Omega Laser Facility and Diagnostic Timing Management

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Summary

LLE is committed to achieving the highest-quality timing

- The Omega Laser Facility continues to build capabilities to achieve the desired experimental beam-to-beam timing and accurately capture the target event on diagnostics
- Diagnostics predict the timing before the shot
- Target diagnostics can be used to measure beam-to-beam timing under appropriate conditions
- The presented results indicate the currently achievable timing
- The Principal Investigator (PI) can work with the shot crew to ensure that the timing feedback is correctly incorporated to achieve the desired result by separating observed errors and new desired timing requests

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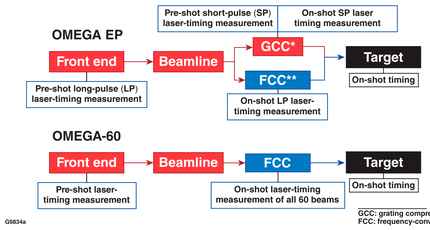
Laser and target diagnostics are used to time the OMEGA-60 and OMEGA EP Laser Systems

- Timing of the OMEGA-60 and OMEGA EP Laser Systems relies on multiple pre-shot and on-shot laser predictive diagnostics
- These laser diagnostics predict T-0 on-target timing based on historical calibration from on-shot target diagnostics
- To determine on-shot timing, a target timing diagnostic must be used



GCC: grating compressor chamber
FCC: frequency-conversion crystals

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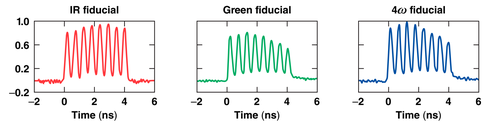
T-0 is the nominal system timing for the Omega Laser Facility

- T-0 (Tzero) is the theoretical time when all laser pulses arrive at target chamber center (TCC) if no delay is applied
  - All shot request form (SRF) timing delays and diagnostic timing delays are applied with respect to T-0
- Most diagnostics use the fiducial laser to reference timing with respect to T-0



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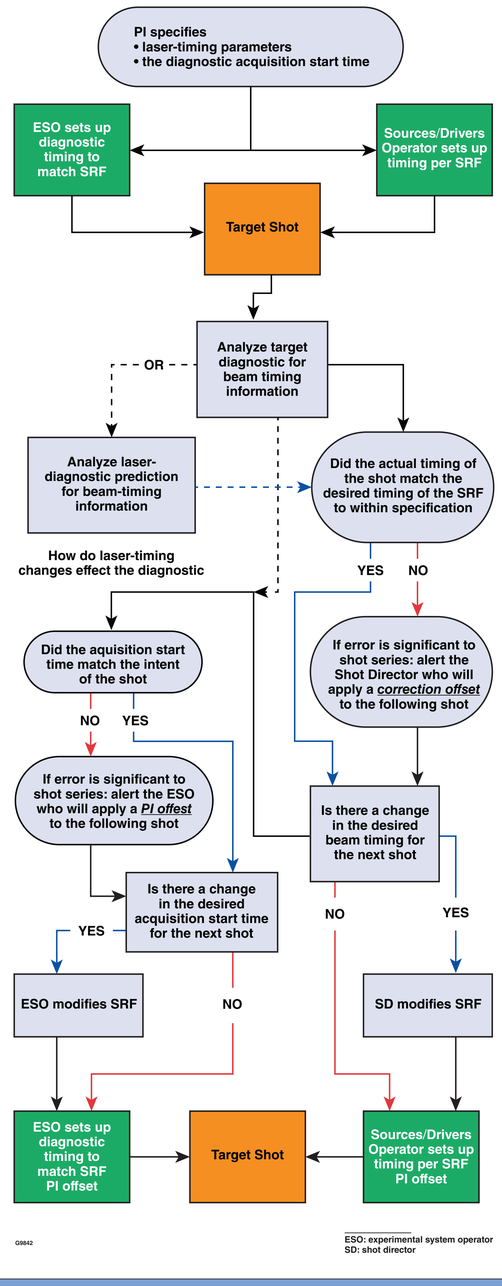
PI shot day guidance



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ESO: experimental system operator
SD: shot director

Methods to change and measure OMEGA-60 beam-to-beam timing are well understood

- Beam-to-beam timing is adjusted using path-length adjustment system (PLAS) delays
  - PLAS delays can be applied to any individual beam
  - beam-to-beam timing is checked twice a year
  - the PLAS delay error is <10 ps over the full range
- When using both the smoothing by spectral dispersion (SSD) and backlighter drivers, driver-to-driver timing is adjusted by changing the timing of the driver

Diagnostic	Location	Capture Time	Contact
Fast scope	Front end	Pre-shot	Front end drivers—E. Hill
P510(s)	UV	On-shot	Beamlines—R. Dean
NTD	Target chamber—fixed	On-shot	Neutronics—C. Stoeckl
PJX	Target chamber—TIM	On-shot	Neutronics—C. Stoeckl
UFXRSC	Target chamber—TIM	On-shot	Neutronics—C. Stoeckl

NTD: neutron temporal diagnostic
UFXRSC: ultrafast x-ray streak camera

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OMEGA EP timing is moved by individual beamline and measured by a suite of diagnostics

- Beam-to-beam timing is adjusted by changing the timing of the entire laser system (seed laser and all active beamline components)
- Timing adjustments in long-pulse mode are relatively straightforward
- Timing adjustments in short-pulse mode may take up to 30 min; this will not cause shot delays if timing changes are requested within 30 min post-shot
- All beam-to-beam timing uses Beamline 2 as the reference

Diagnostic	Location	Capture Time	Contact
Fast scope	Front end	Pre-shot	Front sources—E. Hill
UV ROSS	UV	On-shot	Front sources—E. Hill
SPDP PSM	SPDP	Pre-shot/On-shot	Front-end sources—E. Hill
PJX	Target chamber—TIM	On-shot	Neutronics—C. Stoeckl
UFXRSC	Target chamber—TIM	On-shot	Neutronics—C. Stoeckl

UV ROSS: Ultra violet Rochester Optical Streak System
SPDP PSM: short pulse diagnostic package pulse shape measurement
TIM: ten-inch manipulator

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Overview of OMEGA-60 on-shot timing and nominal setup conditions

- Timing is configured for the first shot of that day such that the predicted timing at the front-end timing diagnostic is within 50 ps of the SRF
- On-shot timing as predicted by the UV timing diagnostics is within 100 ps of the SRF requested timing
- Timing errors can be tightened up in the UV at the request of the PI

	T-0 (average)	STD	Diagnostic
SSD	20 ps	10 ps	P510
SSD to backlighter	120 ps	50 ps	P510
SSD to OMEGA EP	40 ps	40 ps	NTD

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OMEGA EP timing can be improved after the first shot of the day

- Timing is set up for the first shot of that day such that the predicted timing at the front-end timing diagnostic is within 100 ps of the SRF request unless tighter timing is required
- On-shot timing as predicted by the UV timing diagnostics is within 100 ps of the SRF requested timing on the first shot of the day
- Timing errors can be reduced up if data is available from a target timing diagnostic and upon PI request

	First shot of day		Subsequent shots		Critical timing		Diagnostic
	T-0 (average)	STD	T-0 (average)	STD	T-0 (average)	STD	
SP beam to beam*			10 ps	30 ps	10 ps	20 ps	SPDP PSM
LP beam to beam*	20 ps	75 ps	10 ps	75 ps			UV ROSS

STD: standard deviation
*Beam-to-beam timing is reported with respect to Beamline 2

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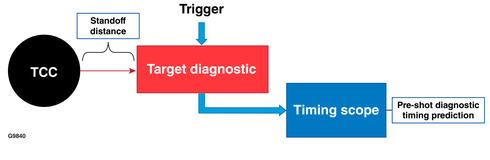
The target diagnostic timing manager (TDTM) will be available in FY14

- TDTM is an upcoming software package to centralize control of timing and feedback from pre-shot timing checks to ensure that the diagnostics are triggered per the SRF request
- This software will take into account the standoff distance from TCC, current TIM conditions, the diagnostic configuration, and the desired timing relative to T-0
- In pre-shot, the timing scope is utilized to compare a characteristic signal from the target diagnostic to the fiducial laser pulse
- Corrections are applied to the trigger timing to ensure the diagnostic captures the shot event



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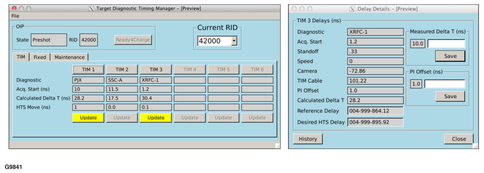
TDTM will replace spreadsheet-based timing configuration

- Historical characterization of the diagnostic will be tracked and accounted for in diagnostic setup
  - new diagnostics will require additional effort to characterize and may require calibration target shots
  - when diagnostics are modified, characterization of changes will be required to achieve desired results on the first shot
- Daily adjustments might be required because of system drift



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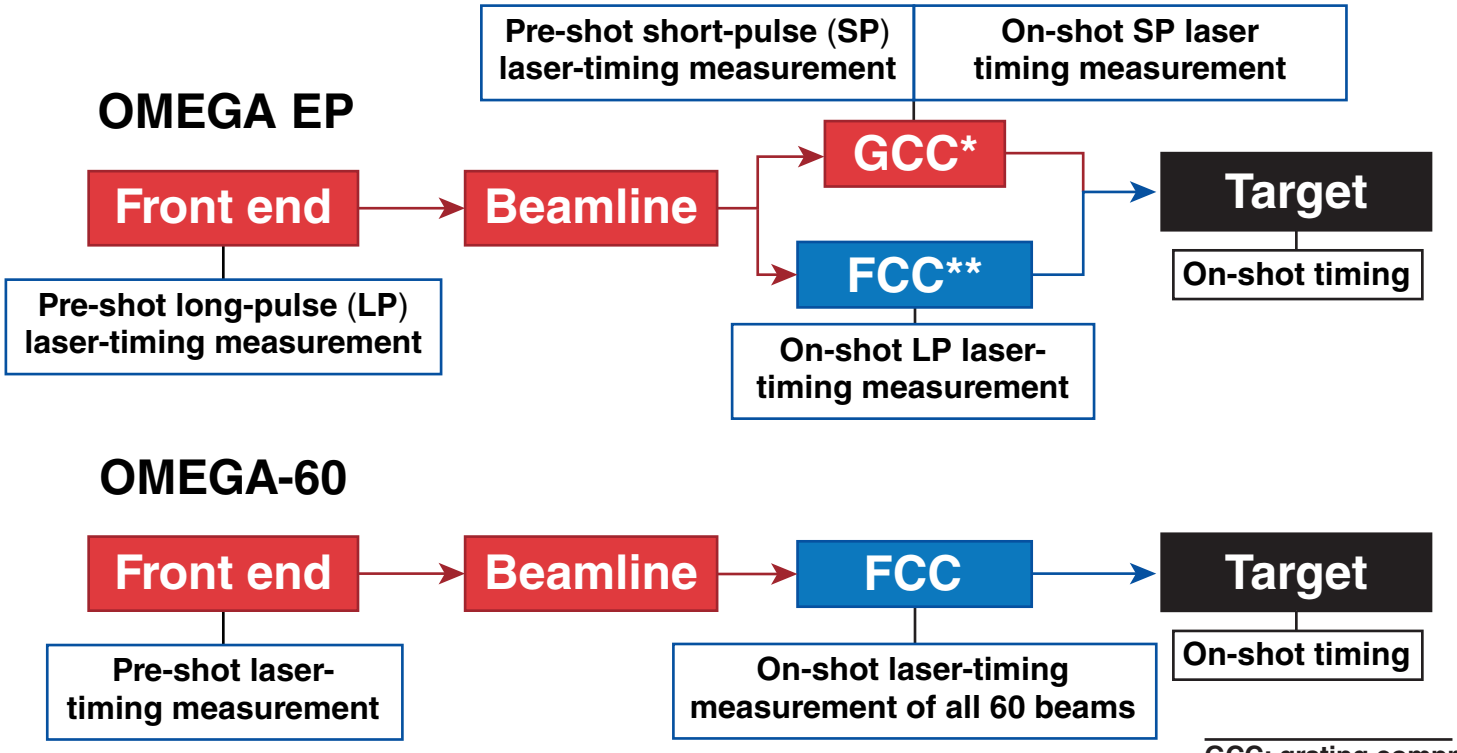

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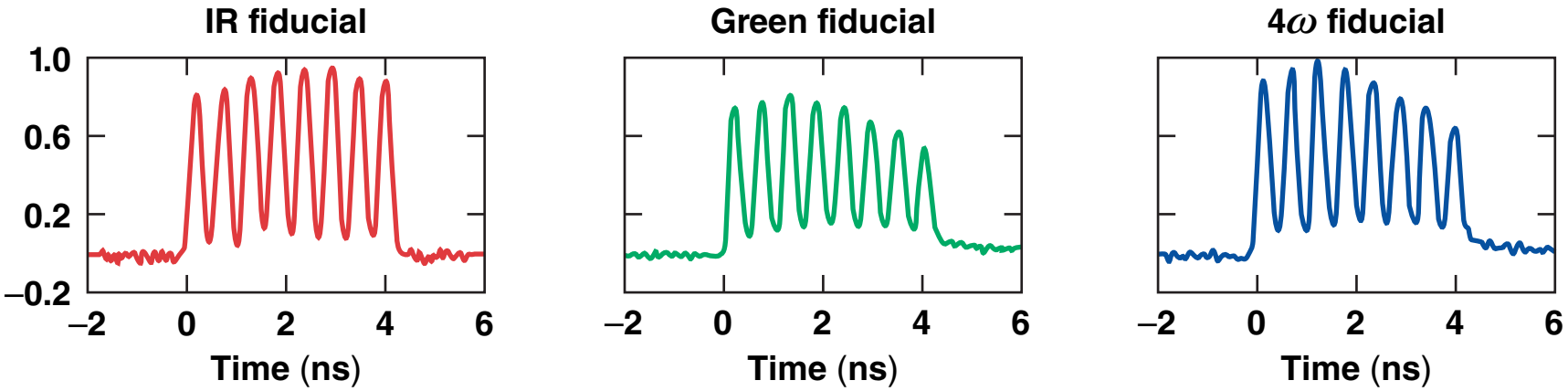

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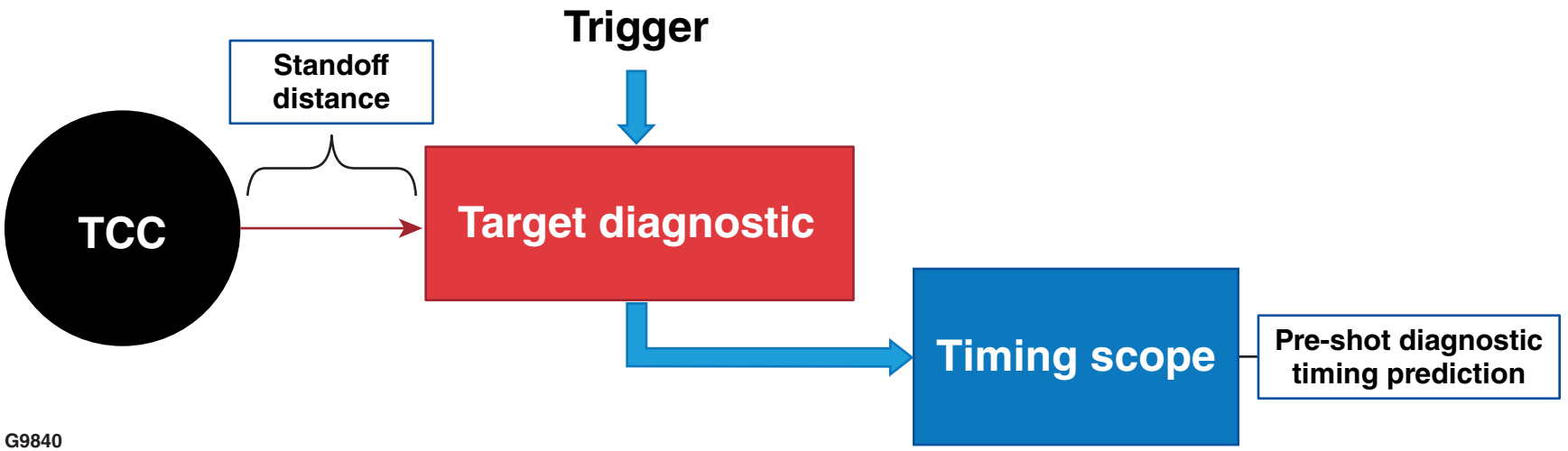

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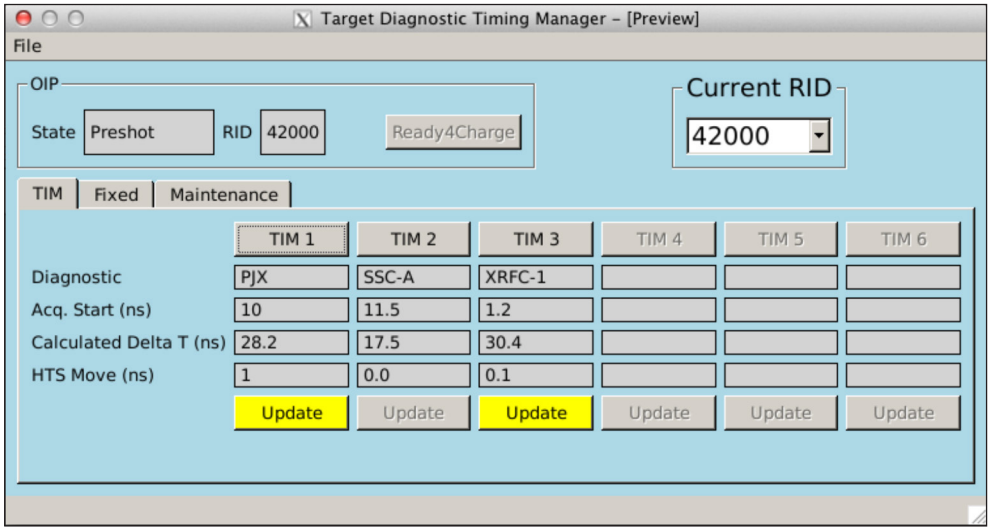

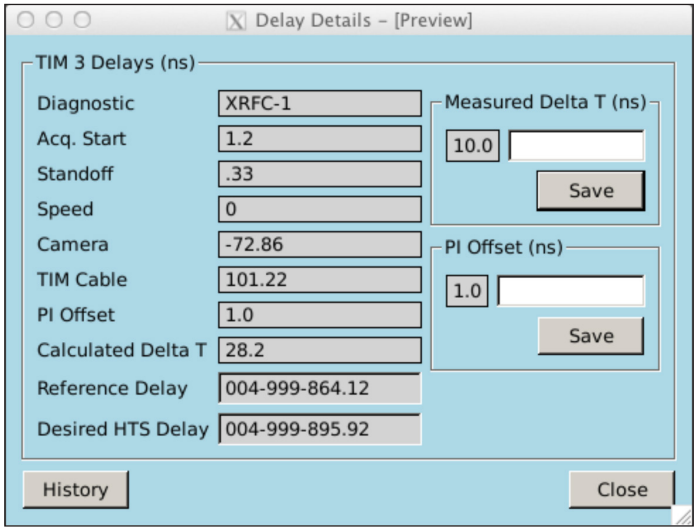

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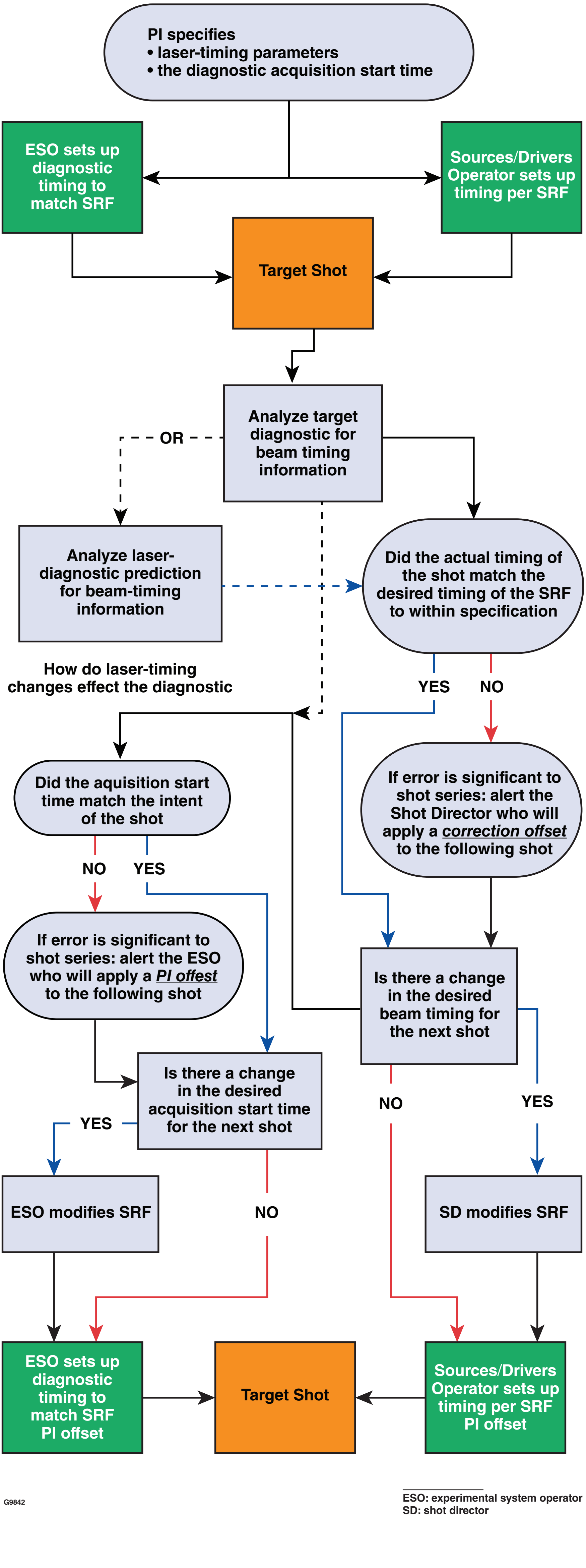

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