Gaudi based framework in Docker as prototype of future SPD software

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Why Docker?

To run thousands or even hundreds of thousands of SPD jobs

Consider Docker as a very light virtual machine

Docker provides the ability to package and run an application in a loosely isolated environment called a container

Application running in Docker can run on any OS system, any OS flavor, can run in distributed environment

Read about Docker https://habr.com/ru/search/?q=docker&target_type=posts

I created a Docker with HSF software

What is HSF?

HSF stands for "HEP Software Foundation" https://hepsoftwarefoundation.org/

What is HSF? contd.

HSF provides Gaudi based packages https://git.jinr.ru/x2v0/hsf

That include:
- Pythia8 generator and particle gun
- GDML based detector geometry description
- Geant4 Full Simulation
- ROOT files on output

The list of packages:
- key4hep/k4FWCore - Basic I/O components
- key4hep/k4Gen - Generators and Particle Guns
- key4hep/k4SimGeant4 - Geant4 Full Simulation
- hep-fcc/FCCDetectors - DD4hep models of FCC detector geometries for Full Sim
- key4hep/k4ActsTracking - Acts Common Tracking Software

What is Gaudi?

https://gaudi.web.cern.ch

Gaudi is a framework software package that is used to build data processing applications for High-Energy Physics experiments. It contains all of the components and interfaces to allow you to build event data processing frameworks for your experiment.

Gaudi scales to the needs of the most demanding experiments at the LHC, but is simple enough to get started quickly and have an application running in just a short time.

Gaudi has been in production for the ATLAS and LHCb experiments and others for many years and is also the framework used by the *Key4hep* common software for Future Collider studies such as FCC, CLIC/ILC and CEPC. A (non-exhaustive) list of framework users:

- LHCb Computing
- ATLAS Athena framework
- HARP Gaudino framework
- Fermi (previously GLAST)
- MINERvA
- BESIII BOSS framework
- LBNE (Long Baseline Neutrino Detector, WCD group), see also GARPI project
- Key4hep (common software for FCC, CLIC/ILC and CEPC)

HSF software dependencies

HSF software build is based on /cvmfs/sw.hsf.org/spackages7
It contains ~480 packages and libraries which are not relocatable (RPATH)
Even if select only packages which needed the size of distribution is ~45 Gb

```
acts                      gdb                       libmicrohttpd             physsim                   py-mako                   py-uproot
aida                      gdbm                      libmng                    pigz                      py-markdown-it-py         py-urllib3
aidatt                    geant4                    libpciaccess              pixman                    py-markupsafe             py-versioneer
alpaka                    geant4-data               libpipeline               pkgconf                   py-matplotlib             py-virtualenv
assimp                    gear                      libpng                    pmix                      py-matplotlib-inline      py-wcwidth
autoconf                  generalbrokenlines        libpthread-stubs          podio                     py-mdit-py-plugins        py-webencodings
autoconf-archive          genfit                    libsigsegv                popt                      py-meson-python           py-websocket-client
automake                  gettext                   libsm                     protobuf                  py-mistune                py-wheel
babayaga                  git                       libsodium                 py-anyio                  py-mpi4py                 py-xgboost
bdftopcf                  gl2ps                     libtiff                   py-argon2-cffi            py-mpmath                 pythia6
bdsim                     glew                      libtirpc                  py-argon2-cffi-bindings   py-nbclassic              pythia8
berkeley-db               glib                      libtool                   py-asttokens              py-nbclient               python
bhlumi                    glproto                   libunistring              py-attrs                  py-nbconvert              qd
bin                       glx                       libunwind                 py-awkward                py-nbformat               qgraf
bison                     gmake                     libx11                    py-awkward-cpp            py-nest-asyncio           qhull
boost                     gmp                       libxau                    py-babel                  py-networkx               qt
bzip2                     gobject-introspection     libxcb                    py-backcall               py-nodeenv                r
ca-certificates-mozilla   googletest                libxcrypt                 py-beautifulsoup4         py-notebook               r-rcpp
cairo                     gosam-contrib             libxdmcp                  py-beniget                py-notebook-shim          r-rinside
catch2                    gperf                     libxext                   py-bleach                 py-numexpr                raida
ced                       groff                     libxfixes                 py-bottleneck             py-numpy                  randrproto
cedviewer                 gsl                       libxfont                  py-build                  py-onnx                   range-v3
cepcsw                    guinea-pig                libxft                    py-cerberus               py-onnxruntime            rapidjson
clhep                     harfbuzz                  libxi                     py-certifi                py-packaging              re2
clicperformance           hdf5                      libxkbcommon              py-cffi                   py-pandas                 re2c
clupatra                  hepmc                     libxkbfile                py-cfgv                   py-pandocfilters          readline
cmake                     hepmc3                    libxml2                   py-charset-normalizer     py-parso                  renderproto
```

What is LFSPD?

To provide all HSF dependencies locally, LFSPD distro was created https://git.jinr.ru/x2v0/lfspd

It doesn't require any OS. This is "fake" Linux, imitates Linux distribution

It contains all major HEP packages and scientific software. That allows to build HSF packages.

It contains **> 170** packages with the size of the distribution **~4.2 Gb** . That includes **2.2 Gb** of Geant4 data.

This is the set of Linux packages for docker container.

The main features of the distro:

- minimalistic linux distribution (no X11, no GUIs, no mans, no locales etc.).

  supposed that all applications will run in docker container in batch mode

- all packages built from sources

- minimized by size (compiled with size optimization flags + stripped & cleaned)

- set of packages for scientific programming **Readme/packages.md**

- the latest versions of all the packages : glibc, gcc, perl, cmake, python etc.

- packages installed in `/usr /usr/local` . Greatly simpifies **setup scripts**

- customizable. Package not needed - comment it out & rebuild. To add - valeriy.onuchin@yandex.ru

Based on the Linux From Scratch project https://www.linuxfromscratch.org/

The way to Gaudi based SPD software

HSF use DD4hep package https://dd4hep.web.cern.ch to describe Detector Geometry which can use GDML files on input.

SpdRoot use ROOT TGeo classes for SPD detector geometry description.
So, we can generate GDML files and adapt them to DD4hep & HSF stack.

Our main goal is to use [GeoModel)](GeoModel) for SPD detector geometry description.

I suggest to use DD4hep with SPD GDML files for a moment.

We will replace DD4hep step by step, seamlessly to the end-user.
The same is for all [AIDASoft/PODIO)](AIDASoft/PODIO)

What's next?

- **Run HSF** [Examples)](#) **-> learn & adapt**
- **Create SPD GDML files. Adapt them to HSF stack**
- **Create Gaudi based SPD framework**
- **Replace DD4hep with GeoModel.**
      PODIO with SPDIO (hdf5, RDataFrame)
- **Build SPD tests, examples and tutorials**
- **Create documentation, dedicated website**
- **Involve new users -> education & training**