LCLS Physics Requirements Document # 1.3-020	Linac	Revision 1

PHYSICS SPECIFICATIONS FOR THE LINAC OTR PROFILE MONITORS

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Brief Summary:
This document describes the location and performance requirements for the linac beam profile monitors using optical transition radiation (OTR) from a metal screen.

Change History Log:

Rev Number	Revision Date	Sections Affected	Description of Change
000	Feb. 16, 2006	All	Initial Version
001	Dec. 14, 2006	All	Added OTR22, updated Table 1

Physics Specifications for the Linac OTR Profile Monitors

This document gives the specifications for the 8 OTR profile monitors (view screens) in the linac and is based on the detailed information found in the PRD 1.2-21 [Physics Specifications for the Injector Profile Monitors (YAG & OTR)]. Here only the differences with respect to the injector profile monitors will be documented. The specifications are given in Table 1. All screens are Aluminum.

Table 1.

Numbers for the beam size in brackets refer to special modes of operation and specify the full extend of the beam whereas the numbers without brackets refer to the nominal rms beam size at 1-nC bunch charge. The minimum beam size σ_{min} is for a 0.2-nC charge and refers to the smallest of x or y. $S_{Position}$ is the screen distance from the cathode, and "Direction" specifies either the axis in which the OTR light is reflected or a close-to-normal incidence reflection. "Diameter" is the clear diameter of the foil.

OTR	Reso-lution [μm]	Dia-meter [mm]	Thick-ness [μm]	Nominal Energy [GeV]	Direc-tion	σ_{min} [μm]	σ_x [μm]	σ_y [μm]	$S_{Position}$ [m]
OTR11	25	20	1	0.25	Vertical	75	3800 [16000]	100	34.76
OTR12	13	20	1	0.25	Horizontal	30	40	40 [8000]	41.52
OTR21	15	20	1	4.30	Vertical	35	2600 [13000]	50	411.2
OTR22	15	20	1	4.82	Horizontal	45	75	60	460.6
OTR_TCAV	15	20	1	5.88	Horizontal	35	50	70 [1500]	523.2
OTR30	5	20	1	13.64	Normal	15	20 [1000]	25 [1000]	1328
OTR33	13	20	1	13.64	Horizontal	30	40	40 [1000]	1463
OTRDMP	20	20	1	13.64	Horizontal	60	75	60 [600]	1756

Optics and Camera

The standard optical setup and CCD camera used for many of the beam profile monitors in the injector (e.g. OTR3) will be used for all linac profile monitors (Fig. 1). The exception is OTR30 which requires a special design to achieve the focused field of view and resolution for this location. The beam splitter shall reflect about 90% of the light to maximize the amount of OTR light in the CCD and still enable to view the reticule. The strong synchrotron radiation background [1] at OTR11 and OTR21 shall be reduced by either a polarization sensitive beam splitter which transmits the horizontal and reflects the vertical polarization with a contrast of better than 20:1 or a polarization filter. Remote control is required for filter selection and illumination.

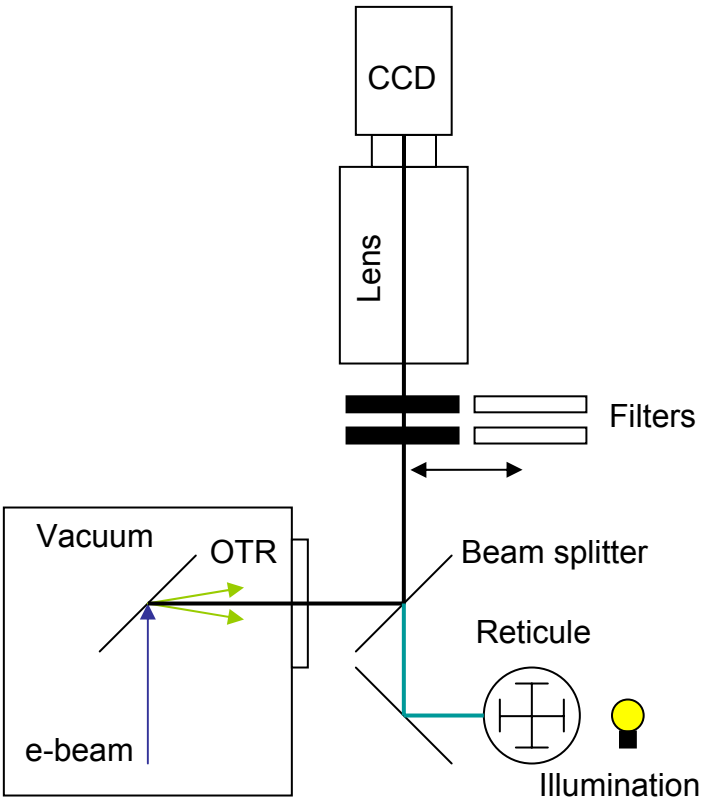

Figure 1: Layout of the OTR beam profile monitor.

OTR_TCAV

The OTR_TCAV profile monitor will be used in a pulse stealing mode where the beam is horizontally kicked with the kicker BXKIK [2] upstream of the transverse cavity TCAV3 [3]. The OTR foil will be located off-axis (Fig. 2) with an adjustable horizontal position, including full retraction capability. The foil will be mounted at 45 degree to the beam to reflect the light horizontally. The edge of the foil mount will have a minimum 4-mm stay clear to the nominal beam axis. The foil mount shall be small enough to enable a pass through of the kicked beam 7 mm off axis. The diameter of the foil will be 20 mm to get a large enough vertical field of view for the calibration procedure of the transverse cavity.

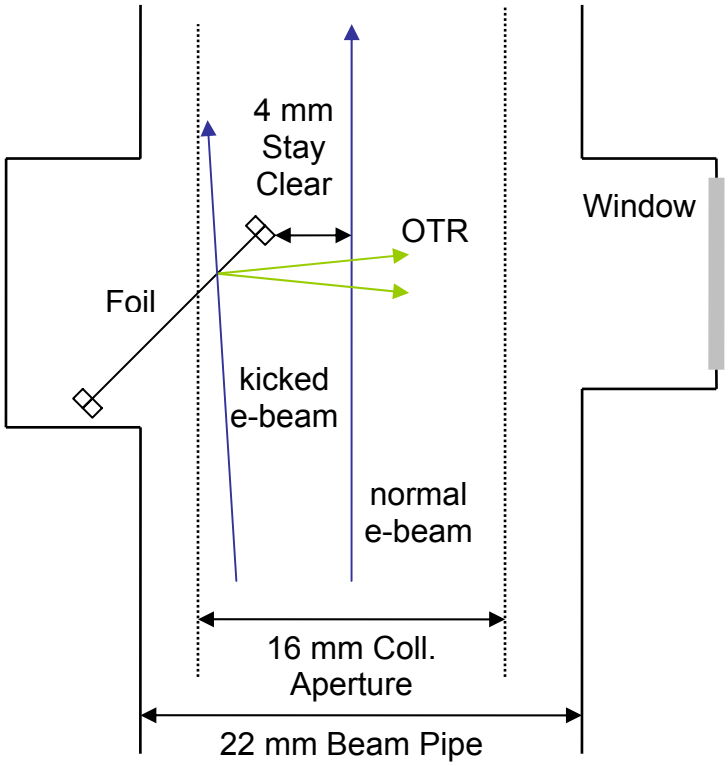

Figure 2: Layout of the Vacuum chamber for the OTR_TCAV beam profile monitor.

OTR30

The resolution requirement for OTR30 can not be met over the full extent of the beam with a 45 degree foil angle. The foil shall therefore have an angle of less than 15 degree with respect to the beam axis and the OTR light shall be sent out of the vacuum chamber with an in-vacuum mirror leaving at least 8 mm stay clear for the electron beam. The in-vacuum path length shall not exceed 90 mm. A schematic of the setup is shown in Fig. 3. The imaging optics including the vacuum window shall provide the required resolution of 5 μm with a fixed 1:1 magnification within a 5-mm by 5-mm field of view. The distance of the lens to the foil needs remote adjustment. The CCD will be tilted at the same angle as the foil. (Alternatively, the in-vaccum mirror can be an off-axis paraboloid with an accompanying paraboloid to focus the light back into the CCD.)

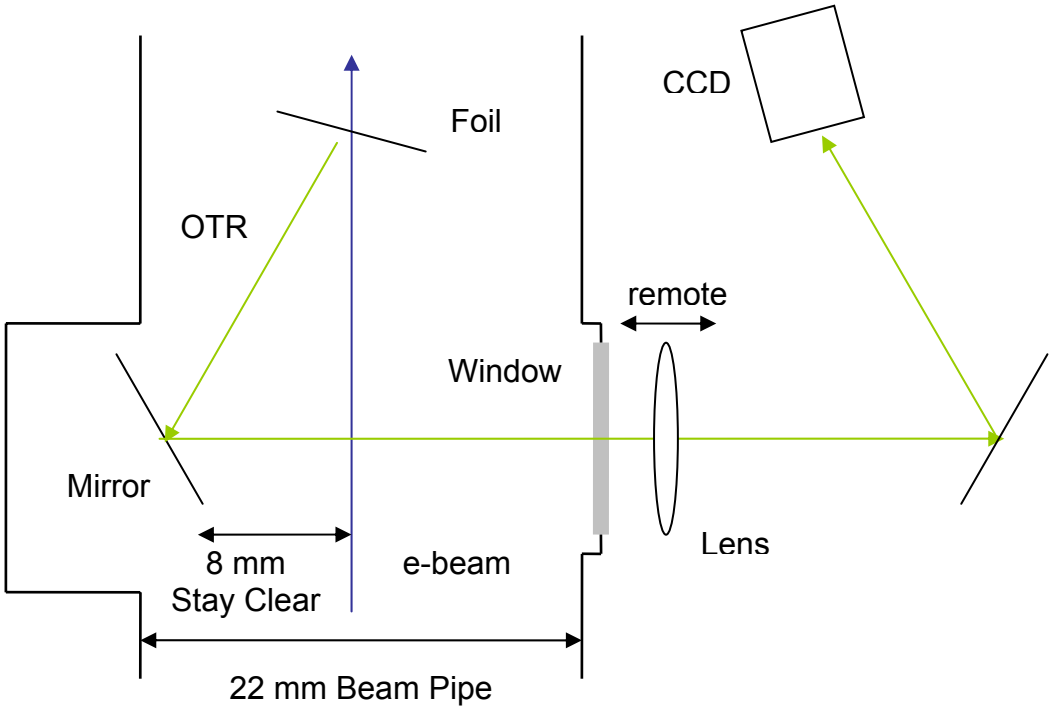

Figure 3: Layout of the Vacuum chamber for the OTR30 beam profile monitor.

Wakefield Mitigation
No wakefield mitigation is required for the profile monitors in the linac.

Radiation Shielding
The radiation background during LCLS operation of the linac is expected to be low enough to cause no damage to the CCD and optical elements, even with the profile monitors inserted, due to the use of thin foils. However, sufficient shielding of the CCD and the optics for OTR11 through OTR_TCAV is required to prevent damage during non-LCLS operation. The CCD and the optics might be removed from the tunnel for special linac operations requiring very high charge, such as used during the E-158 experiments.

References
[1] H. Loos, Synchrotron Radiation Background in OTR Beam Profile Measurements for LCLS, in preparation.
[2] PRD 1.3-015, http://www-ssrl.slac.stanford.edu/lcls/prd/1.3-015-r1.pdf.
[3] PRD 1.3-011, http://www-ssrl.slac.stanford.edu/lcls/prd/1.3-011-r2.pdf.