

FAST WIRE SCANNER MOTION CONTROL SOFTWARE UPGRADE FOR LCLS-II

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LCLS-II FAST WIRE SCANNER

LCLS-II has 20 operating fast wire scanners which are based on the Aerotech Ensemble controller with position feedback aiming to measure the beam transverse profile[1,2]. To meet the measurement requirement under both low and high beam repetition rates, we upgrade the motion control software for LCLS-II fast wire scanners.

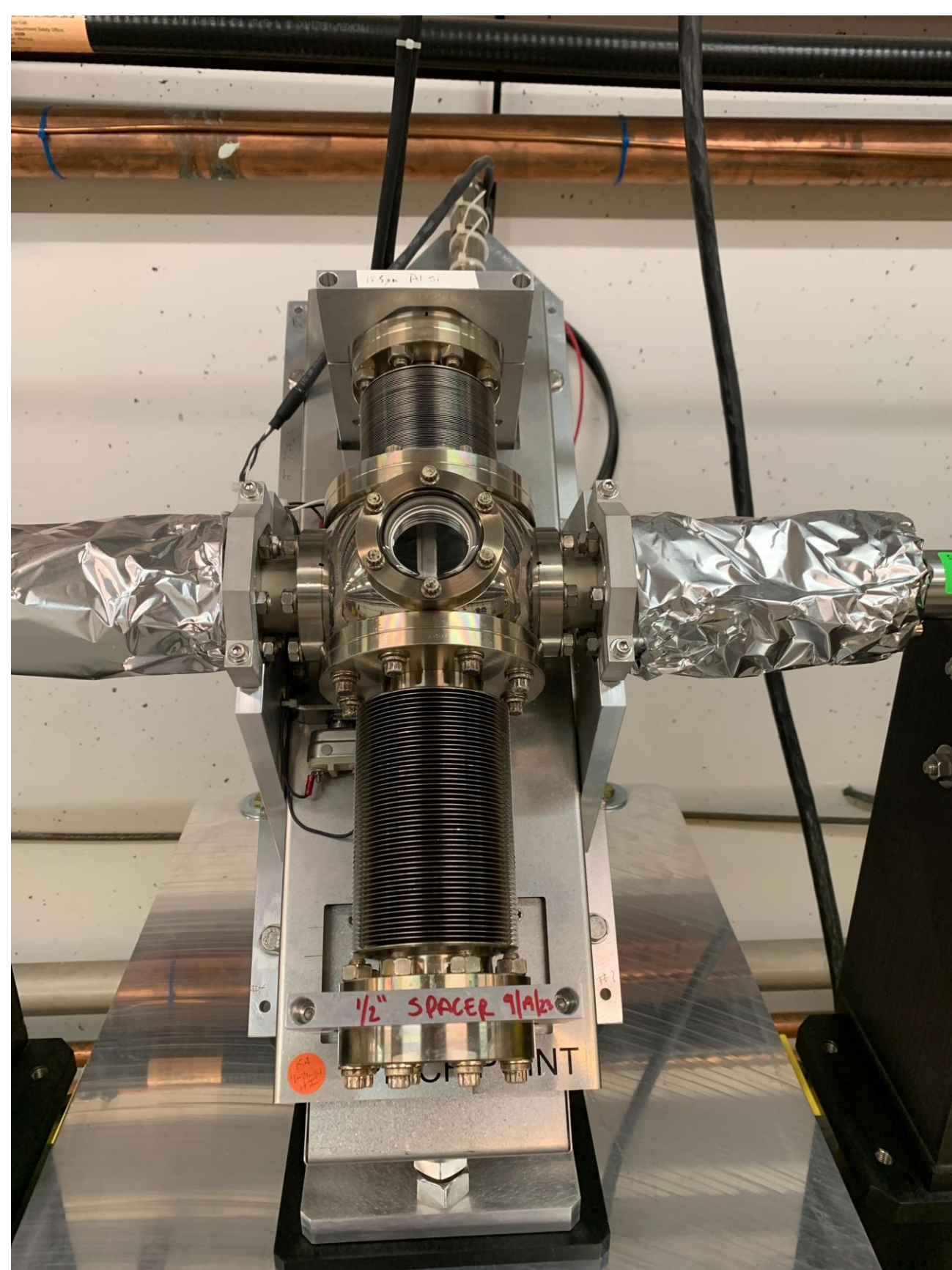


Figure 1: LCLS-II Fast Wire Scanners

MOTION CONTROL SOFTWARE DESIGN REQUIREMENTS

LCLS-II beam repetition rate can be continuously adjusted from 1Hz to 1 MHz[3]. Thus, the wire scanner should also be compatible:

- Step mode: Wire scanner approaches scan start position with 10mm/s, then scans with a desired speed less than 10mm/s;
- Continuous mode: Wire scanner moves to the top position with only the desired speed.

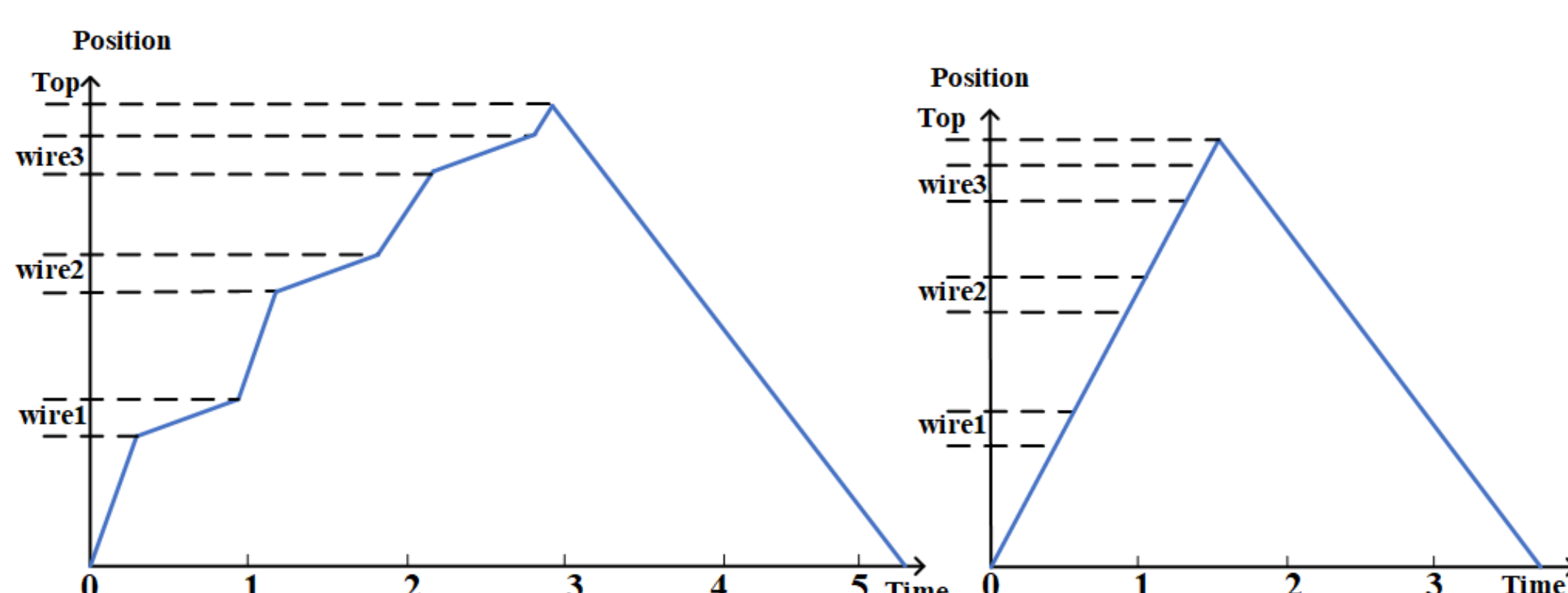


Figure 2: Step Scan Trajectory(left) and Continuous Scan Trajectory (right)

Other requirements:

- Wire scanners should automatically change scan mode based on the NC/SC Linac;
- Add a “local mode” to read local simulated beam parameters for commissioning.

SOFTWARE ARCHITECTURE

- EPICS Layer: control scan modes, set parameters for Aerotech controller, communication with high level;
- Aerotech layer: listens to the scan start/stop command and other parameters from IOC. Fault handler monitors faults that may occur [4].

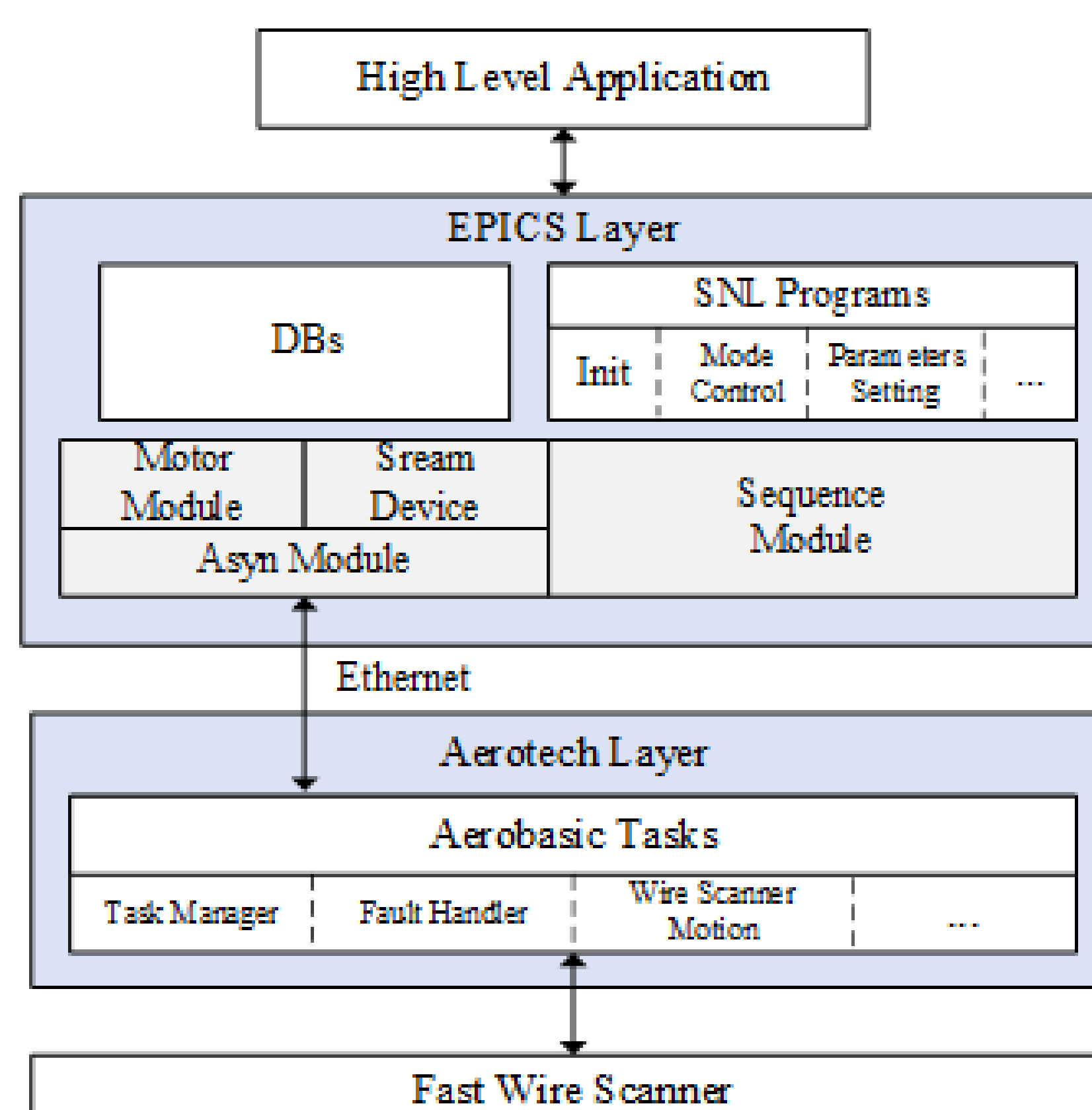


Figure 3: Fast Wire Scanner Software Architecture

SOFTWARE FLOWCHART

- EPICS IOC reads beam parameters in global mode or local mode;
- EPICS IOC calculates scan speed and other parameters, set to Aerotech controller;
- Aerotech controller activates the motor torque, starts the scan, and handles any fault;
- Aerotech controller reports the scan results to EPICS IOC.

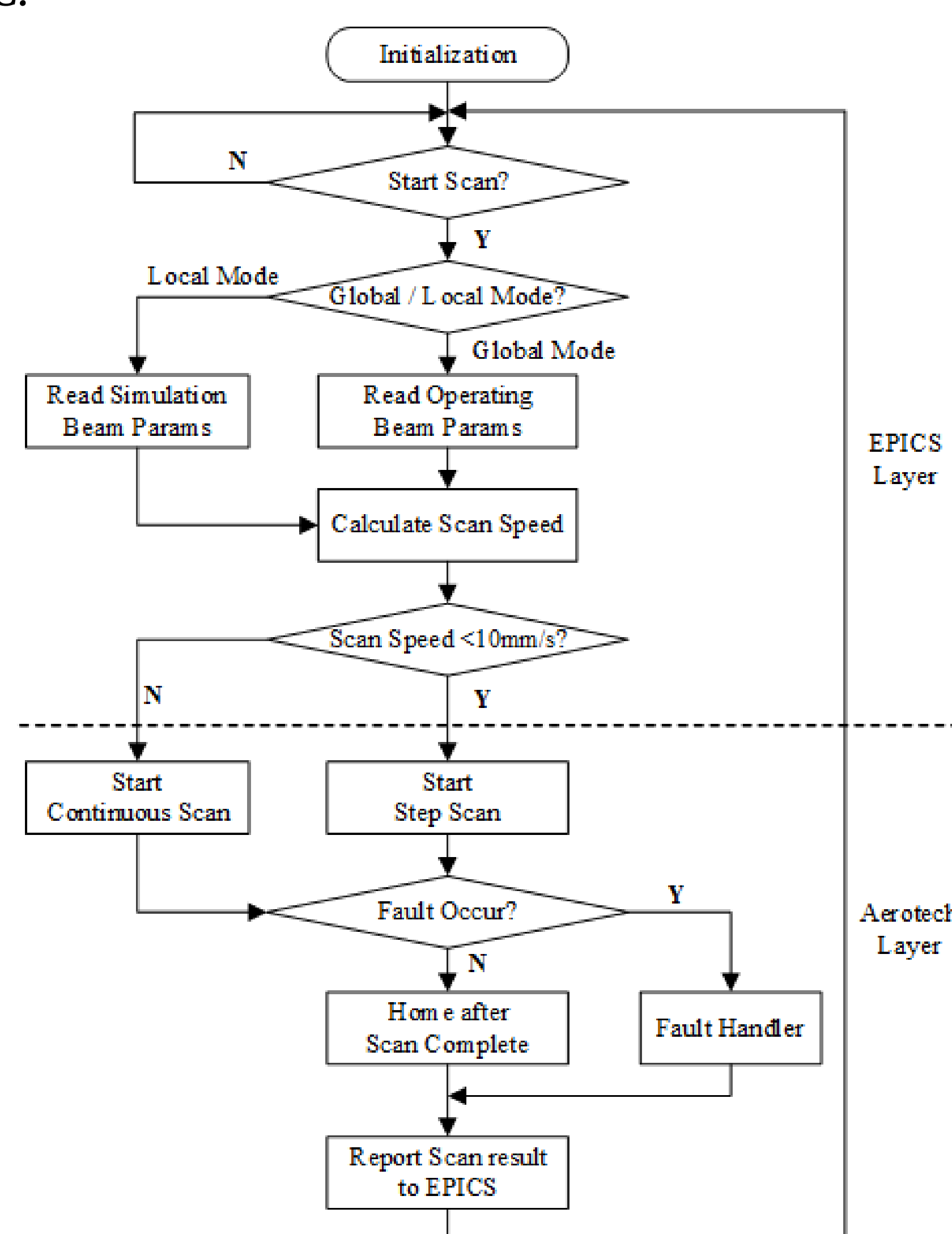


Figure 4: Fast Wire Scanner Software Flowchart

NEW UI BASE ON PYDM

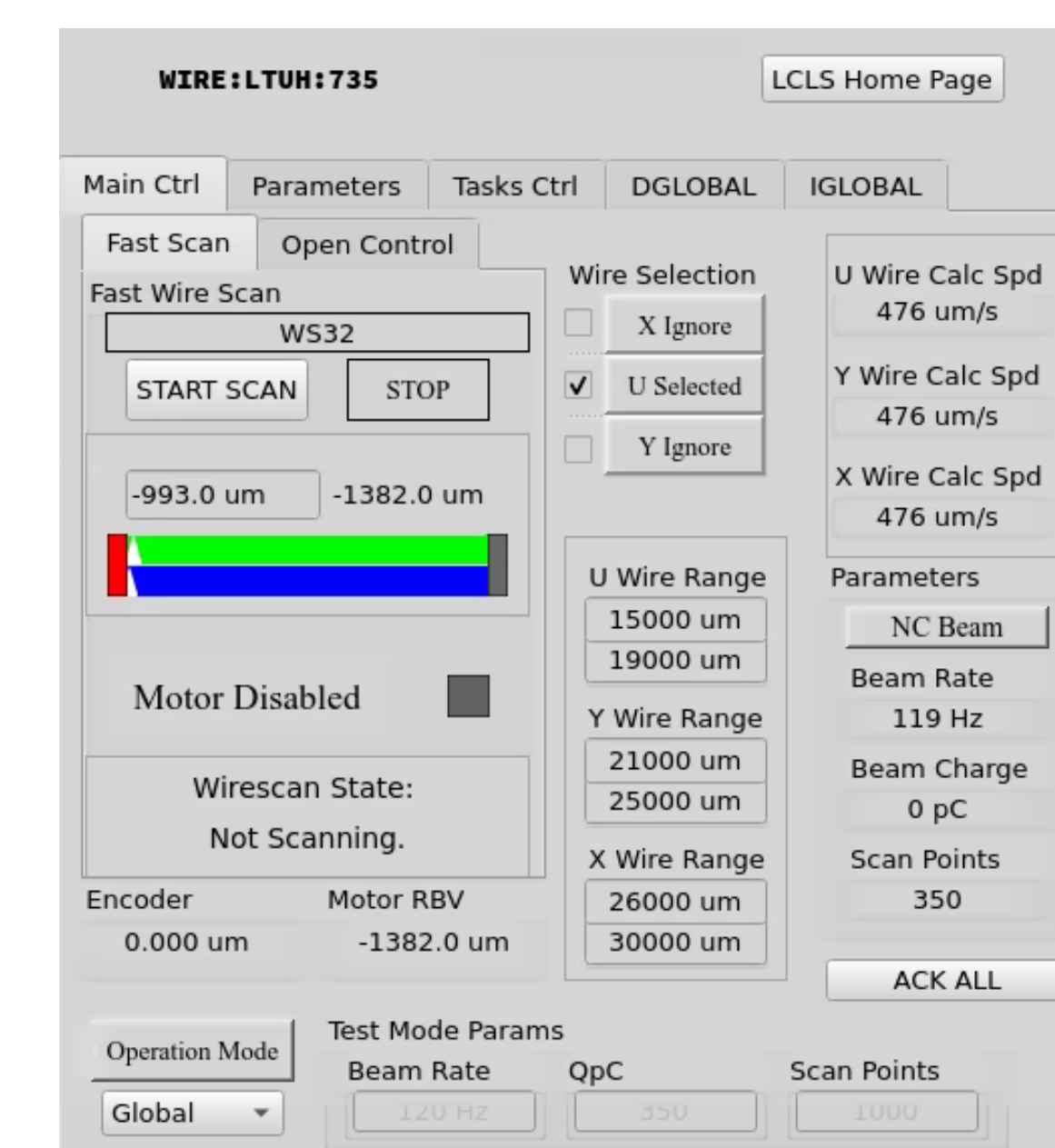


Figure 5: Fast Wire Scanner PyDM UI

- Displays beam and wire parameters to users with essential information in a simple manner;
- Provides expert-level data and functions in other 4 selectable widgets.

FIELD COMMISSIONING

All the 20 fast wire scanners' motion control software in LCLS-II have been upgraded.

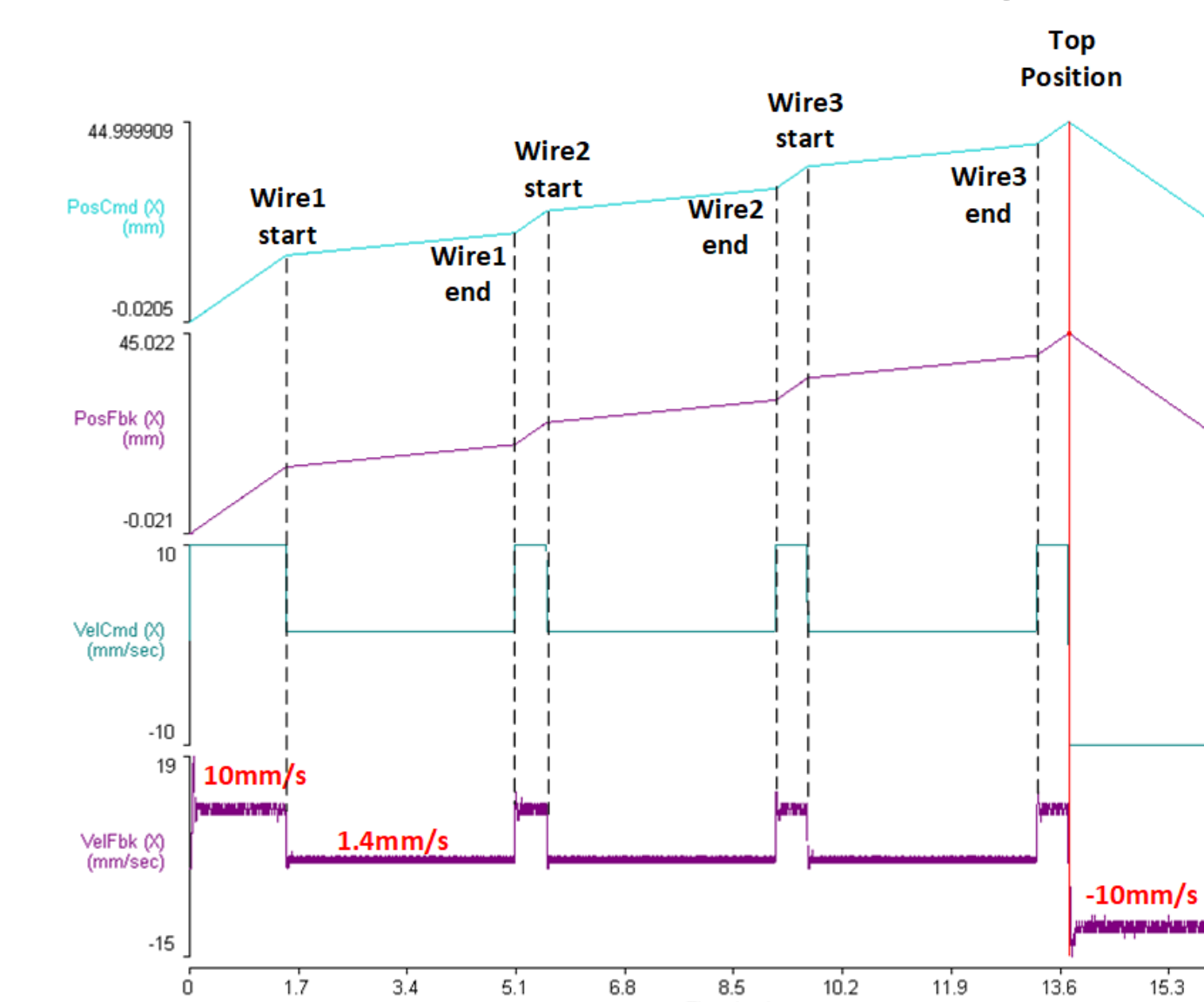


Figure 7: Step Scan Scope Data

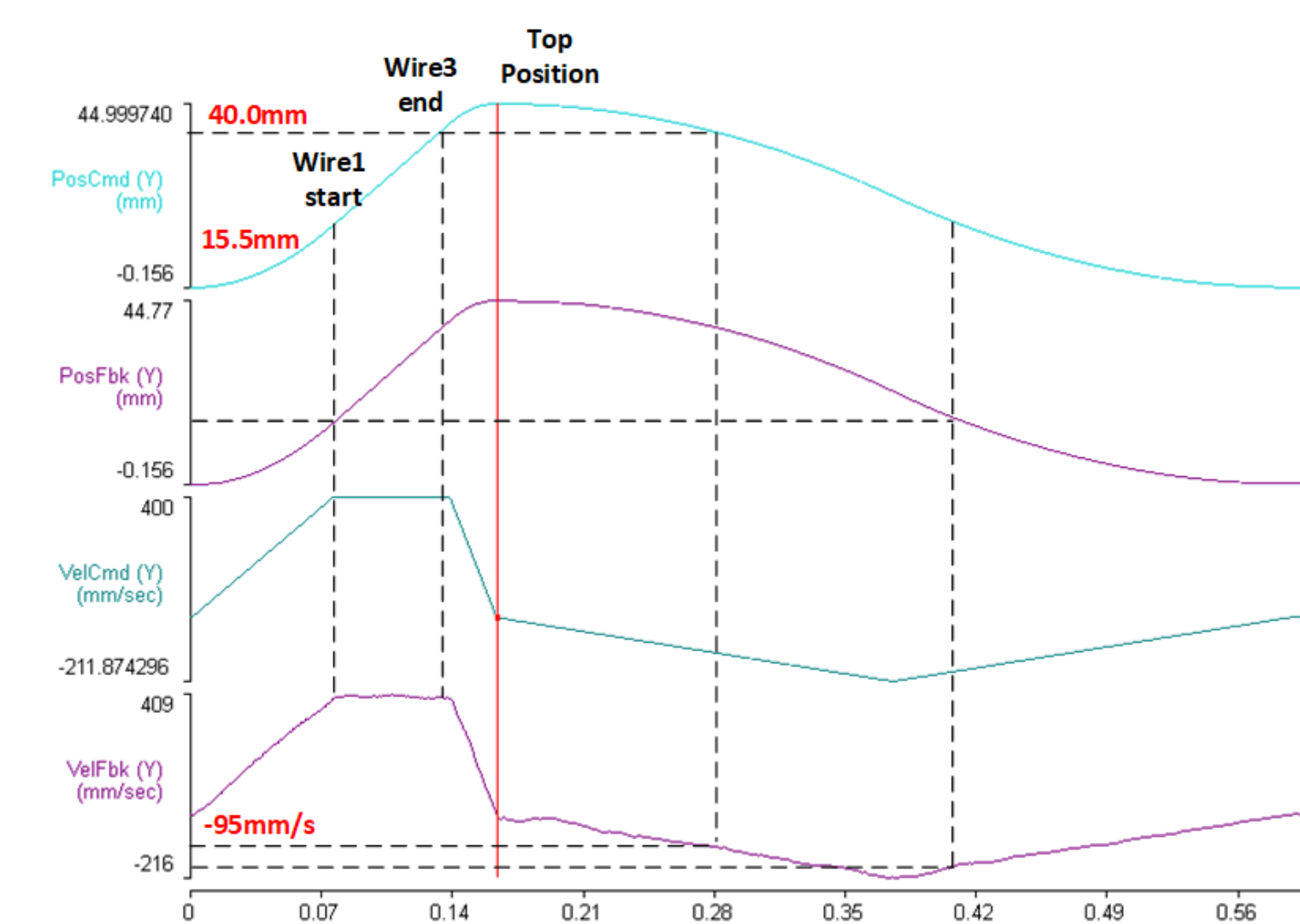


Figure 8: Continuous Scan Scope Data

- Wire scanner moved in 1.4mm/s in step mode and takes 13.7s move to the top position;
- In continuous mode, the wire scanner can be accelerated into 400mm/s within 77μs and decelerated to 0mm/s within 26 μs.

CONCLUSION

The upgrade system provides a wide range of scan speeds which is compatible with both low and high beam repetition rates, all the scan performance has met the design requirements.

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REFERENCES

- [1] J. M. D'Ewart, et al. "Fast wire scanner upgrade for LCLS", ICALEPCS 2015, Melbourne, Australia (2015)
- [2] N. Balakrishnan, L. Sapozhnikove, et al. "Control Systems Design for LCLS-II Fast Wire Scanners at SLAC National Accelerator Laboratory", ICALEPCS 2019, New York, NY, USA (2019)
- [3] "LCLS-II Final Design Report", SLAC, Menlo Park, USA, Rep. LCLSII-1.1-DR-0251, 2015.
- [4] "LCLS-II General Motion and Fast Wire Scanner Controls Functional Requirements Specification", SLAC, Menlo Park, USA, Rep. LCLSII-2.7-FR-0878, 2017.