



DD4hep-ACTS integration for B0

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Relevant matrix operations in ACTS core

```
Acts::Result<Acts::Vector2> Acts::PlaneSurface::globalToLocal(  
    const GeometryContext& gctx, const Vector3& position,  
    const Vector3& /*unused*/, double tolerance) const {  
    auto inverse = transform(gctx).inverse();  
    Vector3 loc3Dframe = inverse * (position);  
    Vector3 global3Dframe = localToGlobal(gctx,{loc3Dframe.x(),loc3Dframe.y()}, {0,0,0});  
    if (loc3Dframe.z() * loc3Dframe.z() > tolerance * tolerance) {  
        .....  
        return Result<Vector2>::failure(SurfaceError::GlobalPositionNotOnSurface);  
    }  
    return Result<Vector2>::success({loc3Dframe.x(), loc3Dframe.y()});  
}
```

Round trip test.
Log the inverse
matrix and local
and global
positions.

Manual matrix operations in ElCrecon

```
auto inverse =  
((surface->transform(Acts::GeometryContext()))).inverse();  
local_x = hit_pos.x*inverse(0,0)+hit_pos.y*inverse(0,1)  
          +hit_pos.z*inverse(0,2),  
local_y = hit_pos.x*inverse(1,0)+hit_pos.y*inverse(1,1)  
          +hit_pos.z*inverse(1,2),  
local_z = hit_pos.x*inverse(2,0)+hit_pos.y*inverse(2,1)  
          +hit_pos.z*inverse(2,2));
```

ACTS global x y z

-92.3752 -123.472 5906.54

ACTS inverse

-0.906025 -0.422618 -0.0226553

0.422486 -0.906308 0.0105644

-0.0249974 1.16226e-16 0.999688

ACTS local x y z ztolerance

-2.44 45.16 -0.000180419 0.0001

ACTS 360 global x y z

-92.3752 -123.472 5906.54

ElCrecon global x y z

-92.37521 -123.47248 5906.5386

ElCrecon inverse

-0.9060245806039117 -0.4226182617408825 -0.022655334573139643

0.4224862004124976 -0.9063077870365647 0.010564356009524422

-0.024997395914712218 1.1622647289044608e-16 0.9996875162757026

ElCrecon local x y z

2.0613318104478537 135.27559407627325 5907.002016835014

Sample point that fails the “On Surface Test”

ACTS core matrix operations
passes round trip test
(global=>local=>global)

Data point is passed properly
from eicrecon to acts

Local coordinates from manual
multiplication do not match that
from ACTS core. Why?

ACTS core local z is only
slightly higher the threshold for
on surface tolerance. Can we
increase this to 1 micron just for
the B0?

```

    auto hit_det = hit->getCellID() & 0xFF;
    auto onSurfaceTolerance = 0.0001;          // By default, ACTS uses 0.1
micron as the on surface tolerance
    if (hit_det == 150) {
        onSurfaceTolerance = 0.001;           // Ugly hack for testing B0.
Should be a way to increase this tolerance in geometry.
    }

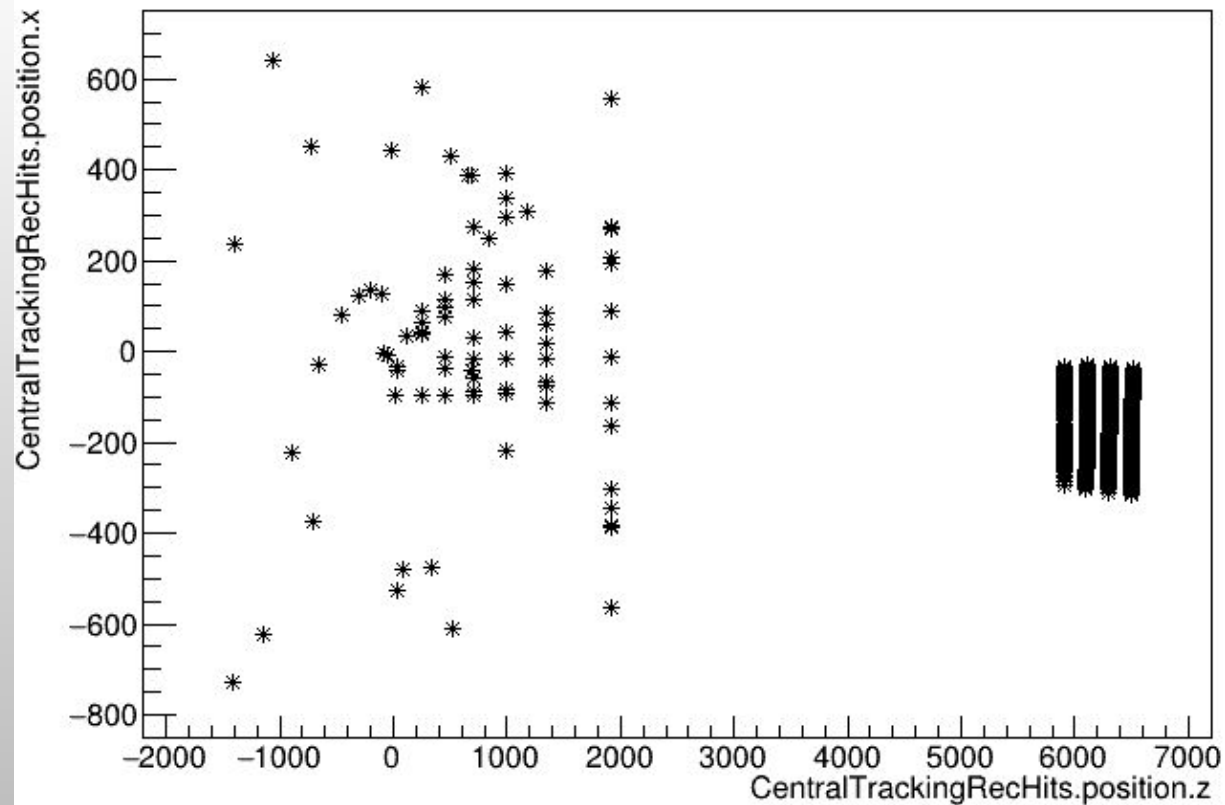
    try {
        // transform global position into local coordinates
        // geometry context contains nothing here
        pos = surface->globalToLocal(
            Acts::GeometryContext(),
            {hit_pos.x, hit_pos.y, hit_pos.z},
            {0, 0, 0}, onSurfaceTolerance).value();

        loc[Acts::eBoundLoc0] = pos[0];
        loc[Acts::eBoundLoc1] = pos[1];
    }

```

Change
onSurfaceTolerance
for just B0

CentralTrackingRecHits.position.x:CentralTrackingRecHits.position.z



Now hits from B0 no longer fail the on surface test.

However, reconstruction still seems to be not working for these events. Don't have any error messages to go by.

Debugging

Step 1: Increase ACTS Log Level

```
./eicrecon <rootfile>.edm4hep.root -Ppodio:output_file=<outfile>.tree.edm4eic.root  
-Pacts_init:LogLevel=trace -Pacts:InitLogLevel=trace -Pacts:LogLevel=trace  
-Pplugins=dump_flags -Pdump_flags:json=log.json
```

```
uparticles : Could not find factory<edm4hep::SimulatorDetector> with tag=ECatEndcapMPCs.  
[2023-01-26 17:33:00.883] [Digi:SmearedFarForwardParticles] [warning] No incoming ion beam; using 100 GeV ion beam energy.  
[2023-01-26 17:33:00.883] [ZDCEcalIslandProtoClusters] [info] Clustering uses dimScaledLocalDistXY with distances <= [5,5]  
[INFO] Status: 0 events processed 0.0 Hz (0.0 Hz avg)  
[INFO] Status: 0 events processed 0.0 Hz (0.0 Hz avg)  
[INFO] Status: 8 events processed 16.0 Hz (1.1 Hz avg)  
[INFO] Status: 26 events processed 36.0 Hz (3.5 Hz avg)  
[INFO] Status: 45 events processed 38.0 Hz (5.6 Hz avg)  
[INFO] Status: 45 events processed 0.0 Hz (5.3 Hz avg)  
[INFO] Status: 54 events processed 18.0 Hz (6.0 Hz avg)  
[INFO] Status: 86 events processed 64.0 Hz (9.0 Hz avg)  
[INFO] Status: 97 events processed 22.0 Hz (9.7 Hz avg)  
[INFO] JArrow: Finalized JEventSource '../.../test/epic/proton_275GeV_6mrad_22mrad_cotheta.edm4hep.root' (JEventSourcePODIOsimpl  
e)  
[INFO] Status: 100 events processed 18.1 Hz (9.8 Hz avg)  
[INFO] All workers have stopped.  
[INFO] Merging threads ...  
[INFO] JArrow: Finalized JEventProcessor 'JEventProcessorPODIO'
```

No helpful info

Debugging

Step 2: Check truth seeder (Look in the only place that you assumed was correct to begin with)

```
./eicrecon <rootfile>.edm4hep.root -Ppodio:output_file=<outfile>.tree.edm4eic.root  
-Pacts_init:LogLevel=trace -Pacts:InitLogLevel=trace -Pacts:LogLevel=trace  
-Ptracking:InitTrackParams:LogLevel=trace -Pplugins=dump_flags -Pdump_flags:json=log.json
```

```
22444, limit is set to 4  
[INFO] Status: 5 events processed 10.0 Hz (0.8 Hz avg)  
[2023-01-27 13:00:43.395] [tracking:InitTrackParams] [trace] ignoring particle with Eta = 4.58  
74352, limit is set to 4  
[2023-01-27 13:00:43.399] [tracking:InitTrackParams] [trace] ignoring particle with Eta = 4.57  
04436, limit is set to 4  
[2023-01-27 13:00:43.401] [tracking:InitTrackParams] [trace] ignoring particle with Eta = 4.53  
1755, limit is set to 4  
[2023-01-27 13:00:43.556] [tracking:InitTrackParams] [trace] ignoring particle with Eta = 5.34  
4453, limit is set to 4  
[2023-01-27 13:00:43.568] [tracking:InitTrackParams] [trace] ignoring particle with Eta = 4.97  
16907, limit is set to 4  
[2023-01-27 13:00:43.586] [tracking:InitTrackParams] [trace] ignoring particle with Eta = 4.91  
21785, limit is set to 4  
[2023-01-27 13:00:43.591] [tracking:InitTrackParams] [trace] ignoring particle with Eta = 4.62  
80837, limit is set to 4
```

Truth seeder had max eta limit of 4

Debugging

Step 3: Update Max Eta Limit

```
./eicrecon <rootfile>.edm4hep.root -Ppodio:output_file=<outfile>.tree.edm4eic.root  
-Pacts_init:LogLevel=trace -Pacts:InitLogLevel=trace -Pacts:LogLevel=trace  
-Ptracking:InitTrackParams:LogLevel=trace -Ptracking:InitTrackParams:MaxEtaForward=6  
-Pplugins=dump_flags -Pdump_flags:json=log.json
```

```
22444, limit is set to 4  
[INFO] Status: 5 events processed 10.0 Hz (0.8 Hz avg)  
[2023-01-27 13:00:43.395] [tracking:InitTrackParams] [trace] ignoring particle with Eta = 4.58  
74352, limit is set to 4  
[2023-01-27 13:00:43.399] [tracking:InitTrackParams] [trace] ignoring particle with Eta = 4.57  
04436, limit is set to 4  
[2023-01-27 13:00:43.401] [tracking:InitTrackParams] [trace] ignoring particle with Eta = 4.53  
1755, limit is set to 4  
[2023-01-27 13:00:43.556] [tracking:InitTrackParams] [trace] ignoring particle with Eta = 5.34  
4453, limit is set to 4  
[2023-01-27 13:00:43.568] [tracking:InitTrackParams] [trace] ignoring particle with Eta = 4.97  
16907, limit is set to 4  
[2023-01-27 13:00:43.586] [tracking:InitTrackParams] [trace] ignoring particle with Eta = 4.91  
21785, limit is set to 4  
[2023-01-27 13:00:43.591] [tracking:InitTrackParams] [trace] ignoring particle with Eta = 4.62  
80837, limit is set to 4
```

Setting max eta value with plugin did not work. Something else is wrong?

Debugging

Step 4: Check truth seeder (Are you absolutely certain everything is correct?)

✓ fix: avoid m_cfg shadowing

main (#452)

v0.5.1 v0.5.0

wdconinc committed 3 days ago Verified

commit 9c279fedde948b88d9c885957e1bc6cd14ff3209

src/algorithms/tracking/TrackParamTruthInit.h

```
@@ -27,7 +27,6 @@ namespace eicrecon {  
27 27  
28 28     private:  
29 29         std::shared_ptr<spdlog::logger> m_log;  
30 -        TrackParamTruthInitConfig m_cfg;  
31 30         std::shared_ptr<TDatabasePDG> m_pdg_db;  
32 31  
33 32         std::default_random_engine generator; // TODO: need something more appropriate here
```

Duplicate definition in derived class.
Fix applied.

Debugging

Step 5: Run again with max eta limit updated to 6

```
15:08:07 CKFTracking VERBOSE Stepping loop done.
[2023-01-27 15:08:07.501] [tracking:InitTrackParams] [debug] Invoke track finding seeded by truth particle with:
[2023-01-27 15:08:07.502] [tracking:InitTrackParams] [debug] p = 274.99997 GeV"
[2023-01-27 15:08:07.502] [tracking:InitTrackParams] [debug] charge = 1
[2023-01-27 15:08:07.502] [tracking:InitTrackParams] [debug] q/p = 0.0036363640399019043
15:08:07 CKFTracking VERBOSE Path aborter limit set to 1.69517e+06 (full helix = 3.39034e+06)
15:08:07 CKFTracking VERBOSE Entering propagation.
15:08:07 CKFTracking VERBOSE No Volume | Entering navigator::status.
15:08:07 CKFTracking VERBOSE No Volume | Initialization.
15:08:07 CKFTracking VERBOSE No Volume | Current surface set to start surface undefined
15:08:07 CKFTracking VERBOSE No Volume | Slow start initialization through search.
15:08:07 CKFTracking VERBOSE No Volume | Starting from position (0.0000, 0.0000, 0.0000) and direction (0.0159, -0.0072,
0.9998)
15:08:07 CKFTracking VERBOSE VertexBarrelSubAssembly::Barrel | Start volume resolved.
15:08:07 CKFTracking VERBOSE CombinatorialKalmanFilter step
15:08:07 CKFTracking VERBOSE Perform filter step
15:08:07 CKFTracking VERBOSE Target: 0 | Target stepSize (path limit) updated to ( +∞, +∞, +∞, +∞)
15:08:07 CKFTracking VERBOSE Target: 0 | Target stepSize (path limit) updated to ( +∞, +∞, 1.69517e+06, +∞)
15:08:07 CKFTracking VERBOSE VertexBarrelSubAssembly::Barrel | Entering navigator::target.
15:08:07 CKFTracking VERBOSE VertexBarrelSubAssembly::Barrel | Start layer to be resolved.
15:08:07 CKFTracking VERBOSE VertexBarrelSubAssembly::Barrel | No surface candidates found.
15:08:07 CKFTracking VERBOSE VertexBarrelSubAssembly::Barrel | No layers present, resolve volume first.
15:08:07 CKFTracking VERBOSE VertexBarrelSubAssembly::Barrel | Searching for compatible layers.
15:08:07 CKFTracking VERBOSE VertexBarrelSubAssembly::Barrel | No compatible layer candidates found.
15:08:07 CKFTracking VERBOSE Last layer done, target volume boundary.
15:08:07 CKFTracking VERBOSE VertexBarrelSubAssembly::Barrel | Try to find boundaries, we are at: 0 0 0, dir: 0.0158689
-0.00719277 0.999848
15:08:07 CKFTracking VERBOSE Finding compatibleBoundaries
15:08:07 CKFTracking VERBOSE Volume reports 4 boundary surfaces
15:08:07 CKFTracking VERBOSE Processing boundaries
15:08:07 CKFTracking VERBOSE Consider boundary surface vol=26|bnd=1 :
Acts::DiscSurface
Center position (x, y, z) = (0.0000, 0.0000, -136.0005)
```

Debugging

Step 5: Run again with max eta limit updated to 6

```
15:08:07 CKFTracking VERBOSE - Surface intersecion invalid
15:08:07 CKFTracking VERBOSE Consider boundary surface vol=26|bnd=4 :
Acts::CylinderSurface
  Center position (x, y, z) = (0.0000, 0.0000, 0.0000)
  Rotation:
    colX = (1.000000, 0.000000, 0.000000)
    colY = (0.000000, 1.000000, 0.000000)
    colZ = (0.000000, 0.000000, 1.000000)
  Bounds : Acts::CylinderBounds: (radius, halfLengthZ, halfPhiSector, averagePhi, bevelMinZ, bevelMaxZ) = (122.0000000, 136.0
005000, 3.1415927, 0.0000000, 0.0000000, 0.0000000)
15:08:07 CKFTracking VERBOSE - Surface intersecion invalid
15:08:07 CKFTracking VERBOSE Consider boundary surface vol=25|bnd=4 :
Acts::CylinderSurface
  Center position (x, y, z) = (0.0000, 0.0000, 0.0000)
  Rotation:
    colX = (1.000000, 0.000000, 0.000000)
    colY = (0.000000, 1.000000, 0.000000)
    colZ = (0.000000, 0.000000, 1.000000)
  Bounds : Acts::CylinderBounds: (radius, halfLengthZ, halfPhiSector, averagePhi, bevelMinZ, bevelMaxZ) = (34.0000000, 136.00
05000, 3.1415927, 0.0000000, 0.0000000, 0.0000000)
15:08:07 CKFTracking VERBOSE - Surface intersecion invalid
15:08:07 CKFTracking VERBOSE Volume reports 0 confined dense volumes
15:08:07 CKFTracking VERBOSE 0 boundary candidates found at path(s):
15:08:07 CKFTracking VERBOSE VertexBarrelSubAssembly::Barrel | No further navigation action, proceed to target.
15:08:07 CKFTracking VERBOSE Starting stepping loop
15:08:07 CKFTracking VERBOSE Step with size = 413.86 performed
15:08:07 CKFTracking VERBOSE CombinatorialKalmanFilter step
15:08:07 CKFTracking VERBOSE Kalman filtering finds 0 tracks
15:08:07 CKFTracking VERBOSE Target: 0 | Target stepSize (path limit) updated to (449.408, +∞, 1.69517e+06, +∞)
15:08:07 CKFTracking WARNING No tracks found
15:08:07 CKFTracking VERBOSE Stepping loop done.
```

For events with $\eta > 4$, the navigation gives up after vertex barrel assembly. There is a hole in navigation. Check geometry building.