D0 – Intercryostat Detector
Summary of Calibration and Energy Contributions

In view of recent issues with excess numbers of jets in the ICR, a reconsideration of the ICD calibration and the contributions of the ICD to event energy has taken place. The main items are summarized below:

A) ICD Energy scale from MIP calibration

In order to get an absolute energy calibration for the ICD, we carried out studies at the ICD test stand using cosmic rays. The energy loss for a MIP in the ICD scintillator is 2.02 MeV/cm. Therefore in an ICD tile (thickness 1.27 cm) we expect 2.57 MeV to be deposited by a MIP.

In order to facilitate the study of ICD signals at the teststand using an ADC, we boosted these signals TWICE:

a) by a factor of x22.5/5.5 by using regular calorimeter preamps instead of ICD (I-type) preamps - the factor comes from the ratio of the values of the feedback capacitors.
b) by a factor of x8.7 by using a voltage amplifier.

After using both these boosting factors, we saw the average ICD MIP peak in 135.7 ADC channels (these least count of the teststand preamp is 1mV).

2) The 135.7 ADC counts translates into

135.7 * 1.0/0.14 = 969 ADC counts in DZero

However, we boosted the signal at the teststand by the factor

22.5/5.5 * 8.7

so we must now DIVIDE by this combined factor, to give:

969 / [22.5/5.4 * 8.7] = 27.2 ADC counts for a MIP.

3) Finally, the ADC to GeV conversion factor is the ratio of the results from 1) and 2) above:

2.57 MeV/MIP / 27.2 = 0.0945 MeV/ADC count = 0.0000945 GeV/ADC count

This is the number that is used to convert the AD counts in the raw data to energy (GeV)

B) Individual tile relative calibration

At the ICD teststand, each tile+wavelength shifting fiber, clear fiber, fiber backplane, PMT combination was individually calibrated by measuring the position of its MIP peak. This was done in two stages. First a MIP distribution was taken with PMT voltage set at a value from the PMT testing – aiming for equal gains in all ICD tubes. Then, based on the observed position of the MIP peak, the PMT voltage was adjusted to try to move the MIP peak to 140 ADC counts at the teststand. This resulted in a relative calibration number for each ICD channel that scattered around the target mean (the actual mean was 135.7 ADC counts rather than the original target 140). The results of this process should then be used to adjust the output signal levels for each ICD channel. However, this level of calibration **has yet to be implemented and tested.**

C) Sampling weights

The ICD sampling weights (one for each of the three eta bins covered by the ICD) Were determined from an early version of the Run II Monte Carlo. These weights are also linked to item F) below.

D) ICD Energies

There are various pieces of evidence that indicated that the ICD energy is underrepresented in the energy per event in D0:

a) Vivian's studies of jet-photon balancing and ICD fraction show that a larger weight is needed for the ICD energies to obtain a response that is flat in eta across the ICR.
b) Bob's comparison of L1 Cal energy vs. precision readout energy also points to ICD energies that are too small. This may also be true for the CC massless gaps.

E) Correction factor for ICD energies

The manner in which the ICD signals are handled like signals from the liquid argon, and the difference in ICD vs. calorimeter preamp gains, lead to a suggestion that we should be boosting the ICD signals by a factor of 3.8 (which actually came from the measured ratio of the gains of the calorimeter and ICD preamps). However, subsequent investigations and, in particular, tests at the teststand and on the detector with a radioactive source have shown that the signal sizes for MIPs are the **same** in both locations, and that the number determined for the ICD ADC to GeV conversion factor is correct and derived from an internally consistent procedure.
There is therefore **no basis related to the hardware** for using the factor of 3.8 to boost the ICD signals.

F) The nature of the ICD process(es)

The original Monte Carlo studies for the ICD (carried out by A.White in 1986) showed that there exists a correlation between the energy lost in the dead material (cryostats etc.) and the signal seen in the ICD. Indeed this was the basis for the decision to build the ICD in the first place. The nature of the signal in the ICD is complex. However, the Monte Carlo studies showed that, on average, about 60% of the ICD signals come from protons resulting from particle interactions in the steel of the cryostats. Translating the ICD signals into a number of MIPs, and then using the ADC to GeV conversion factor does not necessarily fully account for the energy loss in the dead material. For this reason it may be necessary to boost the observe ICD signals by a factor to achieve a flat response in eta across the ICR. In Run I this factor was obtained by "floating" the weights and letting the jet-photon and jet-jet balance studies determine the best factor. A similar procedure may now be necessary for Run II and should derive from Vivian's studies.

G) Recommendations

1) The ICD ADC to GeV conversion factor should stay at its present value: 0.0000945 GeV/ADC count.
2) The factor of 3.8 should **not** be used. For the Winter conferences we should adopt the conservative approach of using the ICD signals without a boost factor.
3) More studies of the required ICD boost factor should be carried out as soon as possible and the best factor determined and then used in energy correction.
4) The channel to channel relative calibration for the ICD should be tested and implemented as soon as possible.