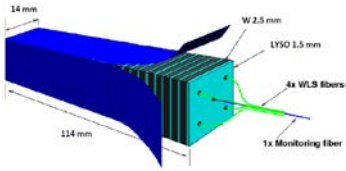


# Gamma-ray Induced Radiation Damage up to 100 Mrad in Wrapping Materials

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# Tyvek Paper after 100 Mrad

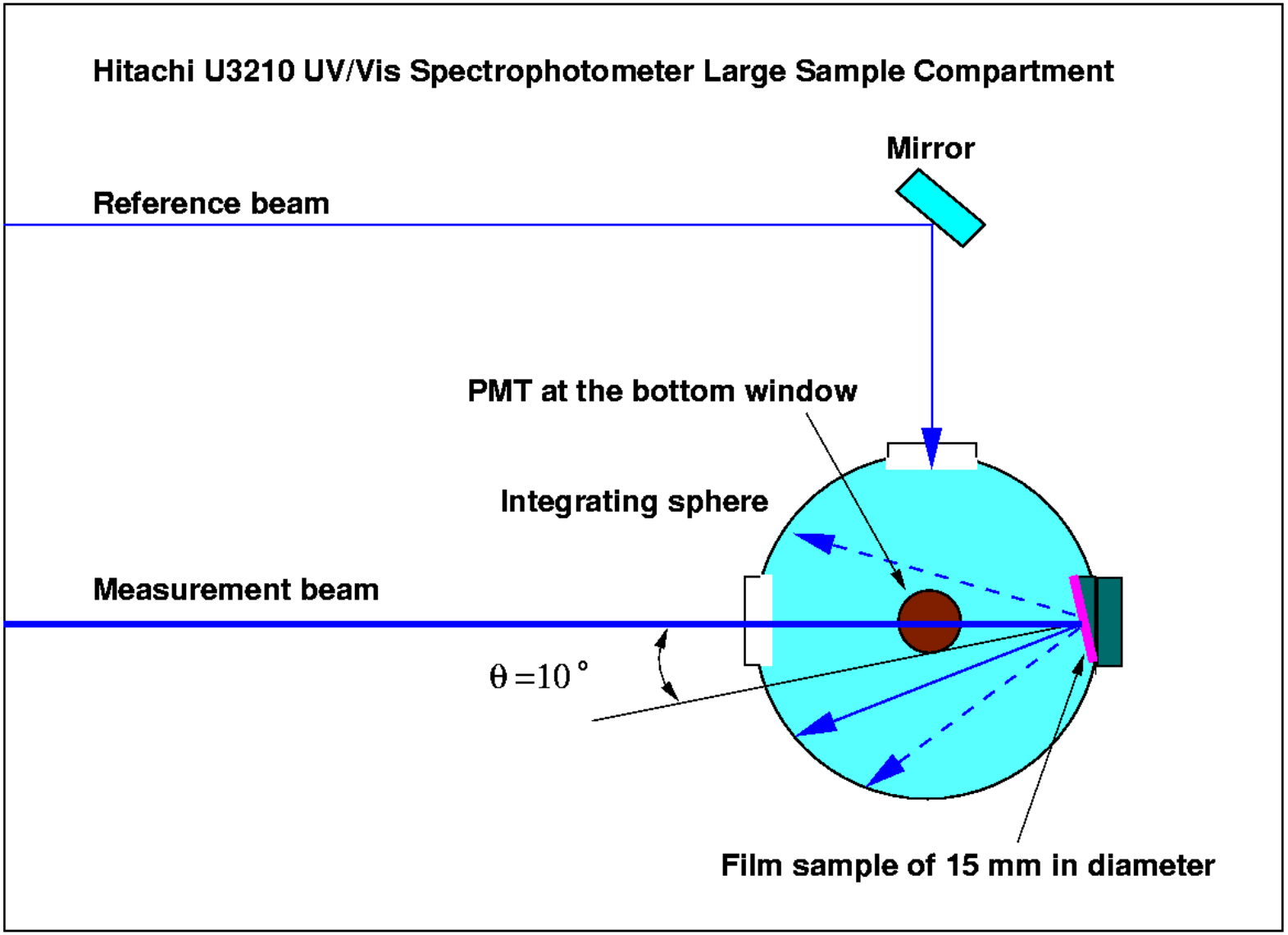
The Tyvek paper used in the test cell was broken and felled to pieces with color turned to gray, indicating serious damage. It is clear that Tyvek paper can not survive 100 Mrad.

An investigation was carried out to look for an effective wrapping material which is robust up to 100 Mrad for LYSO/W Shashlik cells.

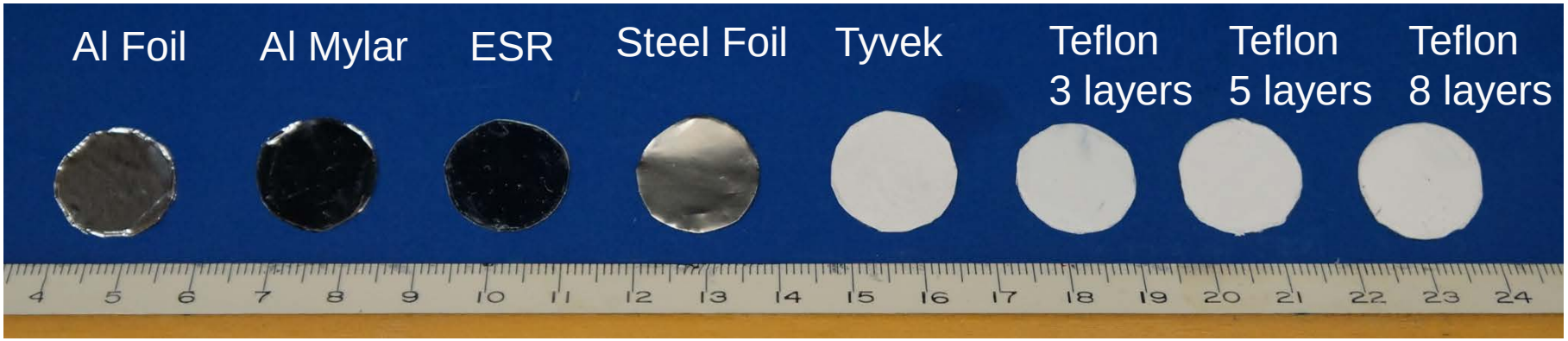
Various wrapping materials were irradiated up to 100 Mrad at the TAD facility at JPL with a dose rate of 1 Mrad/h. Relative reflectance were measured as a function of wavelength, and the emission weighted relative reflectance (EWRR) is defined as

$$EWRR = \int em(\lambda) \cdot reflectance(\lambda) d\lambda / \int em(\lambda) d\lambda$$

# Setup for Reflectance Measurements



# Wrapping Materials Measured

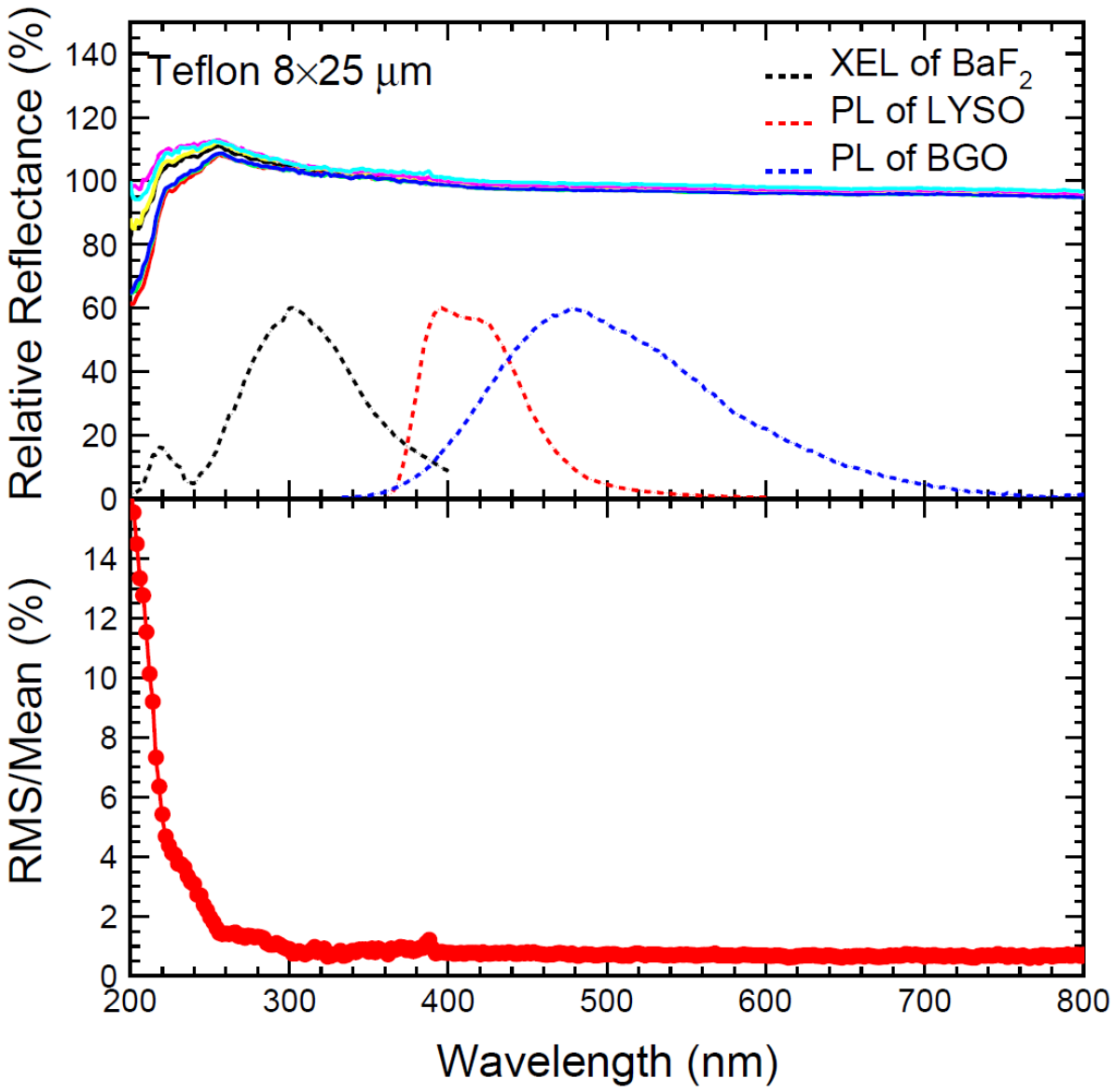



| Sample ID | Thickness (μm) |
|---|---|
| Al Foil | 15 |
| Al Mylar | 10 |
| ESR | 65 |
| Steel Foil | 50 |
| Tyvek | 150 |
| Teflon ×3 | 25×3 |
| Teflon ×5 | 25×5 |
| Teflon ×8 | 25×8 |

Properties measured at room temperature:

Reflectance as a function of wavelength

# Systematic Uncertainties

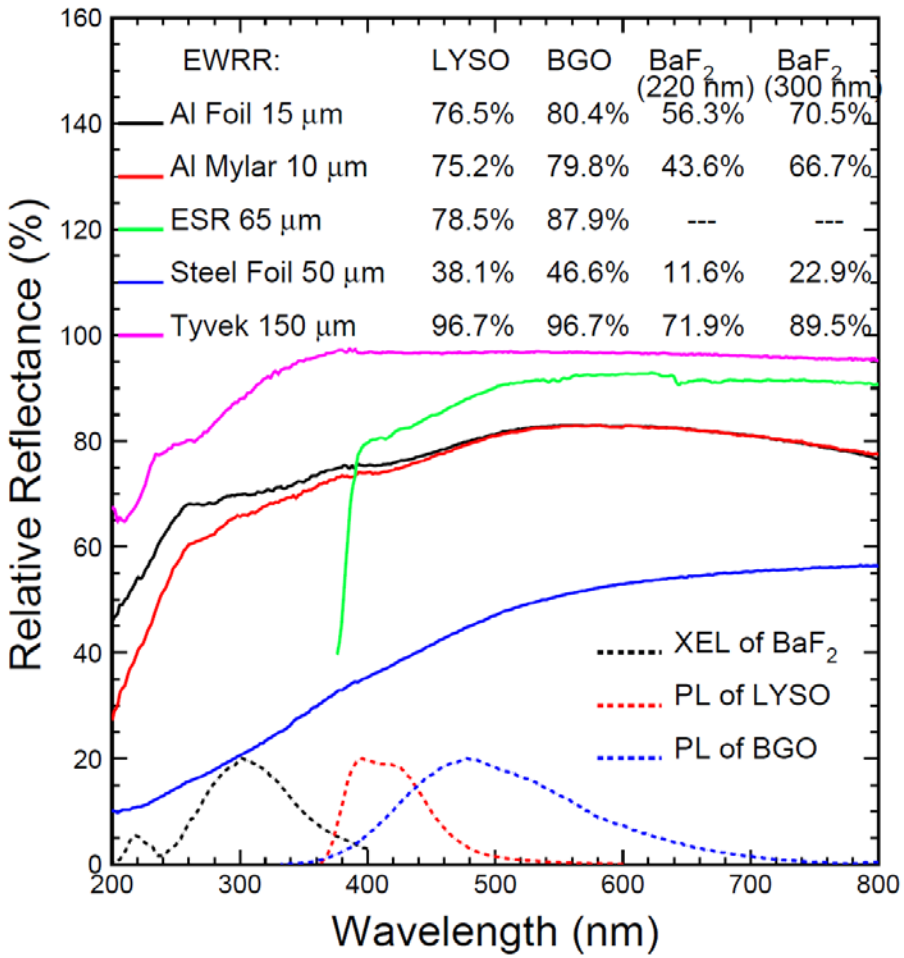


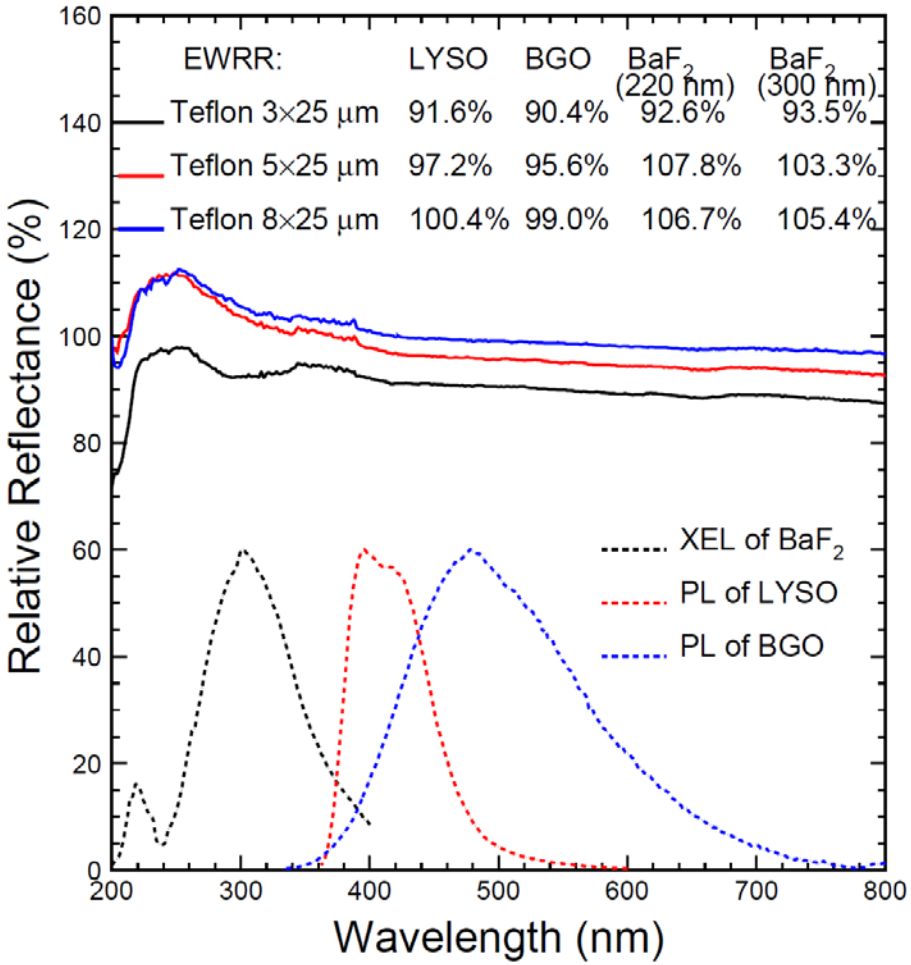

RMS values extracted from ten repeated measurements for 8 layers of Teflon films:

<1% with λ longer than 250 nm; and Up to 15% with λ shorter than 250 nm.

# Relative Reflectance & EWRR

Measured reflectance is relative to $BaSO_4$ which is the coating material used in the integrating sphere

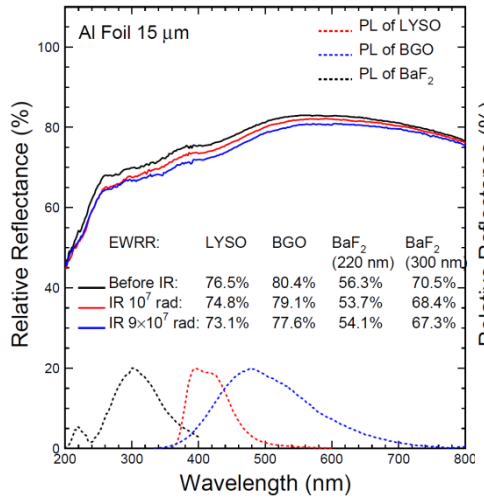


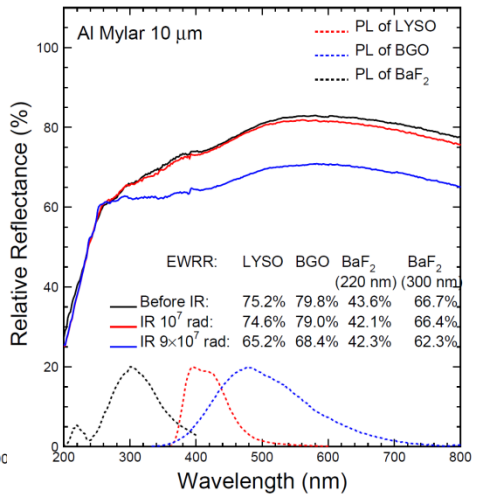



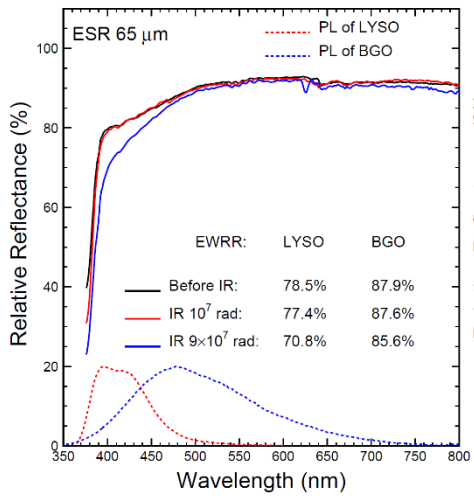

The order of EWRR for LYSO: 8 x Teflon, Tyvek, ESR, Al foil and Al Mylar

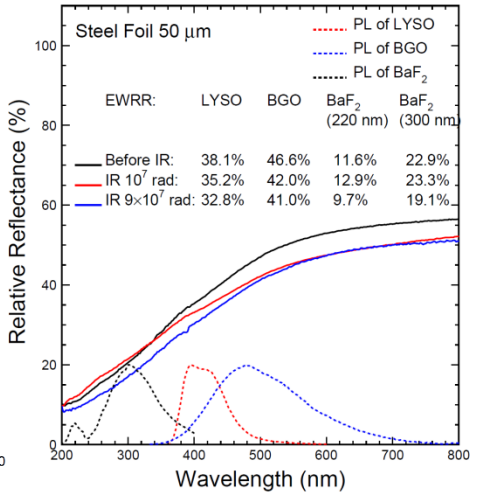
# Radiation Damage of Reflectance

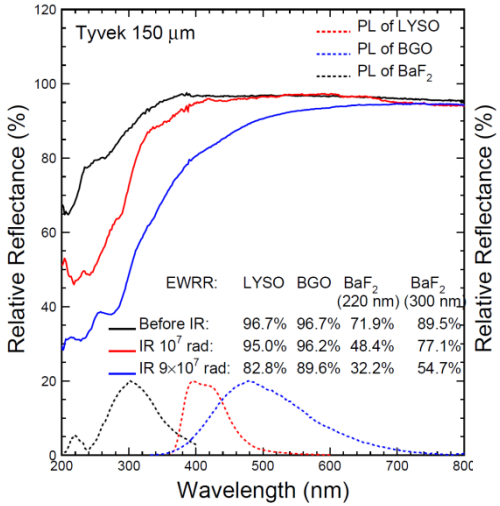
Significant degradation observed after 100 Mrad

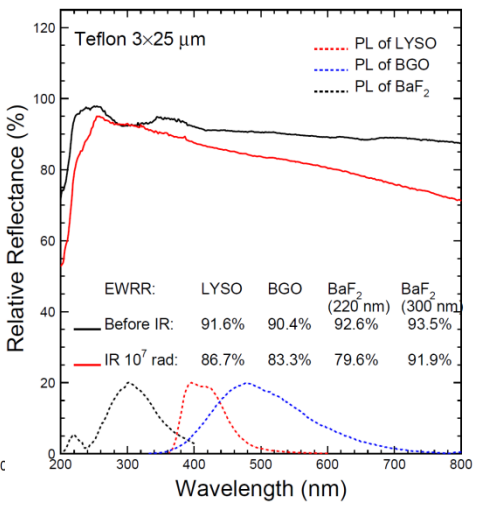


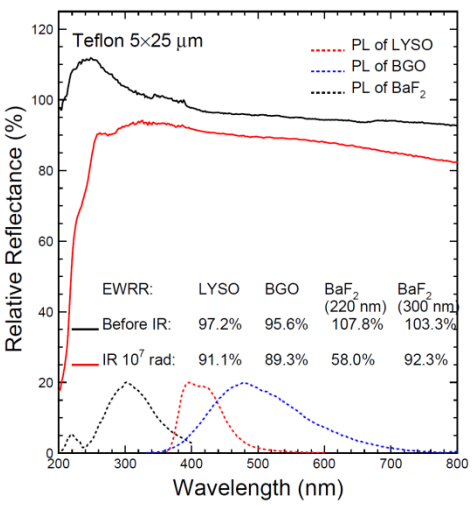



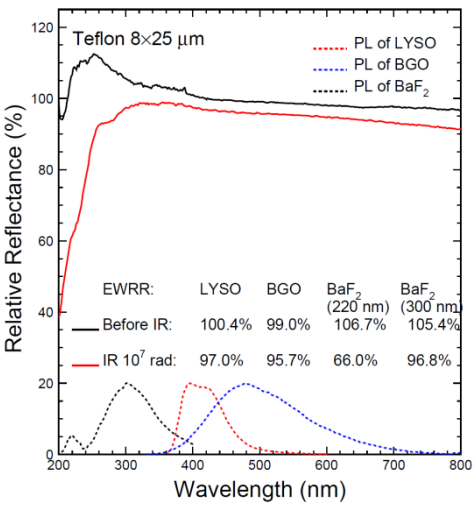



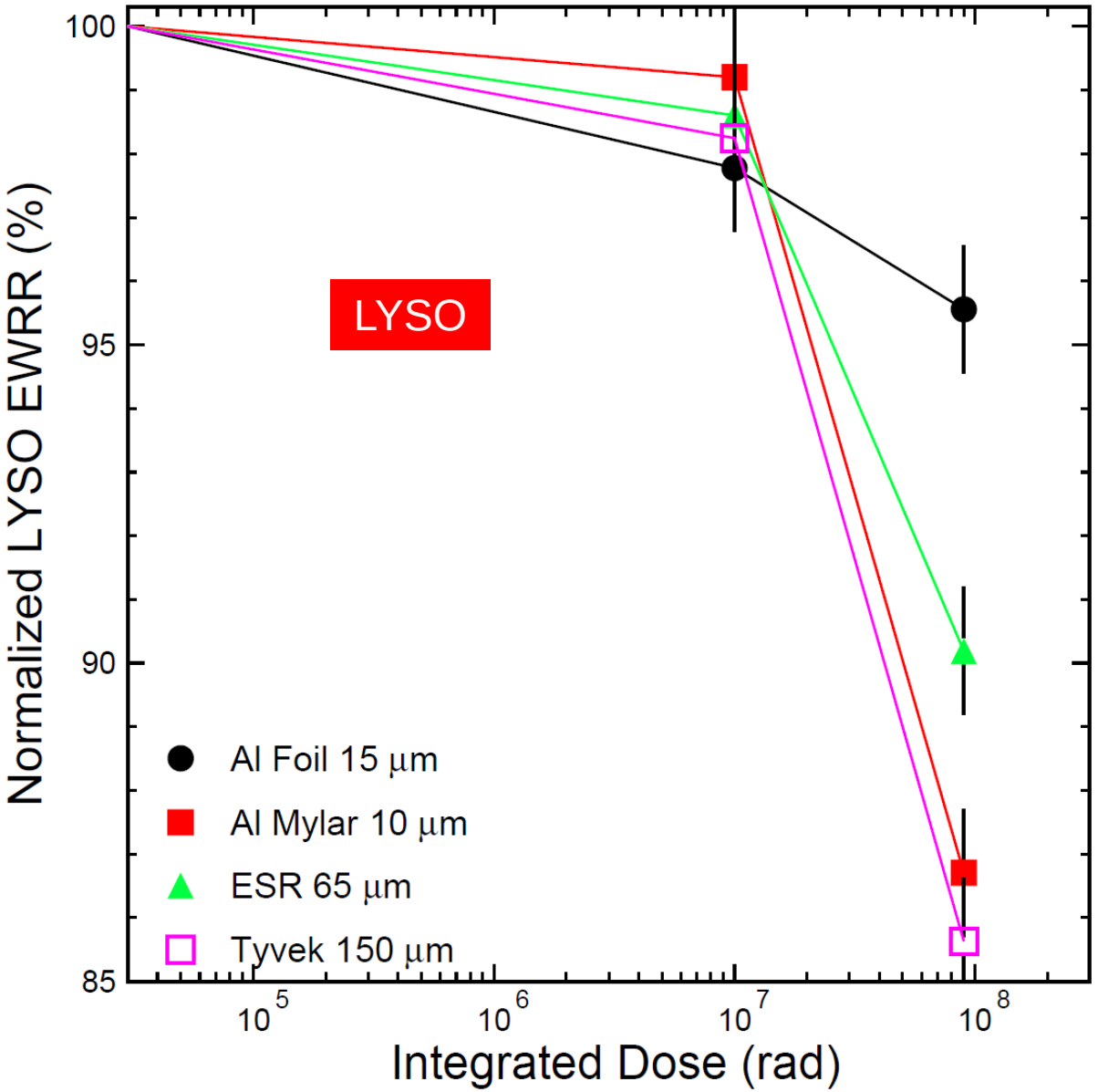




Aluminum foil is robust against Gamma-rays up to 100 Mrad

# Emission Weighted Relative Reflectance for LYSO

Less than 5% damage is observed in Al foil after 100 Mrad.



# Summary

- While it is a very good reflector, Tyvek paper did not survive 100 Mrad, so is not ideal wrapping material for LYSO/W Shashlik cells.
- Measurements of relative reflectance for various wrapping materials show that eight layers of PTFE film (8 x 25 μm) provide the best light output, followed by Tyvek, ESR, Al foil and Al Mylar.
- Aluminum foil is radiation hard up to 100 Mrad with less than 5% degradation in reflectance.
- Consequence of replacing 150 μm Tyvek paper with 15 μm Al foil:
  - Light output is expected to be lower by more than 20%;
  - Shashlik cell length is expected to be shorten by 8 mm.
- Possible solution to look: Al coating on W plates.

# Photo-Luminescence of ESR

Martin Janecek, “Reflectivity Spectra for Commonly Used Reflectors” *IEEE Transaction on Nuclear Science*, March 2012

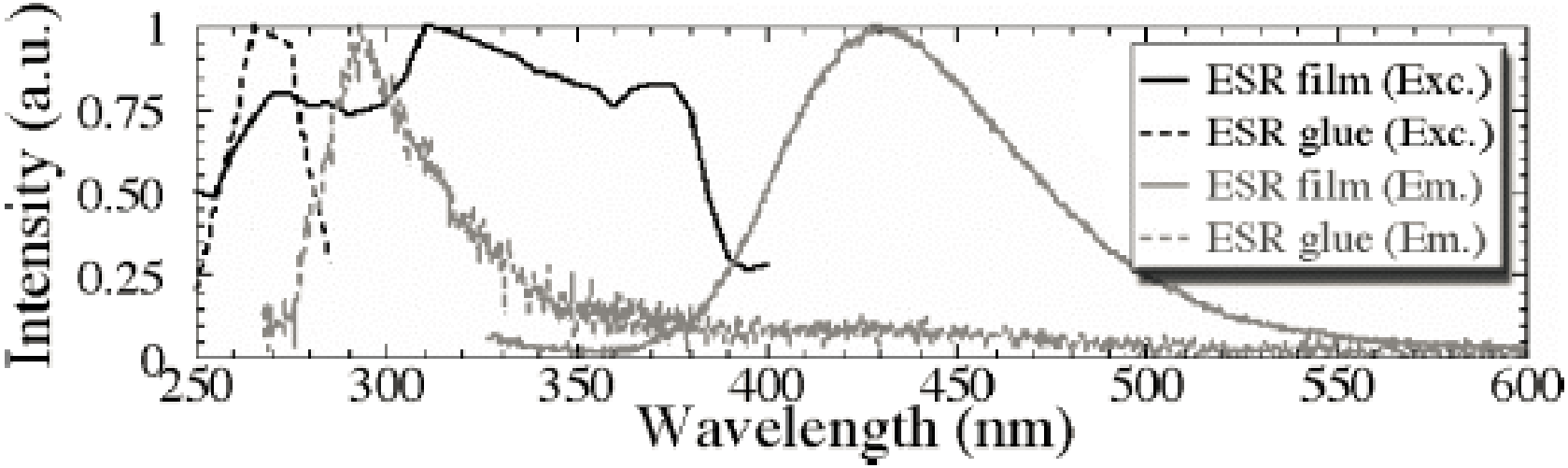



Fig. 6. Excitation and emission profiles for ESR film and ESR glue. The profiles are taken from data from Figs. 5(a) and 5(b) and pass through the maximum value in the fluorescence spectra.