MCNP / X Merger

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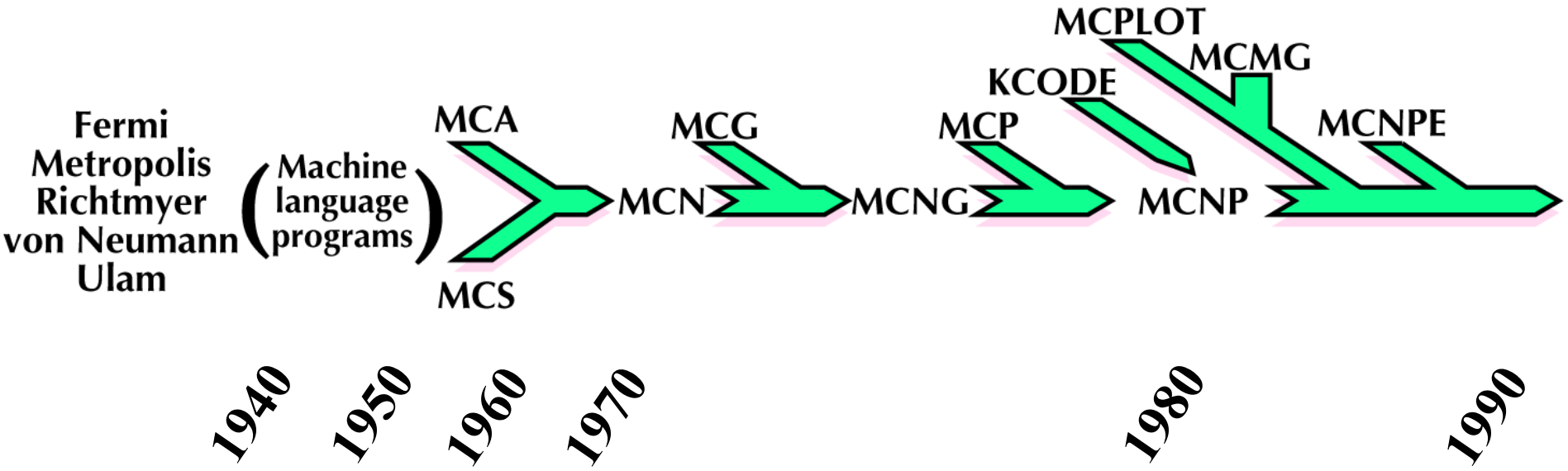
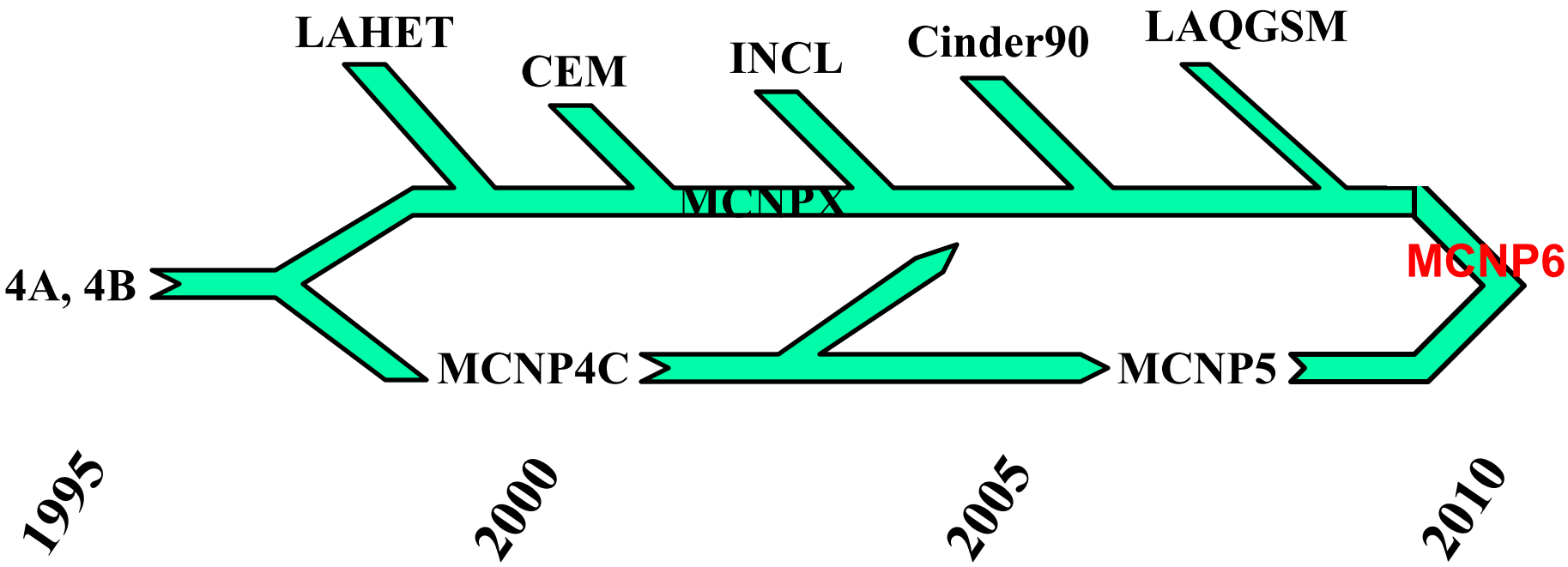
Outline

- Merger Project
- Demonstration
- Implications

MCNP - a history of integrating codes



MCNP / X – continued history of integrating codes



Overview

- Goal – combine all features of MCNP5 and MCNPX into a single code to be released as MCNP6
- Level of support: $3M
  - FY07: 2.5 FTE
  - FY08: 2.0 FTE
  - FY09: 2.0 FTE
- Strategy: Integrate MCNPX capabilities into MCNP5 / 6 subroutine by subroutine
- Planned Milestones:
  - MCNP6 at MCNP / MCNPX workshops (May 2008)
  - Alpha (internal release): October 2008
  - Beta (limited external release): April 2009
  - RSICC Release: October 2009

Challenges

- ~ 1000 subroutines in 9 directories
  - ~500 new subroutines in 8 sub-directories
  - ~400 subroutines & modules in MCNP6
- ~400 subroutines in MCNPX /mcnpf/ directory
  - ~ 55 new MCNPX subroutines
  - ~200 subroutines nearly the same as MCNP5
  - ~150 subroutines require careful merging
- Phased approach with building & testing after each step

Challenges – 2 Teams / 2 Cultures

MCNP5 Team	*MCNPX Team*
Jeremy Sweezy	Gregg W. McKinney
J. Tim Goorley	Laurie S. Waters
Tom Booth	Joseph W. Durkee
Forrest B. Brown	Jay Elson
Jeff Bull	Michael L. Fensin
Avneet Sood	John S. Hendricks
Roger Martz	Michael R. James
Art Forster	Russell C. Johns
	Denise B. Pelowitz
Richard Prael	
Stepan Mashnik	Franz X. Gallmeier
Tony Zukaitis	M. William Johnson

Challenges - MCNPX 2.6.0 (April 2008)

Integrates: CEM03, CINDER90, LAQGSM

Extends MCNPX

- *Beyond 34 particles to 2205 heavy ions;*
- *Beyond static nuclides to decaying & emitting;*
- *Beyond fixed materials to burnup / depletion / transmutation & dynamic materials;*
- *New variance reduction, sources, tallies, graphics, data*

http://mcnpx.lanl.gov

Challenges - MCNPX 2.6.0 – *Additional Capabilities*

- Long file names;
- Tally stop on precision;
- Charged ions from neutron capture in table range (in addition to light-ion recoil from elastic);
- Weight-window MESH angles in radians and degrees;
- Piping PTRAK results;
- Spherical GRIDCONV;
- Proton step size control: HSTEP on M card;
- New photon emission data: PHTLIB;
- New S(α,β) scattering law;
- Differential data tallies extended to table physics;
- Separate printout/calculation of induced fission multiplicity;
- Interrupts in electron tracking;
- Extend ZAID identifiers;
- Neutron models produce light (A<4) nuclei <100 MeV;
- Additional enhancements and corrections.

Challenges – MCNP5 – *Additional Capabilities*

- Shannon Entropy for criticality convergence diagnostics;
- Pulse-height tallies with variance reduction, including DXTRAN;
- Electron physics enhancements;
- Long file names;
- Mesh tallies;
- Angles in radians and degrees;
- Prompt fission multiplicity;
- Supplemental random number generators;
- Extensive benchmark test set;
- Additional enhancements and corrections.

Strategy

Phase 1

Move MCNPX variables to MCNP6 (reconcile particles, common, etc.)

Phase 2

First half of IMCN (card reading)

Phase 3

Second half of IMCN (geometry, tallies materials)

Phase 4

XACT (Read / process cross sections, proton library, heating)

Phase 5

MCRUN - particle transport

Phase 6

MCRUN – sources and tallies

Phase 7

Tally and cross section plots

Phase 8

Geometry plot

Phase 9

MCNPX 26 C, D, E, F, … upgrade

Phase 10

Debug

Quality control

Documentation

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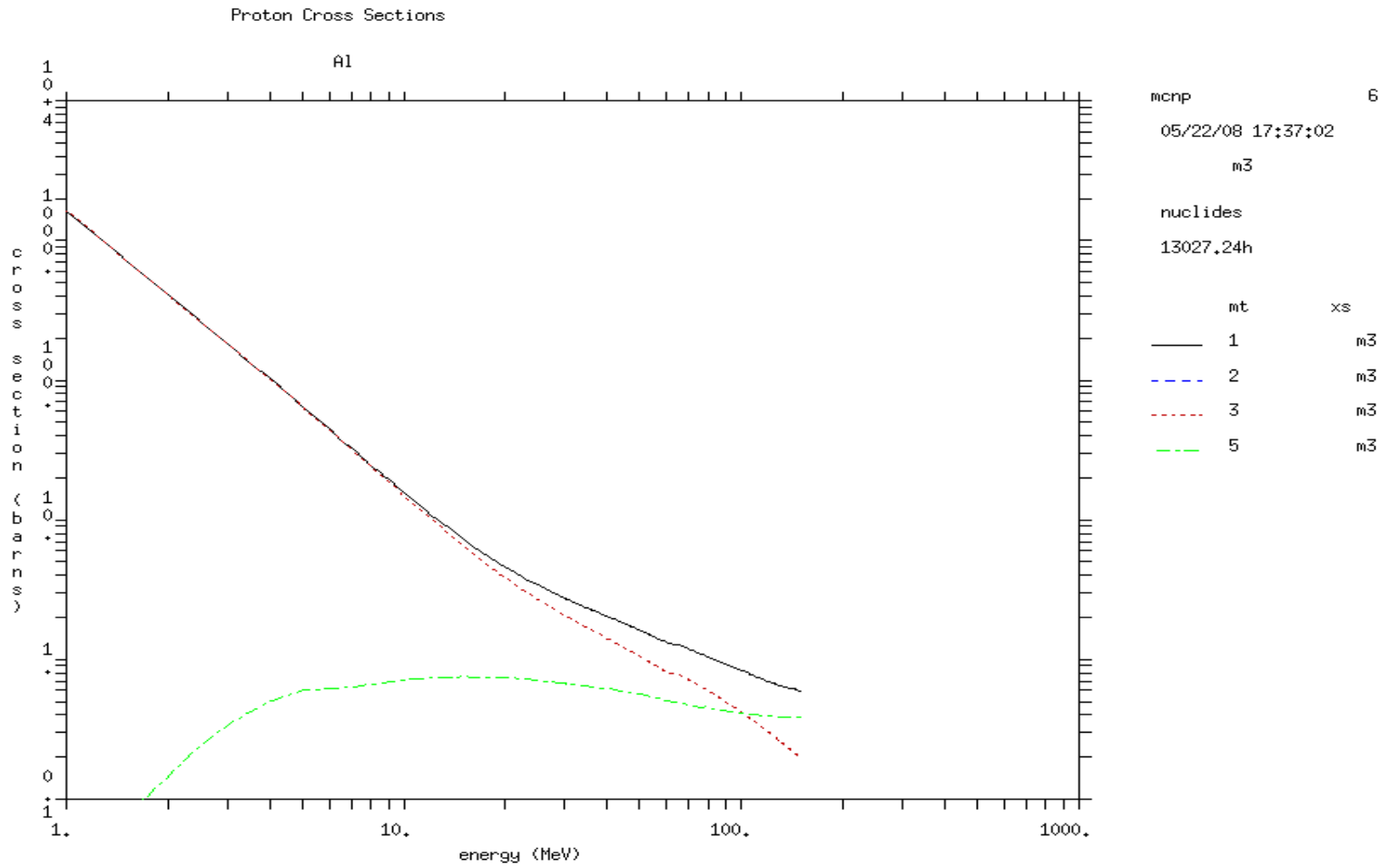
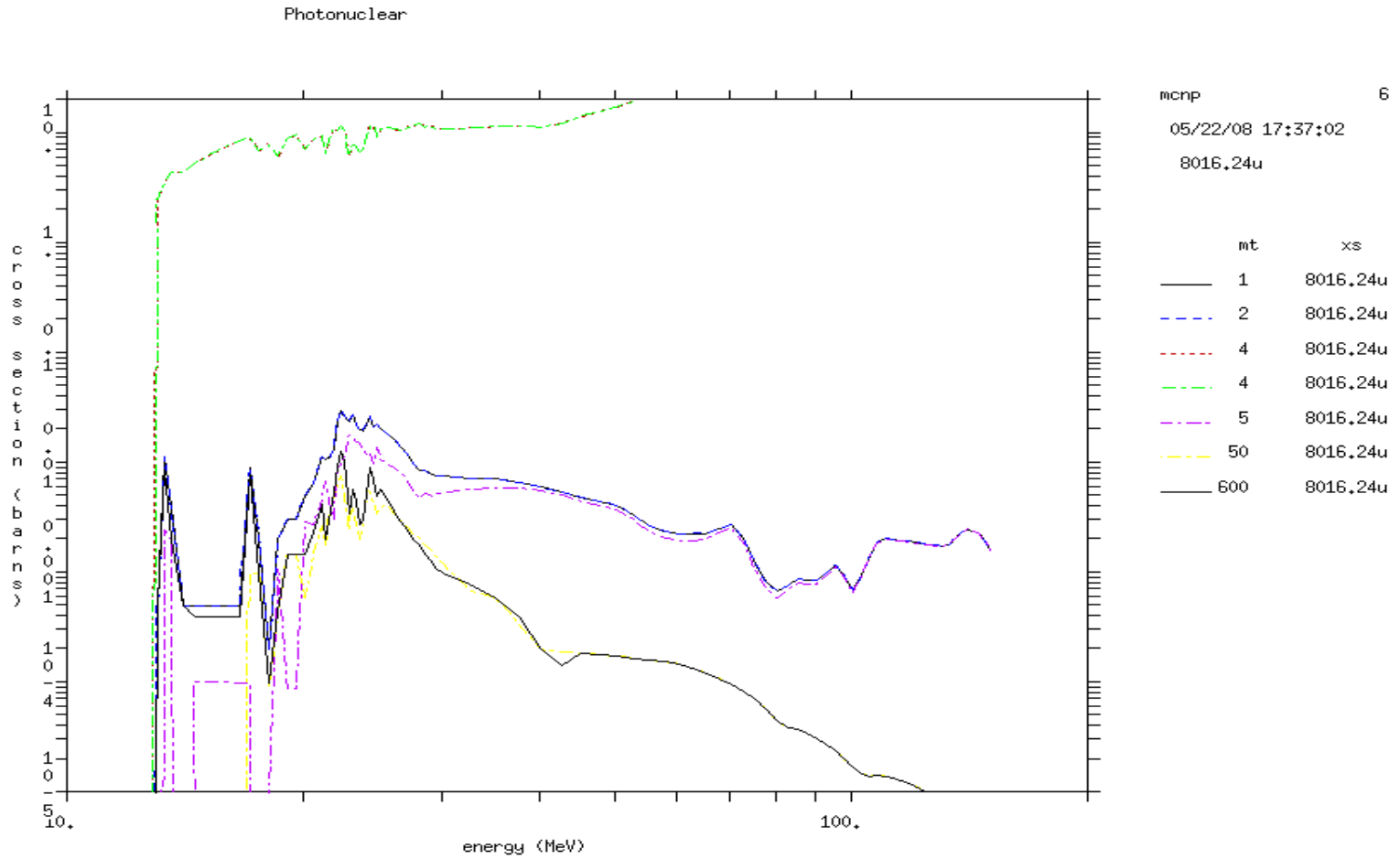
Demonstration – Proton Cross Section Plot



Demonstration – Photonuclear cross section plot



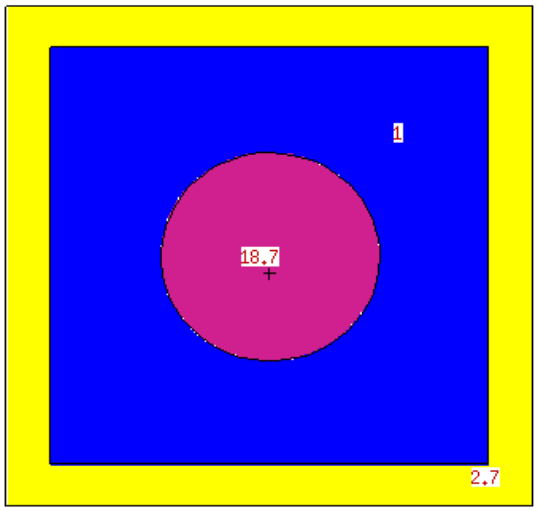
Demonstration- Geometry plot – new interactive buttons

```
 05/22/08 17:45:35
file:handouts\geom2a sphere in a
 box in a box

probid =  05/22/08 17:45:10
basis:   YZ
( 0.000000, 1.000000, 0.000000)
( 0.000000, 0.000000, 1.000000)
origin:
(     0.00,     0.00,    -0.85)
extent = (    21.20,    21.20)
cell labels are
 mass densities

.
```

UP	RT	DN	LF	Origin	.1	.2	Zoom	5.	10



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Value for den 18.7

in Cell 1

xyz = 0.00, 0.00, -0.85

0

CURSOR	Restore	CellLine
PostScript	ROTATE	
COLOR	SCALES 0	LEVEL
XY	YZ	ZX
LABELS	L1 off	L2 den
MBODY on		

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Click here or picture or menu

		Redraw	Plot>		End

Demonstration - Geometry plot – ijk indices

05/22/08 17:49:06
PWR Core

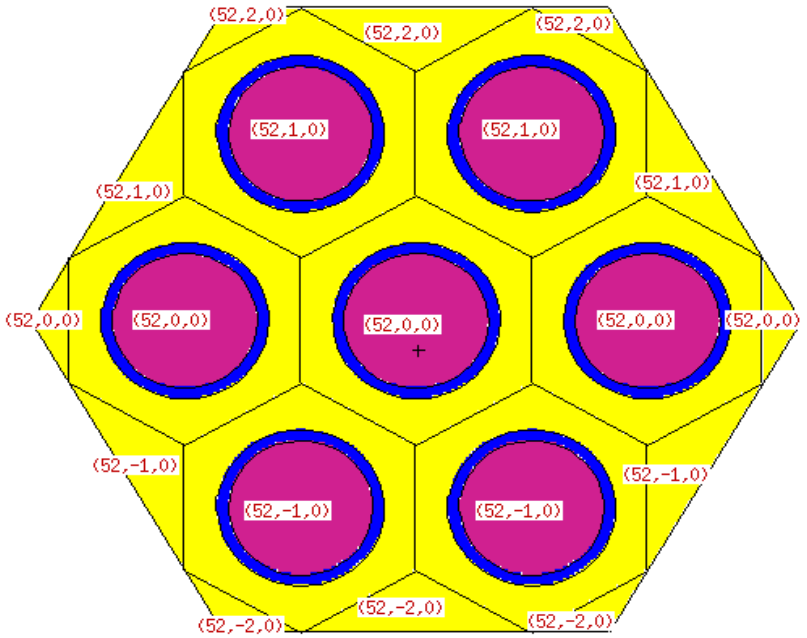
probid = 05/22/08 17:48:32
basis: XY
(1.000000, 0.000000, 0.000000)
(0.000000, 1.000000, 0.000000)
origin:
(0.02, -0.19, 49.23)
extent = (2.69, 2.69)
cell labels are
lattice indices ijk

Value for ijk (2,0,0)
in Cell 41
xyz = 0.02, -0.19, 49.23

CURSOR	Restore	CellLine
PostScript	ROTATE	
COLOR	SCALES 0	LEVEL
XY	YZ	ZX
LABELS	L1 off	L2 ijk
MBODY on		

Click here or picture or menu

UP	RT	DN	LF	Origin	.1 .2 Zoom 5. 10



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		Redraw	Plot>		End

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Secrets of MCNP / X Success

- It's Free & Available
  - Almost
- It Works
  - Gets right answers
- It Meets Your Needs
  - Repository of physics knowledge
  - Reasonably easy to use

Essentials for MCNP6 Success (prioritized)

- **Leadership:**
  - Jeremy E. Sweezy, Gregg W. McKinney,
  - J. Tim Goorley, Laurie S. Waters
- **Quality:**
  - MCNPX Beta Testers
  - MCNP4 / MCNPX Expert Code Review & Integration
  - MCNP5 Benchmarks
  - MCNP5 & MCNPX Extended Regression Test Sets
- **Value**
  - Free Availability
  - Documentation, *interactive* Workshops
- **Features** – new capabilities

Outline

- Merger Project – *major undertaking*
- Demonstration – *works - mostly*
- Implications – *can succeed if it embodies the best of both MCNP5/X*