Investigative Steps Taken to Address DTrackTimeBased Result Inconsistencies Between JANA1 and JANA2

Event of focus:

15th event by event number is used from **hd_rawdata_121120_000.evio data file for all this analysis.**

hd_dump of event 15 with -DDTrackTimeBased shows missing cdc hits in JANA2 that are present in JANA1:

cdc hits are getting lost somewhere in JANA2 but are present in JANA1 for candidate 2. See the candidate 2 ndof in the DTrackTimeBased difference here https://www.diffchecker.com/vIkvqcjL/, the values of ndof should stay the same for a particular candidate. However, in case of JANA2, for candidate 2, it is 5 for 4 mass hypothesis and 17 for 5th mass hypothesis while for JANA1 it is 17 for all the 5 mass hypothesis of candidate 2. Moreover, the comparison of the hd_dump of event 15 along with listing associated objects for DTrackTimeBased also shows that for JANA1 there are 12 CDC Hits that are getting lost in JANA2. Compare the rows 1,3 and 4 of associated objects for event 15 both for JANA1 and JANA2 to see the difference. The link to the outputs and their difference https://www.diffchecker.com/WD8TpWGN/ .

How to Reproduce?

To get this output one just need to run following command for both halld_recon with JANA1 and JANA2 and compare the results

```
hd_dump -PEVIO:NTHREADS=1 -a -s -q15 hd_rawdata_121120_000.evio
-DDTrackTimeBased
```

Here is a short glimpse of the output too:

```
 DCDCTrackHit 0x7fe46f7296c0
                0x7fe46f7297a0
                0x7fe46f729880
                0x7fe46f729960
                0x7fe46f72b100
                0x7fe46f72b1e0
                0x7fe46f72b2c0
                0x7fe46f72b480
                0x7fe46f72b560
```

```
              0x7fe46f72b640
              0x7fe46f72b720
              0x7fe46f8a7950
      DFDCPseudo 0x7fe47016dc70
              0x7fe472f79df0
              0x7fe472fe1a20
              0x7fe472fe22c0
              0x7fe4748fb950
```

Printing value of chi2_hit, cdc_chi2cut and k:

A print statement   was added to /src/libraries/TRACKING/DTrackFitterKalmanSIMD:4698 just after the initialization of chi2_hit:

```
std::cout<<std::endl<<"chi2_hit: "<<chi2_hit<<", cdc_chi2cut: "<<cdc_chi2cut<<",k: "<<k<<:std::endl;
```

Now the code was rebuilt using the following instructions:

```
source /group/halld/Software/build_scripts/gluex_env_boot_jlab.csh
gxenv halld_recon_prereqs_version.xml
cd src
nice scons install -j32     //for normal building
nice scons install -j32 DEBUG=1 OPTIMIZATION=0  SHOWBUILD=1 // for debugging efficient
```

Once building was done now following command was run:

JANA1:
```
hd_root -PEVENTS_TO_KEEP=20  -PPLUGINS=monitoring_hists -PEVIO:NTHREADS=1 ../hd_rawdata_121120_000.evio
```
JANA2:
```
hd_root -Pjana:nevents=20  -PPLUGINS=monitoring_hists -PEVIO:NTHREADS=1 ../hd_rawdata_121120_000.evio
```

The comparison of results generated by these led to following observations:

196 extra repetitions are happening for JANA1 that are not there for JANA2. The outputs difference can be seen here https://www.diffchecker.com/QGQas6h4/ . Some important observations done about these differences are following:

k: 39   —> very important number because all the refits (in the repetitions) that are happening for JANA1 but not for JANA2 are starting from k:39 and then moving forward. But as for JANA2 k:39 is never showing again which shows that it is removed, thus jumping back to this hit is not possible, hence no refits are happening. To understand this further search k: 39 in the search bar on this link https://www.diffchecker.com/QGQas6h4/

JANA1: chi2_hit: 26.6706, cdc_chi2cut: 25,k: 39 —> Appearing again in JANA1 although chi2_hit>cdc_chi2cut
JANA2: chi2_hit: 26.6706, cdc_chi2cut: 25,k: 39 —> Not appearing again in JANA2 because chi2_hit>cdc_chi2cut

However, looking at other numbers we can see that JANA2 is not always removing the hit when chi2_hit>cdc_chi2cut. Both JANA1 and JANA2 are sometimes removing it and other times not while the right behavior would be to remove it and never show a k again once the condition for it is not satisfied. Examples below dig deeper into this:

k: 34 —> Not appearing again both for JANA1 and JANA2 as chi2_hit>cdc_chi2cut

JANA1: chi2_hit: 62.6524, cdc_chi2cut: 25,k: 101
JANA2:chi2_hit: 62.6524, cdc_chi2cut: 25,k: 101

k: 108 —> Appearing again both for JANA1 and JANA2 although chi2_hit>cdc_chi2cut

JANA1: chi2_hit: 110.456, cdc_chi2cut: 25,k: 108
JANA2: chi2_hit: 110.456, cdc_chi2cut: 25,k: 108

k: 99 —> Appearing again in JANA1 event after chi2_hit>cdc_chi2cut for k=99
JANA1: chi2_hit: 84.9194, cdc_chi2cut: 25,k: 99
JANA2: chi2_hit: 84.9194, cdc_chi2cut: 25,k: 99

k: 95 —> Not appearing again after chi2_hit>cdc_chi2cut for both JANA1 and JANA2
chi2_hit: 119.789, cdc_chi2cut: 25,k: 95
chi2_hit: 119.789, cdc_chi2cut: 25,k: 95

Debugging inside GDB:

1. Print statement added to the code to print current event number :

A print statement is added src/libraries/TRACKING/

DTrackTimeBased_factory.cc:298 inside the event function right after myevt variable initialization:

 jerror_t DTrackTimeBased_factory::evnt(JEventLoop *loop, uint64_t eventnumber)
{
  // Save event number to help with debugging
  myevt=eventnumber;
  std::cout<<std::endl<<std::endl<<std::endl<<"I am event:"<<myevt;

This was done to confirm the event numbers that have already been processed even though we are not stopping at that. After adding this code line, we had to building again. For which following instructions were followed:

Building Halld_recon:
source /group/halld/Software/build_scripts/gluex_env_boot_jlab.csh
gxenv halld_recon_prereqs_version.xml
cd src
nice scons install -j32   //for normal building
nice scons install -j32 DEBUG=1 OPTIMIZATION=0 SHOWBUILD=1 // for debugging efficient

2. Inside GDB:

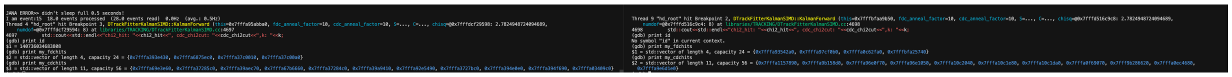
To jump directly to event 15 and perform the deeper analysis at that event these instructions were followed in gdb:

JANA1
First set this break point
break halld_recon_jana1/halld_recon/halld_recon/src/libraries/TRACKING/DTrackTimeBased_factory.cc:290 if myevt == 15
Now run this command
run -PPLUGINS=monitoring_hists -PEVIO:NTHREADS=1 ../hd_rawdata_121120_000.evio
Once above breakpoint is reached, add these two breakpoints and start your analysis
break src/libraries/TRACKING/DTrackFitterKalmanSIMD.cc:4697 —> As from hd_dump result it is now proven that problem is with cdc hits so the analysis was focused on these hits only by setting the breakpoint that is supposed to set once event 15 is reached to cdc_hit outlier setting only.

JANA2
First set this break point
break src/libraries/TRACKING/DTrackTimeBased_factory.cc:298 if myevt == 15

Now run this command
run -PPLUGINS=monitoring_hists -PEVIO:NTHREADS=1 ../
hd_rawdata_121120_000.evio
Once above breakpoint is reached, add these two breakpoints and start your analysis
break src/libraries/TRACKING/DTrackFitterKalmanSIMD.cc:4698

After adding the last breakpoint, `continue` was entered as instruction in gdb terminal and first time this breakpoint was hit we got following values for id, my_fdchits, my_cdchits:



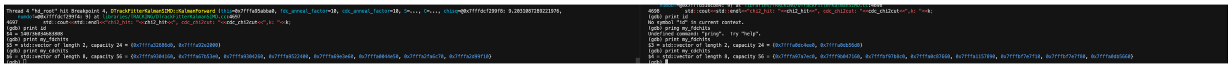
```
JANA ERROR>> didn't sleep full 0.5 seconds!
I am event:15  18.0 events processed  (28.0 events read)  0.0Hz  (avg.: 0.5Hz)
Thread 4 "hd_root" hit Breakpoint 3, DTrackFitterKalmanSIMD::KalmanForward (this=0x7fffa95abba0, fdc_anneal_factor=10, cdc_anneal_factor=10, S=..., C=..., chisq=@0x7fffdcf29598: 2.7824948724094689,
    numdof=@0x7fffdcf29594: 8) at libraries/TRACKING/DTrackFitterKalmanSIMD.cc:4697
4697          std::cout<<std::endl<<"chi2_hit: "<<chi2_hit<<", cdc_chi2cut: "<<cdc_chi2cut<<",k: "<<k;
(gdb) print id
$1 = 140736034683808
(gdb) print my_fdchits
$2 = std::vector of length 4, capacity 24 = {0x7fffa393e430, 0x7fffa6875ec0, 0x7fffa37c0010, 0x7fffa37c00a0}
(gdb) print my_cdchits
$3 = std::vector of length 11, capacity 56 = {0x7fffa69e3e60, 0x7fffa37285c0, 0x7fffa39aec70, 0x7fffa67b6660, 0x7fffa37284c0, 0x7fffa39a9410, 0x7fffa92e5490, 0x7fffa3727bc0, 0x7fffa394e0e0, 0x7fffa394f690, 0x7fffa03409c0}
```

```
Thread 9 "hd_root" hit Breakpoint 2, DTrackFitterKalmanSIMD::KalmanForward (this=0x7fffbfaa9b50, fdc_anneal_factor=10, cdc_anneal_factor=10, S=..., C=..., chisq=@0x7fffd516c9c8: 2.7824948724094689,
    numdof=@0x7fffd516c9c4: 8) at libraries/TRACKING/DTrackFitterKalmanSIMD.cc:4698
4698          std::cout<<std::endl<<"chi2_hit: "<<chi2_hit<<", cdc_chi2cut: "<<cdc_chi2cut<<",k: "<<k;
(gdb) print id
No symbol "id" in current context.
(gdb) print my_fdchits
$1 = std::vector of length 4, capacity 24 = {0x7fffa93542a0, 0x7fffa97cf0b0, 0x7fffa0c62fa0, 0x7fffbfa25740}
(gdb) print my_cdchits
$2 = std::vector of length 11, capacity 56 = {0x7fffa1157890, 0x7fffa9b158d0, 0x7fffa96e0f70, 0x7fffa96e1050, 0x7fffa10c2040, 0x7fffa10c1e80, 0x7fffa10c1da0, 0x7fffa0f69070, 0x7fff9b286620, 0x7fffa0ec4680,
  0x7fffa9e6d1e0}
```

Now the breakpoint set in the file src/libraries/TRACKING/DTrackFitterKalmanSIMD.cc: at code line `if chi2_hit<cdc_chi2cut` inside KalmanForward was deleted and new breakpoints were set which were conditioned now to stop at if statement only if the condition is not met that is, chi2_hit>cdc_chi2cut:

JANA1:
break src/libraries/TRACKING/DTrackFitterKalmanSIMD.cc:4697 if chi2_hit>cdc_chi2cut
JANA2:
break src/libraries/TRACKING/DTrackFitterKalmanSIMD.cc:4698 if chi2_hit>cdc_chi2cut

Continuing this time and hitting the above breakpoint for the first time gave us following results:



```
Thread 4 "hd_root" hit Breakpoint 4, DTrackFitterKalmanSIMD::KalmanForward (this=0x7fffa95abba0, fdc_anneal_factor=10, cdc_anneal_factor=10, S=..., C=..., chisq=@0x7fffdcf299f8: 9.2031087289221976,
    numdof=@0x7fffdcf299f4: 9) at libraries/TRACKING/DTrackFitterKalmanSIMD.cc:4697
4697          std::cout<<std::endl<<"chi2_hit: "<<chi2_hit<<", cdc_chi2cut: "<<cdc_chi2cut<<",k: "<<k;
(gdb) print id
$4 = 140736034683808
(gdb) print my_fdchits
$5 = std::vector of length 2, capacity 24 = {0x7fffa32686d0, 0x7fffa92e2000}
(gdb) print my_cdchits
$6 = std::vector of length 8, capacity 56 = {0x7fffa9304160, 0x7fffa67b53e0, 0x7fffa9304260, 0x7fffa9522400, 0x7fffa69e3e60, 0x7fffa0044e50, 0x7fffa2fa6c70, 0x7fffa2d99f10}
(gdb) 
```

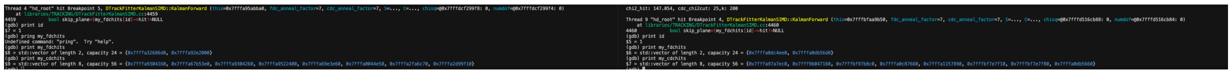
```
    numdof=@0x7fffd516cb84: 9) at libraries/TRACKING/DTrackFitterKalmanSIMD.cc:4698
4698          std::cout<<std::endl<<"chi2_hit: "<<chi2_hit<<", cdc_chi2cut: "<<cdc_chi2cut<<",k: "<<k;
(gdb) print id
No symbol "id" in current context.
(gdb) pring my_fdchits
Undefined command: "pring".  Try "help".
(gdb) print my_fdchits
$3 = std::vector of length 2, capacity 24 = {0x7fffa0dc4ee0, 0x7fffa0db56d0}
(gdb) print my_cdchits
$4 = std::vector of length 8, capacity 56 = {0x7fffa97a7ec0, 0x7fff9b047160, 0x7fffbf97b8c0, 0x7fffa0c87660, 0x7fffa1157890, 0x7fffbf7e7f10, 0x7fffbf7e7f80, 0x7fffa0db5660}
(gdb) 
```

OBSERVATION: The size of vector my_cdchits and my_fdchits is reduced when we are printing them out on first time hitting chi2_hit>cdc_chi2cut breakpoint.

After hitting the above breakpoint if I am deleting all the breakpoints and adding this new one only:

break src/libraries/TRACKING/DTrackFitterKalmanSIMD.cc:4458

And entering continue I am now getting the right value for id but the size of vectors is still reduced one because they were never supposed to get reduced in the size in the first place.



```
Thread 4 "hd_root" hit Breakpoint 5, DTrackFitterKalmanSIMD::KalmanForward (this=0x7fffa95abba0, fdc_anneal_factor=7, cdc_anneal_factor=7, S=..., C=..., chisq=@0x7fffdcf299f8: 0, numdof=@0x7fffdcf299f4: 0)
    at libraries/TRACKING/DTrackFitterKalmanSIMD.cc:4459
4459            bool skip_plane=(my_fdchits[id]->hit!=NULL
(gdb) print id
$7 = 1
(gdb) pring my_fdchits
Undefined command: "pring".  Try "help".
(gdb) print my_fdchits
$8 = std::vector of length 2, capacity 24 = {0x7fffa32686d0, 0x7fffa92e2000}
(gdb) print my_cdchits
$9 = std::vector of length 8, capacity 56 = {0x7fffa9304160, 0x7fffa67b53e0, 0x7fffa9304260, 0x7fffa9522400, 0x7fffa69e3e60, 0x7fffa0044e50, 0x7fffa2fa6c70, 0x7fffa2d99f10}
```

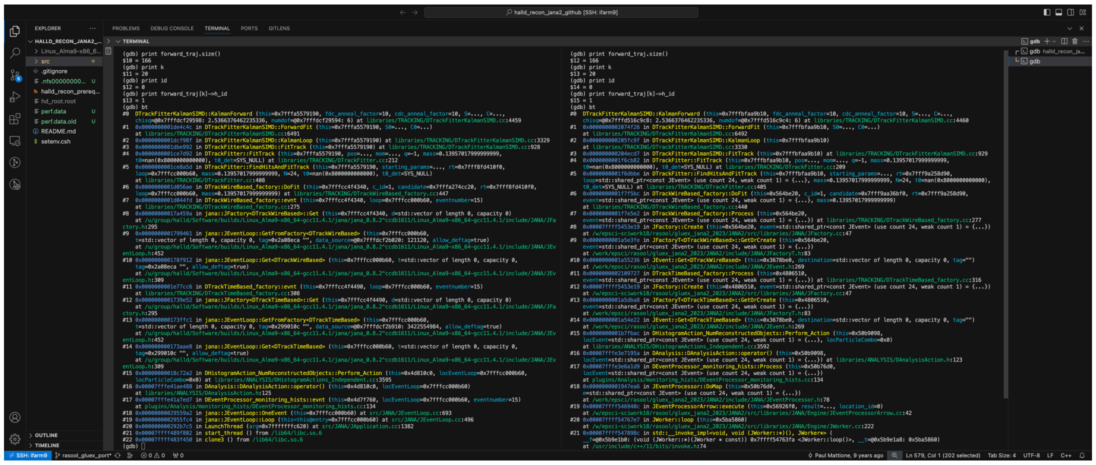
```
chi2_hit: 147.054, cdc_chi2cut: 25,k: 200

Thread 9 "hd_root" hit Breakpoint 4, DTrackFitterKalmanSIMD::KalmanForward (this=0x7fffbfaa9b50, fdc_anneal_factor=7, cdc_anneal_factor=7, S=..., C=..., chisq=@0x7fffd516cb88: 0, numdof=@0x7fffd516cb84: 0)
    at libraries/TRACKING/DTrackFitterKalmanSIMD.cc:4460
4460            bool skip_plane=(my_fdchits[id]->hit!=NULL
(gdb) print id
$5 = 1
(gdb) print my_fdchits
$6 = std::vector of length 2, capacity 24 = {0x7fffa0dc4ee0, 0x7fffa0db56d0}
(gdb) print my_cdchits
$7 = std::vector of length 8, capacity 56 = {0x7fffa97a7ec0, 0x7fff9b047160, 0x7fffbf97b8c0, 0x7fffa0c87660, 0x7fffa1157890, 0x7fffbf7e7f10, 0x7fffbf7e7f80, 0x7fffa0db5660}
```

Id variable value check:

At the breakpoints mentioned above we saw that id variable is uninitialized in case of JANA1 and undeclared in case of JANA2. This was concerning because id is a variable within the KalmanForward function, the same functions where previous breakpoints are set, and is initialized before the lines for which breakpoints were set above. To confirm if it was even initialized, a breakpoint was added immediately after the line `unsigned int id=forward_traj[k].h_id-1; `

break src/libraries/TRACKING/DTrackFitterKalmanSIMD.cc:4458

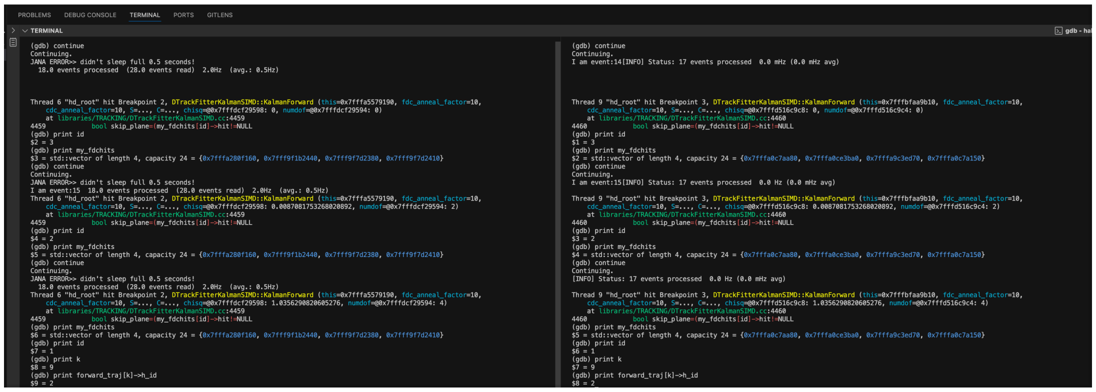
On hitting this breakpoint we observed that id is getting initialized inside the same function where the if statement for chi2_hit<cdc_chi2cut exist as it can be seen in the bt below when breakpoint is set at break src/libraries/TRACKING/DTrackFitterKalmanSIMD.cc:4458 which is a line next to id variable declaration.



```
(gdb) print forward_traj.size()
$10 = 166
(gdb) print k
$11 = 20
(gdb) print id
$12 = 0
(gdb) print forward_traj[k]->h_id
$13 = 1
(gdb) bt
#0  DTrackFitterKalmanSIMD::KalmanForward (this=0x7fffa5579190, fdc_anneal_factor=10, cdc_anneal_factor=10, S=..., C=...,
    chisq=@0x7fffdcf29598: 2.5366376462235336, numdof=@0x7fffdcf29594: 6) at libraries/TRACKING/DTrackFitterKalmanSIMD.cc:4459
#1  0x0000000001de4c4c in DTrackFitterKalmanSIMD::ForwardFit (this=0x7fffa5579190, S0=..., C0=...)
    at libraries/TRACKING/DTrackFitterKalmanSIMD.cc:6491
#2  0x0000000001dcf98f in DTrackFitterKalmanSIMD::KalmanLoop (this=0x7fffa5579190) at libraries/TRACKING/DTrackFitterKalmanSIMD.cc:3329
#3  0x0000000001dbe992 in DTrackFitterKalmanSIMD::FitTrack (this=0x7fffa5579190) at libraries/TRACKING/DTrackFitterKalmanSIMD.cc:928
#4  0x0000000001ce7d92 in DTrackFitter::FitTrack (this=0x7fffa5579190, pos=..., mom=..., q=-1, mass=0.13957017999999999,
    t0=nan(0x8000000000000), t0_det=SYS_NULL) at libraries/TRACKING/DTrackFitter.cc:212
#5  0x0000000001ce8a5d in DTrackFitter::FindHitsAndFitTrack (this=0x7fffa5579190, starting_params=..., rt=0x7fff8fd410f0,
    loop=0x7fffcc000b60, mass=0.13957017999999999, N=24, t0=nan(0x8000000000000), t0_det=SYS_NULL)
    at libraries/TRACKING/DTrackFitter.cc:408
#6  0x0000000001d056ae in DTrackWireBased_factory::DoFit (this=0x7fffcc4f4340, c_id=1, candidate=0x7fffa274cc20, rt=0x7fff8fd410f0,
    loop=0x7fffcc000b60, mass=0.13957017999999999) at libraries/TRACKING/DTrackWireBased_factory.cc:447
#7  0x0000000001d044fd in DTrackWireBased_factory::evnt (this=0x7fffcc4f4340, loop=0x7fffcc000b60, eventnumber=15)
    at libraries/TRACKING/DTrackWireBased_factory.cc:275
#8  0x00000000017a459a in jana::JFactory<DTrackWireBased>::Get (this=0x7fffcc4f4340, d=std::vector of length 0, capacity 0)
    at /u/group/halld/Software/builds/Linux_Alma9-x86_64-gcc11.4.1/jana/jana_0.8.2^ccdb1611/Linux_Alma9-x86_64-gcc11.4.1/include/JANA/JFa
ctory.h:295
#9  0x0000000001799461 in jana::JEventLoop::GetFromFactory<DTrackWireBased> (this=0x7fffcc000b60,
    t=std::vector of length 0, capacity 0, tag=0x2a08eca "", data_source=@0x7fffdcf2b020: 121120, allow_deftag=true)
    at /u/group/halld/Software/builds/Linux_Alma9-x86_64-gcc11.4.1/jana/jana_0.8.2^ccdb1611/Linux_Alma9-x86_64-gcc11.4.1/include/JANA/JEv
entLoop.h:452
#10 0x000000000178f912 in jana::JEventLoop::Get<DTrackWireBased> (this=0x7fffcc000b60, t=std::vector of length 0, capacity 0,
    tag=0x2a08eca "", allow_deftag=true)
    at /u/group/halld/Software/builds/Linux_Alma9-x86_64-gcc11.4.1/jana/jana_0.8.2^ccdb1611/Linux_Alma9-x86_64-gcc11.4.1/include/JANA/JEv
entLoop.h:309
#11 0x0000000001e77cc6 in DTrackTimeBased_factory::evnt (this=0x7fffcc4f4490, loop=0x7fffcc000b60, eventnumber=15)
    at libraries/TRACKING/DTrackTimeBased_factory.cc:308
#12 0x0000000001739e52 in jana::JFactory<DTrackTimeBased>::Get (this=0x7fffcc4f4490, d=std::vector of length 0, capacity 0)
    at /u/group/halld/Software/builds/Linux_Alma9-x86_64-gcc11.4.1/jana/jana_0.8.2^ccdb1611/Linux_Alma9-x86_64-gcc11.4.1/include/JANA/JFa
ctory.h:295
#13 0x000000000173ffc1 in jana::JEventLoop::GetFromFactory<DTrackTimeBased> (this=0x7fffcc000b60,
    t=std::vector of length 0, capacity 0, tag=0x299010c "", data_source=@0x7fffdcf2b910: 3422554984, allow_deftag=true)
    at /u/group/halld/Software/builds/Linux_Alma9-x86_64-gcc11.4.1/jana/jana_0.8.2^ccdb1611/Linux_Alma9-x86_64-gcc11.4.1/include/JANA/JEv
entLoop.h:452
#14 0x000000000173aae8 in jana::JEventLoop::Get<DTrackTimeBased> (this=0x7fffcc000b60, t=std::vector of length 0, capacity 0,
    tag=0x299010c "", allow_deftag=true)
    at /u/group/halld/Software/builds/Linux_Alma9-x86_64-gcc11.4.1/jana/jana_0.8.2^ccdb1611/Linux_Alma9-x86_64-gcc11.4.1/include/JANA/JEv
entLoop.h:309
#15 0x00000000018c72a2 in DHistogramAction_NumReconstructedObjects::Perform_Action (this=0x4d810c0, locEventLoop=0x7fffcc000b60,
    locParticleCombo=0x0) at libraries/ANALYSIS/DHistogramActions_Independent.cc:3595
#16 0x00007fffe41ae488 in DAnalysis::DAnalysisAction::operator() (this=0x4d810c0, locEventLoop=0x7fffcc000b60)
    at libraries/ANALYSIS/DAnalysisAction.h:125
#17 0x00007fffe41a7ed7 in DEventProcessor_monitoring_hists::evnt (this=0x4d7f760, locEventLoop=0x7fffcc000b60, eventnumber=15)
    at plugins/Analysis/monitoring_hists/DEventProcessor_monitoring_hists.cc:134
#18 0x00000000029559a2 in jana::JEventLoop::OneEvent (this=0x7fffcc000b60) at src/JANA/JEventLoop.cc:693
#19 0x0000000002955fc4 in jana::JEventLoop::Loop (this=this@entry=0x7fffcc000b60) at src/JANA/JEventLoop.cc:496
#20 0x000000000292b7c5 in LaunchThread (arg=0x7fffffffc620) at src/JANA/JApplication.cc:1382
#21 0x00007ffff489f802 in start_thread () from /lib64/libc.so.6
#22 0x00007ffff483f450 in clone3 () from /lib64/libc.so.6
(gdb) 
```

```
(gdb) print forward_traj.size()
$12 = 166
(gdb) print k
$13 = 20
(gdb) print id
$14 = 0
(gdb) print forward_traj[k]->h_id
$15 = 1
(gdb) bt
#0  DTrackFitterKalmanSIMD::KalmanForward (this=0x7fffbfaa9b10, fdc_anneal_factor=10, cdc_anneal_factor=10, S=..., C=...,
    chisq=@0x7fffd516c9c8: 2.5366376462235336, numdof=@0x7fffd516c9c4: 6) at libraries/TRACKING/DTrackFitterKalmanSIMD.cc:4460
#1  0x0000000002074f26 in DTrackFitterKalmanSIMD::ForwardFit (this=0x7fffbfaa9b10, S0=..., C0=...)
    at libraries/TRACKING/DTrackFitterKalmanSIMD.cc:6492
#2  0x000000000205fc9f in DTrackFitterKalmanSIMD::KalmanLoop (this=0x7fffbfaa9b10)
    at libraries/TRACKING/DTrackFitterKalmanSIMD.cc:3330
#3  0x000000000204ecd7 in DTrackFitterKalmanSIMD::FitTrack (this=0x7fffbfaa9b10) at libraries/TRACKING/DTrackFitterKalmanSIMD.cc:929
#4  0x0000000001f6cb82 in DTrackFitter::FitTrack (this=0x7fffbfaa9b10, pos=..., mom=..., q=-1, mass=0.13957017999999999,
    t0=nan(0x8000000000000), t0_det=SYS_NULL) at libraries/TRACKING/DTrackFitter.cc:209
#5  0x0000000001f6dbbe in DTrackFitter::FindHitsAndFitTrack (this=0x7fffbfaa9b10, starting_params=..., rt=0x7fff9a258d90,
    loop=std::shared_ptr<const JEvent> (use count 24, weak count 1) = {...}, mass=0.13957017999999999, N=24, t0=nan(0x8000000000000),
    t0_det=SYS_NULL) at libraries/TRACKING/DTrackFitter.cc:405
#6  0x0000000001f7f5bc in DTrackWireBased_factory::DoFit (this=0x564be20, c_id=1, candidate=0x7fff9aa36bf0, rt=0x7fff9a258d90,
    event=std::shared_ptr<const JEvent> (use count 24, weak count 1) = {...}, mass=0.13957017999999999)
    at libraries/TRACKING/DTrackWireBased_factory.cc:440
#7  0x0000000001f7e5e2 in DTrackWireBased_factory::Process (this=0x564be20,
    event=std::shared_ptr<const JEvent> (use count 24, weak count 1) = {...}) at libraries/TRACKING/DTrackWireBased_factory.cc:277
#8  0x00007ffff5453e19 in JFactory::Create (this=0x564be20, event=std::shared_ptr<const JEvent> (use count 24, weak count 1) = {...})
    at /w/epsci-sciwork18/rasool/gluex_jana2_2023/JANA2/src/libraries/JANA/JFactory.cc:47
#9  0x0000000001a5e3fe in JFactoryT<DTrackWireBased>::GetOrCreate (this=0x564be20,
    event=std::shared_ptr<const JEvent> (use count 24, weak count 1) = {...})
    at /work/epsci/rasool/gluex_jana2_2023/JANA2/include/JANA/JFactoryT.h:83
#10 0x0000000001a55236 in JEvent::Get<DTrackWireBased> (this=0x3678be0, destination=std::vector of length 0, capacity 0, tag="")
    at /work/epsci/rasool/gluex_jana2_2023/JANA2/include/JANA/JEvent.h:269
#11 0x0000000002109727 in DTrackTimeBased_factory::Process (this=0x4806510,
    event=std::shared_ptr<const JEvent> (use count 24, weak count 1) = {...}) at libraries/TRACKING/DTrackTimeBased_factory.cc:316
#12 0x00007ffff5453e19 in JFactory::Create (this=0x4806510, event=std::shared_ptr<const JEvent> (use count 24, weak count 1) = {...})
    at /w/epsci-sciwork18/rasool/gluex_jana2_2023/JANA2/src/libraries/JANA/JFactory.cc:47
#13 0x0000000001a5dba8 in JFactoryT<DTrackTimeBased>::GetOrCreate (this=0x4806510,
    event=std::shared_ptr<const JEvent> (use count 24, weak count 1) = {...})
    at /work/epsci/rasool/gluex_jana2_2023/JANA2/include/JANA/JFactoryT.h:83
#14 0x0000000001a54e22 in JEvent::Get<DTrackTimeBased> (this=0x3678be0, destination=std::vector of length 0, capacity 0, tag="")
    at /work/epsci/rasool/gluex_jana2_2023/JANA2/include/JANA/JEvent.h:269
#15 0x0000000001b7fbac in DHistogramAction_NumReconstructedObjects::Perform_Action (this=0x50b9098,
    locEvent=std::shared_ptr<const JEvent> (use count 24, weak count 1) = {...}, locParticleCombo=0x0)
    at libraries/ANALYSIS/DHistogramActions_Independent.cc:3592
#16 0x00007fffe3e7195a in DAnalysis::DAnalysisAction::operator() (this=0x50b9098,
    locEvent=std::shared_ptr<const JEvent> (use count 24, weak count 1) = {...}) at libraries/ANALYSIS/DAnalysisAction.h:123
#17 0x00007fffe3e6a1d9 in DEventProcessor_monitoring_hists::Process (this=0x50b76d0,
    locEvent=std::shared_ptr<const JEvent> (use count 24, weak count 1) = {...})
    at plugins/Analysis/monitoring_hists/DEventProcessor_monitoring_hists.cc:134
#18 0x0000000001947ea6 in JEventProcessor::DoMap (this=0x50b76d0,
    e=std::shared_ptr<const JEvent> (use count 24, weak count 1) = {...})
    at /work/epsci/rasool/gluex_jana2_2023/JANA2/include/JANA/JEventProcessor.h:78
#19 0x00007ffff546940c in JEventProcessorArrow::execute (this=0x56926f0, result=..., location_id=0)
    at /w/epsci-sciwork18/rasool/gluex_jana2_2023/JANA2/src/libraries/JANA/Engine/JEventProcessorArrow.cc:42
#20 0x00007ffff54767e7 in JWorker::loop (this=0x5ba5860)
    at /w/epsci-sciwork18/rasool/gluex_jana2_2023/JANA2/src/libraries/JANA/Engine/JWorker.cc:222
#21 0x00007ffff547898c in std::__invoke_impl<void, void (JWorker::*)(), JWorker*> (
    __f=@0x5b9e1b0: (void (JWorker::*)(JWorker * const)) 0x7ffff54763fa <JWorker::loop()>, __t=@0x5b9e1a8: 0x5ba5860)
    at /usr/include/c++/11/bits/invoke.h:74
```

We are able to see the value of this id at this breakpoint as shown below:



```
(gdb) continue
Continuing.
JANA ERROR>> didn't sleep full 0.5 seconds!
  18.0 events processed  (28.0 events read)  2.0Hz  (avg.: 0.5Hz)



Thread 6 "hd_root" hit Breakpoint 2, DTrackFitterKalmanSIMD::KalmanForward (this=0x7fffa5579190, fdc_anneal_factor=10,
    cdc_anneal_factor=10, S=..., C=..., chisq=@0x7fffdcf29598: 0, numdof=@0x7fffdcf29594: 0)
    at libraries/TRACKING/DTrackFitterKalmanSIMD.cc:4459
4459            bool skip_plane=(my_fdchits[id]->hit!=NULL
(gdb) print id
$2 = 3
(gdb) print my_fdchits
$3 = std::vector of length 4, capacity 24 = {0x7fffa280f160, 0x7fff9f1b2440, 0x7fff9f7d2380, 0x7fff9f7d2410}
(gdb) continue
Continuing.
JANA ERROR>> didn't sleep full 0.5 seconds!
I am event:15  18.0 events processed  (28.0 events read)  2.0Hz  (avg.: 0.5Hz)
Thread 6 "hd_root" hit Breakpoint 2, DTrackFitterKalmanSIMD::KalmanForward (this=0x7fffa5579190, fdc_anneal_factor=10,
    cdc_anneal_factor=10, S=..., C=..., chisq=@0x7fffdcf29598: 0.0087081753268020892, numdof=@0x7fffdcf29594: 2)
    at libraries/TRACKING/DTrackFitterKalmanSIMD.cc:4459
4459            bool skip_plane=(my_fdchits[id]->hit!=NULL
(gdb) print id
$4 = 2
(gdb) print my_fdchits
$5 = std::vector of length 4, capacity 24 = {0x7fffa280f160, 0x7fff9f1b2440, 0x7fff9f7d2380, 0x7fff9f7d2410}
(gdb) continue
Continuing.
JANA ERROR>> didn't sleep full 0.5 seconds!
  18.0 events processed  (28.0 events read)  2.0Hz  (avg.: 0.5Hz)
Thread 6 "hd_root" hit Breakpoint 2, DTrackFitterKalmanSIMD::KalmanForward (this=0x7fffa5579190, fdc_anneal_factor=10,
    cdc_anneal_factor=10, S=..., C=..., chisq=@0x7fffdcf29598: 1.0356290820605276, numdof=@0x7fffdcf29594: 4)
    at libraries/TRACKING/DTrackFitterKalmanSIMD.cc:4459
4459            bool skip_plane=(my_fdchits[id]->hit!=NULL
(gdb) print my_fdchits
$6 = std::vector of length 4, capacity 24 = {0x7fffa280f160, 0x7fff9f1b2440, 0x7fff9f7d2380, 0x7fff9f7d2410}
(gdb) print id
$7 = 1
(gdb) print k
$8 = 9
(gdb) print forward_traj[k]->h_id
$9 = 2
```

```
(gdb) continue
Continuing.
I am event:14[INFO] Status: 17 events processed  0.0 mHz (0.0 mHz avg)



Thread 9 "hd_root" hit Breakpoint 3, DTrackFitterKalmanSIMD::KalmanForward (this=0x7fffbfaa9b10, fdc_anneal_factor=10,
    cdc_anneal_factor=10, S=..., C=..., chisq=@0x7fffd516c9c8: 0, numdof=@0x7fffd516c9c4: 0)
    at libraries/TRACKING/DTrackFitterKalmanSIMD.cc:4460
4460            bool skip_plane=(my_fdchits[id]->hit!=NULL
(gdb) print id
$1 = 3
(gdb) print my_fdchits
$2 = std::vector of length 4, capacity 24 = {0x7fffa0c7aa80, 0x7fffa0ce3ba0, 0x7fffa9c3ed70, 0x7fffa0c7a150}
(gdb) continue
Continuing.
I am event:15[INFO] Status: 17 events processed  0.0 Hz (0.0 mHz avg)

Thread 9 "hd_root" hit Breakpoint 3, DTrackFitterKalmanSIMD::KalmanForward (this=0x7fffbfaa9b10, fdc_anneal_factor=10,
    cdc_anneal_factor=10, S=..., C=..., chisq=@0x7fffd516c9c8: 0.0087081753268020892, numdof=@0x7fffd516c9c4: 2)
    at libraries/TRACKING/DTrackFitterKalmanSIMD.cc:4460
4460            bool skip_plane=(my_fdchits[id]->hit!=NULL
(gdb) print id
$3 = 2
(gdb) print my_fdchits
$4 = std::vector of length 4, capacity 24 = {0x7fffa0c7aa80, 0x7fffa0ce3ba0, 0x7fffa9c3ed70, 0x7fffa0c7a150}
(gdb) continue
Continuing.
[INFO] Status: 17 events processed  0.0 Hz (0.0 mHz avg)

Thread 9 "hd_root" hit Breakpoint 3, DTrackFitterKalmanSIMD::KalmanForward (this=0x7fffbfaa9b10, fdc_anneal_factor=10,
    cdc_anneal_factor=10, S=..., C=..., chisq=@0x7fffd516c9c8: 1.0356290820605276, numdof=@0x7fffd516c9c4: 4)
    at libraries/TRACKING/DTrackFitterKalmanSIMD.cc:4460
4460            bool skip_plane=(my_fdchits[id]->hit!=NULL
(gdb) print my_fdchits
$5 = std::vector of length 4, capacity 24 = {0x7fffa0c7aa80, 0x7fffa0ce3ba0, 0x7fffa9c3ed70, 0x7fffa0c7a150}
(gdb) print id
$6 = 1
(gdb) print k
$7 = 9
(gdb) print forward_traj[k]->h_id
$8 = 2
```

Hence some memory corruption is happening between the location where id is initialized and if chi2_hit<chi2_cut line.

Extra info:
my_fdchits has the actual hits and data related to them while forward_traj has the trajectory points for a particular trajectory that is generated so forward_traj has the predicted value and we will compare it with my_fdchits to see if the hit given for this k is resembling with the value predicted but if chi2_hit got really big then that k should be ignored forever.

```
4457:    unsigned int id=forward_traj[k].h_id-1;
4478:    Mdiff(1)=my_fdchits[id]->vstrip-vpred-doca*lorentz_factor;
```