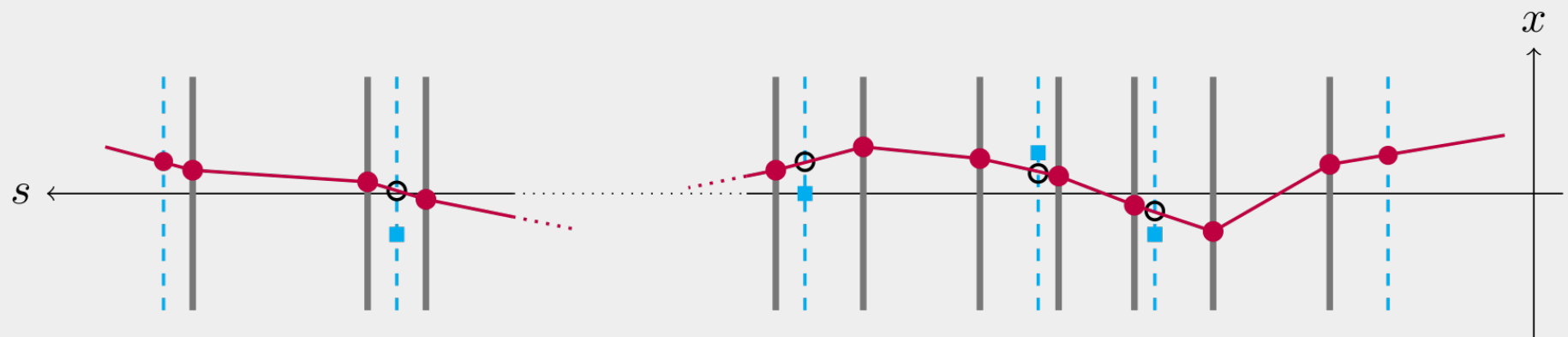


GBL Track Resolution Calculator

<https://github.com/simonspa/resolution-simulator/>

Hands-On Exercises



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Installation

- Install and source ROOT (from <https://root.cern.ch/>), either ROOT5 or ROOT6 will work fine.
- Install GBL (from <https://www.wiki.terascale.de/Index.php/GeneralBrokenLines>)

```
svn checkout http://svnsrv.desy.de/public/GeneralBrokenLines/tags/V01-18-00/cpp GeneralBrokenLines
cd GeneralBrokenLines
mkdir build && cd build/
cmake ..
make && make install
```

- Export the GBL library path:

```
export GBLPATH=/path/to/gbl/installation
```

If you exactly follow the above description for GBL Installation, It will simply be

```
cd ../
export GBLPATH=`pwd`
```

- Clone and compile the GBL Track Resolution Calculator:

```
cd ../
git clone https://github.com/simonspa/resolution-simulator.git && cd resolution-simulator/
mkdir build && cd build
cmake ..
make
```



All binaries are now in the build directory under `build/devices/`

Software/Class Structure

- (simple) interface to GBL providing convenience functions
- Plane class
 - hold information on material, position, resolution
- Telescope class
 - hold planes, provide access to (total) material budget, GBL trajectory and fit results (resolution)
- Utility functions:
 - Generator functions for GBL points (with/without measurement ...)
 - (some) constants for material radiation lengths
 - Logging mechanism

Repository & Contributions

- Hosted on GitHub
- Licensed LGPLv3
- Go ahead, fork, improve, contribute back!

 cmake	Update FindGBL cmake module	3 months ago
 devices	Make CMakeLists for device targets more flexible: use GLOB	2 hours ago
 doc	Add drawings of plane structure by Micha	a year ago
 telescope	Add child classes of plane: scatterer and reference, merely for conve...	10 months ago
 utils	Remove hardcoded beam energy	a year ago
 .gitignore	update gitignore	a year ago
 CMakeLists.txt	Slightly rework CMake mechanism	a year ago
 LICENSE.md	Add LGPLv3 license file	10 months ago
 README.md	Update description for compiling device targets	2 hours ago

Tasks

(It's a Hands-On Session!)



Task 1: DUT Material in the DATURA Telescope

- After compilation: binaries in “./devices”
- DATURA telescope with variable DUT material in the center
 - Read the code: `tscope_datura.cc`
 - Call the executable: `devices/datura`
 - Check the output in `datura-resolution.root`
- Dependency of track resolution at DUT on DUT material budget
- Tasks:
 - Is the order of adding planes of importance?
 - Where the trajectory is built? Where the track fit is performed?
 - What is the track resolution with DUTs of 0.002, 0.01, 0.02 X_0 ?

Task 2: Calculate the Track Resolution

- Implement a telescope with the following properties
 - 6 pixel detectors, intrinsic resolution 4.512 μm , 70 μm Silicon
 - 55 mm equidistant spacing between tel. planes, beam energy 5 GeV
 - Additional Silicon scatterer, 700 μm thick, at telescope center
- Evaluate the resolution at the position of
 - The scatterer (“Device under test”)
 - The first and last telescope plane
- Hints
 - Use new source file!
 - Commit!
- Explain the resolution values, what resolution is calculated?

Task 3: Find the Optimal Plane Spacing

- Consider the DATURA geometry/telescope from task 1
- The distance between DUT and the two adjacent telescope planes remains constant at 20mm
- Scan through the telescope plane distance $20\text{mm} < x < 150\text{mm}$
- What are the preferred plane distances for
 - a DUT with $0.01\% X_0$
 - a DUT with $0.001\% X_0$in order to achieve the best possible track resolution at the DUT?
- Plot the result.

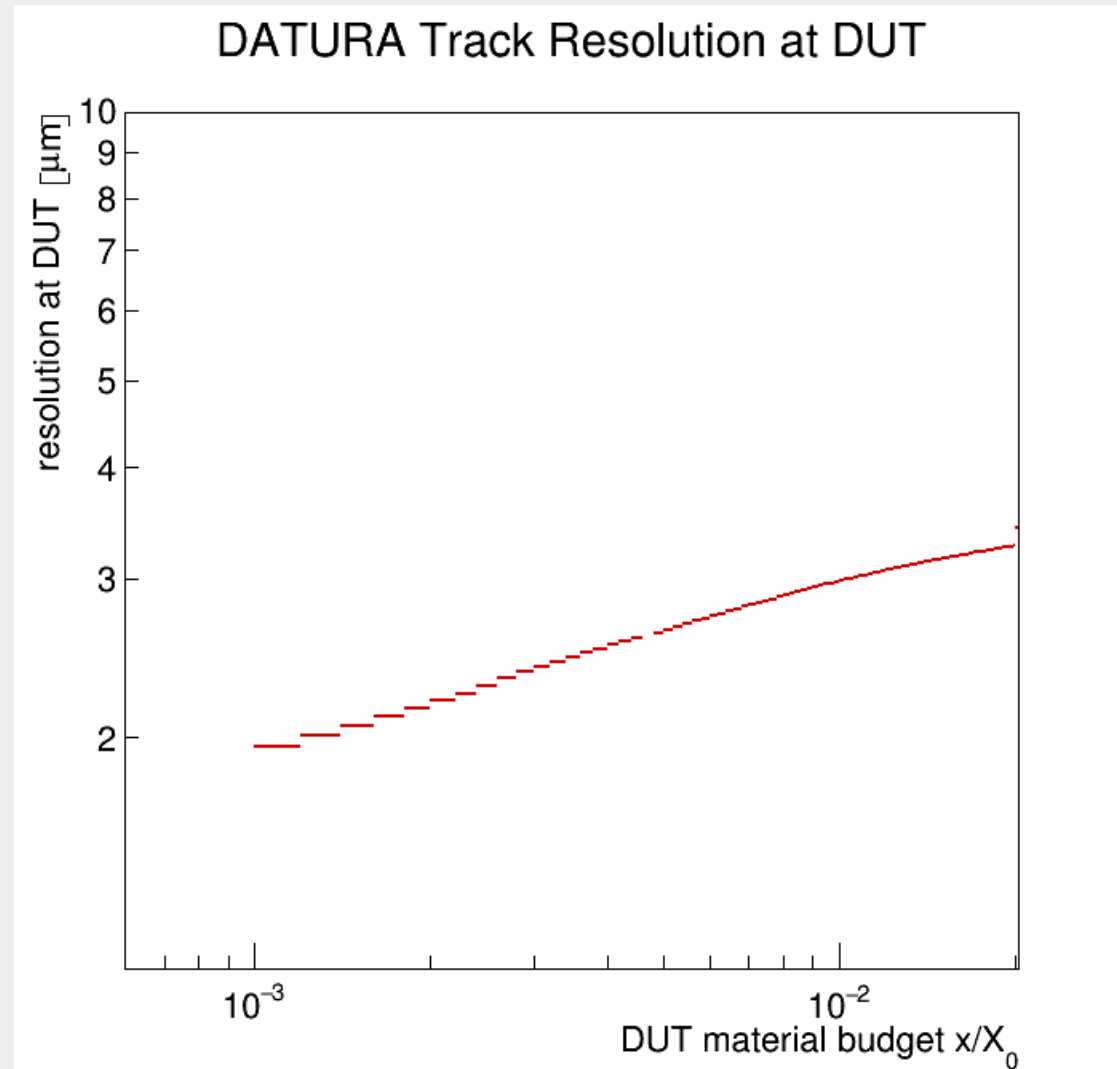
Solutions



Solutions/Output Task 1

- Trajectory build in `telescope constructor/getTrajectory()`
- Track fit performed in `getResolution()`
- Resolutions:

Resolution at DUT with 0.002 X_0 : 2.18581
 Resolution at DUT with 0.01 X_0 : 2.98493
 Resolution at DUT with 0.02 X_0 : 3.27203



Solution/Output Task 2

INFO: Received 7 planes.

DEBUG: <assembly.cc/getTotalMaterialBudget:L114> Calculating total material in the path...

DEBUG: <assembly.cc/getTotalMaterialBudget:L130> Total track material budget $x/X0=0.0128634$

DEBUG: <assembly.cc/telescope:L48> Added plane at 0 (scatterer + measurement)

DEBUG: <assembly.cc/telescope:L96> Added plane at 55 (scatterer + measurement)

DEBUG: <assembly.cc/telescope:L96> Added plane at 110 (scatterer + measurement)

DEBUG: <assembly.cc/telescope:L100> Added plane at 137.5 (scatterer)

DEBUG: <assembly.cc/telescope:L96> Added plane at 165 (scatterer + measurement)

DEBUG: <assembly.cc/telescope:L96> Added plane at 220 (scatterer + measurement)

DEBUG: <assembly.cc/telescope:L96> Added plane at 275 (scatterer + measurement)

DEBUG: <assembly.cc/telescope:L109> Finished building trajectory.

RESULT: Track resolution at SCAT with 0.00747464 X0: 3.74985um

RESULT: Track resolution at first telescope planes: 4.00032um

RESULT: Track resolution at last telescope planes: 4.00032um

- Resolution at scatterer is calculated from unbiased residuals
(no measurement of “DUT” added)
- Telescope plane resolutions are calculated from biased residuals
(including the plane under investigation)

Solution/Output Task 3

