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Title: CAMEL - Conversational Agent for MCNP Exploration at Lujan

Author(s): Krivos, Martin
Svoboda, Josef
Kral, Dusan
Stastny, Ondrej

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CAMEL - Conversational Agent for MCNP Exploration at Lujan

M. Krivos, J. Svoboda, D. Kral, O. Stastny

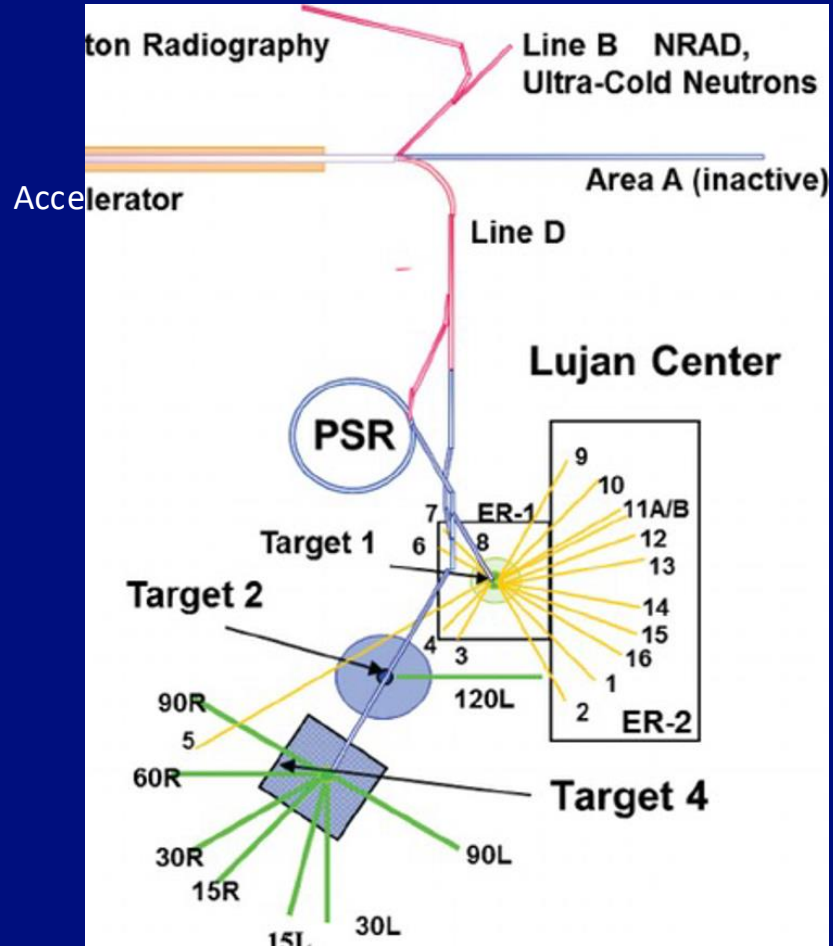
8/25/2026



Lujan Center

- 16 flight paths
- Complicated geometry
 - Single flight-path ~6k lines
- Decades of MCNP inputs
- Multiple generations of engineers

Q: Has someone changed shielding around the mercury shutter at FP 14?



Our Goal and Challenges

- Goal:

Create a tool that opens new possibilities at the Lujan Center.

- Challenges:

1. US/EU models

- Working at LANL

2. Open model restriction

- Whole pipeline can run locally (+ LANL aiportal)
- US/EU models are not released regularly
- Currently using mostly Gemma 4

3. MCNP input is not 'native' to LLMs

1. One Lujan model can take whole context window.

CAMEL - Interface

Sessions

[New Session](#)

No sessions found

Fangorn file **FP12_13_14 / i89r**

[Open](#)

[Reload](#)

i89r (fangorn)

```

LANSCe Lujan Center Mark-III, Physics Model
c      Simplified geometry of Mark-III - so called physics model
c      based on the as-built model of Mark-III
c
c      Prepared by Michal Mocko, Mar 2012
c      Modified by Suzanne Nowicki, May 2015
c
c      Be in upper section and moderators in upper tier were removed
c      Target was translated to upper tier.
c
c =====
c      exterior universe
1 0 1
c      inside universe
2 0 -1 #(-21 22 -23 24 -25 26)
      #50006 -50005 50012 -50011 50014 -50013
      (-50002:50001:-50004:50003))
      #50019 50018 50005 -50017 (50435:-50207) -51435 51207)
      #50001
c =====
c      Lower-tier High-Intensity water moderator
c      water moderator for flight paths 3,4 and 5
c
c      moderator water (cell #102):
102 1 1.00166E-01 108 -2002 -110 109 -112 111
c      pre-moderator water (cell #103):
103 1 1.00166E-01 2005 107 -110 109 -112 111
c
c      poison plates
10210 2 6.04484E-02 (111 -112 109 -110 2002 -2003):
      (111 -112 109 -110 2004 -2005)
c      poison material (Gd)
10211 5 3.02151E-02 (111 -112 109 -110 2003 -2004)
c      moderator aluminum can
118 2 6.04484E-02 (-108:-107:-111:112:-109:110)
      103 -104 101 -102 105 -106
      #50105 #50106
c      cadmium film
122 4 4.63393E-02 (-103:104:-101:102:-105:106)
      153 -154 151 -152 155 -156
      #50105 #50106
c      poison plates
```

Hello, how can you help me?

8/10/2026, 4:52:30 PM



Hello! I'm a helpful assistant specialized in supporting you with MCNP (Monte Carlo N-Particle) simulations and navigating the archives of the Lujan Center and its Mark neutron sources.

Here are some of the things I can help you with:

For your currently opened MCNP file (i89r):

- **Analysis:** I can tell you how specific **cells**, **surfaces**, or **materials** are being used within your geometry.
- **Simulation:** I can run and test your MCNP input files to see the output.
- **Documentation:** I can add comments to specific cells in your file.

General Knowledge & Research:

- **MCNP Manual:** I can search the MCNP manual database to help you with syntax, cards, or general modeling questions.
- **Lujan Center Archives:** Using the Fangorn tool, I can search through historical data and archives related to the Lujan Center and Mark neutron sources to answer technical questions.
- **Calculations:** I can perform arithmetic calculations to help with your modeling parameters.

How can I assist you with your work today?

Query took 2.76s | Tools: none

Optional comment...

★ ★ ★ ★ ★

Ask a question

[Send](#)

[Reset Chat](#)

[Reset All](#)

?



[Choose File](#)

LLM vs Agent

- LLM = Large Language Model
 - Takes a text input, processes it, and outputs text.
 - 1. Stateless 'machine'
 - 2. Has no memory
 - 3. Input is tokenized: Hello, how are you?
- Agents:
 - Has a goal / agency
 - LLM is its 'brain'
 - Can use external tools
 - Has state and memory
 - Does multiple steps

Tools

- Modern LLMs can invoke external tools

Thinking: User wants to do basic math operation. I can use calculator tool.

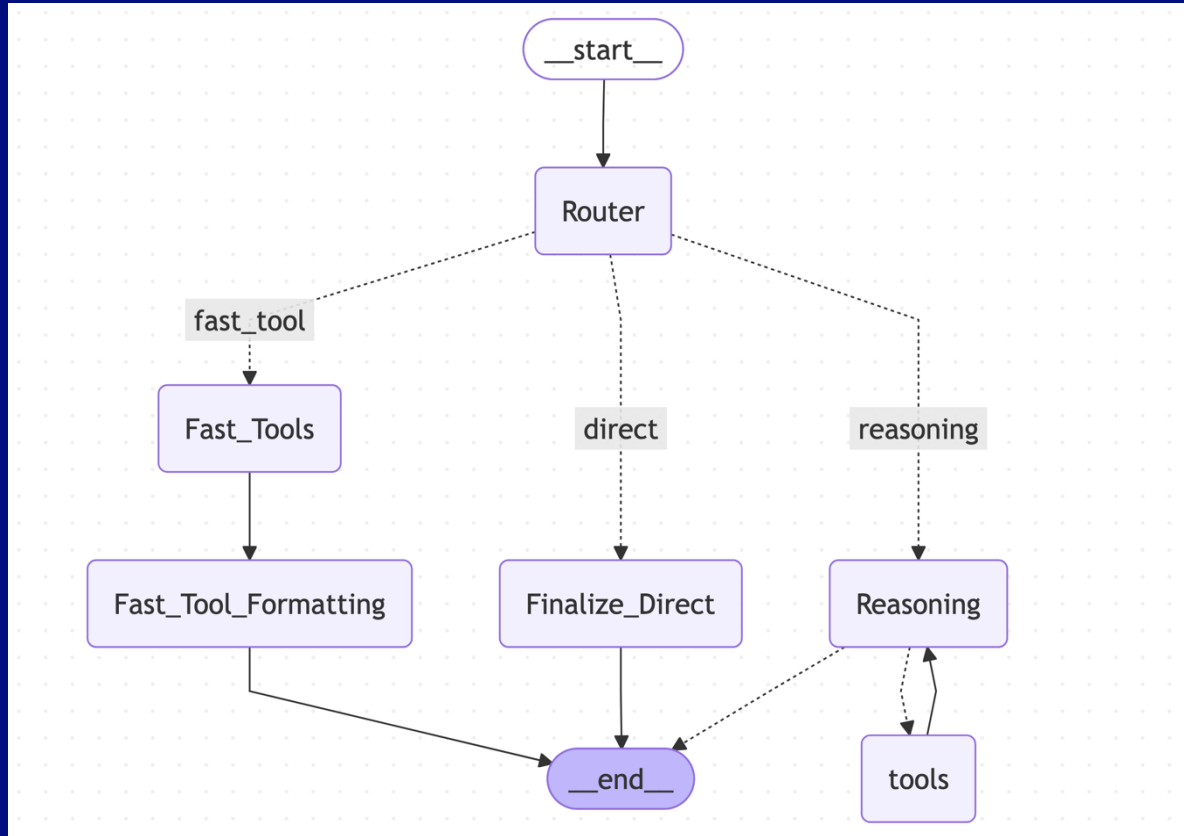
Call calculator(sqrt(144))
-> Returns 12

The result is 12.

What is sqrt(144)?

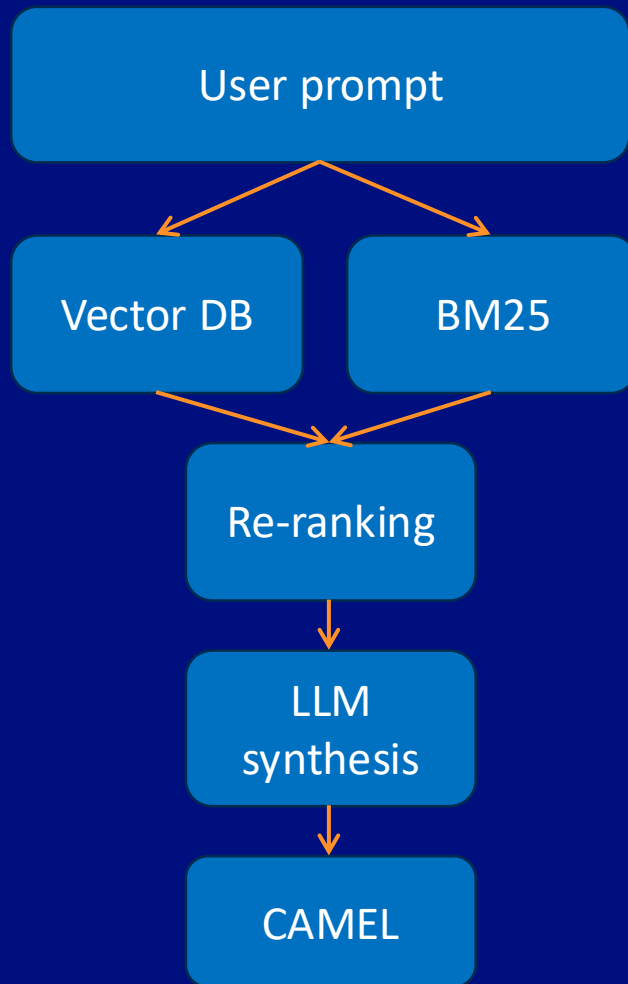
- Most of the work goes into constructing these tools**

CAMEL - The Agent



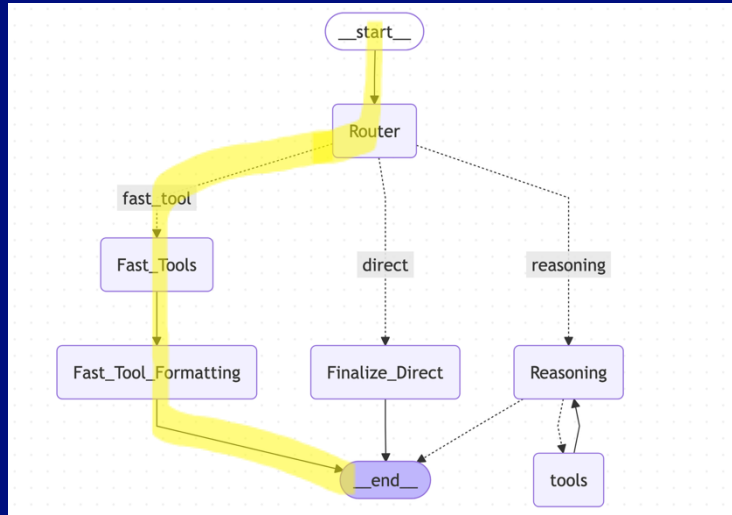
Tool: MCNP Manual

1. Visible as a simple tool to CAMEL
2. ~30 seconds of runtime
3. Complicated pipeline, but worth it

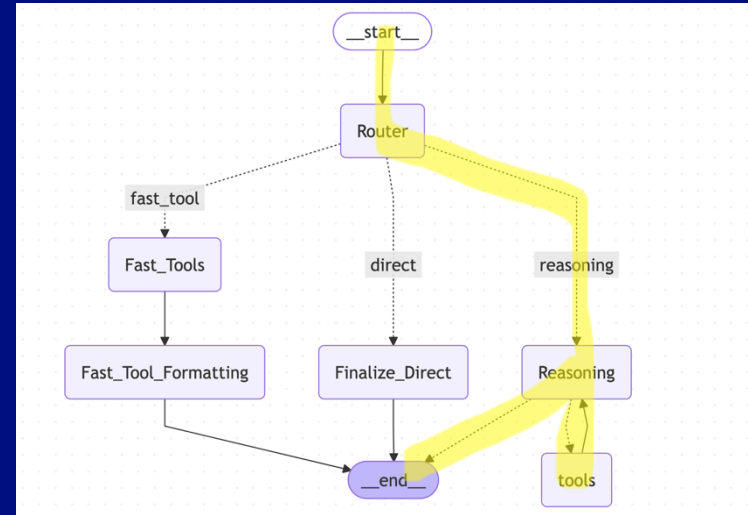


Tool: MCNP Manual

Basic question

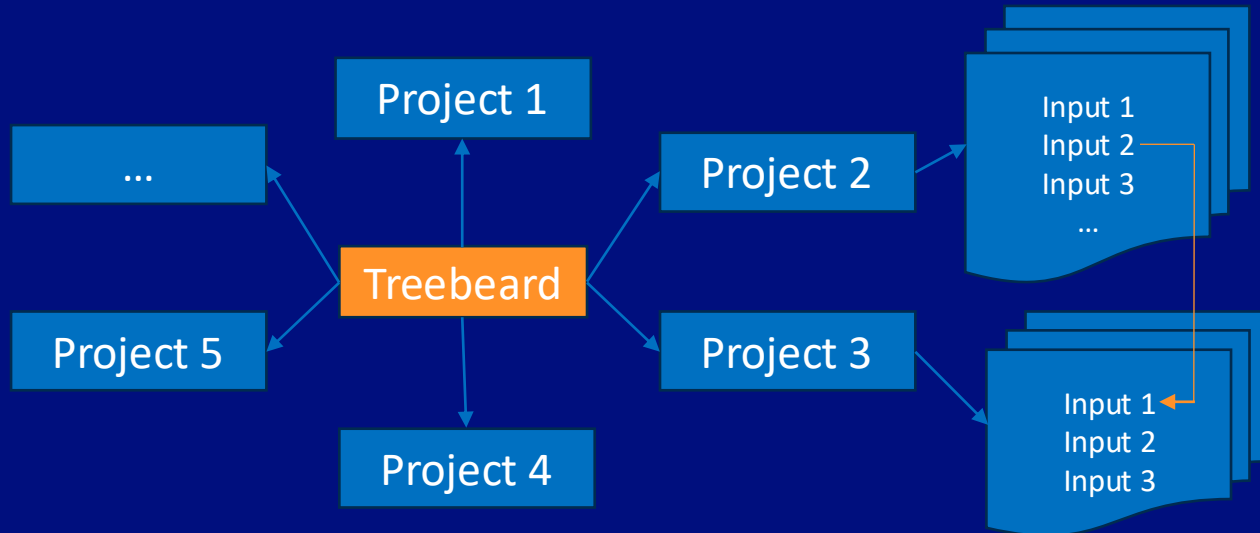


Complex question



Tool: Fangorn

1. Lujan Center MCNP Archival and Versioning system
2. Based on TOML files
3. Creates a hierarchy between individual models, assigns them to a specific flight path etc.
4. The hierarchy is important, because changes between individual models are miniscule



Tool: Fangorn



Fangorn ⓘ

28 TOML files, 692 models loaded [Refresh Database](#)

Lujan Center MCNP Archival and Versioning System

TOML / Model Lineage	Ty...	Created	Output	Previous Versions	Slurm	I Mo...	I Chll...	Setup Comment	Results Comment	Veri...	Note
» /Users/jmkivos/Documents/MCNP/Fangorn/sandbox/josef/FP13/MCNPX/FP13/README.toml	TOML					2	1	facility = Lujan; target_name = MarkIV; flight_path = fp13; MCNP_version = MCNPX; project_name = FP13			
» /Users/jmkivos/Documents/MCNP/Fangorn/sandbox/josef/FP14/MCNP63/CSG/input/121/README.toml	TOML					159	32	facility = Lujan; target_name = MarkIV; flight_path = fp14; MCNP_version = MCNP63; geometry_style = CSG; project_name = i21			
» /Users/jmkivos/Documents/MCNP/Fangorn/sandbox/josef/FP14/MCNP63/hybrid/input/Mk4/README.toml	TOML					2	1	facility = Lujan; target_name = MarkIV; flight_path = fp14; MCNP_version = MCNP63; geometry_style = hybrid; project_name = Mk4			
» /Users/jmkivos/Documents/MCNP/Fangorn/sandbox/josef/FP14/MCNP63/hybrid/input/README.toml	TOML					4	2	facility = Lujan; target_name = MarkIV; flight_path = fp14; MCNP_version = MCNP63; geometry_style = hybrid; project_name = hybrid_input			
» /Users/jmkivos/Documents/MCNP/Fangorn/sandbox/josef/lowe_tier/HIPPO/J_burn-up/README.toml	TOML					14	7	facility = Lujan; flight_path = HIPPO; project_name = HIPPO			
» /Users/jmkivos/Documents/MCNP/Fangorn/sandbox/josef/upper_tier/FP13/README.toml	TOML					2	1	facility = Lujan; target_name = MarkIV; flight_path = fp13; project_name = FP13			
» /Users/jmkivos/Documents/MCNP/Fangorn/sandbox/josef/upper_tier/FP14_Calculations-Michael-2010-FP14analysis/README.toml	TOML					2	2	facility = Lujan; flight_path = fp14; project_name = _Calculations-Michael-2010-FP14analysis			
» /Users/jmkivos/Documents/MCNP/Fangorn/sandbox/josef/upper_tier/FP14/i20/README.toml	TOML					3	3	facility = Lujan; flight_path = fp14; project_name = i20			
✓ /Users/jmkivos/Documents/MCNP/Fangorn/sandbox/josef/zavorka/FP12_13_14/README.toml	TOML					304	46	facility = Lujan; project_name = FP12_13_14			
irf2	model	MM/DD/YYYY		ire2			Invalid N...	1	like ire2 but tally FP14 real FOV		
i03a	model	MM/DD/YYYY		base			Invalid N...	2	reference M-III, LT FP2, FP4, and FP11 from /user/mocko/Calculations/Lujan_Mark4/2018/designC		
i10a	model	MM/DD/YYYY		base			Invalid N...	0	Reference case Mark-III FP2 FP4 adapted from ~/calculations/mcnp/mark4/design/i10a		
i14a	model	MM/DD/YYYY		base			Invalid N...	1	Engineering design "C" from /user/mocko/Calculations/Lujan_Mark4/2018/designC		
i30a	model	MM/DD/YYYY		base			Invalid N...	0	Updated engineering design "C" from /user/mocko/Calculations/Lujan_Mark4/2018/designC		
i40a	model	MM/DD/YYYY		base			Invalid N...	1	Updated engineering design "C" from /user/mocko/Calculations/Lujan_Mark4/2018/designC. Be instead of AI support of UT target		
i10d	model	MM/DD/YYYY		i10b			Invalid N...	1	same as i10b, but UT disks are thinner by 0.0254 cm (10 mil)		
i10e	model	MM/DD/YYYY		i10b			Invalid N...	1	same as i10b, but UT disks are thinner by 0.0508 cm (20 mil)		
i10f	model	MM/DD/YYYY		i10b			Invalid N...	1	same as i10b, but UT disks are thinner by 0.1016 cm (40 mil)		
i11b	model	MM/DD/YYYY		i10b			Invalid N...	0	same as i10b, but a narrower beam 2.0 x 2.5 cm (FWHM; horizontal x vertical) beam profile from file: zavorka/calculations/mcnp/mark4/edesign/		
i50d	model	MM/DD/YYYY		base			Invalid N...	1	Copy of BeamProfilesDevelopmentTime.xlsx from /user/mocko/Calculations/Lujan_Mark4/2018/designD		
i50j	model	MM/DD/YYYY		base			Invalid N...	0	from /user/mocko/Calculations/Lujan_Mark4/2018/designD heating numbers with narrow beam 2.4x1.01 cm2 FWHM		
i60a	model	MM/DD/YYYY		base			Invalid N...	0	new design with 3 thin disks from Eric from 061418 heating number calculation i70a iteration of 3-disk design with increased diameter of the center disk based on 070218 design from Eric narrow beam 2.40 x 1.01 cm		
i70b	model	MM/DD/YYYY		i70a			Invalid N...	0	like i70a beam mis-steared by -0.7 cm vertically (towards rear side)		
i70c	model	MM/DD/YYYY		i70a			Invalid N...	0	like i70a beam mis-steared by +0.7 cm vertically (towards front side)		
i70d	model	MM/DD/YYYY		i70a			Invalid N...	0	like i70a, but production beam 3.53 x 3.53 cm FOV REAL tally FP2,4,11, and		

Page Size: 100+ 1 to 28 of 28 << >> Page 1 of 1 >>

Add New Directory Path: Enter relative or absolute path to README.toml directory

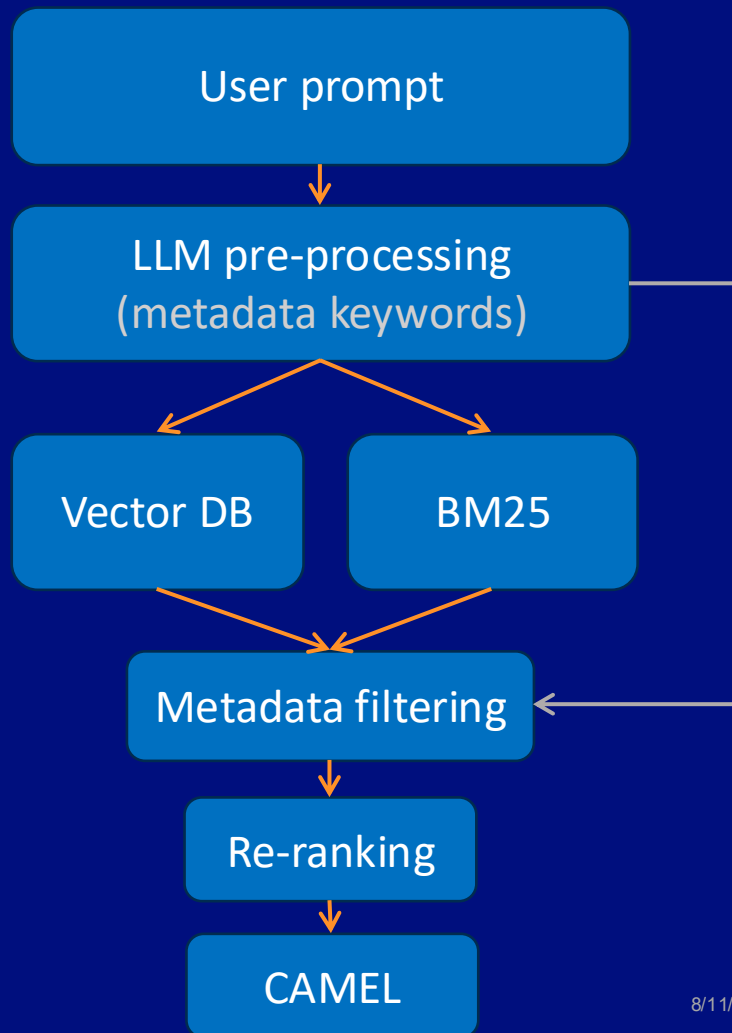
Screenshot

Add Directory

Tool: Fangorn

- Should extract metadata from user's prompt:

Show me changes in mercury shutter at flight path 14.



Tool: Fangorn

- MCNP context-aware diffs

```
1 pz -50.0  
2 pz 50.0  
3 c/z 100.0 0.0 3.0  
4 c/z 80.5 58.7
```

```
4 c/z 80.5 58.7  
2 pz 50.0  
1 pz -30.0  
3 c/z 100.0 0.0 3.0
```

Changes:

Surface 1 position: 50.0 -> -30.0

Tool: Cell Usage

Fangom file

i01a (fangom)

```
:(-9813 -9814):(-9821 -9822)))  
#(-9847 -9850 9886 -9887)  
1203 1205 1207  
1209 1211 1213 1215 1217 1219 u=1  
-12011 901 -951 #(-1201 10804 -10810 ((-10835 -10836)  
:(-10827 -10828):(-10813 -10814):(-10821 -10822)))  
#(-1201 -847 -850 211 -807)  
10811-9811951) u=1  
c Cd-decoupler on the outer lead reflector (flux-trap moderator)  
1202 4 4.63393E-02 -1201 12011 10804 -10810 ((-10835 -10836):  
(-10827 -10828):(-10813 -10814):(-10821 -10822)))  
#12021 u=1  
c Flight paths within the outer lead reflector (flux-trap)  
12021 0 -1201 12011 48804 -48810 ((-48835 -48836):  
(-48827 -48828):(-48813 -48814):(-48821 -48822)) u=1  
12022 0 801 -12011 10804 -10810 ((-10835 -10836):  
(-10827 -10828):(-10813 -10814):(-10821 -10822)))  
#12021 u=1  
1203 0 -1201 12011 -48847 -48850 48886 -48887 u=1  
12031 0 801 -12011 -847 -850 211 -807 u=1  
c Cd-decoupler on the outer lead reflector (upper moderators)  
12032 4 4.63393E-02 -1201 12011 -847 -850 211 -807 #1203 u=1  
c void between the lower target and the beam stop  
1204 0 -12011 -901 1202 u=1  
c outer lead reflector tie rods  
1205 0 8.76288E-02 -1203 1204 1202 -951 u=1  
1206 0 -1204 1202 -951 u=1  
1207 0 8.76288E-02 -1205 1206 1202 -951 u=1  
1208 0 -1206 1202 -951 u=1  
1209 0 8.76288E-02 -1207 1208 1202 -951 u=1  
1210 0 -1208 1202 -951 u=1  
c outer lead reflector cooling pipes  
1211 0 8.76288E-02 -1209 1210 u=1  
1212 20 9.98703E-02 -1210 u=1  
1213 0 8.76288E-02 -1211 1212 u=1  
1214 20 9.98703E-02 -1212 u=1  
1215 0 8.76288E-02 -1213 1214 u=1  
1216 20 9.98703E-02 -1214 u=1  
1217 0 8.76288E-02 -1215 1216 u=1  
1218 20 9.98703E-02 -1216 u=1  
1219 0 8.76288E-02 -1217 1218 u=1  
1220 20 9.98703E-02 -1218 u=1  
1221 0 8.76288E-02 -1219 1220 u=1  
1222 20 9.98703E-02 -1220 u=1  
c beam stop (upper part)  
1223 3 8.62190E-02 ((-1201 -1202 1222):(-1227 -1222 1223)) #1224  
#1225 #1226 #12231 u=1  
c Cd-film on top of the beam stop  
12231 4 4.63393E-02 -8011 -1202 12021 u=1  
c lower part of the beam stop  
1224 0 -1224 -1202 1221 u=1  
1225 0 -1225 -1202 1221 u=1  
1226 0 -1226 -1202 1221 u=1  
c steel rings  
12271 0 (-951 1222 -12295 1201) #1228 #1229 u=1  
12272 3 8.62190E-02 ((-951 1222 -12294 12295):(1228 -1222 -12294 1227))  
#1228 #1229 u=1  
12273 0 (-951 1228 -12293 12294) #1228 #1229 u=1  
12274 3 8.62190E-02 (-951 1228 -12292 12293) #1228 #1229 u=1
```

Show me cell 805.

8/10/2026, 5:20:48 PM



Cell card:

805 1 -1 0 (250 -249 252 -253): (250 -249 254 -255): (250 -249 256 -257): (250 -249 258 -259): (250 -249 260 -261) U=1

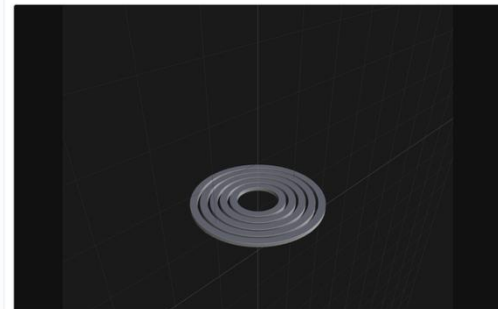
Its surface cards:

- 249 pz 25.045
- 250 pz 23.545
- 252 cz 7.6200
- 253 cz 10.24128
- 254 cz 11.19378
- 255 cz 13.81586
- 256 cz 14.76756
- 257 cz 17.38884
- 258 cz 18.34134
- 259 cz 20.96262
- 260 cz 21.91512
- 261 cz 24.5364

Material: 1

m1 1001.60c 6.67674E-02 1002.60c 1.00166E-05
8016.66c 3.33754E-02 8017.66c 1.33823E-05

3D Geometry View:



Tool: Surface / Material Usage

Surface ID: 705

Cell cards using this surface:

- **802 2** 0.0604484 **705 -118 #821 -5033** #((10151 -10152 10153 -10154 10155):(((10164 10152 10167 -10168):(10163 -10151 10155 -10161)) 10165 -10166)) #((351 -352 353 -354 355):(((10164 10152 10167 -10168):(10163 -10151 10155 -10161)) 10165 -10166)) #((151 -152 153 -154 155):(((10164 10152 10167 -10168):(10163 -10151 10155 -10161)) 10165 -10166)) #((5010 5011 -5012 5015 -5014) #(-5033 5032 (-5014:-5034) (5015:-5035) 5010 -5031)) U=1
- **8031 4** 0.0463393 **801 118 -690 (810:814:813:-819) (810:822:821:-820) (810:828:827:-833) 8011 #(-836 -5002 -835 705) U=1**
- **821 0** 705 ((-118 -842 -843 -844 504):(-118 874 -151 -10151 -864 504)) #((10163 -10151 10155 -10161 10165 -10166)) #((351 -352 353 -354 355):((363 -351 355 -361 389 365 -366)) #((163 -151 155 -161 165 -166))) U=1
- **902 118 -1.8534 -8011 922 -705 902** #((751 612 710 -711 -742 -741 (-707:-746) (706:-745)): (-747 749 -751): (766 -767 -764): (-749 -747 771)) U=1
- **9021 4** 0.0463393 **8011 -801 -705 901 U=1**
- **919 8** 0.0876288 **-922 923 901 -705 U=1**
- **920 0 -705 -923 901 (701:734:-733) U=1**

Query took 3.69s | Tools: mcnp_surface_usage

Show me surface 705

8/10/2026, 5:25:58 PM

Show me material 10

8/10/2026, 5:27:50 PM

Material ID: 10

Material definition:

m10 74182.66c 1.67021E-02 74183.66c 9.02749E-03
74184.66c 1.94078E-02 74186.66c 1.80803E-02

Cell cards using this material:

- **6620 10** 0.0632177 **-66281 1138 -2238 U=2**
- **6622 10** 0.0632177 **-66281 -1137 2237 U=2**
- **6624 10** 0.0632177 **-66280 639 -640 U=2**
- **6050 10** 0.0632177 **-6628 66310 -66320 U=1**
- **6060 10** 0.0632177 **-6628 66330 -66340 U=1**
- **6070 10** 0.0632177 **-6628 66350 -66360 U=1**
- **6080 10** 0.0632177 **-6628 66370 -66380 U=1**
- **6090 10** 0.0632177 **-6628 66390 -66400 U=1**
- **6100 10** 0.0632177 **-6628 66410 -66420 U=1**
- **702 10** 0.0632177 **-6628 7728 -7733 U=1**
- **2702 10** 0.0632177 **-6628 7730 -7729 U=1**
- **2703 10** 0.0632177 **-6628 7731 -7730 U=1**
- **2704 10** 0.0632177 **-6628 7732 -7731 U=1**
- **2705 10** 0.0632177 **-6628 7733 -7732 U=1**
- **1032 10** 0.0632177 **-1015 947 -1059 1012 1060 #1035 #1036 U=1**
- **10321 10** 0.0632177 **-1015 947 -1012 1016 1060 #1035 #1036 -1012 U=1**

Summary



- CAMEL – a new tool with agentic capabilities to aid MCNP model development
- Using
 - Open Western models
 - Runs locally
 - Tools developed for MCNP