

# SWEATERS Project

## Garfield Changes for Micromegas at low pressure

Status Report for DRD1 -WG4

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# Garfield++ baseline and running mode

## ❑ Garfield++ master version baselines

### A. Jun 20, 2021

- All code changes

### B. Jan 22, 2025 [ee94282e7e8a3b3af364d193e1f90fe94a929874]

- All code changes except for three items with limited impact on final results (B02, B03, B04: see next slides)

## ❑ Garfield++ running mode

- ✓ Enabled Null Collision Steps to update electron energy on null collisions (off by default)

*avalanchemicroscopic->EnableNullCollisionSteps(true)*

- ✓ Use of detailed deexcitation mode instead of Penning transfer rate mode

*gas->EnableDeexcitation()*

- ✓ Use photon transport

*EnablePhotonTransport(true)*

- ✓ Enable radiation trapping

*gas->EnableRadiationTrapping()*

# Sweaters changes to Garfield++ [1/3]

## A. Corrections due to lower pressure conditions

- A01 Fix Null Collision frequency calculation by increasing inversely proportional to the density
  - *MediumMagboltz.cc*
- A02 Fix the unnecessary scaling of Electric Field in Ion Velocity calculation (then also fixed in Garfield)
- A03 Fix the negative extrapolation from IonMobility\_Ar+\_Ar.txt file by extending data range in mobility file (then also fixed in Garfield)

## B. Detailed Deexcitation Mode

- B01 Tuning of some Argon rate constants
  - *MediumMagboltz.cc*
- B02 New specific level for Ar excimer while currently it is the same as Ar dimer *[Jun2021 Garfield++ version only]*
  - *MediumMagboltz.cc*
- B03 Deexcitation of CO2+\* *[Jun2021 Garfield++ version only]*
  - *GarfieldConstants.hh, AvalancheMicroscopic.cc, MediumMagboltz.hh, MediumMagboltz.cc*
- B04 Displacement of excited states during lifetime *[Jun2021 Garfield++ version only]*
  - *AvalancheMicroscopic.hh, AvalancheMicroscopic.cc, MediumMagboltz.cc*

## C. Radiation Trapping

- C01 Adjustments to broadening of discrete line emissions
  - *MediumMagboltz.cc*
- C02 Collision frequencies for discrete lines absorption based on Holstein absorption coefficient
  - *MediumMagboltz.hh, MediumMagboltz.cc*
- C03 Fix fwhmGauss calculation
  - *MediumMagboltz.cc*

# Sweaters changes to Garfield++ [2/3]

## D. Photoelectric induced secondary electrons

- D01 New code to handle photons hitting the mesh (as Ansys medium) so generating secondary electrons
  - *AvalancheMicroscopic.hh, AvalancheMicroscopic.cc*

## E. Ion induced secondary electrons

- E01 New code to add TransportMC in AvalancheMicroscopic
  - *AvalancheMicroscopic.hh, AvalancheMicroscopic.cc, AvalancheMC.hh, AvalancheMC.cc*
- E02 New code to handle ions hitting the mesh (as Ansys medium) so generating secondary electrons
  - *AvalancheMicroscopic.hh, AvalancheMicroscopic.cc*

## F. Discharge handling

- F01 Dynamic calculation of  $\beta M$  to control avalanche growth and prevent program hanging (discharges)
  - *AvalancheMicroscopic.cc*
- F02 New particle attribute to trace the origin of the avalanche to which it belongs to
  - *AvalancheMicroscopic.hh, AvalancheMicroscopic.cc*

## G. Statistics

- G01 New histograms for some physical properties at mesh ( ion energy, ion time arrival, photon energy,...)
  - *AvalancheMicroscopic.hh, AvalancheMicroscopic.cc*
- G02 New counters to monitor and tune some relevant processes (penning rate,...)
  - *AvalancheMicroscopic.hh, AvalancheMicroscopic.cc, AvalancheMC.hh, AvalancheMC.cc*

# Sweaters changes to Garfield++ [3/3]

## H. Execution handling

- ❑ H01 Configuration of physical and control parameters
  - *AvalancheMicroscopic.hh*, *MediumMagboltz.hh*
- ❑ H02 Debug mode specific to the new functions
  - *AvalancheMicroscopic.cc*, *AvalancheMC.cc*
- ❑ H03 Detailed exit codes (mainly to intercept “discharge” conditions)
  - *AvalancheMicroscopic.hh*, *AvalancheMicroscopic.cc*

# Tagging conventions of code changes

## ❑ Comment one line

```
//SW-1#XXX  
//line
```

## ❑ Add one line

```
//SW+1#XXX  
new line
```

## ❑ Replace one line

```
//SW-+#XXX  
//line
```

new line

## ❑ Comment block of lines

```
//SW-s#XXX  
// block  
//SW-e#XXX
```

## ❑ Add block of lines

```
//SW+s#XXX  
new block  
//SW+e#XXX
```

```
//SW-1#E01
```

```
// return TransportElectrons(particles, true);
```

```
-----
```

```
//SW+1#C02
```

```
    mSw_Mgas[iGas] = m;
```

```
-----
```

```
//SW-+#C05
```

```
//  const double fwhmGauss = dxc.sDoppler * sqrt(2. * log(2.));  
    const double fwhmGauss = dxc.sDoppler * 2 * sqrt(2. * log(2.));
```

```
-----
```

```
//SW-s#C02
```

```
//  if (dxc.cf > 0. && fabs(e - dxc.energy) <= dxc.width) {  
//    cfSum += dxc.cf *  
//          TMath::Voigt(e - dxc.energy, dxc.sDoppler, 2 * dxc.gPressure);
```

```
//SW-e#C02
```

```
-----
```

```
//SW+s#C02
```

```
    if (dxc.cf > 0. && fabs(e - dxc.energy) <= dxc.width*mSw_MMCnf.CfAbsWidths) {  
        cfSum += Sw_CalcDiscreteLineCf(dxc,e,cfSum);
```

```
//SW+e#C02
```

# Improvements? [2025 Garfield based version]

## A. Complete

- B02 New specific level for Ar excimer while currently it is the same as Ar dimer
- B03 Deexcitation of CO<sub>2</sub>+\*
- B04 Displacement of excited states during lifetime

## B. Improve

- Avoid changing arguments of Garfield functions (eg AvalancheMicroscopic::MakePoint)
- Extend also other avalanche conditions (TransportElectronBfield?) with the new functions
- Example program
- ...

## C. Investigate

- Ion velocity, average speed increases between 2021 and 2025 version
- Penning transfer rate calculation
- Mixtures other than Ar/CO<sub>2</sub>
- ...