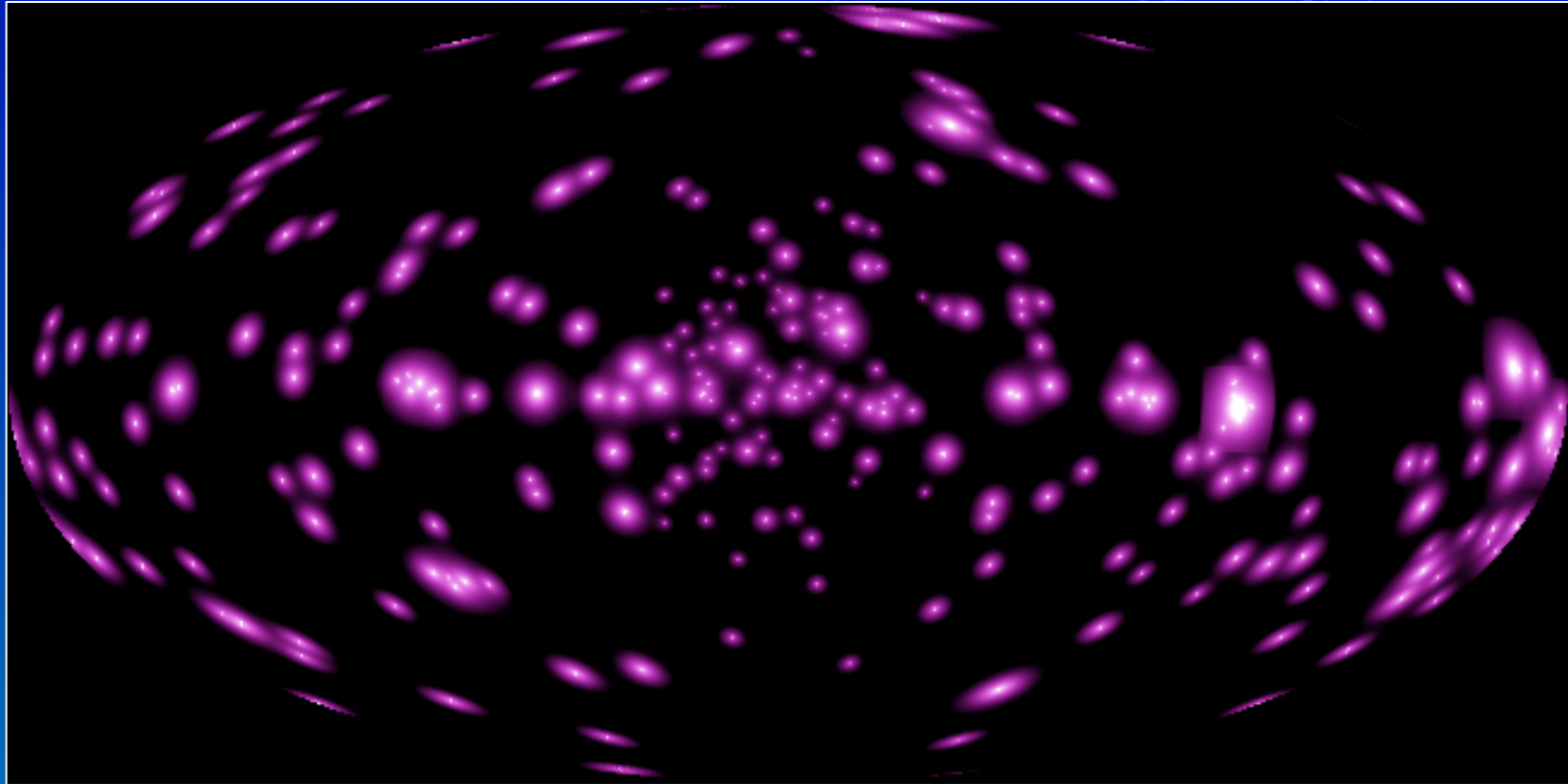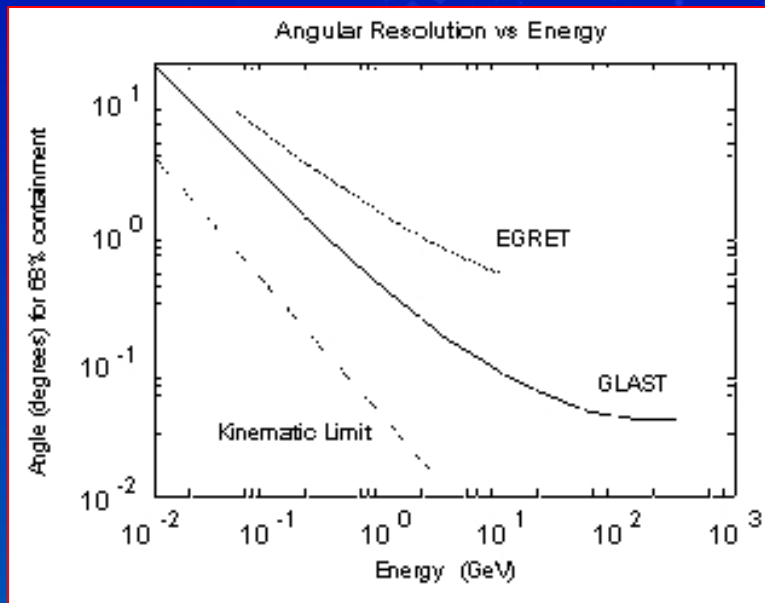# sourceIdentify
and identification strategies for LAT sources

Jürgen Knödlseder
Centre d'Etude Spatiale des Rayonnements, Toulouse, France
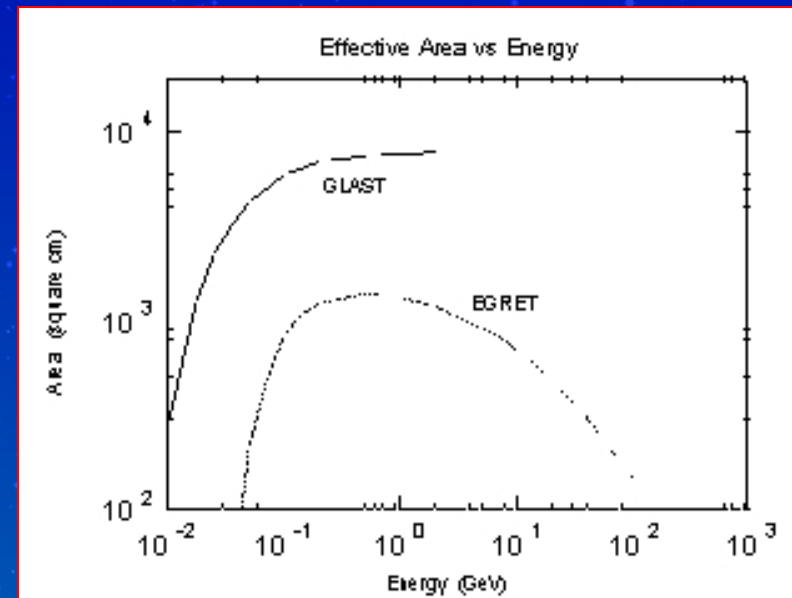
GLAST source identification

New challanges

GLAST angular resolution

- **better than EGRET**
  $\Rightarrow$ **less sources in error boxes**
- **but still far worse than at other** λ
  $\Rightarrow$ **positional coincidence not sufficient for source identification**

GLAST effective area

- **better than EGRET**
  $\Rightarrow$ **from 270 sources to thousands**
- **many more to identify**
  $\Rightarrow$ **automatic procedures**

Counterpart identification

Basics

General definition of counterpart probability

- **Counterpart probability P_c**
  $P_c = P_{pos} \times P^{(i)}_{SED} \times P^{(i)}_{var} \times P^{(i)}_{ext} \times ...$

- **Positional coincidence probability P_{pos}**
  proportional to overlap of the error region of the GLAST source with that of the counterpart candidate (source class independent)

- **Spectral energy density distribution (SED) probability $P^{(i)}_{SED}$**
  proportional to the probability that a given source class (i) shows the observed SED (i.e. radio flatness $\Rightarrow$ large $P^{(i)}_{SED}$ for Blazar source class)

- **Source variability probability $P^{(i)}_{var}$**
  proportional to the probability that a given source class (i) shows the observed variability

- **Source extension probability $P^{(i)}_{ext}$**
  proportional to the probability that a given source class (i) shows the observed extension

- **others …**
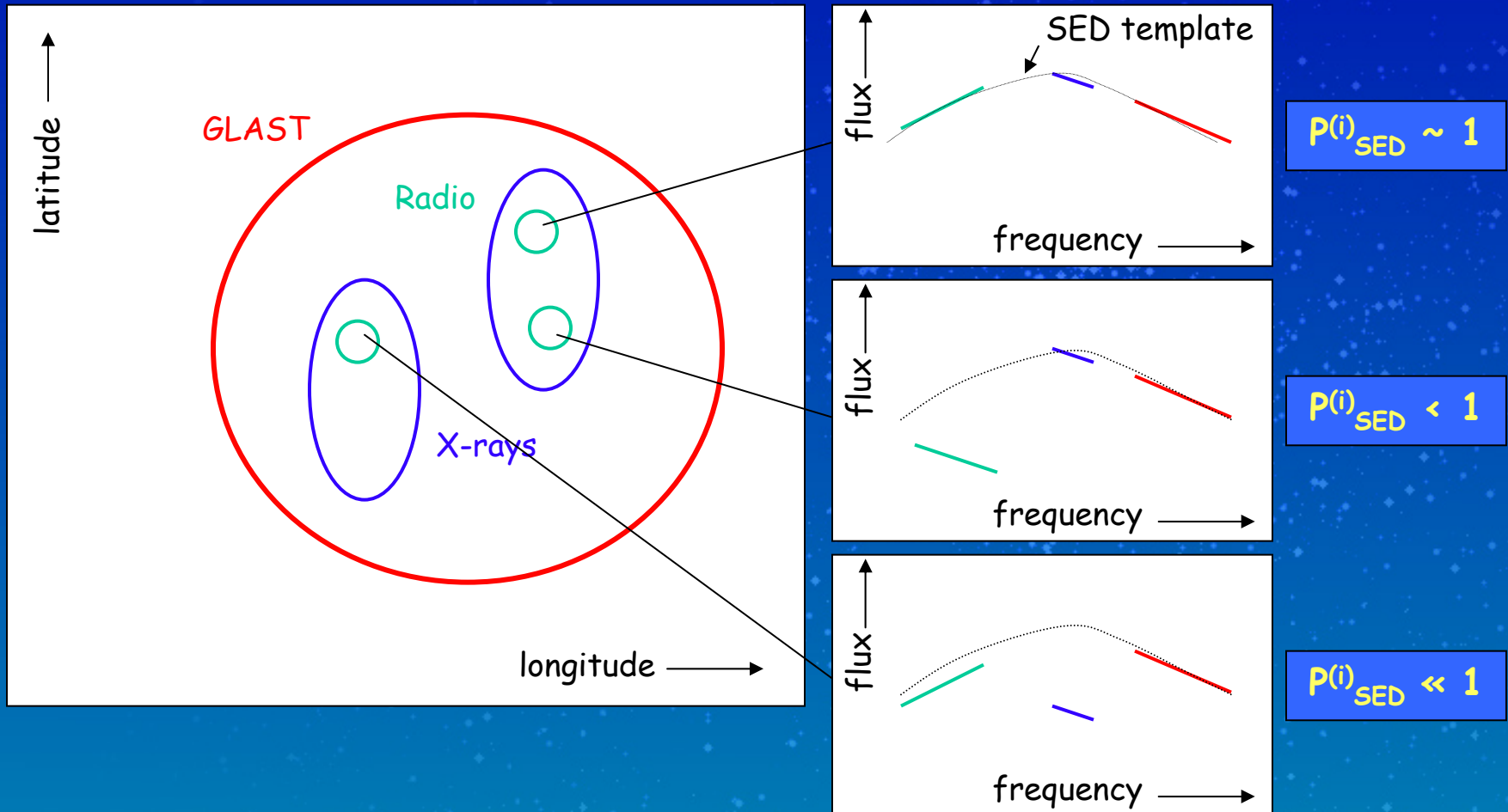
Counterpart identification

Open issues

How to define counterpart probabilities

- **How to define $P^{(i)}_{SED}$**
  (e.g. Mattox et al. 1997 for flat spectra radio quasars)
- **How to define $P^{(i)}_{var}$**
  variability characterisation (classes ? ; power density distributions ?)
  pulsar information
  variability information very catalogue specific
- **How to define $P^{(i)}_{ext}$**
  characterisation of source extension
  (e.g. gamma-ray emission from a SNR knot)

How to add auxilliary information

- **Catalogue completeness, exposure, sensitivity limit**
  maybe we found no counterpart because the sky region was not included in the catalogue or only weakly exposed in the survey ; upper limits ?
- **Homogeniety of quantities**
  calculation of SED from catalogue information
  (e.g. count rates and no fluxes are given in ROSAT catalogue ; photon vs. energy flux)

sourceIdentify

A2 in the Science Tools
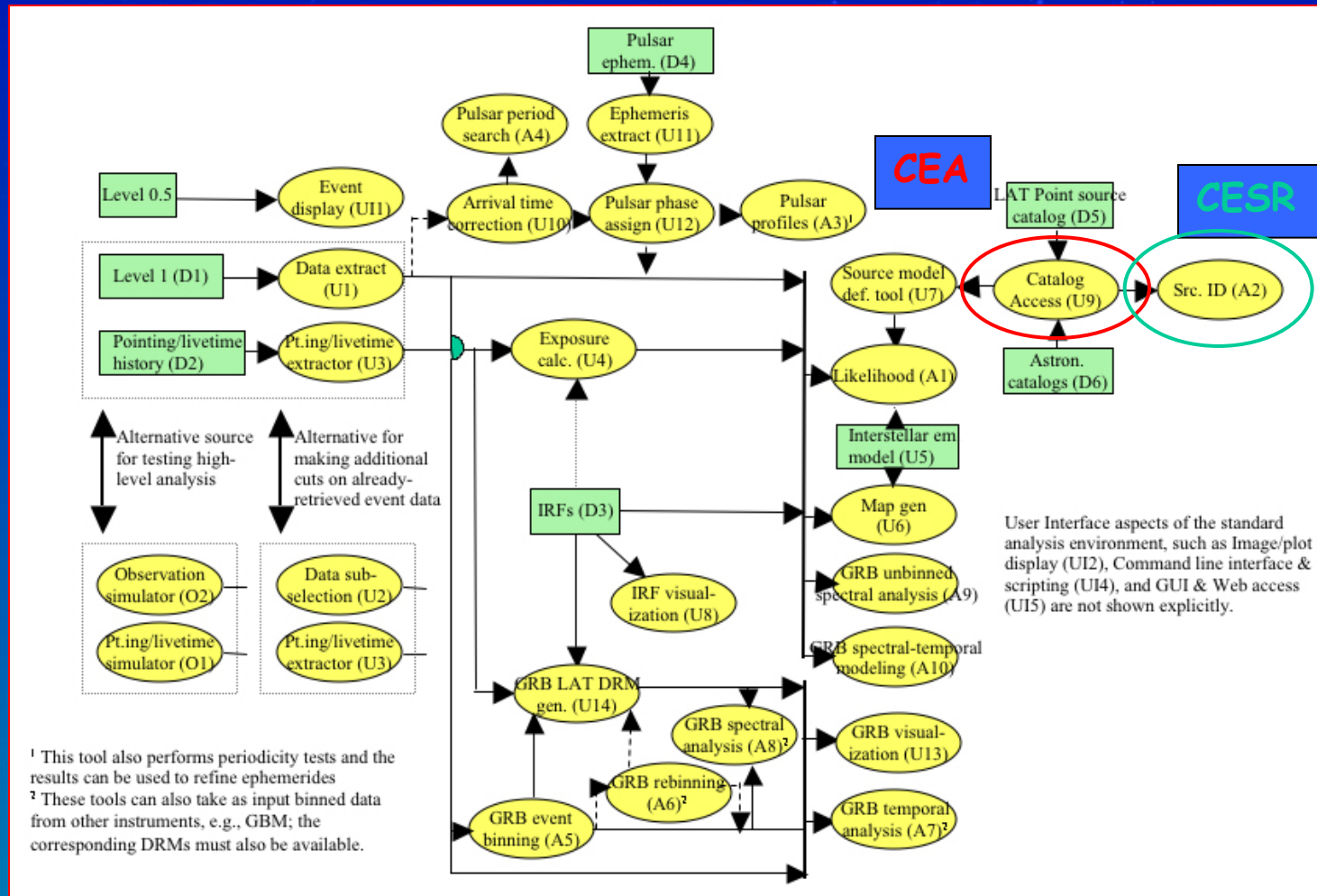
Requirements

A2 requirements (Standard Analysis Environment definition, 2-2-2004)

(1) evaluates probabilities of coincidence between a specified LAT point source and astronomical catalogs of potential counterparts
- ⇒ 1.1 coincidence algorithm needed

(2) works on client's computer
- ⇒ 2.1 use publically available catalogues
- ⇒ 2.2 not computationally intensive
- ⇒ 2.3 modest memory requirements

(3) catalog access through U9
- ⇒ local catalogues (TSV, FITS)
- ⇒ WWW interface
- ⇒ generic catalogue quantities (for limited # of predefined catalogues)
- ⇒ coded by CEA

A2 sophistication level

(1) Positional coincidence (v0)
- ⇒ works for all catalogues

(2) Positional and SED (v1)
- ⇒ A2 needs to know the catalogue (flux interpretation, auxillary information)

(3) Positional and SED and Variability / Extension (v++)
- ⇒ A2 needs time variability information (source and catalogue)

sourceIdentify

Design
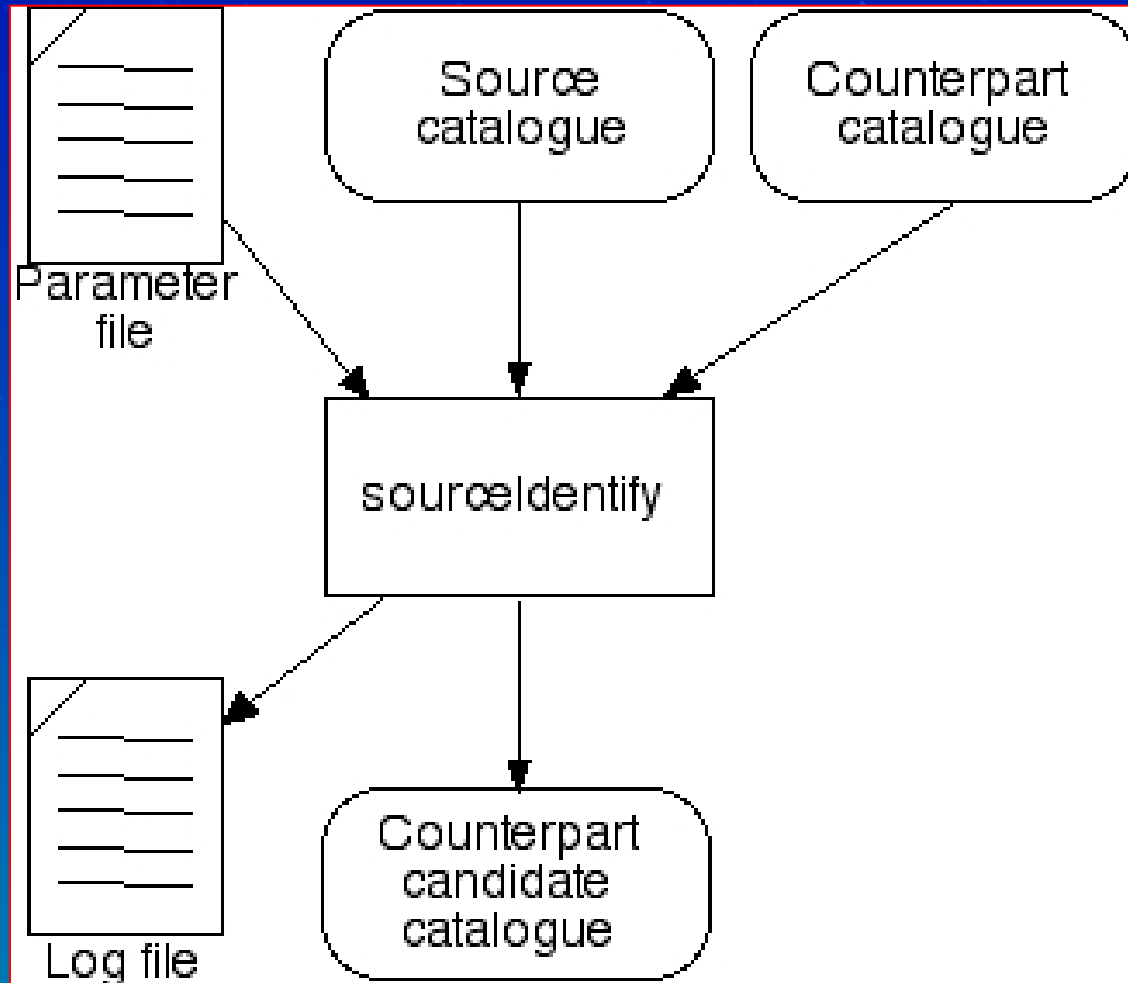
sourceIdentify

Usage

Example : correlate multi-λ radio catalogue to GLAST catalogue

Example : find multi-λ counterparts (large errors $\rightarrow$ small errors)

Implementation

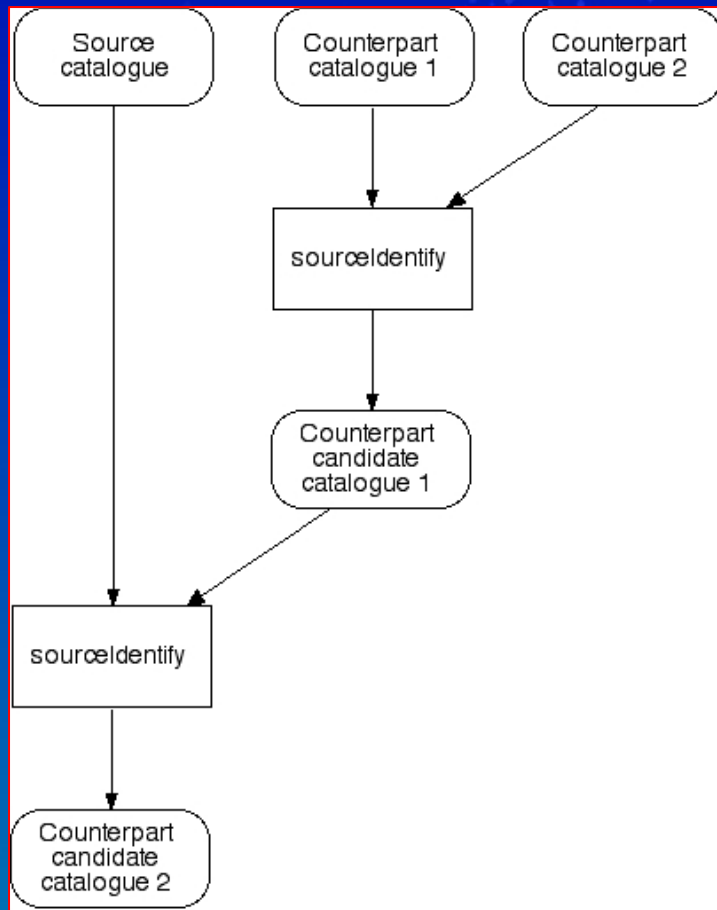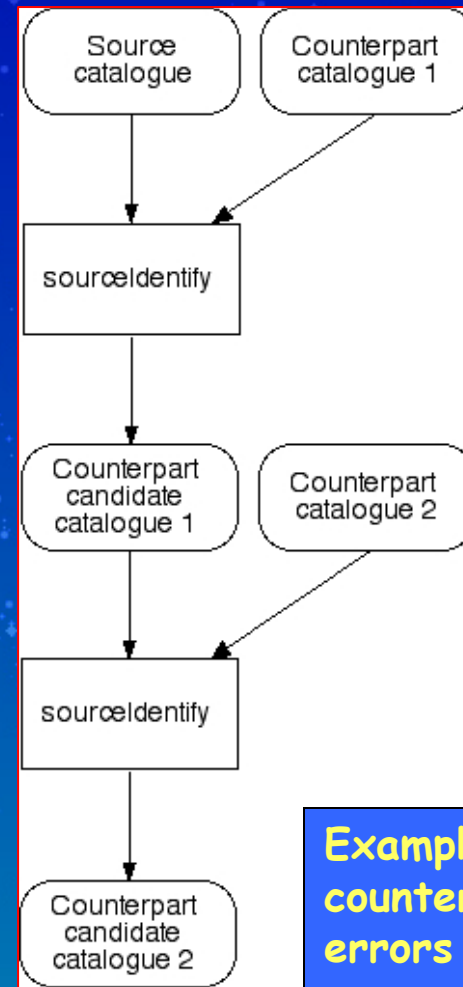## Parameter file

```
#
# Source Catalogue information
#=============================
srcCatName,s,a,"../../data/3EG_all.tsv",,,"Source catalogue name"
srcCatQty, s,a,        "RAJ2000,DEJ2000",,,"Source catalogue quantities to be written"
#
# Counterpart Catalogue information
#===================================
cptCatName,s,a,"../../data/1rxs_50.tsv",,,"Counterpart catalogue name"
cptCatQty, s,a,        "RAJ2000,DEJ2000",,,"Counterpart catalogue quantities to be written"
#
# Output Catalogue information
#=============================
outCatName,   s,a,"../../data/outref/test1.fits",,,"Output catalogue name"
outCatQty01, s,h,                          "",,,"New output catalogue quantity 1"
outCatQty02, s,h,                          "",,,"New output catalogue quantity 2"
outCatQty03, s,h,                          "",,,"New output catalogue quantity 3"
outCatQty04, s,h,                          "",,,"New output catalogue quantity 4"
outCatQty05, s,h,                          "",,,"New output catalogue quantity 5"
outCatQty06, s,h,                          "",,,"New output catalogue quantity 6"
outCatQty07, s,h,                          "",,,"New output catalogue quantity 7"
outCatQty08, s,h,                          "",,,"New output catalogue quantity 8"
outCatQty09, s,h,                          "",,,"New output catalogue quantity 9"
#
# Task parameters
#=================
probMethod, s,a,"POSITION",,,"Probability method"
probThres,  r,a,      0.05,,,"Probability threshold"
maxNumCtp,  i,a,       100,,,"Maximum number of counterpart candidates"
select01,   s,h,        "",,,"Selection cirterium 1"
select02,   s,h,        "",,,"Selection cirterium 2"
select03,   s,h,        "",,,"Selection cirterium 2"
select04,   s,h,        "",,,"Selection cirterium 2"
select05,   s,h,        "",,,"Selection cirterium 2"
select06,   s,h,        "",,,"Selection cirterium 2"
select07,   s,h,        "",,,"Selection cirterium 2"
select08,   s,h,        "",,,"Selection cirterium 2"
select09,   s,h,        "",,,"Selection cirterium 2"
#
# Standard parameters
#=====================
chatter, i,h, ]4,0,4,"Chattiness of output"
clobber, b,h,   yes,,,"Overwrite existing output catalogue ?"
debug,   b,h,    no,,,"Debugging mode activated"
mode,    s,h, "ql",,,"Mode of automatic parameters"
```

Implementation

Parameter file

```
#
# Source Catalogue information
#==============================
srcCatName,s,a,"../../data/3EG_all.tsv",,,"Source catalogue name"
srcCatQty, s,a,      "RAJ2000,DEJ2000",,,"Source catalogue quantities to be written"
#
# Counterpart Catalogue information
#==================================
cptCatName,s,a,"../../data/1rxs_50.tsv",,,"Counterpart catalogue name"
cptCatQty, s,a,      "RAJ2000,DEJ2000",,,"Counterpart catalogue quantities to be written"
#
# Output Catalogue information
#==============================
outCatName,  s,a,"../../data/outref/test1.fits",,,"Output catalogue name"
outCatQty01, s,h,                     "",,,"New output catalogue quantity 1"
outCatQty02, s,h,                     "",,,"New output catalogue quantity 2"
outCatQty03, s,h,                     "",,,"New output catalogue quantity 3"
outCatQty04, s,h,                     "",,,"New output catalogue quantity 4"
outCatQty05, s,h,                     "",,,"New output catalogue quantity 5"
outCatQty06, s,h,                     "",,,"New output catalogue quantity 6"
outCatQty07, s,h,                     "",,,"New output catalogue quantity 7"
outCatQty08, s,h,                     "",,,"New output catalogue quantity 8"
outCatQty09, s,h,                     "",,,"New output catalogue quantity 9"
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# Task parameters
#=================
probMethod, s,a,"POSITION",,,"Probability method"
probThres,  r,a,      0.05,,,"Probability threshold"
maxNumCtp,  i,a,       100,,,"Maximum number of counterpart candidates"
select01,   s,h,        "",,,"Selection cirterium 1"
select02,   s,h,        "",,,"Selection cirterium 2"
select03,   s,h,        "",,,"Selection cirterium 2"
select04,   s,h,        "",,,"Selection cirterium 2"
select05,   s,h,        "",,,"Selection cirterium 2"
select06,   s,h,        "",,,"Selection cirterium 2"
select07,   s,h,        "",,,"Selection cirterium 2"
select08,   s,h,        "",,,"Selection cirterium 2"
select09,   s,h,        "",,,"Selection cirterium 2"
#
# Standard parameters
#=====================
chatter, i,h, ]4,0,4,"Chattiness of output"
clobber, b,h,   yes,,,"Overwrite existing output catalogue ?"
debug,   b,h,    no,,,"Debugging mode activated"
mode,    s,h, "ql",,,"Mode of automatic parameters"
```

**Source catalogue :
(e.g. GLAST sources)**
- **catalogue filename**
- **quantities to extract into
  output catalogue**

Implementation

Parameter file

```
#
# Source Catalogue information
#==============================
srcCatName,s,a,"../../data/3EG_all.tsv",,,"Source catalogue name"
srcCatQty, s,a,       "RAJ2000,DEJ2000",,,"Source catalogue quantities to be written"
#
# Counterpart Catalogue information
#==================================
cptCatName,s,a,"../../data/1rxs_50.tsv",,,"Counterpart catalogue name"
cptCatQty, s,a,       "RAJ2000,DEJ2000",,,"Counterpart catalogue quantities to be written"
#
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#==============================
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outCatQty02, s,h,                       "",,,"New output catalogue quantity 2"
outCatQty03, s,h,                       "",,,"New output catalogue quantity 3"
outCatQty04, s,h,                       "",,,"New output catalogue quantity 4"
outCatQty05, s,h,                       "",,,"New output catalogue quantity 5"
outCatQty06, s,h,                       "",,,"New output catalogue quantity 6"
outCatQty07, s,h,                       "",,,"New output catalogue quantity 7"
outCatQty08, s,h,                       "",,,"New output catalogue quantity 8"
outCatQty09, s,h,                       "",,,"New output catalogue quantity 9"
#
# Task parameters
#=================
probMethod, s,a,"POSITION",,,"Probability method"
probThres,  r,a,       0.05,,,"Probability threshold"
maxNumCtp,  i,a,       100,,,"Maximum number of counterpart candidates"
select01,   s,h,        "",,,"Selection cirterium 1"
select02,   s,h,        "",,,"Selection cirterium 2"
select03,   s,h,        "",,,"Selection cirterium 2"
select04,   s,h,        "",,,"Selection cirterium 2"
select05,   s,h,        "",,,"Selection cirterium 2"
select06,   s,h,        "",,,"Selection cirterium 2"
select07,   s,h,        "",,,"Selection cirterium 2"
select08,   s,h,        "",,,"Selection cirterium 2"
select09,   s,h,        "",,,"Selection cirterium 2"
#
# Standard parameters
#=====================
chatter, i,h, [4,0,4,"Chattiness of output"
clobber, b,h,   yes,,,"Overwrite existing output catalogue ?"
debug,   b,h,    no,,,"Debugging mode activated"
mode,    s,h, "ql",,,"Mode of automatic parameters"
```

Counterpart catalogue :
- **catalogue filename**
- **quantities to extract into output catalogue**

Implementation

Parameter file

```
#
# Source Catalogue information
#==============================
srcCatName, s, a, "../../data/3EG_all.tsv",,, "Source catalogue name"
srcCatQty,  s, a,        "RAJ2000,DEJ2000",,, "Source catalogue quantities to be written"
#
# Counterpart Catalogue information
#====================================
cptCatName, s, a, "../../data/1rxs_50.tsv",,, "Counterpart catalogue name"
cptCatQty,  s, a,        "RAJ2000,DEJ2000",,, "Counterpart catalogue quantities to be written"
#
# Output Catalogue information
#===============================
outCatName,   s, a, "../../data/outref/test1.fits",,, "Output catalogue name"
outCatQty01,  s, h,                          "",,, "New output catalogue quantity 1"
outCatQty02,  s, h,                          "",,, "New output catalogue quantity 2"
outCatQty03,  s, h,                          "",,, "New output catalogue quantity 3"
outCatQty04,  s, h,                          "",,, "New output catalogue quantity 4"
outCatQty05,  s, h,                          "",,, "New output catalogue quantity 5"
outCatQty06,  s, h,                          "",,, "New output catalogue quantity 6"
outCatQty07,  s, h,                          "",,, "New output catalogue quantity 7"
outCatQty08,  s, h,                          "",,, "New output catalogue quantity 8"
outCatQty09,  s, h,                          "",,, "New output catalogue quantity 9"
#
# Task parameters
#=================
probMethod, s, a, "POSITION",,, "Probability method"
probThres,  r, a,      0.05,,, "Probability threshold"
maxNumCtp,  i, a,       100,,, "Maximum number of counterpart candidates"
select01,   s, h,        "",,, "Selection cirterium 1"
select02,   s, h,        "",,, "Selection cirterium 2"
select03,   s, h,        "",,, "Selection cirterium 2"
select04,   s, h,        "",,, "Selection cirterium 2"
select05,   s, h,        "",,, "Selection cirterium 2"
select06,   s, h,        "",,, "Selection cirterium 2"
select07,   s, h,        "",,, "Selection cirterium 2"
select08,   s, h,        "",,, "Selection cirterium 2"
select09,   s, h,        "",,, "Selection cirterium 2"
#
# Standard parameters
#=====================
chatter, i, h, |4,0,4, "Chattiness of output"
clobber, b, h,   yes,,, "Overwrite existing output catalogue ?"
debug,   b, h,    no,,, "Debugging mode activated"
mode,    s, h, "ql",,, "Mode of automatic parameters"
```

Output catalogue :
- **catalogue filename**
- **derived quantities (e.g. flux ratios, colors)**

Implementation

Parameter file

```
#
# Source Catalogue information
#===============================
srcCatName,s,a,"../../data/3EG_all.tsv",,,"Source catalogue name"
srcCatQty, s,a,       "RAJ2000,DEJ2000",,,"Source catalogue quantities to be written"
#
# Counterpart Catalogue information
#===================================
cptCatName,s,a,"../../data/1rxs_50.tsv",,,"Counterpart catalogue name"
cptCatQty, s,a,       "RAJ2000,DEJ2000",,,"Counterpart catalogue quantities to be written"
#
# Output Catalogue information
#===============================
outCatName,  s,a,"../../data/outref/test1.fits",,,"Output catalogue name"
outCatQty01, s,h,                         "",,,"New output catalogue quantity 1"
outCatQty02, s,h,                         "",,,"New output catalogue quantity 2"
outCatQty03, s,h,                         "",,,"New output catalogue quantity 3"
outCatQty04, s,h,                         "",,,"New output catalogue quantity 4"
outCatQty05, s,h,                         "",,,"New output catalogue quantity 5"
outCatQty06, s,h,                         "",,,"New output catalogue quantity 6"
outCatQty07, s,h,                         "",,,"New output catalogue quantity 7"
outCatQty08, s,h,                         "",,,"New output catalogue quantity 8"
outCatQty09, s,h,                         "",,,"New output catalogue quantity 9"
#
# Task parameters
#=================
probMethod, s,a,"POSITION",,,"Probability method"
probThres,  r,a,       0.05,,,"Probability threshold"
maxNumCtp,  i,a,       100,,,"Maximum number of counterpart candidates"
select01,   s,h,        "",,,"Selection cirterium 1"
select02,   s,h,        "",,,"Selection cirterium 2"
select03,   s,h,        "",,,"Selection cirterium 2"
select04,   s,h,        "",,,"Selection cirterium 2"
select05,   s,h,        "",,,"Selection cirterium 2"
select06,   s,h,        "",,,"Selection cirterium 2"
select07,   s,h,        "",,,"Selection cirterium 2"
select08,   s,h,        "",,,"Selection cirterium 2"
select09,   s,h,        "",,,"Selection cirterium 2"
#
# Standard parameters
#=====================
chatter, i,h, [ 4,0,4,"Chattiness of output"
clobber, b,h,   yes,,,"Overwrite existing output catalogue ?"
debug,   b,h,    no,,,"Debugging mode activated"
mode,    s,h, "ql",,,"Mode of automatic parameters"
```

Task parameters :

- counterpart probability algorithm
- probability threshold
- maximum number of counterpart candidates
- selection on catalogue quantities and derived quantities

Implementation

Parameter file

```
#
# Source Catalogue information
#==============================
srcCatName,s,a,"../../data/3EG_all.tsv",,,"Source catalogue name"
srcCatQty, s,a,        "RAJ2000,DEJ2000",,,"Source catalogue quantities to be written"
#
# Counterpart Catalogue information
#====================================
cptCatName,s,a,"../../data/1rxs_50.tsv",,,"Counterpart catalogue name"
cptCatQty, s,a,        "RAJ2000,DEJ2000",,,"Counterpart catalogue quantities to be written"
#
# Output Catalogue information
#==============================
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outCatQty01,  s,h,                        "",,,"New output catalogue quantity 1"
outCatQty02,  s,h,                        "",,,"New output catalogue quantity 2"
outCatQty03,  s,h,                        "",,,"New output catalogue quantity 3"
outCatQty04,  s,h,                        "",,,"New output catalogue quantity 4"
outCatQty05,  s,h,                        "",,,"New output catalogue quantity 5"
outCatQty06,  s,h,                        "",,,"New output catalogue quantity 6"
outCatQty07,  s,h,                        "",,,"New output catalogue quantity 7"
outCatQty08,  s,h,                        "",,,"New output catalogue quantity 8"
outCatQty09,  s,h,                        "",,,"New output catalogue quantity 9"
#
# Task parameters
#=================
probMethod, s,a,"POSITION",,,"Probability method"
probThres,  r,a,       0.05,,,"Probability threshold"
maxNumCtp,  i,a,        100,,,"Maximum number of counterpart candidates"
select01,   s,h,         "",,,"Selection cirterium 1"
select02,   s,h,         "",,,"Selection cirterium 2"
select03,   s,h,         "",,,"Selection cirterium 2"
select04,   s,h,         "",,,"Selection cirterium 2"
select05,   s,h,         "",,,"Selection cirterium 2"
select06,   s,h,         "",,,"Selection cirterium 2"
select07,   s,h,         "",,,"Selection cirterium 2"
select08,   s,h,         "",,,"Selection cirterium 2"
select09,   s,h,         "",,,"Selection cirterium 2"
#
# Standard parameters
#=====================
chatter, i,h, 4,0,4,"Chattiness of output"
clobber, b,h,  yes,,,"Overwrite existing output catalogue ?"
debug,   b,h,   no,,,"Debugging mode activated"
mode,    s,h, "ql",,,"Mode of automatic parameters"
```

Standard parameters

Example

Correlate Cygnus 3EG sources with ROSAT Bright Source Catalogue

```tcsh
#!/bin/tcsh -f
#
# Testrun 1
#
set     RUN_ID = "test1"
setenv PFILES ../../pfiles
#
# Find Cygnus region 3EG counterparts in ROSAT catalogue
#========================================================
gtsrcid.exe \
  srcCatName="../../data/cygob2_egret_3eg.tsv" \
  srcCatQty="3EG,RAJ2000,DEJ2000,theta95" \
  cptCatName="../../data/cygob2_rosat_1rxs.tsv" \
  cptCatQty="1RXS,RAJ2000,DEJ2000,PosErr" \
  outCatName="../../data/outref/${RUN_ID}.fits" \
  probMethod="POSITION" \
  probThres="0.05" \
  maxNumCtp="100" \
  chatter="4" \
  clobber="yes" \
  debug="no" \
  mode="ql" >& "../../data/outref/$RUN_ID.dump"
mv gtsrcid.log "../../data/outref/$RUN_ID.log"
```

Example

Correlate Cygnus 3EG sources with ROSAT Bright Source Catalogue

Log file

```
Source catalogue contains 7 sources.

Source      0 ...................: J2027+3429 ( 306.950,  34.500) +/-   0.770
Loaded catalogue '../../data/cygob2_rosat_1rxs.tsv' from file.
Counterpart catalogue loaded.
Counterpart catalogue contains 115 sources.
 Filter step candidates ..........: 115
 Refine step candidates ..........: 5
 Counterpart candidate     1 .....: 1RXS J202422.2+344631 Prob= 37.397 % (RA,DEC)=( 306.092,  34.775) +/-   0.004  Sep=   0.757 deg
 Counterpart candidate     2 .....: 1RXS J202658.5+334253 Prob= 35.216 % (RA,DEC)=( 306.744,  33.715) +/-   0.003  Sep=   0.804 deg
 Counterpart candidate     3 .....: 1RXS J203107.6+333229 Prob= 21.581 % (RA,DEC)=( 307.782,  33.541) +/-   0.003  Sep=   1.181 deg
 Counterpart candidate     4 .....: 1RXS J202402.8+330824 Prob= 13.060 % (RA,DEC)=( 306.012,  33.140) +/-   0.003  Sep=   1.567 deg
 Counterpart candidate     5 .....: 1RXS J202509.2+363121 Prob=  6.599 % (RA,DEC)=( 306.288,  36.523) +/-   0.003  Sep=   2.093 deg

Source      1 ...................: J2016+3657 ( 304.050,  36.940) +/-   0.550
 Filter step candidates ..........: 115
 Refine step candidates ..........: 3
 Counterpart candidate     1 .....: 1RXS J201700.4+372524 Prob= 39.612 % (RA,DEC)=( 304.252,  37.423) +/-   0.005  Sep=   0.509 deg
 Counterpart candidate     2 .....: 1RXS J201605.5+380944 Prob= 10.831 % (RA,DEC)=( 304.023,  38.162) +/-   0.003  Sep=   1.223 deg
 Counterpart candidate     3 .....: 1RXS J201154.9+381557 Prob=  5.718 % (RA,DEC)=( 302.979,  38.266) +/-   0.010  Sep=   1.574 deg

Source      2 ...................: J2021+3716 ( 305.300,  37.270) +/-   0.300
 Filter step candidates ..........: 115
 Refine step candidates ..........: 1
 Counterpart candidate     1 .....: 1RXS J201700.4+372524 Prob=  5.936 % (RA,DEC)=( 304.252,  37.423) +/-   0.005  Sep=   0.847 deg

Source      3 ...................: J2020+4017 ( 305.250,  40.300) +/-   0.160
 Filter step candidates ..........: 115
 Refine step candidates ..........: no

Source      4 ...................: J2033+4118 ( 308.410,  41.320) +/-   0.280
 Filter step candidates ..........: 115
 Refine step candidates ..........: 5
 Counterpart candidate     1 .....: 1RXS J203315.8+411848 Prob= 77.595 % (RA,DEC)=( 308.316,  41.313) +/-   0.002  Sep=   0.071 deg
 Counterpart candidate     2 .....: 1RXS J203309.4+411353 Prob= 63.588 % (RA,DEC)=( 308.289,  41.232) +/-   0.005  Sep=   0.127 deg
 Counterpart candidate     3 .....: 1RXS J203241.2+411408 Prob= 49.320 % (RA,DEC)=( 308.172,  41.236) +/-   0.006  Sep=   0.198 deg
 Counterpart candidate     4 .....: 1RXS J203224.0+411759 Prob= 43.403 % (RA,DEC)=( 308.100,  41.300) +/-   0.004  Sep=   0.234 deg
 Counterpart candidate     5 .....: 1RXS J203226.2+405725 Prob= 21.689 % (RA,DEC)=( 308.109,  40.957) +/-   0.002  Sep=   0.428 deg

Source      5 ...................: J2022+4317 ( 305.520,  43.290) +/-   0.720
 Filter step candidates ..........: 115
 Refine step candidates ..........: 2
 Counterpart candidate     1 .....: 1RXS J202028.5+435111 Prob= 41.474 % (RA,DEC)=( 305.119,  43.853) +/-   0.002  Sep=   0.634 deg
 Counterpart candidate     2 .....: 1RXS J202538.9+415345 Prob= 11.763 % (RA,DEC)=( 306.412,  41.896) +/-   0.003  Sep=   1.541 deg

Source      6 ...................: J2035+4441 ( 308.850,  44.690) +/-   0.540
 Filter step candidates ..........: 115
 Refine step candidates ..........: 1
 Counterpart candidate     1 .....: 1RXS J203902.9+451222 Prob= 21.640 % (RA,DEC)=( 309.762,  45.206) +/-   0.004  Sep=   0.827 deg

Save counterpart candidate catalogue:
=====================================
Task terminated using 0.020 sec CPU time.
```

Example

Correlate Cygnus 3EG sources with ROSAT Bright Source Catalogue

```
Source catalogue contains 7 sources.

Source    0 ....................: J2027+3429 ( 306.950,  34.500) +/-   0.770
Loaded catalogue '../../data/cygob2_rosat_1rxs.tsv' from file.
Counterpart catalogue loaded.
Counterpart catalogue contains 115 sources.
 Filter step candidates ..........: 115
 Refine step candidates ..........: 5
 Counterpart candidate    1 .....: 1RXS J202422.2+344631 Prob= 37.397 % (RA,DEC)=( 306.092,  34.775) +/-  0.004  Sep=  0.757 deg
 Counterpart candidate    2 .....: 1RXS J202658.5+334253 Prob= 35.216 % (RA,DEC)=( 306.744,  33.715) +/-  0.003  Sep=  0.804 deg
 Counterpart candidate    3 .....: 1RXS J203107.6+333229 Prob= 21.581 % (RA,DEC)=( 307.782,  33.541) +/-  0.003  Sep=  1.181 deg
 Counterpart candidate    4 .....: 1RXS J202402.8+330824 Prob= 13.060 % (RA,DEC)=( 306.012,  33.140) +/-  0.003  Sep=  1.567 deg
 Counterpart candidate    5 .....: 1RXS J202509.2+363121 Prob=  6.599 % (RA,DEC)=( 306.288,  36.523) +/-  0.003  Sep=  2.093 deg

Source    1 ....................: J2016
 Filter step candidates ..........: 115
 Refine step candidates ..........: 3
 Counterpart candidate    1 .....: 1RXS
 Counterpart candidate    2 .....: 1RXS
 Counterpart candidate    3 .....: 1RXS

Source    2 ....................: J2021
 Filter step candidates ..........: 115
 Refine step candidates ..........: 1
 Counterpart candidate    1 .....: 1RXS

Source    3 ....................: J2020
 Filter step candidates ..........: 115
 Refine step candidates ..........: no

Source    4 ....................: J2033
 Filter step candidates ..........: 115
 Refine step candidates ..........: 5
 Counterpart candidate    1 .....: 1RXS J203315.8+411848 Prob= 77.595 % (RA,DEC)=( 308.316,  41.313) +/-  0.002  Sep=  0.071 deg
 Counterpart candidate    2 .....: 1RXS J203309.4+411353 Prob= 63.588 % (RA,DEC)=( 308.289,  41.232) +/-  0.005  Sep=  0.127 deg
 Counterpart candidate    3 .....: 1RXS J203241.2+411408 Prob= 49.320 % (RA,DEC)=( 308.172,  41.236) +/-  0.006  Sep=  0.198 deg
 Counterpart candidate    4 .....: 1RXS J203224.0+411759 Prob= 43.403 % (RA,DEC)=( 308.100,  41.300) +/-  0.004  Sep=  0.234 deg
 Counterpart candidate    5 .....: 1RXS J203226.2+405725 Prob= 21.689 % (RA,DEC)=( 308.109,  40.957) +/-  0.002  Sep=  0.428 deg

Source    5 ....................: J2022+4317 ( 305.520,  43.290) +/-   0.720
 Filter step candidates ..........: 115
 Refine step candidates ..........: 2
 Counterpart candidate    1 .....: 1RXS J202028.5+435111 Prob= 41.474 % (RA,DEC)=( 305.119,  43.853) +/-  0.002  Sep=  0.634 deg
 Counterpart candidate    2 .....: 1RXS J202538.9+415345 Prob= 11.763 % (RA,DEC)=( 306.412,  41.896) +/-  0.003  Sep=  1.541 deg

Source    6 ....................: J2035+4441 ( 308.850,  44.690) +/-   0.540
 Filter step candidates ..........: 115
 Refine step candidates ..........: 1
 Counterpart candidate    1 .....: 1RXS J203902.9+451222 Prob= 21.640 % (RA,DEC)=( 309.762,  45.206) +/-  0.004  Sep=  0.827 deg

Save counterpart candidate catalogue:
=====================================
Task terminated using 0.020 sec CPU time.
```

Log file

Two-step approach to optimise identification :

(1) Filter : Make a coarse selection on position (no probability calculation)

(2) Refine : Calculate probabilities only for filtered sources

Example

Correlate Cygnus 3EG sources with ROSAT Bright Source Catalogue

```
Source catalogue contains 7 sources.

Source      0 ...................: J2027+3429 ( 306.950,  34.500) +/-    0.770
Loaded catalogue '../../data/cygob2_rosat_1rxs.tsv' from file.
Counterpart catalogue loaded.
Counterpart catalogue contains 115 sources.
 Filter step candidates ..........: 115
 Refine step candidates ..........: 5                                       ep=   0.757 deg
 Counterpart candidate                                                      ep=   0.804 deg
 Counterpart candidate                                                      ep=   1.181 deg
 Counterpart candidate                                                      ep=   1.567 deg
 Counterpart candidate                                                      ep=   2.093 deg

Source      1 ...........
 Filter step candidates ..
 Refine step candidates ..
 Counterpart candidate                                                      ep=   0.509 deg
 Counterpart candidate                                                      ep=   1.223 deg
 Counterpart candidate                                                      ep=   1.574 deg

Source      2 ...........
 Filter step candidates ..
 Refine step candidates ..
 Counterpart candidate       1 .....: 1RXS J201700.4+372524 Prob=  5.936 % (RA,DEC)=( 304.252,   37.423) +/-   0.005  Sep=  0.847 deg

Source      3 ...................: J2020+4017 ( 305.250,  40.300) +/-    0.160
 Filter step candidates ..........: 115
 Refine step candidates ..........: no

Source      4 ...................: J2033+4118 ( 308.410,  41.320) +/-    0.280
 Filter step candidates ..........: 115
 Refine step candidates ..........: 5
 Counterpart candidate       1 .....: 1RXS J203315.8+411848 Prob= 77.595 % (RA,DEC)=( 308.316,   41.313) +/-   0.002  Sep=  0.071 deg
 Counterpart candidate       2 .....: 1RXS J203309.4+411353 Prob= 63.588 % (RA,DEC)=( 308.289,   41.232) +/-   0.005  Sep=  0.127 deg
 Counterpart candidate       3 .....: 1RXS J203241.2+411408 Prob= 49.320 % (RA,DEC)=( 308.172,   41.236) +/-   0.006  Sep=  0.198 deg
 Counterpart candidate       4 .....: 1RXS J203224.0+411759 Prob= 43.403 % (RA,DEC)=( 308.100,   41.300) +/-   0.004  Sep=  0.234 deg
 Counterpart candidate       5 .....: 1RXS J203226.2+405725 Prob= 21.689 % (RA,DEC)=( 308.109,   40.957) +/-   0.002  Sep=  0.428 deg

Source      5 ...................: J2022+4317 ( 305.520,  43.290) +/-    0.720
 Filter step candidates ..........: 115
 Refine step candidates ..........: 2
 Counterpart candidate       1 .....: 1RXS J202028.5+435111 Prob= 41.474 % (RA,DEC)=( 305.119,   43.853) +/-   0.002  Sep=  0.634 deg
 Counterpart candidate       2 .....: 1RXS J202538.9+415345 Prob= 11.763 % (RA,DEC)=( 306.412,   41.896) +/-   0.003  Sep=  1.541 deg

Source      6 ...................: J2035+4441 ( 308.850,  44.690) +/-    0.540
 Filter step candidates ..........: 115
 Refine step candidates ..........: 1
 Counterpart candidate       1 .....: 1RXS J203902.9+451222 Prob= 21.640 % (RA,DEC)=( 309.762,   45.206) +/-   0.004  Sep=  0.827 deg

Save counterpart candidate catalogue:
=====================================
Task terminated using 0.020 sec CPU time.
```

3EG J2033+4118 : an unidentified EGRET source with a X-ray counterpart ?
1RXS J203315.8+411848 = Cyg OB2 #8a (O star binary)

Gamma-ray emission from wind interaction ?

Example

Correlate Cygnus 3EG sources with ROSAT Bright Source Catalogue

fv: Binary Table of test1.fits[1] in /home/knodlseder/glast/src/sourceIdentify/v0/data/outref/

File   Edit   Tools

Select	ID 20A	POS_EQ_RA 1E	POS_EQ_DEC 1E	POS_ERR_MAJ 1E	POS_ERR_MIN 1E	POS_ERR_ANG 1E	PROB 1E	SRC_3EG 10A
All		deg	deg	deg	deg	deg	probability	
1	cc_00001_00001	3.060925E+02	3.477542E+01	3.611111E-03	3.611111E-03	0.000000E+00	3.739680E-01	J2027+3429
2	cc_00001_00002	3.067437E+02	3.371472E+01	2.500000E-03	2.500000E-03	0.000000E+00	3.521575E-01	J2027+3429
3	cc_00001_00003	3.077817E+02	3.354139E+01	2.777778E-03	2.777778E-03	0.000000E+00	2.158053E-01	J2027+3429
4	cc_00001_00004	3.060117E+02	3.314014E+01	3.055556E-03	3.055556E-03	0.000000E+00	1.305995E-01	J2027+3429
5	cc_00001_00005	3.062883E+02	3.652264E+01	3.055556E-03	3.055556E-03	0.000000E+00	6.598712E-02	J2027+3429
6	cc_00002_00001	3.042517E+02	3.742333E+01	5.000000E-03	5.000000E-03	0.000000E+00	3.961219E-01	J2016+3657
7	cc_00002_00002	3.040229E+02	3.816236E+01	2.777778E-03	2.777778E-03	0.000000E+00	1.083068E-01	J2016+3657
8	cc_00002_00003	3.029788E+02	3.826583E+01	1.027778E-02	1.027778E-02	0.000000E+00	5.717539E-02	J2016+3657
9	cc_00003_00001	3.042517E+02	3.742333E+01	5.000000E-03	5.000000E-03	0.000000E+00	5.935648E-02	J2021+3716
10	cc_00005_00001	3.083158E+02	4.131347E+01	1.944444E-03	1.944444E-03	0.000000E+00	7.759482E-01	J2033+4118
11	cc_00005_00002	3.082892E+02	4.123153E+01	5.000000E-03	5.000000E-03	0.000000E+00	6.358755E-01	J2033+4118
12	cc_00005_00003	3.081717E+02	4.123569E+01	6.388889E-03	6.388889E-03	0.000000E+00	4.931991E-01	J2033+4118
13	cc_00005_00004	3.081000E+02	4.129972E+01	4.444445E-03	4.444445E-03	0.000000E+00	4.340278E-01	J2033+4118
14	cc_00005_00005	3.081092E+02	4.095694E+01	1.944444E-03	1.944444E-03	0.000000E+00	2.168880E-01	J2033+4118
15	cc_00006_00001	3.051187E+02	4.385305E+01	1.944444E-03	1.944444E-03	0.000000E+00	4.147429E-01	J2022+4317
16	cc_00006_00002	3.064121E+02	4.189597E+01	2.500000E-03	2.500000E-03	0.000000E+00	1.176298E-01	J2022+4317
17	cc_00007_00001	3.097621E+02	4.520625E+01	3.611111E-03	3.611111E-03	0.000000E+00	2.163999E-01	J2035+4441

Go to: [   ]   Edit cell: [   ]

Development timeline

May 2005	**V0 delivery** U9 interface usage, GLAST class usage (application, pfiles), catalogue output (FITS format)
Summer 2005	**Development of identification strategies** Diploma thesis of Francesca Faedi
Autumn 2005	**V1 development** Implementation of probability calculation
Dec. 2005	**V1 delivery** DC2 readiness
January 2006	**DC2** Test plan to be discussed / defined