Design of a Radiation Tolerant Profile Monitor for the LCLS Electron Beam

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Introduction

The Linac Coherent Light Source (LCLS) electron beam can damage YAG:Ce scintillation screens. After one year of use, the existing profile monitor screen has diminished fluorescence. The decrease in performance has resulted in distorted beam images which can compromise the acquired beam data.

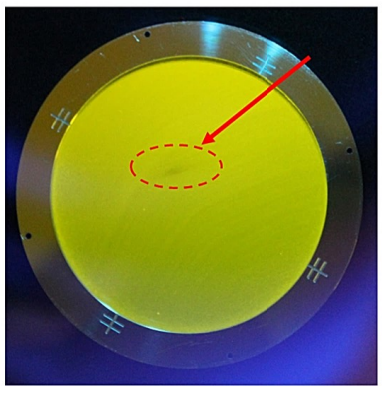
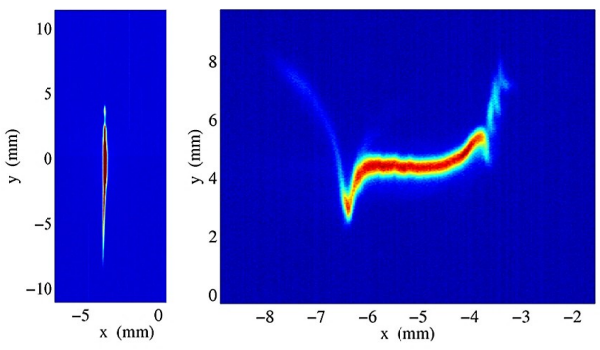


Photo of YAG damage illuminated by blue LED illuminator

Device Background

PURPOSE	Image transversely kicked beam
LOCATION	Upstream of e⁻ beam dump
BEAM INTENSITY	1.5-2.0 pC /pulse @ 120 Hz
DAMAGE	1 month (initially) and 10-12 months (retracting YAG screen)

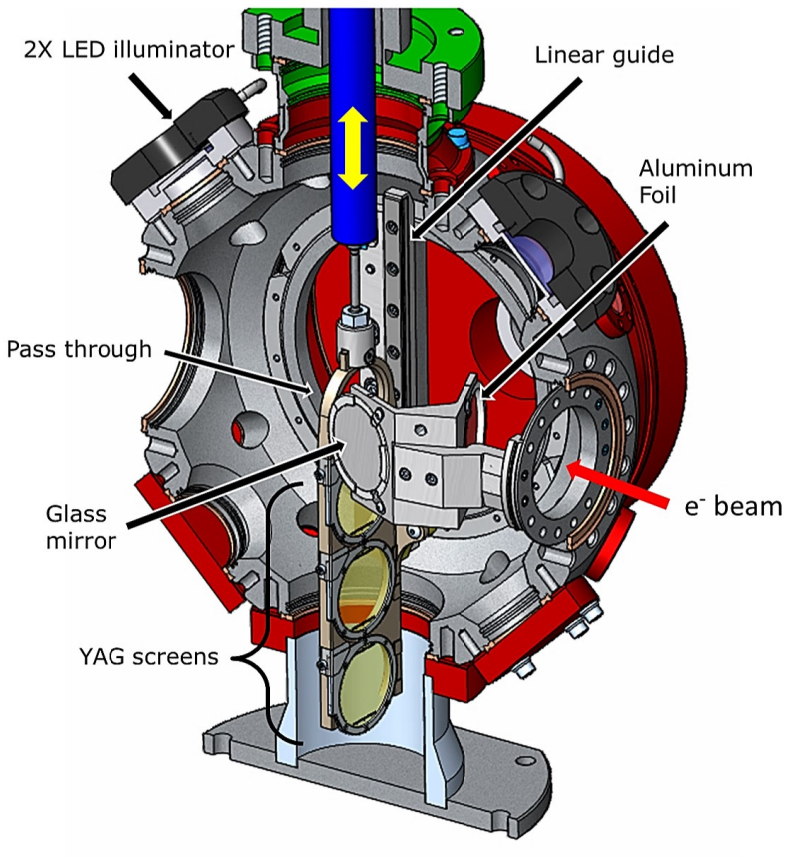


Nominal beam profile (left) and profile after passing through a transverse accelerating radio frequency (RF) cavity.

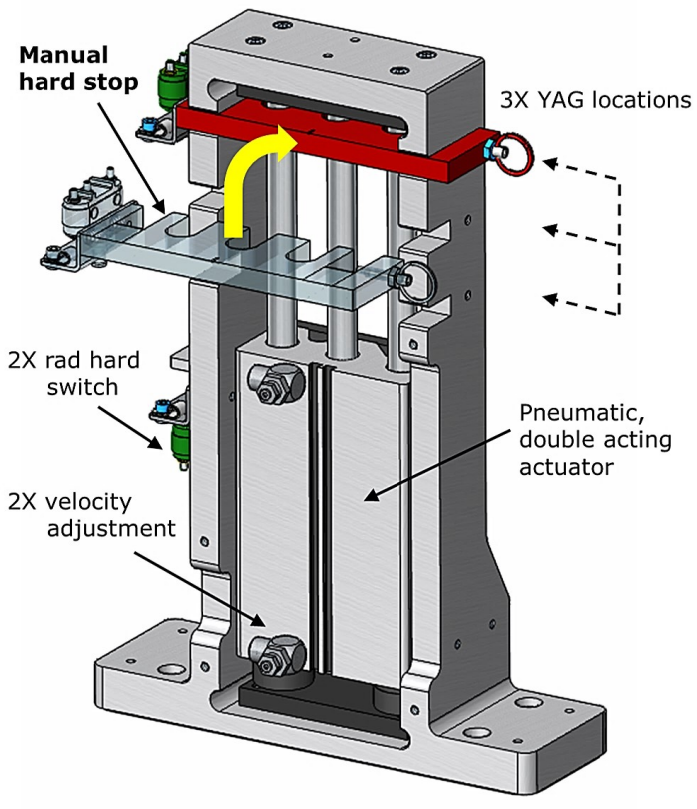
Design Requirements

1. Multiple YAG screens to increase service interval period.
2. Immediate operation after installation. Use proven geometry to direct the COTR away from the camera.
3. Fail out of the beam.
4. Easily removable YAG screens.
5. In situ damage assessment

Motion



Isometric cross section showing internal components.



Actuator assembly using a 2-position pneumatic actuator to achieve 4 total positions.

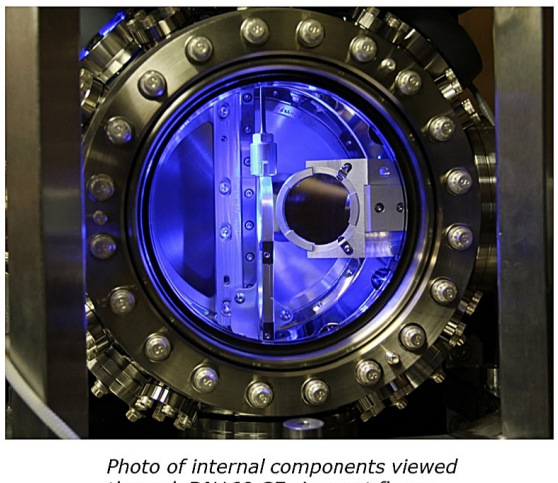


Photo of internal components viewed through DN160 CF viewport flange.

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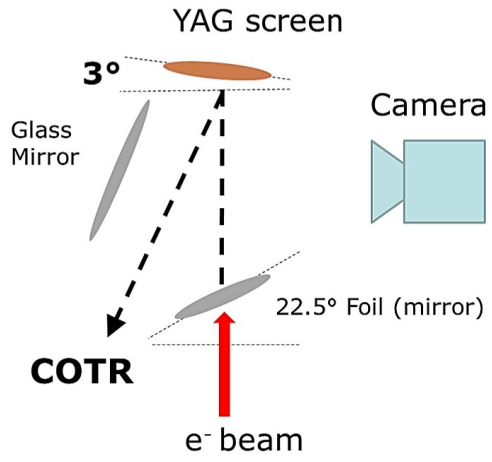
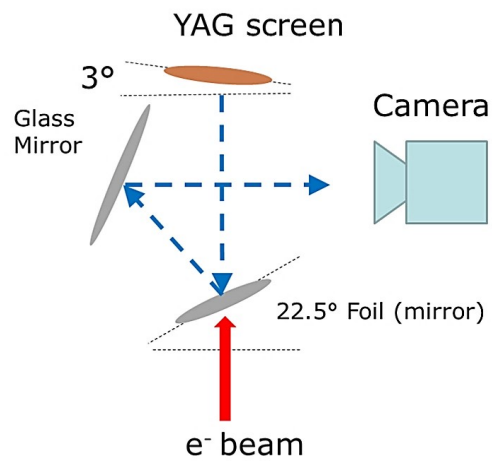
Optics

YAG Screens

MATERIAL	YAG: Ce
DIMENSIONS	Ø 40 mm, 50 um thick
ASSEMBLY	• Bonded to keyed YAG frame • Held in place by screw & clip
LOCATION ADJUSTMENT	Coupler rod – RH & LH threads
FEATURES	Chrome scale, scribe mark (frame)



Orientation of YAG screen to direct COTR away from optical path of camera.



Optical path of YAG fluorescence to camera.

Conclusion

We have designed a reliable indexing profile monitor that has increased the service interval period from 1 year to 3 years with improved serviceability. The device was successfully installed on the LCLS beamline in August 2017 and is currently performing beyond expectations.

Multiple features of the previous design were improved upon from multiple YAG screens with a pneumatic actuator, ease of YAG replacement, optics to mitigate COTR light and YAG inspection methods.

Acknowledgments

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