



Solar EUV inter-calibration workshop
LASP, University of Colorado, Boulder

October 25-27, 2011

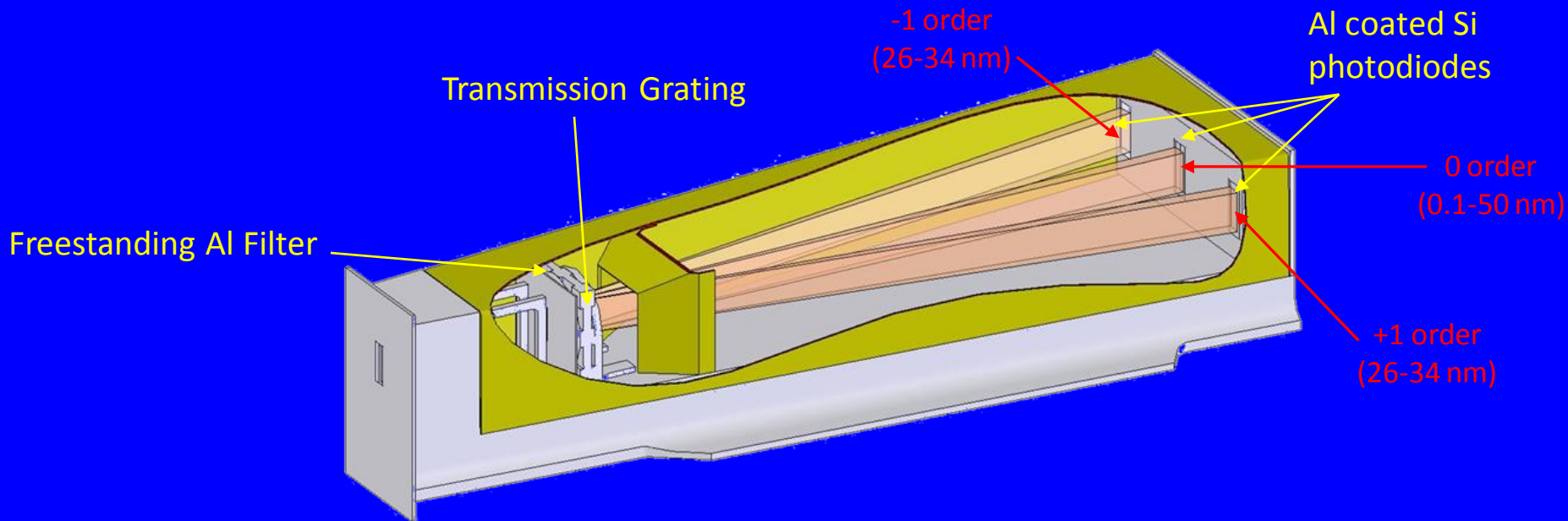
Solar EUV Monitor (SEM) instrument
overview background and calibration

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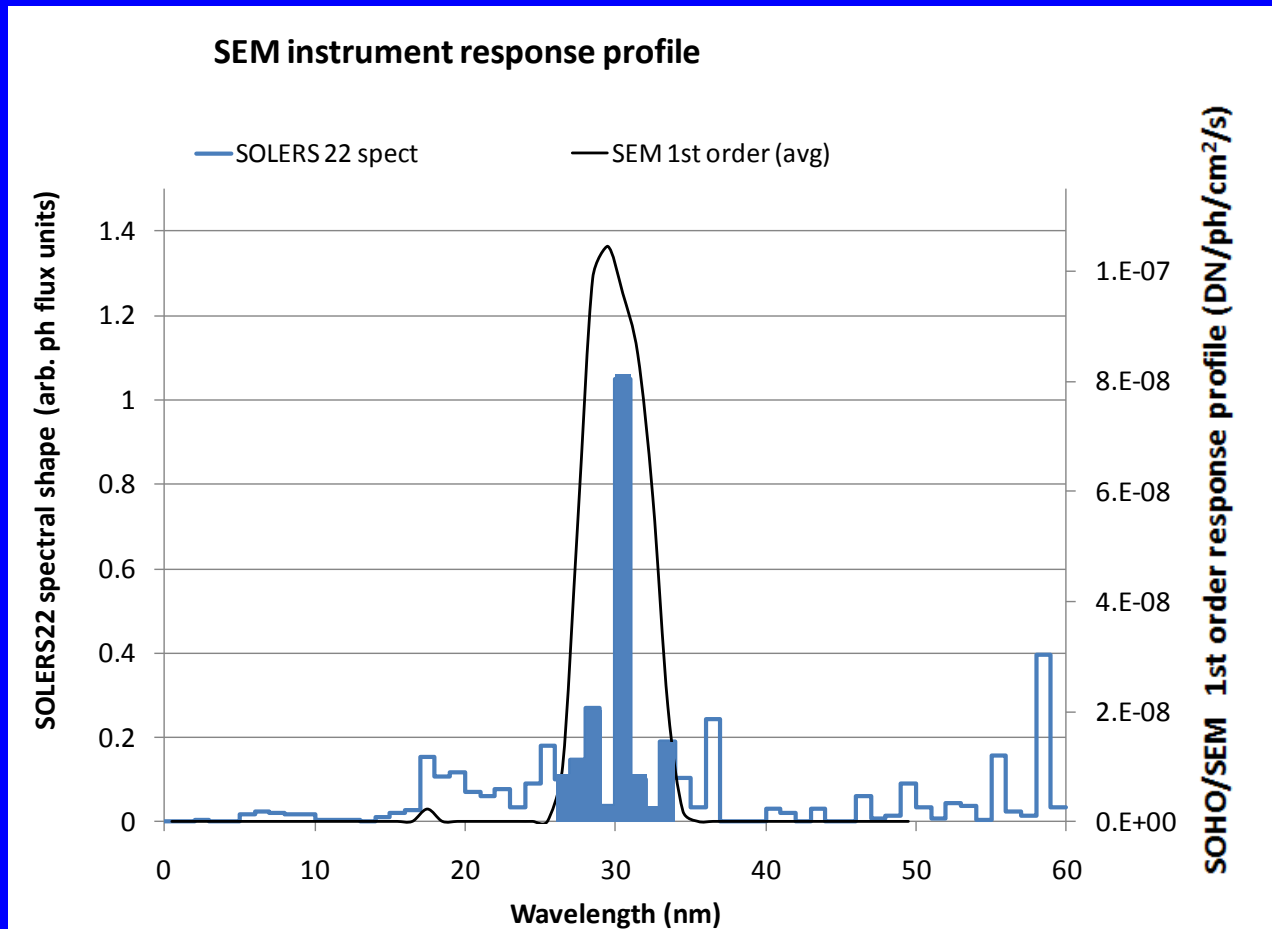
Introduction



- SOHO/CELIAS/SEM has been providing nearly continuous (with the exception of the summer of 1998 when SOHO went offline) EUV irradiance measurements for all of the nearly 16 yrs. SOHO has been in operation
- It is a highly stable transmission grating spectrometer with high photometric accuracy
- Measures solar flux in two bandpasses: 26-34 nm(+/- 1st order) and 0.1-50 nm (0-order)
- Data used for researching the sun, interplanetary space, and earth/planetary atmospheres



How irradiance is calculated



- NIST measured instrument efficiencies
- SOLERS22 composite reference spectrum [Woods, T., H. Ogawa, K. Tobiska, and F. Farnik, Solers 22 WG-4 and WG-5 Report for The 1996 Solers 22 Workshop, Solar Physics, 511, 1998]

How irradiance is calculated



$$SEM\ EUV\ flux = k_1 \frac{DN_{SEMch} - bkgrd}{\left(\frac{A \int_{\lambda_1}^{\lambda_2} \eta \cdot \phi_{S22} \cdot f_{carbon-trans} \cdot d\lambda \cdot f_{1AU}}{\int_{\lambda_1}^{\lambda_2} \phi_{S22} \cdot d\lambda} \right)}$$

where:

k_1 = correction for SEM sensitivity band which extends slightly beyond 26-34 nm (including second order contributions from wavelengths near 17 nm)

$bkgrd$ = background signal due to diode/electrometer dark current and residual light leaks

DN_{SEMch} = data channel raw count rate $\int_{26nm}^{34nm} \phi_{S22} \cdot d\lambda$

A = entrance aperture area

η = SEM channel efficiency from NIST calibration

ϕ_{S22} = Solar flux from SOLERS22 reference spectrum $\int_{\lambda_1}^{\lambda_2} \phi_{S22} \cdot d\lambda$

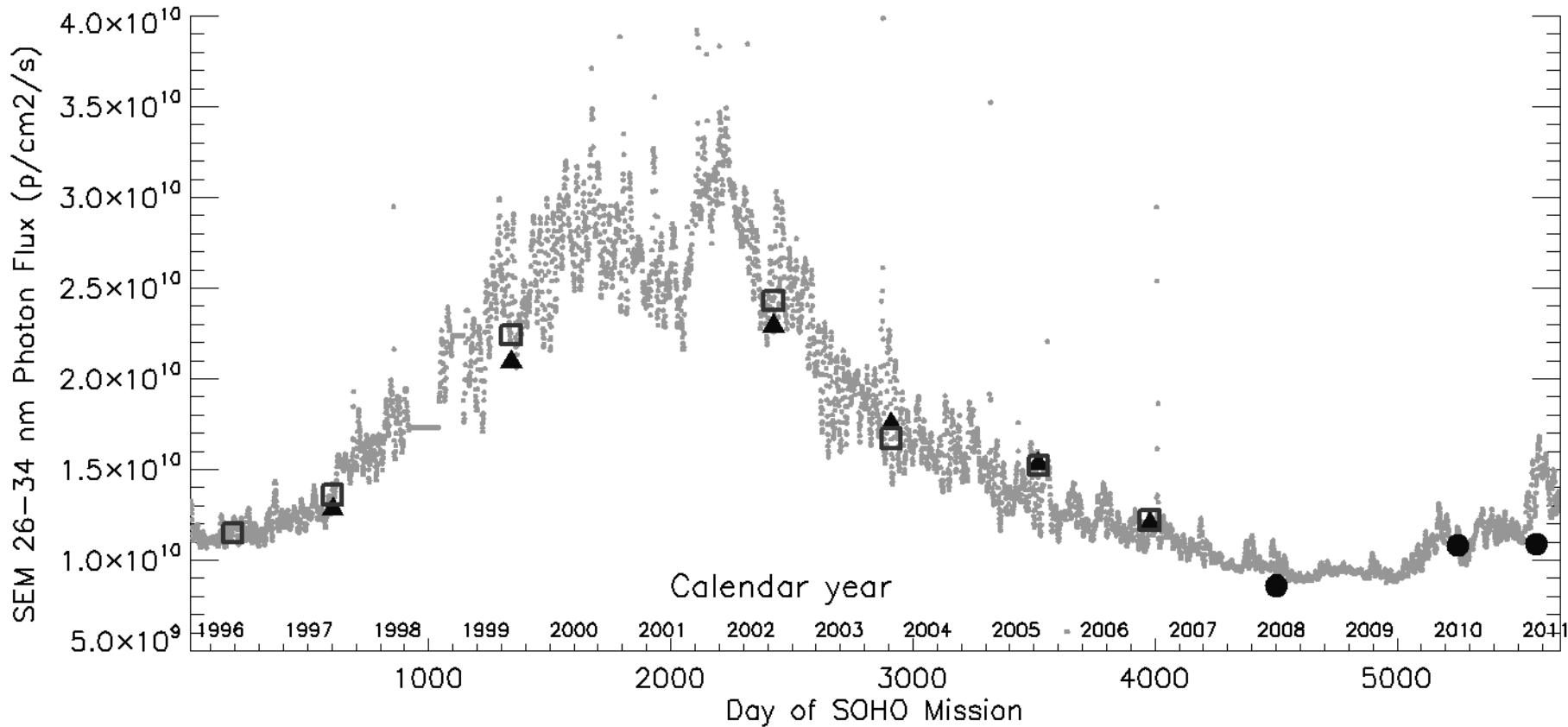
$f_{carbon-trans}$ = transmission through carbon contamination layer, f(time)

f_{1AU} = correction for 1 AU, and

$\lambda_1 - \lambda_2$ = range of wavelengths over which SEM the first order channel is sensitive

} all functions of λ

SEM 26-34 nm irradiance



- Time series, January 1996 – Present. Black squares, triangles and circles represent sounding rocket measurements using a Rare Gas Ionization Cell (RGIC), the SEM clone instrument, and the SDO/EVE/ESP clone instrument, respectively



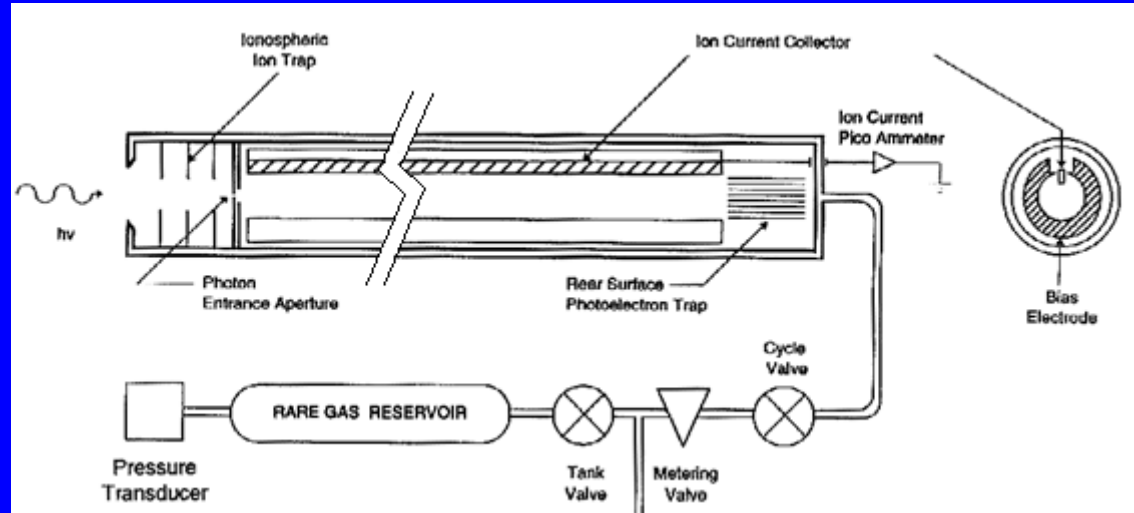
Date	Rocket Flight	SOHO/SEMDaily avg. 26-34 nm flux (ph/cm ² /s)	SEM clone 26-34 nm flux (ph/cm ² /s)	26-34 nm flux RGIC (ph/cm ² /s)	ESP Ch9 flux (SEM) 26-34nm (ph/cm ² /s)	SOHO/SEM to RGIC (26-34nm) ratio	SOHO/SEM to SEM clone (26-34nm) ratio	SOHO/SEM to ESP ratio
6/26/96	36.147	1.21E+10	1.32E+10	1.15E+10		0.95	0.92	
8/11/97	36.164	1.42E+10	1.28E+10	1.36E+10		0.96	1.11	
8/18/99	36.181	2.22E+10	2.09E+10	2.24E+10		1.01	1.06	
8/6/02	36.202	2.28E+10	2.29E+10	2.43E+10		1.06	1.00	
12/5/03	36.211	1.78E+10	1.75E+10	1.67E+10		0.94	1.02	
8/3/05	36.227	1.57E+10	1.53E+10	1.52E+10		0.96	1.03	
11/7/06	36.236	1.26E+10	1.20E+10	1.22E+10		0.97	1.05	
4/14/08	36.240	0.95E+10			0.86E+10			1.10
5/3/10	36.258	1.18E+10			1.08E+10			1.09
3/23/11	36.275	1.37E+10			1.09E+10			1.26

red text indicates SDO/EVE sounding rocket measurements

Ne RGIC

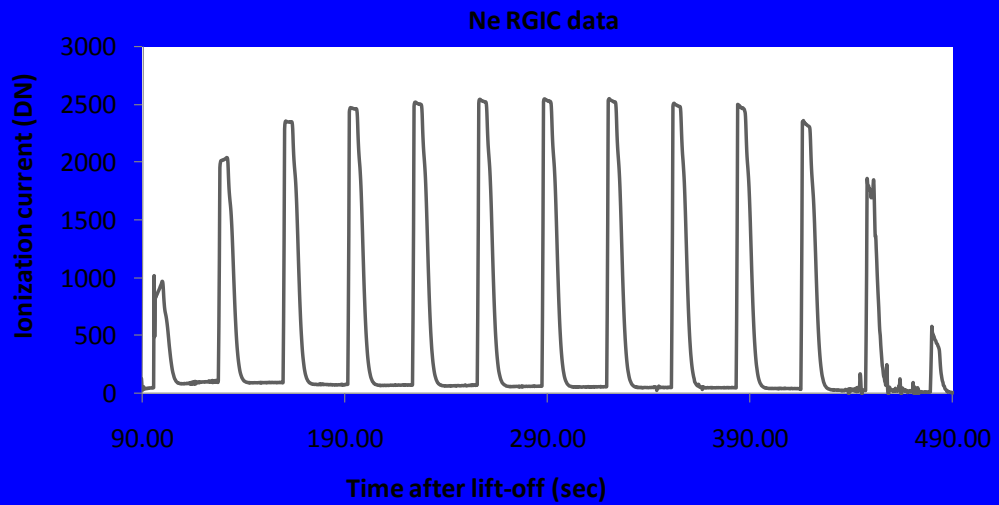


- Operates optically **thick**
- Windowless; no optical surfaces to degrade
- Target gas is periodically cycled through the cell

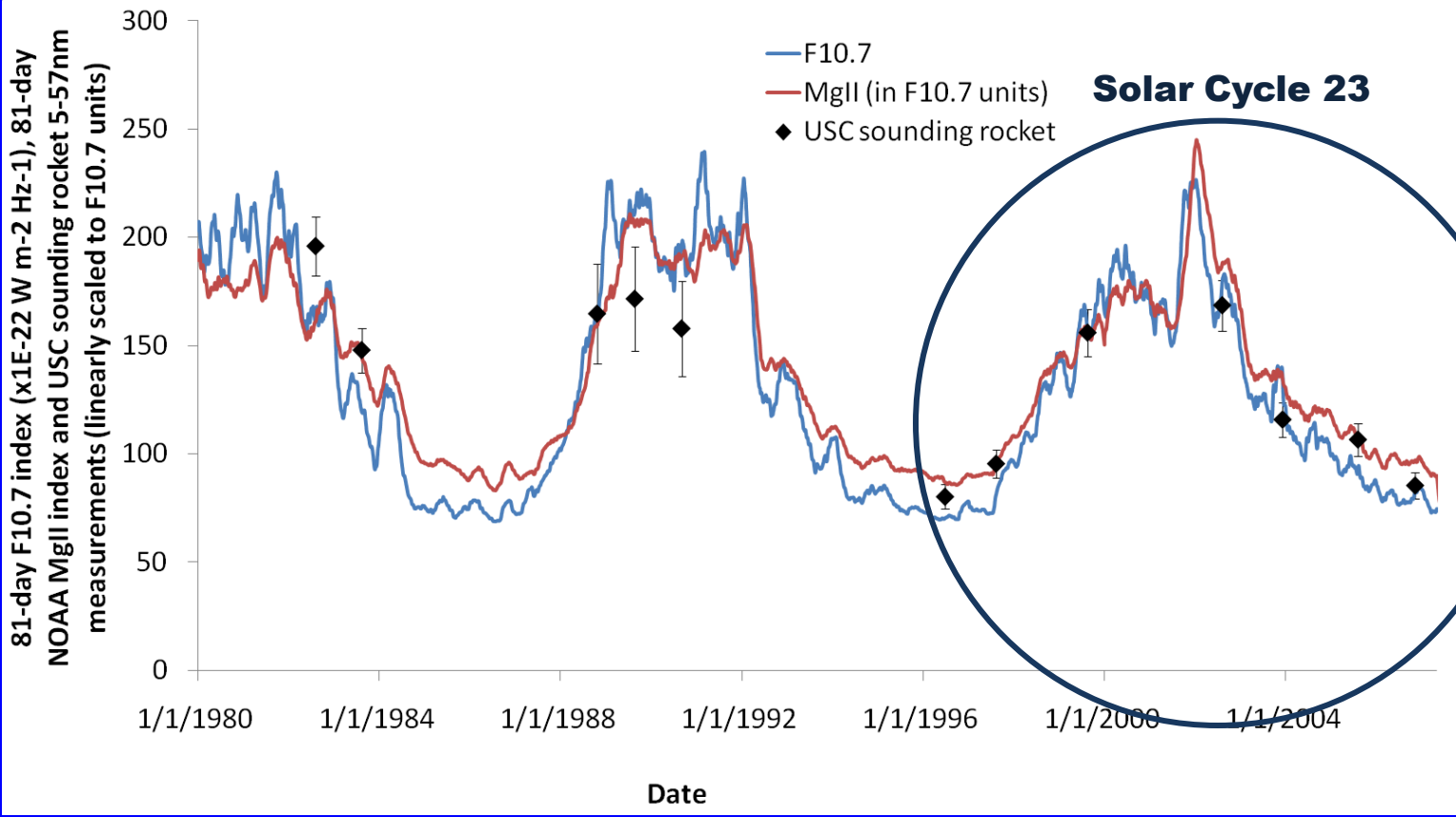


Schematic of the Ne rare gas ionization cell and gas supply system

Typical Ne RGIC sounding rocket data . Periodic gas pulses give rise to peaks in ionization current. Peaks are highest near flight apogee (~ 300 sec after lift-off) where atmospheric EUV absorption is at a minimum



USC sounding rocket absolute EUV irradiance measurements 1982 -2006



EUV variability based on scaled flux values (5-57 nm) from USC sounding rocket measurements are generally in good agreement with F10.7 and NOAA composite Mg-II solar activity indices

Ne RGIC



- Solar flux is determined from ionization vs. pressure curve from each purge-fill cycle (linear portion of curve is extrapolated back to zero pressure current corresponding to current with no contribution from secondary ionization)
- Geometry of cell (long along optic axis with small radius) makes it optically thick for EUV but “optically thin” for ejected photoelectrons

