# CMCOS: The Run 1A Cosmic Ray Filter

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The cosmic ray filter that is in 6_1 production is fundamentally the same as the filter used in the 1988-1989 run, although the return codes are different. (The cosmic ray filter from last run was written by Aesook Byon-Wagner, Aseet Mukherjee, Dave Smith, Dave Kardelis and Sarah Eno. It is described in CDF 1260.)

The routine last run was called CMUCOS. The module for the 1992 run is called CMCOS and is located in the file C$MUO:CMCOS.CDF. The dictionary is in C$DIC:CMCOS.UIC. The filter subroutine in this module is COSCMU; it runs on each CMUO bank, and its return code is placed in the (*MOCrFL*) word in the CMUO bank.

The possible return codes are:

- -1: There is no good primary vertex in the event.

  A good primary vertex is defined as having *kclass* $\geq$ 0 and $\mid z \mid < 60\,cm.$

- 0: The cosmic ray filter has not been run.

- 1: The muon passed the cosmic ray filter.

- $> 1$: The muon failed the cosmic ray filter.

- 2: Muon impact parameter $> 0.5$cm or no primary vertex within 5cm

- 3: Back to back tracks

  > There is a $r - -\phi$ track with $p_T$ >10 GeV back-to-back track within 2 degrees in $\phi$, or
  > There is a three dimensional track of $p_T$ >10 GeV back-to-back track within 2 degrees in $\phi$ for which $\mid \eta \mid < 1.2$ (last run this cut was

$| \eta | < 1.0$ - it was changed because of the increased muon acceptance with CMX) and an impact parameter>0.5cm, or

There is a three dimensional track of $p_T$ >10 GeV back-to-back track within 2 degrees in $\phi$ for which $| \eta | < 1.2$ (last run this cut was $| \eta | < 1.0$ — again, it was changed because of the increased muon acceptance with CMX) and impact parameter $< 0.5$cm and the back-to-back track has a $z$ vertex within 5cm of the primary event vertex found for the muon in question and the back-to-back track fails track quality cuts.
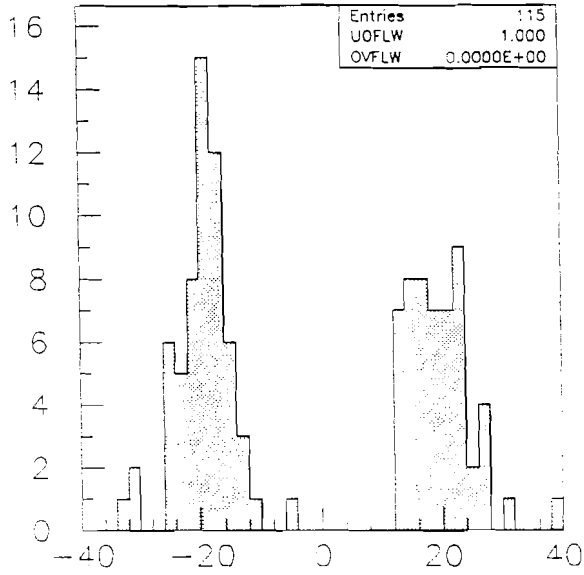
- 4: Back to back good track with large $t_0$

    There is a three dimensional track of $p_T$ >10 GeV back-to-back track within 2 degrees in $\phi$ for which $| \eta | < 1.2$ (last run this cut was $| \eta | < 1.0$ - once again, it was changed for CMX) and impact parameter$< 0.5$ cm and the back-to-back track has a $z$ vertex within 5cm of the primary event vertex found for the muon in question and the back-to-back track passes track quality cuts - however, the routine CTCOSM manages to fit both legs as one continuous track and therefore determines we are dealing with a cosmic ray.
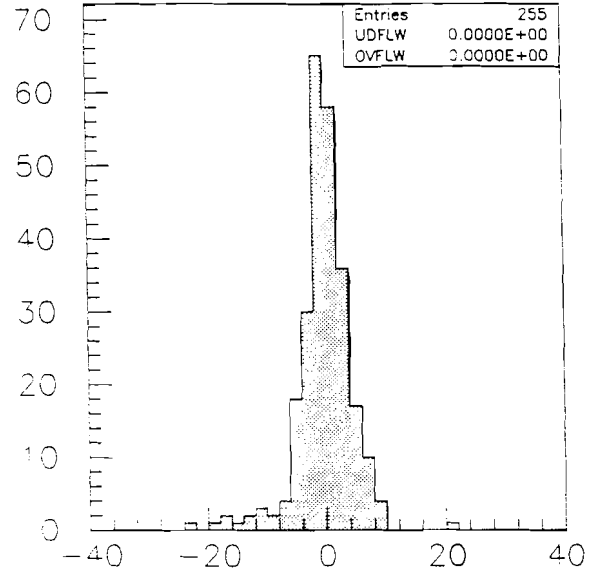
The last return code is a major reason why the filter was added to production. It requires the CTCD bank (which is not present in PADs). To check that it works, we plotted the TDC timing difference for the two legs of a $Z^0 \rightarrow \mu^+\mu^-$ candidate. A cosmic ray would be expected to have a timing difference of approximately 20 ns in the Central Hadron TDCs. In Figure 1, upper left, shows the TDC distribution for $Z^0$ candidates that are flagged as cosmic rays by CMCOS. (In all the plots, an additional requirement of muon impact parameter less than 0.2 cm was imposed.) The upper right plot shows the same distribution for those candidates that are not flagged as cosmic rays. Because the hadron TDCs are not perfectly efficient, not every cosmic ray can be flagged by timing information - hence the need for something like the cosmic ray filter.

The lower left figure shows the dimuon mass in the $Z^0$ region for events failing the cosmic ray filter - that is, events that CMCOS determines are due to cosmic rays - and the lower right figure shows the dimuon mass for events that pass the cosmic ray filter.
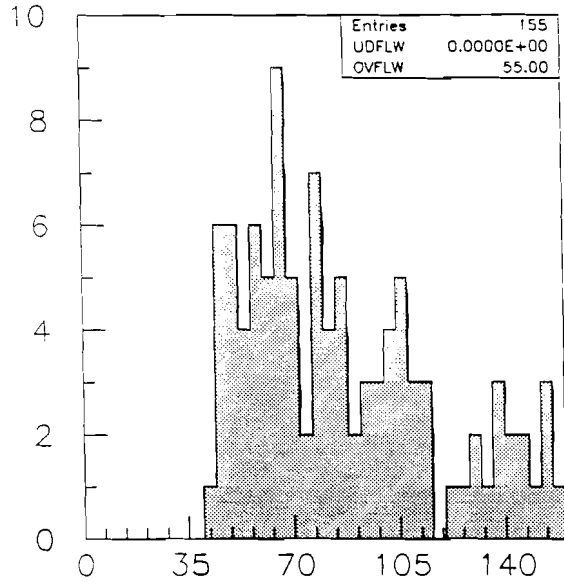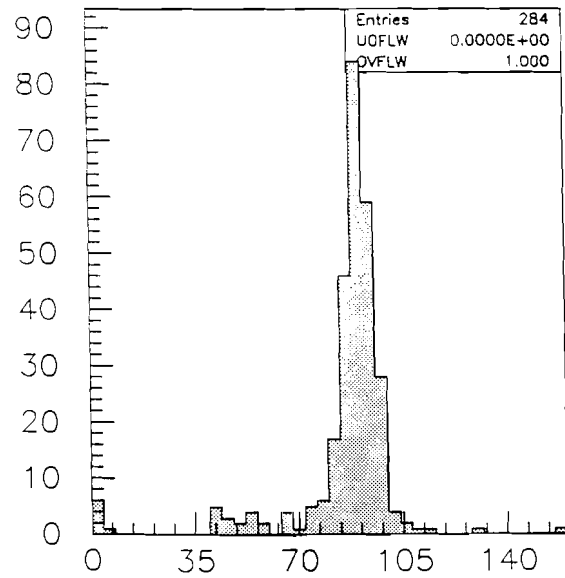
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# Cosmic Ray Filter related to Hadron TDC info



Figure 1: *Top left: TDC distribution for $Z^0 \rightarrow \mu^+\mu^-$ candidates identified as cosmic rays. Top right: TDC distribution for events not flagged as comsic rays. Bottom Left: $Z^0 \rightarrow \mu^+\mu^-$ mass distribution for events failing CMCOS. Bottom Right: $Z^0 \rightarrow \mu^+\mu^-$ mass distribution for events passing CMCOS.*