

Ctools: simulating CTA data

Inizializzazione dei Ctools

```
>module load CTOOLS_1.5.2b  
>gammalibinit>ctoolsinit  
>source activate py_ctools
```

Ctools: simulating CTA data

Simulare i dati

- * *Preparare il file .xml che definisce la Rol: vedi esempio nella slide successiva*
- * *Il modello della sorgente va estratto dal paper Aleksic et al . 2014 A&A 563, A91*
- * *Si consideri lo stato alto o basso e solo i dati osservati non quelli intrinseci*
- * *Una volta costruita la Rai lanciare il comando ctobssim per simulare il file di eventi.*
- * *Simulare 5 h di daticercare la matrice di risposta giusta.... (Nord, Sud, ore di integrazione)*

Ctobssim

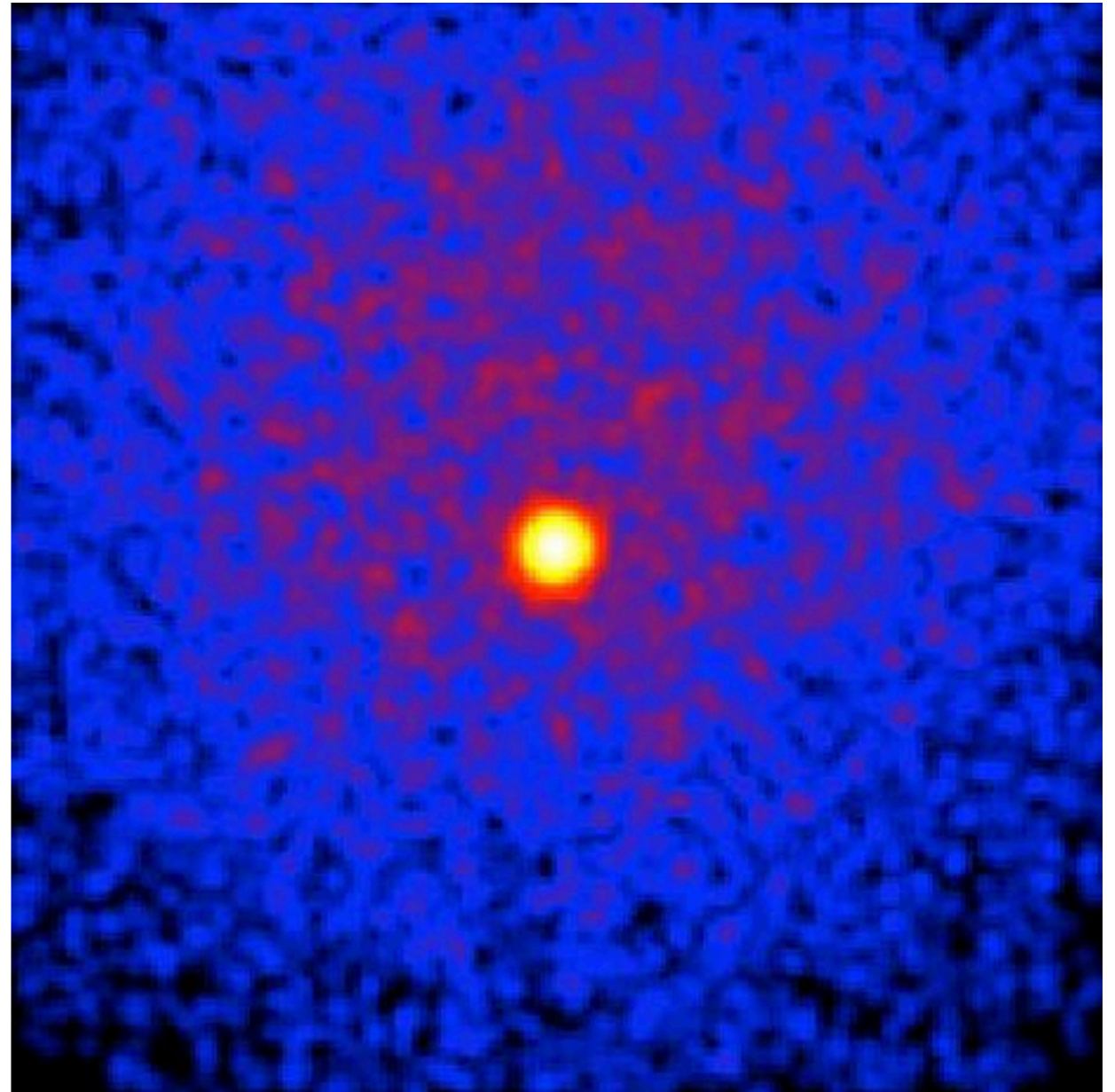
RA of pointing (degrees) (0-360) []
Dec of pointing (degrees) (-90-90) []
Radius of FOV (degrees) (0-180) [5.0]
Start time (UTC string, JD, MJD or MET in seconds) [2020-01-01T00:00:00]
Stop time (UTC string, JD, MJD or MET in seconds) [[2020-01-01T05:00:00]]
Lower energy limit (TeV) [0.1]
Upper energy limit (TeV) [100.0]
Calibration database [prod2]
Instrument response function [?]
Input model definition XML file []
Output event data file or observation definition XML file [events.fits]

Creare una skymap

```
$ ctskymap
Input event list or observation definition XML file [events.fits] selected_events.fits
First coordinate of image center in degrees (RA or galactic l) (0-360) [83.63]
Second coordinate of image center in degrees (DEC or galactic b) (-90-90) [22.01]
Projection method (AIT|AZP|CAR|GLS|MER|MOL|SFL|SIN|STG|TAN) [CAR]
Coordinate system (CEL - celestial, GAL - galactic) (CEL|GAL) [CEL]
Image scale (in degrees/pixel) [0.02]
Size of the X axis in pixels [200]
Size of the Y axis in pixels [200]
Lower energy limit (TeV) [0.1]
Upper energy limit (TeV) [100.0]
Background subtraction method (NONE|IRF|RING) [NONE]
Output skymap file [skymap.fits]
```

Esempio di count map

Crab



ESEMPIO di ROI

```
<?xml version="1.0" standalone="no"?>
<source_library title="source library">
  <source name="Name" type="PointSource" tscal="1">
    <spectrum type="PowerLaw">
      <parameter name="Prefactor" scale="1e-16" value="5.7" min="1e-07" max="1000.0" free="1"/>
      <parameter name="Index" scale="-1" value="2.48" min="0.0" max="+5.0" free="1"/>
      <parameter name="PivotEnergy" scale="1e6" value="0.3" min="0.01" max="1000.0" free="0"/>
    </spectrum>
    <spatialModel type="PointSource">
      <parameter name="RA" scale="1.0" value="83.6331" min="-360" max="360" free="0"/>
      <parameter name="DEC" scale="1.0" value="22.0145" min="-90" max="90" free="0"/>
    </spatialModel>
  </source>
  <source name="CTABackgroundModel" type="CTAIfBackground" instrument="CTA">
    <spectrum type="PowerLaw">
      <parameter name="Prefactor" scale="1.0" value="1.0" min="1e-3" max="1e+3" free="1"/>
      <parameter name="Index" scale="1.0" value="0.0" min="-5.0" max="+5.0" free="1"/>
      <parameter name="PivotEnergy" scale="1e6" value="1.0" min="0.01" max="1000.0" free="0"/>
    </spectrum>
  </source>
</source_library>
```

Inserire il vostro
modello per la sorgente

Background

ANALISI del file simulato

1. binnare i dati in energia e in RA e Dec

ctbin

Input event list or observation definition XML file [events.fits]
First coordinate of image center in degrees (RA or galactic l) (0-360) [83.63]
Second coordinate of image center in degrees (DEC or galactic b) (-90-90) [22.51]
Projection method (AIT|AZP|CAR|GLS|MER|MOL|SFL|SIN|STG|TAN) [CAR]
Coordinate system (CEL - celestial, GAL - galactic) (CEL|GAL) [CEL]
Image scale (in degrees/pixel) [0.02]
Size of the X axis in pixels [200]
Size of the Y axis in pixels [200]
Algorithm for defining energy bins (FILE|LIN|LOG) [LOG]
Lower energy limit (TeV) [0.1]
Upper energy limit (TeV) [100.0]
Number of energy bins (1-200) [20]
Output counts cube file [cntcube.fits]

Calcolare l'esposizione in funzione della posizione nel cielo e dell'energia

2. ctexpcube

Input event list or observation definition XML file [NONE] events.fits
Calibration database [prod2]
Instrument response function []
Input counts cube file to extract exposure cube definition [NONE] cntcube.fits
Output exposure cube file [expcube.fits]

Costruire la PSF in funzione della posizione nel cielo e dell'energia

3. ctpsfcube

Input event list or observation definition XML file [NONE] selected_events.fits
Calibration database [prod2]
Instrument response function [South_0.5h]
Input counts cube file to extract PSF cube definition [NONE]
First coordinate of image center in degrees (RA or galactic l) (0-360) [83.63]
Second coordinate of image center in degrees (DEC or galactic b) (-90-90) [22.51]
Projection method (AIT|AZP|CAR|GLS|MER|MOL|SFL|SIN|STG|TAN) [CAR]
Coordinate system (CEL - celestial, GAL - galactic) (CEL|GAL) [CEL]
Image scale (in degrees/pixel) [1.0]
Size of the X axis in pixels [10]
Size of the Y axis in pixels [10]
Algorithm for defining energy bins (FILE|LIN|LOG) [LOG]
Lower energy limit (TeV) [0.1]
Upper energy limit (TeV) [100.0]
Number of energy bins (1-200) [20]
Output PSF cube file [psfcube.fits]

Calcolare il background in funzione della posizione nel cielo e dell'energia

4. ctbkcube

Input event list or observation definition XML file [NONE] selected_events.fits
Calibration database [prod2]
Instrument response function [South_0.5h]
Input counts cube file to extract background cube definition [NONE] cntcube.fits
Input model definition XML file [NONE] \$CTOOLS/share/models/crab.xml
Output background cube file [bkgcube.fits]
Output model definition XML file [NONE] **models.xml**

Calcolare la likelihood

5. ctlike

Input event list, counts cube or observation definition XML file [events.fits] cntcube.fits
Input exposure cube file [NONE] expcube.fits
Input PSF cube file [NONE] psfcube.fits
Input background cube file [NONE] bkgcube.fits
Input model definition XML file [\$CTOOLS/share/models/crab.xml] **models.xml**
Output model definition XML file [crab_results.xml]

Viene prodotto un file ctlike.log in cui vengono riportati i parametri del fit e in particolare il TS

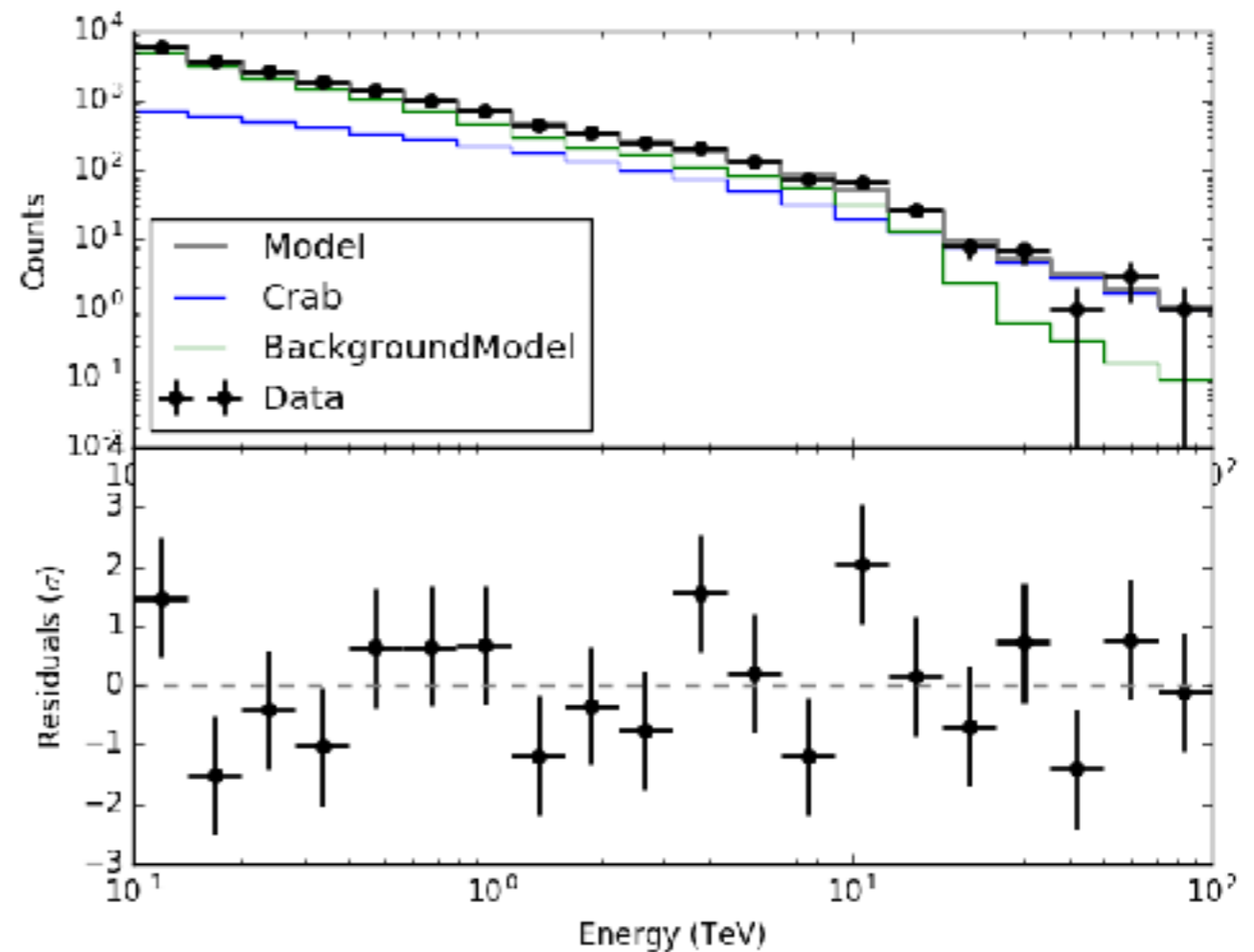
Visualizzare lo spettro e i residui

6. csresspec components=yes

```
Input event list, counts cube, or observation definition XML file [events.fits] cntcube.fits
Input exposure cube file [NONE] expcube.fits
Input PSF cube file [NONE] psfcube.fits
Input background cube file [NONE] bkgcube.fits
Input model definition XML file [$CTOOLS/share/models/crab.xml] crab_results.xml
Mask data to calculate residuals in ROI? [no]
Residuals computation algorithm (SUB|SUBDIV|SUBDIVSQRT|SIGNIFICANCE) [SIGNIFICANCE]
Output residual spectrum file [resspec.fits]
```

Per ottenere il grafico

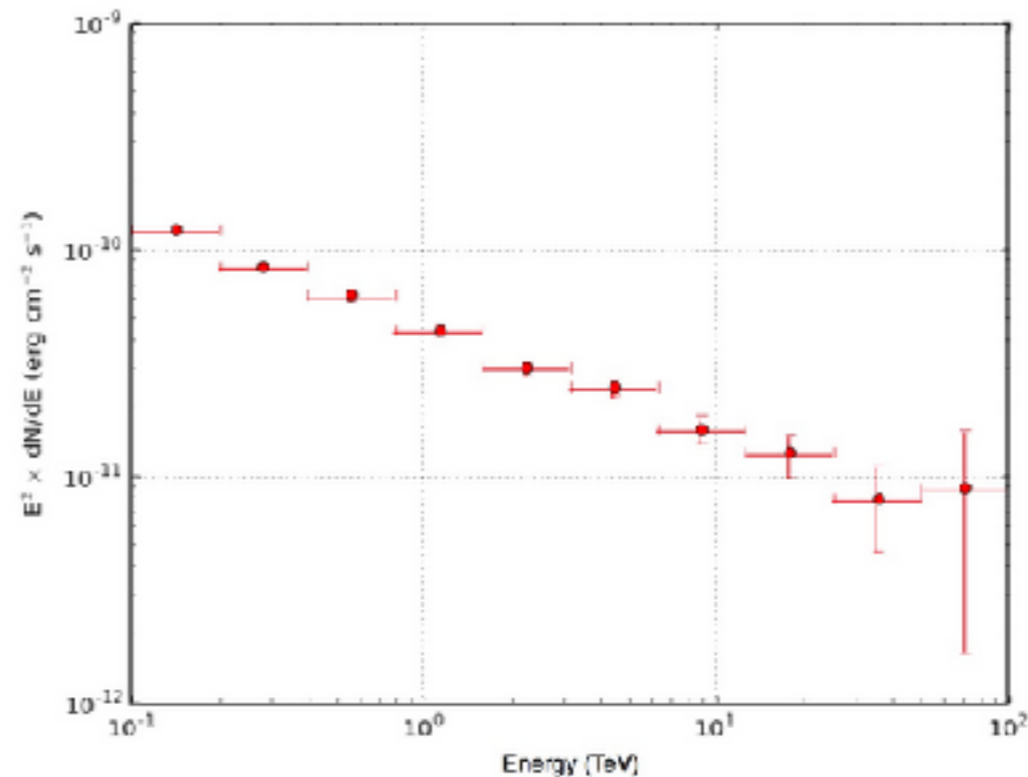
```
$CTOOLS/share/examples/python/show_residuals.py resspec.fits
```



Produrre lo spettro

6. csspec

```
Input event list, counts cube, or observation definition XML file [events.fits] cntcube.fits
Input exposure cube file [NONE] expcube.fits
Input PSF cube file [NONE] psfcube.fits
Input background cube file [NONE] bkgcube.fits
Input model definition XML file [$CTOOLS/share/models/crab.xml] crab_results.xml
Source name [Crab]
Spectrum generation method (SLICE|NODES|AUTO) [AUTO]
Binning algorithm (LIN|LOG|FILE) [LOG]
Lower energy limit (TeV) [0.1]
Upper energy limit (TeV) [100.0]
Number of energy bins [20] 10
Output spectrum file [spectrum.fits]
```



Spectral energy distribution of the Crab nebula