

WP4: Analysis and Simulation Techniques for Underground Physics Experiments

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Simplified Layout

Signal Model

Background
Model

Detector
Response

Reconstruction

Data Analysis

Phenomenology

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FLUX

Halo Model
Oscillated solar neutrinos
Core-collapse supernovae
Neutrinoless double-beta decay
(...)

CROSS SECTION

Neutrino Coherent Scattering
WIMP-nucleus form factor
Migdal effect
(...)

PARTICLE
GENERATORS

In some areas (e.g. SNEWS2.0) there are attempts to build generators for all experiments, giving the possibility to choose the most appropriate model.

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RADIOACTIVE DECAYS

GEANT4-ENSDF
(Alpha, neutron) reactions with
SOURCES, TALYS, etc
(...)

COSMIC / COSMOGENICS

GEANT4, FLUKA, CORSIKA, ...

NEUTRINOS

Neutrino floor, ...

SOFTWARE
VALIDATION AND
DISSEMINATION

Review what's already been done and
understand what's needed for the future

Detector

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PARTICLE TRACKING

GEANT4, FLUKA, ...

RESPONSE MODELS

Ionization, scintillation, phonons,
Cherenkov (NEST, PARIS, ...)

ELECTRONIC SIMULATION

Well known? It depends on the PHYSICS LIST

CRITICAL:
atomic physics expertise is needed

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STANDARD APPROACHES

Position reconstruction (time-of-flight / charge collection, ...)

Particle Identification (Gatti, PSD, time-of-flight, ...)

MACHINE LEARNING

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Profile Likelihood Ratio (RooFit,
R, python-based)

Bayesian Approaches

Alternative Frequentist
Approaches (Yellin Method...)

What to use and why?

Can we directly
compare results
obtained with different
approaches?

Should we adopt a
reference approach?

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Theoretical framework to allow
comparisons

DM direct search and collider results
ALPs from different sources
DBD results vs matrix elements

...

Can we set tighter limits or make the
observations more significant by
combining multiple results?

Interactions with
theoreticians are
needed

Our proposal is to address the mentioned topics through

- overview talks on broad subjects (e.g. Geant4 physics, Bayesian approaches, the physics of NEST) given by experts in the field
- talks on the methods used in individual experiments given, if possible, by young people.