Machine Protection System for High Powered Lasers

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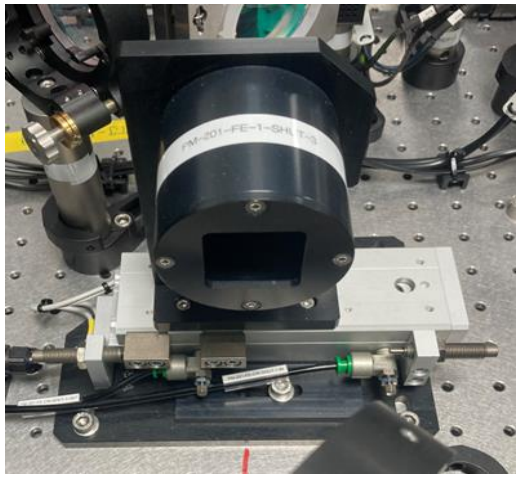
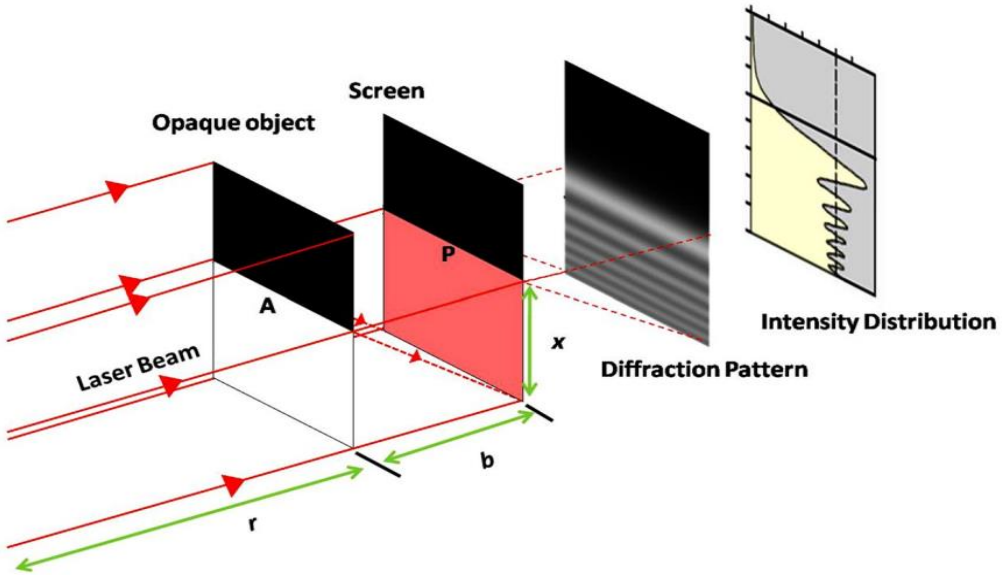
Setting the stage

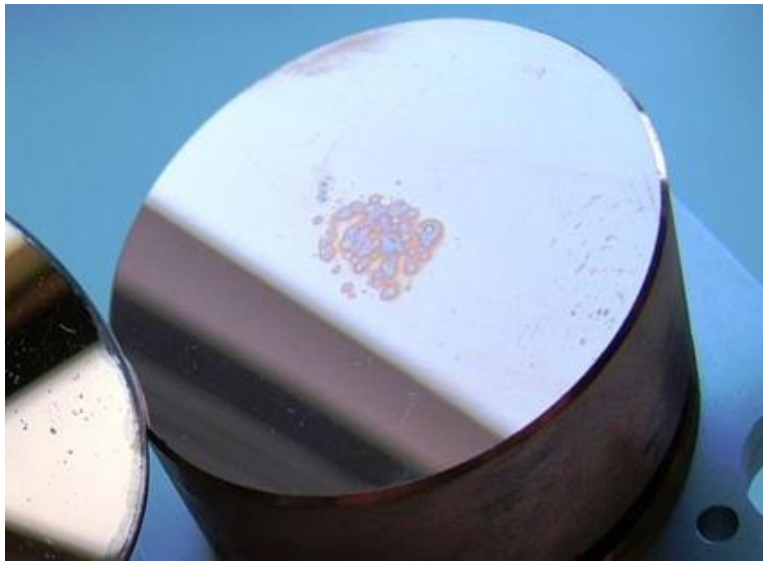
- What is Machine Protection System?
- Fail-Safe Mechanism
- Risk Reduction

Why Reliability and Timescale matters?





Diffraction phenomenon by a straight edge*



- Sharp edges in the beam lead to diffraction.
- The average beam intensity is the same, but the peak is increased.
- The increase may push the intensity over the damage threshold and destroy components.

*Image from T. Santhanakrishnan et al. DOI:10.1038/s41598-019-40270-w

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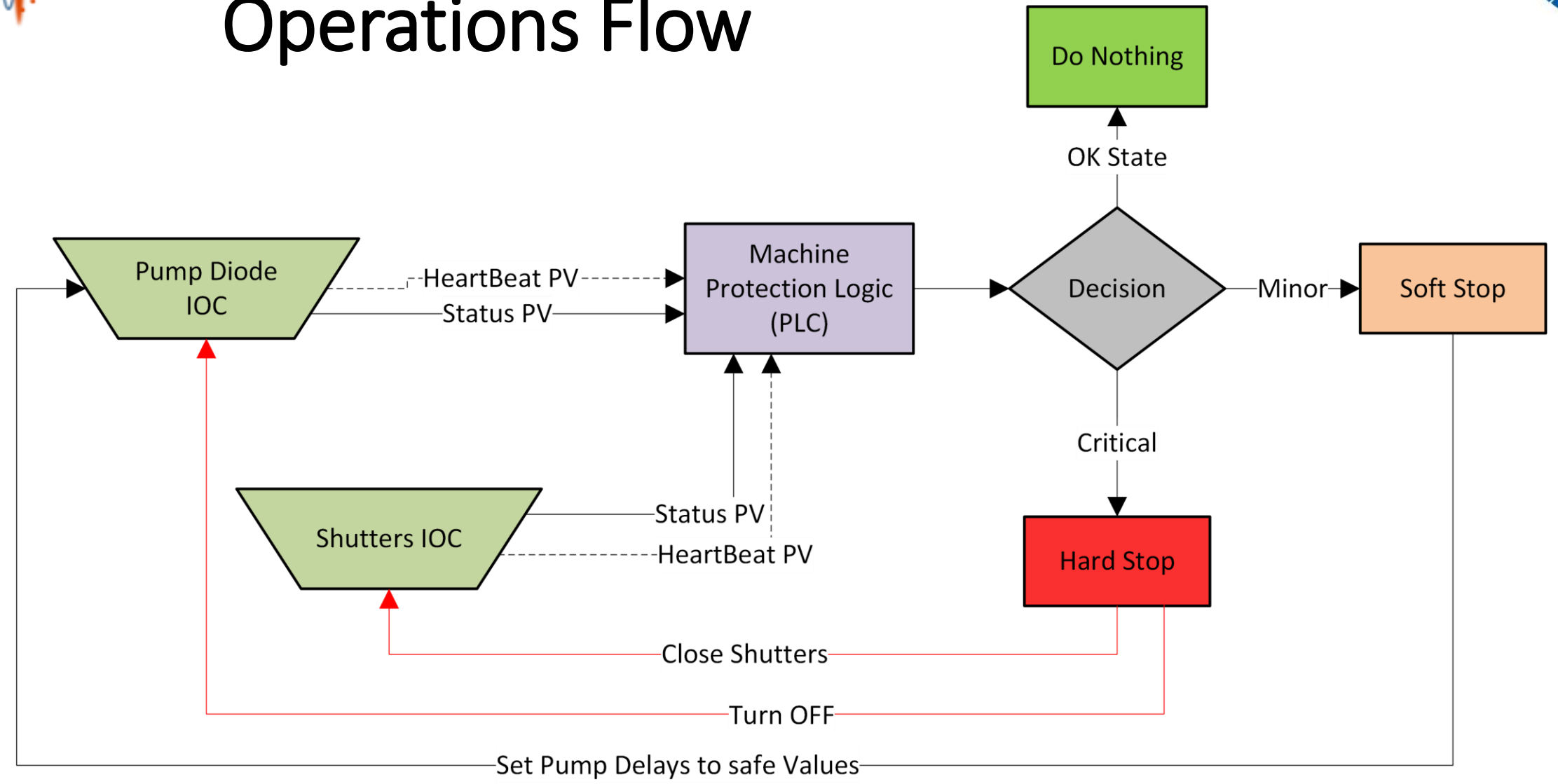
Current MPS Implementation

- May be a dedicated PLC
- **Hard Stop**
- **Soft Stop**
- **HeartBeat**
- 8ms Clock cycle
- **OPC UA** – Why?

- Every address space is a node
- Access restricted to specific memory location; Tool like UaExpert to build logic
- Wide range of data types; Metadata
- User and App-Level Authentication; Message Encryption: SSL/TLS, SHA-256 (Not yet implemented)
- Both licensed and open-source SDKs are available

Operations Flow



Future Scope

- Balancing Risk with Enhanced Protection Protocols through FMEA (Failure Mode and Effects Analysis)
- Transitioning from Software to Hardware for Real-Time Performance
- Enhancing Accuracy in Robust, High-Speed Systems

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Thank You

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