

Monte Carlo Particle Lists

MCPL

Legacy: 2016 overview

MCNP: target, moderator, reflector design

McStas: (+other ray-tracing codes) for instrument design

GEANT4: for shielding and backgrounds

Vitess & NADS & Particle swarms: shielding & optics

– - design documentation for the instrument

MCNP: safety, dose-rates (future use of FLUKA or MARS)

GEANT4: detector design

MARS: Accelerator

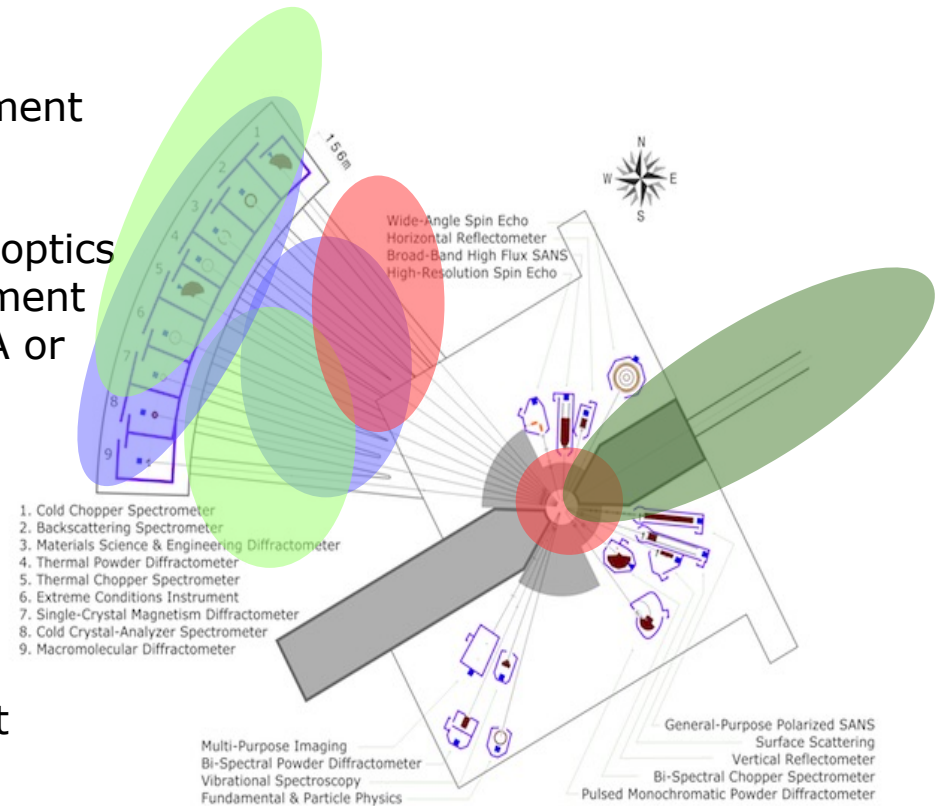
→ Interfacing is important!

→ MCNP-McStas interface is insufficient

→ A common file format would facilitate
'cradle to grave' simulations, without

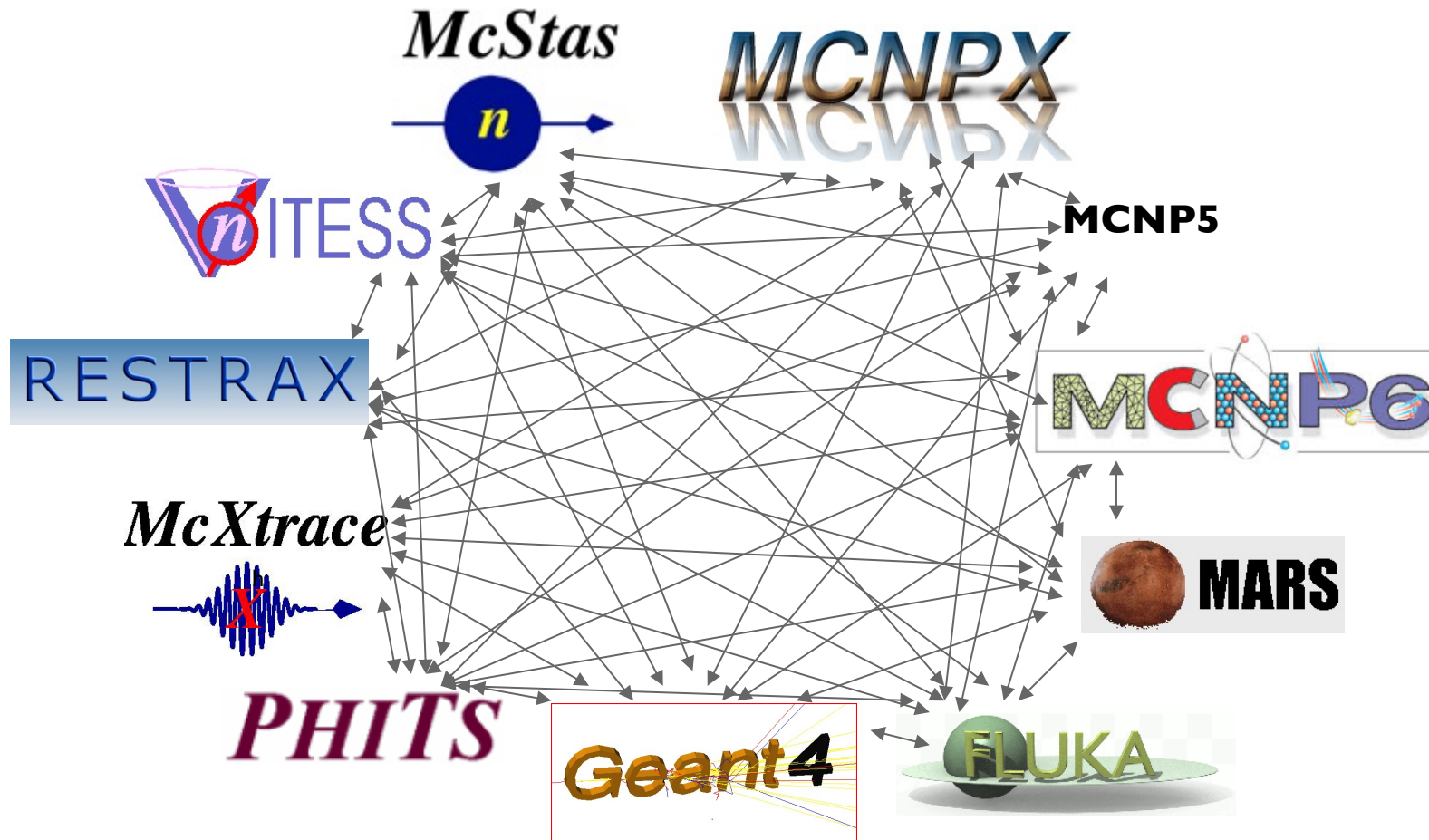
intermediate loss of information
(e.g. through fitting etc)

Monte Carlo Particle Lists: MCPL

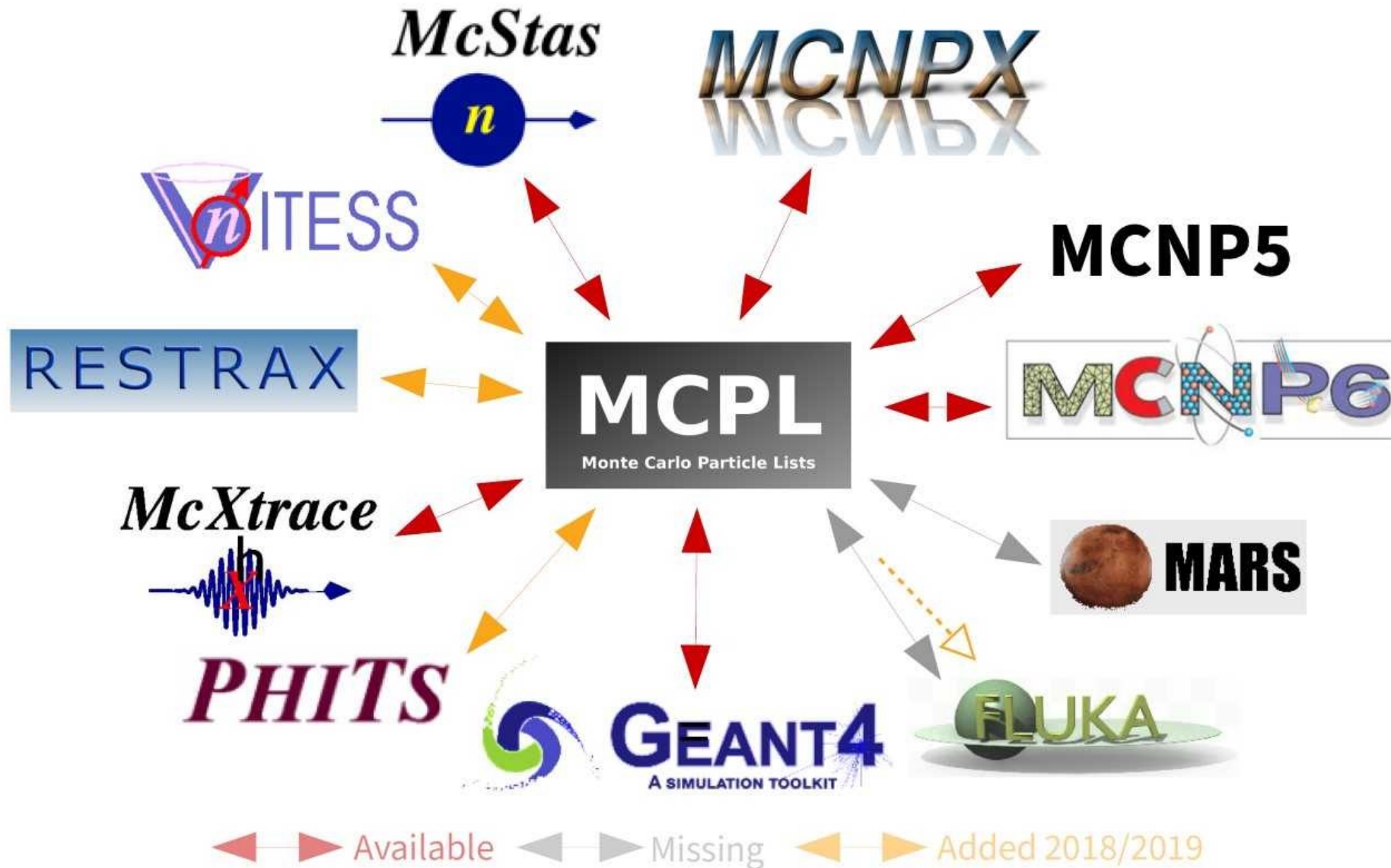


Software integration: **MCPL**

- *Mish-mash of converters and ad-hoc solutions of varying quality is what we want to avoid*

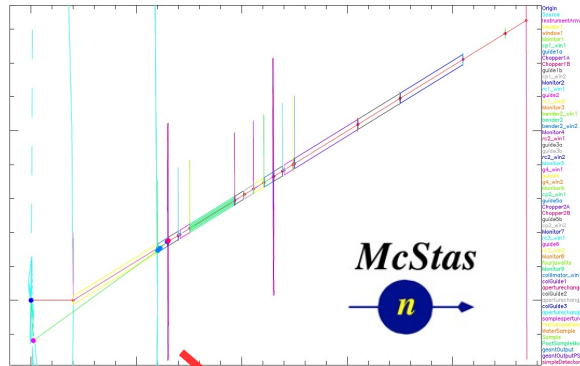


Software integration: **MCPL**



MCPL example use-case

Typical MCPL usage in detector studies

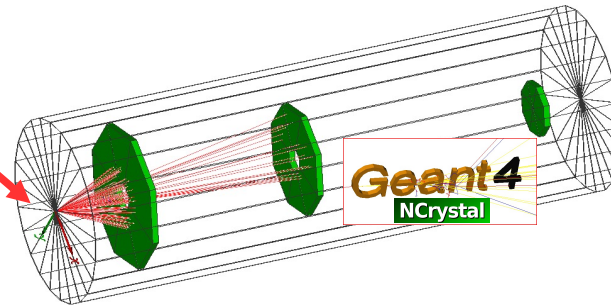


First capture output of instrument simulations

- Set up by or with instrument scientist, using dedicated SW like McStas.
- Provides realistic distributions of neutron energies, divergence, etc.
- Might include modeling of representative sample

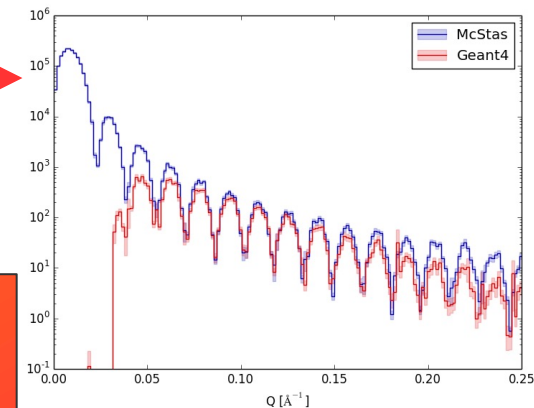
Or use output from shielding simulations for background studies

MCPL
Monte Carlo Particle Lists



Then feed into detailed Geant4-based detector simulation

- Emulate detector response as needed
- Construct realistic high-level observables to study impact of detector on instrument performance.
- Study other interesting aspects (rates & occupancy, efficiencies, etc.)



MCPL: hands-on

```
xlinkby@laptop:~/projects/dg_dgcode$ ess_mcpl_tool ./packages/Validation/UnitTests/MCPLTests/data/reffile_skip123.mcpl
Opened MCPL file reffile_skip123.mcpl:

Basic info
  Format      : MCPL-2
  No. of particles : 123
  Header storage : 59 bytes
  Data storage  : 8364 bytes

Custom meta data
  Source      : "MyMCApp"
  Number of comments : 0
  Number of blobs   : 0

Particle data format
  User flags      : no
  Polarisation info : no
  Fixed part. type : no
  FP precision    : double
  Endianness      : little
  Storage         : 68 bytes/particle

index  pdgcode  ekin[MeV]  x[cm]  y[cm]  z[cm]  ux  uy  uz  time[ms]  weight
0      2112    1.234    0      0      0      0  1  0      0      1
1      2112     0      0      0    0.01  0.01  0 -0.99995  0      1
2      2112    1.234    0      0    0.02  0.02  0  0.9998  0      1
3      2112     0      0      0    0.03  0.03 -0.99955  0      0      1
4      2112    1.234    0      0    0.04  0.04  0  0.9992  0      1
5      2112     0      0      0    0.05  0.05  0 -0.99875  0      1
6      2112    1.234    0      0    0.06  0.06  0.9982  0      0      1
7      2112     0      0      0    0.07  0.07  0 -0.99755  0      1
8      2112    1.234    0      0    0.08  0.08  0  0.99679  0      1
9      2112     0      0      0    0.09  0.09 -0.99594  0      0      1
```

- › Developed within the software framework of the ESS Detector Group – Thomas Kittelmann is the main developer
- › Core software (written in c) is stable and released
- › Use-cases for McStas-Geant4–MCNPX couplings: [arXiv:1509.03036](https://arxiv.org/abs/1509.03036)

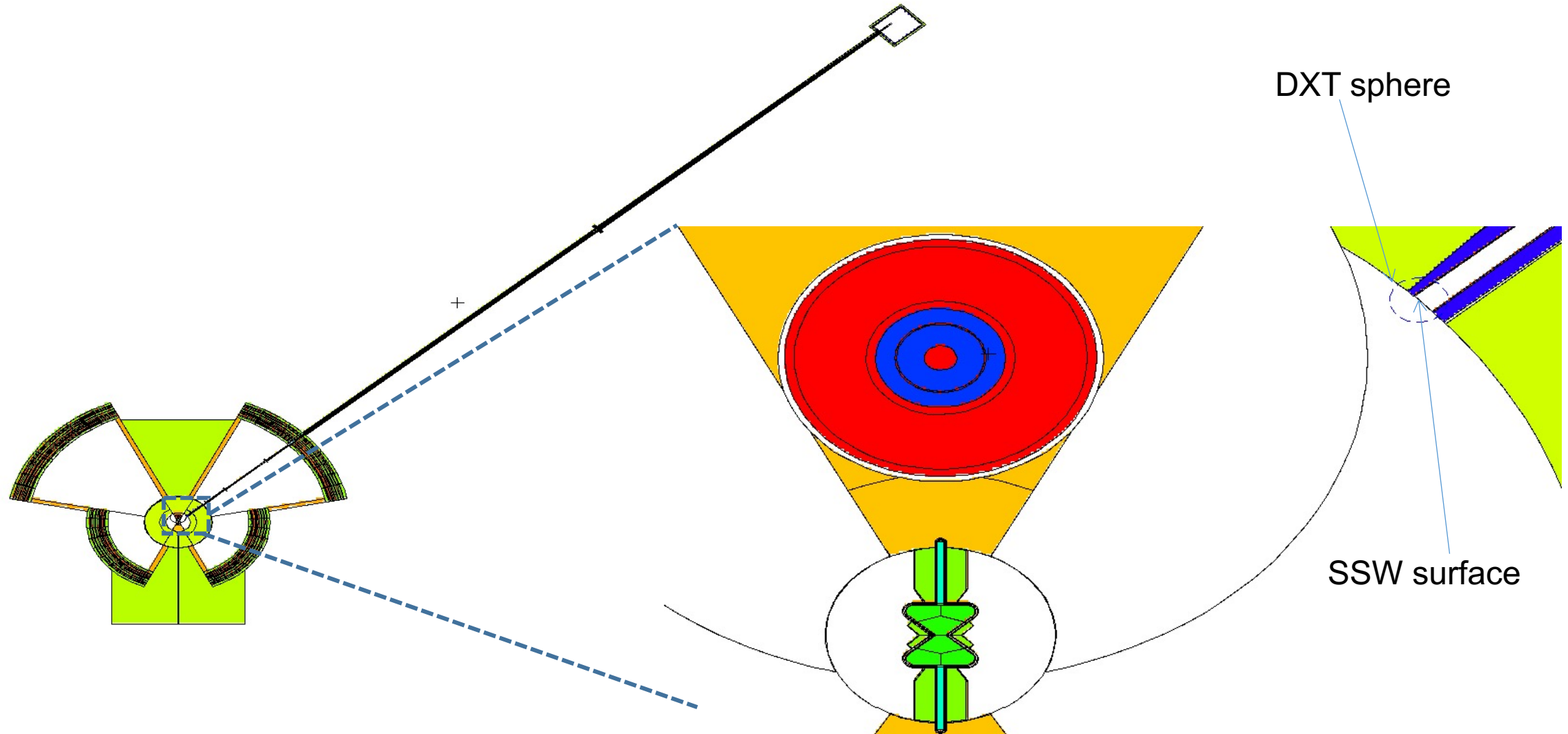
› <https://mctools.github.io/mcpl/>

› <https://mctools.github.io/mcpl/mcpl.pdf>

MCPL: Coupling MCNP & McStas

- One example, of particular interest concerns coupling MCNP and McStas through MCPL, exploiting variance production in MCNP : the DXT sphere.
- DXT sphere combined with SSW interface, can be setup to bias simulations toward a given beamline (while conserving neutron weight)

MCPL: Coupling MCNP & McStas



- =>SSW file including: gamma, neutrons at all energies (ie usable for background + signal)
- =>convert to MCPL and use MCPL tools to select particles of interest
- =>use MCPL file as source in McStas

MCPL: Coupling MCNP & McStas

- Some words of caution: MCPL file inherit MCNP coordinate system
- Mixture of low weight and high weight neutrons can be confusing

- Let's try it out (tasks are also on GitHub, see [link also posted in chat](#))
 - 1. pick a folder on the cluster to work in

 - 2. Copy one or more MCPL files from either
 - /nfs/www/html/users/willend/MCPL/1e6/ ~ 30 Mb each
 - /nfs/www/html/users/willend/MCPL/1e7/ ~ 300 Mb each

 - 3. Find the instrument ESS_butterfly_Guide_curved_test.instr via Files, New From Template..., ESS

 - 4. Look in the code for rotations + translations taking you from the MCNP / TCS to the McStas / beamline coordinate system

 - 5. Run the instrument for one or more combinations of Sector= and beamline=, both in "simulation" and "trace" modes.