;
; **Documentation for the IDL GRB simulator, GRBfullsim.pro, extracted from its comment lines.**
;
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;
; **Overview:**
; **(1) The main routine calls GRBglobal; sets up arrays; loops through the number of bursts to be**
; **generated, calling makeGRB for each burst; optionally records the photon list per burst in**
; **an output file; optionally plots the burst time profile.**
; **(2) Module GRBglobal computes the number of bursts/year (Nbsim) within GLAST FOV**
; **and calls procedures { get_durs, get_fluxes, get_plaws } which return Nbsim samples from**
; **each of the distributions { durations, peak fluxes, power-law indices }, respectively.**
; **(3) Module makeGRB computes the number of photons for this burst, and calls maketimes.**
; **(4) Module maketimes makes BATSE-like time profiles, but with pulse widths extrapolated to**
; **GLAST energies, generated in a call to module pickwidth; photons are distributed within a**
; **given pulse according to an energy-dependent formulation.**
;

```
pro GRBglobal, iseed, Zen_Norm
;
;  The program computes the number of bursts per year expected in the GLAST
;  field of view.  It then calls procedures which return samples from global
;  distributions for GRBs:  durations, peak fluxes, and power-law indices.

;  INPUT:
;  none

;  OUTPUT:
;  durs, the duration array
;  dur_gt2s, flag indicating if duration is {<>} 2 seconds
;  Frats, the array of ratios of peak flux to maximum
;  Fp, the array of ratios of peak fluxes
;  betas, the array of power-law indices
;  Nbsim, the number of bursts to manufacture
;
;  Assume zenith acceptance angle = 75 degrees, 810 bursts/yr all-sky,
;  and scanning mode.  Then we simulate in this solid angle acceptance
;  Nbsim bursts per year.
```

```
pro makeGRB, isim, Ethres, iseed, madeburst
;
;  Computes number of photons for this burst, N_inc:
;      SpecNorm units, integrated Peak Flux:  photons cm^-2 s^-1 (> Ethres).  Researches on normalization:
;      (1) Bonnell's fits to bright BATSE bursts; (2) comparison with EGRET norms for bright bursts –
;     Catelli's, Dingus' and Schneid's works; and definitively (3) analysis of Preece et al. spectroscopy catalog
;     of bright BATSE bursts (see JPN routine Specanal.pro).
;
;      The cofactors for SpecNorm are:  (a) {average flux / peak flux} =~ 1/7;
;      (b) scaling by (peak_flux)^1.5, determined from inspection of Preece et al.;
;      (c) duration (seconds); (d) 282743 cm^2 (6-meter dia. illuminated disk);
;      (e) scaling to integral above Ethres (e.g., 0.03 GeV) for case beta = -2;
;      (f) dispersion (dynrange) to approximately replicate the scatter in peak flux
;          vs. normalization at 1 MeV as estimated from Preece et al. catalog; and
;      (g) a dependence on power-law index as estimated from Preece et al. catalog.
;
;  Thus, N_inc is number of photons normally incident on projected disk of GLAST illumination sphere,
;  integrated above Ethres, for chosen peak flux & duration.  Energies distributed as power-law, index beta.

;  INPUTS:  (1) Ethres, minimum energy photon for set of simulated bursts; (2) Frats(isim), ratio of this
;  burst's peak flux to the maximum; (3) duration, this burst's total duration, (4) beta, this burst's
;  power-law index; (5) Npuls, this burst's number of pulses.

;  OUTPUTS:
;  The program returns:
;  Specnorm, the spectral normalization described above
;  N_inc [Nphotons(isim)], the total number of photons for which times will be chosen
;  GRBenergies, the array of photon energies
;  madeburst, a flag {y,n} indicating whether or not a burst was made
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```
pro get_durs, iseed
;
;  The program chooses durations from the BATSE bimodal duration distribution,
;  where the measurement process is described by Bonnell et al. (1997, ApJ, 490, 79).
;  The parent sample is same as for peak fluxes:  from GRB 910421 (trig# 105) to
;  GRB 990123 (trig# 7343).  This partial sample (1262) includes bursts where
;  backgrounds could be fitted, and peak fluxes subsequently measured.
;  The sample spans 7.75 years.

;  INPUTS:
;  none

;  OUTPUTS:
;  The program returns a float array of durations (durs), and an integer array
;  (dur_gt2s: 0 or 1) indicating whether the burst's duration is from the
;  long mode (1) or short mode (0); this array is used to determine which
;  peak-flux distribution to choose from.  Size of returned arrays = Nbsim.
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```
pro get_fluxes, iseed
;
;  The program chooses peak fluxes from the BATSE log N - log P; see Bonnell
;  et al. 1997, ApJ, 490, 79, which duplicates the procedure specified by
;  Pendleton*.  The measurement procedure is applied uniformly for that part
;  of the BATSE sample from GRB 910421 (trig# 105) to GRB 990123 (trig# 7343).
;  (*Pendleton used a different PF estimation technique for the initial BATSE Catalog.)
;
;  This partial sample (1262) includes bursts where backgrounds could be fitted,
;  and peak fluxes subsequently measured.  It spans 7.75 years.  Therefore,
;  in order to draw from a PF distribution representing 1 year, we truncate
;  at the eighth brightest burst in 7.75 ~ 8 years.  The peak flux measure
;  in Bonnell et al. is for 256-ms accumulations.

;  INPUTS:
;  The integer array dur_gt2s (0 or 1) indicating whether the burst's duration
;  is from the short mode (0) or long mode (1).  This array is used to determine
;  which peak-flux distribution to choose from, {N,P} for longs, {M,Q} for shorts.

;  OUTPUTS:
;  The program returns an array of peak fluxes (Fp), and an array of peak flux
;  ratios (Frats), normalized to the brightest burst in one year.
;  Size of returned arrays = Nbsim.
```

```
pro get_plaws, iseed
;
;  The program chooses spectral power-law indices from the BATSE power-law
;  distribution, as measured by Preece et al. (1999)

;  INPUTS:
;  none

;  OUTPUTS:
;  The program returns an array of power-law indices.
;  Size of returned arrays = Nbsim.
=========================================================================
pro pickwidth, UnivFWHM, duration, Ethres, iseed
;
;  The program chooses a universal width for the pulses within a given burst.
;  A given GRB tends to have pulses of comparable widths.  Therefore (see Fig 3a
;  of Norris et al. 1996 "attributes" paper), pick one pulse width from the
;  distribution of fitted widths of "All" pulses, 50-300 keV, in bright, long
;  BATSE GRBs.  Then, since (a) ~ 1/4 of GRBs are short, and (b) short GRBs have
;  pulse widths ~ 1/10-1/20 that of long GRBs -- multiply pulse widths for one
;  quarter of the GRBs by compression factor of 1/10.  Then using Width ~ E^(-0.333)
;  relationship, scale chosen width to Ethres, from 100 keV.

;  INPUTS:
;  Ethres, the minimum energy photon for this set of simulated bursts
;  duration, this burst's total duration

;  OUTPUTS:
;  The program returns a FWHM width to be using in making pulses for one burst.
```

```
pro maketimes, GRBtimes, GRBenergies, N_inc, Npuls, duration, Ethres, iseed
;
;  make BATSE-like GRB time profiles, placing GLAST photons a la
;  cumulative BATSE intensity, but in narrower pulses:
;    (1) Npuls = number of pulses, proportional to BATSE duration.
;    (2) pulse peak amplitude is random (0.0=>1.0); sort amps in descending amp order.
;    (3) scramble amps of {1st,2nd} halves of pulses, separately (leaves profile asymmetric)
;    (4) center of pulse time is random within duration.  sort the times, ascending order.
;    (5) pulse width is drawn from BATSE width distribution for bright bursts (attributes
;        paper), scaled to GLAST energies, using width ~ E^-0.333 .
;    (6) make Npuls pulses with "bisigma" shapes => sum to produce time profile
;    (7) form cumulative distribution of BATSE intensity
;    (8) distribute the N_inc photons according cumulative intensity => GRBtimes
;    (9) offset the photon times according to (a) energy dependence, width ~ E^-0.333
;        and (b) time of peak, also proportional to E^-0.333.

;  INPUTS:
;  Ethres, the minimum energy photon for this set of simulated bursts
;  duration, this burst's total duration
;  N_inc, the total number of photons for which times will be chosen
;  GRBenergies, the array of photon energies

;  OUTPUTS:
;  The program returns:
;  Npuls, the number of pulses in this burst
;  amplitudes, the pulse peak amplitudes
;  tmax, the times of peak amplitude
;  GRBtimes, the array of photon times
```