Improvement of a memory profiling tool : MALT

SYED **MEHDI** RAZA JAFFERY

SUPERVISOR: SEBASTIEN VALAT

MALT

MALT - **MAL**loc **T**racker

- A memory profiling tool
- MALT helps deal with three issues:
  - How to reduce **memory footprint**?
  - How to improve **overhead** of memory manage
  - How to improve **memory usage**?

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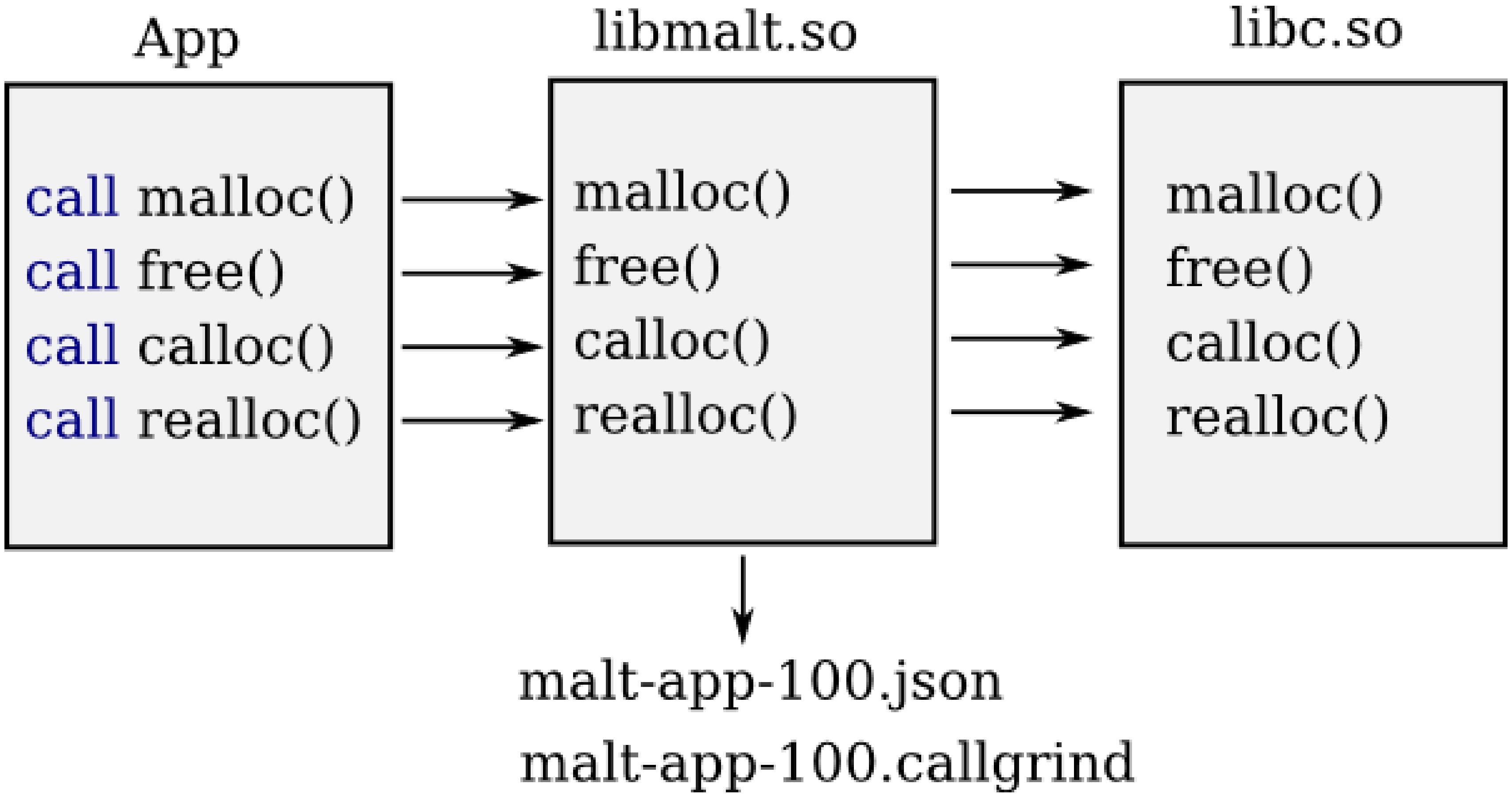
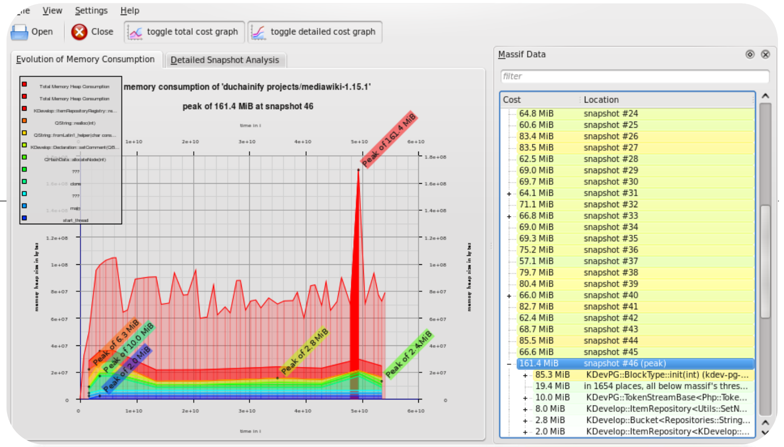


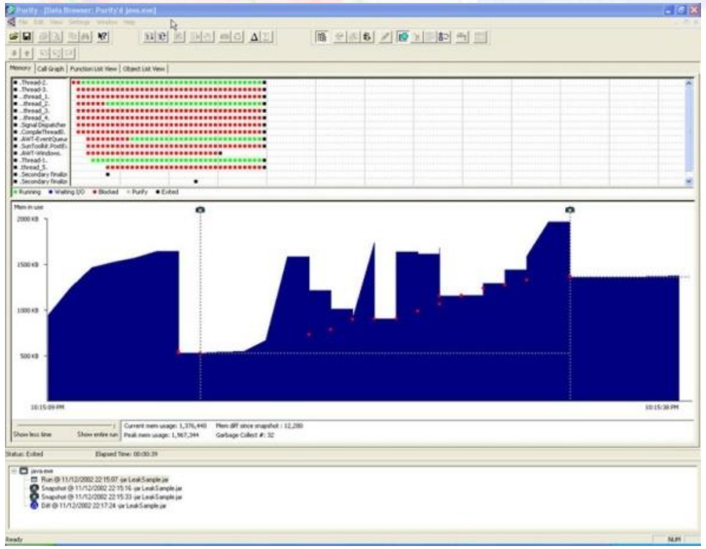
Use LD_PRELOAD to intercept malloc/free/…

Similar Tools

- Valgrind – massif
- Valgrind – memcheck
- Google heap profiler
- IBM Purify++ / Parasoft Insure++
- TAU memory profiler
- Kcachegrind *(visualization)*

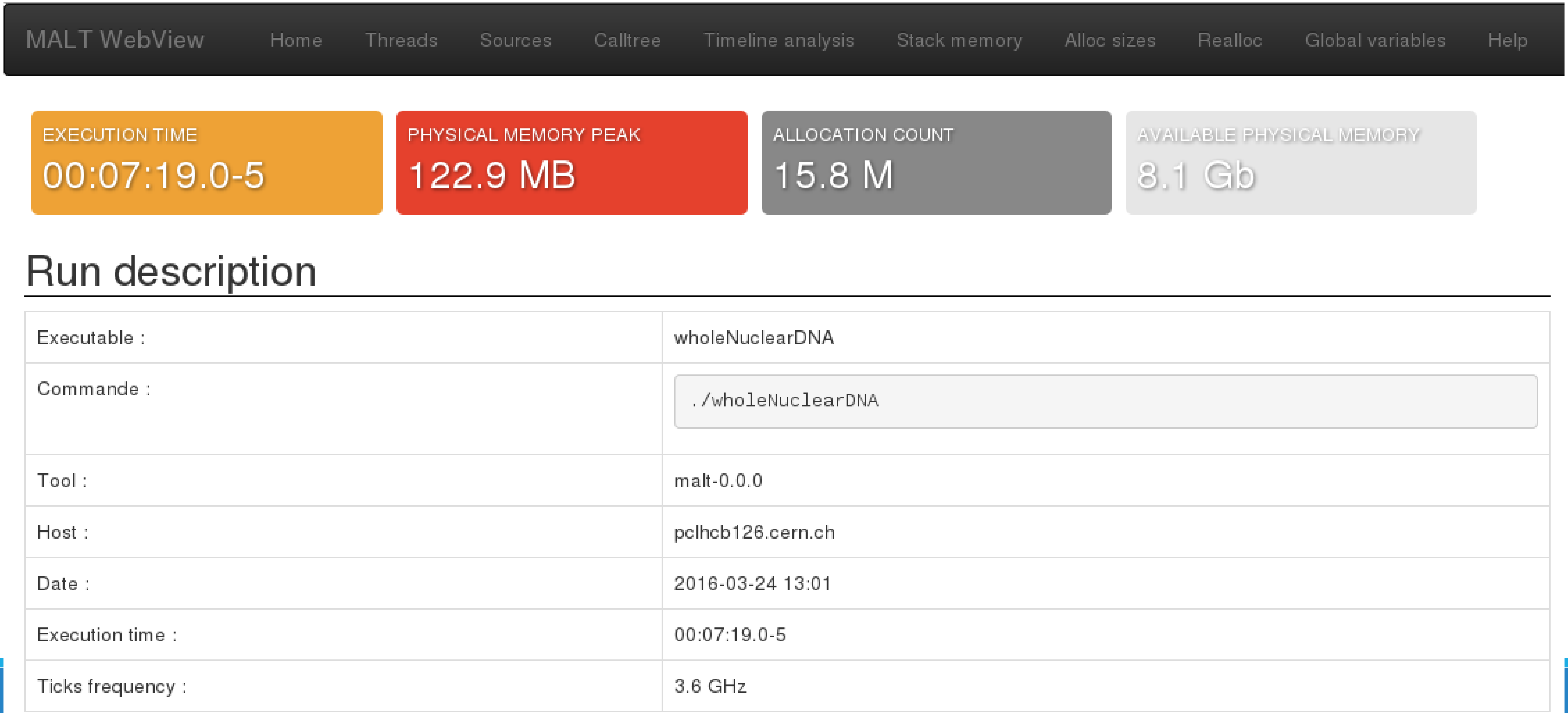

View
Settings
Help
Open
Close
toggle total cost graph
toggle detailed cost graph
Evolution of Memory Consumption
Detailed Snapshot Analysis
Total Memory Heap Consumption
Total Memory Heap Consumption
KDevelop::ItemRepositoryRegistry::re...
QString::realloc(int)
QString::fromLatin1_helper(char cons...
KDevelop::Declaration::setComment(QB...
QHashData::allocateNode(int)
???
clone
???
memory consumption of 'duchainify projects/mediawiki-1.15.1'
peak of 161.4 MiB at snapshot 46
time in i
1e+10
2e+10
3e+10
4e+10
5e+10
6e+10
1.8e+08
1.6e+08
1.4e+08
1.2e+08
1e+08
8e+07
6e+07
4e+07
2e+07
0
Peak of 161.4 MiB
Peak of 2.8 MiB
Peak of 2.4 MiB
memory heap size in bytes
Massif Data
filter

Cost	Location
64.8 MiB	snapshot #24
60.6 MiB	snapshot #25
83.4 MiB	snapshot #26
83.5 MiB	snapshot #27
62.5 MiB	snapshot #28
69.0 MiB	snapshot #29
69.7 MiB	snapshot #30
+ 64.1 MiB	snapshot #31
71.1 MiB	snapshot #32
+ 66.8 MiB	snapshot #33
69.0 MiB	snapshot #34
69.3 MiB	snapshot #35
75.2 MiB	snapshot #36
57.1 MiB	snapshot #37
79.7 MiB	snapshot #38
80.4 MiB	snapshot #39
+ 66.0 MiB	snapshot #40
82.7 MiB	snapshot #41
62.4 MiB	snapshot #42
68.7 MiB	snapshot #43
85.5 MiB	snapshot #44
66.6 MiB	snapshot #45
− 161.4 MiB	snapshot #46 (peak)
+ 85.3 MiB	KDevPG::BlockType::init(int) (kdev-pg-...
19.4 MiB	in 1654 places, all below massif's thres...
+ 10.0 MiB	KDevPG::TokenStreamBase<Php::Toke...
+ 8.0 MiB	KDevelop::ItemRepository<Utils::SetN...
+ 2.8 MiB	KDevelop::Bucket<Repositories::String...
+ 2.0 MiB	KDevelop::ItemRepository<KDevelop::...



MY WORK

Malt Webview



EXECUTION TIME
00:07:19.0-5

PHYSICAL MEMORY PEAK
122.9 MB

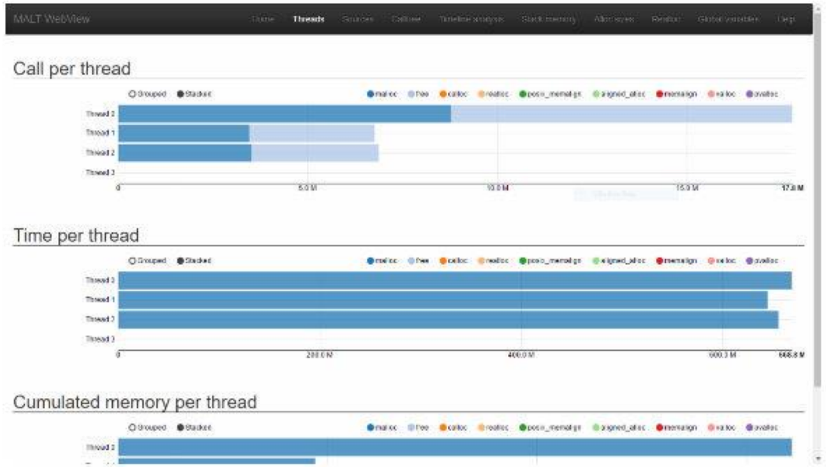
ALLOCATION COUNT
15.8 M

AVAILABLE PHYSICAL MEMORY
8.1 Gb

Run description

Executable :	wholeNuclearDNA
Commande :	`./wholeNuclearDNA`
Tool :	malt-0.0.0
Host :	pclhcb126.cern.ch
Date :	2016-03-24 13:01
Execution time :	00:07:19.0-5
Ticks frequency :	3.6 GHz

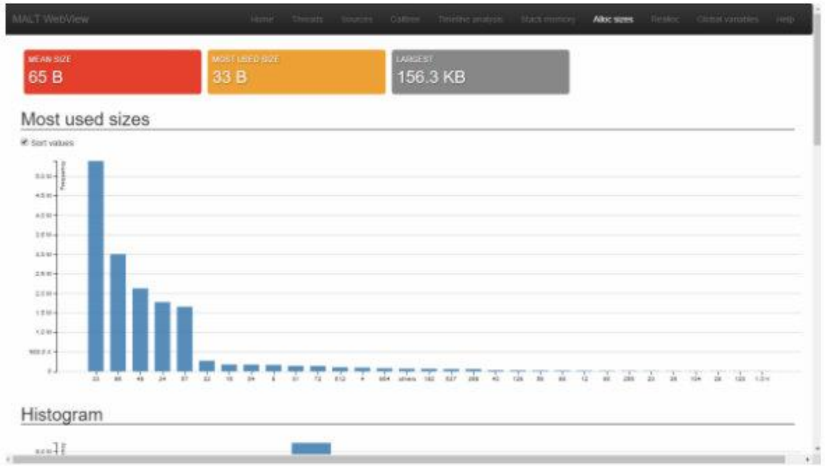
Threads



Call per thread

Time per thread

Cumulated memory per thread



MEAN SIZE
65 B

MOST USED SIZE
33 B

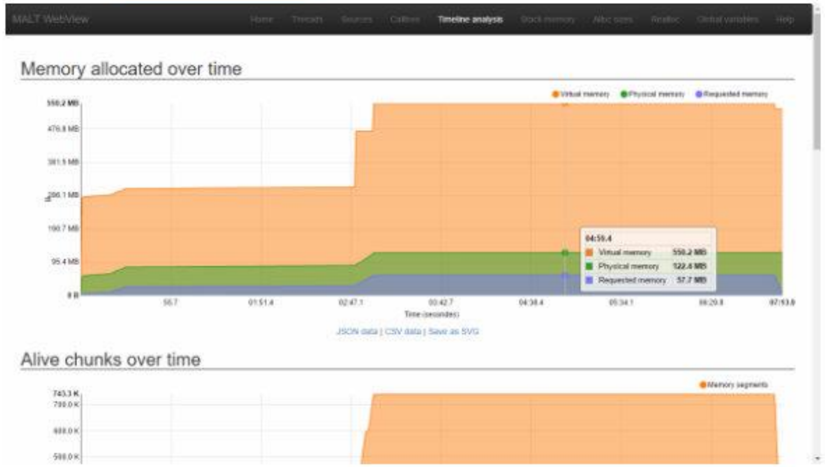
LARGEST
156.3 KB

Most used sizes

Histogram

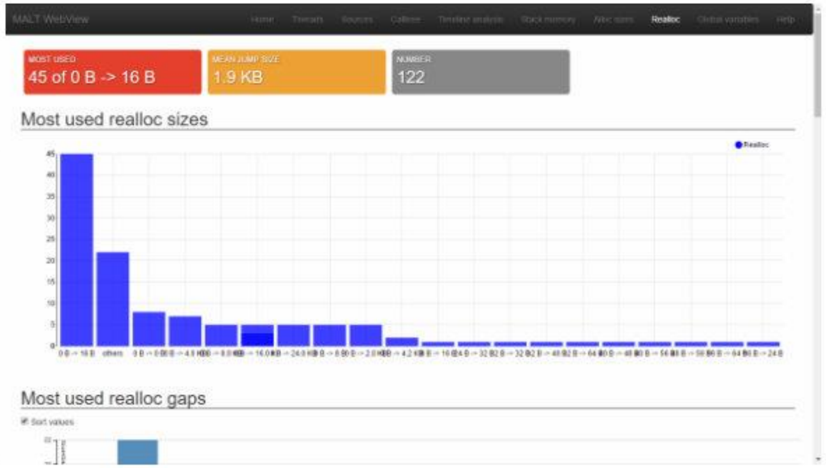
Alloc Sizes

Timeline analysis



Memory allocated over time

Alive chunks over time



MOST USED
45 of 0 B -> 16 B

MEAN JUMP SIZE
1.9 KB

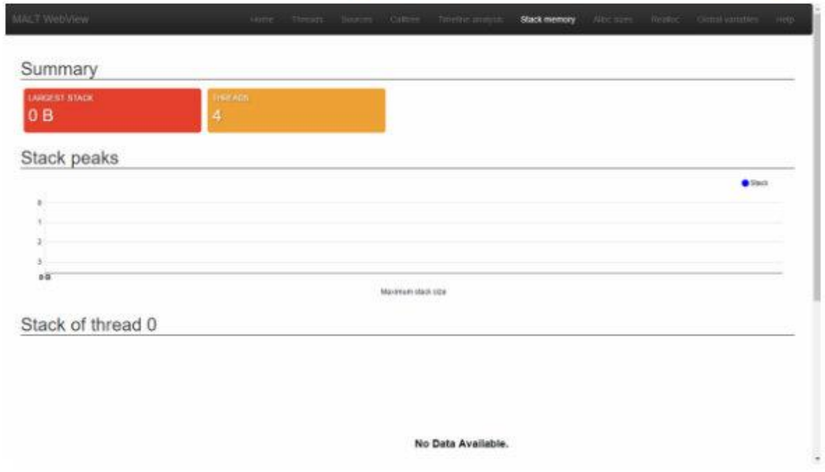
NUMBER
122

Most used realloc sizes

Most used realloc gaps

Realloc

Stack Memory



Summary

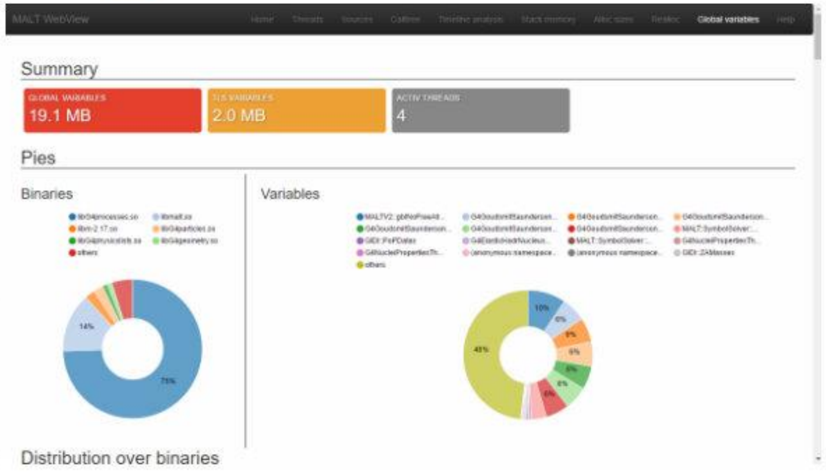
LARGEST STACK
0 B

THREADS
4

Stack peaks

Stack of thread 0

No Data Available.



Summary

GLOBAL VARIABLES
19.1 MB

TLS VARIABLES
2.0 MB

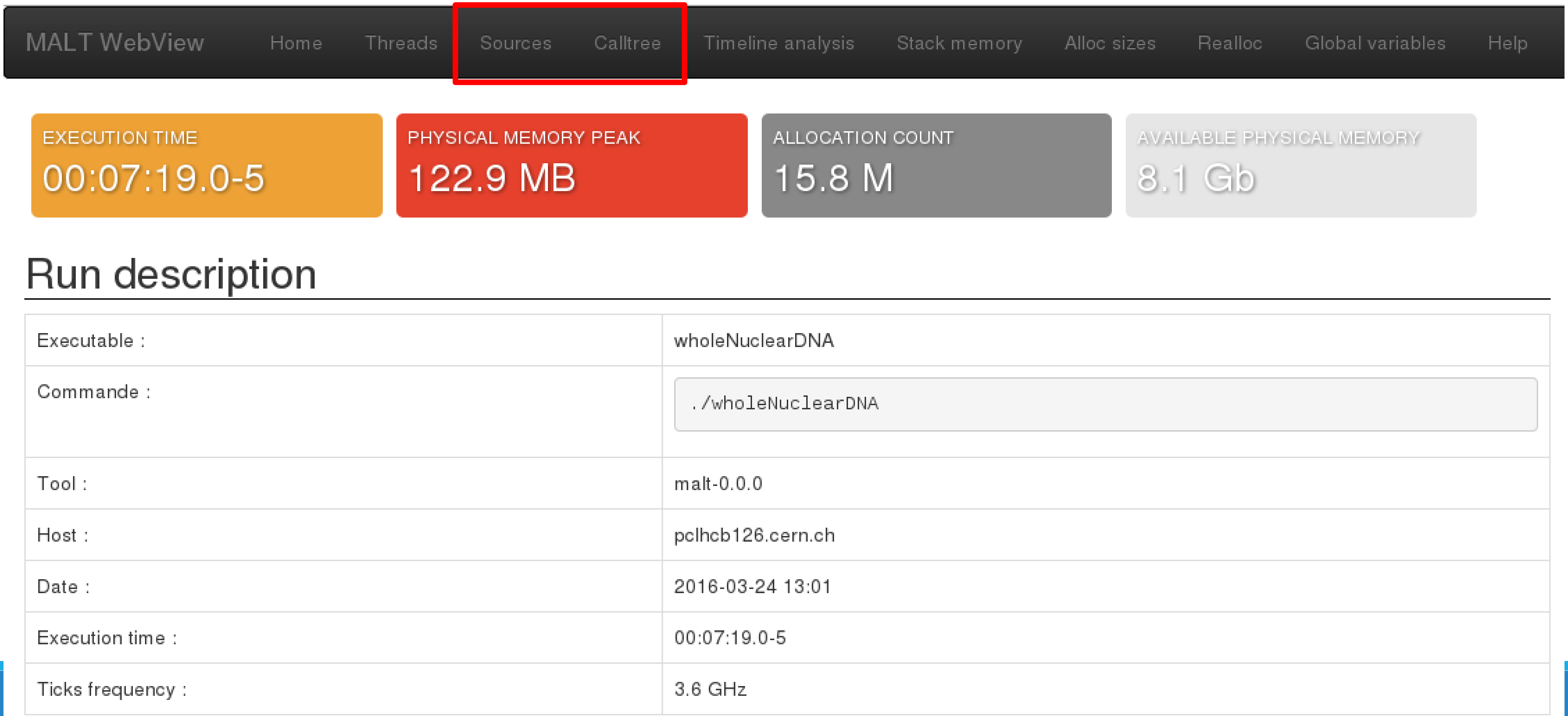
ACTIV THREADS
4

Pies

Distribution over binaries

Global Variables

Malt Webview



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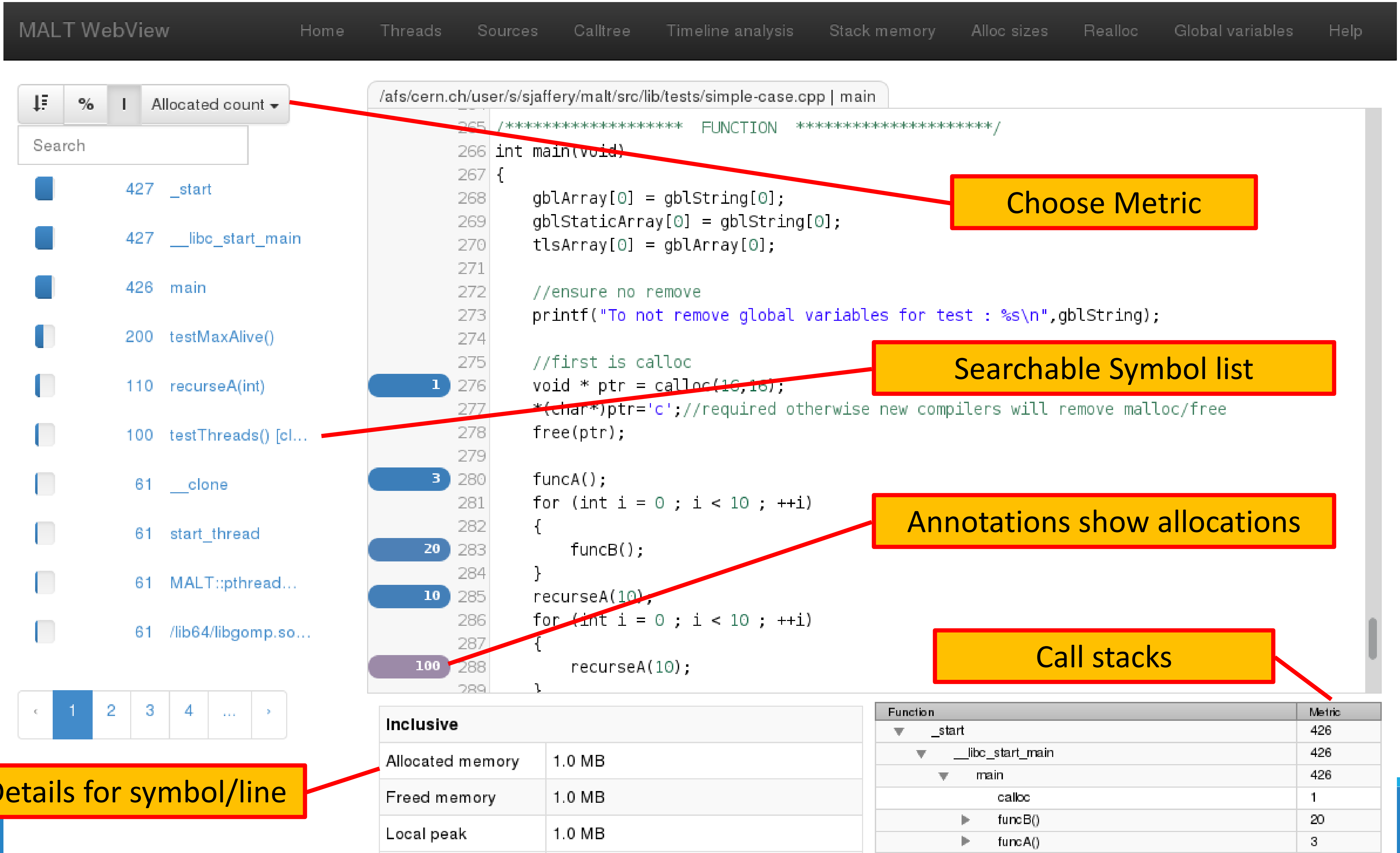
Source Viewer



427	_start
427	__libc_start_main
426	main
200	testMaxAlive()
110	recurseA(int)
100	testThreads() [cl...
61	__clone
61	start_thread
61	MALT::pthread...
61	/lib64/libgomp.so...

/afs/cern.ch/user/s/sjaffery/malt/src/lib/tests/simple-case.cpp | main

```
      /********************  FUNCTION  *********************/
      int main(void)
      {
          gblArray[0] = gblString[0];
          gblStaticArray[0] = gblString[0];
          tlsArray[0] = gblArray[0];

          //ensure no remove
          printf("To not remove global variables for test : %s\n",gblString);

          //first is calloc
  1       void * ptr = calloc(16,16);
          *(char*)ptr='c';//required otherwise new compilers will remove malloc/free
          free(ptr);

  3       funcA();
          for (int i = 0 ; i < 10 ; ++i)
          {
  20          funcB();
          }
  10      recurseA(10);
          for (int i = 0 ; i < 10 ; ++i)
          {
  100         recurseA(10);
          }
```

Inclusive	
Allocated memory	1.0 MB
Freed memory	1.0 MB
Local peak	1.0 MB

Function	Metric
▼ _start	426
▼ __libc_start_main	426
▼ main	426
calloc	1
▶ funcB()	20
▶ funcA()	3

Choose Metric

Searchable Symbol list

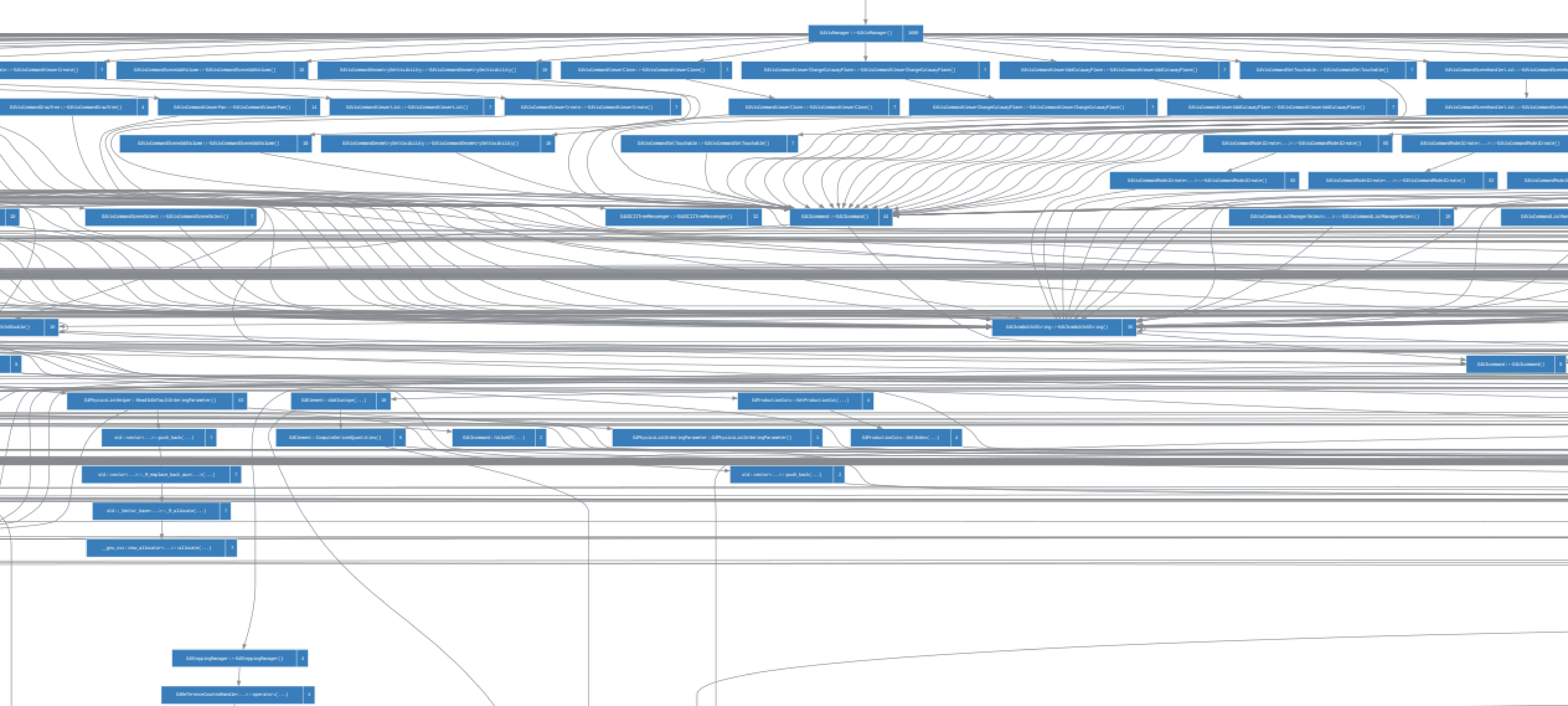
Annotations show allocations

Call stacks

Details for symbol/line

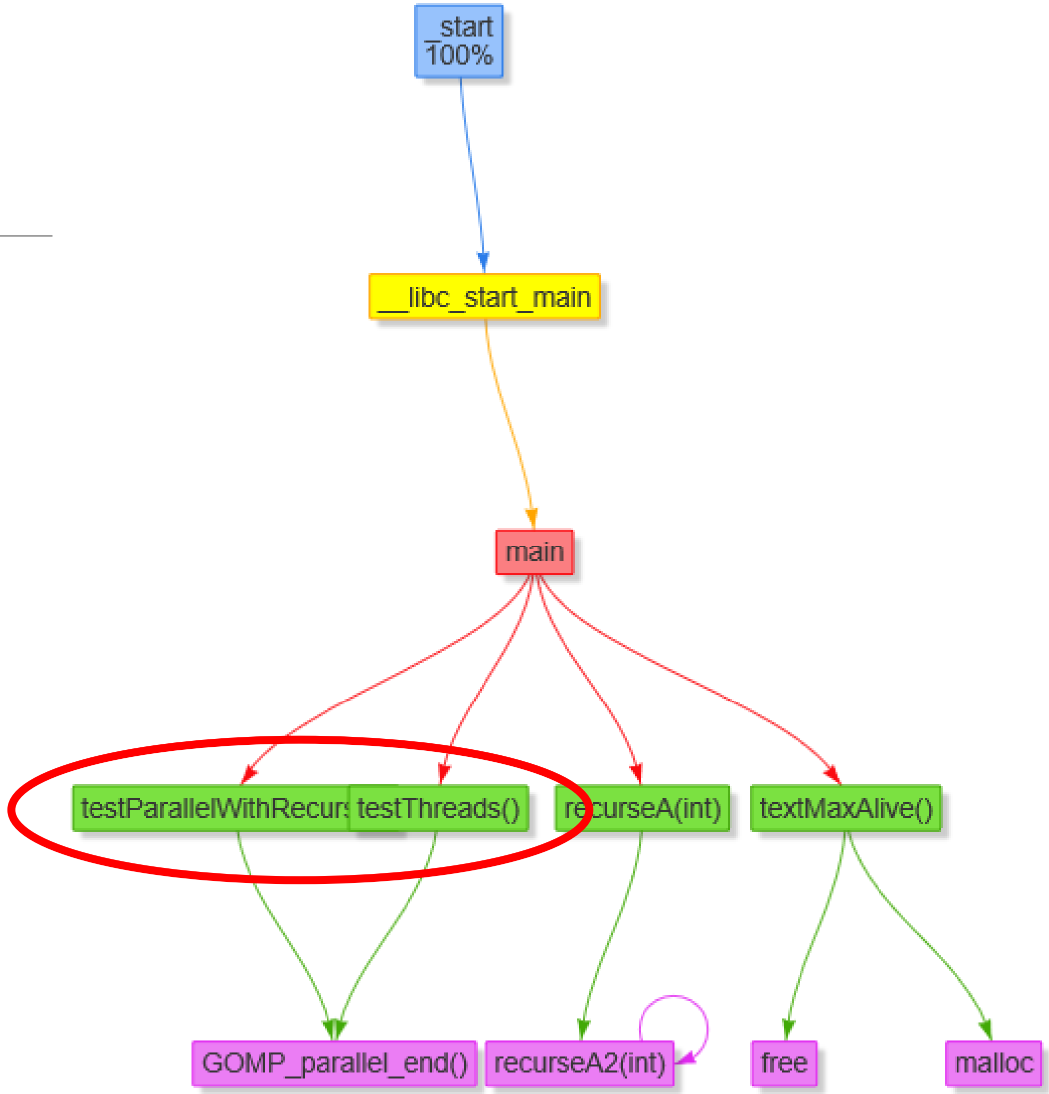
Call Tree

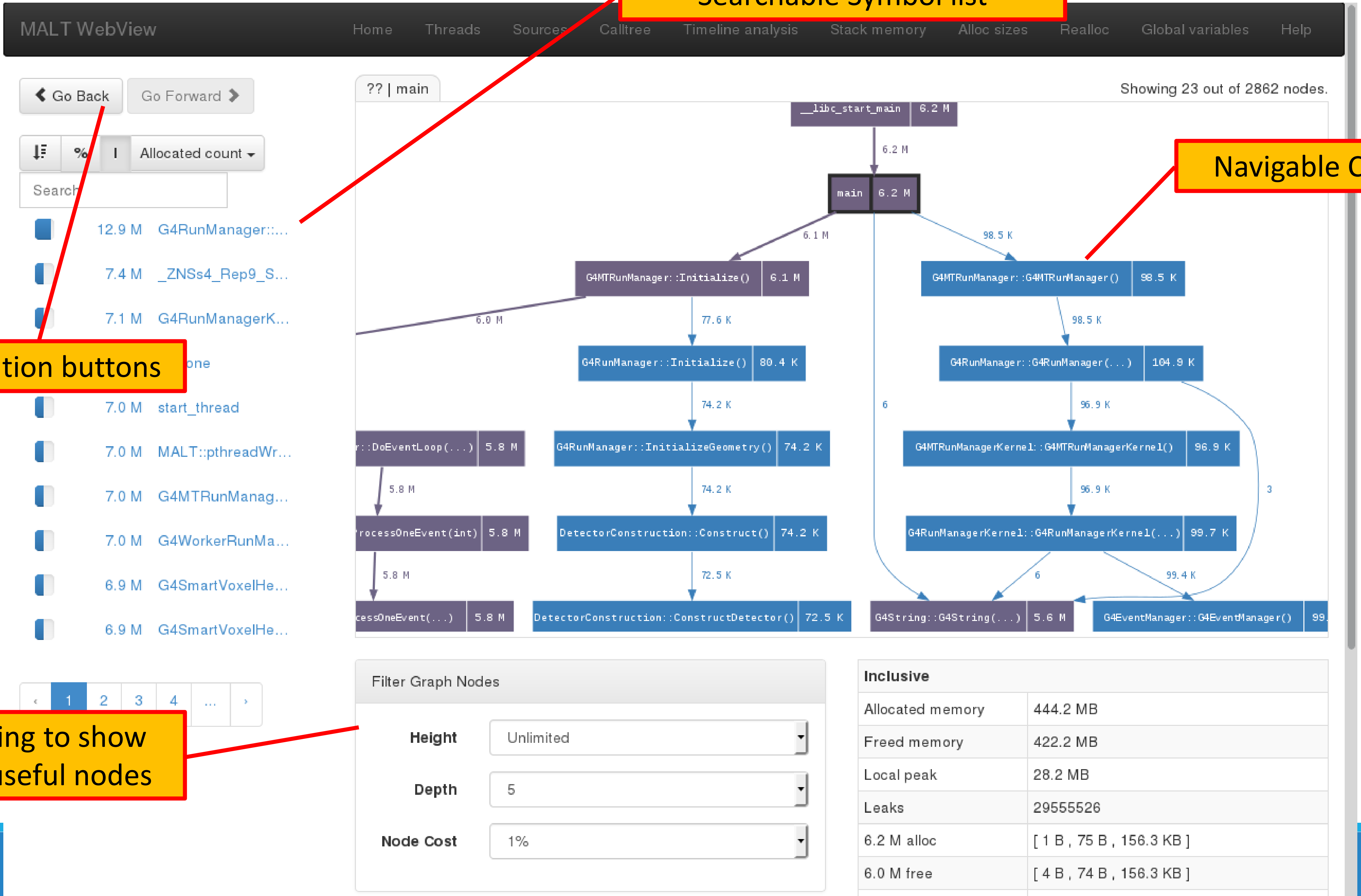
(<10% part of a Geant4 Simulation’s call tree)


G4VisManager::~G4VisManager() 1000
G4VisCommandSceneAddVolume::~G4VisCommandSceneAddVolume() 10
G4VisCommandGeometrySetVisibility::~G4VisCommandGeometrySetVisibility() 10
G4VisCommandViewerClone::~G4VisCommandViewerClone() 7
G4VisCommandViewerChangeCutawayPlane::~G4VisCommandViewerChangeCutawayPlane() 7
G4VisCommandViewerAddCutawayPlane::~G4VisCommandViewerAddCutawayPlane() 7
G4VisCommandSetTouchable::~G4VisCommandSetTouchable() 7
G4VisCommandDrawTree::~G4VisCommandDrawTree() 4
G4VisCommandViewerPan::~G4VisCommandViewerPan() 14
G4VisCommandViewerList::~G4VisCommandViewerList() 7
G4VisCommandViewerCreate::~G4VisCommandViewerCreate() 7
G4VisCommandSceneSelect::~G4VisCommandSceneSelect() 7
G4ASCIITreeMessenger::~G4ASCIITreeMessenger() 32
G4UIcommand::~G4UIcommand() 44
G4UIcmdWithAString::~G4UIcmdWithAString() 36
G4UIcommand::~G4UIcommand() 8
G4PhysicsListHelper::ReadInDefaultOrderingParameter() 63
G4Element::AddIsotope(...) 10
G4ProductionCuts::GetProductionCuts(...) 4
std::vector<...>::push_back(...) 7
G4Element::ComputeDerivedQuantities() 6
G4UIcommand::ValueOf(...) 2
G4PhysicsListOrderingParameter::G4PhysicsListOrderingParameter() 1
G4ProductionCuts::GetIndex(...) 4
std::vector<...>::_M_emplace_back_aux<...>(...) 7
std::vector<...>::push_back(...) 2
std::_Vector_base<...>::_M_allocate(...) 7
__gnu_cxx::new_allocator<...>::allocate(...) 7
G4SteppingManager::~G4SteppingManager() 4
G4ReferenceCountedHandle<...>::operator=(...) 4

Call Tree: Problems

- No JavaScript library produces usable network graph *for large no. of nodes*
- We tried
  - **D3.js** (force directed graphs: overlap of nodes, bad layout)
  - **Vis.js** (network graphs: overlap of nodes, no cycles)
  - **Viz.js** (a GraphViz port for browser so very heavy: browser often crashes)
- So now we filter and render data on server-side using Graphviz





12.9 M	G4RunManager::...
7.4 M	_ZNSs4_Rep9_S...
7.1 M	G4RunManagerK...
	one
7.0 M	start_thread
7.0 M	MALT::pthreadWr...
7.0 M	G4MTRunManag...
7.0 M	G4WorkerRunMa...
6.9 M	G4SmartVoxelHe...
6.9 M	G4SmartVoxelHe...

Showing 23 out of 2862 nodes.

Filter Graph Nodes

Height: Unlimited

Depth: 5

Node Cost: 1%

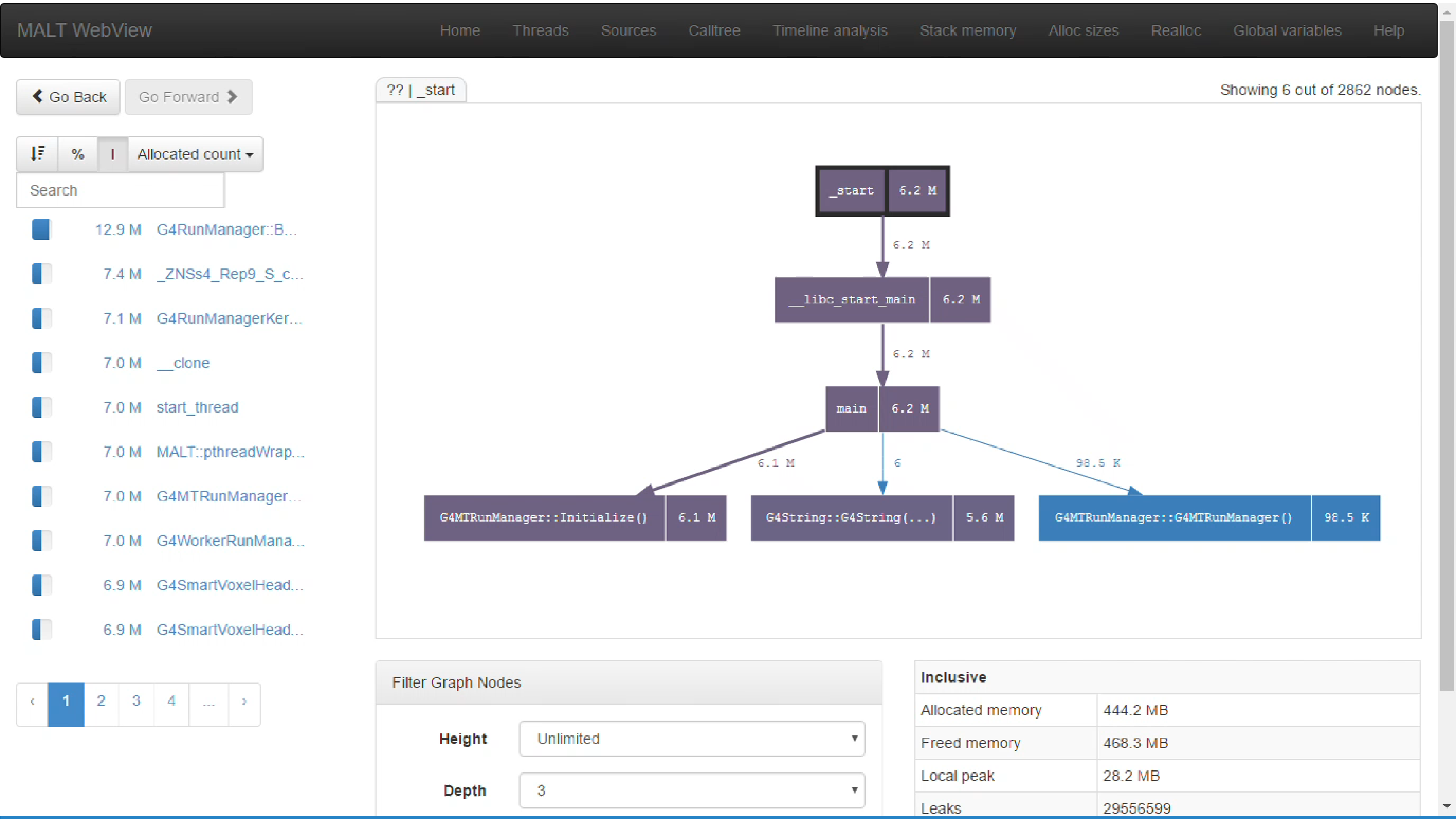
Inclusive	
Allocated memory	444.2 MB
Freed memory	422.2 MB
Local peak	28.2 MB
Leaks	29555526
6.2 M alloc	[1 B , 75 B , 156.3 KB]
6.0 M free	[4 B , 74 B , 156.3 KB]

Searchable Symbol list

Navigable Call Tree

Navigation buttons

Filtering to show only useful nodes



Showing 6 out of 2862 nodes.

12.9 M	G4RunManager::B...
7.4 M	_ZNSs4_Rep9_S_c...
7.1 M	G4RunManagerKer...
7.0 M	__clone
7.0 M	start_thread
7.0 M	MALT::pthreadWrap...
7.0 M	G4MTRunManager...
7.0 M	G4WorkerRunMana...
6.9 M	G4SmartVoxelHead...
6.9 M	G4SmartVoxelHead...

Filter Graph Nodes

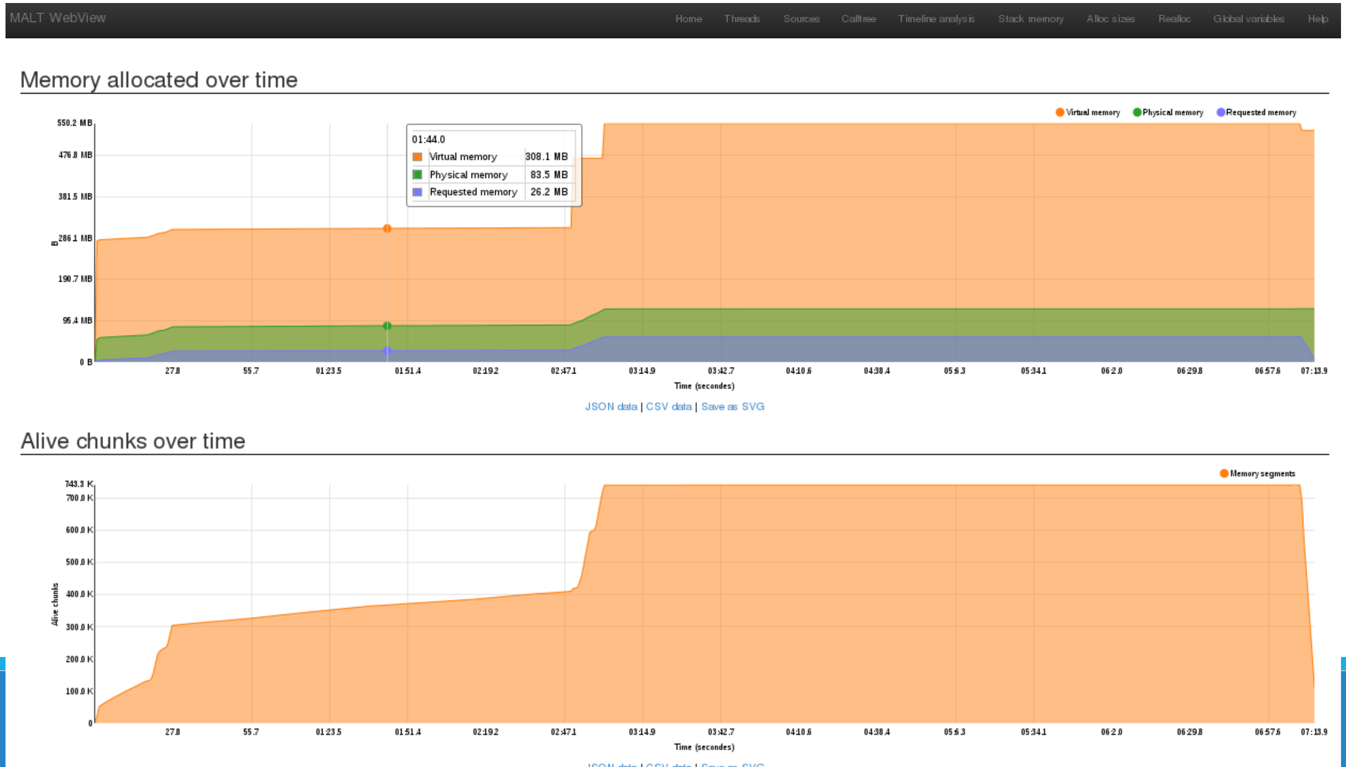
Height: Unlimited

Depth: 3

Inclusive	
Allocated memory	444.2 MB
Freed memory	468.3 MB
Local peak	28.2 MB
Leaks	29556599

Future Work

- Improve performance for **larger Call Trees**
- Add support for **trace visualization** in the web view



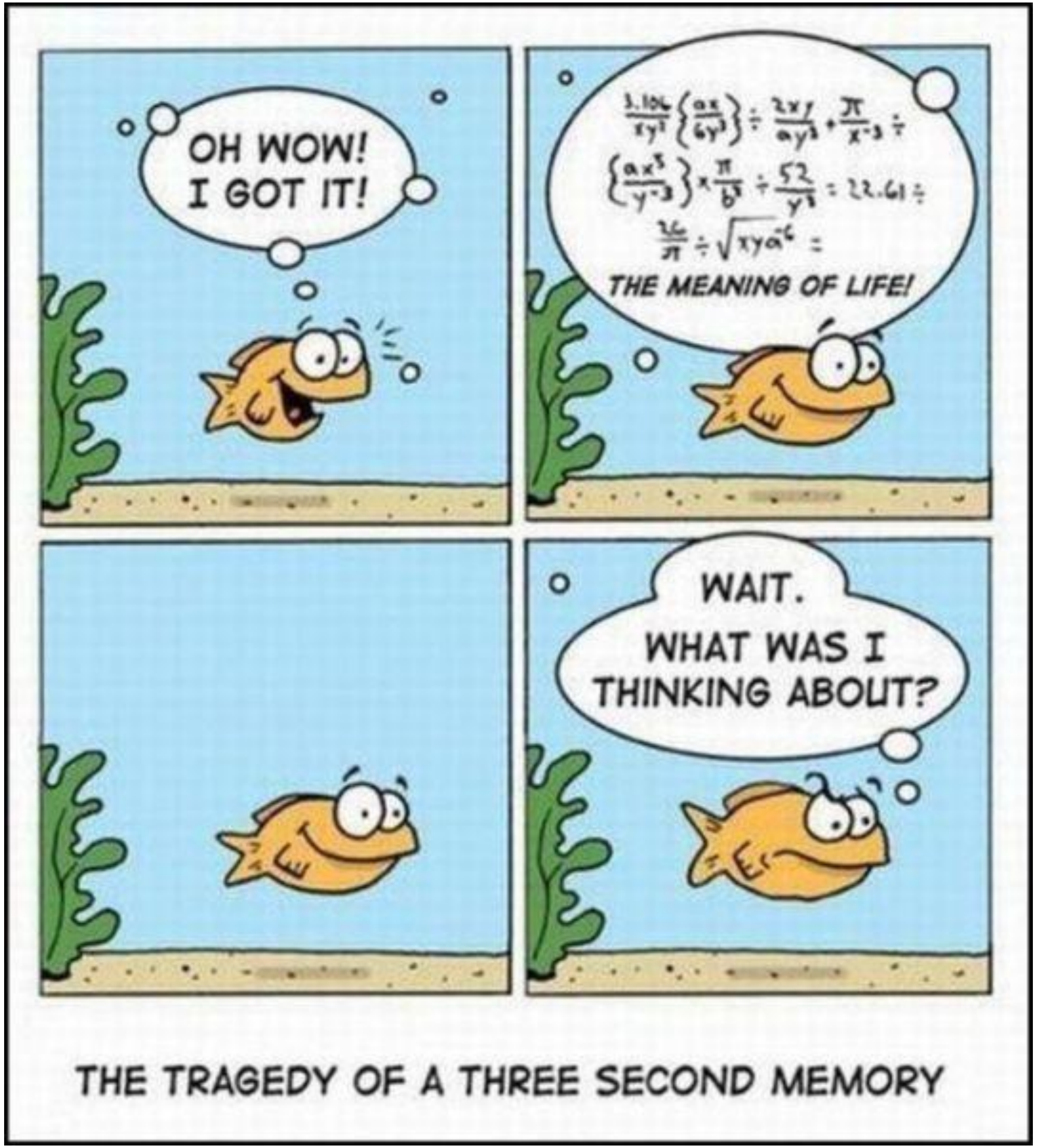
Memory allocated over time

01:44.0

🟧	Virtual memory	308.1 MB
🟩	Physical memory	83.5 MB
🟦	Requested memory	26.2 MB

Alive chunks over time

Thank you for your time! ☺


OH WOW! I GOT IT!
$\frac{3.106}{xy^2}\left\{\frac{ax}{6y^3}\right\} \div \frac{2xy}{ay^3} + \frac{\pi}{x^{-3}} \div \left\{\frac{ax^3}{y^{-3}}\right\} \times \frac{\pi}{6^3} \div \frac{52}{y^3} = 22.61 \div \frac{36}{\pi} \div \sqrt{xya^{-6}} =$
THE MEANING OF LIFE!
WAIT. WHAT WAS I THINKING ABOUT?
THE TRAGEDY OF A THREE SECOND MEMORY