



# eradial

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## Abstract

A routine to extract a radial profile of a source in an image and fit a point spread function to it.

## 1 Instruments/Modes

Instrument	Mode
EPIC	IMAGING

## 2 Use

pipeline processing	no
interactive analysis	yes

## 3 Description

This task allows a user to produce the radial profile of a source in the field of view and compare it with the nominal point spread function from a calibration file. It can be used to test whether a source is extended.

### 3.1 Input

#### 3.1.1 Source image

The source image may be input in detector or sky (X/Y) coordinates. The task expects to find astrometry keywords in a certain part of the primary header and will exit with an error if the keywords are not found. Standard images produced by `evselect` and `xmmselect` and the pipeline will process ok.



### 3.1.2 Source regions

The source region is used to define the centre of the source. Optionally, the program can calculate the centre of the source for calculating the radial profile by setting the parameter `centroid=yes`

The source centre is also used to determine the off-axis angle for the PSF.

Spatial regions may be entered in detector (DETX, DETY), sky (X/Y) or celestial (RA, DEC, FK4 2000) coordinates. If the coordinates of the region are not the same as those of the image, e.g. a sky pixel region on a detector coordinate image, then the task will still function but will run more slowly. An error will result if the spatial region is not within the image. Any shape conforming to the `selectlib` rules may be used.

## 3.2 Output

The main output is a FITS file containing the radial profile, the theoretical PSF at that position in the image and at that energy and the best fit normalisation of that PSF to the actual radial profile data.

The data columns are:

- RAD\_LO: The start of the radial bin (arcsec)
- RAD\_HI: The end of the radial bin (arcsec)
- RPROF: The radial profile in units of counts per arcsec\*\*2
- RPROF\_ERR: The error on the radial profile
- RPSF: The nominal point spread function
- FIT\_RPSF: The PSF after fitting to the radial profile

### 3.2.1 Plotting the result

The resulting radial profile fit can be displayed using the ftool `fplot` with the command:

```
fplot infile=radprof.ds xparm=RAD_LO yparm="RPROF[RPROF_ERR] FIT_RPSF"  
rows=- device=/xw pltcmd="@mycomms.pco"
```

which will plot the radial profile and best fit PSF from the file `radprof.ds` on an X-window display. The file `mycomms.pco` can be tailored by the user. An example might be:

```
> cat mycomms.pco  
mark 2 on 2  
log x y  
plot overlay  
plot
```



### 3.2.2 Fit statistic

The PSF is fit to the radial profile with a linear fit where the constant is the background and the linear term is the normalisation of the PSF to the strength of the source. The code performs a fit weighted by the inverse of the error on each data point. The RMS fit statistic is displayed.

## 4 Examples

To fit a radial profile from a central source with the EXTENDED mode (King profile) PSF at an energy of 1 keV.

```
eradial imageset=myimage.ds srcexp='(X,Y) in CIRCLE(25900,25900,600)' psfenergy=1.0
```

## 5 Parameters

This section documents the parameters recognized by this task (if any).

Parameter	Mand	Type	Default	Constraints
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<b>imageset</b>	yes	string	image	
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The name of the input image.

<b>srcexp</b>	yes	string		
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Expression for determining the source centre.

<b>centroid</b>	no	bool	yes	
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Whether to centroid the source counts before extracting the radial profile.

<b>binwidth</b>	no	double	2.0	
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The width of each radial profile bin in arcseconds.

<b>psftype</b>	no	string	EXTENDED	
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The mode to use for the PSF. The options are EXTENDED (a circular parameterisation based on the King profile), ELLBETA (a 2-d PSF formulisation), HIGH (a three gaussian parameterisation of the Medium mode maps), MEDIUM (2-d maps produced by the science simulator) and LOW (a single Gaussian model).

<b>psfenergy</b>	no	double	2.0	
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The photon energy to use for the PSF. The default is 2.0 keV.

## 6 Errors

This section documents warnings and errors generated by this task (if any). Note that warnings and errors can also be generated in the SAS infrastructure libraries, in which case they would not be documented here. Refer to the index of all errors and warnings available in the HTML version of the SAS



documentation.

**InvalidExpression** (*error*)

The input expression for this spatial region was not valid.

**InvalidRegion** (*error*)

The centre of the source or background region lies outside of the image

**invalidArraySize** (*error*)

The image is not two dimensional.

**InvalidWCSType** (*error*)

The image axes specified in the CTYPE1 and CTYPE2 keywords are not compatible.

**UnknownModeString** (*warning*)

If the image contains an observing mode (in the keyword SUBMODE) which is not recognised then the software assumes that the common PrimeFullWindow mode was in use. The mode is used to calculate certain calibration quantities.

*corrective action:*

**NoInstrument** (*warning*)

If the INSTRUME keyword is not set in the image header a warning is issued and the default of MOS-1 is taken. The instrument determines the PSF used and the position of the optical-axis.

*corrective action:*

**InvalidPosWCSInfo** (*warning*)

The REFERENCE keywords in the image header, e.g. REF\_XCRPX, REF\_XCRVL, REF\_XCDLT are incomplete. Defaults are chosen but there is likely to be a problem later.

*corrective action:*

## 7 Input Files

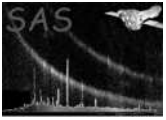
- an EPIC image produced by evselect or xmmselect or the pipeline.

## 8 Output Files

An OGIP standard FITS radial profile file.

## 9 Algorithm

The PSF is fit to the radial profile using the SLATEC routine SLATEC\_DPOLFT.



## 10 Comments

## References