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### SIMONE

#### SIMulations Of Nuclear Experiment and data analysis framework



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#### **Exotic nuclei physics**









- •Light nuclei (A < 50)
- •Exotic structure
- Rare decay modes

#### Experimental equipment

- Our RIB's: typical beam energies < 100 MeV/A</li>
- Few detector types to disposal
- Investigated processes take place inside target







# Data processing

- Energy and time calibrations
- Particle identification + Trajectories reconstruction
- Physical spectra reconstruction
- MC simulations for data
   analysis



## Motivation

- A lot of experiments are performed
- All experiments based on the same pattern
- Simulations used for planning of experiment and for comparison with theory as well
- Generalization of tasks saves time

# **Existing tools**

- Tools for analysis already available (ROOT, Geant4, etc.) but are too general.
- Existing tools should be adopted for needs of our field.
- We don't need many HEP features
- Too much programming for simple tasks



#### **Experimental branch**



- Calibrated data stored container class objects
- Output generated with standardized structure and format.

# Simulations

- All steps can be routinized!
- Theoretical input is unique for each experiment
- Data on early steps also important
- Output data is stored in ROOT Trees of container classes

Simulated data

 Theoretical
 →
 Reaction
 Detector

 Model
 Events
 →
 products
 →
 response

 tracking
 forming

# Simulations

- Containers and Calculators
- Arbitrary distributions, various inputs and outputs for reactions
- Tracking and energy losses in detectors:
  - TGeo + various E-losses
  - •Geant4 externally
- Configuration of simulations in small data exchange files.



# Analysis

- Too complex for just "click and wait" approach.
- Routines helpful at:
  - Beam diagnostics
  - Geometry optimization
  - Reconstruction of hits' coordinates
  - Auxiliary methods for reconstruction of events
- Currently under development



## **Graphic User Interface**

| Edit particle x   | Simulation GUI _ 🗆 🗙                                    |
|---|---|
| Basic properties:   | File Reaction Materials Detectors Info View Preferences |
| Name: 17Ne Z number: 10 2 Å number: 17 2 Mass [MeV] 15853.1860 Kinetic energy [MeV]: 0.0000 2 Observable?<br>Excitation states: | Particles Reactions Materials Detectors                 |
| Width         Mean         Shape         Strength         Add new state   | 150   |
| 1 0.089 1.288 gauss 🗘 1 Remove selected   | p1<br>p2  |
| 2 0.112 1.850 Iorentzian 🗘 1  | 17Ne  |
|   | Add Edit Remove   |
| <u>C</u> ancel <u>O</u> K   | Generate kinematics Generate tracking                   |

| CsIDetector x |                   |            |          |          |  |
|---------------|-------------------|------------|----------|----------|--|
|               | Name              | Value      | Units    | Туре     | Description  |
| 1             | BackDeadLayer     | 0          | um       | double   | default description                                    |
| 2             | FrontDeadLayer    | 14.5       | um       | double   | default description                                    |
| 3             | Thickness         | 50000      | um       | double   | default description                                    |
| 4             | Width             | 200        | mm       | double   | default description                                    |
| 5             | Height            | 200        | mm       | double   | default description                                    |
| 6             | Name              | E_detector | no units | string   | default description                                    |
| 7             | Material for main | •          | no units | material | With what material main part of detector will be build |
| 8             | ×                 | 0          | mm       | double   | default description                                    |
| 9             | Y                 | 0          | mm       | double   | default description                                    |
| 10            | Z                 | 150        | mm       | double   | default description                                    |
|               |                   |            |          |          |  |

Cancel

#### Features

- Predefined detector geometries
- Kinematic calculator
- User friendliness
- Portability
- Saving experimental configuration (compatibility)





**AGH** Cracow







# Plans for the future

- More development and validation
- Testing on multiple platforms
- Add new, specialized detector types
- Diversification of calculation methods
- Handling of ion-optics



## Summary

- Many tasks can be isolated and routinized
- Development of special tools started in an international cooperation
- Advantageous approach for analysis is used
- Early version was released

# Thank you for your attention!