<u>Here's why *xtry* in *sigfac* should be # events BEFORE any cuts (i.e. # Monte Carlo events):</u>

<u>Background</u>
xtry appears in the denominator of sigfac; the combination of sigfac, tempsig, and other factors produces the physical event rate (in Hz).

sigfac = Beam_current*N_A*1e-27*tgm*(ambmax-ambmin)*(xfmax-xfmin)/xtry

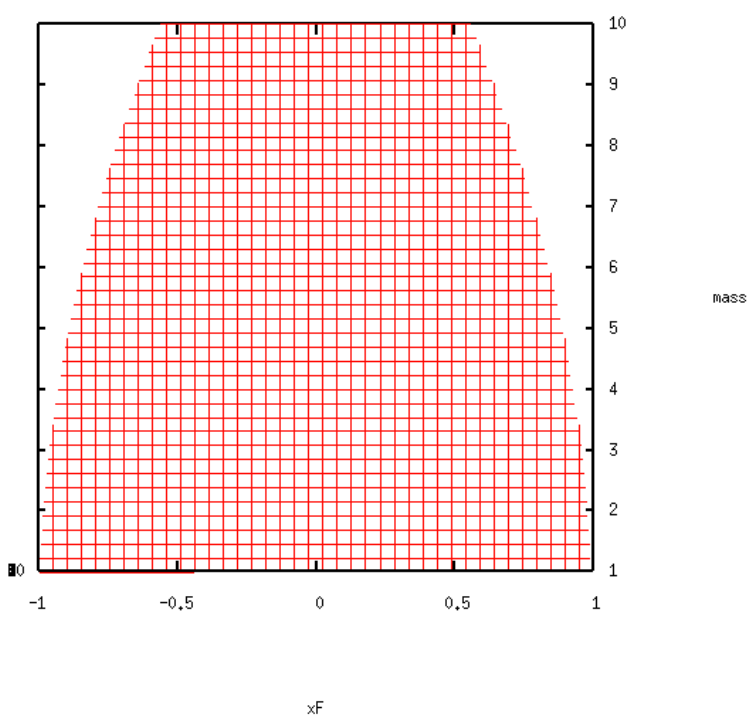
In the Monte Carlo, kinematic cuts (to throw away events with unphysical kinematics) are applied. These cuts remove about 15% of events when a uniform (xf, mass) distribution of -1 < xf < 1 and 1 GeV< mass < 10 GeV is thrown. The kinematic cuts are:

PTSQMAX = (SS**2*(1.-XF**2) - 2.*SS*AMB**2 + AMB**4) / (4.*SS) ≥ 0

and

0 < x1 < 1 and 0 < x2 < 1
where x1=.5*xf+sqrt(.25*xf*xf+tau), and x2=-.5*xf+sqrt(.25*xf*xf+tau).

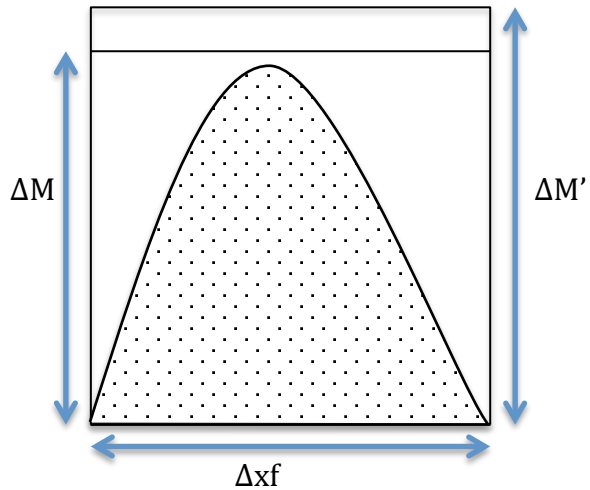
The (xf, mass) pairs that satisfy these cuts are shown here:



The issue is: should we normalize sigfac to (i.e. let xtry be) the #events in the whole thrown (xf, mass) range, or only to the # in the shaded region.

Proof that xtry should take the whole thrown (xf, mass) region

Assume for simplicity that each (xf, mass) event has equal weight.
Let x_{total} be the total # points sampled in the whole thrown region.
Let x_{passed} be the # points sampled which fall in the shaded region (that passed the kinematic cuts).



From the tempsig formula, we see that

$$\text{Total rate (in Hz)} \propto \frac{x_{passed} \times \Delta M}{xtry}$$

where ΔM is the mass range set in the input config. file.

If xtry = x_{total}, then

$$\text{Total rate (in Hz)} \propto \frac{x_{passed} \times \Delta M}{x_{total}}$$

If we increased the mass range to ΔM' while keeping the same # of thrown events, then

$$\text{New total rate} \propto \frac{x_{passed}' \times \Delta M'}{x_{total}}$$

$$= \left(\frac{\Delta M}{\Delta M'}\right) x_{passed} \times \frac{\Delta M'}{x_{total}} \quad \text{(since the density of sampled points scales by } \Delta M/\Delta M'\text{)}$$

$$= \frac{x_{passed} \times \Delta M}{x_{total}}$$

= original total rate, which is what we expect physically.

However, if xtry = x_{passed}, then

$$\text{Total rate (in Hz)} \propto \frac{x_{passed} \times \Delta M}{x_{passed}} = \Delta M$$

This is not physically possible since the rate must be constant when increasing the mass range to include kinematically forbidden events.

Thus, we should take xtry = x_{total}.

Note: A comment in the FastMC code effectively mentions the same conclusion

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FOR PROPER CROSS SECTION NORMALIZATION, WE MUST REJECT, RATHER THAN REPLACE,
THIS MASS,XF PAIR IF IT VIOLATES 4-MOMENTUM CONSERVATION IN ANY WAY.  SOME,
BUT NOT ALL, OF THOSE CONSTRAINTS WERE ALREADY BUILT IN PREVIOUSLY.  -- CAG
12/28/98
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