

X-ray data analysis

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NuSTAR and Xselect

We will use the 2015 observation of the bright AGN
Mrk 766:

ObsID – 60001048002

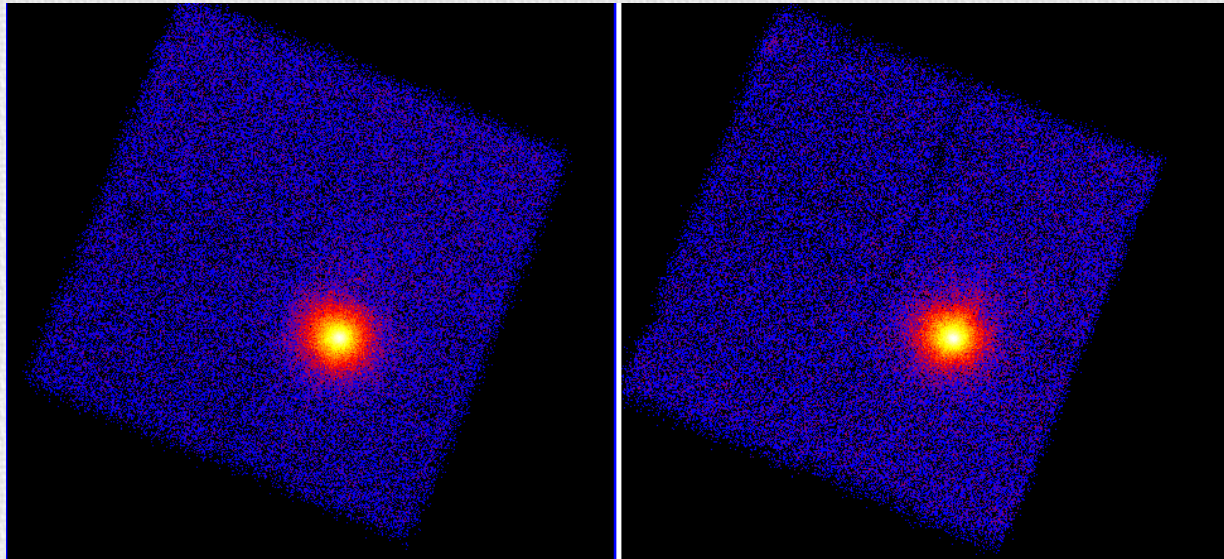
and apply some filters to the event files using
Xselect

NuSTAR and Xselect

We first run the nustar pipeline (nupipeline) and we will obtain two event files:

nu60001048002A01_cl.evt
FPMA

nu60001048002B01_cl.evt
FPMB



NuSTAR pipeline (nupipeline)

The NuSTAR pipeline (tool of the NuSTARDAS package) applies the latest instruments' calibrations to the unfolded event files.

-Initialize ftools and CALDB
(with the path to your NuSTAR CALDB directory)

```
export CALDB=/data/marinucci/marinucci/NuSTAR_software/CALDB
export CALDBCONFIG=$CALDB/software/tools/caldb.config
export CALDBALIAS=$CALDB/software/tools/alias_config.fits
```

!!!Xselect cannot read input files with spaces in the file's name

!!!Known Ftools+SAS conflict

NuSTAR pipeline (nupipeline)

nupipeline

```
=====
                NuSTAR pipeline Report
Task: nupipeline Version: 0.4.4 Release Date: 2015-05-19
=====
evt: .... Optical Axis RA from RA_PNT keyword : 1.8462950000000E+02(deg)
evt: .... Optical Axis DEC from DEC_PNT keyword : 2.9840800000000E+01(deg)
FPMA: .... Stage I: Calibrating Level 1 Event File: './60001048002/event_cl/nu60001048002A_uf.evt'
FPMA: .... Stage I: Calibrated Event File: './60001048002/event_cl/nu60001048002A_uf.evt'
FPMA: .... Stage II: Screening Level 1a Event File: './60001048002/event_cl/nu60001048002A_uf.evt'
FPMA: .... Stage II: Created Filtered Level 2 Event File './60001048002/event_cl/nu60001048002A01_cl.evt' for Observing Mode '01'
FPMA: .... Stage II: Created Filtered Level 2 Event File './60001048002/event_cl/nu60001048002A02_cl.evt' for Observing Mode '02'
FPMA: .... Stage II: Created Filtered Level 2 Event File './60001048002/event_cl/nu60001048002A03_cl.evt' for Observing Mode '03'
FPMA: .... Stage II: Created Filtered Level 2 Event File './60001048002/event_cl/nu60001048002A04_cl.evt' for Observing Mode '04'
FPMA: .... Stage II: WARNING No Filtered Level 2 Event File created for Observing Mode '05'
FPMA: .... Stage II: Created Filtered Level 2 Event File './60001048002/event_cl/nu60001048002A06_cl.evt' for Observing Mode '06'
FPMB: .... Stage I: Calibrating Level 1 Event File: './60001048002/event_cl/nu60001048002B_uf.evt'
FPMB: .... Stage I: Calibrated Event File: './60001048002/event_cl/nu60001048002B_uf.evt'
FPMB: .... Stage II: Screening Level 1a Event File: './60001048002/event_cl/nu60001048002B_uf.evt'
FPMB: .... Stage II: Created Filtered Level 2 Event File './60001048002/event_cl/nu60001048002B01_cl.evt' for Observing Mode '01'
FPMB: .... Stage II: Created Filtered Level 2 Event File './60001048002/event_cl/nu60001048002B02_cl.evt' for Observing Mode '02'
FPMB: .... Stage II: Created Filtered Level 2 Event File './60001048002/event_cl/nu60001048002B03_cl.evt' for Observing Mode '03'
FPMB: .... Stage II: Created Filtered Level 2 Event File './60001048002/event_cl/nu60001048002B04_cl.evt' for Observing Mode '04'
FPMB: .... Stage II: WARNING No Filtered Level 2 Event File created for Observing Mode '05'
FPMB: .... Stage II: Created Filtered Level 2 Event File './60001048002/event_cl/nu60001048002B06_cl.evt' for Observing Mode '06'
```

nupipeline 0.4.4: Exit with no errors - Fri Jun 10 12:03:29 CEST 2016

Xselect and nuproducts

Filters (time, regions, energy) can be applied using Xselect or nuproducts to the two FPMA and FPMB cleaned event files:

<https://heasarc.gsfc.nasa.gov/docs/asca/abc/node8.html>

<http://www.iasf-palermo.inaf.it/~romano/Xselect/node13.html>

<http://heasarc.gsfc.nasa.gov/lheasoft/ftools/caldb/help/nuproducts.html>

Xselect

Different filtering procedures can be performed using the `filter` command (remember that you are now working with detectors' channels, not energies). Some examples can be found below:

```
read ev
./
nu60001048002A01_cl.evt
yes
extra ima
pl ima
filter region
extra curve
save curve
filter pha_cutoff
extra ev
save ev new_event_FPMA.evt
```

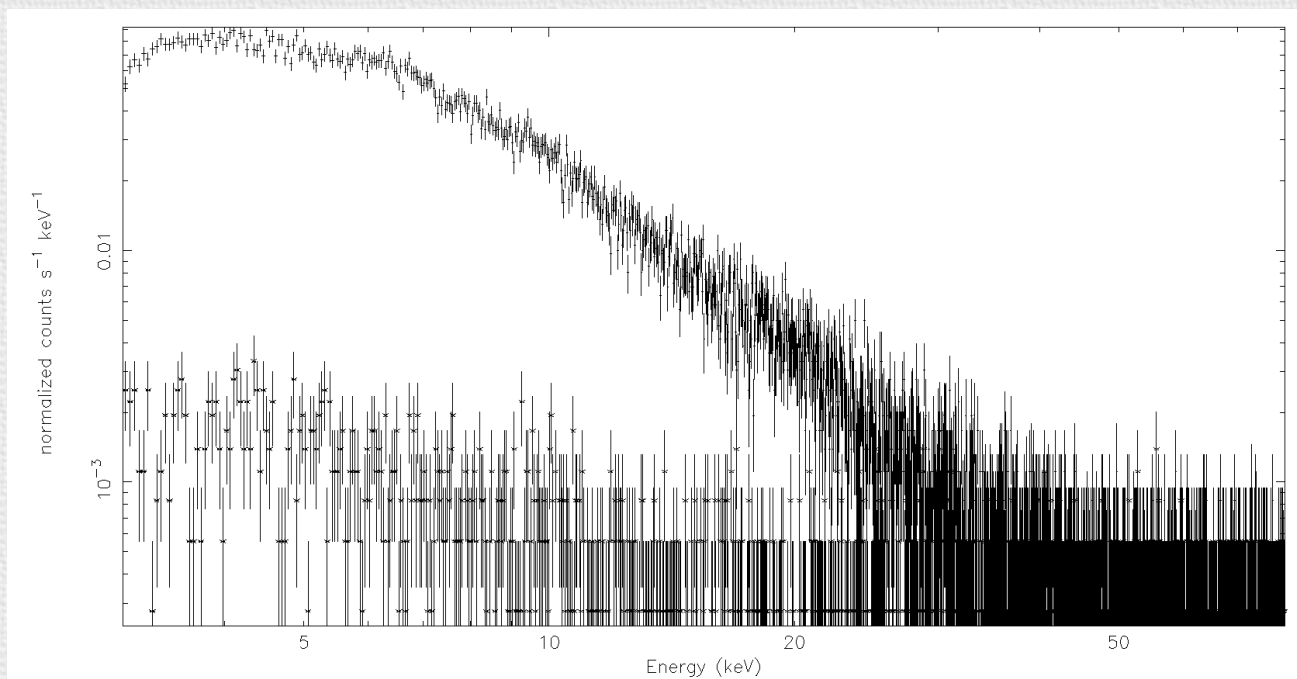
If `ds9` is not the default image plotting device, before opening Xselect, you can run:

```
pset xselect imagedisp=/usr/local/bin/ds9
```

Nuproducts

You can now use the modified event file to extract a spectrum of the source (and background!):

```
nuproducts indir=./ infile=nu60001048002A01_cl.evt
instrument=FPMA steminputs=nu60001048002
srcregionfile=source.reg bkgextract=yes bkgregionfile=bkg.reg
outdir=./products runmkarf=yes runmkrmf=yes extended=no
clobber=yes offaxishisto=DEFAULT psfflag=yes
```



Do not forget to rebin your data!

Nuproducts

The same filters can be applied directly with nuproducts,
always double check what you have produced.

```
nuproducts infile=nu60001048002A01_cl.evt rungrppha=yes  
srcregionfile=source.reg bkgregionfile=bkg.reg indir=./  
outdir=./products steminput=nu60001048002 instrument=FPMA  
grpmincounts=30 grppibadlow=35 grppibadhigh=1909
```