ments, Inc. The R6835 has a MgF_2 window and a CsI photocathode. Reaction cell **200** includes a compartment **220**, positioned between detector **104** and exit window **206***a* for housing filters **216**. Filter **216** is used to form a spectrometer to analyze the wavelength of the emitted radiation from interaction region **218** passing through exit window **206***a*. Exemplary filters that may be used to form a coarse spectrometer include Al_2O_3, CaF_2, SiO_2 filters, and interference filters. Compartment **220** encloses a differentially pumped volume to prevent gas exiting interaction region **218** from coming into contact with the detector **104**. Gas handling system **108** maintains compartment **220** at low pressure using a vacuum pump connected to compartment **220** at manifold **222**.

[0043] Under normal operation of an embodiment of the present invention using gas-phase neutron absorbers, gas handling system **108** will evacuate all gases from reaction cell **200**. Further, reaction cell **200** is heated to remove water and contaminants from cell walls. In one embodiment of the present invention, reaction cell **200** is heated for at least 10 h at 70° C. while being evacuated. Evacuation and heating of reaction cell **200** creates a base pressure within reaction cell **200**. In one embodiment of the present invention, evacuation and heating of reaction cell **200** results in a base pressure of about 3×10^{-8} kPa. After heating and evacuating cell **200** to base pressure, a neutron absorber gas is introduced into cell **200** through manifold **210** using gas handling system **108**. Noble gases are also introduced into interaction region **218** through manifold **210** using gas handling system **108**. In one embodiment of the present invention, noble gases introduced into interaction region include ultrahigh purity Ar, Kr, and Xe. In some embodiments of the present invention, a gas filter is connected between manifold **210** and cube **202** to remove trace contaminants from the gas sources. Exemplary filters that can be used to remove trace contaminants from gas include Microtorr MC1-902-F filter, and the like.

[0044] A beam of neutrons enters reaction cell **200** through entry window **204***a* attached to metal-seal flange port **204** on front face **202***a* of cube **202**. In one embodiment of the present invention, the neutron beam entering reaction cell **200** through entry window **204***a* has a diameter of about 4 mm and a fluence rate of about $(2.61\pm0.37)\times10^5$ neutrons/cm^2 s. An exemplary beam line having such properties includes NG6-A beam line at the NIST Center for Neutron Research (NCNR). Neutrons enter neutron interaction region **218** defined by cylinder **214**. Within interaction region **218**, slow neutrons react with high neutron absorption cross-section nuclei with subsequent decay of the compound nucleus into energetic particles. The energetic particles undergo collisions with noble gas atoms within interaction region **218** to form excimers. Excimers formed within interaction region **218** radiatively decay with emission of FUV electromagnetic radiation. Unreacted neutrons exit from interaction region **218** through exit window **208***c*. FUV emissions pass through exit window **206***a* and filter **216** into compartment **220**. Compartment **220** enclosing a differentially pumped volume is evacuated by gas handling system **108**. FUV emissions pass through compartment **220** into detector housing **224** where FUV emissions are detected by detector **104**. Detector **104** is generally operated in photon-counting mode with its output connected to processor **106**. In photon-counting mode, detector **106** counts the number of FUV photons emitted from interaction region **218**. In one embodiment of the present invention, processor **106** is a preamplifier followed by a spectroscopy amplifier whose output drives the input of a multichannel analyzer.

[0045] Experimental count rates of detector **104** can be corrected for dark current, background gamma radiation, and radiation from the direct interaction of neutrons and noble gases within interaction region **218**. These corrections remove contributions to the signal received by detector **104** from sources other than neutron absorption by a neutron absorber in interaction region **218**. Measurements taken in evacuated reaction cell **200** and with reaction cell **200** filled with different pressures of noble gases, but without a neutron-absorber, may be used to remove signal contributions from sources other than neutron absorption in interaction region **218**. The signal received by detector **104** can also be corrected for FUV radiation that is reflected into detector **104** by scattering from the wall of magnesium cylinder **214**. In some embodiments of the present invention, the ratio of scattered to direct radiation received by detector **104** is between 0.14 and 0.31. Ratios of scattered to direct radiation can be determined from ray tracing calculations based on a 4 mm diameter cylindrical source aligned with the neutron beam and using optical constants for MgO (the surface is assumed to be oxidized rather than unreacted Mg) shown in Table 1.

TABLE 1

λ (μm)	ϵ_1	ϵ_2
135	5.5	1.5
160	8.0	4.0
200	3.5	0

[0046] FIG. **3** illustrates another embodiment of a reaction cell for detecting slow neutrons using solid phase neutron absorbers. Reaction cell **300** includes a stainless steel cube **302** with cylindrical metal-seal flange ports **304**, **306**, **308**, **310**, **312** (five ports shown in FIG. **3**) on each of its six faces. In one embodiment of the present invention, metal-seal flange ports **304**-**312** on each of the six faces of cube **302***a*-*e* (five faces shown in FIG. **3**) are cylindrical with a diameter of about 70 mm. Metal-seal flange port **304** on front face **302***a* of cube **302** includes an entry window **304***a* through which a neutron beam is capable of entering cube **302** of reaction cell **300** and an exit window **308***c* through which a neutron beam is capable of exiting cube **302** of reaction cell **300**. In one embodiment of the present invention, entry window **304***a* and exit window **308***c* have a diameter of about 35 mm and a thickness of about 3.3 mm. Exemplary materials used for making exit window include silicon, magnesium, fused silica, and the like.

[0047] Cube **302** includes a solid target holder **314** positioned vertically in the center of cube **302**. In one embodiment of the present invention, target holder **314** is an aluminum cylinder having a diameter of about 25 mm and a height of about 35 mm. Target holder **314** includes a slot for holding a target neutron absorber **318** such that a neutron beam entering cube **302** is capable of interacting with neutron absorber **318**. Target neutron absorber **318** is positioned such that its planar axis forms an angle with the axis of the neutron beam entering cube **302**. In one embodiment of the present invention, planar axis of neutron absorber **318** and axis of neutron beam form an angle from about 10 degrees to about 90 degrees. In some embodiment of the present invention, planar axis of neutron absorber **318** and axis of neutron beam form an angle of about 45 degrees. Entry window **304***a*, exit window **308***c* and target holder **314** are transparent to neutrons, and neither scatters nor absorbs a neutron beam passing through them. Top face