Monte Carlo Particle Lists

MCPL

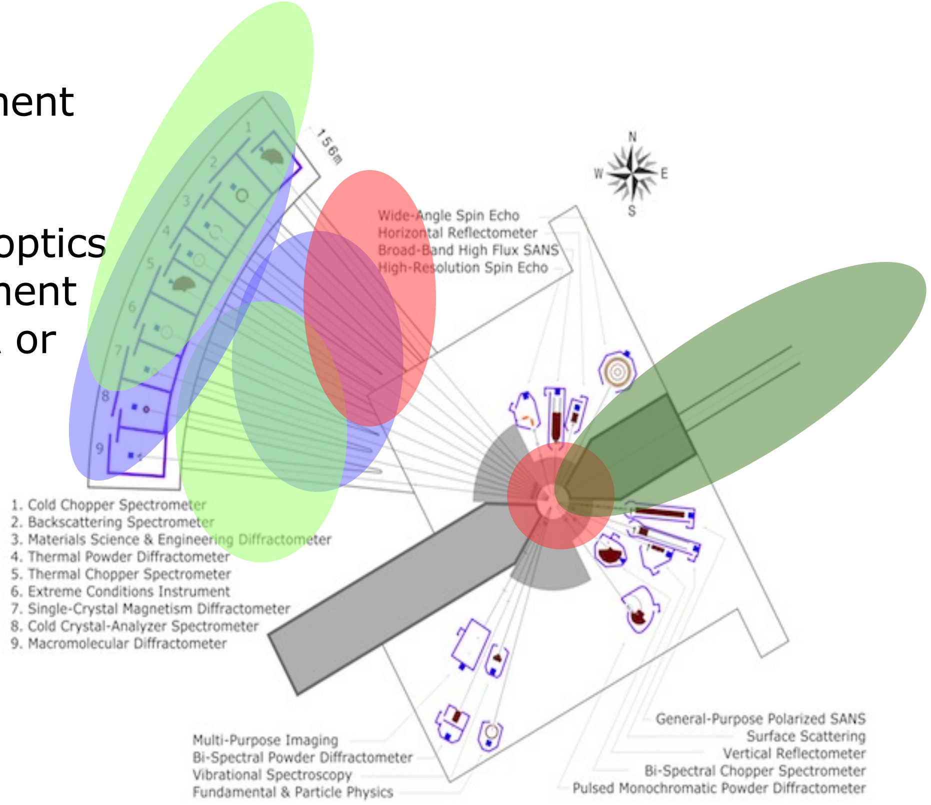
Legacy: 2016 overview

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

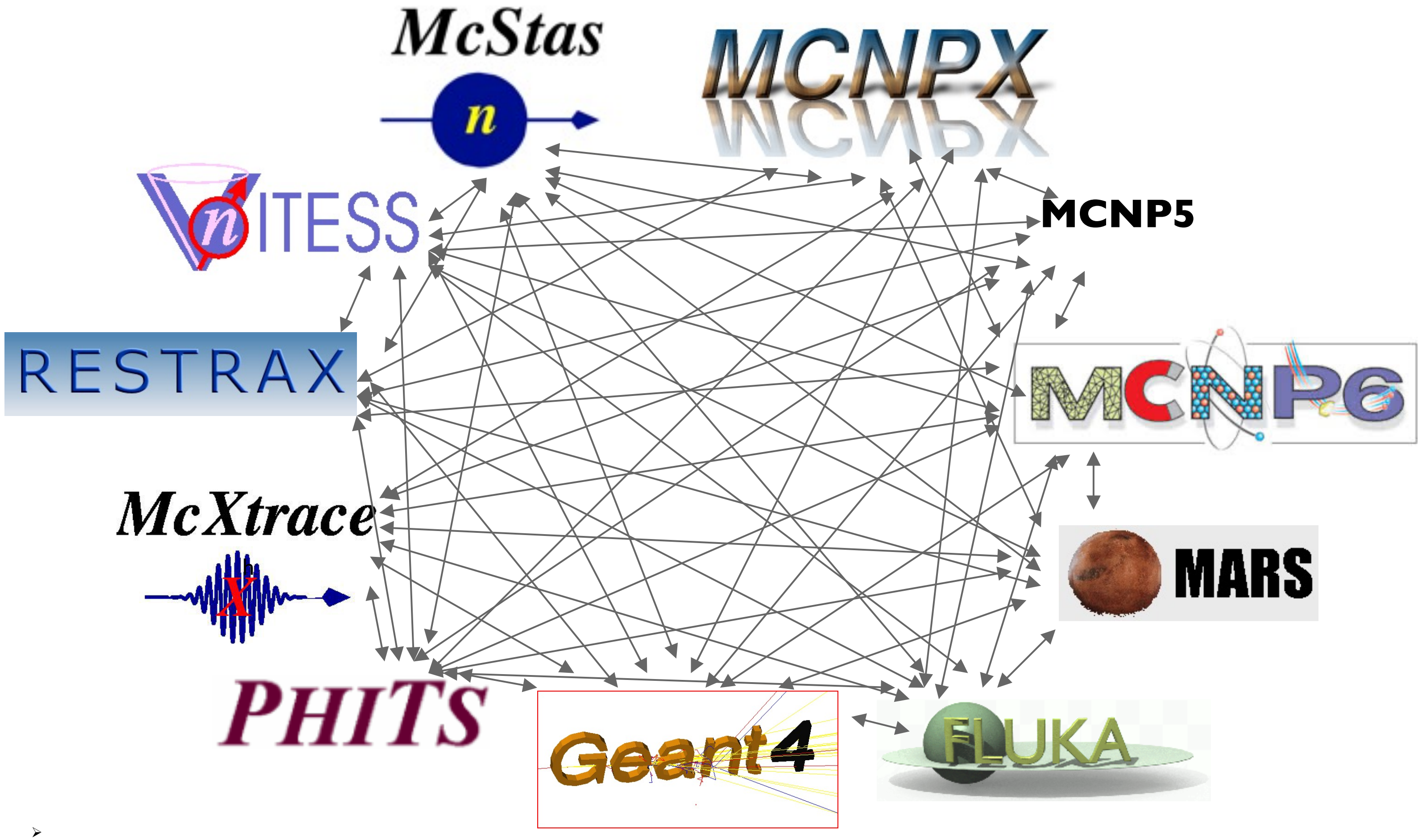
intermediate loss of information (e.g. through fitting etc)



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*



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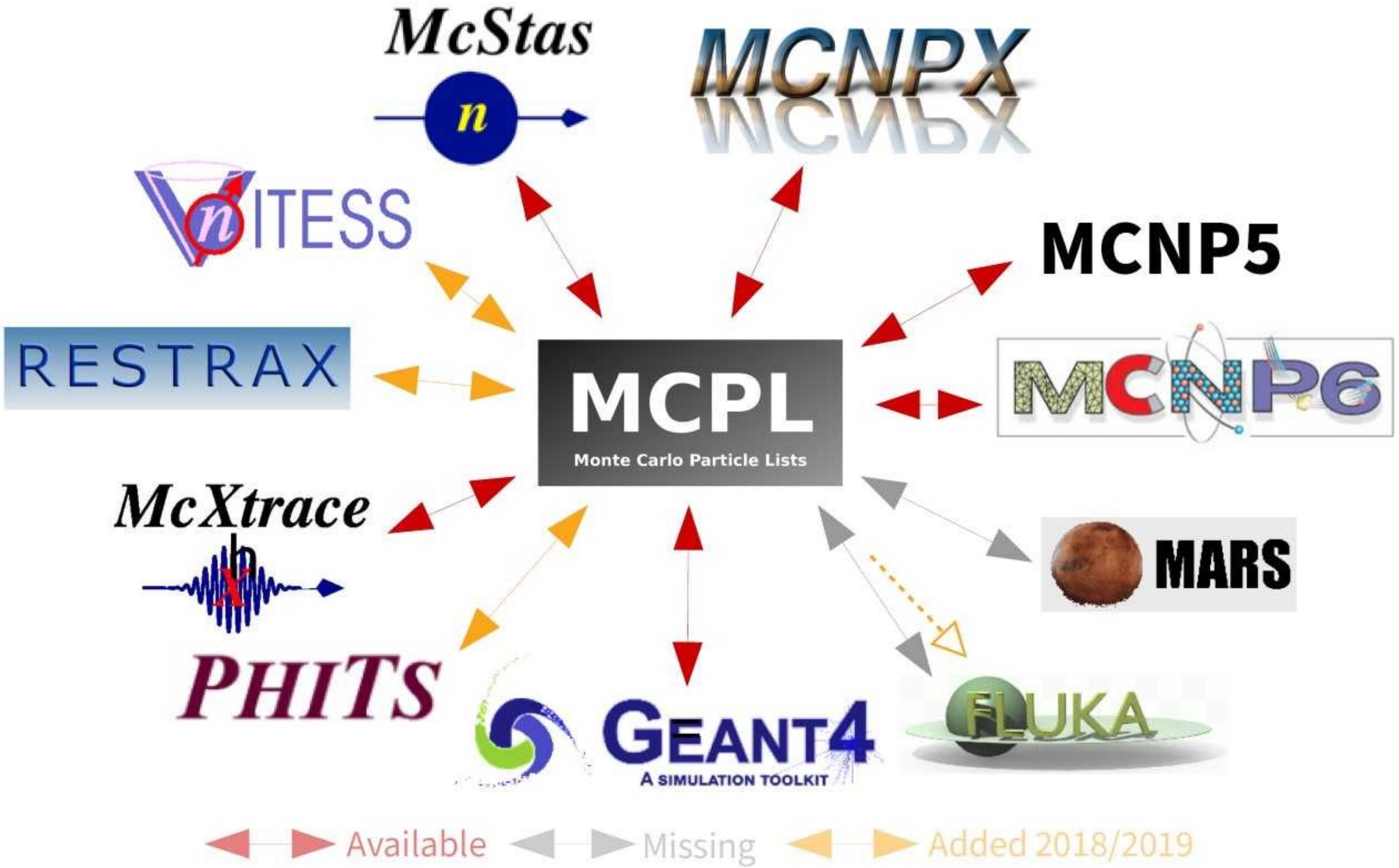
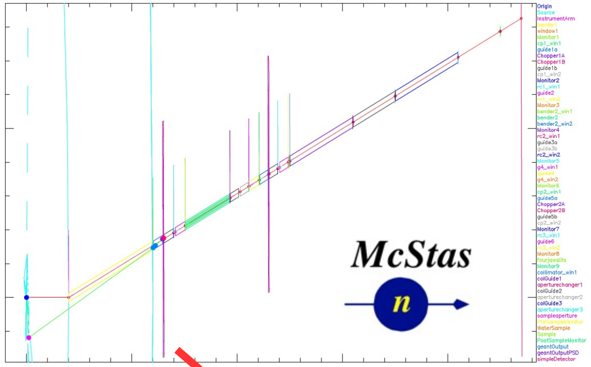
Software integration: **MCPL**



MCPL example use-case

Typical MCPL usage in detector studies

MCPL
Monte Carlo Particle Lists



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

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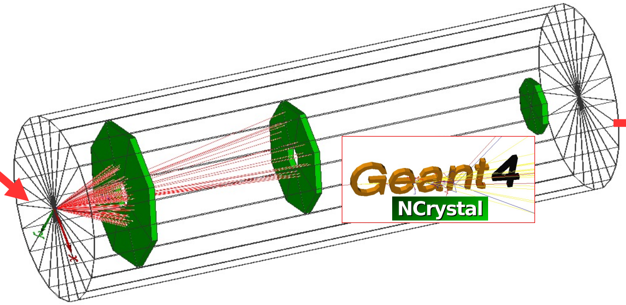
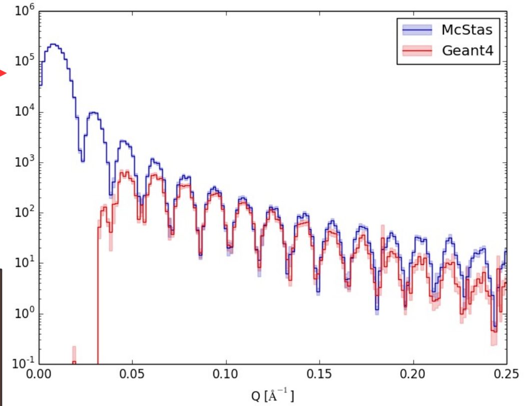




Then feed into detailed Geant4-based detector simulation

- 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

```
klinkby@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

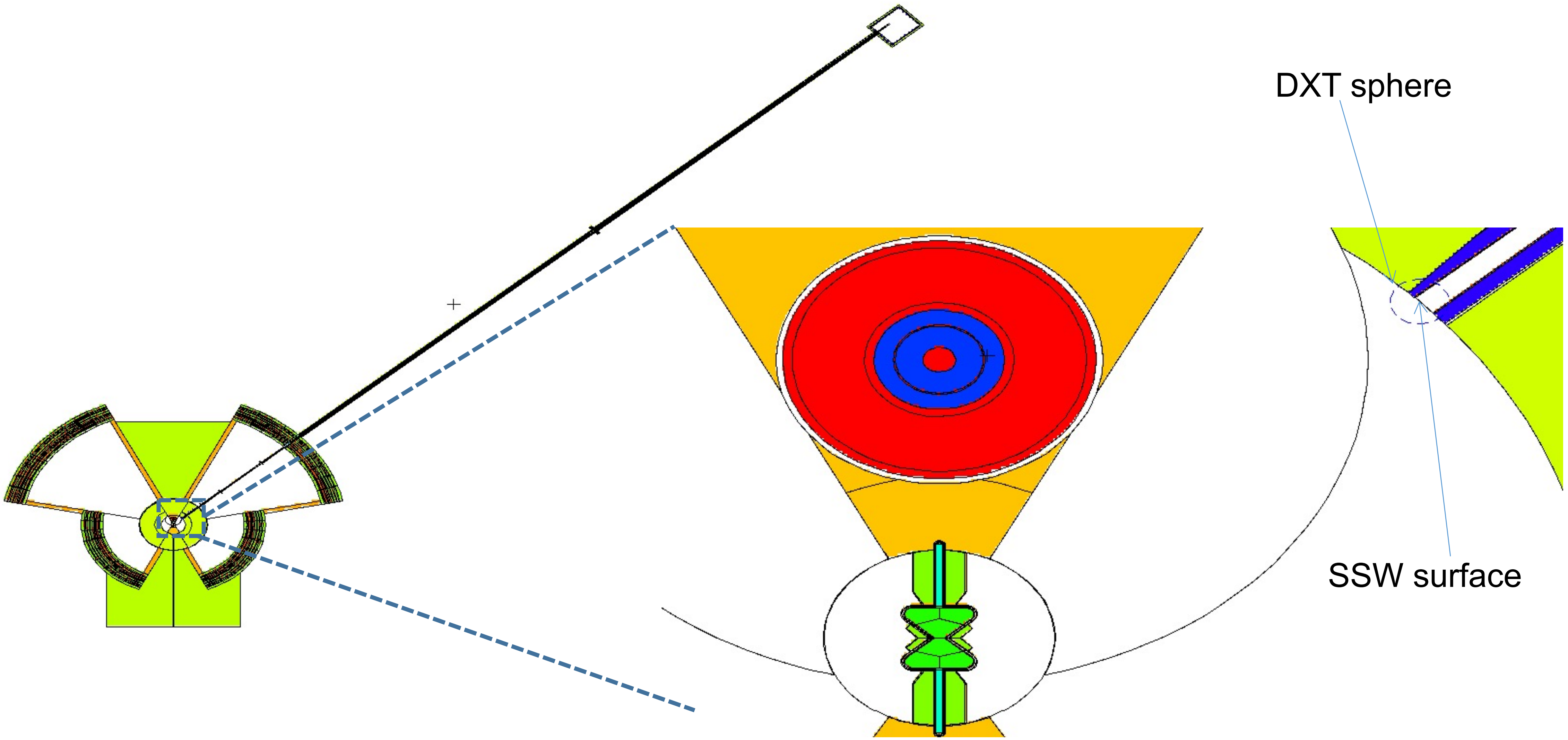
- https://mctools.github.io/mcpl/
- https://mctools.github.io/mcpl/mcpl.pdf

MCPL: Coupling MCNP & McStas

- One example, of particular interest concerns coupling MCNP and McStas through MCPL, exploiting varience 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 https://public.esss.dk/users/willend/MCPL/
    /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.