Development of a simulation code for material analysis using the PIGE technique

K. Preketes-Sigalas, A. Lagoyannis, M. Axiotis

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Particle Induced Gamma-ray Emission
- Light element analysis (e.g., Li, B, F, Mg etc.)
- Resonant-PIGE: depth profiling

Drawback: Use of standards
- Stopping power → Similar-matrix standards
  → Need of several standards in each lab

Solution: Standard-less measurements
- Well-measured cross sections
- Missing: Code
  - ERYA code → Windows (64-bit), LabVIEW
    → not compatible with R33 files
    → not working well
Yield calculation

- Using standards:
  \[ Y_{\text{sam}}(E_{\text{bomb}}, \phi) = Y_{\text{std}}(E_{\text{bomb}}, \phi) \cdot \frac{C_{\text{sam}}}{C_{\text{std}}} \cdot \frac{S_{\text{std}}(E_{\text{bomb}})}{S_{\text{sam}}(E_{\text{bomb}})} \]

- Standard-less measurements:

\[ Y_m = Y_{\text{init}} + \int_{E_{\text{init}}}^{E_{\text{bomb}}} \frac{\sigma(E)}{S_{\text{sam}}(E)} \cdot dE \]
PiGreCo program

- Programmed in C++ / Qt Libraries for GUI
- Distributions for Windows/Linux/Mac
- Homogeneous monolayer matrix
- Stopping power:
  - Elemental: ZBL/SRIM compilations
  - Compound: Bragg's rule
- Cross sections: R33 files, compatibility with IBANDL
Testing the code

- 3 standard samples
  - Phosphate rock (NIST, SRM 120b)
  - Multicomponent glass (NIST, SRM 1412)
  - ST NaF (5.3% Na, 5.3% F in C)
- \( E_p = 1.5 \text{ – } 4.0 \text{ MeV} \) (variable steps)

\[ ^{23}\text{Na}(p, p'\gamma_{1,0})^{23}\text{Na}, E_{\gamma}=440 \text{ keV} \]

@ Tandem Accelerator Laboratory - “Demokritos”
ST NaF (one fitting element)
ST NaF (two fitting elements)
To do list...

- **Near future**
  - Fixing of possible bugs
  - Analysis of the other two standards
  - Up to 5 fitting elements
  - Adding straggling

- **Distant future**
  - Extra features on demand
  - Weight percentage $\leftrightarrow$ Atomic percentage
  - **Multilayer targets** (resonant-PIGE) / ill-posed problem...
Thank you for your attention!