DATA ACQUISITION, DATA ANALYSIS AND SIMULATION TOOLS IN A TEST BENCH ENVIRONMENT

3RD AVA TOPICAL WORKSHOP – MACHINE EXPERIMENT INTERFACE

10 – 11 OCTOBER 2019, COSYLAB, LJUBLJANA, SLOVENIA

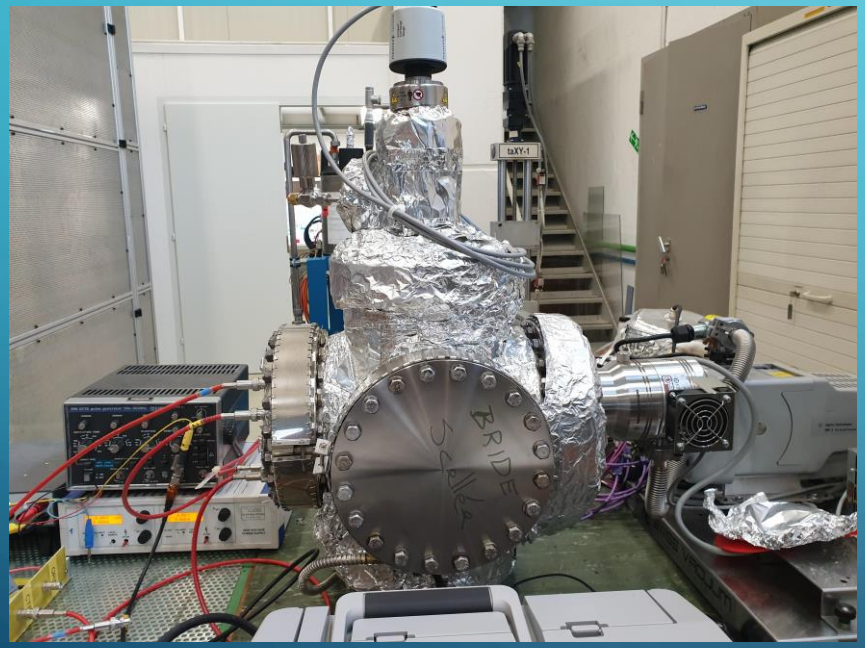
BRUNO GALANTE, CERN

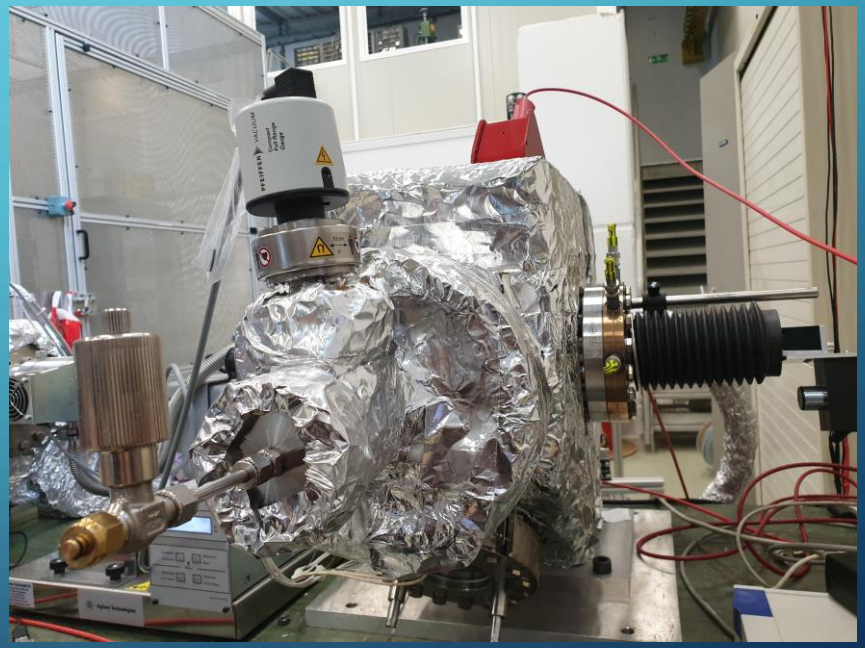
OUTLINE

- Introduction
- Data acquisition: LabView
- Data analysis: MATLAB
- Simulation tools: CST Particle Studio
- Conclusions

INTRODUCTION

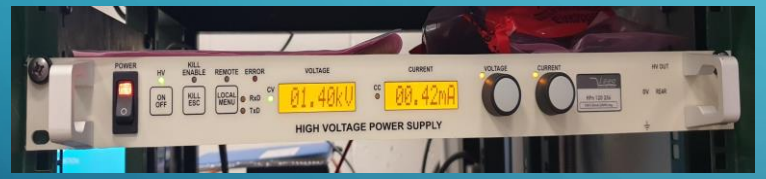
- 2 Test benches for several different experiments
- Independent measurements



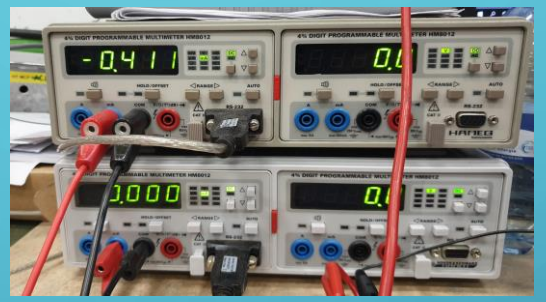


INTRODUCTION

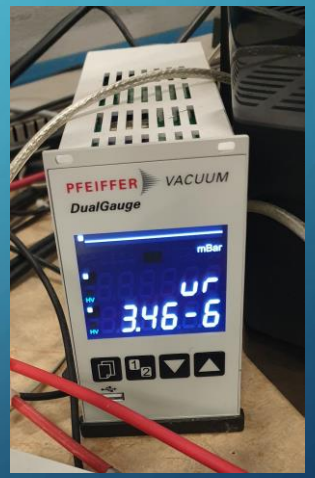
Power Supplies



Digital Multimeters

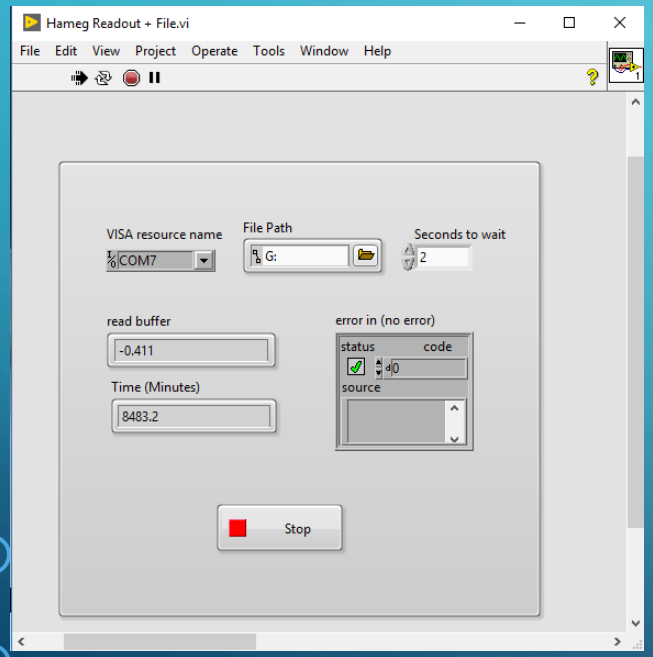


Vacuum DualGauge

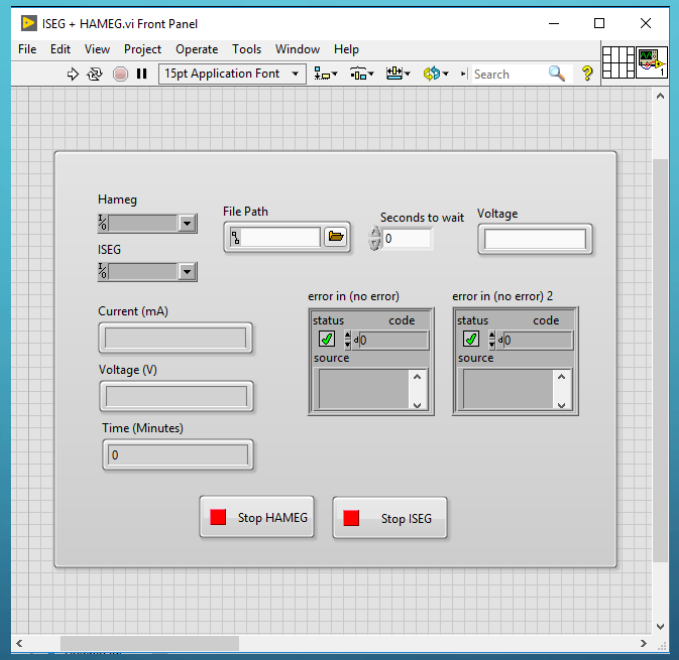


DATA ACQUISITION: LABVIEW

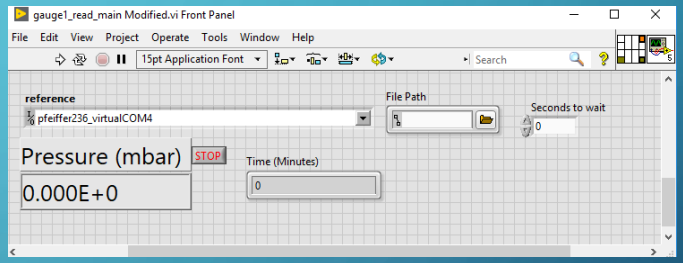
Readout: Same program for readout from different Multimeters or readout from Power Supply



Combination of instruments

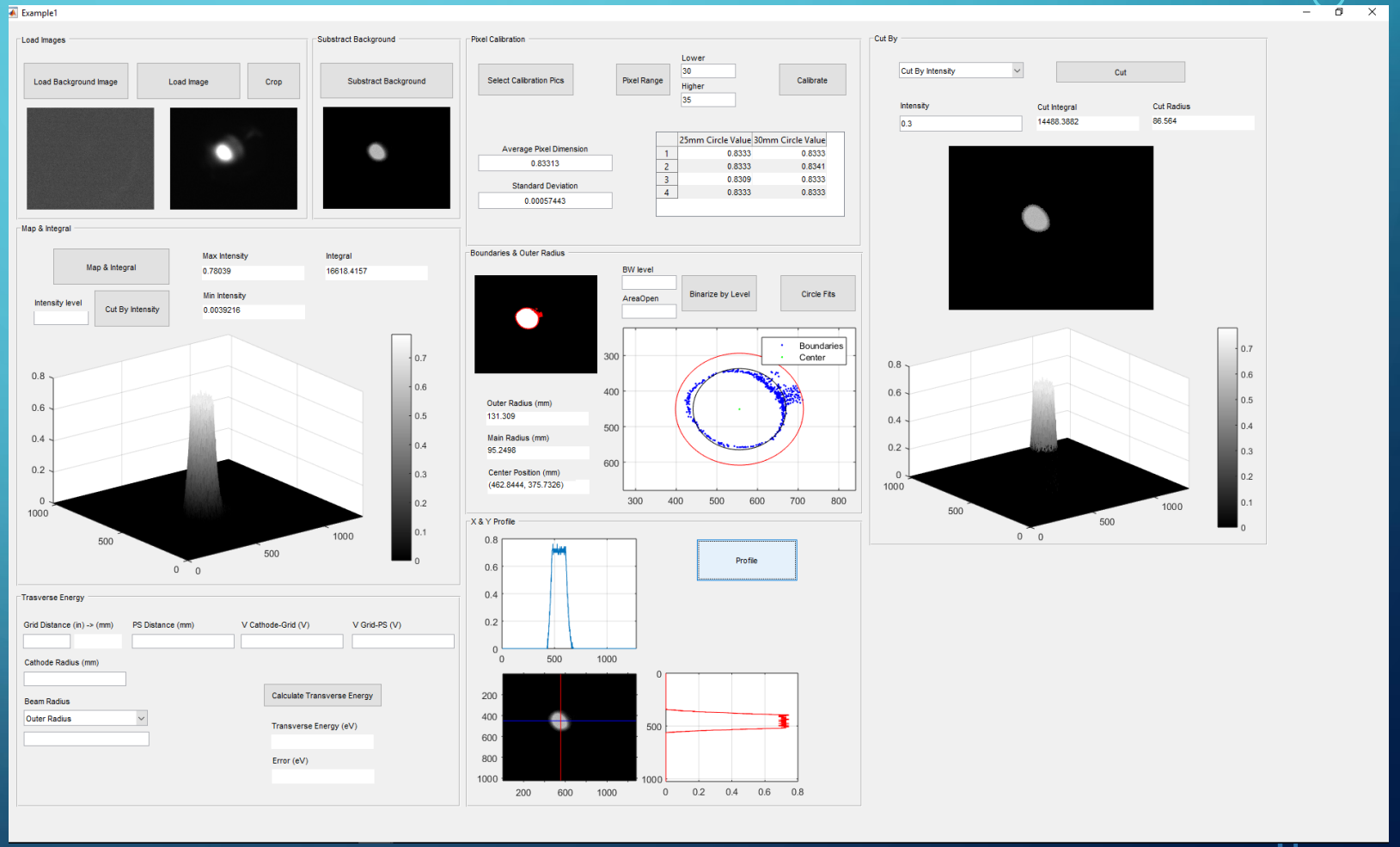


Pressure readout, built on top of instrument own LabView program



DATA ANALYSIS: MATLAB

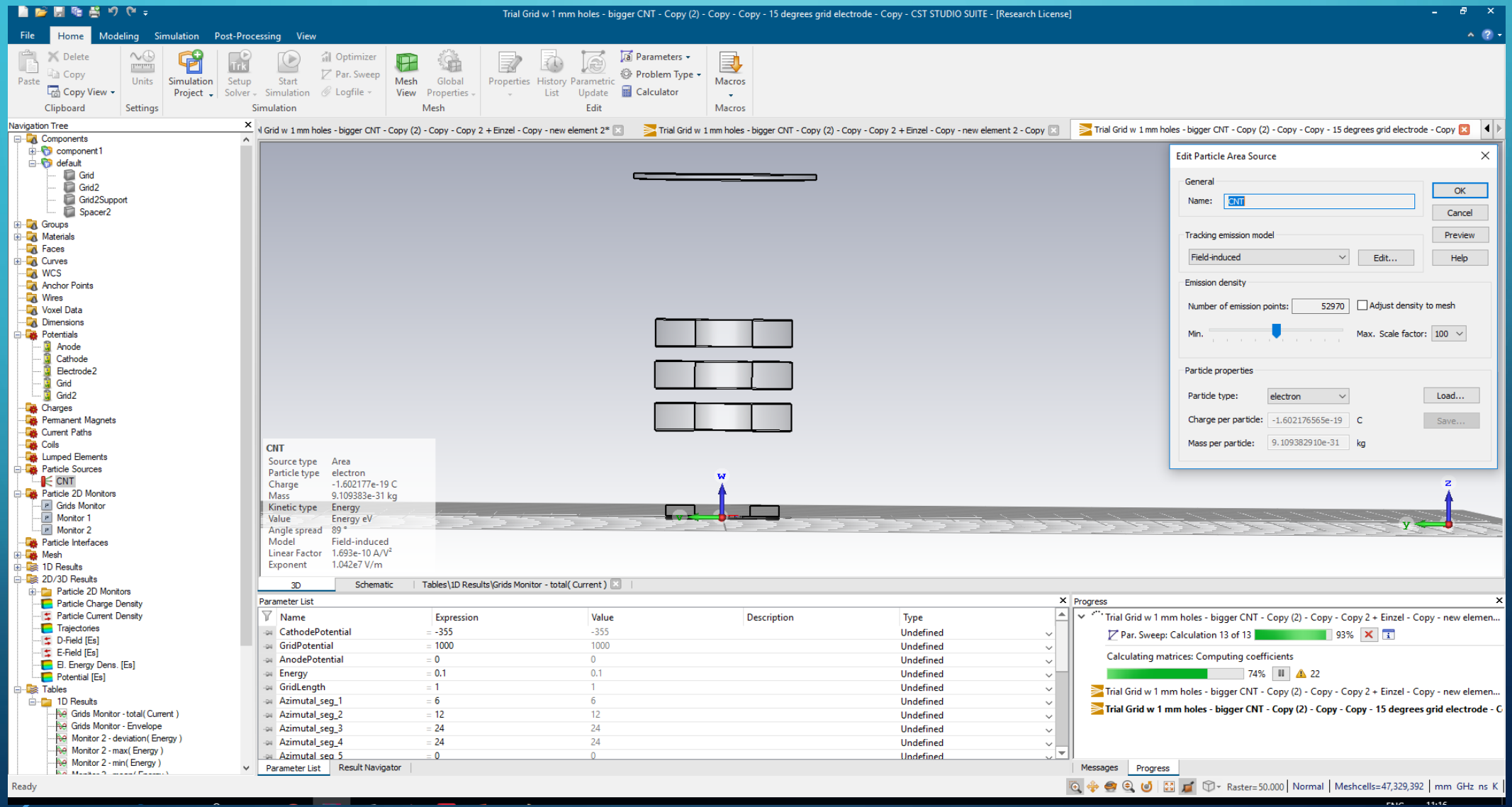
- LabView program save data on a file. MATLAB analyzes data importing from file.
- Image Analysis

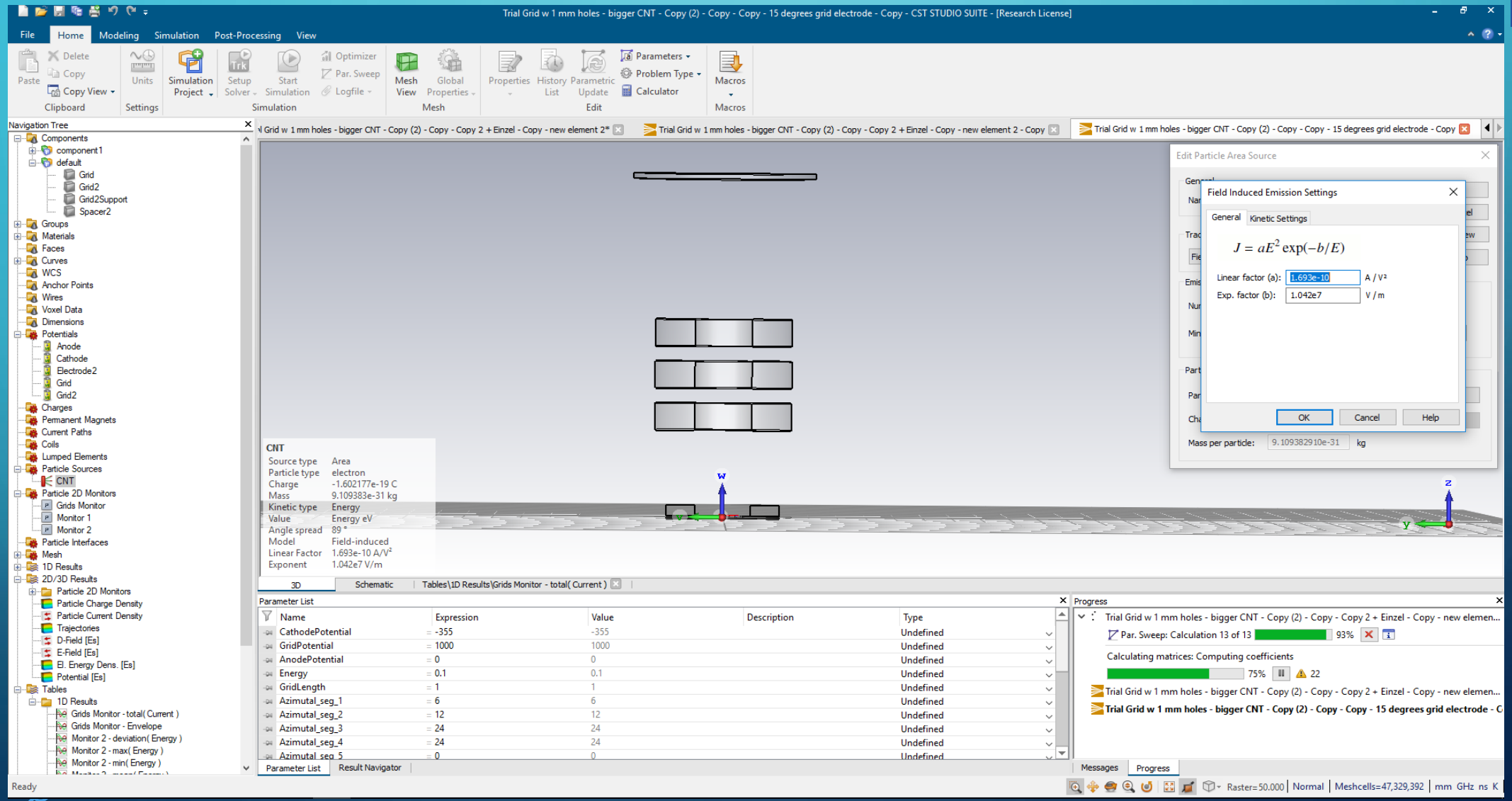


SIMULATION TOOL: CST PARTICLE STUDIO

Among all the simulation software the choice is CST because of:

- built-in field emission module
- straightforward particle tracking module.


Trial Grid w 1 mm holes - bigger CNT - Copy (2) - Copy - Copy - 15 degrees grid electrode - Copy - CST STUDIO SUITE - [Research License]
File
Home
Modeling
Simulation
Post-Processing
View
Navigation Tree
Components
component1
default
Grid
Grid2
Grid2Support
Spacer2
Groups
Materials
Faces
Curves
WCS
Anchor Points
Wires
Voxel Data
Dimensions
Potentials
Anode
Cathode
Electrode2
Grid
Grid2
Charges
Permanent Magnets
Current Paths
Coils
Lumped Elements
Particle Sources
CNT
Particle 2D Monitors
Grids Monitor
Monitor 1
Monitor 2
Particle Interfaces
Mesh
1D Results
2D/3D Results
Particle 2D Monitors
Particle Charge Density
Particle Current Density
Trajectories
D-Field [Es]
E-Field [Es]
El. Energy Dens. [Es]
Potential [Es]
Tables
1D Results
Grids Monitor - total(Current)
Grids Monitor - Envelope
Monitor 2 - deviation(Energy)
Monitor 2 - max(Energy)
Monitor 2 - min(Energy)
Trial Grid w 1 mm holes - bigger CNT - Copy (2) - Copy - Copy 2 + Einzel - Copy - new element 2 - Copy
Trial Grid w 1 mm holes - bigger CNT - Copy (2) - Copy - Copy - 15 degrees grid electrode - Copy
CNT
Source type Area
Particle type electron
Charge -1.602177e-19 C
Mass 9.109383e-31 kg
Kinetic type Energy
Value Energy eV
Angle spread 89 °
Model Field-induced
Linear Factor 1.693e-10 A/V²
Exponent 1.042e7 V/m
Edit Particle Area Source
General
Name: CNT
OK
Cancel
Preview
Help
Tracking emission model
Field-induced
Edit...
Emission density
Number of emission points: 52970
Adjust density to mesh
Min.
Max. Scale factor: 100
Particle properties
Particle type: electron
Load...
Charge per particle: -1.602176565e-19 C
Save...
Mass per particle: 9.109382910e-31 kg
Parameter List
Name
Expression
Value
Description
Type
CathodePotential -355 -355 Undefined
GridPotential 1000 1000 Undefined
AnodePotential 0 0 Undefined
Energy 0.1 0.1 Undefined
GridLength 1 1 Undefined
Azimutal_seg_1 6 6 Undefined
Azimutal_seg_2 12 12 Undefined
Azimutal_seg_3 24 24 Undefined
Azimutal_seg_4 24 24 Undefined
Azimutal_seg_5 0 0 Undefined
Progress
Par. Sweep: Calculation 13 of 13 93%
Calculating matrices: Computing coefficients
74%
Ready
Raster=50.000
Normal
Meshcells=47,329,392
mm GHz ns K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Particle type electron
Charge -1.602177e-19 C
Mass 9.109383e-31 kg
Kinetic type Energy
Value Energy eV
Angle spread 89 °
Model Field-induced
Linear Factor 1.693e-10 A/V²
Exponent 1.042e7 V/m
Edit Particle Area Source
Field Induced Emission Settings
General
Kinetic Settings
$J = aE^2 \exp(-b/E)$
Linear factor (a): 1.693e-10 A / V²
Exp. factor (b): 1.042e7 V / m
OK
Cancel
Help
Mass per particle: 9.109382910e-31 kg
Parameter List
Name Expression Value Description Type
CathodePotential -355 -355 Undefined
GridPotential 1000 1000 Undefined
AnodePotential 0 0 Undefined
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Azimutal_seg_4 24 24 Undefined
Azimutal_seg_5 0 0 Undefined
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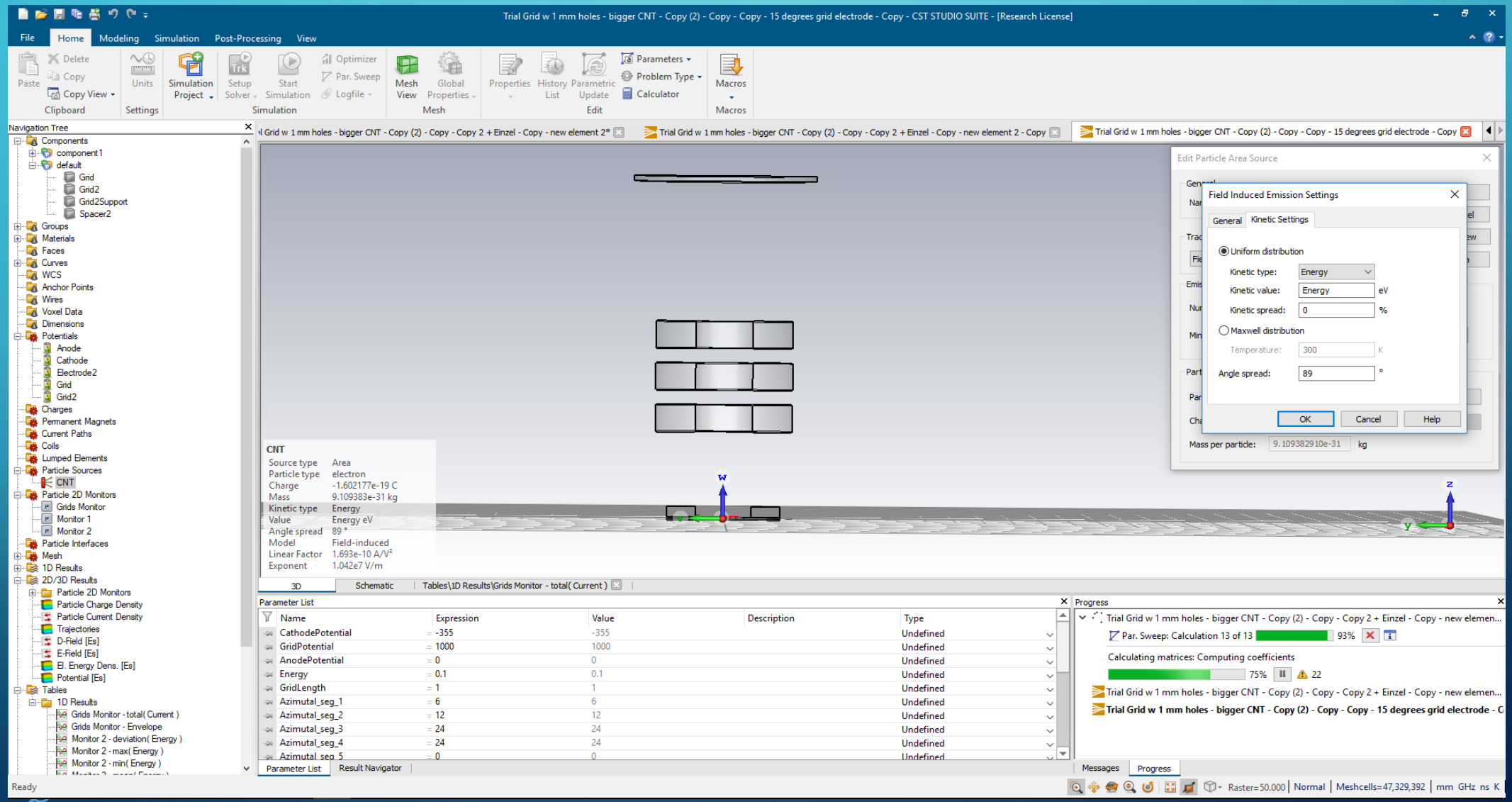
Calculating matrices: Computing coefficients
75%
Ready
Raster=50.000
Normal
Meshcells=47,329,392
mm GHz ns K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Particle type electron
Charge -1.602177e-19 C
Mass 9.109383e-31 kg
Kinetic type Energy
Value Energy eV
Angle spread 89 °
Model Field-induced
Linear Factor 1.693e-10 A/V²
Exponent 1.042e7 V/m
Edit Particle Area Source
Field Induced Emission Settings
General
Kinetic Settings
Uniform distribution
Kinetic type: Energy
Kinetic value: Energy eV
Kinetic spread: 0 %
Maxwell distribution
Temperature: 300 K
Angle spread: 89 °
OK
Cancel
Help
Mass per particle: 9.109382910e-31 kg
Parameter List
Name Expression Value Description Type
CathodePotential -355 -355 Undefined
GridPotential 1000 1000 Undefined
AnodePotential 0 0 Undefined
Energy 0.1 0.1 Undefined
GridLength 1 1 Undefined
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Azimutal_seg_4 24 24 Undefined
Azimutal_seg_5 0 0 Undefined
Progress
Par. Sweep: Calculation 13 of 13 93%
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75%
Ready

CONCLUSIONS

- The choice of such a variety of tools is strictly related to the necessity to make several independent things. Furthermore, being in a test bench environment with a relatively small quantity of data and the possibility to do many things by hand, it seemed too time-consuming develop a full range software.

- For what concerns the simulation part the possibility to add a simulation in COMSOL (or other) is being investigated in order to have a comparison.

THANK YOU

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