



The Virtual Muography Institute: Status and Outlook

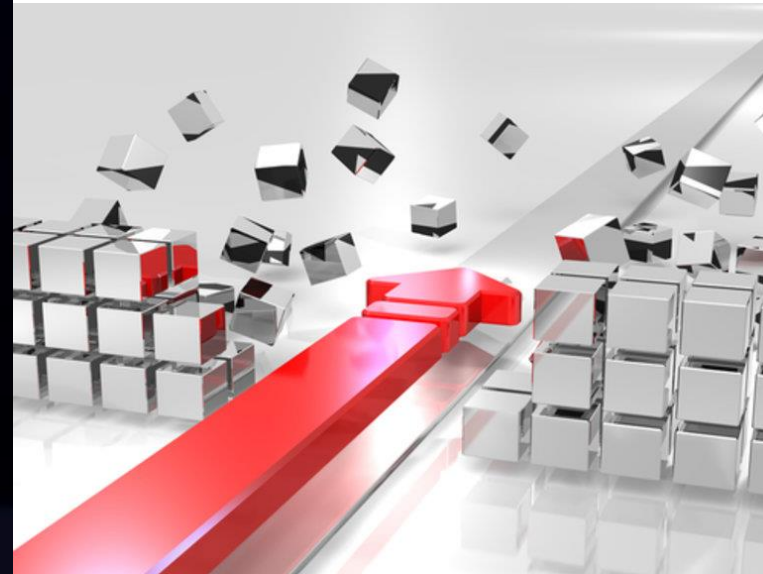
Cristiano Bozza – University of Salerno

Tokyo, Embassy of France

2/10/2017

Motivations for a virtual institute

- Work together to speed up progress on muography
- Split problems, optimize solutions
- Boost discussion, help prepare common projects
- Break software barriers (different environments/formats)



What can VMI do for you – 1/2

- Account (mail), News
- Wiki, Documents
- Project tracking (Redmine)

The image displays a composite of web browser windows. The top window shows the VMI homepage with the text 'INTERNATIONAL VIRTUAL MUOGRAPHY INSTITUTE' and the 'VMI' logo. Below it, a Redmine interface is visible, showing the 'VMI LAB' header and navigation links. The main content area of the Redmine window displays the 'Project Management Center >> TestProject' overview. This overview includes an 'Issue tracking' table, a 'Members' list, and a 'Spent time' section.

Issue tracking

	open	closed	Total
bugReport	1	0	1
function	1	0	1
development	0	0	0
publicInformation	0	0	0

[View all issues](#) | [Calendar](#) | [Gantt](#)

Members

admin: [Ken Tanikawa](#), [Redmine Admin](#), [test user](#)

developer: [Andrea Giammanco](#), [Shinichi Miyamoto](#), [Tadahiro Kin](#), [test user](#)

reporter: [Andrea Giammanco](#), [Shinichi Miyamoto](#), [Tadahiro Kin](#), [test user](#)

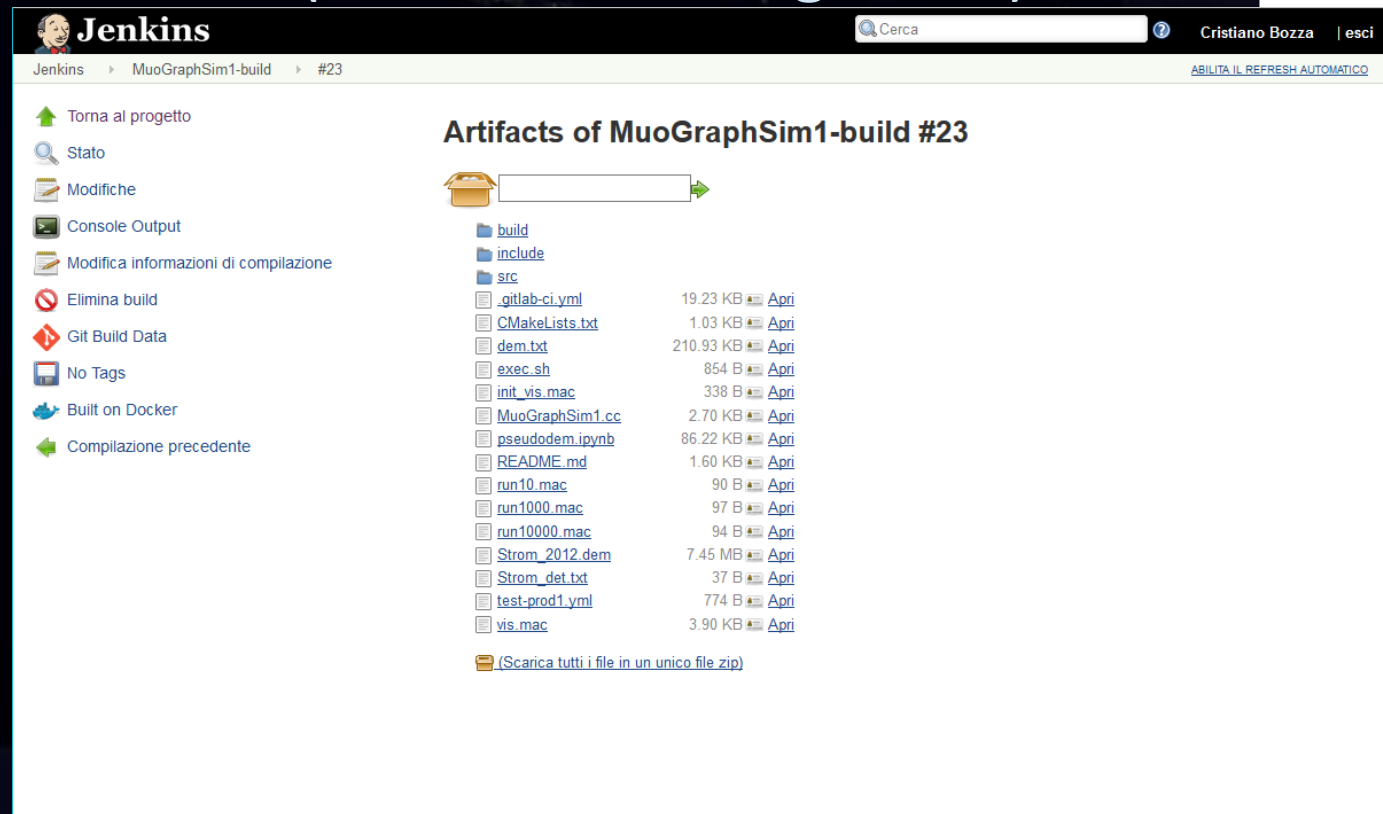
Spent time

0.00 hour

[Details](#) | [Report](#)

What can VMI do for you – 2/2

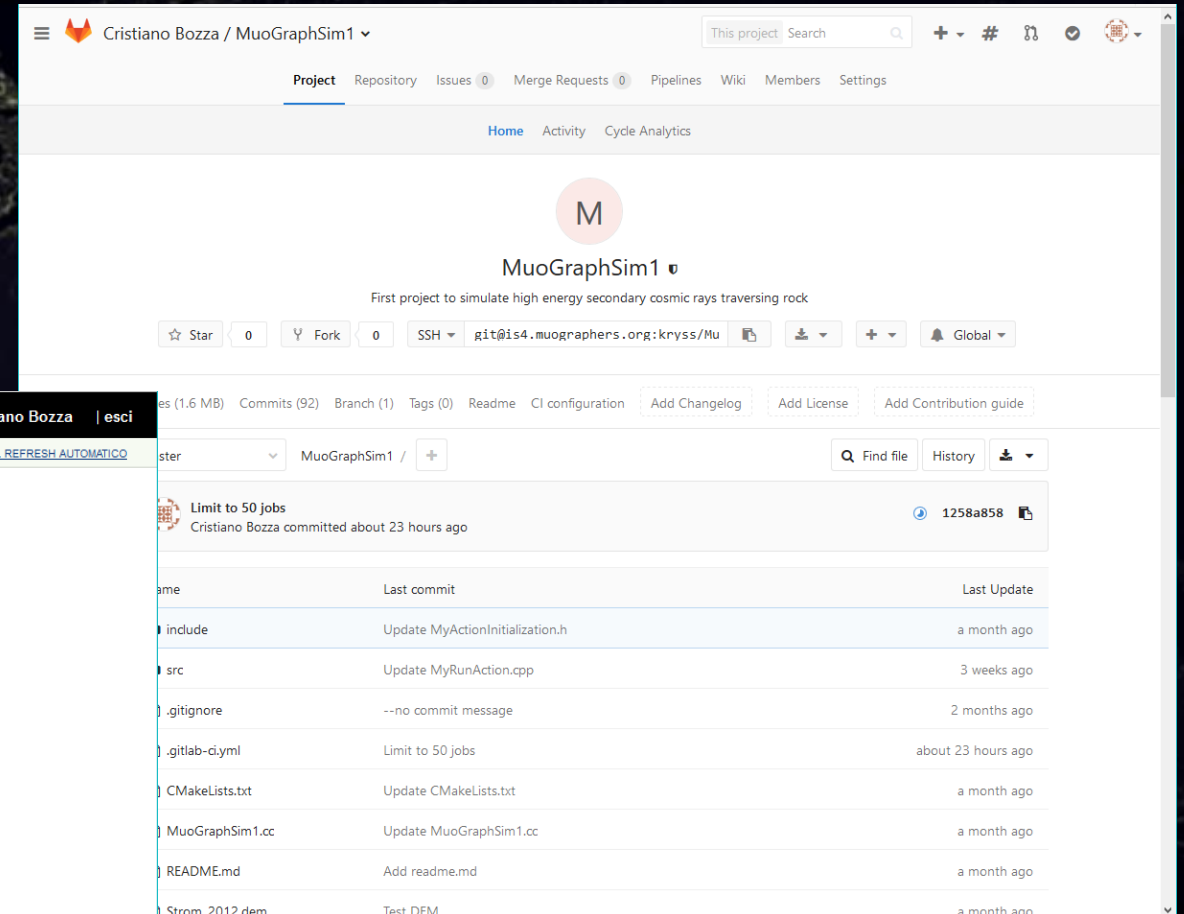
- Geant4 installed
- Gitlab (software management + build/test/run pipelines)
- Jenkins (continuous integration)



The screenshot shows the Jenkins web interface. The top navigation bar includes the Jenkins logo, a search bar, and the user name 'Cristiano Bozza'. The main content area is titled 'Artifacts of MuoGraphSim1-build #23'. On the left, there is a sidebar with various links: 'Torna al progetto', 'Stato', 'Modifiche', 'Console Output', 'Modifica informazioni di compilazione', 'Elimina build', 'Git Build Data', 'No Tags', 'Built on Docker', and 'Compilazione precedente'. The main area displays a list of build artifacts with columns for file name, size, and a download link. The artifacts include folders like 'build', 'include', and 'src', and files like '.gitlab-ci.yml', 'CMakeLists.txt', 'dem.txt', 'exec.sh', 'init_vis_mac', 'MuoGraphSim1.cc', 'pseudodem.ipynb', 'README.md', 'run10_mac', 'run1000_mac', 'run10000_mac', 'Strom_2012.dem', 'Strom_det.txt', 'test-prod1.yml', and 'vis_mac'. A link at the bottom allows downloading all files as a single zip file.

File Name	Size	Download Link
build		
include		
src		
.gitlab-ci.yml	19.23 KB	Apri
CMakeLists.txt	1.03 KB	Apri
dem.txt	210.93 KB	Apri
exec.sh	854 B	Apri
init_vis_mac	338 B	Apri
MuoGraphSim1.cc	2.70 KB	Apri
pseudodem.ipynb	86.22 KB	Apri
README.md	1.60 KB	Apri
run10_mac	90 B	Apri
run1000_mac	97 B	Apri
run10000_mac	94 B	Apri
Strom_2012.dem	7.45 MB	Apri
Strom_det.txt	37 B	Apri
test-prod1.yml	774 B	Apri
vis_mac	3.90 KB	Apri

(Scarica tutti i file in un unico file zip)



The screenshot shows the GitLab web interface for the 'MuoGraphSim1' project by 'Cristiano Bozza'. The top navigation bar includes the GitLab logo, the project name, and a search bar. The main content area shows the project overview, including the project name, a description, and statistics like 'Star' (0), 'Fork' (0), and 'SSH' (git@is4.muographers.org:kryss/Mu). Below this, there is a table of commits with columns for 'Name', 'Last commit', and 'Last Update'. The table lists several commits, including 'Limit to 50 jobs', 'Update MyActionInitialization.h', 'Update MyRunAction.cpp', '--no commit message', 'Limit to 50 jobs', 'Update CMakeLists.txt', 'Update MuoGraphSim1.cc', 'Add readme.md', and 'Test DEM'.

Name	Last commit	Last Update
Limit to 50 jobs	Cristiano Bozza committed about 23 hours ago	1258a858
include	Update MyActionInitialization.h	a month ago
src	Update MyRunAction.cpp	3 weeks ago
.gitignore	--no commit message	2 months ago
.gitlab-ci.yml	Limit to 50 jobs	about 23 hours ago
CMakeLists.txt	Update CMakeLists.txt	a month ago
MuoGraphSim1.cc	Update MuoGraphSim1.cc	a month ago
README.md	Add readme.md	a month ago
Strom_2012.dem	Test DEM	a month ago

Gitlab at VMI – 1/3

- View source files in web browser
- Edit «in place» or use local «git» to manage software evolution
- Define build and test procedures

The image displays three overlapping screenshots of the GitLab web interface for the repository 'Cristiano Bozza / MuoGraphSim1'.

The top screenshot shows a source code file, 'IsotropicFlatMuonSpectrumGenerator.cpp', with a 'delete fParticleGun;' line.

The middle screenshot shows the repository's navigation tabs (Project, Repository, Issues, Merge Requests, Pipelines, Wiki, Members, Settings) and the 'Files' tab.

The bottom screenshot shows the 'Edit file' interface for '.gitlab-ci.yml'. The file content is as follows:

```
1 stages:
2 - build
3 - test
4
5 make_build:
6   stage: build
7   script:
8     - mkdir build bin
9     - cd build
10    - cmake -DCMAKE_C_COMPILER=/usr/bin/gcc-4.8 -DCMAKE_CXX_COMPILER=/usr/bin/g++-4.8 -DCMAKE_MODULE_PATH=/usr/local/geant4 -DCMAKE_PREFIX_PATH=/usr/local/geant4
11    - make
12    - cp MuoGraphSim1 ../*.mac ../*.dem ../det.txt ../exec.sh ../bin
13 artifacts:
14   paths:
15     - bin
```

The interface includes a 'Commit message' field at the bottom with the text 'Update .gitlab-ci.yml'.

Gitlab at VMI – 2/3

- Run tests or use the feature to launch data production

Cristiano Bozza / MuoGraphSim1

Project Repository Issues 0 Merge Requests 0 Pipelines Wiki Members Settings

Pipelines Jobs Schedules Environments Charts

All 74 Pending 0 Running 1 Finished 73 Branches Tags

Run Pipeline CI Lint

Status	Pipeline	Commit	Stages	Actions
running	#1365 by latest	master - 1258a858 Limit to 50 jobs	run_16	Download Cancel
failed	#1364 by	master - ca871854 Update .gitlab-ci.yml - switch t	run_0, run_1, run_10, run_11, run_12, run_13	Download Refresh
failed	#1358 by	master - ca871854 Update .gitlab-ci.yml - switch t	run_0, run_1, run_10, run_11, run_12, run_13	Download Refresh
canceled	#1184 by	master - 1507881a 160 x 1000 jobs	run_0, run_1, run_10, run_11, run_12, run_13	Download Refresh
failed	#1183 by	master - b2a685c4 10000 events, 3 batches, mu+-	run_0, run_1, run_10, run_11, run_12, run_13	Download Refresh
canceled	#1182 by	master - b13db7a1 Add new file	run_0, run_1, run_10, run_11, run_12, run_13	Download Refresh
canceled	#1181 by	master - b13db7a1 Add new file	run_0, run_1, run_10, run_11, run_12, run_13	Download Refresh
passed	#1180 by	master - 40b980ef Update exec.sh	run_0, run_1, run_10, run_11, run_12, run_13	Download
passed	#1179 by	master - 9d9e84a5 Update .gitlab-ci.yml	run_0, run_1, run_10, run_11, run_12, run_13	Download

Cristiano Bozza / MuoGraphSim1

This project Search

✓ This GitLab CI configuration is valid. [Learn more](#)

.gitlab-ci.yml 6.18 KB

```
1 stages:
2   - build
3   - test
4
5 make_build:
6   stage: build
7   script:
8     - make
9     - exec.sh
```

LER=/usr/bin/gcc-4.8 -DCMAKE_CXX_COMPILER=/usr/bin/g++-4.8 -DCMAKE_MODULE_PATH=/usr/local/geant4 -DCMAKE_PREFIX_PATH=/usr/local/g

mac ../../.dem ../../det.txt ../../exec.sh ../../bin

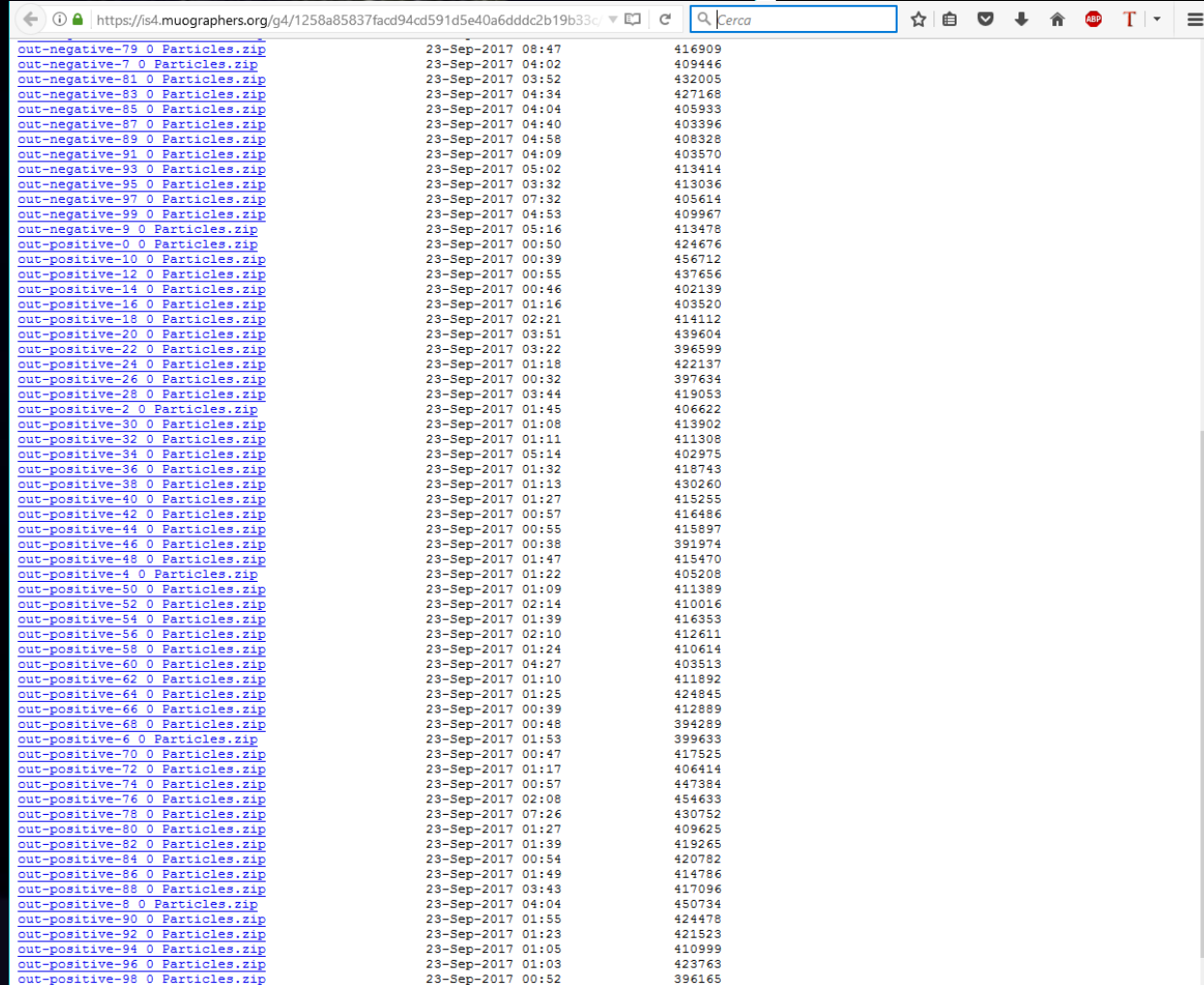
n10000.mac

n10000.mac

n10000.mac

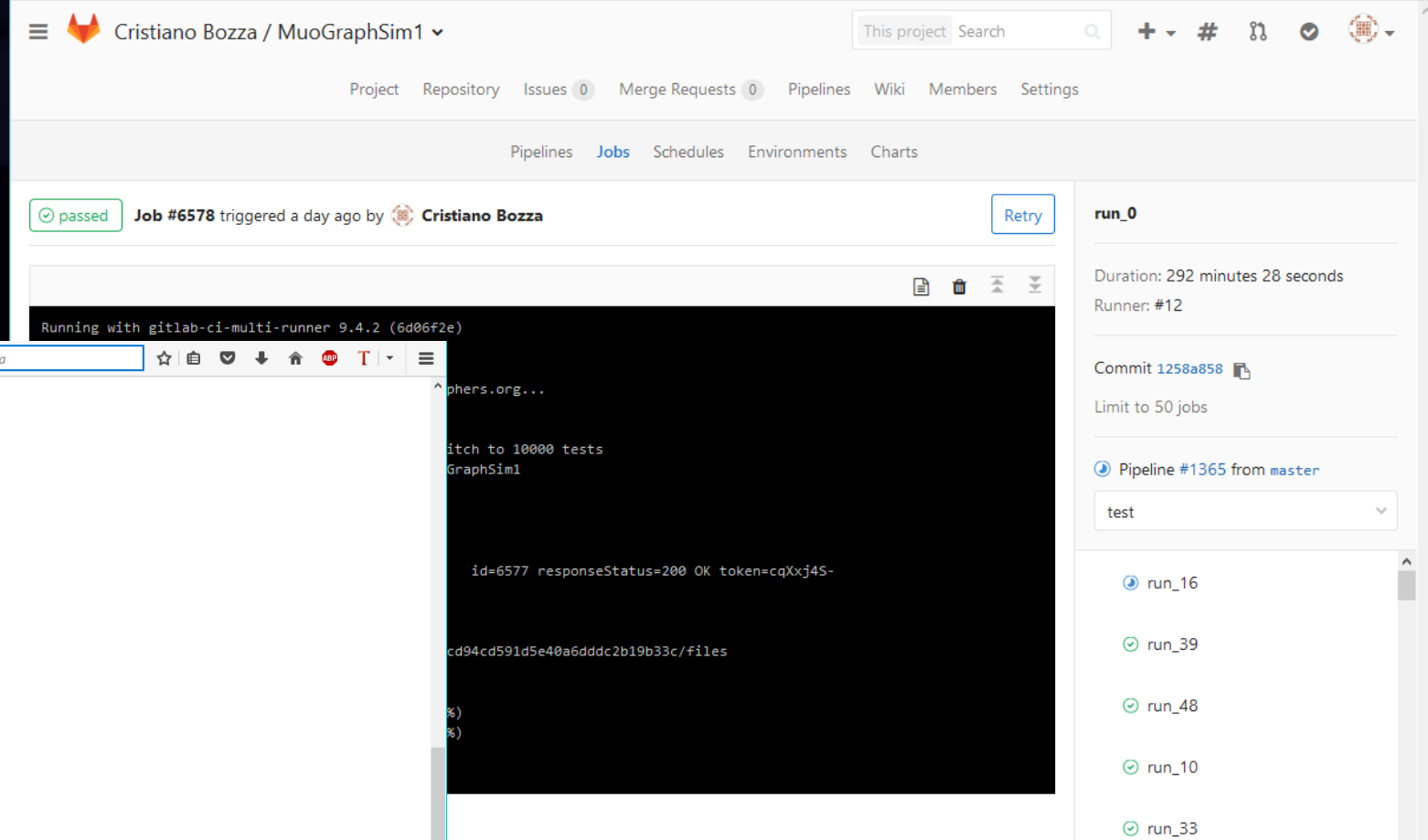
Gitlab at VMI – 3/3

- Pick results of simulations as zip files via HTTP



A screenshot of a web browser displaying a list of simulation results. The browser's address bar shows the URL: `https://is4.muographers.org/g4/1258a85837facd94cd591d5e40a6dddc2b19b33c/`. The page contains a table with three columns: file names, dates, and IDs. The file names are categorized into 'out-negative' and 'out-positive' series, each followed by '0 Particles.zip'. The dates are all '23-Sep-2017' at various times. The IDs are numerical values ranging from 416909 to 396165.

File Name	Date	ID
out-negative-79 0 Particles.zip	23-Sep-2017 08:47	416909
out-negative-7 0 Particles.zip	23-Sep-2017 04:02	409446
out-negative-81 0 Particles.zip	23-Sep-2017 03:52	432005
out-negative-83 0 Particles.zip	23-Sep-2017 04:34	427168
out-negative-85 0 Particles.zip	23-Sep-2017 04:04	405933
out-negative-87 0 Particles.zip	23-Sep-2017 04:40	403396
out-negative-89 0 Particles.zip	23-Sep-2017 04:58	408328
out-negative-91 0 Particles.zip	23-Sep-2017 04:09	403570
out-negative-93 0 Particles.zip	23-Sep-2017 05:02	413414
out-negative-95 0 Particles.zip	23-Sep-2017 03:32	413036
out-negative-97 0 Particles.zip	23-Sep-2017 07:32	405614
out-negative-99 0 Particles.zip	23-Sep-2017 04:53	409967
out-negative-9 0 Particles.zip	23-Sep-2017 05:16	413478
out-positive-0 0 Particles.zip	23-Sep-2017 00:50	424676
out-positive-10 0 Particles.zip	23-Sep-2017 00:39	456712
out-positive-12 0 Particles.zip	23-Sep-2017 00:55	437656
out-positive-14 0 Particles.zip	23-Sep-2017 00:46	402139
out-positive-16 0 Particles.zip	23-Sep-2017 01:16	403520
out-positive-18 0 Particles.zip	23-Sep-2017 02:21	414112
out-positive-20 0 Particles.zip	23-Sep-2017 03:51	439604
out-positive-22 0 Particles.zip	23-Sep-2017 03:22	396599
out-positive-24 0 Particles.zip	23-Sep-2017 01:18	422137
out-positive-26 0 Particles.zip	23-Sep-2017 00:32	397634
out-positive-28 0 Particles.zip	23-Sep-2017 03:44	419053
out-positive-2 0 Particles.zip	23-Sep-2017 01:45	406622
out-positive-30 0 Particles.zip	23-Sep-2017 01:08	413902
out-positive-32 0 Particles.zip	23-Sep-2017 01:11	411308
out-positive-34 0 Particles.zip	23-Sep-2017 05:14	402975
out-positive-36 0 Particles.zip	23-Sep-2017 01:32	418743
out-positive-38 0 Particles.zip	23-Sep-2017 01:13	430260
out-positive-40 0 Particles.zip	23-Sep-2017 01:27	415255
out-positive-42 0 Particles.zip	23-Sep-2017 00:57	416486
out-positive-44 0 Particles.zip	23-Sep-2017 00:55	415897
out-positive-46 0 Particles.zip	23-Sep-2017 00:38	391974
out-positive-48 0 Particles.zip	23-Sep-2017 01:47	415470
out-positive-4 0 Particles.zip	23-Sep-2017 01:22	405208
out-positive-50 0 Particles.zip	23-Sep-2017 01:09	411389
out-positive-52 0 Particles.zip	23-Sep-2017 02:14	410016
out-positive-54 0 Particles.zip	23-Sep-2017 01:39	416353
out-positive-56 0 Particles.zip	23-Sep-2017 02:10	412611
out-positive-58 0 Particles.zip	23-Sep-2017 01:24	410614
out-positive-60 0 Particles.zip	23-Sep-2017 04:27	403513
out-positive-62 0 Particles.zip	23-Sep-2017 01:10	411892
out-positive-64 0 Particles.zip	23-Sep-2017 01:25	424845
out-positive-66 0 Particles.zip	23-Sep-2017 00:39	412889
out-positive-68 0 Particles.zip	23-Sep-2017 00:48	394289
out-positive-6 0 Particles.zip	23-Sep-2017 01:53	399633
out-positive-70 0 Particles.zip	23-Sep-2017 00:47	417525
out-positive-72 0 Particles.zip	23-Sep-2017 01:17	406414
out-positive-74 0 Particles.zip	23-Sep-2017 00:57	447384
out-positive-76 0 Particles.zip	23-Sep-2017 02:08	454633
out-positive-78 0 Particles.zip	23-Sep-2017 07:26	430752
out-positive-80 0 Particles.zip	23-Sep-2017 01:27	409625
out-positive-82 0 Particles.zip	23-Sep-2017 01:39	419265
out-positive-84 0 Particles.zip	23-Sep-2017 00:54	420782
out-positive-86 0 Particles.zip	23-Sep-2017 01:49	414786
out-positive-88 0 Particles.zip	23-Sep-2017 03:43	417096
out-positive-8 0 Particles.zip	23-Sep-2017 04:04	450734
out-positive-90 0 Particles.zip	23-Sep-2017 01:55	424478
out-positive-92 0 Particles.zip	23-Sep-2017 01:23	421523
out-positive-94 0 Particles.zip	23-Sep-2017 01:05	410999
out-positive-96 0 Particles.zip	23-Sep-2017 01:03	423763
out-positive-98 0 Particles.zip	23-Sep-2017 00:52	396165



A screenshot of a GitLab CI/CD pipeline job page. The page title is 'Cristiano Bozza / MuoGraphSim1'. The top navigation bar includes links for Project, Repository, Issues (0), Merge Requests (0), Pipelines, Wiki, Members, and Settings. Below the navigation bar, there are tabs for Pipelines, Jobs, Schedules, Environments, and Charts. The main content area shows a job status of 'passed' for 'Job #6578' triggered a day ago by 'Cristiano Bozza'. A 'Retry' button is visible. Below the job status, there is a terminal window showing the command 'Running with gitlab-ci-multi-runner 9.4.2 (6d06f2e)'. The terminal output shows a successful HTTP request: 'id=6577 responseStatus=200 OK token=cqXxj45-'. On the right side, there is a sidebar with job details for 'run_0', including 'Duration: 292 minutes 28 seconds' and 'Runner: #12'. Below this, there is a section for 'Commit 1258a858' with a 'Limit to 50 jobs' option. A dropdown menu shows 'test' as the selected pipeline. At the bottom of the sidebar, there is a list of other jobs: 'run_16', 'run_39', 'run_48', 'run_10', and 'run_33'.

Jenkins at VMI

- Integrated with git
- Custom shell scripts can be called
- Save artifacts (including possible data files) after build

The screenshot displays the Jenkins configuration page for a job named 'MuoGraphSim1-build'. The interface is divided into several tabs: 'General', 'Gestione Codice Sorgente', 'Build Triggers', 'Build Environment', 'Build', and 'Azioni dopo la build'. The 'Gestione Codice Sorgente' tab is currently selected, showing options for source code management. The 'Build' tab is also visible, showing the 'Execute shell' step with a command to build the project. The 'Azioni dopo la build' tab shows the 'Archive the artifacts' step. The 'General' tab shows the job name and a list of build steps. The 'Build Triggers' tab shows the 'Build Triggers' section. The 'Build Environment' tab shows the 'Build Environment' section. The 'Build' tab shows the 'Execute shell' step with a command to build the project. The 'Azioni dopo la build' tab shows the 'Archive the artifacts' step. The 'General' tab shows the job name and a list of build steps. The 'Build Triggers' tab shows the 'Build Triggers' section. The 'Build Environment' tab shows the 'Build Environment' section. The 'Build' tab shows the 'Execute shell' step with a command to build the project. The 'Azioni dopo la build' tab shows the 'Archive the artifacts' step.

Gestione Codice Sorgente

☐ None
☐ Clone Workspace
☒ Git

Depositi

URL di Deposito

Build

☐ Inject ownership variables into environment
☐ Use secret text(s) or file(s)
☐ With Ant

Execute shell

Command `mkdir build bin
cd build
cmake -DCMAKE_C_COMPILER=/usr/bin/gcc-4.8 -DCMAKE_CXX_COMPILER=/usr/bin/g++-4.8 -DCMAKE_MODULE_PATH=../cmake
make`

See [the list of available environment variables](#)

Azioni dopo la build

Archive the artifacts

Files to archive

Salva Apply

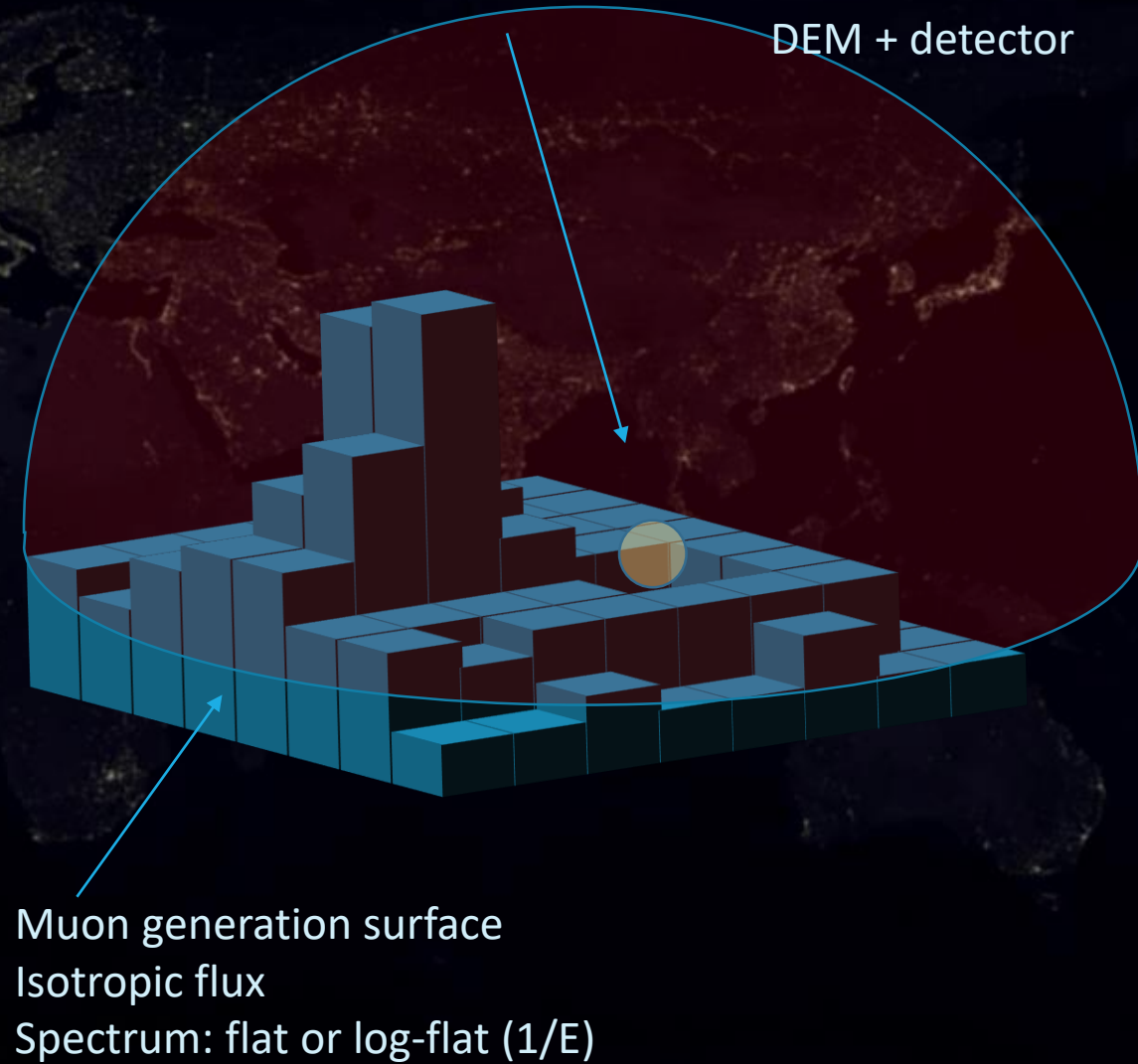
Pagina Generata il: 24-set-2017 8.14.45 JST [REST API](#) [Jenkins ver. 2.60.3](#)

MuoGraphSim1 at VMI

- First Geant4 program at VMI
- Simple but flexible
- Decouple cosmic ray simulation from passage through rock and instrument acceptance
- Output files document incoming muon as well as all particles at the detector surface with a proper range (1 m)
- Easy to apply weights to rescale to cosmic ray models

DEM: rectangular mesh (free step and size)

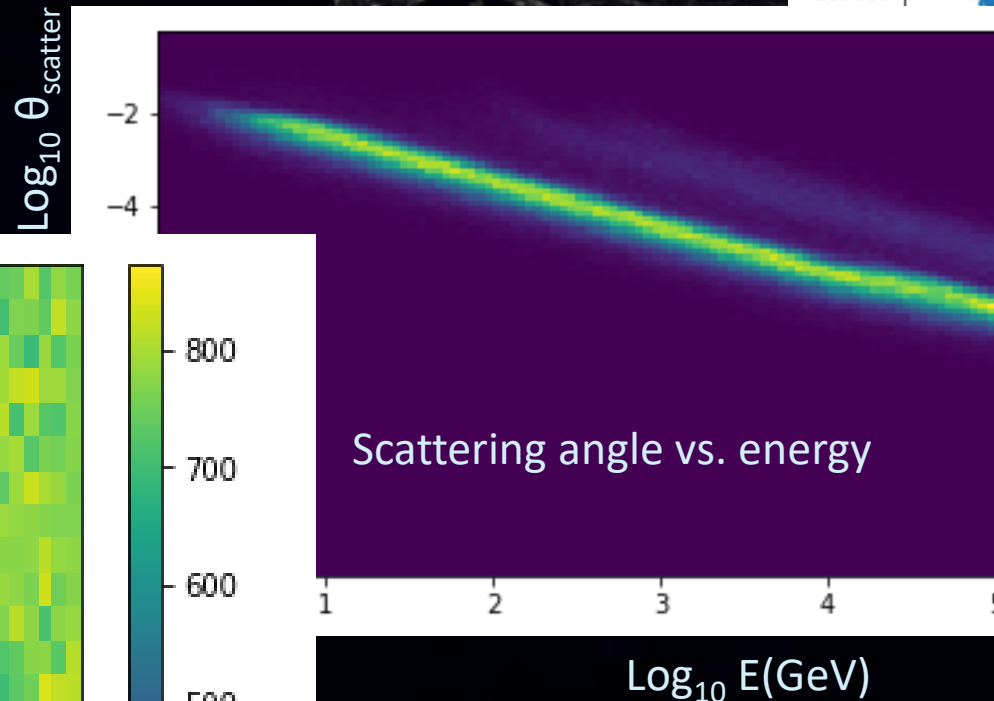
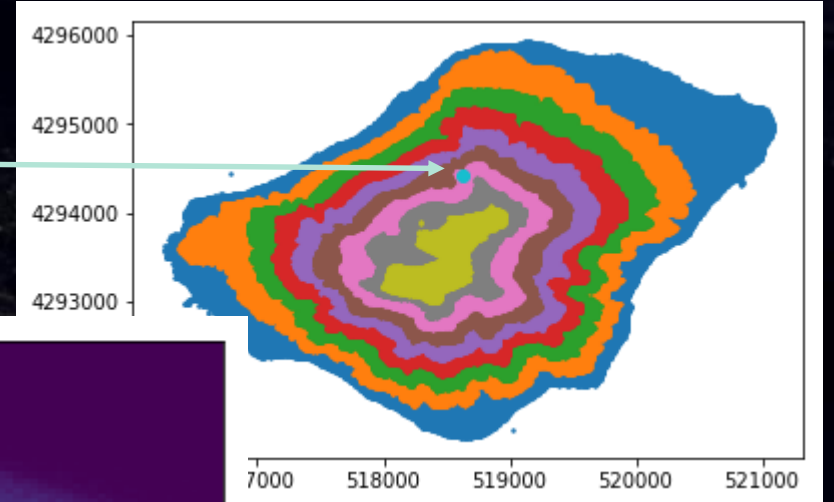
Detector: 10m radius sphere, efficiency = 1



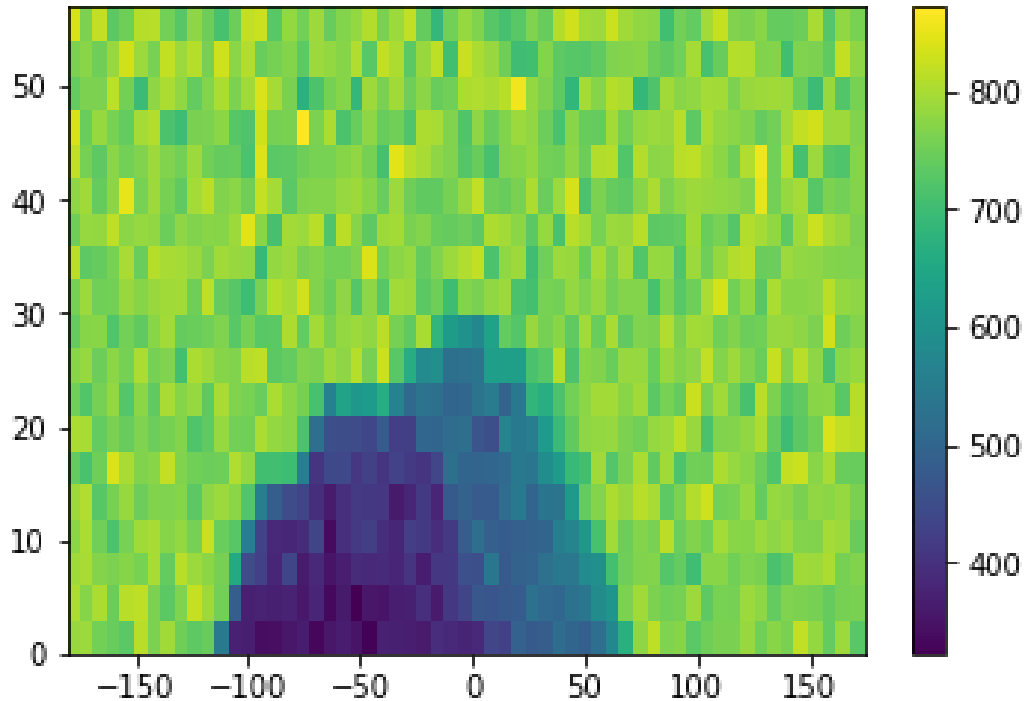
MuoGraphSim1 at VMI

- Example of application to Stromboli
- 1,5 Mtracks
- 5 hour running

Stromboli
DEM 2012
Detector
X,Y in m



Scattering angle vs. energy



Muons crossing rock
(Log-flat isotropic spectrum)

Cloud Hardware at VMI

- CPU: 2×14 cores = 28 real cores, 56 hyperthreaded
- Memory: 64 GiB, possible upgrade to 192 GiB
- Storage: 6 TB
- Upgrades available depending on usage!

Simulation of secondary cosmic rays – 1/2

- Install CORSIKA or COSMOS at VMI
- Use ready-made CORELib production by KM3NeT for ASTERICS (www.asterics2020.eu), currently distributed through a server in Salerno
- 1% «no Cherenkov» pilot production → 550 GB



KM3NeT



High energy model	Low energy model	Option	
		TAULEP	CHARM
QGSJET01	GHEISHA		X
QGSJET01	GHEISHA	X	
QGSJETII-04	GHEISHA	X	
EPOS LHC	GHEISHA	X	

Energy range (GeV)	Number of events
200-1000	10^7
10^3 - 10^4	10^7
10^4 - 10^5	10^6
10^5 - 10^6	10^5
10^6 - 10^7	10^4
10^7 - 10^8	10^3
10^8 - 10^9	10^2

Simulation of secondary cosmic rays – 2/2

Status of CORELib

- Proton-induced showers:
 - HE models : QGSJET01 with CHARM, QGSJET01 with TAULEP, QGSJET-II with TAULEP, EPOS-LHC with TAULEP
 - LE model : GHEISHA
 - about 21M EvtS per HE model
 - 7 energy bins ($2 \times 10^2 \text{ GeV}$ - 10^3 GeV +equally logarithmically spaced from 1TeV to 10^9 GeV)
 - power-law spectrum with -2 spectral index
 - zenith angle from 0 to 89 degrees
- Nuclei-induced showers:
 - HE model : QGSJET01 with CHARM, QGSJET01 with TAULEP, QGSJET-II with TAULEP, EPOS-LHC with TAULEP
 - LE model : GHEISHA
 - about 21M EvtS per HE model
 - 7 energy bins ($2 \times 10^2 \text{ GeV}$ - 10^3 GeV +equally logarithmically spaced from 1TeV to 10^9 GeV)
 - Power-law spectrum with -2 spectral index
 - zenith angle from 0 to 89 degrees

Conclusions

- VMI is moving its first steps
- Very interesting opportunity for real, tight cooperation
- Geant4 cloud already set up and running
- Possible interaction with other projects
- Capabilities will grow with user demand, so don't hesitate to ask!