I09 hard x-ray (I branch) undulator (U27) gap calculation

**u = 27 mm (undulator period)

*M* = 4 (number of magnet blocks per period)

*h* = 16 mm (height of magnet block)

*E*p = photon energy (keV)

*n* = Order of undulator harmonic

*B*r = Remanent field of undulator magnets (T)

*E*e = Electron energy (GeV)

**= 1000\**E*e/*m*e (Lorentz factor, unitless),

where *m*e = 0.510999 (electron rest mass in unit of MeV/c^2 where c is the speed of light)

*K* = Diffraction parameter of undulator = {4.959368×10-6(*n*2/**u*E*p) – 2}1/2

Note that 4.959368×10-6(*n*2/**u*E*p) – 2 must be positive

*g* = undulator gap (mm) = (**u/π)ln(*A*/*K*),

where A = (2×0.0934**u*B*r*M*/π)sin(π/*M*)(1 – e-2π*h*/**u)

*g* range: 5.1 ≤ *g* ≤ 9.1

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| *n* | *E*e (GeV) | *B*r (T) |
| 2 | 3.0227933 | 1.0208672 |
| 3 | 3.0661917 | 1.0386155 |
| 4 | 3.0490044 | 1.0343836 |
| 5 | 3.0655931 | 1.0376554 |
| 6 | 3.058669 | 1.0383222 |
| 7 | 3.0741928 | 1.0416361 |
| 8 | 3.0681712 | 1.0417786 |
| 9 | 3.088366 | 1.0496396 |
| 10 | 3.0719119 | 1.0423881 |
| 11 | 3.0794863 | 1.0457576 |
| 12 | 3.0759411 | 1.0437144 |
| 13 | 3.0761529 | 1.0438783 |
| 14 | 3.0889069 | 1.0497482 |
| 15 | 3.0915926 | 1.0509137 |
| 16 | 3.1036491 | 1.0565081 |
| 17 | 3.1099721 | 1.0592467 |
| 18 | 3.1173194 | 1.0625023 |
| 19 | 3.1220923 | 1.0645749 |
| 20 | 3.133647 | 1.0695994 |
| 21 | 3.1426105 | 1.0735174 |
| 22 | 3.1551003 | 1.078901 |
| 23 | 3.1347609 | 1.0696765 |