Some new thoughts concerning the SR- Monitor at 95 m for the LUMI upgrade

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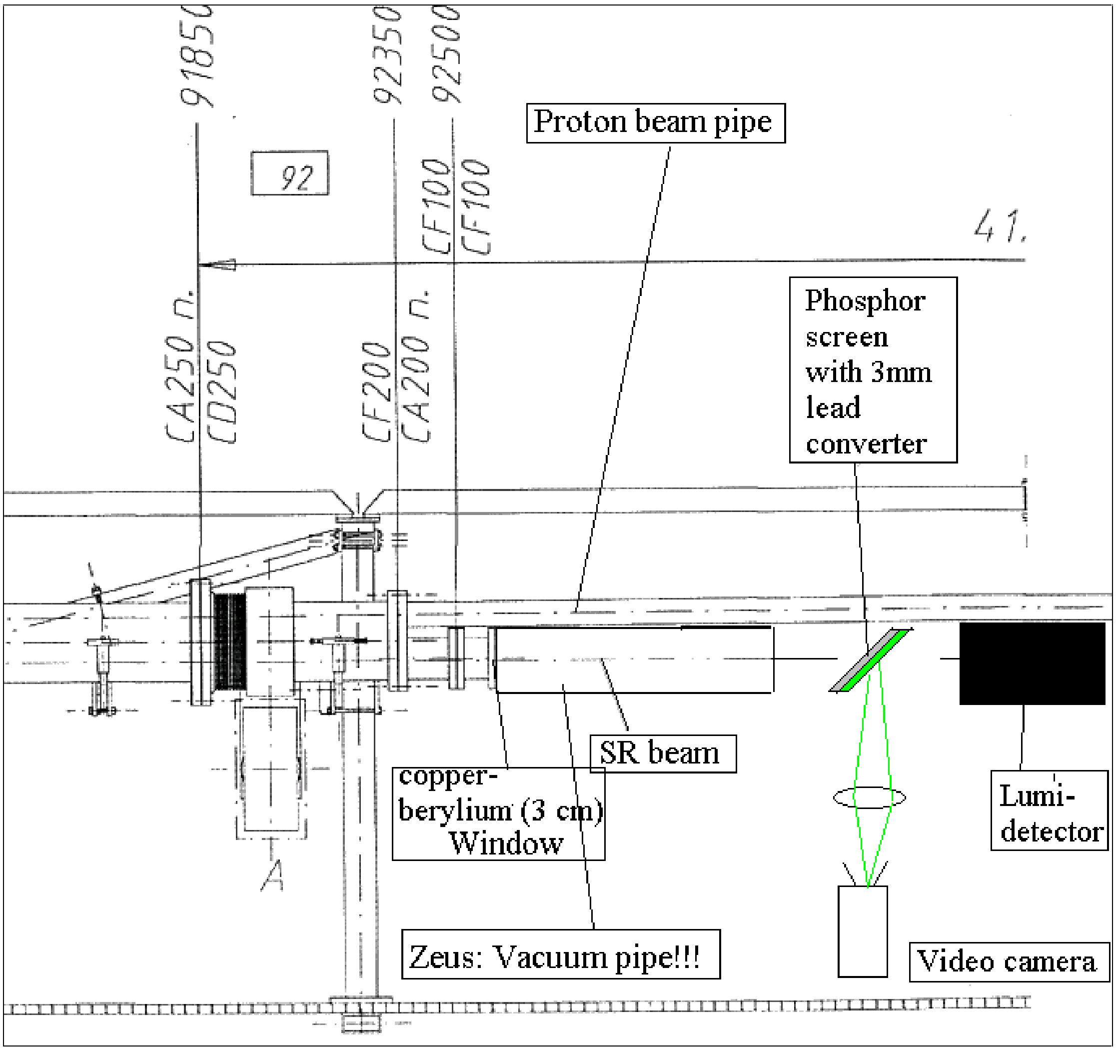

Fig. 1) Sketch of the monitor

Introduction

The synchrotron radiation (SR), which is emitted near the IP in proton direction and the Bremsstrahlung from the IP, will leave the beam pipe after the vertical bend of the proton beam at about 90 m at a special window. The Bremsstrahlung photons have energies up to some GeV while the SR has a critical energy of about 160 keV. Fig. 2 a, b shows the distribution of the critical energy E_{cri} at 99 m. E_{crit} is the usual critical energy of the SR and is define by:

$E_{crit} = \hbar\, 2/3\, \gamma 3\, c/R$, R = bending radius.

Fig. 3 shows the predicted distribution of the photons at the monitor.

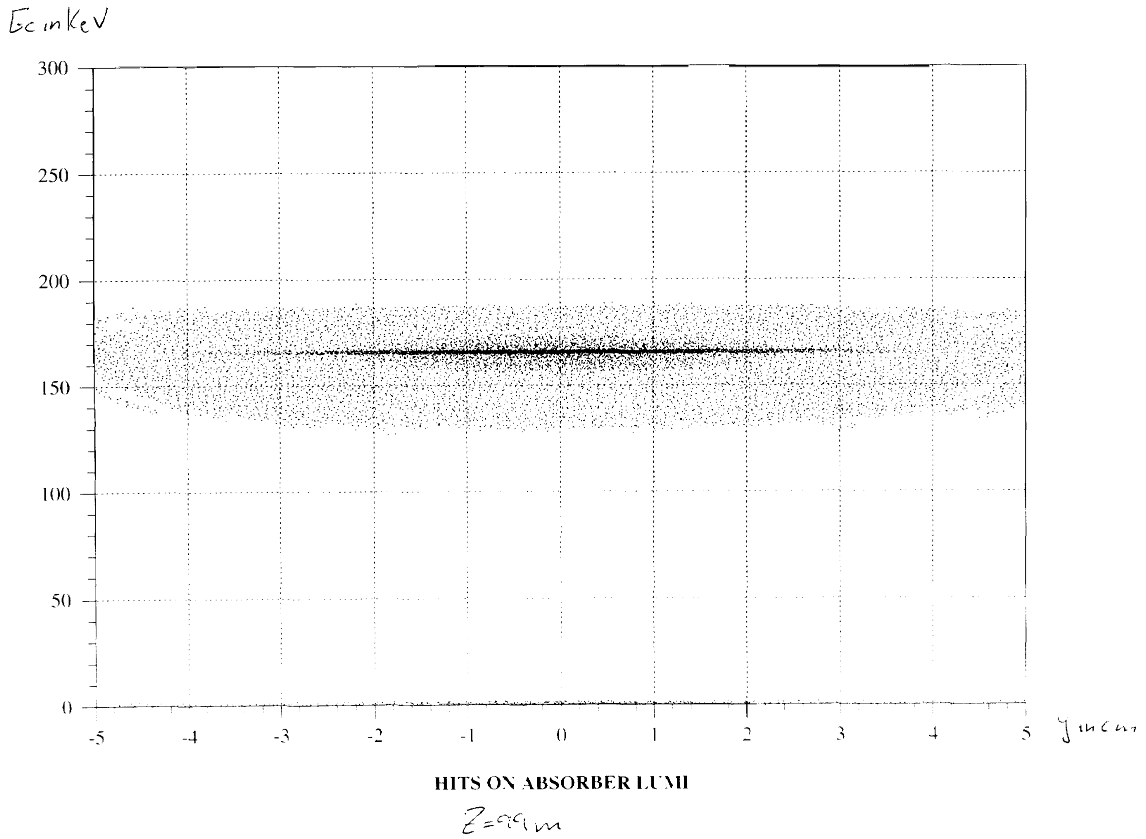

Fig. 2 Critical energy E_{crit} versus position at the SR-monitor (y = vertical) by A. Mesek
The critical energy divides the power spectrum into two equal half's.

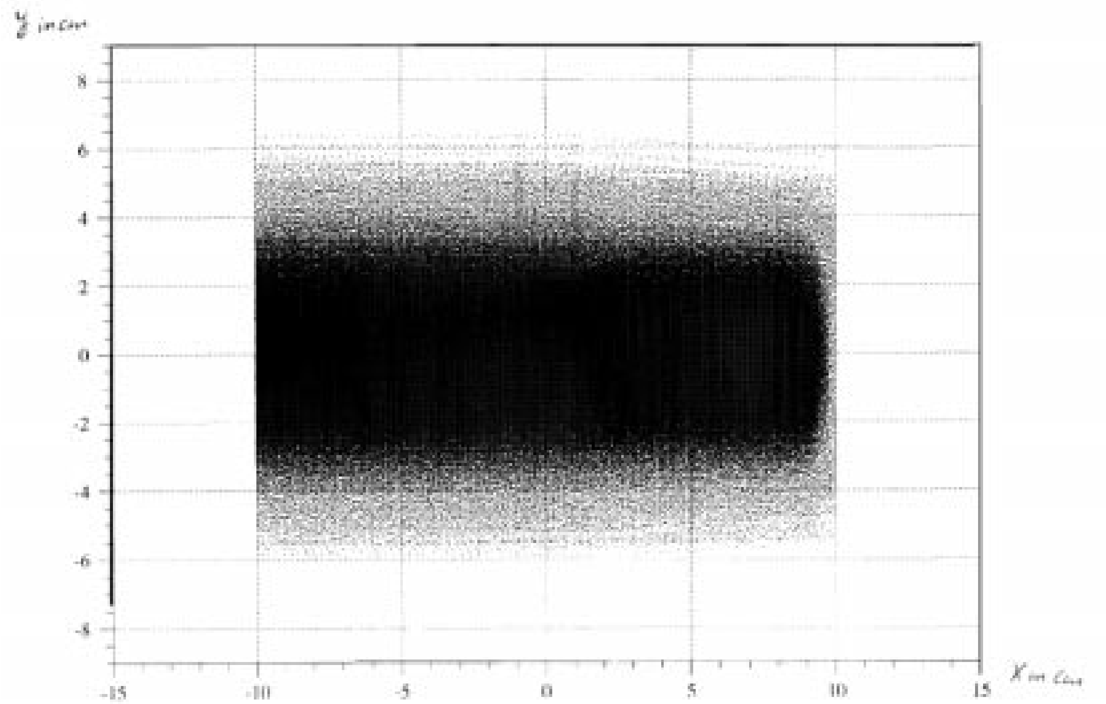

Fig 3: Photon distribution at the monitor; by A. Mesek

The main part of the SR photons will be absorbed in the vacuum window (Radiation length l_{rad} = 0.2, for upgrade: l_{rad} = 0.4; material: Copper – Beryllium) and only the high-energy part of the spectrum can be used for the diagnosis of the beam near the IP. In this case, the idea of "photo current fingers"

like the monitor at 25 m (Ref. 1) will not work, because the efficiency of the photoeffect is very small at high photon energies (Ref. 2).
The new idea is, to make the photon distribution visible by the use of a lead converter and a phosphor screen. The screen will be observed by a video camera. A test at H1 was prepared to proof this idea.
The critical energy of the present SR-photons is E_{crit} = 34 keV[1], and the total energy is E_{tot} / mrad = 2 · 10^5 GeV (Ref. 3) coming from the BH04 dipoles in front of and behind the H1 experiment. After the upgrade: E_{crit} = 115 keV[1], E_{tot} / mrad = 7 · 10^5 GeV (Ref. 3). However, if one can detect a signal with the present parameters, one will have a much higher signal after the Lumi upgrade.

The Test at H1

Fig. 4 shows the setup of the screen installed in front of the H1 Lumi detector (see also Fig. 1). The screen was roughly centered in the vertical plane in respect to the Lumi detector (and therefore we hope it is centered in respect to the SR and to the Bremsstrahlung) We installed the screen horizontally at three different positions, 1. with an offset to the outside of the beam, 2. with an offset to the inside and 3. centered. This was done just to scan a larger area than the sensitive area of the screen.

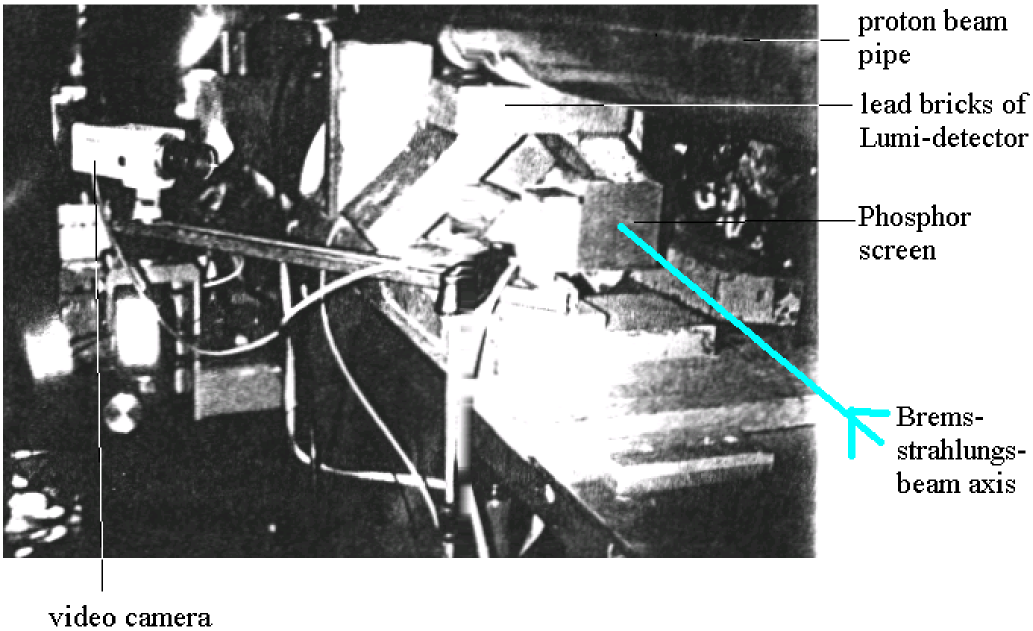

Fig. 4: Experimental setup (by B. Sarau)

Results

1) Signals

Video signals were clearly seen at beam energy of 27.5 GeV and at currents of down to about 9 mA. Two spots left and right from the horizontal center can be observed (Fig. 5). The spots are the result of the SR emitted at the two horizontal bending magnets BH04 near H1 (see chapter: Spots). No additional signal was observable, neither at Lumi-conditions nor at other conditions, meaning that the Bremsstrahlung does not produce any background signals in this measurement. The amount of light produced in the screen was adequate for the video camera, it was not saturated. Therefore there will be enough light after the Lumi upgrade, because of the increase of E_{tot}.

2) Spots

Fig. 5 shows the two observable spots on the screen, together with the different screen positions.

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[1] The bending radius of the BH04 Magnets is 1265 m => E_{crit} = 16 keV(?), Values for 30 GeV!

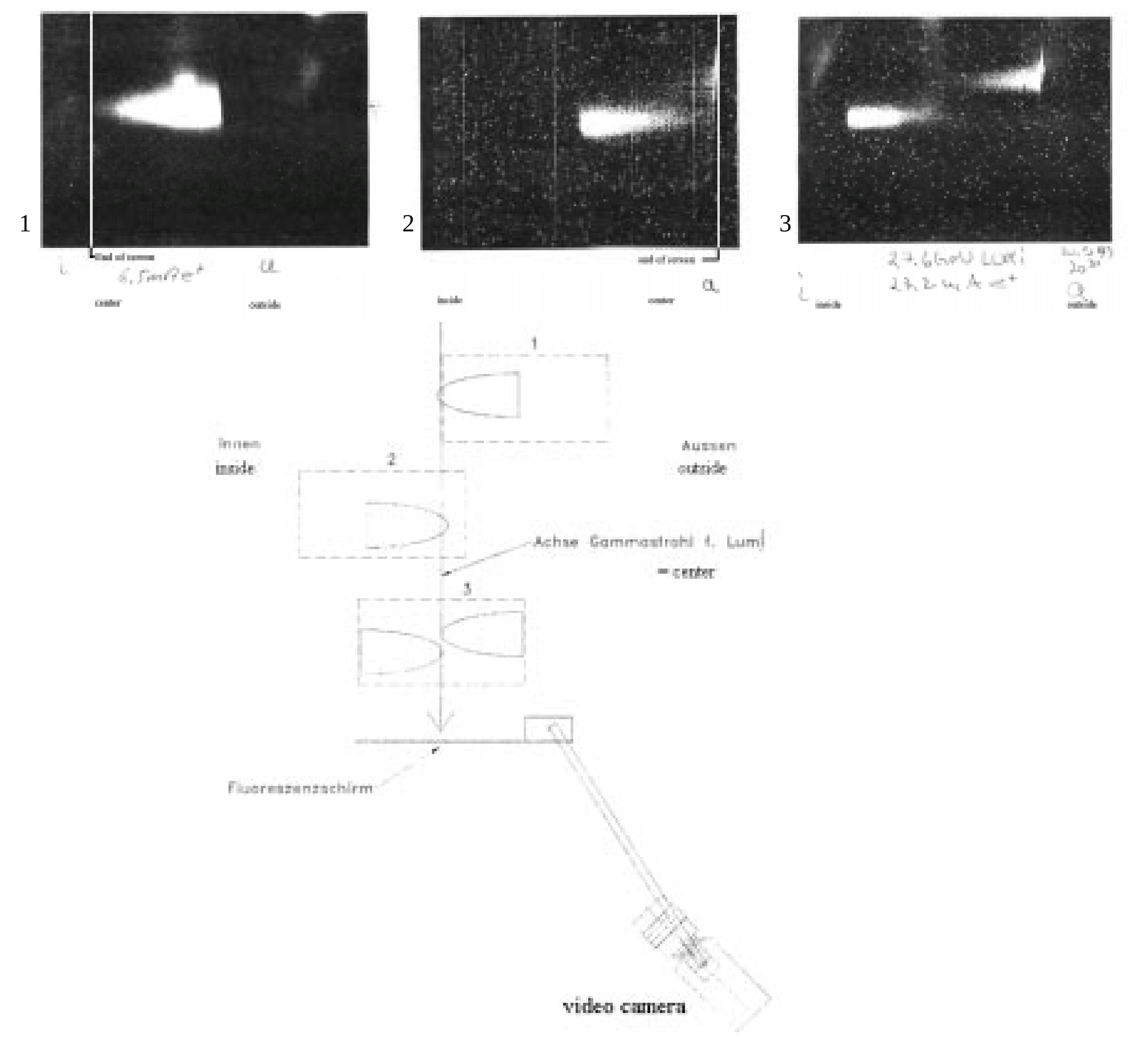

Fig. 5: Observed spots on the screen at different screen positions

The cuts at the far inner and outer sides of the spots are results of the open diameter of the beam pipe. The radiation emitted at larger angles is absorbed in the beam pipe wall. The two spots are assumed to be produced by the two BH04 dipoles in front of and behind H1 at about ± 20 m. The vertical and horizontal offsets between the two spots are results of the additional quadrupoles between the two dipoles, which make additional vertical and horizontal bends. These bends are not strong enough to produce high energy SR photons. After the LUMI upgrade, there will be no Quads between the last dipoles, so that one will observe a homogeneous horizontal distribution (see Fig. 2).
We proof the expectation, that the spots are results of the BH04 dipoles, by driving a symmetric and an asymmetric bump across H1. In the first case the bump changes the angle of the beam at +20 m opposite to the angle at –20 m. The observation on the screen shows a dependence of the vertical offset of the two spots from the bump amplitude. In the asymmetric case, the angels were change in the same direction. The spots on the screen were moved simultaneously in the same direction, depending of the bump amplitude. Both observations are in agreement with the expectation. Fig. 6 shows the symmetric and asymmetric bumps around 20 m.

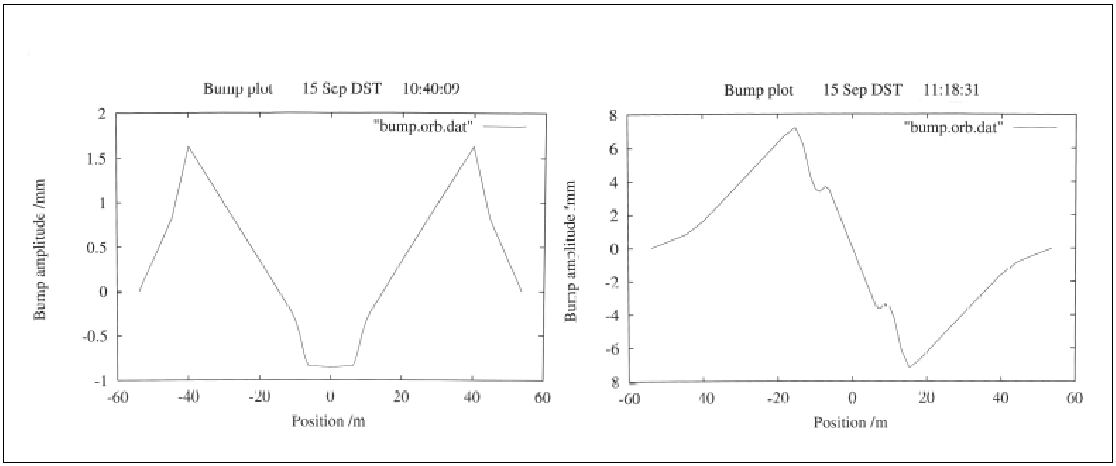

Fig. 6: Symmetric and asymmetric bump at 20 m at H1. The correctors SL54, SL40, SR40 and SR54 were involved. Thanks to Eliana for helping to setup these bumps.

Conclusions

One can clearly observe the Synchrotron light spots from the dipole magnets near the experiments by using a simple phosphor screen behind a 3 mm lead converter. One can expect a larger signal after the Lumi upgrade, because much more photons will reach the screen. Therefore the light collection system must not be designed for very high transmission efficiency. This becomes important for shielding the video camera. Three cameras were destroyed during this experiment over a period of about three month. A much better shielded position far from the beam has to be found.

The additional screen in front of the Lumi detector (3mm lead ≈ 0.5 radiation length X_0) will have a small influence on the detector, but this can be included in its calibration. The detector needs anyhow some radiation length filters in front to prevent it from too much SR (see Fig. 7). To reduce the effect of multiple scattering, the screen (and the filters) has to be installed as close as possible to the Lumi detector. Note that Zeus has and will have an additional vacuum pipe just behind the window up to the first filters in front of the Bremsstrahlung detector (L. Suszycki; Zeus). This pipe may have to be modified to allow the installation of a screen!!!

The bremsstrahlungs photons do not produce a background signal on the screen. Their energies are too high and the quantity is too small.

R. Fischer (MDI) coordinates the construction, fabrication and installation of the setups at H1 and Zeus.

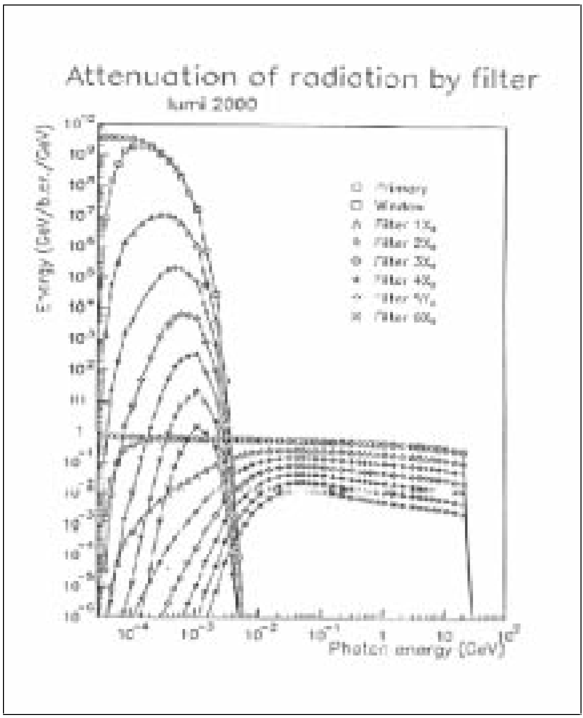

Fig. 7: Influence of material in front of the Lumi detector (from Ref. 3)

Notes

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Zeus: L. Suszycki, U. Schneekloth

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References

Ref. 1) K. Wittenburg, MDI; **Some thoughts concerning the SR- Monitor at 24 m for the LUMI upgrade**; internal MDI note 99-03; 3-Jun-99

Ref. 2) M.A Rumsh and V.N.Shchemelev, **Role of secondary emission phenomena in the x-ray photoeffect in metallic cathodes**; Soviet Physics – Solid Stade, Vol. 5, No. 1 (1993, pp. 46-50

Ref. 3) D. Wyrwa, Zeus, **MC simulation for upgraded LUMI monitor,**
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