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WebSPIT

Philip A. Wilk

Introduction

SPIT is an adaptation by John Wild [Wild 1988] of a neutron evaporation code that has been in circulation around LBNL and LLNL. It is a program for calculating fusion product cross sections for reactions that de-excite through neutron emission. It was originally written in FORTRAN for the VAX microcomputer. It is related closely to another neutron evaporation code JORPLE written by Jose Alonso [Alonso 1974]. SPIT uses a different set of potentials and does a better job of reproducing the excitation function shapes than JORPLE, though both predict approximately the same excitation peak energy. The main difference [Haynes 1988] between the two programs is that JORPLE uses a standard Coulomb potential and the Woods-Saxon potential, while SPIT uses a Bondorf, Sobel, and Sperber coulomb potential [Bondorf 1974] and the Bass proximity potential [Bass 1974]. Our group, the Heavy Element Nuclear & Radiochemistry Group, here at LBNL has made extensive use of this code for estimating reaction cross sections for experiments that are to be performed at the 88-Inch cyclotron. It requires no calculation parameters aside from the Z and A of the projectile and target nucleus, and this feature has allowed us to use it in a consistent manner for experiments here for over ten years. The cross sections that are calculated with SPIT are consistently within an order of magnitude of those experimentally observed.

While it is a straight forward task to translate the FORTRAN code to different platforms, a much more useful solution would be to make a web-based application out of the code that would allow any of our group members to use the code without having to modify and compile it to whatever computer platform they are using. In addition, it was possible to use freely available graphing software to produce a convenient and quick plot of the data, all accessible via a web interface.

Providing a full primer on writing web interfaces for legacy code is beyond the scope of this report and is covered extensively elsewhere [Locklin 1998]. However, in this report I will try to document this specific application and provide source code for the portion I wrote. I also suggest that anybody interested in writing CGI scripts become somewhat familiar with the security issues involved [Phillips 1995, Stein 2001, Christiansen 1996]. I am currently running the application on a computer using the FreeBSD operating system and the application can be viewed (and used) indefinitely at the following uniform resource locator (URL): http://socrates.berkeley.edu/~pwilk/spit.html. The compiler used was the Gnu Compiler Collection that includes support for FORTRAN. For the graphical output I chose GnuPlot, another free application that is easily installable in package form. Since the Gnu compiler and GnuPlot has been ported to basically every platform and is widely used in the scientific community, I can expect my software to be easily transportable if I need to move it to another server running a different operating system.

The SPIT code I started with was the code originally written by John Wild [Wild 1988]. My version of the program was his original code, modified only so that it would compile with the Gnu compiler and output to STDIO (standard input and output), rather than a file. In addition, I added that the first few lines of the SPIT output be prefaced by "#" characters. This makes it easier to use with GnuPlot ("#" characters are ignored).

spit.html

The user directly references this file, spit.html as a URL. It is a hypertext markup language (HTML) form that is interpreted by the browser to allow the user to enter in the atomic number and weight (integer values) of the projectile and target. These values are then passed as parameters to the spit-cgi.pl script that is interpreted by the Perl program [Wall 1987].

spit-cgi.pl

This CGI (common gateway interface) script acts as a "wrapper" for the SPIT program, which is written in FORTRAN. While it is possible to convert the entire program to Perl, it saves an enormous amount of work to use a bit of Perl code to call up the FORTRAN program and intercept the output. Version 5 of the Perl interpreter was used. It is best to invoke Perl CGI scripts in "taint" mode (the "-T" command line option), which offers some protection from malicious attacks through the HTML form [Birznieks 1998]. In addition the use of the command line option "-w" allows for all script warnings that will then be saved to the server log. I also did a little bit of checking to make sure the parameters that were passed from the form were only digits.

The Perl script begins by writing out the parameters to a file that will be read by the SPIT executable file. The Perl script then intercepts all the output from the SPIT executable which is in the form of a multi-column table of numbers (see: Sample Output, Complete Data). This table is then fed through GnuPlot, which generates a graphical plot in portable network graphics (PNG) format. Finally, the Perl script generates the HTML that will be delivered to the user after the web-form submission. This HTML includes a reference to the just generated PNG graphic as well as the complete text of the SPIT table, which allows the user to cut and paste the table into another program (such as Microcal Origin or Microsoft Excel) if the plot is not of sufficient quality.

References

I have copies of all these references, if they are no longer available on the web.

[Alonso 1974] J. Alonso, edited by R. Warncke, *Gmelin Hanbuch der Anorganishen Chemie*, Vol. 7b, p. 28, (Springer-Verlag, New York, 1974).

[Bass 1974] R. Bass, *Nuclear Physics A*, **A231**, 45-63 (1974).

[Birznieks 1998] G. Birznieks, CGI/Perl Taint Mode FAQ, http://gunther.web66.com/FAQS/taintmode.html (1998).

[Bondorf 1974] J. R. Bondorf, M. I. Sobel, D. Sperber, *Physics Reports. Physics Letters Section C*, **15c**, 83-111 (1974).

[Christiansen 1996] T. Christiansen, S. Gundavaram, Perl CGI Programming FAQ, http://www.perl.com/CPAN-local/doc/FAQs/cgi/perl-cgi-faq.html (1996).

[Haynes 1988] G. R. Haynes, J. D. Leyba, D. C. Hoffman, Department of Energy Undergraduate Science and Engineering Research Semester report (1988).

[Locklin 1998] S. C. Locklin, “Integrating legacy software with a Web front end”, *Netscape Enterprise Developer*, http://www.ne-dev.com/ned-05-1998/ned-05-legacy.html, (May 1998).

[Phillips 1995] P. Phillips, Safe CGI Programming, http://www.improving.org/paulp/cgi-security/safe-cgi.txt (1995).

[Stein 2001] L. Stein, in WWW Security FAQ: Safe Scripting in Perl, http://www.w3.org/Security/Faq/wwwsf5.html (2001).

[Wall 1987] L. Wall, the Perl programming language (1987), for more information and to obtain the latest software (version 5) see: http://www.perl.org or http://www.cpan.org.

[Wild 1988] J. F. Wild, private communication (1988).

Appendix

File: spit.html

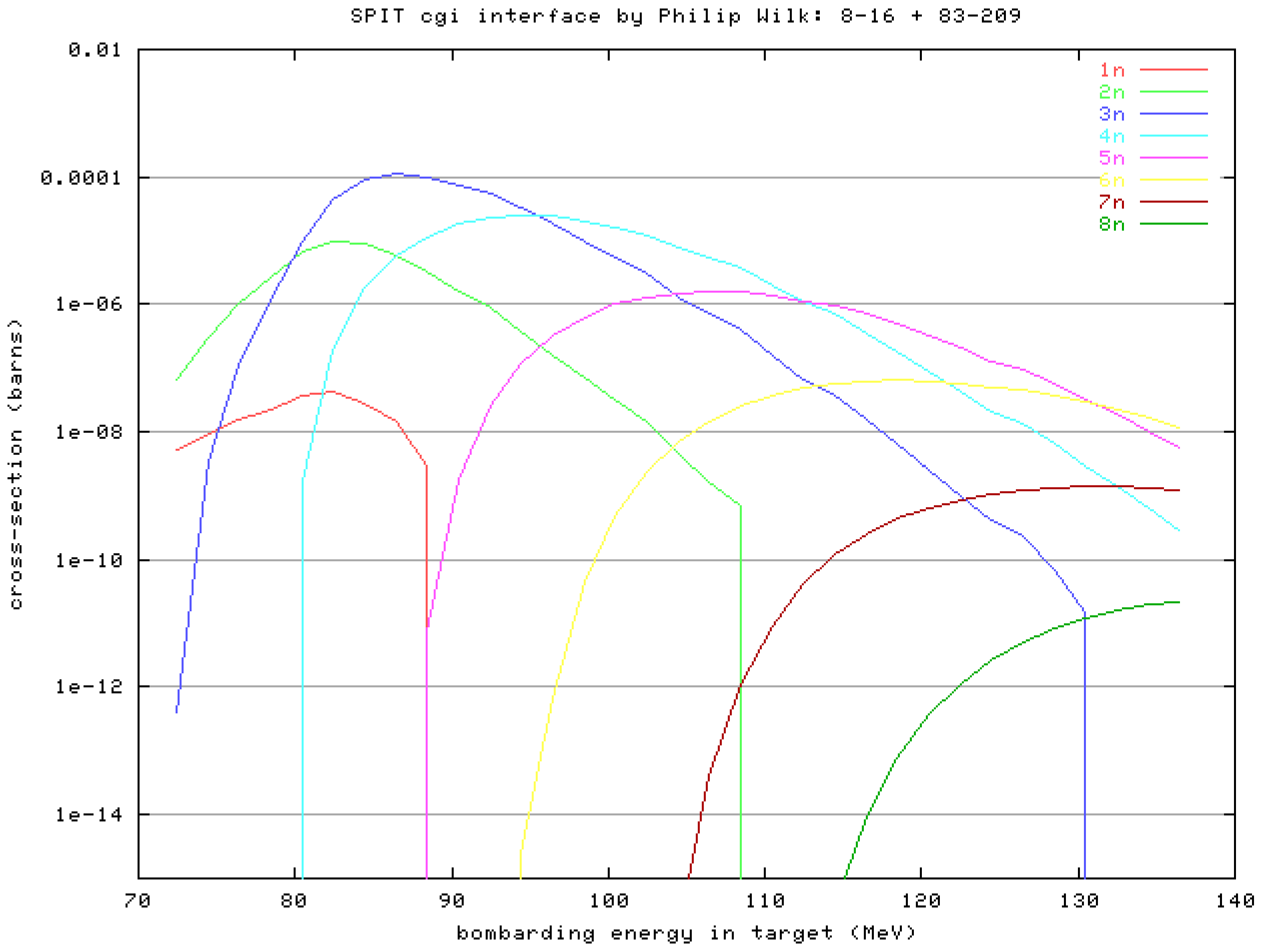
```
<html>
<head>
<title>Spit Calculation</title>
</head>
<body>
<h1> Spit Calculation </h1>
<form method="GET" action="/cgi-bin/spit-cgi.pl">
 <P>enter the Z of the projectile:<input type=text name="one" size=3 maxsize=3><br>
 <P>enter the A of the projectile:<input type=text name="two" size=3 maxsize=3><br>
 <P>enter the Z of the target:<input type=text name="three" size=3 maxsize=3><br>
 <P>enter the A of the target:<input type=text name="four" size=3 maxsize=3><br>
 <P><input type=submit value="submit"> * <input type=reset value="reset">
</form><hr>
<p>
This is a web interface that I wrote for the SPIT code by John Wild (1988). The SPIT code
is a neutron evaporation code for nuclear fusion reactions written in Fortran. The web
interface for the SPIT code is a CGI wrapper written in Perl. For more information about
web integration of legacy code for scientific purposes, see: Locklin and Wilk, LBNL-XXXX
(2001).
<br>
<br>
 - Philip Wilk
</body>
</html>
```

File: spit-cgi.pl

```
#!/usr/bin/perl5 -w -T
# Note that many machines will have perl in /usr/local/bin/perl
# WebSPIT CGI script version 1.1 by Philip A. Wilk
# 17-OCT-2000 Birthday
# 30-MAY-2001 Improved the security a little
```

```
$ENV{'PATH'} = '/bin:/usr/bin:/usr/local/bin';
use CGI(param);

    $PAMS[1] = param("one");
    $PAMS[2] = param("two");
    $PAMS[3] = param("three");
    $PAMS[4] = param("four");

 # Do a little testing to make sure our parameters are actually digits

    $PAMS[1] =~ /\D/ && die "Input Error\n";
    $PAMS[2] =~ /\D/ && die "Input Error\n";
    $PAMS[3] =~ /\D/ && die "Input Error\n";
    $PAMS[4] =~ /\D/ && die "Input Error\n";

 # Write out the parameters for the Fortran code

 open(OUTPUT,">/tmp/spit.in");
 $inc = 1;
 while ($inc <= 4){
   printf OUTPUT ("%d",$PAMS[$inc]);
   printf OUTPUT " ";
   $inc++;
 }
 close(OUTPUT);

 # Call the Fortran routine and pipe the output to the variable $answers
 # Change the CGI directory to whatever directory is currently being used

 open(RESULTS," /home/account/public_html/cgi-bin/spit-cgi.exe|");
 @answers = <RESULTS>;
 close(RESULTS);

 # save to data file
 open(OUTPUT,">/tmp/spit.out");
 printf OUTPUT ("@answers\n");
 close(OUTPUT);

 # generate plot in png format

 open(GP,"|/usr/local/bin/gnuplot");
 printf GP ("set zero 0.0\n");
 printf GP ("set title \"SPIT cgi interface by Philip Wilk: $PAMS[1]-$PAMS[2] + $PAMS[3]-
$PAMS[4]\"\n");
 printf GP ("set xlabel \"bombarding energy in target (MeV)\"\n");
 printf GP ("set ylabel \"cross-section (barns)\"\n");
 printf GP ("set terminal png color\n");
 printf GP ("set grid ytics\n");
 printf GP ("set logscale y\n");
 printf GP ("set yrange [1e-15:]\n");
 printf GP ("set mytics 10\n");
 # Choose a temporary directory that is accessible via the web
 printf GP ("set out '/home/account/public_html/tmp/spit.$$.png'\n");
 printf GP ("plot '/tmp/spit.out' using 1:2 title '1n' with lines, '/tmp/spit.out' using
1:3 title '2n' with lines, '/tmp/spit.out' using 1:4 title '3n' with lines,
'/tmp/spit.out' using 1:5 title '4n' with lines, '/tmp/spit.out' using 1:6 title '5n'
with lines, '/tmp/spit.out' using 1:7 title '6n' with lines, '/tmp/spit.out' using 1:8
title '7n' with lines, '/tmp/spit.out' using 1:9 title '8n' with lines\n");
 close (GP);

 # Print beginning of HTML

 print "Content-Type: text/html\n\n";
 print "<html><head><title>Web Spit</title>\n";
 print "</head>\n";
 print "<body><h1>The results:</h1>\n";

 # Print the information

 print ("<p>\n");
 print ("<img src=\"http://www.mycomputer.gov/~account/tmp/spit.$$.png\"
 alt=\"data plot\">\n");

 print ("<p>\n");

 print ("<pre>\n");

 printf ("@answers\n");

 print ("</pre>\n");

 #  Print the end of the HTML file

 print "</body></html>\n";
```

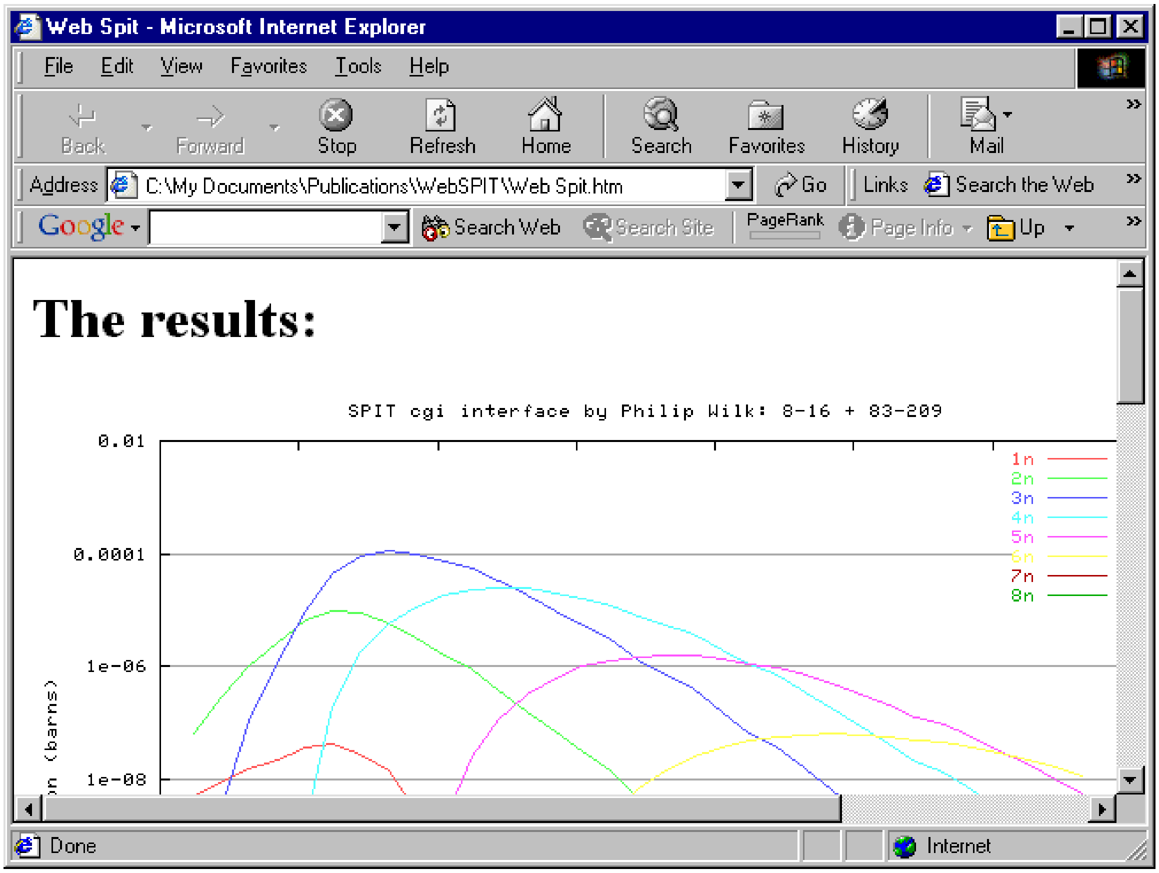
Sample Output, Complete Data



```
#     8   16    -4.737
#    83  209   -17.298
#    91  225    24.561

#     E          1          2          3          4          5          6          7          8
#   -----      -----      -----      -----      -----      -----      -----      -----      -----
   136.446   0.00E+00   0.00E+00   0.00E+00   0.29E-09   0.57E-08   0.12E-07   0.12E-08   0.22E-10
   134.446   0.00E+00   0.00E+00   0.00E+00   0.64E-09   0.10E-07   0.17E-07   0.13E-08   0.20E-10
   132.446   0.00E+00   0.00E+00   0.00E+00   0.14E-08   0.19E-07   0.23E-07   0.14E-08   0.16E-10
   130.446   0.00E+00   0.00E+00   0.15E-10   0.30E-08   0.33E-07   0.30E-07   0.14E-08   0.12E-10
   128.446   0.00E+00   0.00E+00   0.71E-10   0.63E-08   0.57E-07   0.38E-07   0.13E-08   0.83E-11
```

```
 126.446    0.00E+00   0.00E+00   0.23E-09   0.13E-07   0.97E-07   0.46E-07   0.12E-08   0.51E-11
 124.446    0.00E+00   0.00E+00   0.41E-09   0.21E-07   0.13E-06   0.50E-07   0.11E-08   0.27E-11
 122.446    0.00E+00   0.00E+00   0.10E-08   0.43E-07   0.21E-06   0.58E-07   0.89E-09   0.11E-11
 120.446    0.00E+00   0.00E+00   0.26E-08   0.90E-07   0.33E-06   0.63E-07   0.66E-09   0.37E-12
 118.446    0.00E+00   0.00E+00   0.63E-08   0.18E-06   0.49E-06   0.65E-07   0.44E-09   0.79E-13
 116.446    0.00E+00   0.00E+00   0.16E-07   0.36E-06   0.70E-06   0.63E-07   0.25E-09   0.92E-14
 114.446    0.00E+00   0.00E+00   0.38E-07   0.71E-06   0.95E-06   0.58E-07   0.12E-09   0.39E-15
 112.446    0.00E+00   0.00E+00   0.67E-07   0.11E-05   0.11E-05   0.48E-07   0.40E-10   0.40E-18
 110.446    0.00E+00   0.00E+00   0.16E-06   0.20E-05   0.14E-05   0.37E-07   0.92E-11   0.10E-18
 108.446    0.00E+00   0.67E-09   0.39E-06   0.37E-05   0.16E-05   0.25E-07   0.11E-11   0.00E+00
 106.446    0.00E+00   0.17E-08   0.70E-06   0.54E-05   0.16E-05   0.14E-07   0.39E-13   0.00E+00
 104.446    0.00E+00   0.44E-08   0.13E-05   0.77E-05   0.15E-05   0.69E-08   0.15E-15   0.00E+00
 102.446    0.00E+00   0.14E-07   0.30E-05   0.12E-04   0.13E-05   0.24E-08   0.00E+00   0.00E+00
 100.446    0.00E+00   0.31E-07   0.55E-05   0.16E-04   0.10E-05   0.50E-09   0.00E+00   0.00E+00
  98.446    0.00E+00   0.69E-07   0.10E-04   0.20E-04   0.64E-06   0.45E-10   0.00E+00   0.00E+00
  96.446    0.00E+00   0.16E-06   0.18E-04   0.24E-04   0.33E-06   0.67E-12   0.00E+00   0.00E+00
  94.446    0.00E+00   0.37E-06   0.32E-04   0.25E-04   0.12E-06   0.24E-14   0.00E+00   0.00E+00
  92.446    0.00E+00   0.86E-06   0.54E-04   0.23E-04   0.26E-07   0.00E+00   0.00E+00   0.00E+00
  90.446    0.00E+00   0.16E-05   0.75E-04   0.18E-04   0.18E-08   0.00E+00   0.00E+00   0.00E+00
  88.446    0.30E-08   0.32E-05   0.97E-04   0.11E-04   0.74E-11   0.00E+00   0.00E+00   0.00E+00
  86.446    0.14E-07   0.58E-05   0.11E-03   0.57E-05   0.00E+00   0.00E+00   0.00E+00   0.00E+00
  84.446    0.28E-07   0.92E-05   0.90E-04   0.18E-05   0.00E+00   0.00E+00   0.00E+00   0.00E+00
  82.446    0.42E-07   0.10E-04   0.45E-04   0.19E-06   0.00E+00   0.00E+00   0.00E+00   0.00E+00
  80.446    0.38E-07   0.66E-05   0.98E-05   0.16E-08   0.00E+00   0.00E+00   0.00E+00   0.00E+00
  78.446    0.23E-07   0.26E-05   0.12E-05   0.00E+00   0.00E+00   0.00E+00   0.00E+00   0.00E+00
  76.446    0.16E-07   0.10E-05   0.11E-06   0.00E+00   0.00E+00   0.00E+00   0.00E+00   0.00E+00
  74.446    0.94E-08   0.30E-06   0.34E-08   0.00E+00   0.00E+00   0.00E+00   0.00E+00   0.00E+00
  72.446    0.54E-08   0.65E-07   0.39E-12   0.00E+00   0.00E+00   0.00E+00   0.00E+00   0.00E+00
```

Sample Output, Screen Shot


Web Spit - Microsoft Internet Explorer
File Edit View Favorites Tools Help
Back Forward Stop Refresh Home Search Favorites History Mail
Address
Go Links Search the Web
Google
Search Web Search Site PageRank Page Info Up
Done
Internet

Address: C:\My Documents\Publications\WebSPIT\Web Spit.htm

The results:

SPIT cgi interface by Philip Wilk: 8-16 + 83-209
0.01
0.0001
1e-06
1e-08
n (barns)
1n
2n
3n
4n
5n
6n
7n
8n