eic simulation and reconstruction

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gemc 2.0
eic_rec
general libraries
gemc 2.0

3 beta releases

- Output (banks, voltage signal)
- Fast MC mode
- Modular Physics List
- Magnetic Field
- Optical Properties for Materials, Mirrors

Experiments:

- Clas12
- HPS Studies
- Solid (Hall-A)
- EIC

gemc 2.0 is a mac app (dmg)
Linux: still need compilation, but will be rpm
Windows: will be supported
gemc EIC

dual-solenoid in common cryostat
4 m coil

EM calorimeter
e/π threshold Cherenkov
forward tracker
Si-pixel vertex + disks
central tracker
EM calorimeter

RICH + TORCH?

Coil wall

3 m

1 m deep

2 m deep

(top view)

ion side

100GeV proton

ele side

5GeV e−
Output, Bank Scheme

> Header 10, 0
- Event number
- Timestamp
- Event Type
[...]

> True Step by Step infos (101, 0)
- Edep (101, 1)
- Pid (101, 2)
- positions (101, 3)

> True Integrated infos (103, 0)
- Edep (103, 1)
- Pid (103, 2)
- positions (103, 3)

> Dgtz Step by Step infos (102, 0)
- ADCL (102, 1)
- ADCR (102, 2)

> Dgtz Integrated infos (104, 0)
- ADCL (104, 1)
- ADCR (104, 2)

> Voltage as a function of time (105, 0)
- Identifier (105, 1)
- Time (105, 2)
- Voltage (105, 3)

> Generated Particles
- pid
- p
- v
- vector<Det. Summary>
  - EC, 22 hits, 3 GeV
  - DC, 29 hits, 0.6 MeV
  - HTCC, 2 hits, 23 nphe

Fast MC Mode
- ENERGY_CUT
- “fast MC routines”
Modular Physics List

- PHYSICS="HADRONIC + <EM> + <HP> + <OPTICAL>"

Hadronic can be:
- CHIPS
- FTFP_BERT
- FTFP_BERT_TRV
- FTFP_BERT_HP
- FTF_BIC
- LHep
- QGSC_BERT
- QGSP
- QGSP_BERT
- QGSP_BERT_CHIPS
- QGSP_BERT_HP
- QGSP_BIC
- QGSP_BIC_HP
- QGSP_FTFP_BERT
- GGS_BIC
- QGSP_INCLXX

EM can be
- STD
- EMV
- EMX
- EMY
- EMZ
- LIV
- PEN

HP: High Precision cross sections (e.g. thermal neutron, very low energy processes, etc)

Optical: Activate optical processes
Magnetic Fields

Dipole, Quadrupoles, Multipoles
Optical Properties

- surface
- type
- optical properties:
  - photonEnergy
  - indexOfRefraction
  - reflectivity
  - efficiency
  - specularlobe
  - specularspike
  - backscatter

Table of optical photon energies (wavelengths) from 190-650 nm:

```perl
my $penergy = "  1.9074494*eV  1.9372533*eV  1.9680033*eV  1.9997453*eV  2.0325280*eV 
  2.0664035*eV  2.1014273*eV  2.1376588*eV  2.1751616*eV  2.2140038*eV 
  2.2542584*eV  2.2960039*eV  2.3393247*eV  2.3843117*eV  2.4310630*eV 
  2.4796842*eV  2.5302900*eV  2.5830044*eV  2.6379619*eV  2.6953089*eV 
  2.7552047*eV  2.8178230*eV  2.8833537*eV  2.9520050*eV  3.0240051*eV 
  3.0996053*eV  3.1790823*eV  3.2627424*eV  3.3509246*eV  3.4406594*eV 
  3.5424600*eV  3.6465944*eV  3.7570973*eV  3.8745066*eV  4.0049076*eV 
  4.9593684*eV  5.1660088*eV  5.3906179*eV  5.6356459*eV  5.9040100*eV 
  6.1992105*eV ";
```

Reflectivity of AlMgF2 coated on thermally shaped acrylic sheets, measured by AJRP, 10/01/2012:

```perl
my $reflectivity = "  0.8331038     0.8309071     0.8279127     0.8280742     0.8322623 
  0.837572      0.8396875     0.8481834     0.8660284     0.8611336 
  0.8561367     0.8667431     0.86955      0.8722401     0.8728122 
  0.8771635     0.879907     0.879761     0.8831943     0.8894673 
  0.8984234     0.9009531     0.8910166     0.8887382     0.8869093 
  0.8941976     0.8948479     0.897356     0.9026919     0.8999685 
  0.9016197     0.8993005     0.8991694     0.9099867     0.9004093 
  0.9065833     0.9028855     0.895184     0.9009736     0.9069686 
  0.9015145     0.8914838     0.8816829     0.8666895     0.8406298 
  0.9842583 ";
```
Radiation Studies

Rates in Layer: 1a  Edep > 0.02

<table>
<thead>
<tr>
<th>particles</th>
<th>GeV/s</th>
<th>mrad/s</th>
<th>rad/year</th>
</tr>
</thead>
<tbody>
<tr>
<td>pi^-</td>
<td>214</td>
<td>0.105384</td>
<td>3323</td>
</tr>
<tr>
<td>e^-</td>
<td>333</td>
<td>0.163761</td>
<td>5164</td>
</tr>
<tr>
<td>gamma</td>
<td>8211</td>
<td>4.03647</td>
<td>127294</td>
</tr>
<tr>
<td>n</td>
<td>42</td>
<td>0.0210105</td>
<td>662</td>
</tr>
<tr>
<td>e^+</td>
<td>103</td>
<td>0.0508687</td>
<td>1604</td>
</tr>
<tr>
<td>pi^+</td>
<td>465</td>
<td>0.2289998</td>
<td>7221</td>
</tr>
<tr>
<td>p</td>
<td>4784</td>
<td>2.35201</td>
<td>74172</td>
</tr>
<tr>
<td>all</td>
<td>15617</td>
<td>7.67715</td>
<td>242106</td>
</tr>
</tbody>
</table>

| particle rate 1 MeV Neutron Rate |
|-------------------------------|-----------------|-----------------|
| e^-                          | 4.15943         | 0.0393961       |
| pions                        | 2.79386         | 1.92015         |
| neutrons                     | 0.0820305       | 0.0966665       |
| protons                      | 2.74078         | 17.9215         |
| Total:                       | 9.77611         | 19.9777         |

<table>
<thead>
<tr>
<th>target</th>
<th>GeV/s</th>
<th>GeV/(s cm²)</th>
<th>mrad/s</th>
<th>mrad/(s cm²)</th>
<th>rad/year</th>
<th>rad/(year cm²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>lh2</td>
<td>8557</td>
<td>13.039</td>
<td>3.00489</td>
<td>0.00457839</td>
<td>94762</td>
<td>144</td>
</tr>
<tr>
<td>carbon</td>
<td>11303</td>
<td>17.2226</td>
<td>3.96902</td>
<td>0.00604739</td>
<td>125167</td>
<td>190</td>
</tr>
<tr>
<td>iron</td>
<td>13730</td>
<td>20.9207</td>
<td>4.82127</td>
<td>0.00734592</td>
<td>152043</td>
<td>231</td>
</tr>
<tr>
<td>lead</td>
<td>24326</td>
<td>37.0649</td>
<td>8.54178</td>
<td>0.0130147</td>
<td>269373</td>
<td>410</td>
</tr>
</tbody>
</table>
Reconstruction

JLab ANAlysis framework (JANA)

- C++ framework that formalizes the organization of algorithms and data transfer for event based processing
- Multi-threaded event processing
- Numerous additional features:
  - Configuration parameters
  - Web-based Resource retrieval
  - Plugins
  - Automatic ROOT tree creation
  - Calibration DB API
Reconstruction
Reconstruction

DCtrackcandidates

DCrsegment

DCsegment

DCcluster

DChit

DEventProcessor

2000 calls 1546219 ticks 100.0%
2000 calls 0 ticks 0.0%

2000 calls 110832 ticks 88.9%

2000 calls 1685163 ticks 70.1%

2000 calls 1085163 ticks 46.5%

2000 calls 0 ticks 0.0%

GlueX Reconstruction Software

Automatic call graph generation using “dot” program
Common Libraries: Generator

Currently: gemc supports text LUND format, generators: MILOU (dvcs), Forward Tagging LDRD, SIDIS, eicRate (CTEQ)

Desirable:
- general geant4
- MPrimaryGenerator plugin that could be loaded by gemc, fairroot, etc.
Summary

- Simulation: gemc 2.0 is mature framework
- eic_rec project started, integrated in JANA, can already I/O
- Desirable: libraries in common with other simulations, reconstruction
Optical Properties

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- **type**
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  - specularspike
  - backscatter

- polished: smooth perfectly polished surface
- polishedfrontpainted: smooth top-layer (front) paint
- polishedbackpainted: same as 'polished' but with a back-paint
- polishedlumirrorair: mechanically polished surface, with lumirror
- polishedlumirrorglue: mechanically polished surface, with lumirror & meltmount
- polishedair: mechanically polished surface
- polishedteflonair: mechanically polished surface, with teflon
- polishedtioair: mechanically polished surface, with tio paint
- polishedtyvekair: mechanically polished surface, with tyvek
- polishedvm2000air: mechanically polished surface, with esr film
- polishedvm2000glue: mechanically polished surface, with esr film & meltmount
- etchedlumirrorair: chemically etched surface, with lumirror
- etchedlumirrorglue: chemically etched surface, with lumirror & meltmount
- etchedair: chemically etched surface
- etchedteflonair: chemically etched surface, with teflon
- etchedtioair: chemically etched surface, with tio paint
- etchedtyvekair: chemically etched surface, with tyvek
- etchedvm2000air: chemically etched surface, with esr film
- etchedvm2000glue: chemically etched surface, with esr film & meltmount
- groundlumirrorair: rough-cut surface, with lumirror
- groundlumirrorglue: rough-cut surface, with lumirror & meltmount
- groundair: rough-cut surface
- groundteflonair: rough-cut surface, with teflon
- groundtioair: rough-cut surface, with tio paint
- groundtyvekair: rough-cut surface, with tyvek
- groundvm2000air: rough-cut surface, with esr film
- groundvm2000glue: rough-cut surface, with esr film & meltmount
Optical Properties

- surface
- type
- optical properties:
  - photonEnergy
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  - backscatter

- dielectric_metal: 
dielectric_metal interface
- dielectric_dielectric: 
dielectric-dielectric interface
- dielectric_LUT: 
dielectric-Look-Up-Table interface