

WG4: Detector Physics, Simulations & Software Tools

1. Introduction to WG4 (½ page)

[Piet]

- Importance of Detector physics modeling and simulations
- Importance of Software Tools as our toolbox to do the point above
- DSR3: ECFA priority on software tools + DSR8: Attract & Nurture careers Young
- SW development has impact outside gaseous detector field
- Getting some definitions straight - and highlighting where we will concentrate
 - i. Software tools used by Experiments [will just mention, not concentrate]
 - ii. Software tools used by R&D [yes]
 - 1. Detector Physics Modelling [yes]
 - 2. Detector Design [will just mention, not concentrate]
- Teach Detector physics - Train students - Simulation school - COLAB [1]
- Outline: overview of the rest of the document

2. State of the Art (1 page)

[explain simulation to non experts] maybe ½ page?

- State of the art of simulations done in Wire community [ROB]
 - i. Physics is mature - Legacy of Garfield
 - ii. Wire-sag is included; Wire-surface, with SF6 entering into wire surface ...
- State of the art of RPC simulation: [PAULO/MARCELLO]
 - i. Physics that is understood & physics that is not understood
 - ii. Current way RPCs are simulated and their
- State of the art simulation of MPGD, resistive MPGD [PIET,ROB,OZKAN]
 - i. What we can - where it breaks down
 - ii. New tendencies: optical readout - what we can now (afterburner)
- State of the art of TPC simulation [MARYNA,PIET]
 - i. TPC: drift - Garfield - OK
 - ii. TPC: amplification: see wires or MPGD

3. Needs of the Communities (1 page)

[attention: factorize better 2&3]

- What is coming out of the survey: what the community wants
 - i. Maintenance of existing SW Tools
 - ii. Development of new features
- What is missing / desired by Wires
 - i. [Help! - Do we miss something? - [Should reach out more to community]
 - ii. Study eco-gas with wire detectors (which gas they want to replace?)
- What is missing / desired by RPC
 - i. Large avalanches - study Avalanche statistics, timing, non-linearity
 - ii. Avalanche-to-Streamer transition, streamer propagation, quenching
 - iii. Dark counts, physics at high rate, ...

- iv. New gasses what to expect (chemistry)
 - v. There was a question, like, should we examine chemical properties to understand the effects of aging? (Özkan comment)
 - What is missing / desired by MPGD
 - i. Many things - in my head
 - What is required /desired by TPC
 - i. Scintillation (optical readout), Negative Ions, Calibration SW (ML,DNN,...)
4. **Future view on detector simulation (20+ years view) Paulo - diagram** - can be also the final bullet of the section above (3) **[PAULO]**
- Physics is in common - enough to have all the correct boundary conditions
 - We need a skeleton - people will be motivated to fill the box
 - We should envision a GEANT-like tool. Nobody knows all the physics, but one will be able to run with all the physics set correctly...
5. **Project the work for the next 5-10 years (1 page)**
- Identifying SW development work that all other developments depends upon
And identify this as a potential CORE work package
 - i. Improve collaborative work for software integration
 - ii. Adapt software for Multi-Thread, GPU
 - iii. Software algorithms for large avalanches
 - iv. Software algorithms for Photon Tracking (absorption, emission)
 - v. Software algorithms & improvements for space charge
 - Identify SW development work that should go into WPs dedicated to applications
 - i. Simulation of Charge Spread & Signal induction in **Resistive Detectors**
 - ii. Extraction of Gas parameters [need to understand with WP3]
 - iii. Simulation of Negative Ions
 - iv. Simulation of Optical Readout

[1] ESIPAP exercise with Garfield++ in a google workspace - Josh Renner

https://colab.research.google.com/github/jerenner/garfieldfem/blob/master/garfield_FEM_ESIPA_P.ipynb#scrollTo=40_k2_UFK006