# SPIS Numerical core

(or SPIS/NUM, or "the solvers")

# Material interaction modelling

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# Outline

- Photo-emission
- Secondary emission
- Induced conductivity
- General challenges

# Photo-emission

- Yield:
  - One of NASCAP properties (at 1 AU, scales with sun flux)
  - Taken angle-independent (consistent with literature)

- Spectrum of photo-electrons:
  - Current version
    - Maxwellian
    - Temperature can be controled through a global parameter: *photoElectronTemperature* (typically 2-3 eV)
  - Possible extensions:
    - 2 Maxwellians
    - Arbitrary spectrum (40 eV population…)

# Secondary emission / true secondaries

- Yield:
  - Follows NASCAP model
    - Based on yield maximum at normal incidence: *Ym*, *Em*
    - Other energies and angles derived from range function
  - Flexibility/modularity:
    - Following NASCAP approach, range function can easily be changed (use a different RangeFunction object)
    - Changing approach, a different yield function can easily be changed
  - Type of incident particle model:
    - If PIC: microscopic, this yield applied to each particle
    - If fluid (Boltzmann): isotropic yield is used
    - Transparent: Interactor object can handle any type of impinging distribution
- Spectrum of (true) secondary electrons:
  - Maxwellian
  - Temperature can be controled through a global parameter: *secondaryTemperature* (typically 2-3 eV)

# Secondary emission / backscattered electrons

- Yield:
  - Follows NASCAP model (looks rather crude)
  - Small modification w.r.t. NASCAP (to be improved):
    - Yield = 0.5 for dielectrics at low energy (some experimental evidence)
    - Different of NASCAP => 0 below 50 eV
  - Type of incident particle model:
    - If PIC: particle per particle
    - If fluid (Boltzmann): fluid backscatterred flux

- Spectrum of backscattered electrons:
  - Accommodation = 0.95
  - Diffusive

- Need experimental inputs (in particular: experimental yield sums up secondaries and backscattered => ?)

# Induced conductivity

- Simple NACAP approach:
  - ~ $(\text{dose rate})^{\text{exponent}}$
  - Still to be implemented (simple)
- Improved approach:
  - Consider dose rate profile throughout the material (1D)
  - Conductivity becomes:
    - Depth dependant (conductances in series)
    - With an improved dependence in dose rate history (memory effect)
  - Will be mplemented following experimental activity

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# The challenges of interaction modelling

- Challenges:
  - Compute the interaction whatever the type of impinging flux (typically kinetic or fluid): polymorphism
  - Flexibility and easiness to build new interactions
- Ideas of solutions:
  - First approach: compute a function of a distribution from a function of a particle: ok e.g. for true secondary yield since individual particle characteristics can be lost (everything results in a 2eV-Maxwellian), but not for backscattering
  - Capability to combine Interactor objects
- Exemple of application: secondary emission:
  - True secondaries: everything summarised in a microscopic yield, that can also be applied to a fluid distribution through angle averaging
  - Backscattered: a specific reflection interactor was developed, then added to the true secondary generator
  - Possible extension with e.g. a more accurate model of backscattered electrons: define the microscopic yield $Y(E, \theta)$, which will be averaged for fluid impinging flux (and also for outgoing flux)