

## Beam エネルギー vs Range 表 : 固体 -(1)

| Target  | AI                                                     | 2.702      | [g/cm3]    |            |            |            |           |           |          |          |
|---------|--------------------------------------------------------|------------|------------|------------|------------|------------|-----------|-----------|----------|----------|
| WSnm    | im208Pb_Al                                             | m129Xe_Al  | rim84Kr_Al | rim56Fe_Al | rim40Ar_Al | rim20Ne_Al | rim12C_Al | rim4He_Al | rim2H_Al | rim1H_Al |
| [MeV/u] | Beam エネルギー vs Range in Aluminum [μm]                   |            |            |            |            |            |           |           |          |          |
| E_beam  | 208Pb                                                  | 129Xe      | 84Kr       | 56Fe       | 40Ar       | 20Ne       | 12C       | 4He       | 2H       | 1H       |
| 135     | 2,499                                                  | 3,056      | 4,298      | 5,443      | 7,564      | 12,650     | 21,284    | 62,668    | 125,524  | 62,680   |
| 114     | 1,930                                                  | 2,324      | 3,247      | 4,075      | 5,652      | 9,404      | 15,824    | 46,626    | 93,406   | 46,654   |
| 95      | 1,474                                                  | 1,729      | 2,400      | 2,991      | 4,126      | 6,835      | 11,476    | 33,816    | 67,855   | 33,870   |
| 70      | 941                                                    | 1,066      | 1,452      | 1,779      | 2,438      | 3,980      | 6,678     | 19,688    | 39,440   | 19,690   |
| 50      | 589                                                    | 637        | 846        | 1,019      | 1,380      | 2,190      | 3,650     | 10,810    | 21,670   | 10,820   |
| 36      | 384                                                    | 394        | 507        | 599        | 801        | 1,232      | 2,039     | 6,020     | 12,096   | 6,030    |
| 10      | 94                                                     | 83         | 91         | 93         | 114        | 143        | 215       | 625       | 1,260    | 626      |
| 5       | 52                                                     | 44         | 45         | 42         | 48         | 53         | 72        | 190       | 381      | 190      |
| Target  | Si                                                     | 2.321      | [g/cm3]    |            |            |            |           |           |          |          |
| WSnm    | im208Pb_Si                                             | m129Xe_Si  | rim84Kr_Si | rim56Fe_Si | rim40Ar_Si | rim20Ne_Si | rim12C_Si | rim4He_Si | rim2H_Si | rim1H_Si |
| [MeV/u] | Beam エネルギー vs Range in Silicon [μm]                    |            |            |            |            |            |           |           |          |          |
| E_beam  | 208Pb                                                  | 129Xe      | 84Kr       | 56Fe       | 40Ar       | 20Ne       | 12C       | 4He       | 2H       | 1H       |
| 135     | 2,830                                                  | 3,457      | 4,865      | 6,157      | 8,562      | 14,308     | 24,076    | 70,882    | 141,976  | 70,885   |
| 114     | 2,190                                                  | 2,628      | 3,673      | 4,608      | 6,399      | 10,643     | 17,900    | 52,752    | 105,666  | 52,770   |
| 95      | 1,661                                                  | 1,956      | 2,709      | 3,379      | 4,668      | 7,735      | 12,982    | 38,270    | 76,780   | 38,320   |
| 70      | 1,066                                                  | 1,207      | 1,645      | 2,020      | 2,666      | 4,500      | 7,554     | 22,292    | 44,650   | 22,290   |
| 50      | 668                                                    | 722        | 960        | 1,154      | 1,560      | 2,480      | 4,140     | 12,240    | 24,550   | 12,260   |
| 36      | 435                                                    | 447        | 575        | 679        | 908        | 1,400      | 2,311     | 6,820     | 13,708   | 6,836    |
| 10      | 107                                                    | 94         | 104        | 106        | 130        | 163        | 245       | 712       | 1,430    | 713      |
| 5       | 59                                                     | 50         | 52         | 48         | 54         | 61         | 82        | 217       | 435      | 217      |
| Target  | GaN                                                    | 6.100      | [g/cm3]    |            |            |            |           |           |          |          |
| WSnm    | m208Pb_GaN                                             | m129Xe_GaN | m84Kr_GaN  | m56Fe_GaN  | m40Ar_GaN  | m20Ne_GaN  | m12C_GaN  | m4He_GaN  | m2H_GaN  | m1H_GaN  |
| [MeV/u] | Beam エネルギー vs Range in Gallium Nitride (ICRU-482) [μm] |            |            |            |            |            |           |           |          |          |
| E_beam  | 208Pb                                                  | 129Xe      | 84Kr       | 56Fe       | 40Ar       | 20Ne       | 12C       | 4He       | 2H       | 1H       |
| 135     | 1,272                                                  | 1,552      | 2,189      | 2,762      | 3,840      | 6,408      | 10,774    | 31,638    | 63,342   | 31,580   |
| 114     | 990                                                    | 1,185      | 1,651      | 2,077      | 2,876      | 4,782      | 8,037     | 23,596    | 47,241   | 23,558   |
| 95      | 756                                                    | 888        | 1,225      | 1,527      | 2,108      | 3,485      | 5,850     | 17,160    | 34,400   | 17,145   |
| 70      | 490                                                    | 553        | 751        | 920        | 1,258      | 2,050      | 3,428     | 10,040    | 20,090   | 10,020   |
| 50      | 311                                                    | 335        | 444        | 533        | 720        | 1,140      | 1,900     | 5,540     | 11,110   | 5,540    |
| 36      | 207                                                    | 212        | 271        | 319        | 426        | 654        | 1,075     | 3,106     | 6,244    | 3,102    |
| 10      | 54                                                     | 47         | 52         | 53         | 65         | 80         | 121       | 335       | 672      | 335      |
| 5       | 31                                                     | 26         | 27         | 25         | 28         | 31         | 41        | 105       | 210      | 105      |

| Target  | Epoxy                                              | 1.85        | [g/cm3]     |             |             |             |            |            |           |           |
|---------|----------------------------------------------------|-------------|-------------|-------------|-------------|-------------|------------|------------|-----------|-----------|
| WSnm    | m08Pb_Epoxy                                        | m29Xe_Epoxy | m34Kr_Epoxy | m56Fe_Epoxy | m40Ar_Epoxy | m20Ne_Epoxy | m12C_Epoxy | m4He_Epoxy | m2H_Epoxy | m1H_Epoxy |
| [MeV/u] | Beam エネルギー vs Range in Epoxy (molded) [μm]         |             |             |             |             |             |            |            |           |           |
| E_beam  | 208Pb                                              | 129Xe       | 84Kr        | 56Fe        | 40Ar        | 20Ne        | 12C        | 4He        | 2H        | 1H        |
| 135     | 2,895                                              | 3,547       | 4,995       | 6,331       | 8,802       | 14,720      | 24,776     | 72,962     | 146,188   | 73,055    |
| 114     | 2,235                                              | 2,685       | 3,760       | 4,716       | 6,555       | 10,913      | 18,365     | 54,120     | 108,462   | 54,212    |
| 95      | 1,690                                              | 1,996       | 2,769       | 3,452       | 4,762       | 7,900       | 13,266     | 39,122     | 78,515    | 39,225    |
| 70      | 1,072                                              | 1,217       | 1,665       | 2,040       | 2,798       | 4,570       | 7,674      | 22,632     | 45,340    | 22,660    |
| 50      | 663                                                | 720         | 959         | 1,156       | 1,570       | 2,500       | 4,160      | 12,320     | 24,710    | 12,350    |
| 36      | 426                                                | 440         | 568         | 672         | 901         | 1,392       | 2,301      | 6,804      | 13,670    | 6,824     |
| 10      | 98                                                 | 87          | 96          | 99          | 122         | 153         | 232        | 672        | 1,350     | 677       |
| 5       | 52                                                 | 44          | 46          | 42          | 48          | 54          | 74         | 197        | 399       | 199       |
| Target  | SiO2                                               | 2.320       | [g/cm3]     |             |             |             |            |            |           |           |
| WSnm    | m208Pb_SiO2                                        | m29Xe_SiO2  | m84Kr_SiO2  | m56Fe_SiO2  | m40Ar_SiO2  | m20Ne_SiO2  | m12C_SiO2  | m4He_SiO2  | m2H_SiO2  | m1H_SiO2  |
| [MeV/u] | Beam エネルギー vs Range in SiO2-quartz (ICRU-245) [μm] |             |             |             |             |             |            |            |           |           |
| E_beam  | 208Pb                                              | 129Xe       | 84Kr        | 56Fe        | 40Ar        | 20Ne        | 12C        | 4He        | 2H        | 1H        |
| 135     | 2,696                                              | 3,295       | 4,635       | 5,869       | 8,164       | 13,646      | 22,962     | 67,626     | 135,458   | 67,655    |
| 114     | 2,080                                              | 2,501       | 3,501       | 4,385       | 6,093       | 10,141      | 17,052     | 50,268     | 100,708   | 50,314    |
| 95      | 1,582                                              | 1,864       | 2,580       | 3,216       | 4,442       | 7,355       | 12,352     | 36,412     | 73,075    | 36,485    |
| 70      | 1,008                                              | 1,146       | 1,560       | 1,916       | 2,622       | 4,270       | 7,172      | 21,158     | 42,390    | 21,170    |
| 50      | 630                                                | 682         | 906         | 1,092       | 1,480       | 2,350       | 3,920      | 11,580     | 23,230    | 11,600    |
| 36      | 409                                                | 421         | 541         | 639         | 855         | 1,316       | 2,178      | 6,430      | 12,924    | 6,444     |
| 10      | 100                                                | 88          | 97          | 99          | 121         | 152         | 228        | 658        | 1,320     | 660       |
| 5       | 55                                                 | 47          | 48          | 45          | 51          | 57          | 77         | 198        | 398       | 199       |
| Target  | Cu                                                 | 8.920       | [g/cm3]     |             |             |             |            |            |           |           |
| WSnm    | m208Pb_Cu                                          | m129Xe_Cu   | m84Kr_Cu    | m56Fe_Cu    | m40Ar_Cu    | m20Ne_Cu    | m12C_Cu    | m4He_Cu    | m2H_Cu    | m1H_Cu    |
| [MeV/u] | Beam エネルギー vs Range in Copper [μm]                 |             |             |             |             |             |            |            |           |           |
| E_beam  | 208Pb                                              | 129Xe       | 84Kr        | 56Fe        | 40Ar        | 20Ne        | 12C        | 4He        | 2H        | 1H        |
| 135     | 902                                                | 1,102       | 1,548       | 1,951       | 2,716       | 4,530       | 7,624      | 22,420     | 44,878    | 22,370    |
| 114     | 702                                                | 840         | 1,175       | 1,466       | 2,037       | 3,389       | 5,690      | 16,742     | 33,506    | 16,704    |
| 95      | 537                                                | 630         | 870         | 1,080       | 1,494       | 2,465       | 4,146      | 12,184     | 24,435    | 12,175    |
| 70      | 348                                                | 393         | 533         | 652         | 892         | 1,450       | 2,434      | 7,148      | 14,310    | 7,130     |
| 50      | 221                                                | 238         | 315         | 378         | 510         | 809         | 1,350      | 3,960      | 7,940     | 3,950     |
| 36      | 147                                                | 150         | 192         | 226         | 301         | 462         | 761        | 2,228      | 4,474     | 2,228     |
| 10      | 40                                                 | 35          | 38          | 39          | 47          | 59          | 88         | 245        | 492       | 245       |
| 5       | 23                                                 | 20          | 20          | 18          | 21          | 23          | 31         | 78         | 156       | 78        |

## Beam エネルギー vs Range 表 : 固体 -(2)

|         |                                 |          |         |         |         |         |        |        |        |        |      |
|---------|---------------------------------|----------|---------|---------|---------|---------|--------|--------|--------|--------|------|
| Target  | W                               | 19.350   | [g/cm3] |         |         |         |        |        |        |        |      |
| WSnm    | m208Pb_W                        | m129Xe_W | m84Kr_W | m56Fe_W | m40Ar_W | m20Ne_W | m12C_W | m4He_W | m2H_W  | m1H_W  |      |
| [MeV/u] | Beam エネルギー vs Range in Tungsten |          |         |         |         |         |        |        |        |        | [μm] |
| E beam  | 208Pb                           | 129Xe    | 84Kr    | 56Fe    | 40Ar    | 20Ne    | 12C    | 4He    | 2H     | 1H     |      |
| 135     | 555                             | 674      | 948     | 1,196   | 1,660   | 2,764   | 4,640  | 13,622 | 27,194 | 13,485 |      |
| 114     | 435                             | 519      | 722     | 902     | 1,249   | 2,077   | 3,482  | 10,225 | 20,418 | 10,118 |      |
| 95      | 336                             | 392      | 540     | 670     | 924     | 1,525   | 2,552  | 7,492  | 14,980 | 7,425  |      |
| 70      | 221                             | 248      | 335     | 409     | 559     | 905     | 1,514  | 4,448  | 8,880  | 4,400  |      |
| 50      | 144                             | 153      | 202     | 241     | 325     | 513     | 852    | 2,500  | 5,000  | 2,470  |      |
| 36      | 97                              | 99       | 126     | 147     | 196     | 298     | 490    | 1,428  | 2,868  | 1,418  |      |
| 10      | 29                              | 26       | 28      | 28      | 34      | 42      | 62     | 171    | 343    | 169    |      |
| 5       | 18                              | 15       | 15      | 14      | 16      | 17      | 23     | 58     | 115    | 57     |      |

|         |                             |           |          |          |          |          |         |         |        |        |      |
|---------|-----------------------------|-----------|----------|----------|----------|----------|---------|---------|--------|--------|------|
| Target  | Pb                          | 11.344    | [g/cm3]  |          |          |          |         |         |        |        |      |
| WSnm    | m208Pb_Pb                   | m129Xe_Pb | m84Kr_Pb | m56Fe_Pb | m40Ar_Pb | m20Ne_Pb | m12C_Pb | m4He_Pb | m2H_Pb | m1H_Pb |      |
| [MeV/u] | Beam エネルギー vs Range in Lead |           |          |          |          |          |         |         |        |        | [μm] |
| E beam  | 208Pb                       | 129Xe     | 84Kr     | 56Fe     | 40Ar     | 20Ne     | 12C     | 4He     | 2H     | 1H     |      |
| 135     | 980                         | 1,186     | 1,668    | 2,102    | 2,922    | 4,870    | 8,182   | 23,974  | 47,834 | 23,695 |      |
| 114     | 767                         | 915       | 1,271    | 1,594    | 2,209    | 3,654    | 6,147   | 18,003  | 35,924 | 17,794 |      |
| 95      | 593                         | 692       | 953      | 1,185    | 1,626    | 2,690    | 4,502   | 13,200  | 26,380 | 13,055 |      |
| 70      | 391                         | 439       | 593      | 724      | 987      | 1,600    | 2,680   | 7,844   | 15,650 | 7,740  |      |
| 50      | 254                         | 272       | 357      | 428      | 576      | 909      | 1,510   | 4,420   | 8,820  | 4,360  |      |
| 36      | 173                         | 176       | 223      | 261      | 347      | 529      | 869     | 2,530   | 5,064  | 2,500  |      |
| 10      | 52                          | 45        | 49       | 50       | 61       | 75       | 112     | 305     | 610    | 300    |      |
| 5       | 31                          | 26        | 27       | 24       | 28       | 31       | 41      | 103     | 205    | 100    |      |

## Beam エネルギー vs Range 表 : 液体

|         |                                                |              |             |             |             |             |            |            |           |           |      |
|---------|------------------------------------------------|--------------|-------------|-------------|-------------|-------------|------------|------------|-----------|-----------|------|
| Target  | Water                                          | 1.00         | [g/cm3]     |             |             |             |            |            |           |           |      |
| WSnm    | m208Pb_Water                                   | m129Xe_Water | m84Kr_Water | m56Fe_Water | m40Ar_Water | m20Ne_Water | m12C_Water | m4He_Water | m2H_Water | m1H_Water |      |
| [MeV/u] | Beam エネルギー vs Range in Water_Liquid (ICRU-276) |              |             |             |             |             |            |            |           |           | [μm] |
| E beam  | 208Pb                                          | 129Xe        | 84Kr        | 56Fe        | 40Ar        | 20Ne        | 12C        | 4He        | 2H        | 1H        |      |
| 135     | 5,157                                          | 6,319        | 8,902       | 11,272      | 15,676      | 26,222      | 44,134     | 130,082    | 260,594   | 130,215   |      |
| 114     | 3,975                                          | 4,784        | 6,694       | 8,410       | 11,676      | 19,447      | 32,716     | 96,506     | 193,367   | 96,650    |      |
| 95      | 3,006                                          | 3,552        | 4,920       | 6,144       | 8,488       | 14,080      | 23,642     | 69,762     | 140,010   | 69,940    |      |
| 70      | 1,906                                          | 2,172        | 2,962       | 3,635       | 4,988       | 8,140       | 13,670     | 40,372     | 80,870    | 40,410    |      |
| 50      | 1,180                                          | 1,276        | 1,702       | 2,062       | 2,790       | 4,450       | 7,420      | 21,980     | 44,080    | 22,030    |      |
| 36      | 756                                            | 781          | 1,009       | 1,196       | 1,602       | 2,476       | 4,098      | 12,136     | 24,384    | 12,166    |      |
| 10      | 172                                            | 152          | 168         | 173         | 213         | 268         | 406        | 1,200      | 2,410     | 1,200     |      |
| 5       | 91                                             | 78           | 81          | 75          | 86          | 97          | 131        | 351        | 701       | 350       |      |

## Beam エネルギー vs Range 表 : 気体

|         |                                                           |             |           |           |           |           |          |          |           |         |      |
|---------|-----------------------------------------------------------|-------------|-----------|-----------|-----------|-----------|----------|----------|-----------|---------|------|
| 気温      | 25.0                                                      | °C          |           |           |           |           |          |          |           |         |      |
| 気圧      | 1013.0                                                    | hPa         |           |           |           |           |          |          |           |         |      |
| Target  | Air                                                       | 1.2050.E-03 | [g/cm3]   | ThkStd    | 0.9830    |           |          |          |           |         |      |
| WSnm    | m208Pb_Air                                                | m129Xe_Air  | m84Kr_Air | m56Fe_Air | m40Ar_Air | m20Ne_Air | m12C_Air | m4He_Air | m2H_Air   | m1H_Air |      |
| [MeV/u] | Beam エネルギー vs Range in Air, Dry near sea level (ICRU-104) |             |           |           |           |           |          |          |           |         | [mm] |
| E beam  | 208Pb                                                     | 129Xe       | 84Kr      | 56Fe      | 40Ar      | 20Ne      | 12C      | 4He      | 2H        | 1H      |      |
| 135     | 5,015                                                     | 6,131       | 8,639     | 10,936    | 15,209    | 25,427    | 42,784   | 125,953  | 253,568   | 126,685 |      |
| 114     | 3,872                                                     | 4,652       | 6,510     | 8,163     | 11,345    | 18,875    | 31,760   | 93,510   | 188,308   | 94,105  |      |
| 95      | 2,938                                                     | 3,464       | 4,793     | 5,977     | 8,258     | 13,688    | 22,981   | 67,659   | 136,472   | 68,165  |      |
| 70      | 1,873                                                     | 2,128       | 2,896     | 3,552     | 4,873     | 7,935     | 13,331   | 39,217   | 78,963    | 39,451  |      |
| 50      | 1,170                                                     | 1,267       | 1,683     | 2,024     | 2,737     | 4,364     | 7,274    | 21,394   | 43,144    | 21,557  |      |
| 36      | 757                                                       | 780         | 1,004     | 1,186     | 1,589     | 2,452     | 4,051    | 11,839   | 23,929    | 11,935  |      |
| 10      | 180                                                       | 159         | 176       | 180       | 221       | 277       | 419      | 1,190    | 2,401     | 1,200   |      |
| 5       | 98                                                        | 84          | 86        | 80        | 91        | 102       | 139      | 354      | 713       | 356     |      |
| Target  | He                                                        | 1.8000.E-04 | [g/cm3]   | ThkStd    | 0.9830    |           |          |          |           |         |      |
| WSnm    | m208Pb_He                                                 | m129Xe_He   | m84Kr_He  | m56Fe_He  | m40Ar_He  | m20Ne_He  | m12C_He  | m4He_He  | m2H_He    | m1H_He  |      |
| [MeV/u] | Beam エネルギー vs Range in Helium (gas)                       |             |           |           |           |           |          |          |           |         | [mm] |
| E beam  | 208Pb                                                     | 129Xe       | 84Kr      | 56Fe      | 40Ar      | 20Ne      | 12C      | 4He      | 2H        | 1H      |      |
| 135     | 29,975                                                    | 36,757      | 51,836    | 65,661    | 91,338    | 152,840   | 257,287  | 759,255  | 1,538,168 | 769,369 |      |
| 114     | 23,056                                                    | 27,789      | 38,933    | 48,882    | 67,913    | 113,182   | 190,453  | 562,456  | 1,136,942 | 570,313 |      |
| 95      | 17,396                                                    | 20,581      | 28,552    | 35,653    | 49,284    | 81,781    | 137,367  | 405,899  | 824,583   | 412,101 |      |
| 70      | 10,977                                                    | 12,511      | 17,087    | 21,031    | 28,835    | 47,091    | 79,153   | 234,164  | 474,950   | 237,450 |      |
| 50      | 6,739                                                     | 7,339       | 9,793     | 11,850    | 16,043    | 25,626    | 42,768   | 127,011  | 257,989   | 128,984 |      |
| 36      | 4,289                                                     | 4,440       | 5,751     | 6,828     | 9,160     | 14,191    | 23,495   | 69,808   | 142,167   | 70,969  |      |
| 10      | 913                                                       | 807         | 897       | 924       | 1,139     | 1,434     | 2,167    | 6,745    | 13,754    | 6,877   |      |
| 5       | 476                                                       | 407         | 419       | 390       | 444       | 498       | 674      | 1,943    | 3,947     | 1,974   |      |