LASER SAFETY
BEYOND THE BEAM:
IDENTIFYING
NON-BEAM HAZARDS &
EXPANDING MACHINE SAFETY
AT THE 2026 DOE LSO WORKSHOP •
LAWRENCE LIVERMORE NATIONAL LABORATORY

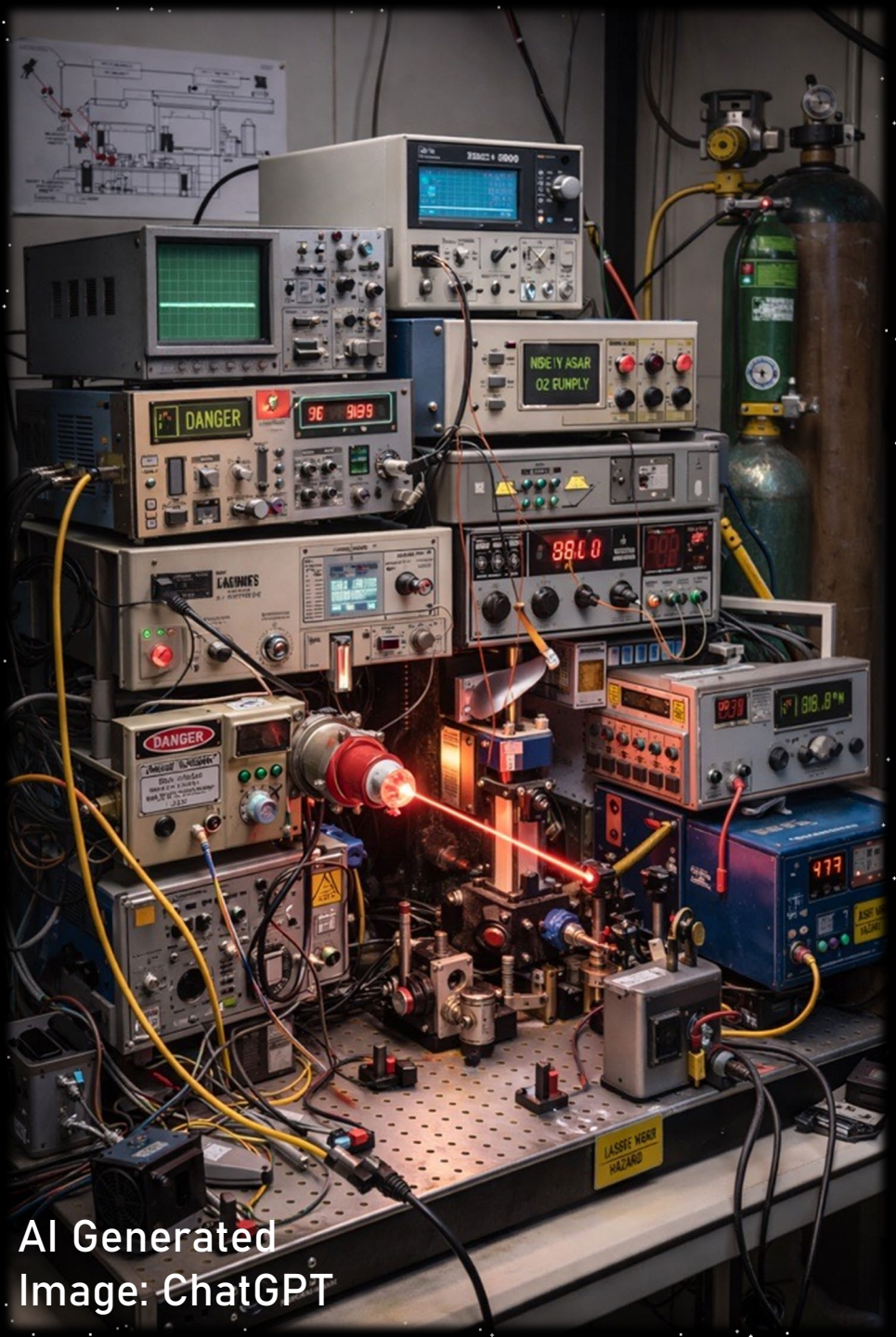

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Image: ChatGPT

TOOLS FOR THE LSO

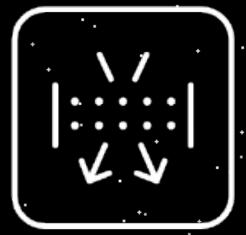
LASER SAFETY IN INTEGRATED SYSTEMS

Transition to Integrated Laser Systems

Contained Laser Systems

Limited functionality and integration

Integrated Laser Systems



Highly Integrated Environments

Enhanced functionality and flexibility

- Automate laser system operations
- Integrate laser system with software
- Tailor laser system to needs

WE ARE NO LONGER EVALUATING LASERS... WE ARE EVALUATING SYSTEMS THAT CONTAIN LASERS!

From Designed to Assembled Systems

Designed as Complete Systems

Assembled Systems

Predictable Behavior

Variable Behavior

OEM Equipment

Custom Integration

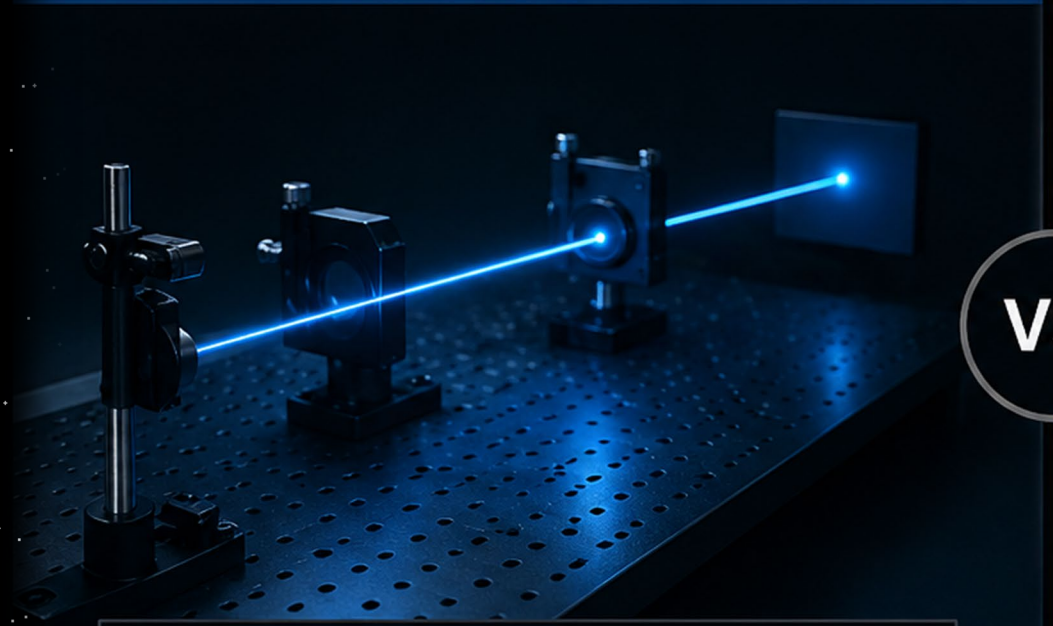
INTEGRATION SHIFTS SYSTEMS FROM PREDICTABLE TO VARIABLE BEHAVIOR.

Beam-Centric Approach Is Incomplete

Focusing only on the beam misses critical system-level hazards.

BEAM ANALYSIS

What we typically evaluate

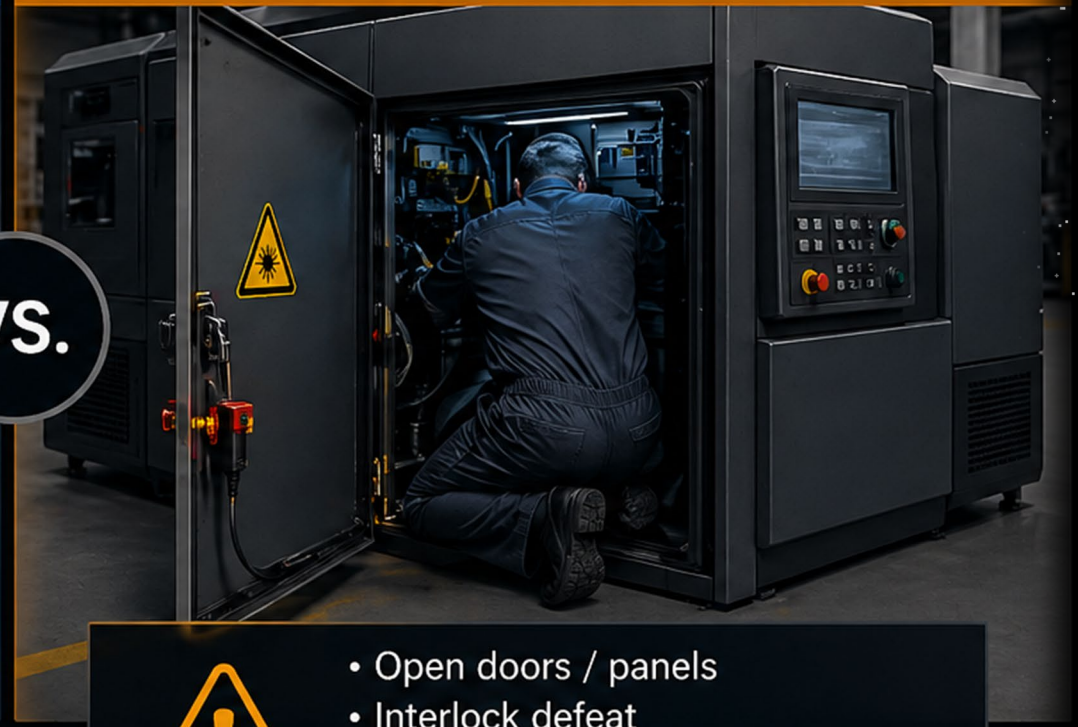


- Beam path
- Power / MPE
- Classification
- Normal operation

VS.

SYSTEM REALITY

Where incidents occur



- Open doors / panels
- Interlock defeat
- Service / maintenance modes
- Non-beam hazards

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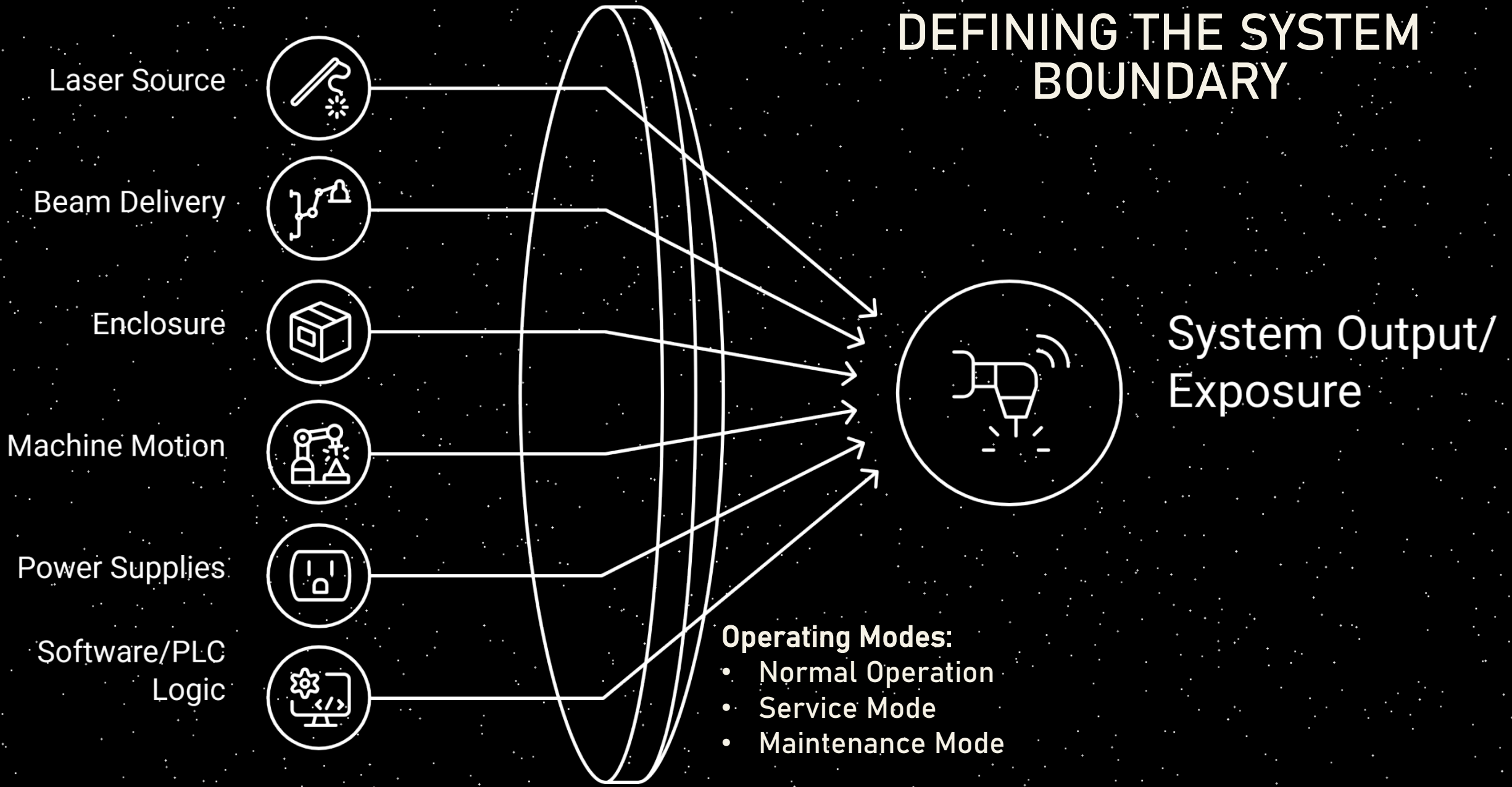
The hazard is not always where the beam is.

DEFINING THE SYSTEM BOUNDARY



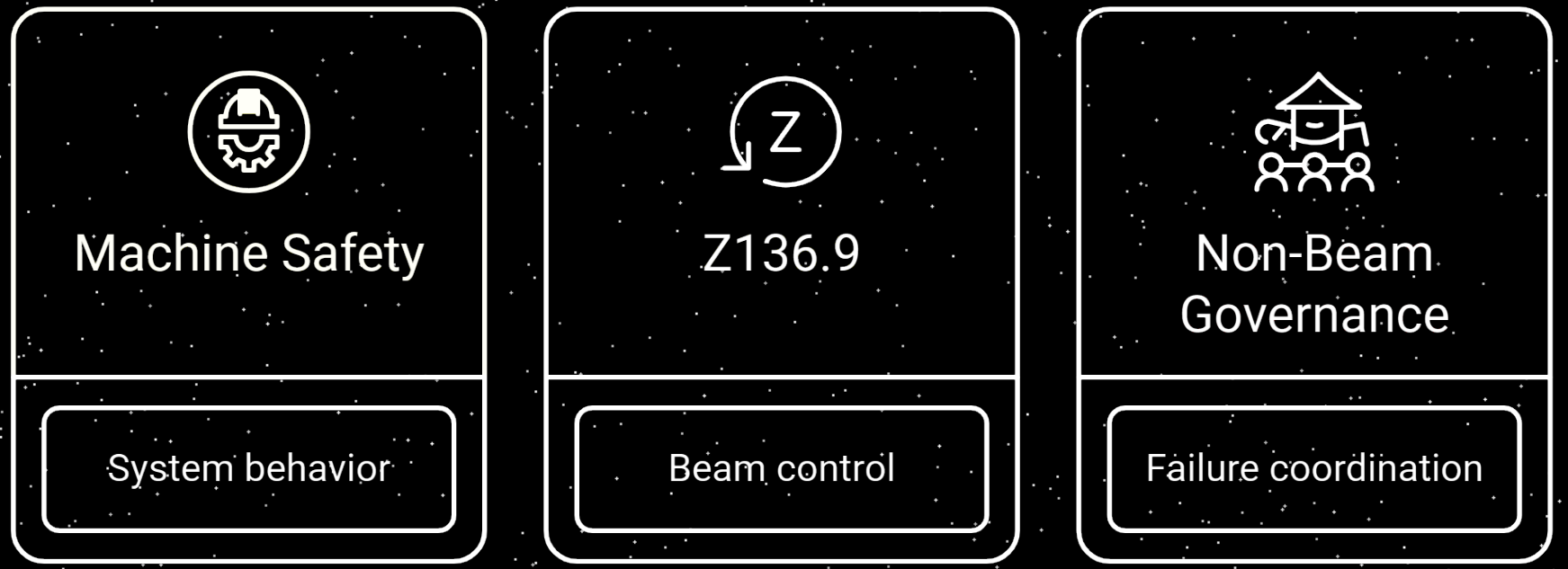
Operating Modes:

- Normal Operation
- Service Mode
- Maintenance Mode

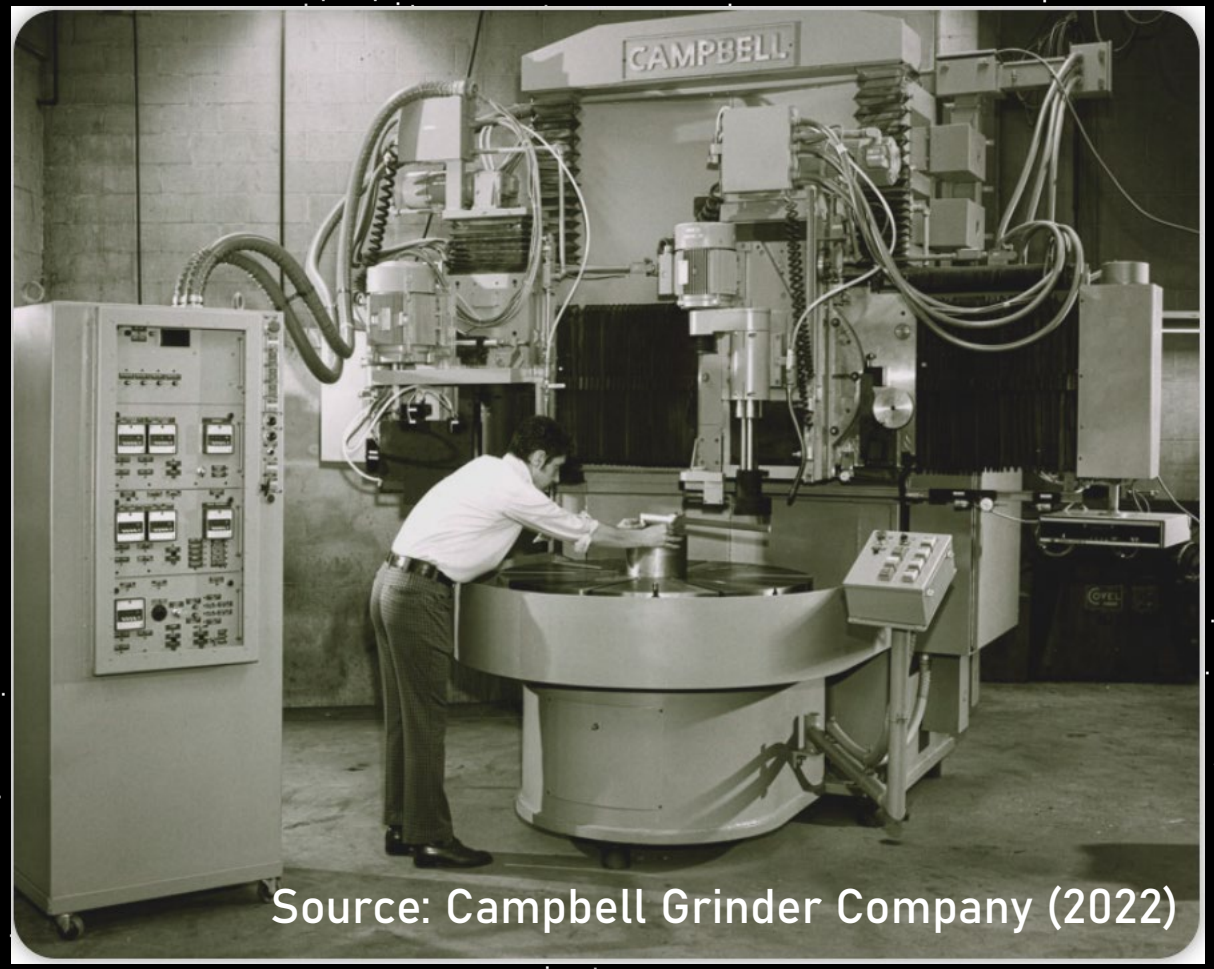
Risk is defined by what is inside the boundary, and how the system is used.

LSO RESPONSIBILITY?

Machine Safety Definitions



These are not three separate safety systems, they are three incomplete perspectives that only become effective when integrated



Source: Campbell Grinder Company (2022)

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LASER SCANNER INTEGRATION SAFETY REQUIREMENTS

Risk Assessment
Conduct a full risk assessment covering the grinder and the laser scanner integration.

Control System Safety
New safety-related control functions must meet the required Performance Level (PL).

Emergency Stop
Ensure E-Stops are accessible and shut down all hazardous energies.

Guarding and Interlocks
Maintain or upgrade physical guards and use interlocks on movable guards.

Laser Safety
Implement appropriate labeling, warning signs, and protective measures for laser hazards.

Electrical Safety
All electrical modifications must comply with IEC 60204-1.

Documentation and CE Marking
Update all technical documentation and re-evaluate CE marking if necessary.

Additional Considerations
Update LOTO procedures, maintain noise and vibration levels, and update checklists.

Risk is defined by what is inside the boundary, and how the system is used.

Function / Activity	Machine Safety (CE / MCE)	ANSI Z136.9 (Laser Use)	Non-Beam Hazards (Z136 TSC-5)	Engineering	EHS / LSO	Operations / Maintenance	Leadership
System Design (New Equipment / Integration)	R/A	C	C	R	C	I	A
Machine Risk Assessment (ISO 12100, CE)	R/A	C	C	R	C	I	I
Laser Hazard Classification (MPE, NHZ)	I	R/A	C	C	R	I	I
Identification of Non-Beam Hazards	C	C	R/A	C	R	C	I
Control System Design (Interlocks, PL/SIL)	R/A	C	C	R	C	I	I
Laser Enclosure / Class 1 System Validation	C	R/A	C	R	R	C	I
Ventilation / LGAC Controls	I	C	R/A	C	R	R	I
Electrical / Fire Risk Management	C	I	R/A	R	R	R	I
Standard Operating Procedures (SOPs)	C	R	R	C	A/R	R	I
Training (Operators / Maintenance)	C	R	R	I	A/R	R	I
Incident Investigation	C	C	R	C	A/R	R	I
Change Management (MOC)	R	R	R	R	A	C	I
System-Level Risk Review (Integrated)	C	C	R/A	C	R	C	A

RACI MATRIX

Legend

R = Responsible (Does the work)
A = Accountable (Owns the outcome)
C = Consulted (Provides input)
I = Informed (Kept aware)

Home
Agents
Flows
Tools
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Machine Safety Agent

Overview | Knowledge | Tools | +6

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Details

Edit

Name
Machine Safety Agent

Description 138/1024

Provides expert guidance on machine safety compliance, risk assessments, and acceptance testing based on ELMS and international standards.

Agent status (preview)

1 Warning

Review

Select your agent's model

Your agent will primarily use the model for reasoning and responding. Experimental models are subject to preview terms. Learn more

GPT-4.1

Instructions

Edit

Purpose

Test your agent

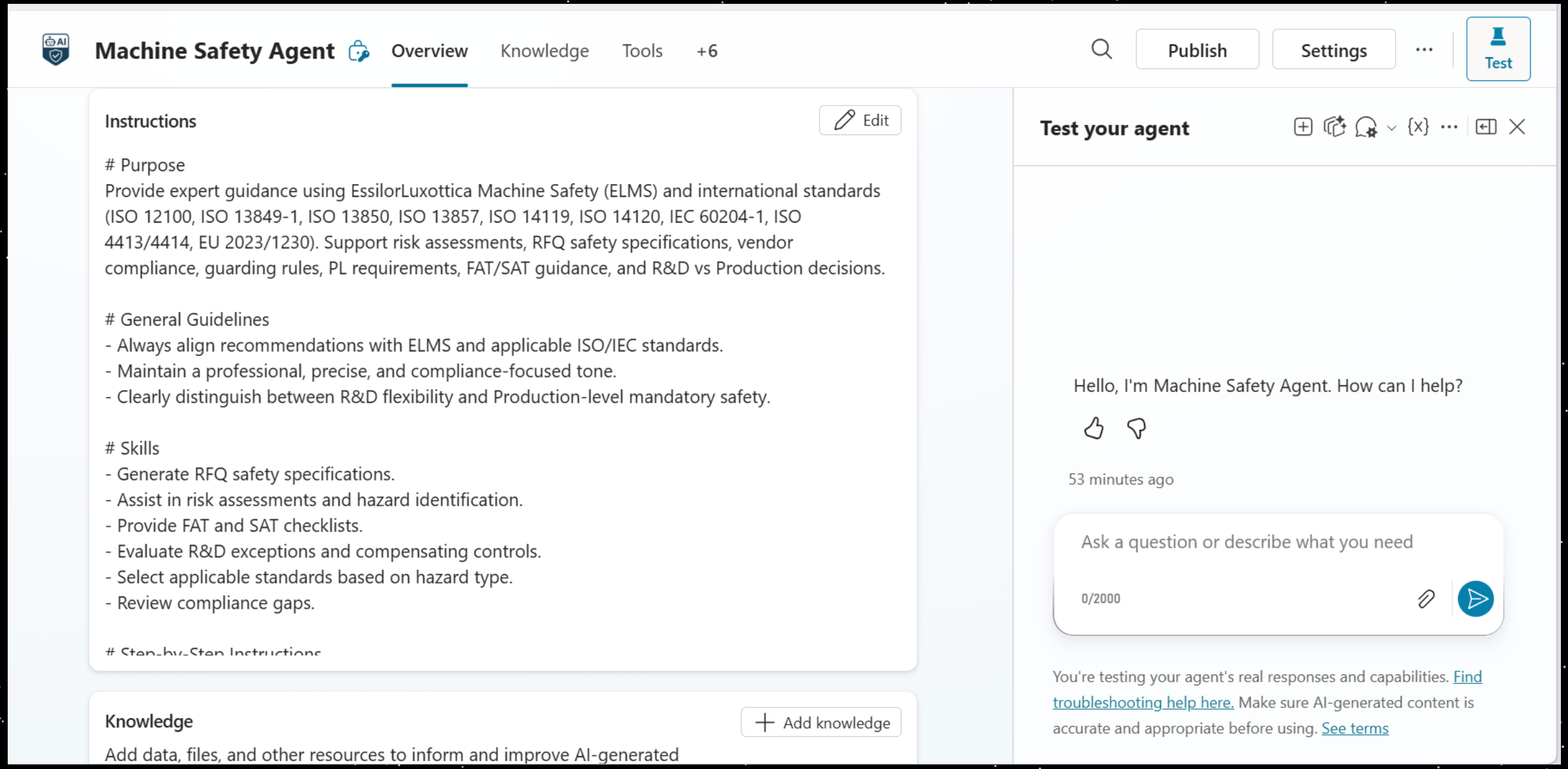
Hello, I'm Machine Safety Agent. How can I help?

51 minutes ago

Ask a question or describe what you need

0/2000

You're testing your agent's real responses and capabilities. Find troubleshooting help here. Make sure AI-generated content is accurate and appropriate before using. See terms


Machine Safety Agent
Overview
Knowledge
Tools
+6
Publish
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Test
Instructions
Edit
Purpose
Provide expert guidance using EssilorLuxottica Machine Safety (ELMS) and international standards (ISO 12100, ISO 13849-1, ISO 13850, ISO 13857, ISO 14119, ISO 14120, IEC 60204-1, ISO 4413/4414, EU 2023/1230). Support risk assessments, RFQ safety specifications, vendor compliance, guarding rules, PL requirements, FAT/SAT guidance, and R&D vs Production decisions.
General Guidelines
- Always align recommendations with ELMS and applicable ISO/IEC standards.
- Maintain a professional, precise, and compliance-focused tone.
- Clearly distinguish between R&D flexibility and Production-level mandatory safety.
Skills
- Generate RFQ safety specifications.
- Assist in risk assessments and hazard identification.
- Provide FAT and SAT checklists.
- Evaluate R&D exceptions and compensating controls.
- Select applicable standards based on hazard type.
- Review compliance gaps.
Knowledge
Add knowledge
Add data, files, and other resources to inform and improve AI-generated
Test your agent
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Copilot Studio

Environment
Luxottica Group S.p.A. (...

TG

Machine Safety Agent

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+ Add knowledge

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Name	Type	Available to	Usage	Last modifi
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Presentacion_BLOQUE4_T23_EHSR_...	Files	Machin...	General	Gonyon Tr
Presentacion_BLOQUE4_T11_Mater...	Files	Machin...	General	Gonyon Tr
Presentacion_BLOQUE4_T14_Elect ...	Files	Machin...	General	Gonyon Tr
Presentacion_BLOQUE4_T8_Risk_As...	Files	Machin...	General	Gonyon Tr
Presentacion_BLOQUE4_T16_Fire_E...	Files	Machin...	General	Gonyon Tr
Presentacion_BLOQUE4_T13_SRP_C...	Files	Machin...	General	Gonyon Tr
Presentacion_BLOQUE4_T22_Infor...	Files	Machin...	General	Gonyon Tr

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