

Argon Storage Dewar

Initial Fill

DO Engineering Note 3740.512-275

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Introduction

The argon storage dewar at the DØ Assembly Hall was filled with approximately 3100 gallons of high purity liquid argon for the first time on December 3, 1990. The oxygen analyzer and high voltage test cell both indicated an oxygen impurity level between 0.4 and 0.5 ppm which is acceptable.

Sequence of Events

The argon storage dewar initially had a "puddle" of liquid in the bottom of it which was left over from a trailer condensation exercise from the previous summer. The dewar pressure was 20 psia and the oxygen content of the argon was measured to be around 1.8 ppm by the high voltage test cell.

The driver arrived at 11 AM which was a couple of hours later than scheduled. After the fill hose was attached and soap tested, the entire fill line from the trailer to the dewar valve was subsequently pumped to 30μ and backfilled from the trailer. This pumping/backfilling process was repeated two more times.

At 1 PM the cooling and condensing of the trailer gas into the argon test cell (ATC) started and the flow to the oxygen detector initiated. The ATC was filled around 2:15 PM and both alpha and beta curves were generated within two hours of high voltage testing. The data from the high voltage cell indicated an oxygen equivalent contamination of slightly more than 0.45 ppm. The oxygen analyzer indicated less than 0.4 ppm but these results were not believed to be entirely accurate due to the flow sensitivity of the device. Shortly after obtaining the purity numbers, it was decided to accept the argon load.

The transfer proceeded slowly at first due to the lines being warm and as a measure of conservatism in the procedure. The pressure in the storage dewar remained fairly constant around 21 psia and the pressure in the trailer varied between 20 and 24 psig. At 7:15 PM the liquid transfer was complete; an additional hour had elapsed during the attempt to condense the remaining liquid/vapor into the storage dewar. After the delivery was deemed to be complete, the control valve at the dewar was closed and the fill connector removed from the truck after the pressure was bled down. The fill line was subsequently evacuated by the utility vacuum system.

The final argon level indication as read by the pressure transmitter was 36.6 inches H₂O (mechanical gage read this within 1%). This number translates to 4051 gallons @ 1 atm according to the level vs. volume chart which was supplied by the dewar vendor. The net weight of the delivery trailer according to both the Fermilab and Linde scales was 36,380 lbs, which is the equivalent weight of 3130 gallons. A total

of 360 gallons of liquid nitrogen was consumed by the condenser during the delivery.

Discussion

The rate of filling occurred at a much slower rate than predicted using incompressible flow equations combined with the choked flow equation (Ref: ISA Handbook of Control Valves) at the inlet valve to the dewar (17 vs. 100 gpm). This is mostly due to the fact that a significant portion of the transfer line and all external trailer piping was uninsulated which greatly reduced the flow rate due to the vaporized cryogen. In fact, the gas/liquid volumetric ratio just past the uninsulated section was 2.7.

The purity of the argon measured by both the ATC and oxygen monitor was the best that we have ever seen in the past few years of measuring this particular vendor's product. Our criteria for acceptance was an amount of collected charge from the alpha source greater than 3E4 electrons, an ATC oxygen equivalent contamination less than 0.6 ppm, and a deviation from the flat portion of the beta vs. voltage slope of no more than 3% (see appendix for graphs and summary of results). The agreement with the vendor, Linde, was that they would provide us with a product with an oxygen content of less than 1 ppm (their results were 0.9 ppm). If we measured an oxygen concentration between our criteria of 0.6 ppm and the agreed criteria of 1 ppm, we would have shipped the load back at a nominal charge to us.

Although we had a "puddle" of argon initially in the dewar, there was a large discrepancy between the volume delivered as measured by scale and what the dewar level gage was indicating (3130 vs 4050 gals). After subsequent deliveries to this vessel, it was learned that the level indication is offset by 5.2-5.4 in. H₂O. This could be due to the liquid tap of the vessel being lower than the bottom of the inner shell of the dewar.

Conclusions

The condenser and insulated piping sizing appears to be correct for a fill rate of a couple of hours. Insulation is required around the inlet to this piping in order to reduce the amount of filling time significantly. The graph of the level indication vs. volume of the dewar should be changed to reflect the apparent 5.2-5.4 in. offset. Another data point may be required to narrow this number down further. A majority of the time spent to fill the vessel was associated with the testing of the liquid-this time will shorten as we gain experience. Subsequent deliveries should be ordered to initiate as early in the morning as possible, this appears to be nearly an all day effort. The argon checked prior to delivery by us indicated that it was acceptable. The analysis of the argon purity that Linde provides us is merely a check that the liquid meets our agreement with them per contract, the actual purity could be much lower than what is written in their analysis results.

Dec-3-1990

HW

First fill of D& LAr dewar from trailer. \checkmark

Trailer arrived on Dec-3-1990 in the morning.

Both O₂ meter and ATC (argon test cell) were filled by condensing gas (?) from trailer into ATC (through O₂ meter!)

The same Jerry + Pat + others got everything ready to test the purity:

Previously set criteria : • O₂ and ATC better than 0.6 ppm
• α -source > 30.000 electrons

The results of measurements are attached.

O₂ : meter 0.37 ppm (error $\sim 0.1 - 0.2$)

β -curve : 0.42 ppm $\pm ??$

plateau rises by 2.3% between 2-3 kV.

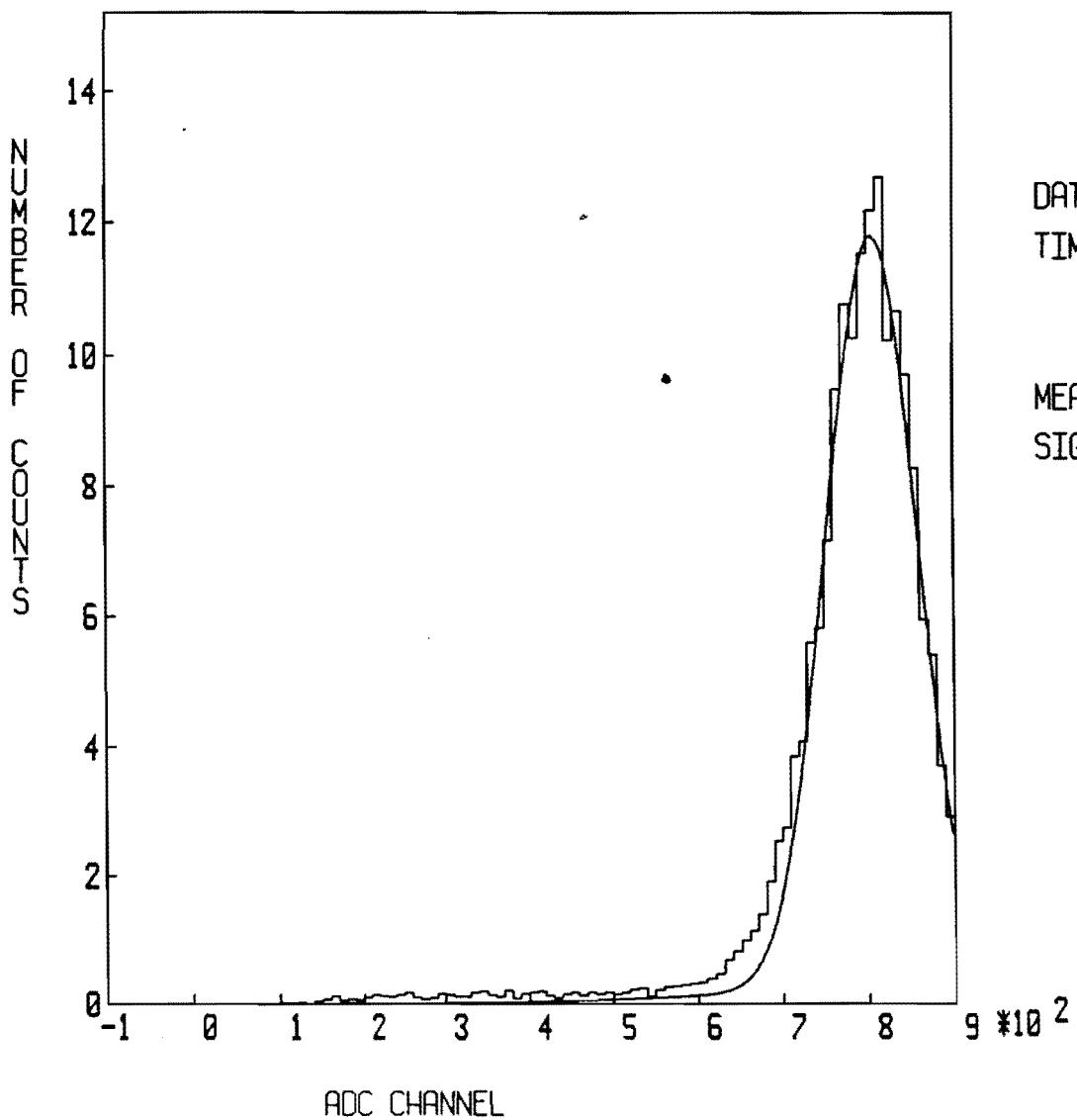
α -source : yielded 35.000 electrons.

Comment by Jerry: best argon he has ever seen!

@ 17:00 transferring trailer into D& dewar (~ 4000 gallons)

α - Source
Criteria was $> 30,000$ electrons

DT ALPHA1 HVOLT HIS
2.5 KV



DATE 3-DEC-1990
TIME 1426

MEAN 806.4 $\sim 32,000$
SIGMA 0.4 electron

DT ALPHA1 HV PLATEAU

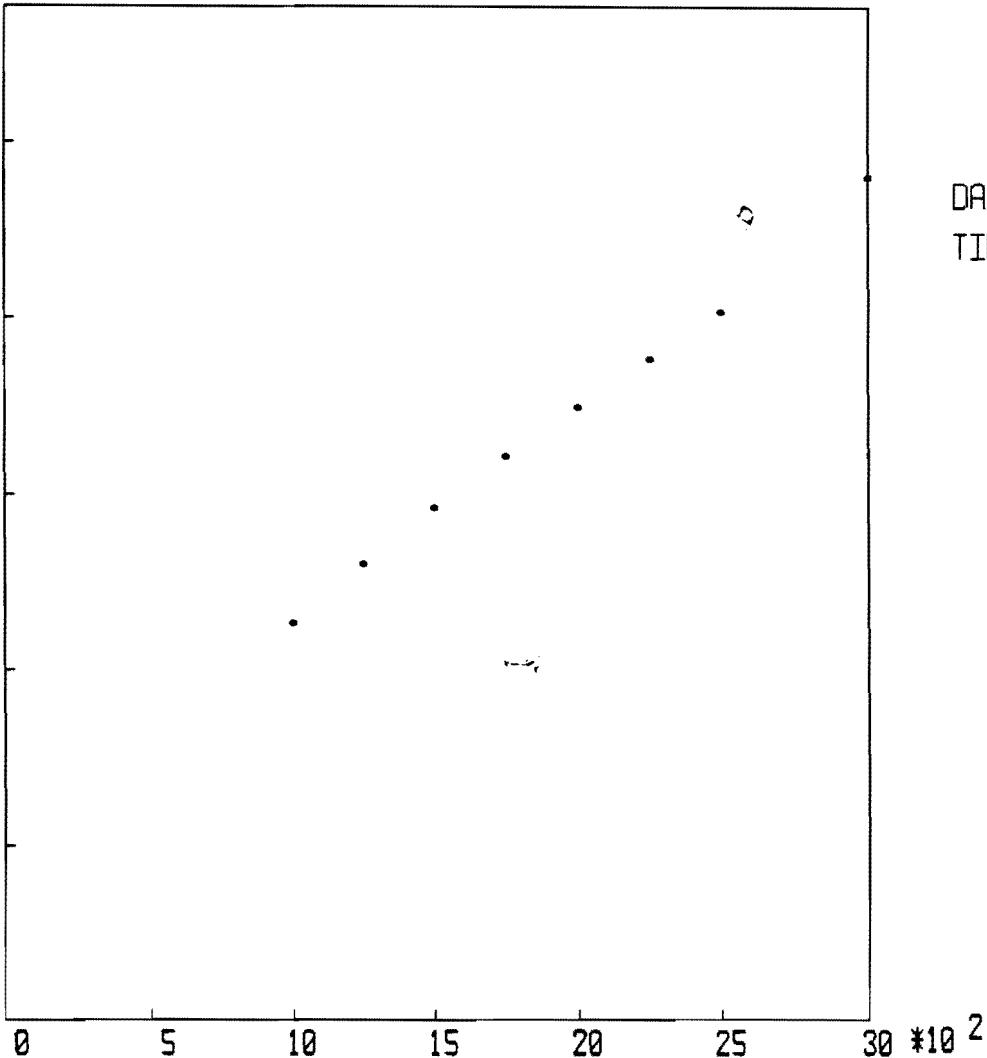
$\times 10^{-2}$

ADC RESPONSE (%)

10
8
6
4
2
0

DATE 3-DEC-1990
TIME 1413

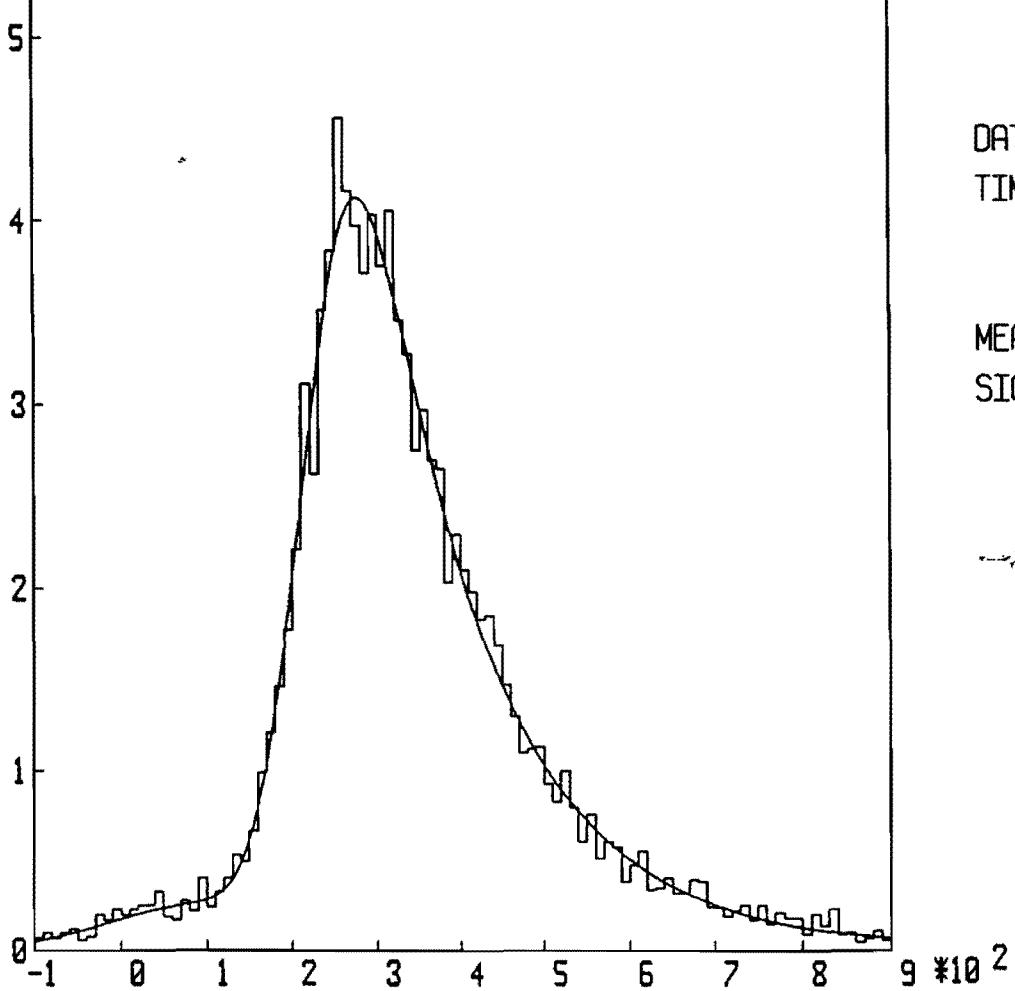
HIGH VOLTAGE



DT BETA1 HVOLT HIS

$\times 10^2$

NUMBER OF COUNTS

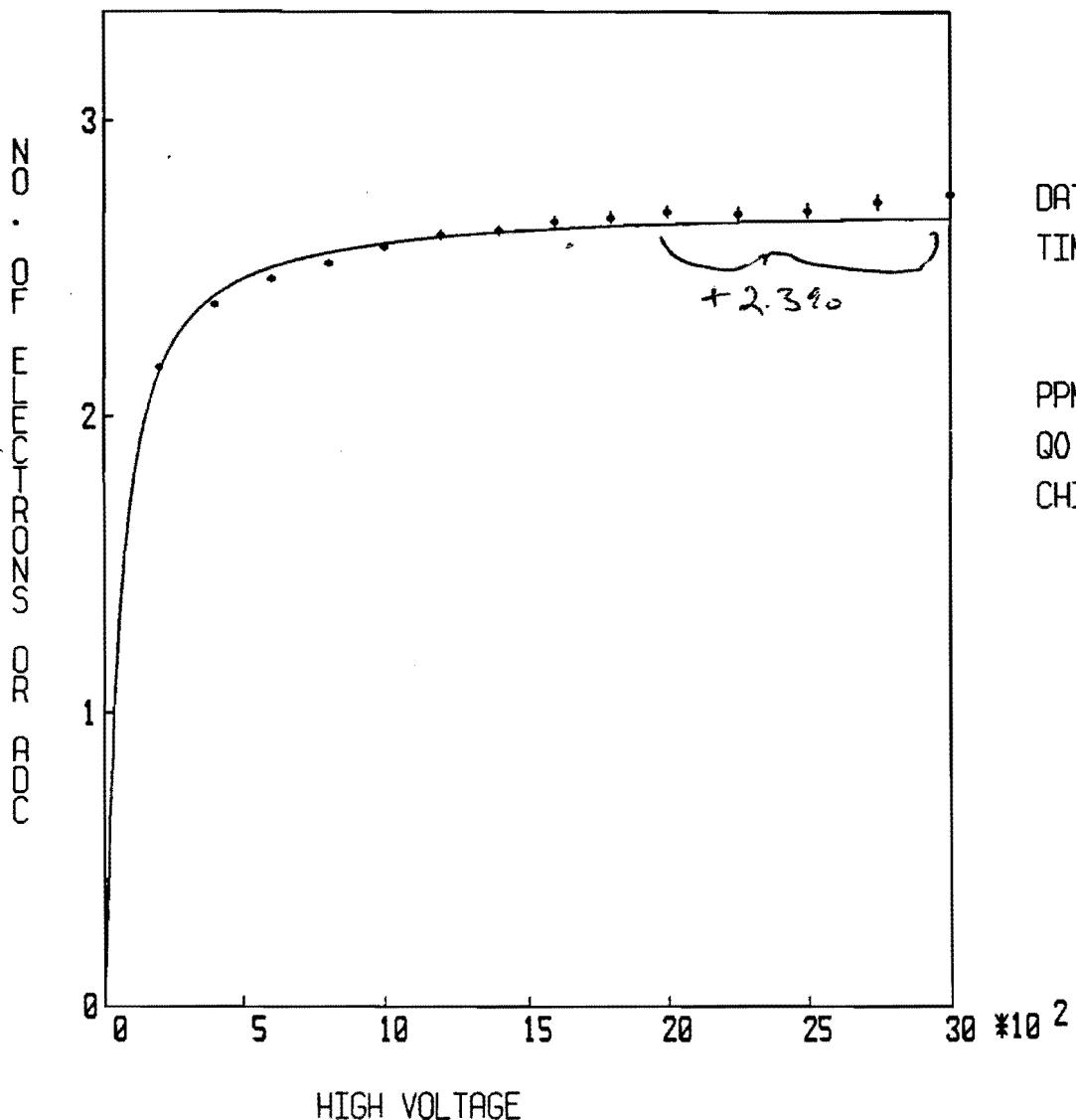


DATE 3-DEC-1990
TIME 1538

MEAN 275.3
SIGMA 1.5

DT BETA1 HV PLATEAU

$\times 10^2$



DATE 3-DEC-1990

TIME 15 1

PPM 0.42

Q0 543

CHI2 15.

HIGH VOLTAGE

100 ppm

100% \pm 1 ppm

PCT

O_2 meter
first $D\phi$ LAr delivery

0.0

14:52:18

15:22:18

15:52:18

2ANALYZE

37.0 PCT

VALU SAMP

TIME: 15:22:00 12-03-90