MCNPX Overview

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HSSW, FNAL, September 6-8, 2006
Outline

• MCNPX Summary and Development History

• User Base, Web Site, Development Philosophy

• Physics and Capability Details

• Select 2.5.0 Features

• Future Development
MCNPX Summary

- **Monte Carlo radiation transport code**
  - Extends MCNP 4C to virtually all particles and energies
  - 34 particle types (\(n,p,e,5\) Leptons, \(11\) Baryons, \(11\) Mesons, \(4\) LI)
  - Continuous energy (roughly 0-100 GeV)
  - Data libraries below ~ 150 MeV (\(n,p,e,h\)) and models otherwise

- **General 3-D geometry**
  - 1\textsuperscript{st} & 2\textsuperscript{nd} degree surfaces, tori, 10 macrobodies, lattices

- **General sources and tallies**
  - Interdependent source variables, 7 tally types, many modifiers

- **Supported on virtually all computer platforms**
  - Unix, Linux, Windows, OS X (parallel with PVM or MPI)
Development History

• **MCNP & LAHET Merger Project** 1995
• **Version 2.1.5** November 14, 1999
  – HISTP/HTAPE3X, Mesh & radiography tallies, CEM
• **Version 2.3.0** April 27, 2002
  – Proton libraries
• **Version 2.4.0** August 1, 2002
  – Update to MCNP 4C, Fortran 90, Windows PC support
• **Version 2.5.0** March 21, 2005
  – Twenty-eight features
Development History

• **Version 2.6.A** December 5, 2005
  – Eigenfunction convergence, Burnup, Long file names

• **Version 2.6.B** June 1, 2006
  – CEM 03, Updated PHTLIB, Burnup predictor-corrector

• **Version 2.6.C** ~November, 2006
  – Activation n+γ, Spherical WW, Photon tally tagging
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User Base

• **~2500 users world wide**
  – Provide 6-8 workshops per year (4-6 US, ~2 international)
  – 150 workshop participants per year
  – Access to RSICC/NEA released versions only
    • [http://rsicc.ornl.gov](http://rsicc.ornl.gov)
  – Limited access to MCNPX web site
    • [http://mcnpx.lanl.gov](http://mcnpx.lanl.gov) (some documentation)

• **~2000 registered Beta Testers**
  – Full access to MCNPX web site
  – Access to intermediate versions
  – Increased user support
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Welcome to the home of the MCNPX code!

MCNPX is a general-purpose Monte Carlo radiation transport code for modeling the interaction of radiation with everything. MCNPX stands for Monte Carlo N-Particle eXtended. It extends the capabilities of MCNP4C3 to nearly all particle types, to nearly all energies, and to nearly all applications without additional computational time penalty. MCNPX is fully three-dimensional and time dependent. It utilizes the latest nuclear cross section libraries and uses physics models for particle types and energies where tabular data are not available. Applications range from outer space (the discovery of water on Mars) to deep underground (where radiation is used to search for oil.) MCNPX is used for nuclear medicine, nuclear safeguards, accelerator applications, nuclear criticality, and much more.

MCNPX is available (source code, executables, data) from the Radiation Safety
MCNPX Source Code Page

This is the place to find copies of the code.

**General Release**

MCNPX version 2.5.0 is currently available from RSICC, The Radiation Safety Information Computational Center at Laboratory. It will soon be available from OECD/NEA, The European Community Organization for Economic Coope Nuclear Energy Agency.

For code access, contact RSICC or OECD/NEA for copies.

**Beta Release**

MCNPX is under active development and newer versions are available to beta testers under a beta test agreement. The beta testing program should contact the MCNPX team, mcnpx@lanl.gov, for information.

Beta testers can access the code by using Beta Release access.

**Developer Release**

For sponsors and MCNPX developers, intermediate developmental versions are available. Developers can access the access.
MCNPX Document Page

Reports and Papers


John S. Hendricks, "MCNPX Model/Table Comparison," LA-14030 (March 2003) (3.3 MB), is a 50-page report dem-mix-and-match capability and assessing the ability to use neutron physics models below 20-MeV.

The following papers describe the CEM03 physics model: LA-UR-06-1764 cover page (.05 MB), LA-UR-06-1764 (1 MB).

The following papers describe the INCL4 physics model (IntraNuclear Cascade Liege - Cugnon) and ABLA physics (Schmidt(GSI)): NuclPhys620_475 (1.5 MB), NuclPhys625_729 (1.2 MB), NuclPhys628_458 (1.0 MB), NuclPhys628 PhysRevC33_2039 (3.1 MB), PhysRevC66_44615 (.5 MB).


Installation Notes:
Development Philosophy

- **Quality**
  - Active Beta Testers (~2000)
  - Bug rewards ($4 for old bugs, $20 new bugs)
  - Extensive test suite (~300 problems, ~75% coverage)

- **Value**
  - Thorough documentation (manual, web site)
  - Users forum
  - Three levels of workshops (intro, intermediate, advanced)

- **Features**
  - Beta release ~3 months
  - Public release ~2 years
  - Average ~1 feature/month
Outline

• MCNPX Summary and Development History
• User Base, Web Site, Development Philosophy
• Physics and Capability Details
• Select 2.5.0 Features
• Future Development
<table>
<thead>
<tr>
<th>General</th>
<th>MCNPX</th>
<th>GEANT4</th>
<th>FLUKA</th>
<th>MARS</th>
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**Models**

- CSDA
- Bethe-Bloch
- Rossi
- Vavilov
- No

**Cont. (ENDF)**

- Models

**Model List:**

- Bertini
- ISOBEL
- CEM
- INCL
- FLUKA89>3 GeV
- LAQGSM (2.6.D)

**Charged particles**

- Energy loss
  - Beta-Bloch
  - Lewis
  - Custom
- Scatter
- Straggling
- XTR/Cherenkov
- No

**Leptons**

- Electrons
- Muon
- Neutrino
- Other

**Theory**

- ITS 3.0
- CSDA/decay
- Production
- Decay

**Models**

- EEDL, EADL
- Production
- Decay
- Custom
- Models
- Decay
- Custom
- Models
- Decay

**Theory**

- ITS 3.0
- CSDA/decay
- Models
- Models
- Models
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Outline

• MCNPX Summary and Development History
• User Base, Web Site, Development Philosophy
• Physics and Capability Details
• Select 2.5.0 Features
• Future Development
Select 2.5.0 Features

• User-interface enhancements (15)
  – 5 new source options
  – 4 new tally options
  – 3 new graphics options
  – 3 other miscellaneous improvements

• Physics enhancements (9)
  – 4 new model physics features
  – 2 new neutron physics features
  – 3 new photon physics features

• Infrastructure enhancements (4)
User-Interface Enhancements

- Five new source options
  - Positron sources
  - Spontaneous fission sources
  - Multiple source particles
  - Default VEC for cylindrical sources
  - Extension of the TR keyword
Multiple Source Particles / TR Extension

Distribution for PAR and TR Keywords
1 0 -1 imp:n=1
2 0 1 imp:n=0

1 SPH 0 0 0 100

mode n p
sdef par=d1 erg=fpar=d2 tr=fpar=d3
  x=d4 y=d5 z=0 cell=1
s1  L n p
sp1  1 1
ds2  L 1.0 2.0
ds3  L 1 2
s4  -50 50
sp4  0 1
s5  -50 50
sp5  0 1
tr1  -50 50 0
tr2  50 -50 0
nps 10000
tmesh
  rmesh2  n p
cora2  -100 99i 100
corb2  -100 99i 100
corc2  -1 1
endmd
User-Interface Enhancements

• **Four new tally options**
  – Lattice tally speedup
  – Anticoincidence pulse-height tally
  – Coincidence capture pulse-height tally
  – Residual nuclei pulse-height tally
Anticoincidence Pulse-Height Tally

Anticoincidence PHT 1 MeV Photons => Plastic/BGO
1 1 -7.130 -1 imp:p=1
2 2 -1.032  1 -2  3 imp:p=1
3 0         1 -2 -3 imp:p=1
4 0         2 imp:p=0

1 SPH 0 0 0 5.0
2 SPH 0 0 0 6.0
3 RCC -7 0 0 4 0 0 3.0

mode p e
sdef sur=2 nrm=-1 par=p erg=1.0
nps 100000
m1 83000 -0.671 32000 -0.175 8000 -0.154
m2 6000 -0.9153 1000 -0.0847
f26:e 2 $ Plastic energy dep
ft26 GEB 0 0.1098 0
sd26 1
f36:e 1 $ BGO energy dep.
ft36 GEB 0 0.1098 0
sd36 1
f18:e 1 $ Plastic/BGO PHT
e18 0. 1.0
fu18 0. 99i 1.0
ft18 phl 1 26 1 1 36 1
fu18 u e
### Anticoincidence Pulse-Height Tally

**tally 18**

nps = 100000

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- B: Plastic
- G: BGO
- O: Anticoincidence

ACS/BGO Pulse Height Response - all particles

- Particle(s): photon, electron
- Units: number
- Particle type: photon, electron
- Tally type: 8
- Pulse height distribution
- Cell 1
- Energy: 0.0000E+00, 1.0000E+00
- Total
- This tally is modified by ft phl
Anticoincidence Pulse-Height Tally

Pulse-Height Tally

Accepted Spectrum

Rejected Spectrum
Residuals for 1.2 GeV Protons => Pb

1 1 -11. -1 imp:h 1
2 0 1 imp:h 0

1 so .01

mode h n
sdef par h erg=1200
  vec 0 0 1 dir 1
ml 82208 1
phys:h 1300 j 0
phys:n 1300 3j 0
nps 10000
f8:h 1
ft8 RES 1 99
lca 7j -2 0

All Isotopes
Residual Nuclei Pulse-Height Tally

All Pb Isotopes

[Bar chart showing the pulse-height tally for various lead isotopes.]

Operated by the Los Alamos National Security, LLC for the DOE/NNSA
User-Interface Enhancements

• Three new graphics options
  – Lattice index labeling
  – WWG superimposed mesh plots
  – Color contour and mesh tally plots
WWG Superimposed Mesh Plots

Cylindrical WW Mesh-3 MeV Photons => H2O
1 1 1.0 -1 imp:p 1
2 0 1 imp:p 0
1 rcc 0 0 0 0 10 0 5

mode p
sdef sur=1.3 vec=0 1 0 dir=1 erg=3
ml 1001 2 8016 1
nps 1000000
f1:p 1.2
wwg 1 0
mesh geom=cyl origin=0 -1 0 ref=0 .1 0
  axs=0 1 0 vec=1 0 0
  imesh 6 iints 7
  jmesh 12 jints 7
  kmesh 1 kints 3

Cylindrical WW Mesh-3 MeV Photons => H2O
1 1 1.0 -1 imp:p 1
2 0 1 imp:p 0
1 rcc 0 0 0 0 10 0 5

mode p
sdef sur=1.3 vec=0 1 0 dir=1 erg=3
ml 1001 2 8016 1
nps 1000000
f1:p 1.2
wwg 1 0
mesh geom=cyl origin=0 -1 0 ref=0 .1 0
  axs=0 1 0 vec=1 0 0
  imesh 6 iints 14
  jmesh 12 jints 14
  kmesh 1 kints 6
wwp:p 4j -1
Color Contour and Mesh Tally Plots

HEU Cans in a Hex Lattice
1 1 -8.4 -1 u=1 imp:n=1
2 0 -2 u=1 imp:n=1
3 2 -2.7 -3 1 2 u=1 imp:n=1
4 3 -.001 3 u=1 imp:n=1
10 3 -.001 -6 lat=2 u=2 imp:n=1 fill=-2:2 -2:2 0:0
   2 2 2 2 2 2 1 1 2 2 1 1 2 2 1 1 2 2 2 2 2
11 0 -8 imp:n=1 fill=2
50 0 8 imp:n=0

1 rcc 0 0 0 0 12 0 5
2 rcc 0 12 0 0 8 0 5
3 rcc 0 -1 0 0 22 0 6
6 rhp 0 -1 0 0 22 0 9 0 0
8 rcc 0 -1 0 0 22 0 30

m1 1001 5.7058e-2 8016 3.2929e-2 92238 2.0909e-3 92235 1.0889e-4
m2 13027 1
m3 7014 .8 8016 .2
kcode 10000 1 10 40
ksrc 0 6 0 -18 6 0 9 6 15 -9 6 15 9 6 -15 -9 6 -15
tmesh
   rmesh12
  coral12 -30.53i 30.
  corb12 0.12.
corcl2 -30.35i 30.
endmd
Color Contour and Mesh Tally Plots

Air

HEU

~5% Enriched

Aluminum
04/12/05 15:41:44

Cylinders containing critical fluid in macrobody hex lattice

probid = 04/11/05 16:42:09
basis: XZ
(1.000000, 0.000000, 0.000000)
(0.000000, 0.000000, 1.000000)
origin:
(0.00, 5.00, 0.00)
extent = (40.00, 40.00)

Edit cel 1
Cell 1
xyz = 0.00, 5.00, 0.00
CURSOR SCALES 0 MT+Cell
PostScript ROTATE
COLOR ta12 LEVEL
XY YZ ZX
LABEL off off
MBODY on

Click here or picture or menu

Redraw Plot> End
User-Interface Enhancements

• Three other miscellaneous improvements
  – READ card
  – HISTP card extension
  – DXTRAN/Detector underflow control
User-Interface Enhancements

HEU Cans in a Hex Lattice

READ FILE=cells NOECHO

READ FILE=surfaces

m1 1001 5.7058e-2 8016 3.2929e-2
   92238 2.0909e-3 92235 1.0889e-4
m2 13027 1
m3 7014 .8 8016 .2
kcode 10000 1 10 40
ksrc 0 6 0 18 6 0 -18 6 0 9 6 15
   -9 6 15 9 6 -15 -9 6 -15
tmesh
   rmesh12
cora12 -30. 53i 30.
corb12 0. 12.
corc12 -30. 35i 30.
endmd

File “cells”

1 1 -8.4 -1 u=1 imp:n=1
2 0 -2 u=1 imp:n=1
3 2 -2.7 -3 1 2 u=1 imp:n=1
4 3 -.001 3 u=1 imp:n=1
10 3 -.001 -6 lat=2 u=2 imp:n=1
   fill=-2:2 -2:2 0:0
   2 2 2 2
   2 2 1 2
   2 1 1 2
   2 1 2 2
   2 2 2 2
11 0 -8 imp:n=1 fill=2
50 0 8 imp:n=0

File “surfaces”

1 rcc 0 0 0 0 12 0 5
2 rcc 0 12 0 0 8 0 5
3 rcc 0 -1 0 0 22 0 6
6 rhp 0 -1 0 0 22 0 9 0 0
8 rcc 0 -1 0 0 22 0 30
Physics Enhancements

• **Four model physics improvements**
  – Mix & match of libraries and models
  – CEM upgrade to version 2K
  – INCL 4/ABLA physics models
  – Secondary-particle production
CEM Upgrade (versions 95, 2K, 03)

CEM for 1.2 GeV Protons => Pb
1 1 -11. -1 imp:h 1
2 0 1 imp:h 0
1 so 1.0

mode h n
sdef par=h erg=1200 vec=1 0 0 dir=1
m1 82208 1
phys:h 1300 j 1
phys:n 1300 3j 1
nps 100000
lca 8j 1
f1:n 1
ft1 frv 1 0 0
*c1 175 34i 0
f11:n 1
e11 1. 30log 1200.
f21:h 1
ft21 frv 1 0 0
*c21 175 34i 0
f31:h 1
e31 1. 30log 1200.
CEM Upgrade (versions 95, 2K, 03)

Neutron Production

95 (2.4.0) 2K (2.5.0) 03 (2.6.C)

Proton Production

95 (2.4.0) 2K (2.5.0) 03 (2.6.C)
CEM Upgrade (versions 95, 2K, 03)

Neutron Production

- 03 (2.6.C)
- 2K (2.5.0)
- 95 (2.4.0)

Proton Production

- 2K (2.5.0)
- 03 (2.6.C)
- 95 (2.4.0)
INCL 4/ABLA Physics Models

Various Physics Models for 1.2 GeV Protons => Pb

1 1 -11. -1 imp:h 1
2 0 1 imp:h 0
1 so .01

mode h n
sdef par h erg=1200 vec 0 0 1 dir 1
ml 82208 1
phys:h 1300 j 0
phys:n 1300 3j 0
nps 100000
f1:n 1
ft1 frv 0 0 1
*c1 167.5 9i 17.5 0 T
e1 1 501og 1300
LCA 7j -2 0 $ Bertini/Dresner
LCA 7j -2 0 $ Bertini/ABLA
LEA 6J 2
LCA 2j 2 4j -2 $ ISABEL/Dresner
LCA 2j 2 4j -2 $ ISABEL/ABLA
LEA 6J 2
LCA 7j -2 2 $ INCL4/ABLA
LEA 6j 2
LCA 7j -2 2 $ INCL4/Dresner
LCA 7j -2 1 $ CEM2K
Secondary-Particle Production

Neutron Production

ncnpx 2.5e

tally 1
n
mps 100000
bin normed
nctal = imp91m

f surface 1
d flag/dir 1
u user 1
s segment 1
m mult 1
c cosine 13 t
e energy *
t time 1

--def B-D
---Bert-ABLA
---Leab-ABLA
---INCL-ABLA
---INCL-3res
---CEM2k
Physics Enhancements

- Two neutron physics improvements
  - Fission multiplicity
  - $S(\alpha,\beta)$ secondary-energy smoothing
Fission Multiplicity

Pu-239 Fission Multiplicity in H2O
1 1 -1.0 -1 imp:n=1
2 0 1 imp:n=0

1 SPH 0 0 0 100

sdef par=sf pos=0 0 0 rad=d1 axs=0 0 1 ext=0
sil 0 90
sp1 -21 1
ml 1001 2 8016 1 94239 1.e-4
phys:n 5j -1
nps 100000
# Fission Multiplicity

1spontaneous fission source multiplicity and moments.

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<td>2.41961E-03</td>
<td>0.1621</td>
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<td></td>
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<tr>
<td>7</td>
<td>1</td>
<td>7</td>
<td>6.36740E-05</td>
<td>2.93841E-05</td>
<td>2.05689E-04</td>
<td>6.36740E-05</td>
<td>1.0000</td>
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<td></td>
</tr>
<tr>
<td>total</td>
<td>15705</td>
<td>34032</td>
<td>1.00000E+00</td>
<td>4.61477E-01</td>
<td>1.00000E+00</td>
<td>1.00000E+00</td>
<td>0.0059</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## Factorial Moments

<table>
<thead>
<tr>
<th>nu</th>
<th>by number</th>
<th>by weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>nu</td>
<td>2.16695E+00 0.0044</td>
<td>2.16695E+00 0.0044</td>
</tr>
<tr>
<td>nu(nu-1)/2!</td>
<td>1.96683E+00 0.0093</td>
<td>1.96683E+00 0.0093</td>
</tr>
<tr>
<td>nu(nu-1)(nu-2)/3!</td>
<td>9.38364E-01 0.0176</td>
<td>9.38364E-01 0.0176</td>
</tr>
<tr>
<td>nu(nu-1) .... (nu-3)/4!</td>
<td>2.51958E-01 0.0349</td>
<td>2.51958E-01 0.0349</td>
</tr>
<tr>
<td>nu(nu-1) .... (nu-4)/5!</td>
<td>3.78223E-02 0.0777</td>
<td>3.78223E-02 0.0777</td>
</tr>
<tr>
<td>nu(nu-1) .... (nu-5)/6!</td>
<td>2.86533E-03 0.2071</td>
<td>2.86533E-03 0.2071</td>
</tr>
<tr>
<td>nu(nu-1) .... (nu-6)/7!</td>
<td>6.36740E-05 1.0000</td>
<td>6.36740E-05 1.0000</td>
</tr>
</tbody>
</table>
## Fission Multiplicity

1 spontaneous and induced fission multiplicity and moments.

<table>
<thead>
<tr>
<th>by number</th>
<th>by weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>fissions</td>
<td>fissions</td>
</tr>
<tr>
<td>neutrons</td>
<td>neutrons</td>
</tr>
<tr>
<td>multiplicity</td>
<td>multiplicity</td>
</tr>
<tr>
<td>fraction</td>
<td>fraction</td>
</tr>
<tr>
<td>error</td>
<td>error</td>
</tr>
</tbody>
</table>

| nu = 0 | 1499 | 0 | 5.39713E-02 | 3.95528E-02 | 0.00000E+00 | 6.50562E-02 | 0.0261 |
| nu = 1 | 4627 | 4627 | 1.66595E-01 | 1.13595E-01 | 1.13595E-01 | 1.86840E-01 | 0.0145 |
| nu = 2 | 8169 | 16338 | 2.94124E-01 | 1.87902E-01 | 3.75804E-01 | 3.09060E-01 | 0.0105 |
| nu = 3 | 7844 | 23532 | 2.82422E-01 | 1.63875E-01 | 4.91624E-01 | 2.69540E-01 | 0.0110 |
| nu = 4 | 4200 | 16800 | 1.51221E+00 | 7.89230E-02 | 3.15692E-01 | 1.29812E-01 | 0.0162 |
| nu = 5 | 1212 | 6060 | 4.36379E-02 | 2.06316E-02 | 1.03158E-01 | 3.39348E-02 | 0.0316 |
| nu = 6 | 208 | 1248 | 7.48902E-03 | 3.28351E-03 | 1.97011E-02 | 5.40070E-03 | 0.0762 |
| nu = 7 | 13 | 91 | 4.68064E-04 | 1.91773E-04 | 1.34241E-03 | 3.15428E-04 | 0.2943 |
| nu = 8 | 2 | 16 | 7.20098E-05 | 2.50905E-05 | 2.00724E-04 | 4.12687E-05 | 0.7174 |
| total | 27774 | 68712 | 1.00000E+00 | 6.07979E-01 | 1.42112E+00 | 1.00000E+00 | 0.0035 |

<table>
<thead>
<tr>
<th>factorial moments</th>
<th>by number</th>
<th>by weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>nu</td>
<td>2.47397E+00</td>
<td>2.33744E+00</td>
</tr>
<tr>
<td>nu(nu-1)/2!</td>
<td>2.60927E+00</td>
<td>2.32469E+00</td>
</tr>
<tr>
<td>nu(nu-1)(nu-2)/3!</td>
<td>1.49388E+00</td>
<td>1.24950E+00</td>
</tr>
<tr>
<td>nu(nu-1) .... (nu-3)/4!</td>
<td>5.03168E+00</td>
<td>3.94425E+00</td>
</tr>
<tr>
<td>nu(nu-1) .... (nu-4)/5!</td>
<td>1.02434E+00</td>
<td>7.52740E+00</td>
</tr>
<tr>
<td>nu(nu-1) .... (nu-5)/6!</td>
<td>1.27817E+00</td>
<td>8.76422E+00</td>
</tr>
<tr>
<td>nu(nu-1) .... (nu-6)/7!</td>
<td>1.04414E+00</td>
<td>6.45578E+00</td>
</tr>
</tbody>
</table>
Physics Enhancements

• Three photon physics improvements
  – Photonuclear physics model
  – Photon Doppler broadening
  – Variance reduction with pulse-height tallies
Photonuclear Physics Model

Photonuclear 10 MeV Photons => Pb
1  1 -7.86  -1  imp:n=1
2  0          1  imp:n=0

1 SPH 0 0 0 2

mode n p
sdef par=p erg=10.0
phys:p 3j 1
ml  82208 1
c mx1:p model
nps 1000000
f1:n 1
e1  1e-3 50log 10.

Photonuclear 10 MeV Photons => U-235
1  1 -7.86  -1  imp:n=1
2  0          1  imp:n=0

1 SPH 0 0 0 2

mode n p
sdef par=p erg=10.0
phys:p 3j 1
ml  92235 1
c mx1:p model
nps 1000000
f1:n 1
e1  1e-3 50log 10.
Photonuclear Physics Model

Neutron Production from Pb

Model

Library
Photonuclear Physics Model

Neutron Production from U-235
Infrastructure Enhancements

• **8-byte integers**
  – Users can now run billions of particles
  – Often required for parallel calculations
  – Runs about 20% slower on most systems

• **Support for new compilers**
  – Mac OS X with IBM compiler
  – Windows PC and Linux with Intel compiler

• **Parallel processing with MPI**
  – PVM option is still available

• **MPI speedup for criticality problems**
  – Eliminates collection of fission source after each cycle
Outline

• MCNPX Summary and Development History

• User Base, Web Site, Development Philosophy

• Physics and Capability Details

• Select 2.5.0 Features

• Future Development
Future Development

• **MCNP 6 and MCNPX 2.6.B merger project**
  – Preserve all capabilities of both codes
  – Complete merger within one year
  – Release merged code as MCNP 6 or MCNP 7
  – MCNPX final version likely 2.6.0

• **Features beyond version 2.6.0**
  – Non-uniform electric and magnetic fields
  – Coupling of secondary particles for library interactions
  – Direct CAD links with spline surface tracking
  – Enhanced visualization tools