImageHDU		24	(50, 50, 2)	float64
14	QN	1	ImageHDU		24	(50, 50, 2)	float64
15	QN_ERR	1	ImageHDU		24	(50, 50, 2)	float64
16	UN	1	ImageHDU		24	(50, 50, 2)	float64
17	UN_ERR	1	ImageHDU		24	(50, 50, 2)	float64
18	QUN_COV	1	ImageHDU		24	(50, 50, 2)	float64
19	PD	1	ImageHDU		24	(50, 50, 2)	float64
20	PD_ERR	1	ImageHDU		24	(50, 50, 2)	float64
21	PA	1	ImageHDU		24	(50, 50, 2)	float64
22	PA_ERR	1	ImageHDU		24	(50, 50, 2)	float64
23	P_VALUE	1	ImageHDU		24	(50, 50, 2)	float64
24	CONFID	1	ImageHDU		24	(50, 50, 2)	float64
25	SIGNIF	1	ImageHDU		24	(50, 50, 2)	float64
26	EBOUNDS	1	BinTableHDU		34	2R x 2C	['E', 'E']

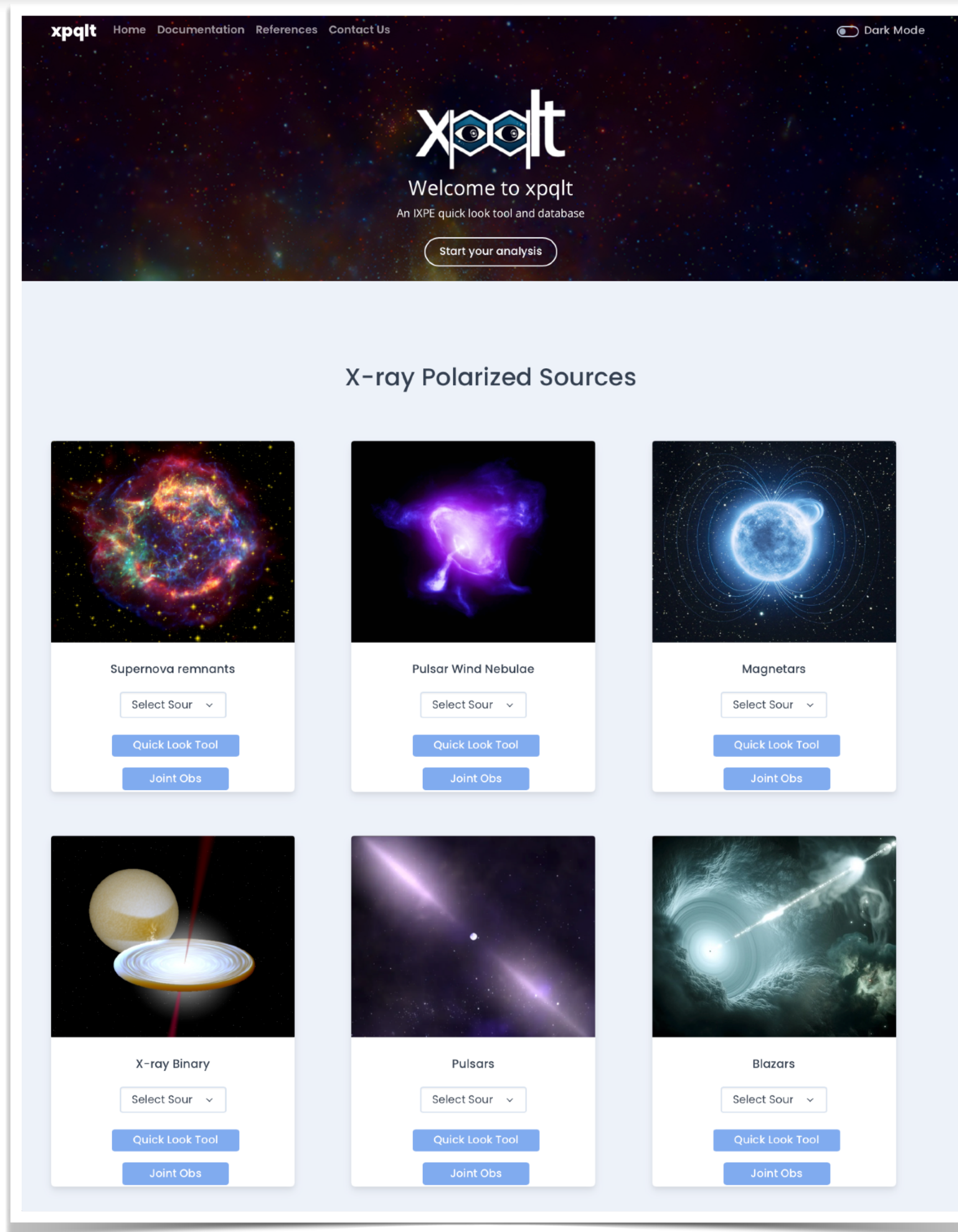
MDP map!



For more analysis tools see Niccolò DI Lalla's presentation to the "Friends of IXPE" forum last week:

<https://heasarc.gsfc.nasa.gov/docs/ixpe/friendsofixpe/20260618-NDL.pdf>

xpqlt.com – a quick-look tool and database



xpqlt.com – a quick-look tool and database

xpqlt

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Dark Mode

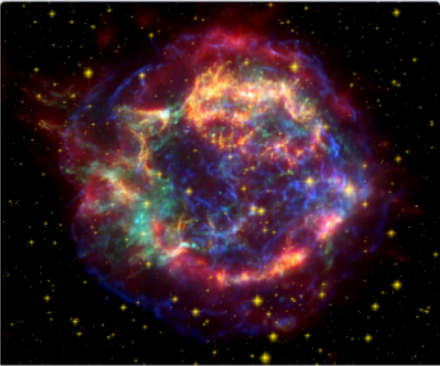
xpqlt

Welcome to xpqlt

An IXPE quick look tool and database

Start your analysis

X-ray Polarized Sources

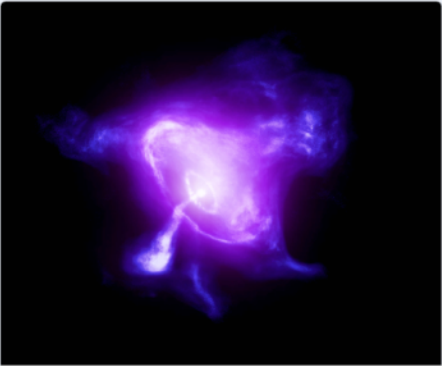


Supernova remnants

Select Sour

Quick Look Tool

Joint Obs

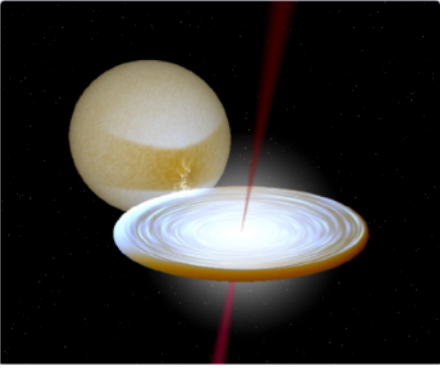


Pulsar Wind Nebulae

Select Sour

Quick Look Tool

Joint Obs



X-ray Binary

Select Sour

Quick Look Tool

Joint Obs



Pulsars

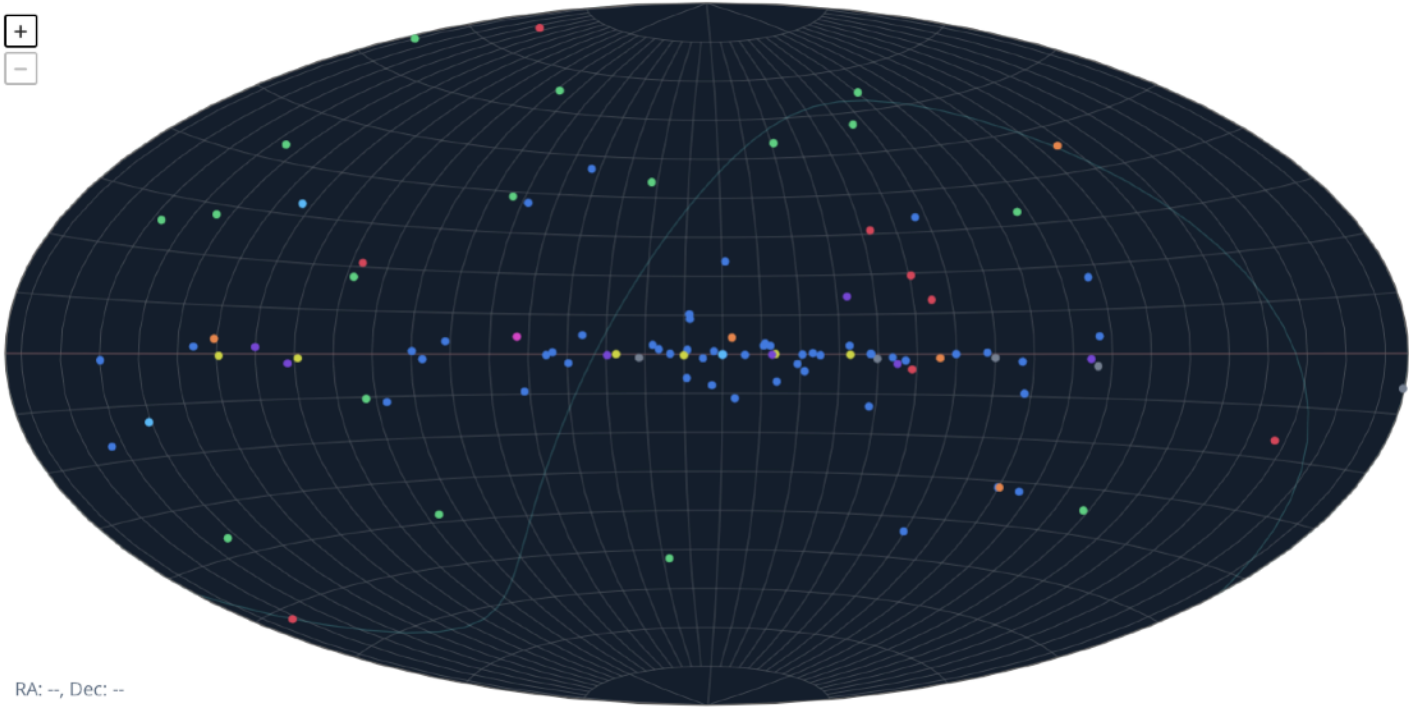
Select Sour

Quick Look Tool

Joint Obs

IXPE Observation Map

+
-



RA: --, Dec: --

Map Options

Coordinate System

Galactic

Map Projection

Aitoff

Overlays

☒ Equatorial

☐ Ecliptic

☐ Constellation

☒ Galactic

☐ Supergalactic

☒ Grid

Legend

AGN

Blazar

Complex

GRB

Magnetar

Pulsar

PWN

SNR

X-ray Binary

IXPE Observations

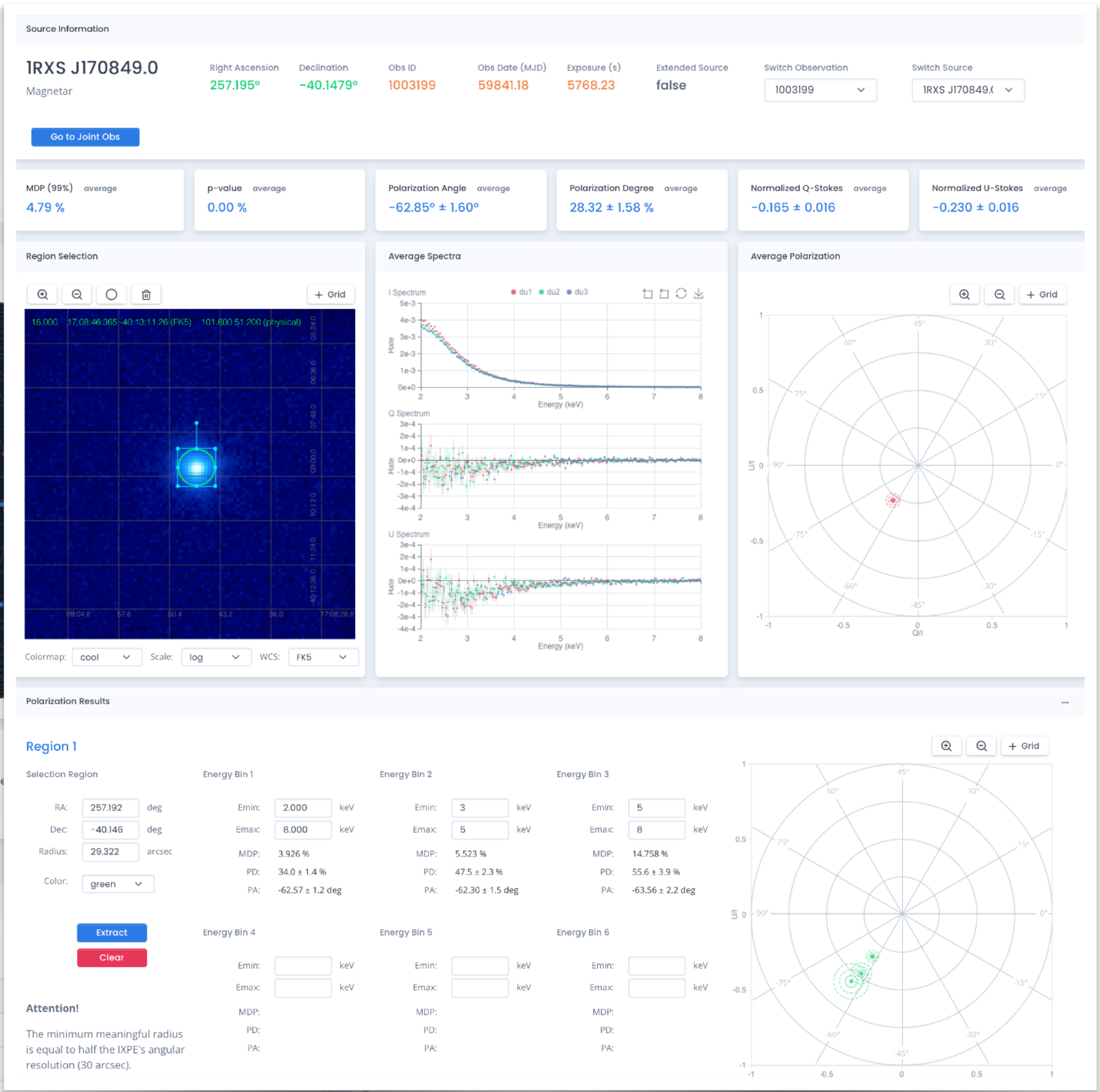
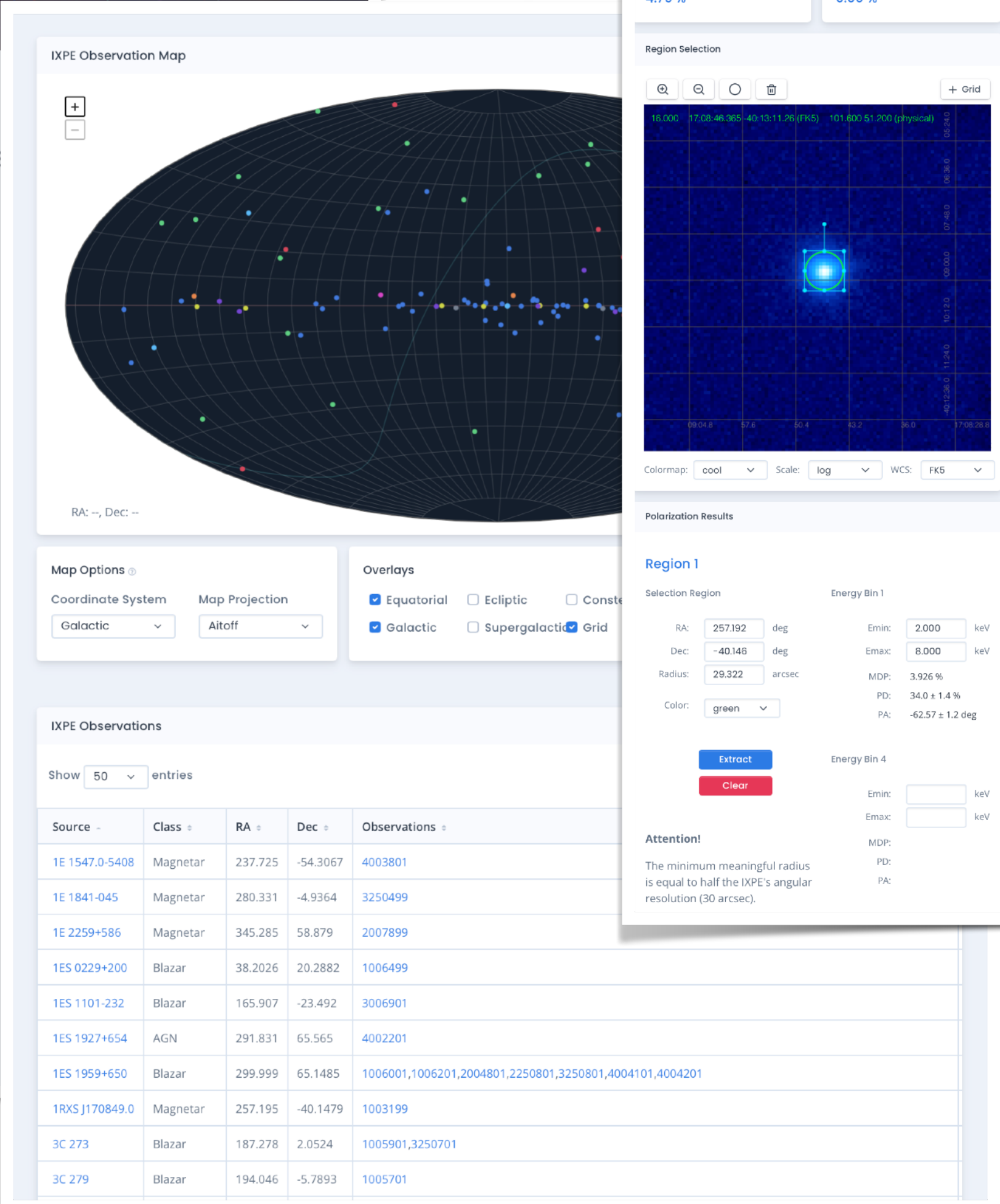
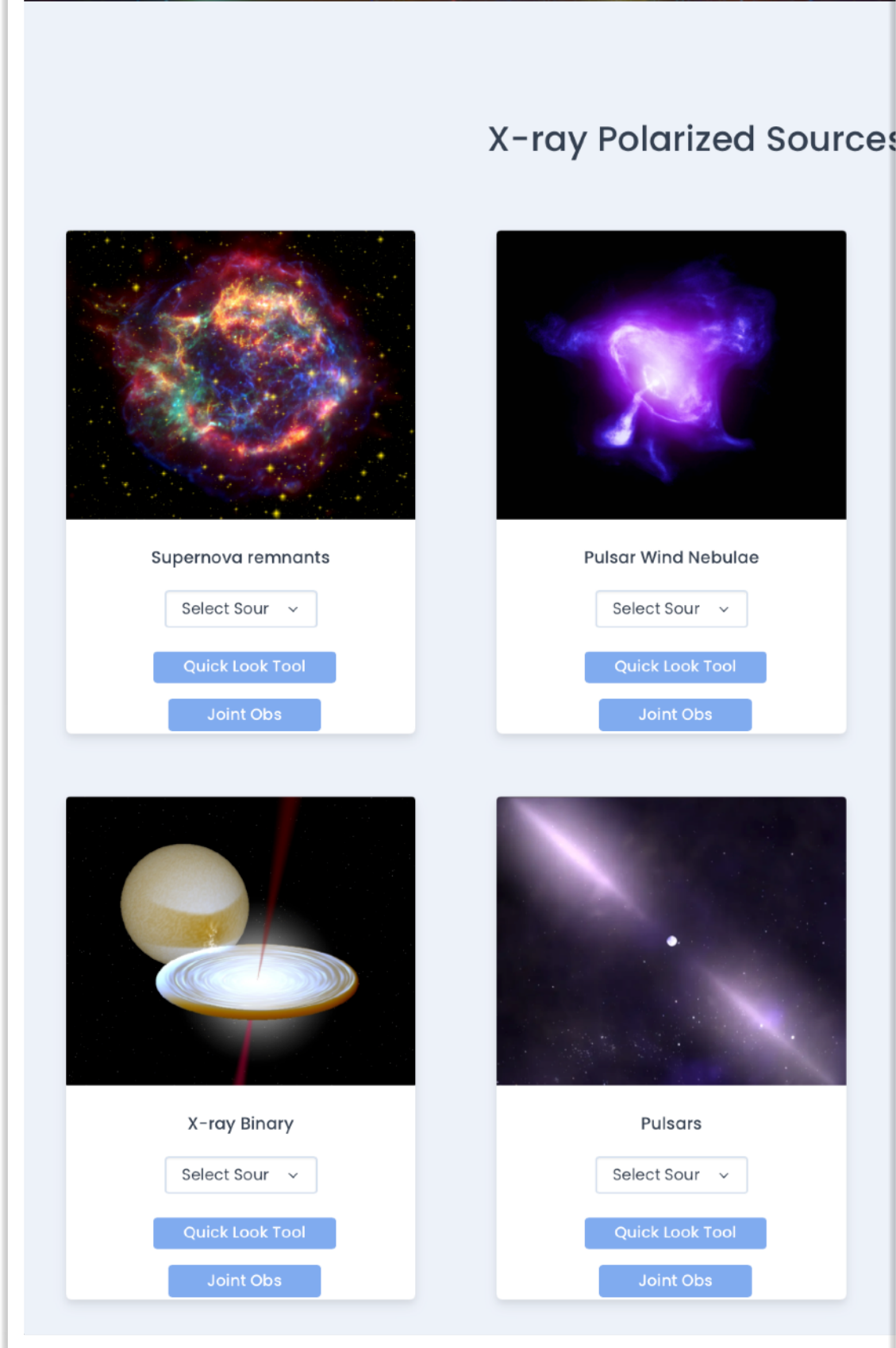
Show 50 entries

Search...

Source	Class	RA	Dec	Observations
1E 1547.0-5408	Magnetar	237.725	-54.3067	4003801
1E 1841-045	Magnetar	280.331	-4.9364	3250499
1E 2259+586	Magnetar	345.285	58.879	2007899
1ES 0229+200	Blazar	38.2026	20.2882	1006499
1ES 1101-232	Blazar	165.907	-23.492	3006901
1ES 1927+654	AGN	291.831	65.565	4002201
1ES 1959+650	Blazar	299.999	65.1485	1006001,1006201,2004801,2250801,3250801,4004101,4004201
1RXS J170849.0	Magnetar	257.195	-40.1479	1003199
3C 273	Blazar	187.278	2.0524	1005901,3250701
3C 279	Blazar	194.046	-5.7893	1005701

NASA-funded project through ADAP
LSU, Stanford, INFN-Pisa, NASA-MSFC

xpqlt.com – a quick-look tool and database



NASA-funded project through ADAP
LSU, Stanford, INFN-Pisa, NASA-MSFC

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Dark Mode

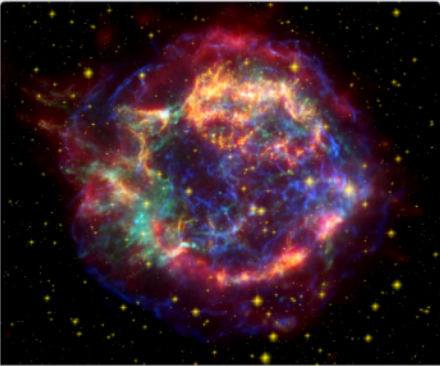
xpqlt

Welcome to xpqlt

An IXPE quick look tool and database

Start your analysis

X-ray Polarized Sources

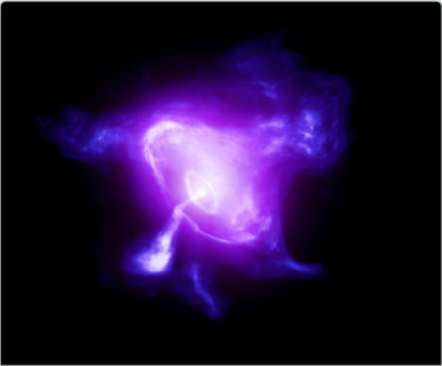


Supernova remnants

Select Sour

Quick Look Tool

Joint Obs

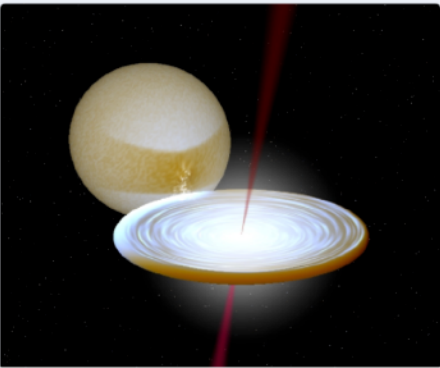


Pulsar Wind Nebulae

Select Sour

Quick Look Tool

Joint Obs

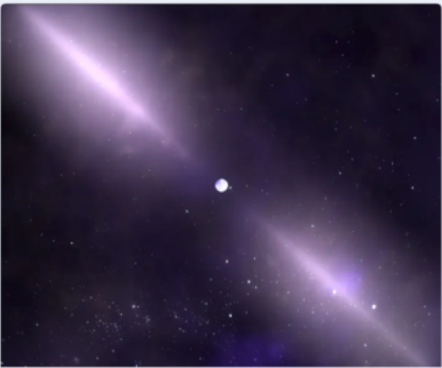


X-ray Binary

Select Sour

Quick Look Tool

Joint Obs

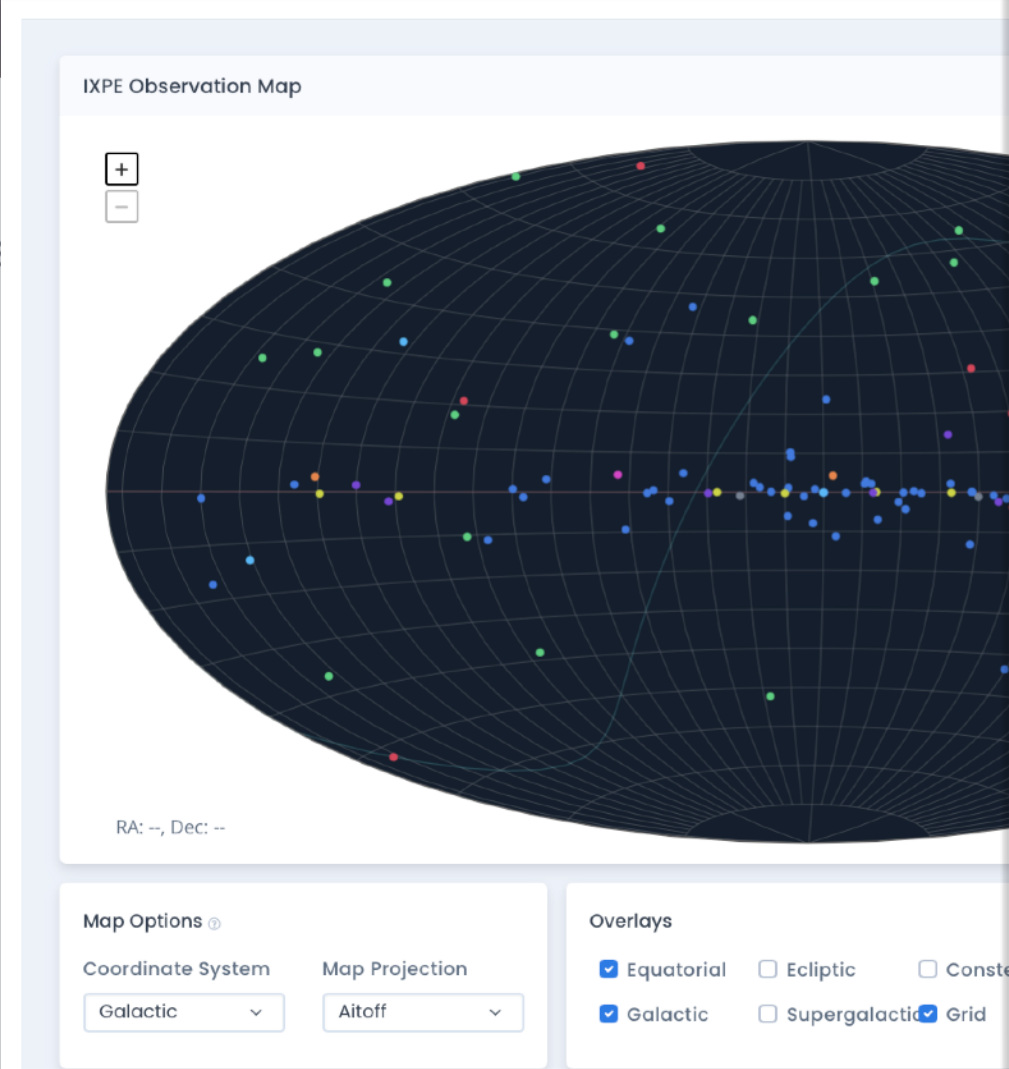


Pulsars

Select Sour

Quick Look Tool

Joint Obs



IXPE Observations

Show 50 entries

Source	Class	RA	Dec	Observations
1E 1547.0-5408	Magnetar	237.725	-54.3067	4003801
1E 1841-045	Magnetar	280.331	-4.9364	3250499
1E 2259+586	Magnetar	345.285	58.879	2007899
1ES 0229+200	Blazar	38.2026	20.2882	1006499
1ES 1101-232	Blazar	165.907	-23.492	3006901
1ES 1927+654	AGN	291.831	65.565	4002201
1ES 1959+650	Blazar	299.999	65.1485	1006001,1006201,2004801,2250801,3250801,4004101,4004201
1RXS J170849.0	Magnetar	257.195	-40.1479	1003199
3C 273	Blazar	187.278	2.0524	1005901,3250701
3C 279	Blazar	194.046	-5.7893	1005701

Source Information

1RXS J170849.0

Magnetar

Right Ascension

257.195°

Declination

-40.1479°

Obs ID

1003199

Obs Date (MJD)

59941.18

Exposure (s)

5768.23

Extended Source

false

Switch Observation

1003199

Switch Source

1RXS J170849.0

Go to Joint Obs

MDP (99%)

average

4.79 %

p-value

average

0.00 %

Polarization Angle

average

-62.85° ± 1.60°

Polarization Degree

average

28.32 ± 1.58 %

Normalized Q-Stokes

average

-0.165 ± 0.016

Normalized U-Stokes

average

-0.230 ± 0.016

Region Selection

Average Spectra

Region 1

Selection Region

RA: 257.192 deg, Dec: -40.148 deg, Radius: 29.322 arcsec, Color: green

Energy Bin 1: Emin: 2.000 keV, Emax: 8.000 keV, MDP: 3.926 %, PD: 34.0 ± 1.4 %, PA: -62.57 ± 1.2 deg

Energy Bin 2: Emin: 3 keV, Emax: 5 keV, MDP: 5.523 %, PD: 47.5 ± 2.3 %, PA: -62.30 ± 1.5 deg

Energy Bin 3: Emin: 5 keV, Emax: 8 keV, MDP: 14.758 %, PD: 55.6 ± 3.9 %, PA: -63.56 ± 2.2 deg

Energy Bin 4: Emin: keV, Emax: keV, MDP: %, PD: %, PA: %

Energy Bin 5: Emin: keV, Emax: keV, MDP: %, PD: %, PA: %

Energy Bin 6: Emin: keV, Emax: keV, MDP: %, PD: %, PA: %

Attention! The minimum meaningful radius is equal to half the IXPE's angular resolution (30 arcsec).

IXPE Publications

IXPE launched on Dec. 9 2021 on a Falcon 9 rocket from NASA's Kennedy Space Center. IXPE Mission Overview

Number of Publications

Year

2014 2016 2017 2018 2019 2020 2021 2022 2023 2024 2025 2026

Search...

Date	Title	Authors
2026-05-19	The first IXPE view of the eclipsing ADC source 4U 1822-37	A. Anitra et al.
2026-05-18	Pulse profile modelling of the 2024 outburst of the accreting millisecond pulsar SRGA J144459.2-604207	Bas Dorsman et al.
2026-05-15	X-Ray Polarization from the Gamma-Ray Binary LS I +61 303	Philip Kaaret et al.
2026-05-15	Bridging X-ray Polarization with Timing & Spectroscopic Parameters of a galactic black hole: Swift J1727.8-1613	Arka Chatterjee et al.
2026-05-12	Tracking down the broadband polarimetric properties of PG 1553+113	Riccardo Middei et al.
2026-05-08	Resonant Inverse Compton Scattering and Hard X-ray Emission in Magnetar Magnetospheres	Kun Hu et al.
2026-05-06	Theoretical Constraints on Neutron Star Superfluidity from Her X-1 Precession	Anton Biryukov et al.
2026-05-04	Detectability of Magnetar-Induced Vacuum Birefringence with IXPE and eXTP	Fayez Abu-Ajamieh
2026-05-01	XRISM/Resolve observations of Hercules X-1: a pulsating highly broadened Fe K emission line from the neutron star accretion column	Peter Kosec et al.
2026-04-29	Energy-Dependent Polarization Angle Variability as a Robust Diagnostic for Blazar Flaring Mechanisms	Haocheng Zhang et al.
2026-04-24	IXPE Polarizations of the Lighthouse Pulsar Trail and Filament	Jack T. Dinsmore et al.
2026-04-20	X-Ray Polarization from the Atoll 4U 1735-44 Suggests a Low Inclination	M. A. Diaz Teodori et al.
2026-04-16	Refined Constraints on the Hard X-ray Polarization of the Crab Pulsar and Nebula Derived from an Extended XL-Calibur Dataset	Matthew G. Baring et al.
2026-04-03	The hitchhiker's guide to the IXPE data analysis	Alessandro Di Marco
2026-03-27	NuSTAR's Intentional Stray Light Observation of Scorpius X-1	S. Li et al.
2026-03-25	IXPE view of the Crab pulsar following the 17 July and 6 August 2025 glitches	Paolo Soffitta et al.
2026-03-21	X-Ray Polarization Study of Pulsar Wind Nebulae with eXTP: Simulation Results and Scientific Prospects	Kuan Liu et al.
2026-03-11	X-ray polarization in the soft state of Cyg X-1	A. Niedzwecki et al.
2026-03-10	The Geometric Crisis in Cygnus-X-3: Limitations of Wind-Fed Accretion and the Case for Roche-Lobe Overflow	Nicholas E. White
2026-03-07	Vacuum Birefringence Ellipticity and the Anomalous Magnetic Moment of a Photon	Sree Ram Valluri et al.

NASA-funded project through ADAP
LSU, Stanford, INFN-Pisa, NASA-MSFC

References

Installation, overview,
documentation, tutorials



Github repository



Please, cite the Paper
L. Baldini et al. 2022



Visit the ixpeobssim GitHub repository to contribute and
submit issues you may find while using the software.

Take a look to the ixpeobssim tutorial material that was
presented at HEAD20 meeting (March 2023)



ixpeobssim: a simulation
and analysis framework for IXPE



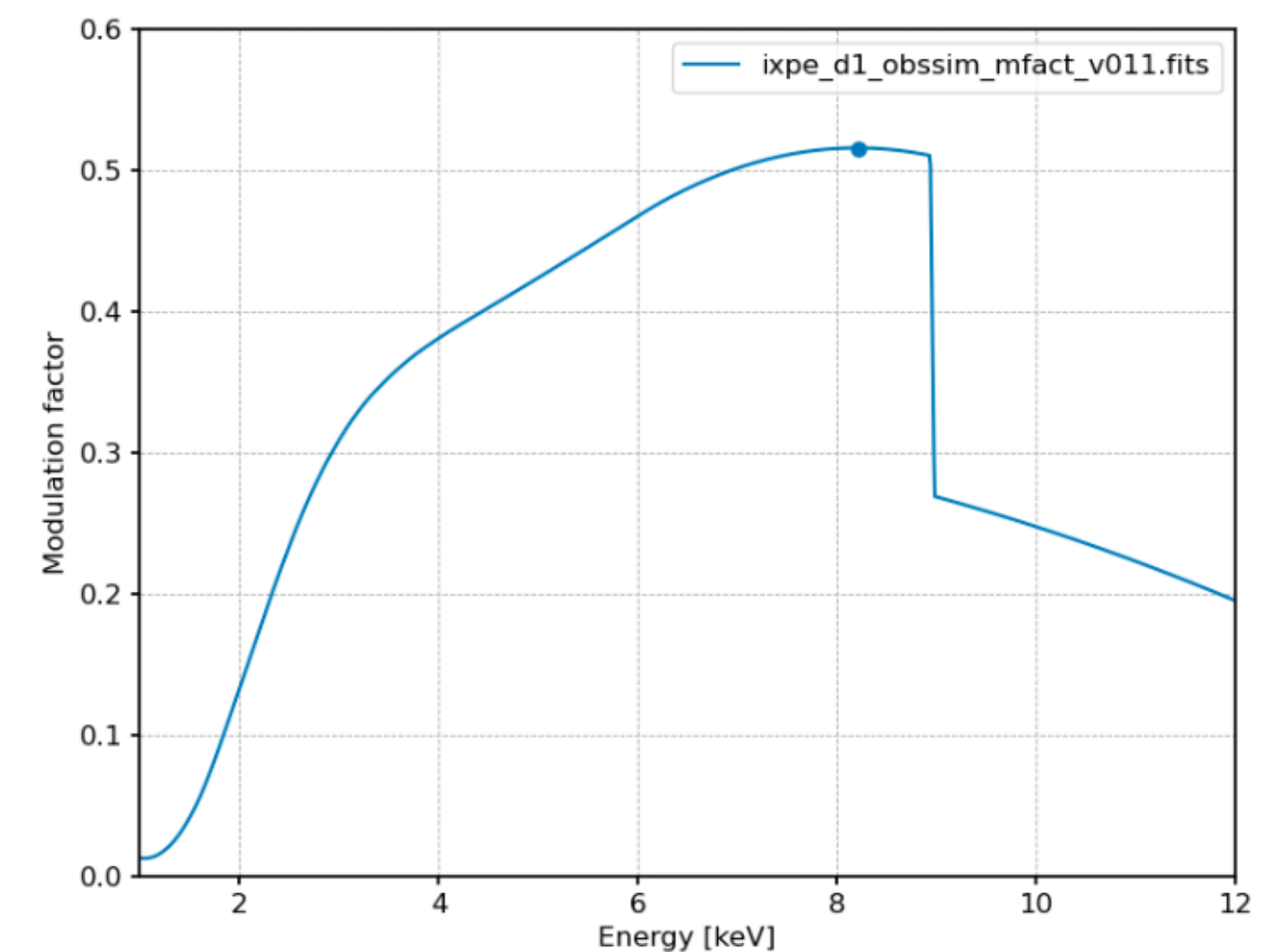
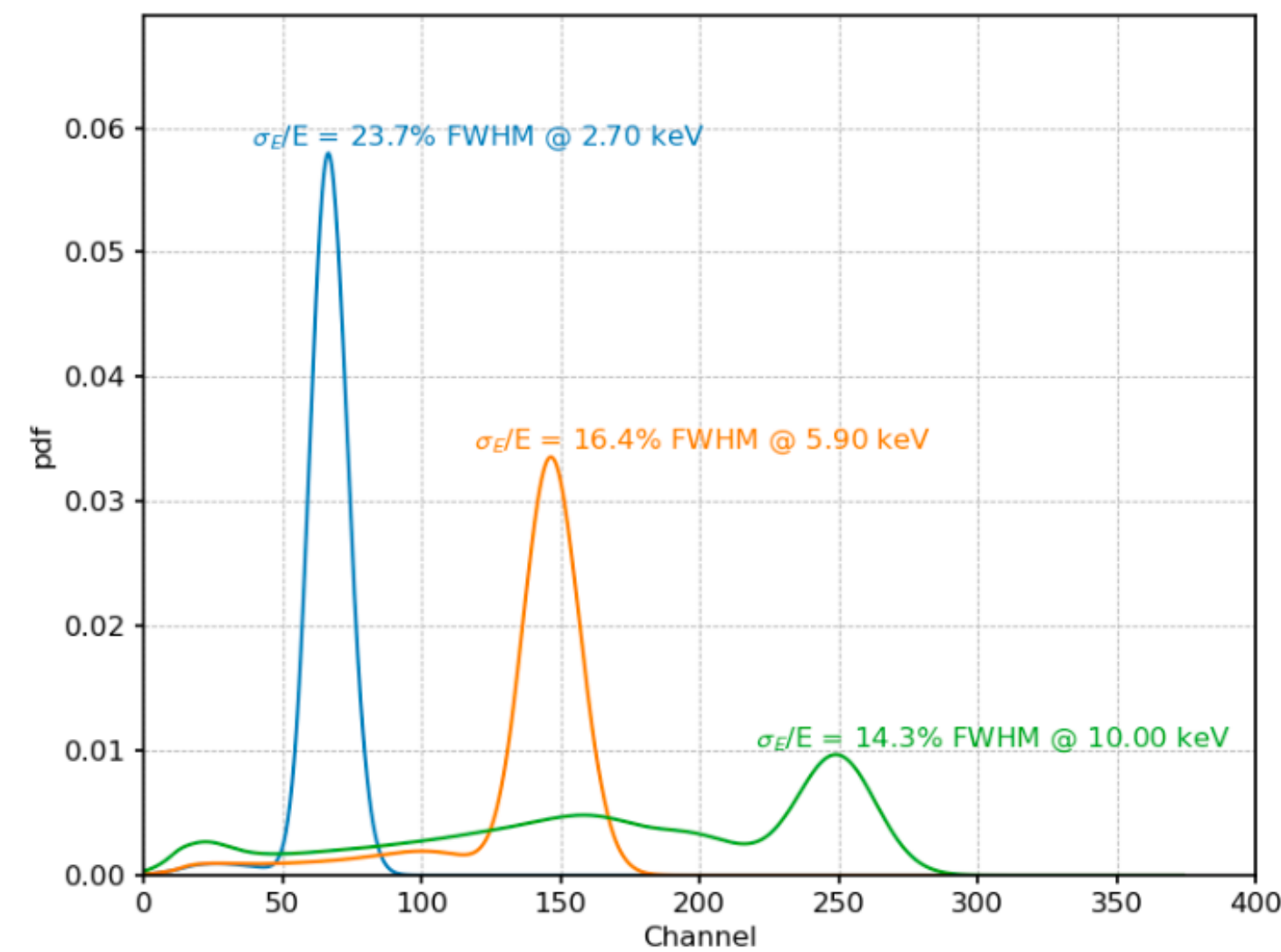
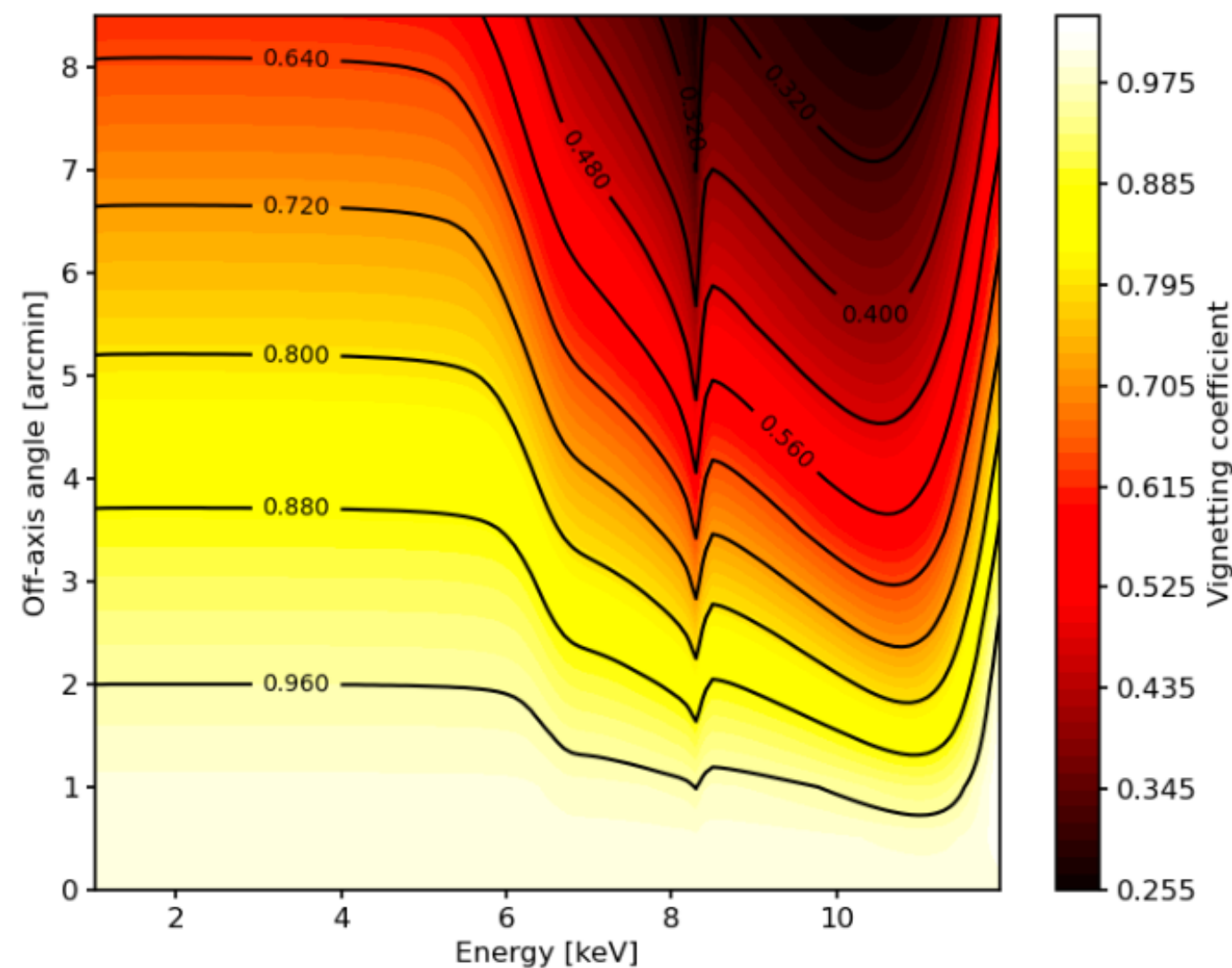
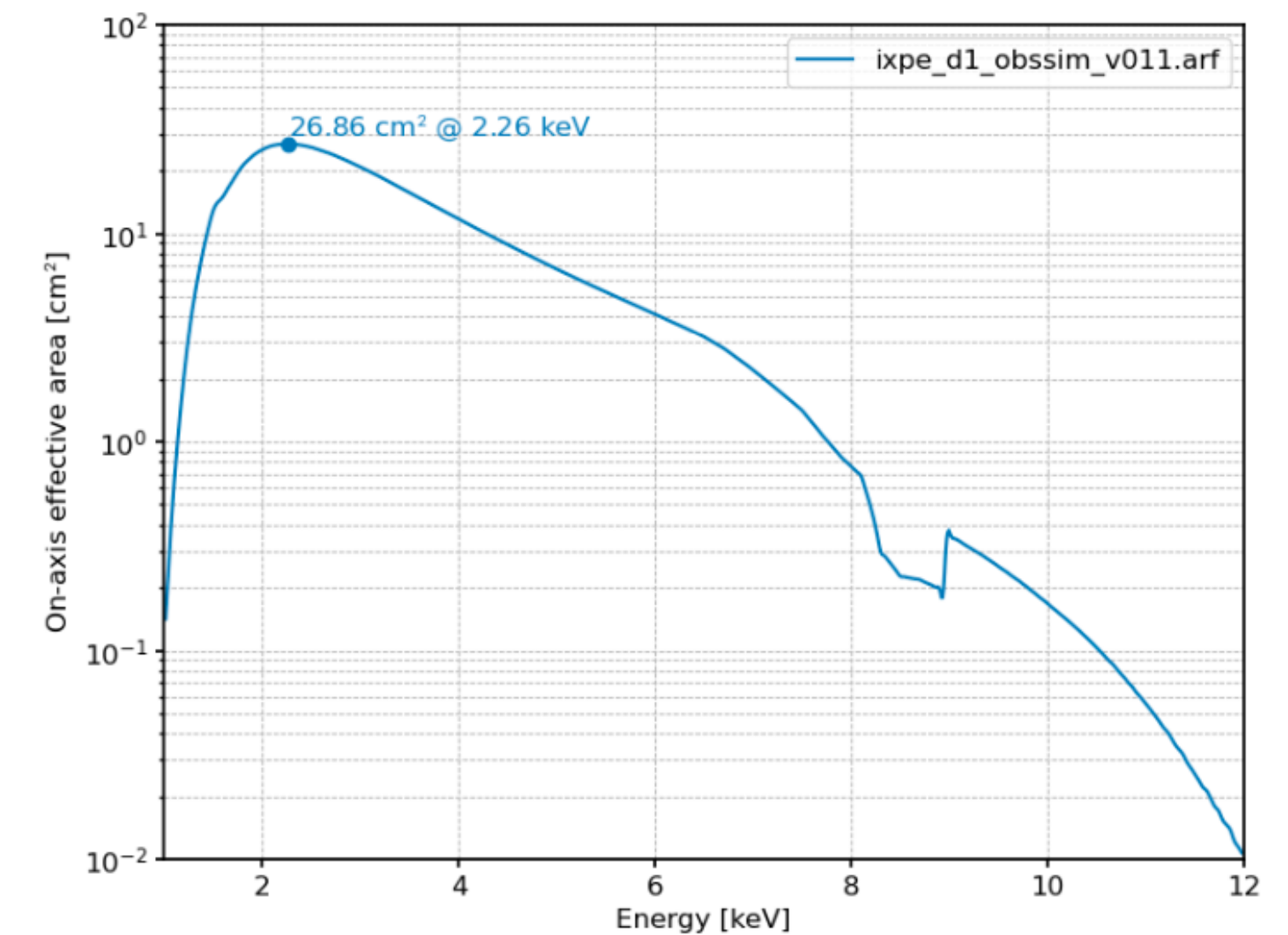
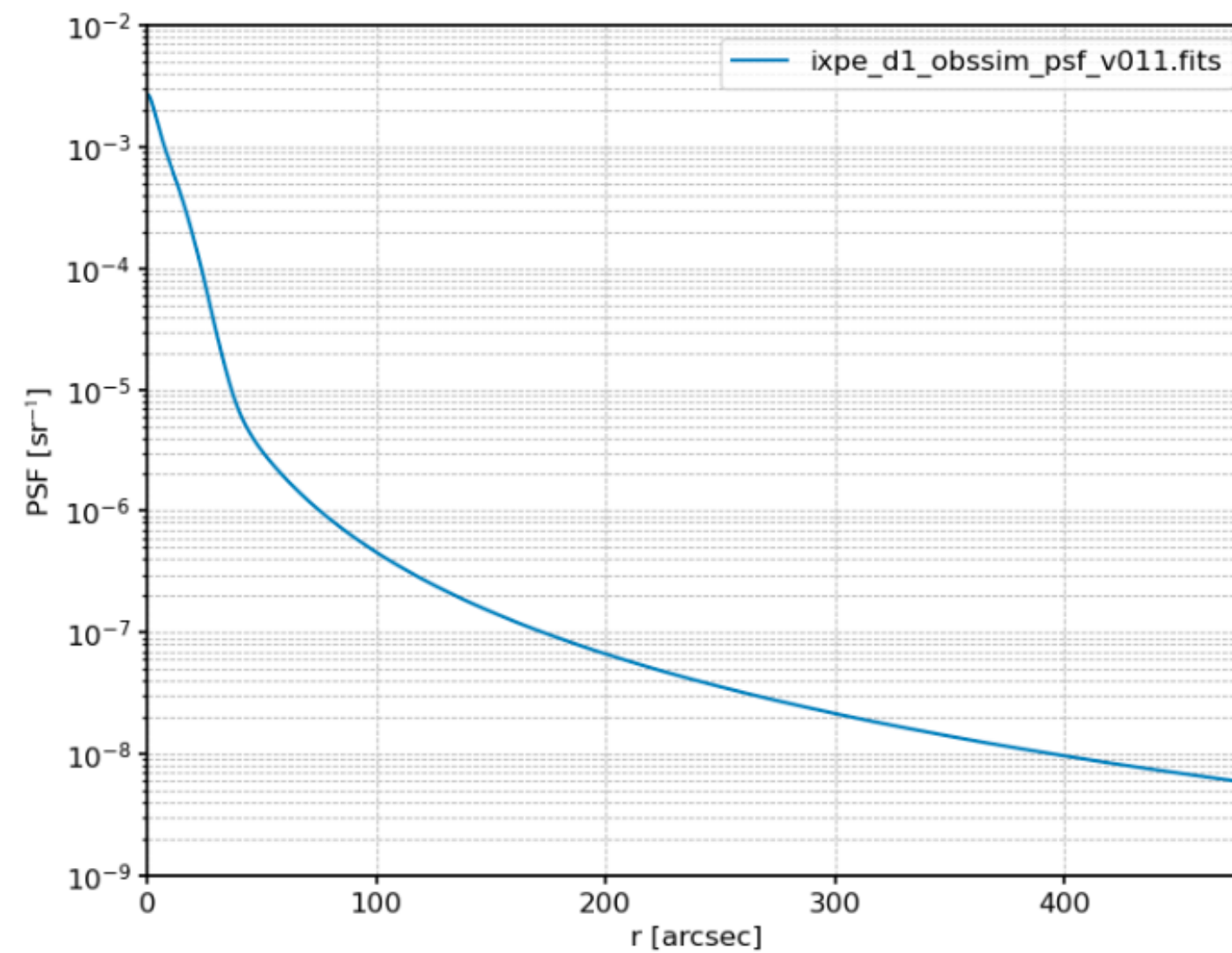
Back-up

The project

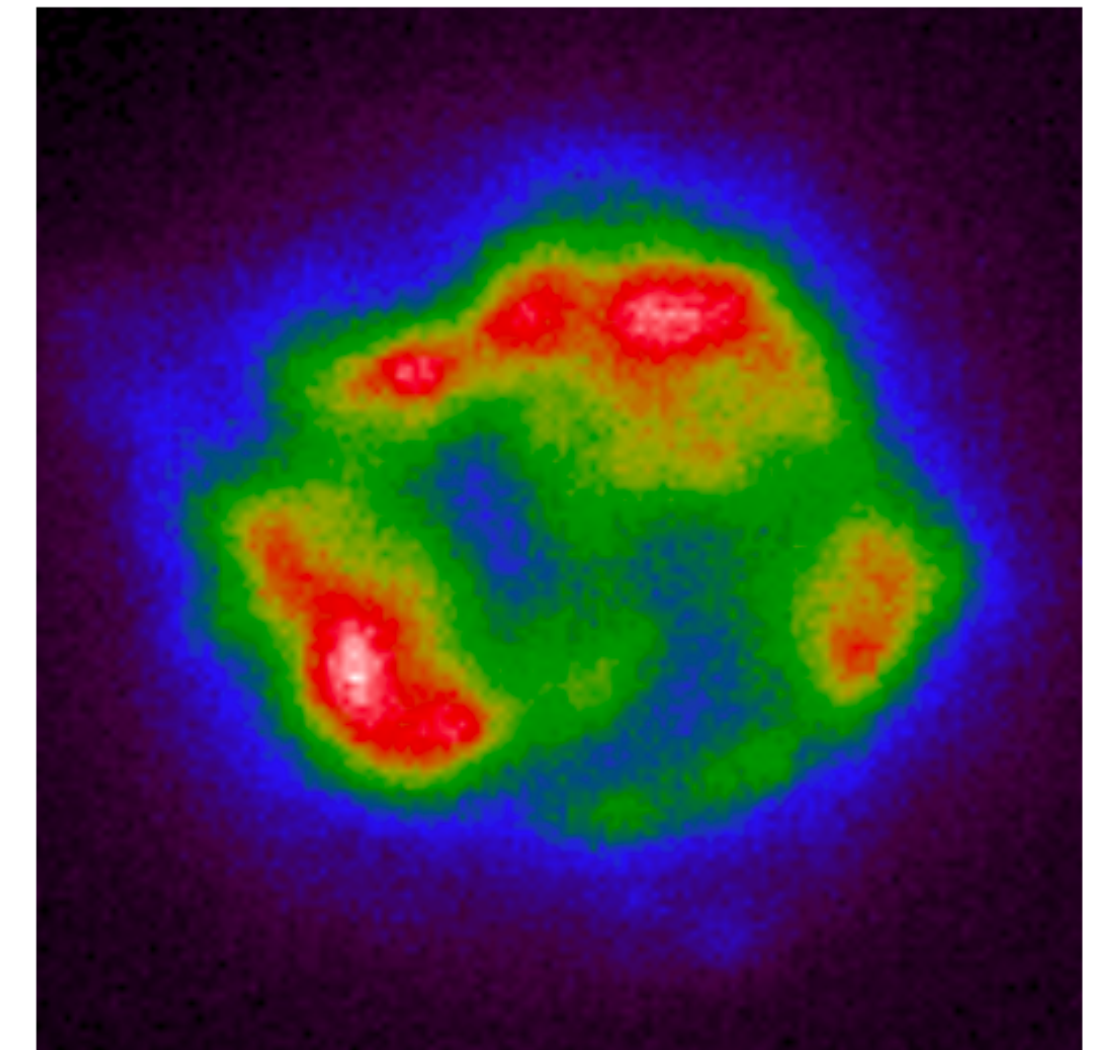
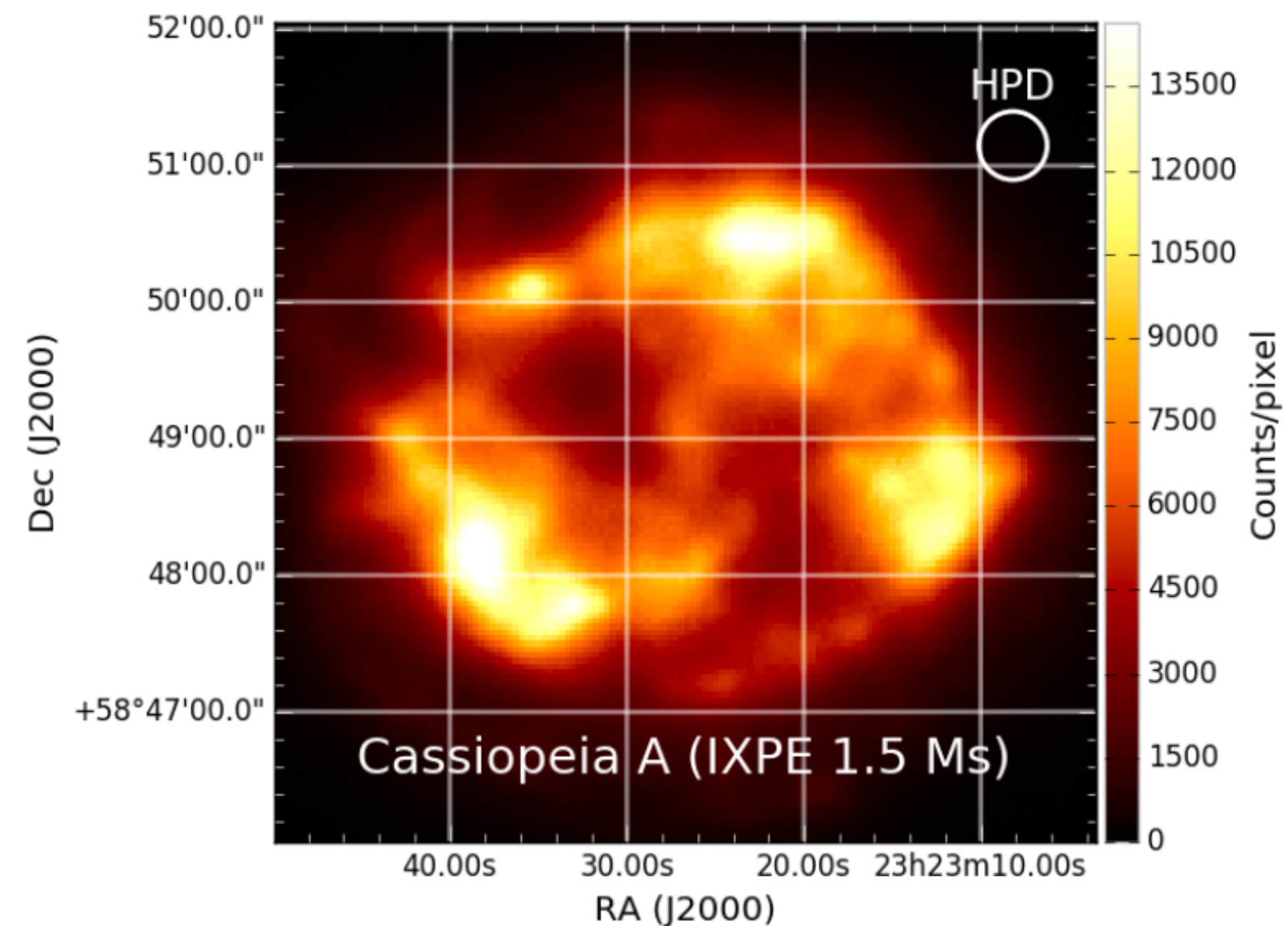
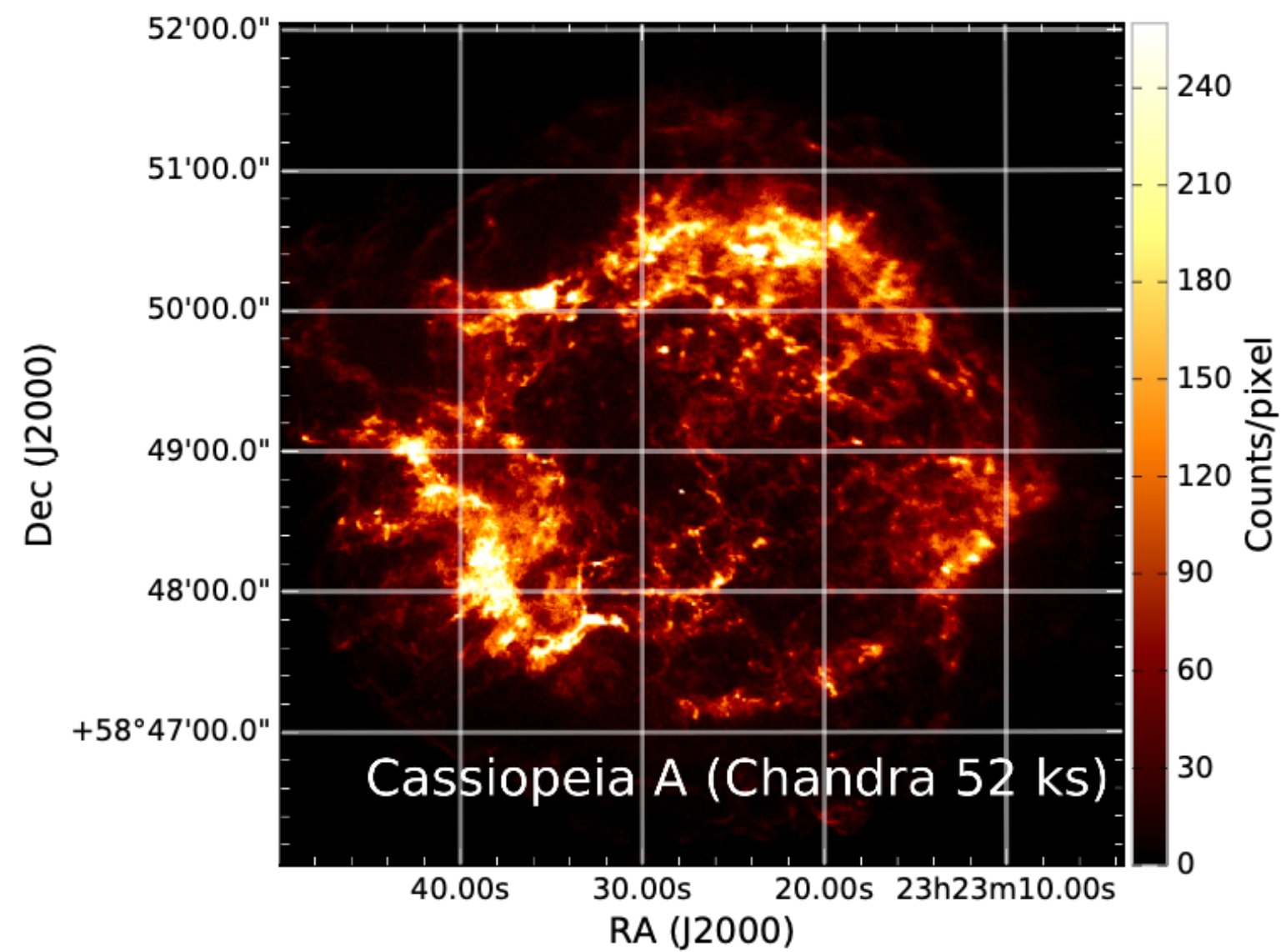
- ▷ Project started in 2015 under the name of XIMPOL:
 - ▷ Initially not tied to any specific mission or instrument design
 - ▷ After IXPE selection in 2017, it was renamed and progressively tailored in preparation for the new mission
 - ▷ **Publicly released in 2022** to support the analysis of public IXPE data and engage the broader community in anticipation of the upcoming General Observer program

Instrument Response Functions

- ▷ FITS files in OGIP format
- ▷ Each of the three IXPE DUs has its own set of IRFs
- ▷ Generated and stored in a local CALDB, then submitted to HEASARC



Simulation – extended source, from Chandra image

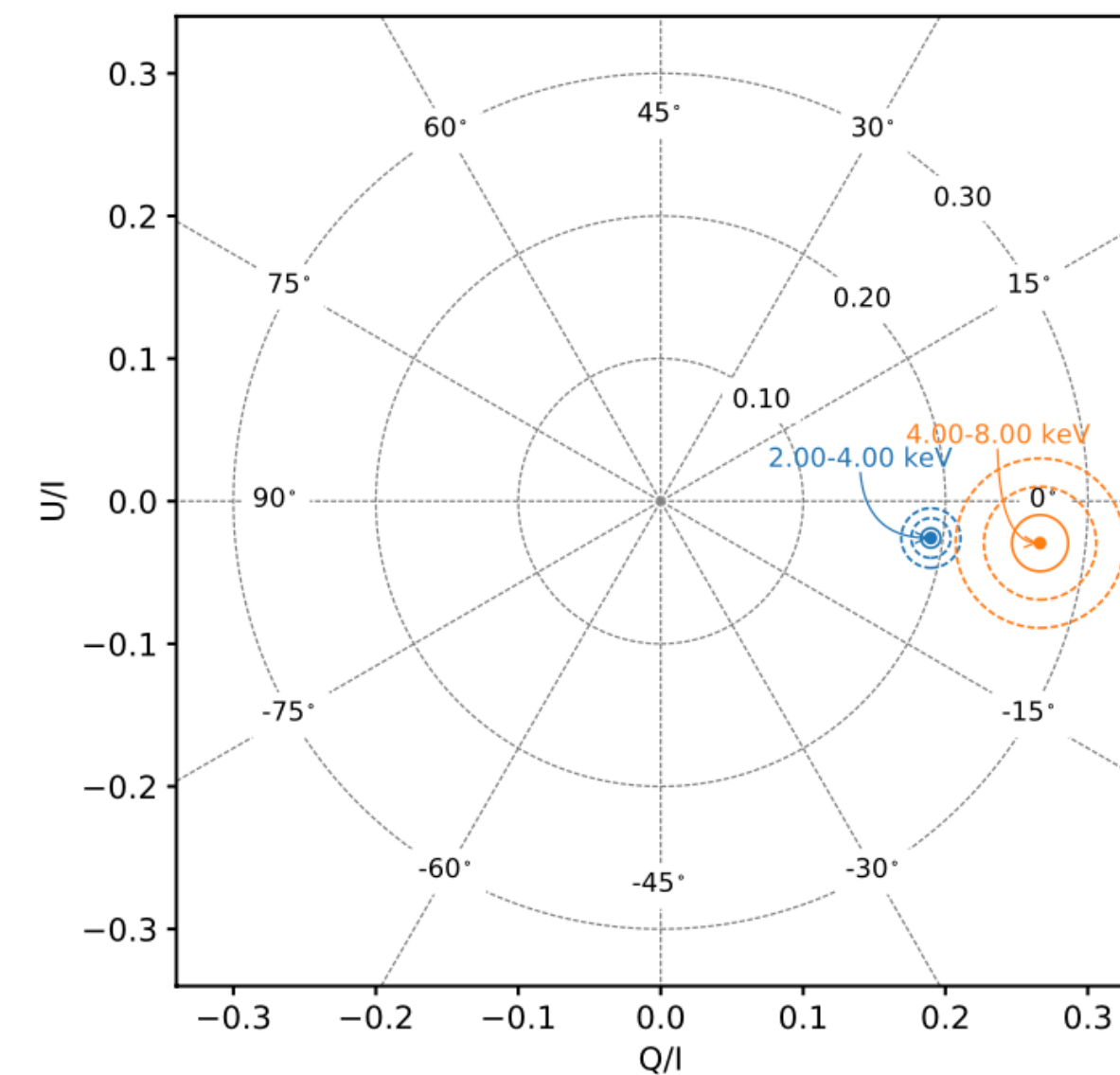
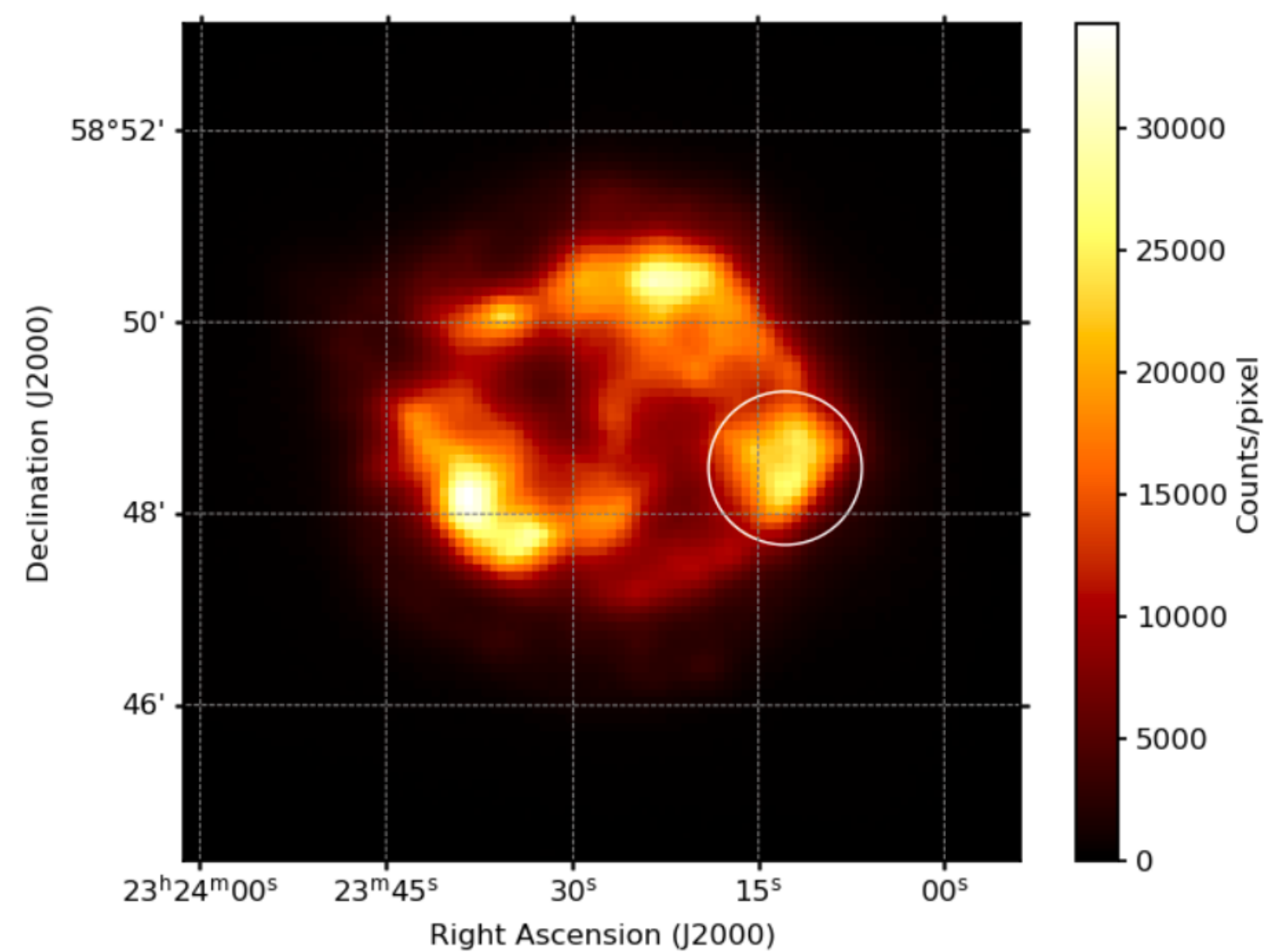


The simulation pipeline will generate 3 fits files, one for each DU.
Each file contains the simulated photon list and is analogous to the real-data files.

Analysis – xpbins PCUBE

Polarization cube

- ▷ The simplest possible data structure holding polarization information
- ▷ Table listing I, Q, U, polarization degree and angle with the associated uncertainties in multiple energy bins:
 - ▷ Provided with methods to rescale and subtract the background contribution



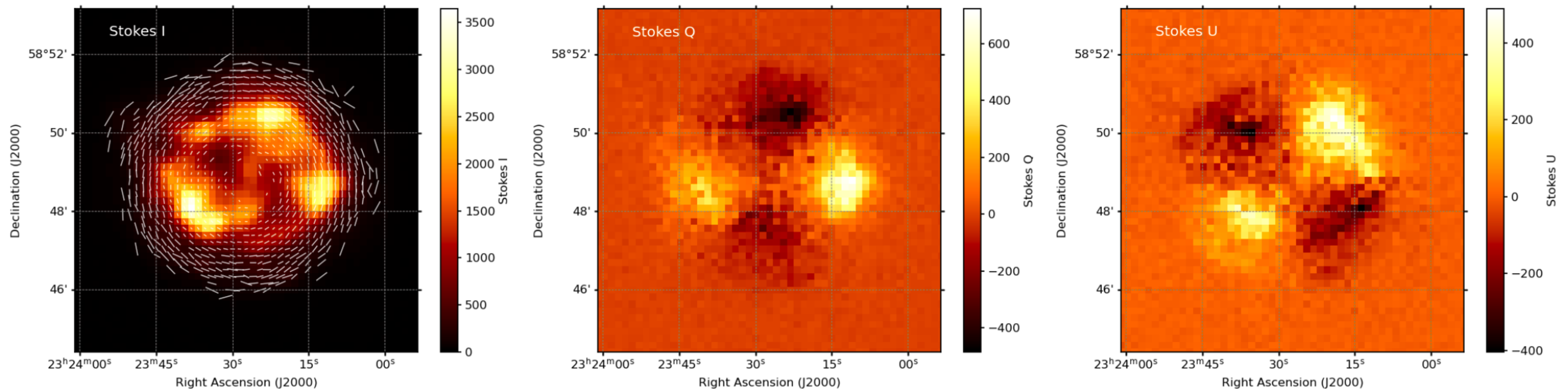
Quantity	2.00--8.00 keV

E_MEAN	5.0117599361664364
COUNTS	5762.0
MU	0.3921964538001015
W2	170.2692108154297
N_EFF	1664.503662109375
FRAC_W	0.28887602605160967
MDP_99	0.2681089106047689
I	532.3661499023438
I_ERR	13.048724174499512
Q	-67.53325653076172
Q_ERR	47.02301654580805
U	-61.832847595214844
U_ERR	47.02772717795586
QN	-0.12685489654541016
QN_ERR	0.08832833671794095
UN	-0.11614722013473511
UN_ERR	0.08833718519966481
QUN_COV	-8.85179443077969e-06
PD	0.17199519276618958
PD_ERR	0.0883654765108721
PA	-68.76152928032351
PA_ERR	14.73511598093247
P_VALUE	0.15021762132159794
CONFID	0.849782378678402
SIGNIF	1.035500479458798

Analysis – xpbins PMAP

Polarization map

- ▷ Hold the exact same information as polarization cubes, but binned in sky-coordinates
- ▷ Maps of I, Q, U, polarization degree and angle in multiple energy layers
 - ▷ Provided with methods to convolve the map with a generic binned kernel and overlay the arrows of the polarization information



with the command `xpbinsview` it is possible to quickly visualize all the outputs from `xpbins`

Analysis – xpbins PHA1, PHA1Q, PHA1U

Polarization map

- ▷ Main interface to spectro-polarimetric fitting in XSPEC, Sherpa and 3ML
- ▷ Generalization of the standard PHA spectra:
 - ▷ PHA1, PHA1Q and PHA1U
- ▷ Lightweight python wrapper dubbed *xpxspec* shipped with *ixpeobssim*:
 - ▷ Together with a few simple, multiplicative polarimetric models provided by HEASARC through the page hosting XSPEC additional models

