**Comparison of sources for multi-anvil experiments**

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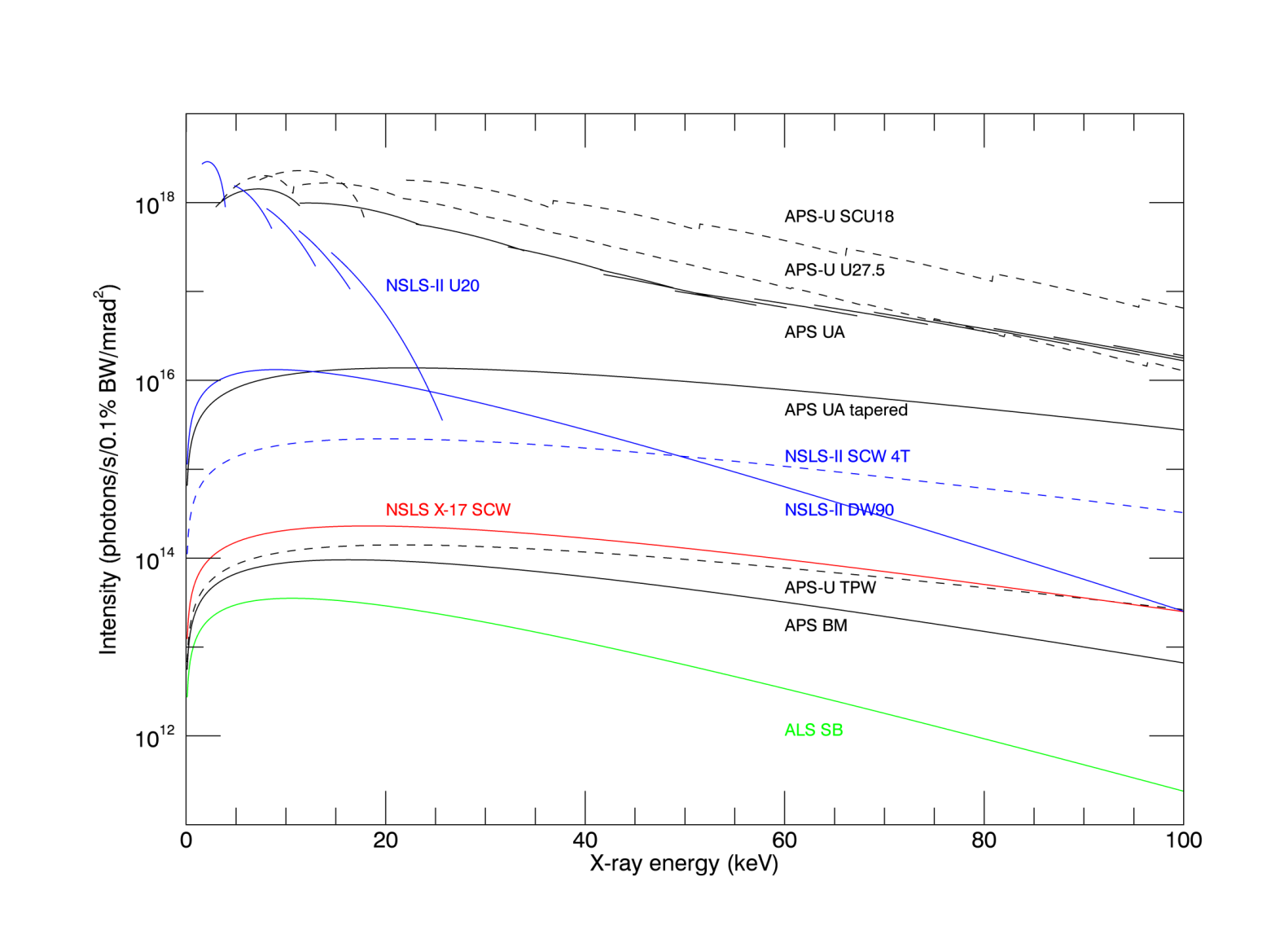
The following figures shows the intensity and brightness of a number of beamlines where high-pressure experiments have been conducted in the past, are conducted now, or may be conducted in the future. The following table lists the labels used in the plots and corresponding source descriptions.

|  |  |
| --- | --- |
| **Past sources** | |
| NSLS X-17 SCW | NSLS-X17 superconducting wiggler |
| **Current sources** | |
| ALS SB | ALS superbend beamline 12.2.2 |
| APS BM | APS bending magnet |
| APS UA | APS 33mm period undulator untapered |
| APS UA | APS 33 mm period undulator tapered |
| NSLS-II U20 | NSLS-II 20mm period undulator at HXN |
| NSLS-II DW90 | NSLS-II 90 mm period damping wiggler at XPD |
| **Potential future sources** | |
| NSLS-II SCW 4T | NSLS-II 4 tesla superconducting wiggler at HEX |
| APS-I U27.5 | APS upgrade 27.5 mm period normal undulator |
| APS-U SCU18 | APS upgrade 18 mm period superconducting undulator |
| APS-U TPW | APS upgrade three pole wiggler |

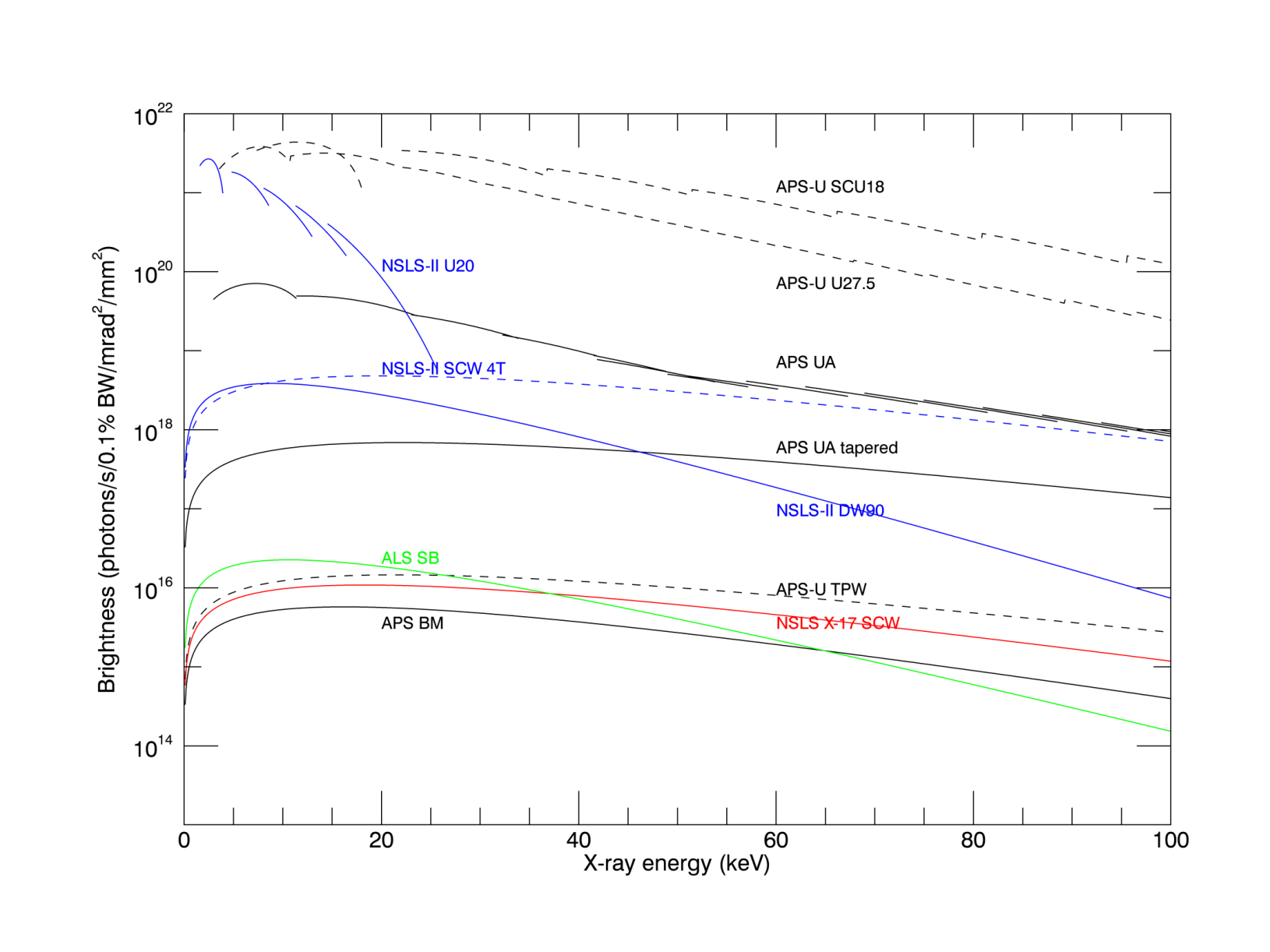
Intensity is flux per solid angle, and is the appropriate figure of merit for beamlines without focusing, or where the focusing is far from preserving the source brightness. This is thus normally the most relevant figure of merit for multi-anvil experiments, where focusing to a source-size limited spot is not normally done.

The important energy range for multi-anvil experiments is generally between 30 and 80 keV. It can be seen that the NSLS-II XPD source is ~10-100 times higher intensity than the ALS superbend, APS bending magnet, and X-17 superconducting wiggler. It is ~100 times lower intensity than the APS undulators.

An APS bending magnet that uses vertical focusing to gain a factor of 10 in intensity on the sample would thus be about the same as the NSLS-II XPD or HEX with no vertical focusing.

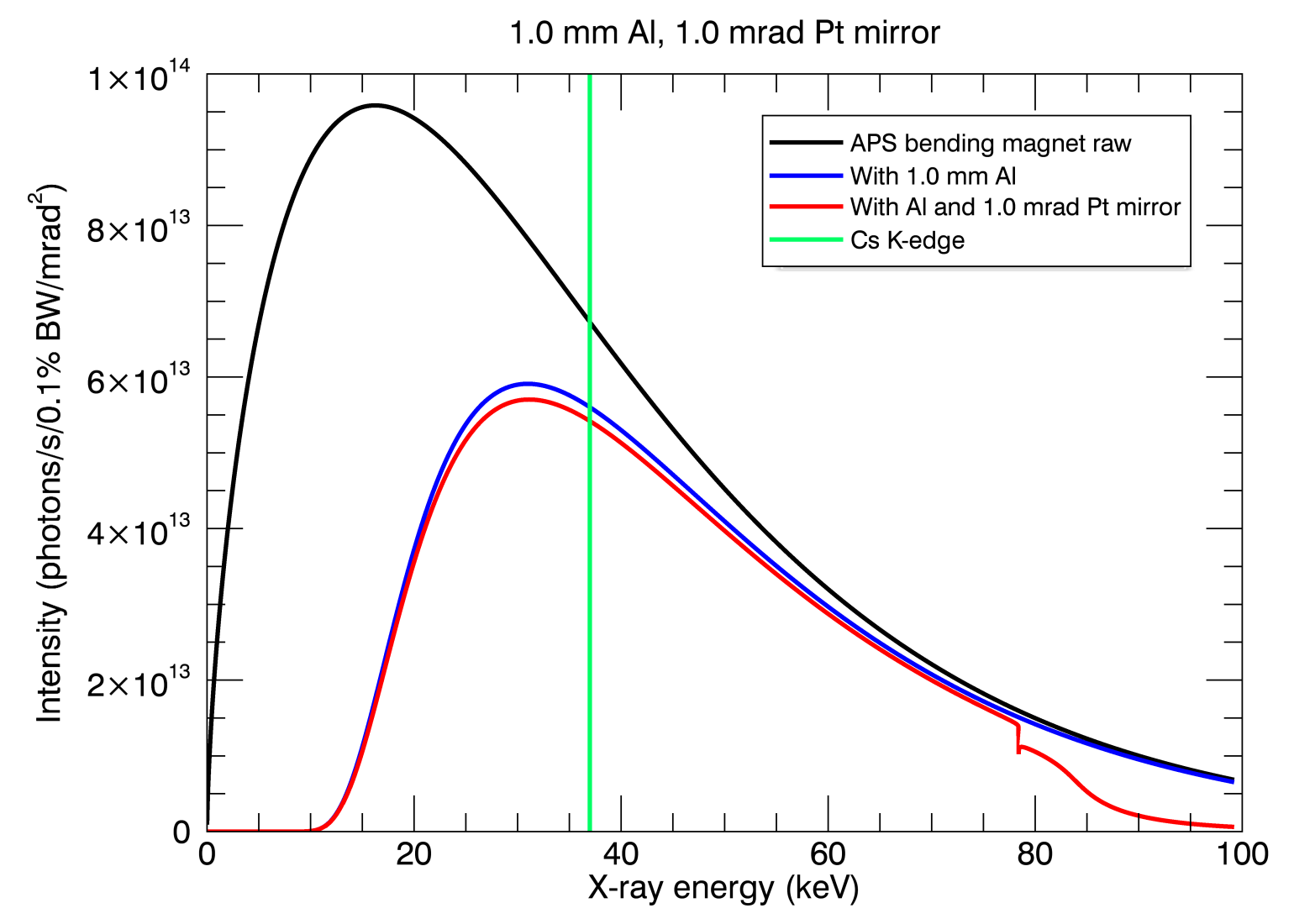


The following figure shows the brightness of the same beamlines shown in the previous figure. Brightness is flux per solid angle per source size, and is the appropriate figure of merit for beamlines that are focusing to a small spot size. It can be seen that the NSLS-II XPD source is ~100 times brighter than the ALS superbend, APS bending magnet, and X-17 superconducting wiggler. It is ~10-100 times less bright than the APS undulators today, and 1000 times less bright than APS undulators after the upgrade.

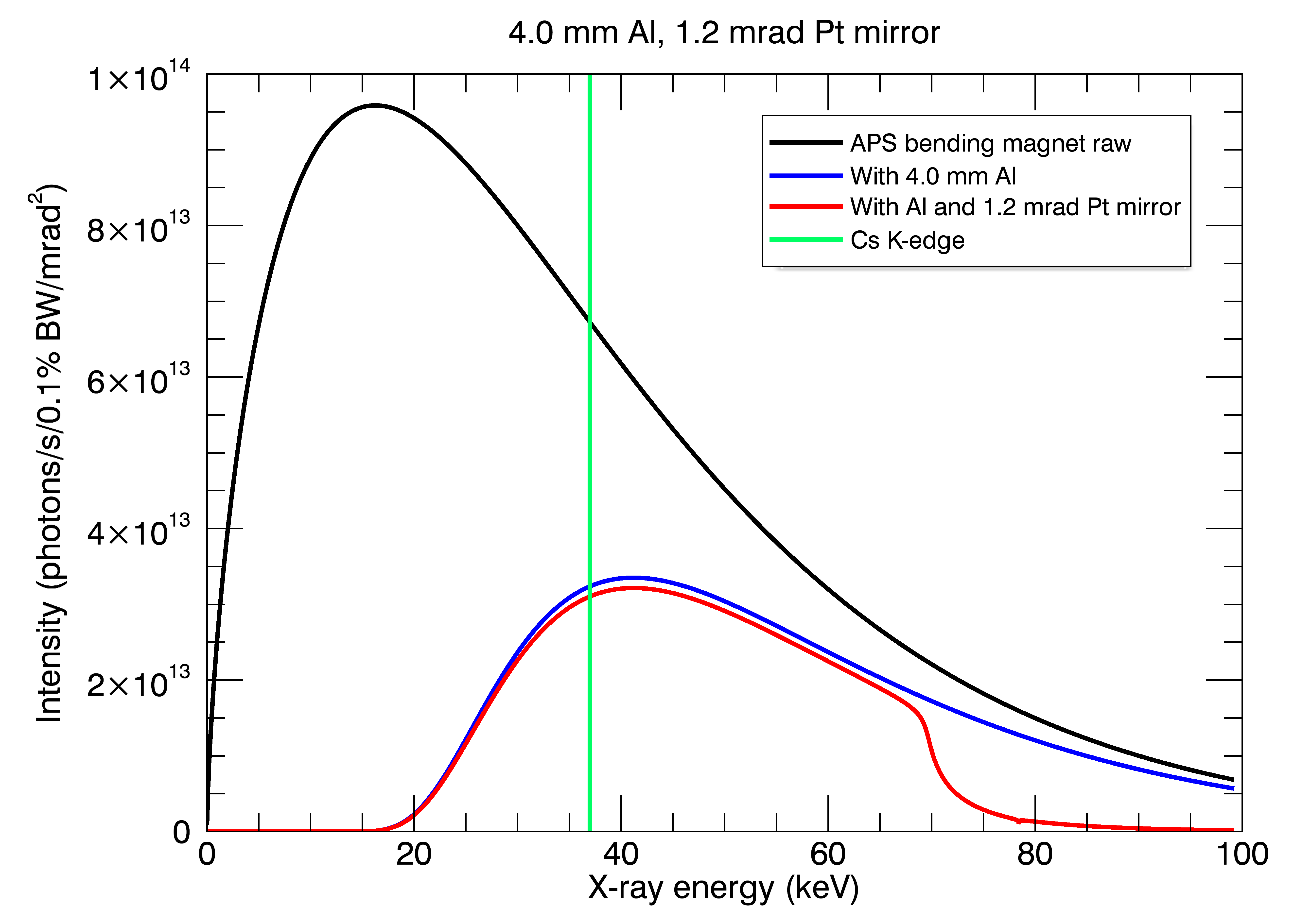


We can gain intensity at 13-BM-D by using a vertical focusing mirror. The mirror is 1 meter long. We can control the pitch of the mirror, which controls the high-energy cutoff and the solid angle that the mirror collects.

At 1 mrad the mirror has nearly 100% efficiency to 78 keV, and drops off at about 85 keV. At this angle the mirror will collect 1 mm of beam in the vertical direction (because it is 1 meter long at 1 mrad incident angle). The mirror can focus that beam to less than 100 microns, probably as small as 25 microns. At 100 microns that would be a factor of 10 increase in intensity, and at 25 microns it would be a factor of 40.



At 1.2 mrad the mirror collects 1.2 mm of beam in the vertical direction, but the energy cutoff drops to 70 keV. In this case the intensity would be 12 times greater than the unfocused beam.



The following shows a comparison of diffraction in the multi-anvil press with focused pink beam and white beam. These were both collected for 500 seconds of live time. The mirror was at 1.2 mrad angle, so the high-energy cutoff was around 70 keV. Below this the pink beam is about 10 times more intense. At 80 keV the two are about the same, and at 100 keV the white beam is much more intense.

