MAJORANA Background Modeling Framework

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motivation

- before taking data: would like to use MaGe to predict counts near 0νββ end point
  - for DEMONSTRATOR and tonne scale
- after taking data: would like to show that we can explain background spectrum near the end point

background modeling framework needed

MJ framework requirements

- take input from databases of MaGe runs, material purity, component information
- produce plots and tables of predicted energy spectrum
  - show effects of SSTC, PSA, granularity cuts on the spectrum
  - show contribution from each background source
- keep track of systematic and statistical errors

main classes

all classes
name
description

Prediction
experiment start date
experiment stop date
list of PredictedContributions

methods:
output info for a ROI

PredictedContribution
MaGeResult
Component
Contaminant
histograms

return:
n initial contaminant atoms
n expected decays

MaGeResult
number of initial events
filenames
histograms
adjustment factor, explanation

return:
counts in an ROI

Component
mass
material
activation start time
activation stop time
contribution start time
contribution stop time

Material
list of ContaminationData

ContaminationData
activity or production rate
contaminant

Contaminant:RadioactiveIsotope
tau

main classes

all classes
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n initial contaminant atoms
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input from database

MaGeResult
number of initial events
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Material
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ContaminationData
activity or production rate
contaminant

Contaminant:RadioactiveIsotope
tau

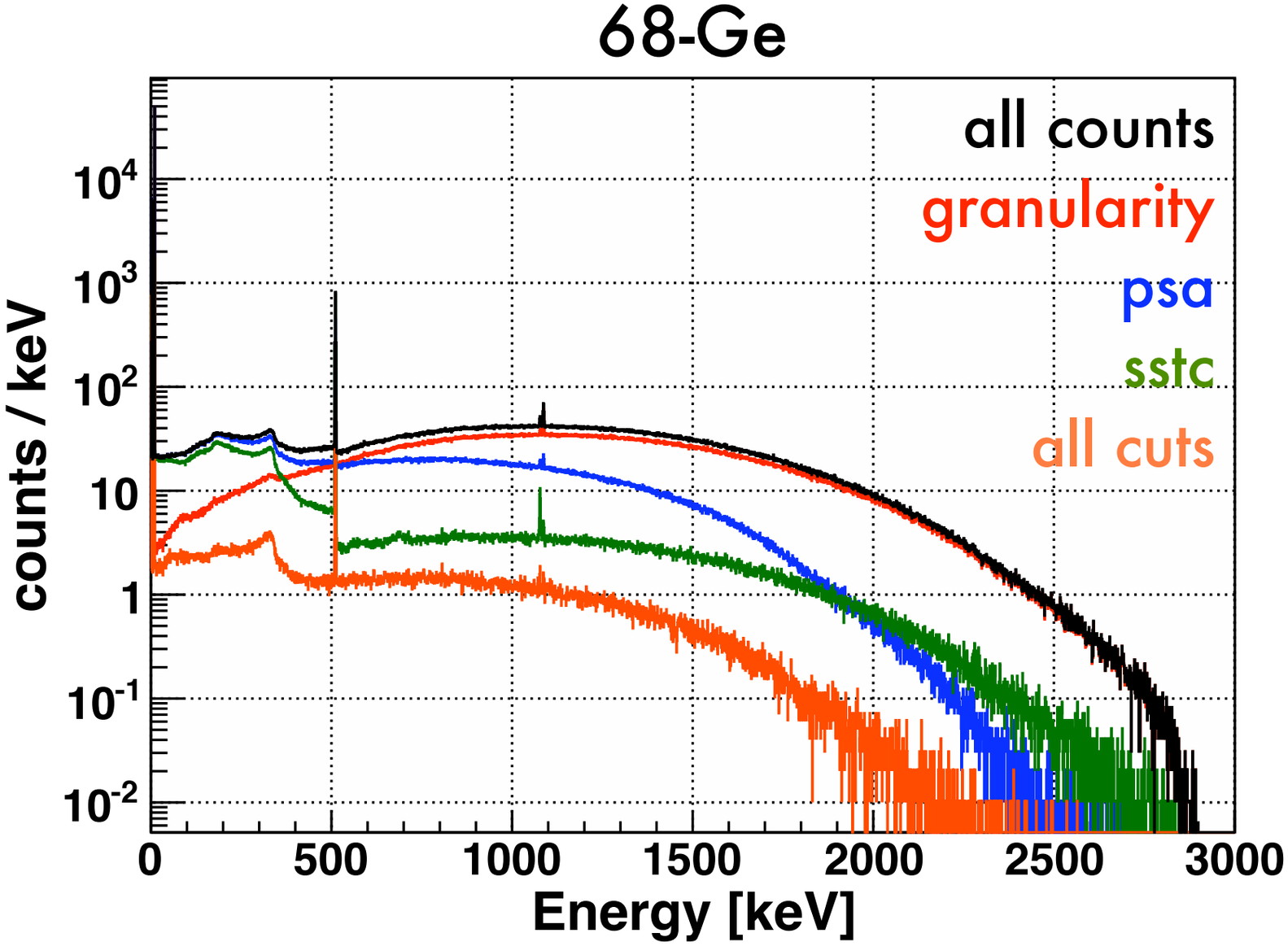
```
# define contaminant
ge68 = MJBMContaminant.RadioactiveIsotope(
    name='ge68',
    description='68-Ge',
    tau_in_seconds= 270.8*24*60*60)

# define material and add contaminant data to it
enr_ge = MJBMComponent.Material('enriched germanium')

enr_ge.add_contamination_data(
    MJBMComponent.ContaminationData(
        ge68,
        production_rate_in_atoms_per_day_per_kg=1.0  ))

# define component
detector_one = MJBMComponent.Component(
    "detectorOne",
    "detector one",
    mass_in_kg=.6,
    material=enr_ge,
    activation_start_time=dets_refine_stop,
    activation_stop_time=dets_ug,
    contribution_start_time = exp_start,
    contribution_stop_time = exp_stop )

# define a mage result
ge_in_det1_sim = MJBMMaGeResult.MJHistResult(
    'geInEnrGe',
    '68-Ge in enr ge',
    [ resultsdir +
        '/hists/Hists_Processed_simpleStringTest_G492p01_A68Z32_1000000_0.root'] )

# define a contribution
ge_in_dets = MJBMPredictedContribution.PredictedContribution(
    name='ge68InDetsFrom',
    description='68-Ge in detector one',
    component=detector_one, contaminant=ge68,
    mageresult = ge_in_det1_sim,
    correction_factor = 1000/0.6,
    correction_explanation = 'scale from 0.6 kg to 1000 kg' )

# define a prediction
prediction = MJBMPrediction.Prediction(savedir)
prediction.add_contribution( ge_in_dets )
prediction.write_latex()
```

example plot: 68-Ge

one contribution

inputs:

- cosmogenic production rate
- activation time
- cooldown time
- detector mass
- experiment start and stop times



latex output

database sample

material purity


```
"eFormedCopper": {
    "description": "electroformed copper",
    "contaminationData": {
        "A208-Z81":{
            "description": "208-Tl",
            "activityInBqPerkg": {
                "value": 0.2e-6,
                "error": 0.1e-6,
                "confidenceLevelInPercent": 90,
                "type": "centralConfidenceInterval",
                "reference": "Hop09, CL is guess"
            }
        },
        "A214-Z83": {
            "description": "214-Bi",
            "activityInBqPerkg": {
                "value": 40.0e-6,
                "confidenceLevelInPercent": 90,
                "type": "upperLimit",
                "reference": "Hop08, CL is guess"
            }
        }
    }
}
```

fitting DAQ data

- fit DAQ data with same MaGe results used for prediction
- requires some reorganization

future work

- classes should take information from database
- get rid of correction factor; replace with more natural scaling to one tonne
- output TH1Ds, TTree of predictions
  - currently outputs plots and tables
- do some restructuring to facilitate fitting
  - merge MaGeResult and PredictedContribution
  - make default contribution start and stop times same as experiment

other classes

ValueWithErrors
value
statistical error
systematic error

TexOutput
methods:
table header
table entry
table footer
image
...

Utilities
methods:
setup histograms
output scientific notation string