

# Decommissioning of the DØ Cryogenic PLC System

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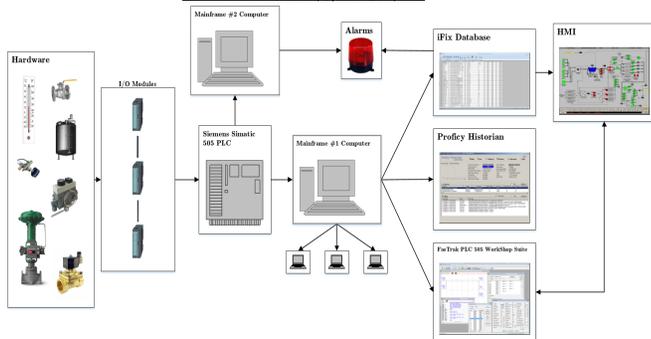
August 6<sup>th</sup>, 2014

## Abstract

The DØ Collider Cryogenic Programmable Logic Controller (PLC) System was partially decommissioned in order to harvest equipment for future experiments. Altogether, 4 out of 12 of the I/O bases located throughout the DØ Assembly Building (DAB) were deprogrammed and removed from the main Siemens PLC System. Approximately 2,000 addresses and tags (correlating to 13,000 words or 832 kB – 50% of the total PLC Storage) were removed from the database/historical record and the logic was removed from the "FasTrak PLC 505 Workshop Suite" Programming Tool (FWPT). In the end, the Department of Energy along with Fermilab has saved an estimated \$100,000+ by reusing this equipment in other experiments.

## Project and PLC System Overview

The Architecture of the Cryogenic PLC System:



PLCs used within DAB are Siemens Simatic 505s programmed within the FasTrak PLC 505 Workshop Suite Programming Tool. In each PLC System there are several I/O bases. Each I/O base contains the following:

Up to 16 slots available with 16 channels in each to place physical hardware connections (relay logic hardware). → Each piece of relay logic hardware can be classified into 1 of 7 primary categories (with the address-prefix in parenthesis) and can be programmed using the FWPT described below also:

### Relay Logic Hardware/Software Tag Categories:

1. Analog Inputs/Outputs (WX / WY)
2. Discrete Input/Outputs (X / Y)
3. Variable-Memory (V / VF)
4. Contacts/Internal Relays (C / CR)
5. Constants (K)
6. Ladder Memory (L)
7. Special Function Memory (S)

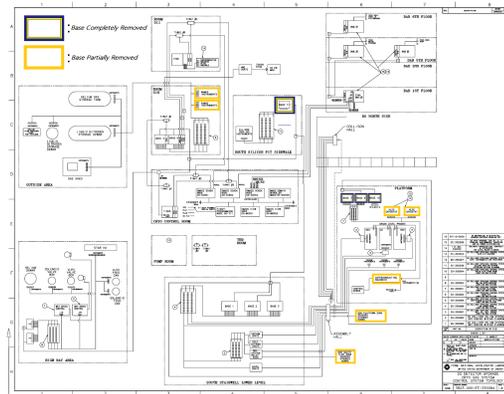
### Programming Utilities within FWPT:

1. Ladder Logic:
  - Programming language used to construct a program dependent on the circuitry within the hardware.
2. Special Functions:
  - Custom programming language within FWPT used to control inputs and outputs and store variables.
3. P.I.D. Loops:
  - Proportional integral derivative loops are used to control a certain input or output relative to a user-defined or control-defined process variable to reach a desired state.

For this project, categories 1 through 4 in the above list will be the primary concern due to the scarcity of 5 through 7. These pieces of relay logic hardware and addresses are physically located inside of the I/O base, and the way which they operate are defined in the logic of the FWPT. The FWPT consists of three primary tools that control the function of these addresses. These three tools are listed above.

## Input / Output Bases

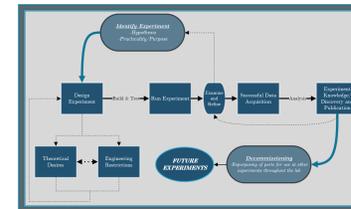
- The I/O bases that were decommissioned control several systems inside of the DAB. Some of them include the Silicon Management System, the superconducting solenoid cryogenic controls, the visible light photon counter (VLCP) cryogenic controls, and the insulating vacuum controls.
  - Base 7 – Removed 7 / 7 / 2014
  - Base 10 – Removed 7 / 7 / 2014
  - Base 11 – Removed 6 / 18 / 2014
  - Base 8 – Removed 6 / 28 / 2014
  - Oxygen Deficiency Hazard (ODH) System – Removed 7 / 17 / 2014
  - Miscellaneous Tags (Cleaning of Unused Memory Slots in PLC) – Completed 7 / 30 / 2014



## Process

- Step 1 • Identify Bases/Addresses to be Removed
- Step 2 • Remove Addresses from Alarm Database
- Step 3 • Remove Addresses from iFix Database
- Step 4 • Remove Addresses from TIE Driver Database
- Step 5 • Remove Logic from Programming Tool (FWPT)
- Step 6 • Remove/Deconfigure Physical I/O Base → Future Equipment Use

## Life Cycle



This diagram shows the cycle of equipment and experiments both at Fermilab and in any scientific institution. Decommissioning is a heavily emphasized portion due to the potential savings in other projects throughout Fermilab.

## Results / Conclusions

By decommissioning particular I/O bases in the PLC System throughout DAB, it will save the expenses of other experiments throughout the Fermilab. The estimated potential savings can be calculated by assuming the average cost per I/O base being \$25,000/unit. Without considering labor costs and other miscellaneous expenses, the raw estimated potential savings is shown below.

I/O Base	Slots Cleared	Addresses Cleared	Total Memory Cleared (kB)	Estimated Potential Savings
7	14	517	557	≈ \$25,000
8	15	379	149	≈ \$25,000
10	11	379	149	≈ \$25,000
11	10	300	115	≈ \$25,000
ODH	----	83	24	----
MISC	----	455	180	----
<b>TOTAL</b>	----	≈ 1980	832	≈ \$100,000

The equipment will be primarily utilized within the cryogenic controls within the following experiments:

- LArIAT
- LAPD
- LBNE
- MicroBooNE

**Overall, the decommissioning and repurposing of the DØ Cryogenic PLC System has brought several benefits to both Fermilab and the U.S. Department of Energy from a financial perspective. In an era that emphasizes reuse and environmentally friendly alternatives, this approach of reusing PLC modules is evidently the most pragmatic.**

## Acknowledgements

This work was supported in part by the U.S. Department of Energy, Office of Science and Office of Workforce Development for Teachers and Scientists (WDTS) under the Community College Internship (CCI) Program.

• Special thanks to Dan Markley and the entire Controls Group in the Particle Physics Division at Fermilab. Also, thank you to Karen Kephart and Tanja Waltrip for all of their help and support throughout the entire project. If it were not for these people, success in this Community College Internship would not have been possible.