Лекция 2

Инструменты отладки и профилирования:

- cuda-gdb
- Data Display Debugger (ddd)
- Nsight Eclipse Plugins
- Nsight Visual Studio Code Edition
- nvprof
- nvvp
- Nsight Compute CLI
- Nsight Compute

```
> ~Lecture3/Lab3-gdb> g++ lab3a.cpp  -g3 -o lab3a
> ~Lecture3/Lab3-gdb> gdb lab3a
```

```
(gdb) list main
…….
36        gettimeofday(&t, NULL);
37        Start =(double)t.tv_sec*1000000.0 +
(double)t.tv_usec;
38        hTest(N,a,b);
39        gettimeofday(&t, NULL);
40        Finish =(double)t.tv_sec*1000000.0 +
(double)t.tv_usec;
……
(gdb) b 38
Breakpoint 1 at 0x400865: file lab3a.cpp, line 38.
```

```
(gdb) run 256
Starting program: ~/Lecture3/Lab3-gdb/lab3a 16
(gdb) step
hTest (N=16, a=0x613e70, b=0x613ec0) at lab3a.cpp:7
7          for(int i=0; i<N;i++)
(gdb) list hTest
1        #include <malloc.h>
2        #include <stdio.h>
3        #include <stdlib.h>
4        #include <sys/time.h>
5
6        void hTest(int N, int* a, int* b){
7          for(int i=0; i<N;i++)
8            a[i]+=b[i];
9        }
```

```
(gdb) info args
N = 16
a = 0x613e70
b = 0x613ec0
(gdb) info locals
i = 0
(gdb) next 8
7           for(int i=0; i<N;i++)
(gdb) info locals
i = 3
(gdb) print b[2]
$1 = 5
(gdb) print a[2]
$2 = 9
```

```
gdb) break 8 if i==12
Breakpoint 3 at 0x400705: file lab3a.cpp, line 8.
(gdb) c
Continuing.

Breakpoint 3, hTest (N=16, a=0x613e70, b=0x613ec0) at
lab3a.cpp:8
8             a[i]+=b[i];
(gdb) info locals
i = 12
(gdb) finish
Run till exit from #0  hTest (N=16, a=0x613e70,
b=0x613ec0) at lab3a.cpp:8
main (argc=2, argv=0x7fffffffd9b8) at lab3a.cpp:39
39        gettimeofday(&t, NULL);
```

```
(gdb) x/16d  b
0x613ec0:       1       3       5       7
0x613ed0:       9       11      13      15
0x613ee0:       17      19      21      23
0x613ef0:       25      27      29      31
(gdb) x/16d  a
0x613e70:       1       5       9       13
0x613e80:       17      21      25      29
0x613e90:       33      37      41      45
0x613ea0:       49      53      57      61
(gdb) print a[2]-b[2]
$16 = 4
```

```
(gdb) c
Continuing.
Elapsed time: 9.57138e+06 ms
0       1       1
1       5       3
2       9       5
3       13      7
4       17      9
5       21      11
……..
13      53      27
14      57      29
15      61      31
[Inferior 1 (process 4272) exited normally]

(gdb) quit
```

Отладка многопоточных программ

```
~/Lecture3/Lab3-gdb> gdb lab3b
(gdb) list hTest
16  void* hTest(void* arg){
17      struct targ* s arg=(struct targ*)arg;
18      int length=s arg->length;
19      int offset=s_arg->num_thread*length;
20      int i;
21     for(i=0;i<length;i++)
22         a[i+offset]+=/*1000*sin((double)*/b[i+offset];
23     return NULL;
25  }
(gdb) break lab3b.cpp:22
Breakpoint 1 at 0x40083f: file lab3b.cpp, line 22.
```

```
(gdb) run 4 16
Starting program: …/Lecture3/Lab3-gdb/lab3b 4 16
[Thread debugging using libthread_db enabled]
Using host libthread_db library
"/lib64/libthread_db.so.1".
[New Thread 0x7ffff6ed1700 (LWP 10741)]
[New Thread 0x7ffff66d0700 (LWP 10742)]
[New Thread 0x7ffff5ecf700 (LWP 10743)]
[Switching to Thread 0x7ffff6ed1700 (LWP 10741)]

Thread 2 "lab3b" hit Breakpoint 1, hTest (arg=0x614e70)
at lab3b.cpp:22
22          a[i+offset]+=/*1000*sin((double)*/b[i+offset];
```

```
(gdb) info threads
  Id   Target Id                                          Frame
  1    Thread 0x7ffff7fc0740 (LWP 10737) "lab3b" clone ()
at ../sysdeps/unix/sysv/linux/x86_64/clone.S:78
* 2    Thread 0x7ffff6ed1700 (LWP 10741) "lab3b" hTest
(arg=0x614e70) at lab3b.cpp:22
  3    Thread 0x7ffff66d0700 (LWP 10742) "lab3b" hTest
(arg=0x614e7c) at lab3b.cpp:22
  4    Thread 0x7ffff5ecf700 (LWP 10743) "lab3b" clone ()
at ../sysdeps/unix/sysv/linux/x86_64/clone.S:78
```

```
(gdb) print offset
$1 = 0
(gdb) thread 3
[Switching to thread 3 (Thread 0x7ffff66d0700 (LWP
10742))]
#0  hTest (arg=0x614e7c) at lab3b.cpp:22
22
a[i+offset]+=/*1000*sin((double)*/b[i+offset];
(gdb) print offset
$2 = 4
```

```
(gdb) break 22 thread 3
Note: breakpoint 1 (all threads) also set at pc
0x40083f.
Breakpoint 2 at 0x40083f: file lab3b.cpp, line 22.
(gdb) info breakpoints
Num     Type           Disp Enb Address            What
1       breakpoint     keep y   0x000000000040083f in
hTest(void*) at lab3b.cpp:22
       breakpoint already hit 1 time
2       breakpoint     keep y   0x000000000040083f in
hTest(void*) at lab3b.cpp:22 thread 3
       stop only in thread 3
(gdb) delete 1
```

```
(gdb) x/16d a
0x614ee0:       0       2       4       6
0x614ef0:       8       10      12      14
0x614f00:       16      18      20      22
0x614f10:       24      26      28      30
```

```
(gdb) continue
Continuing.

Thread 3 "lab3b" hit Breakpoint 2, hTest (arg=0x614e7c)
at lab3b.cpp:22
22          a[i+offset]+=/*1000*sin((double)*/b[i+offset];
(gdb) c
……
(gdb) x/16d a
0x614ee0:       1       2       4       6
0x614ef0:       17      21      12      14
0x614f00:       33      37      20      22
0x614f10:       49      53      28      30
```

```
(gdb) c
Continuing.
[Thread 0x7ffff5ecf700 (LWP 10743) exited]
[Thread 0x7ffff66d0700 (LWP 10742) exited]
Thread-specific breakpoint 2 deleted - thread 3 no
longer in the thread list.
[Thread 0x7ffff56ce700 (LWP 11167) exited]
[Thread 0x7ffff6ed1700 (LWP 10741) exited]
Elapsed time: 2.22941e+06 ms
0       1       1
1       3       5
2       5       9
……
14      29      57
15      31      61
[Inferior 1 (process 10737) exited normally]
```

```
(gdb)print a[1]
……..
(gdb)info locals
……..
(gdb) info args
arg = 0x614e7c
(gdb) print ((struct targ*)arg)->length
$1 = 4
```

Отладка программ, выполняемых на GPU

https://docs.nvidia.com/cuda/archive/11.2.0/cuda-gdb/index.html

```
> nvcc -g  -G …
```

```
~/Workshop/VSC> cuda-gdb lab3c
```

```
(cuda-gdb) list main
23      __global__ void gSum(int* a, int *b){
24        int i=threadIdx.x+blockIdx.x*blockDim.x;
25        a[i]+=b[i];
26      }
27
28      int main(){
29        int N=VECTOR_LENGTH;
30        int *a, *b;
31        int *a_h;
32
(cuda-gdb) break 25
Breakpoint 1 at 0x403fdd: file lab3c.cu, line 26.
(cuda-gdb) run
```

```
(cuda-gdb) info cuda threads
BlockIdx ThreadIdx To BlockIdx ThreadIdx Count  VirtualPC
                                          Filename  Line
Kernel 0
*  (0,0,0)   (0,0,0)      (0,0,0)   (3,0,0)      4
0x00007fffe525c3e0
…/Lecture3/Lab3-cuda-gdb/lab3c.cu      9
   (1,0,0)   (0,0,0)      (3,0,0)   (3,0,0)     12
0x00007fffe525c2b0
…/Lecture3/Lab3-cuda-gdb/lab3c.cu      8
```

```
cuda-gdb) cuda block 2 thread 3
[Switching focus to CUDA kernel 0, grid 1, block
(2,0,0), thread (3,0,0), device 0, sm 2, warp 0, lane 3]
8          b[i]=2*i+1;
(cuda-gdb) print i
$2 = 11
```

```
(cuda-gdb) n
9        }
(cuda-gdb) x/16d b
0x7fffecc00200: 1        3        5        7
0x7fffecc00210: 0        0        0        0
0x7fffecc00220: 0        0        0        0
0x7fffecc00230: 0        0        0        0
```

```
malkov@192:~> ssh cyber.sibsutis.ru
```

```
malkov@linux-47dw: ~/WORKSHOP/PGP-2023> cuda-gdb  lab3c
```

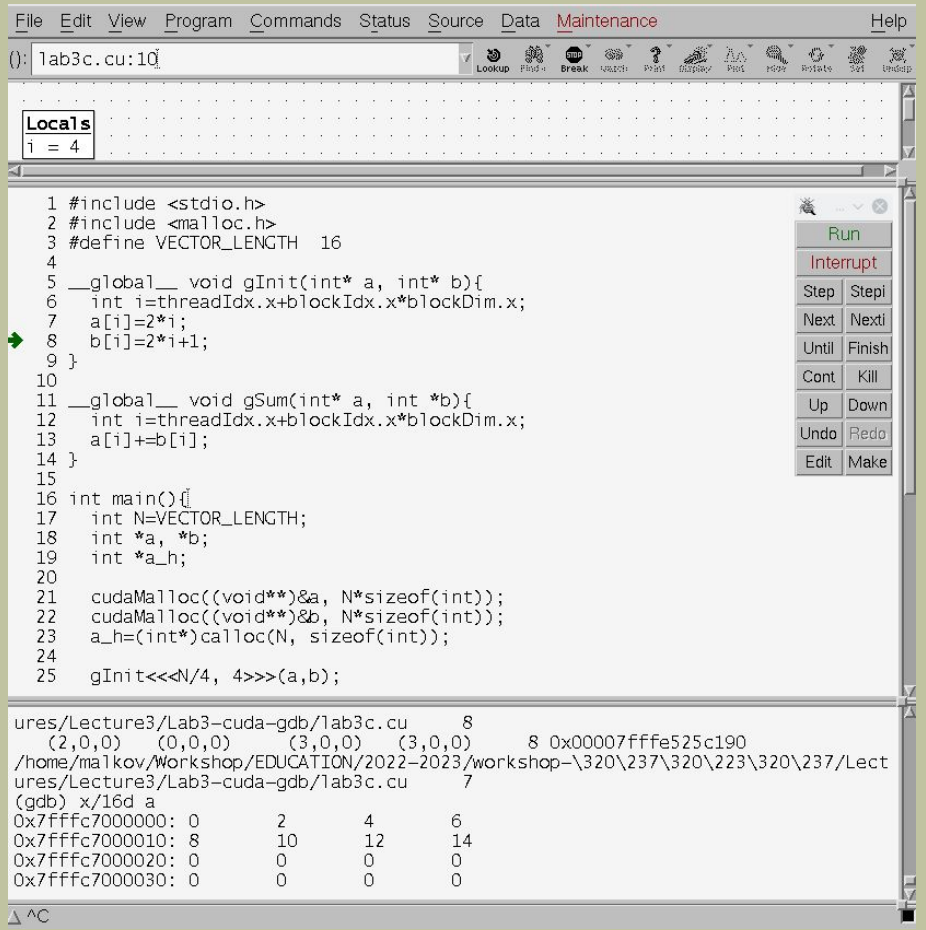
```
(cuda-gdb) break 8
Breakpoint 1 at 0x403851: file lab3c.cu, line 8.
(cuda-gdb) run
Starting program: /home/malkov/WORKSHOP/PGP-2023/lab3c
……
[Switching focus to CUDA kernel 0, grid 1, block
(0,0,0), thread (0,0,0), device 0, sm 0, warp 0, lane 0]
Thread 1 "lab3c" hit Breakpoint 1,
gInit<<<(4,1,1),(4,1,1)>>> (a=0x7fffe6800000,
b=0x7fffe6800200) at lab3c.cu:8
8           b[i]=2*i+1;
```

Data Display Debugger (ddd)

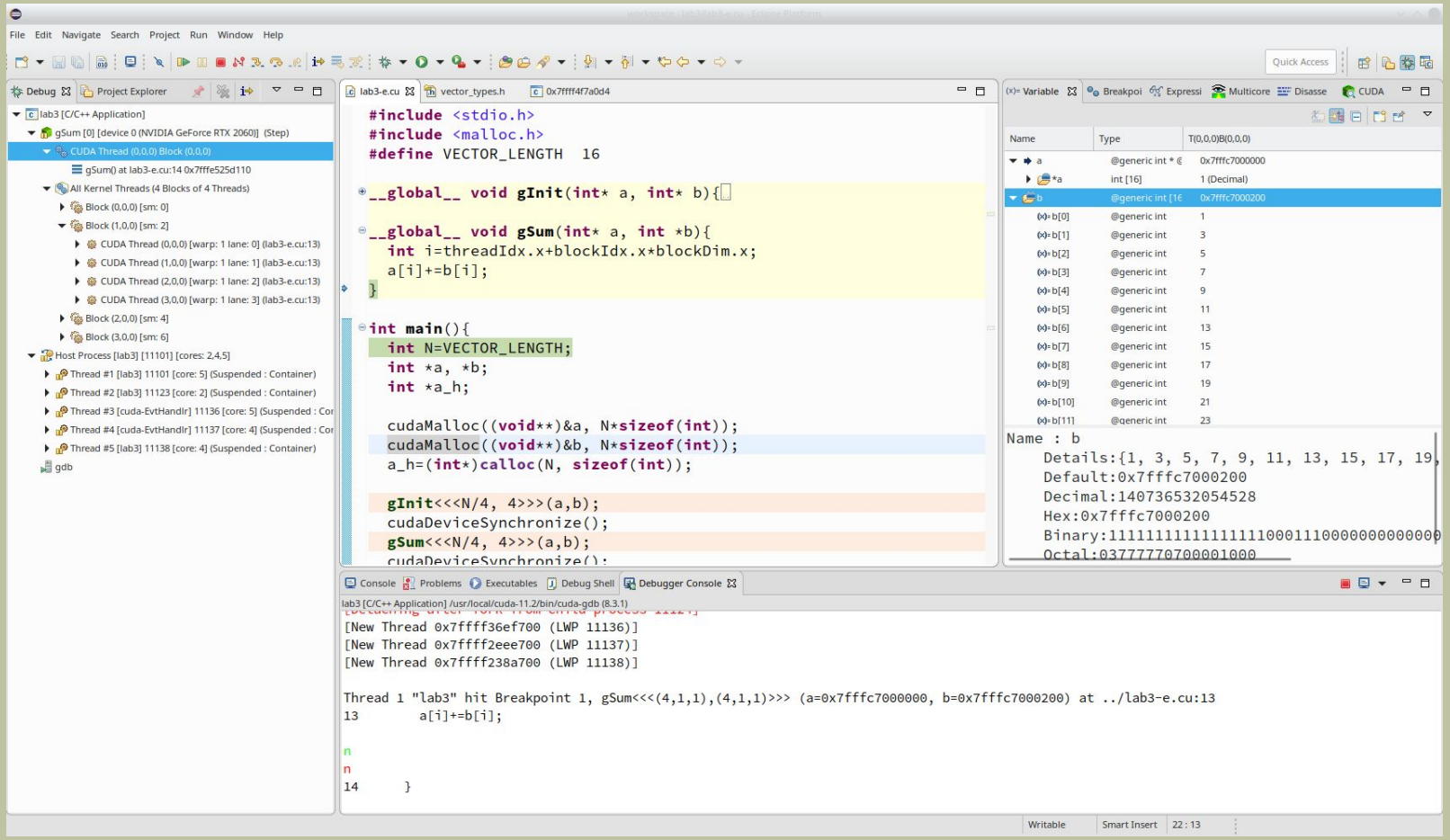
```
…/Lecture3/
Lab3-cuda-gdb>
ddd cuda-gdb lab3c
```

```
malkov@192:~> ssh
cyber.sibsutis.ru -X
```

```
malkov@linux-47dw:
~/WORKSHOP/PGP-2023>
ddd cuda-gdb lab3c
```



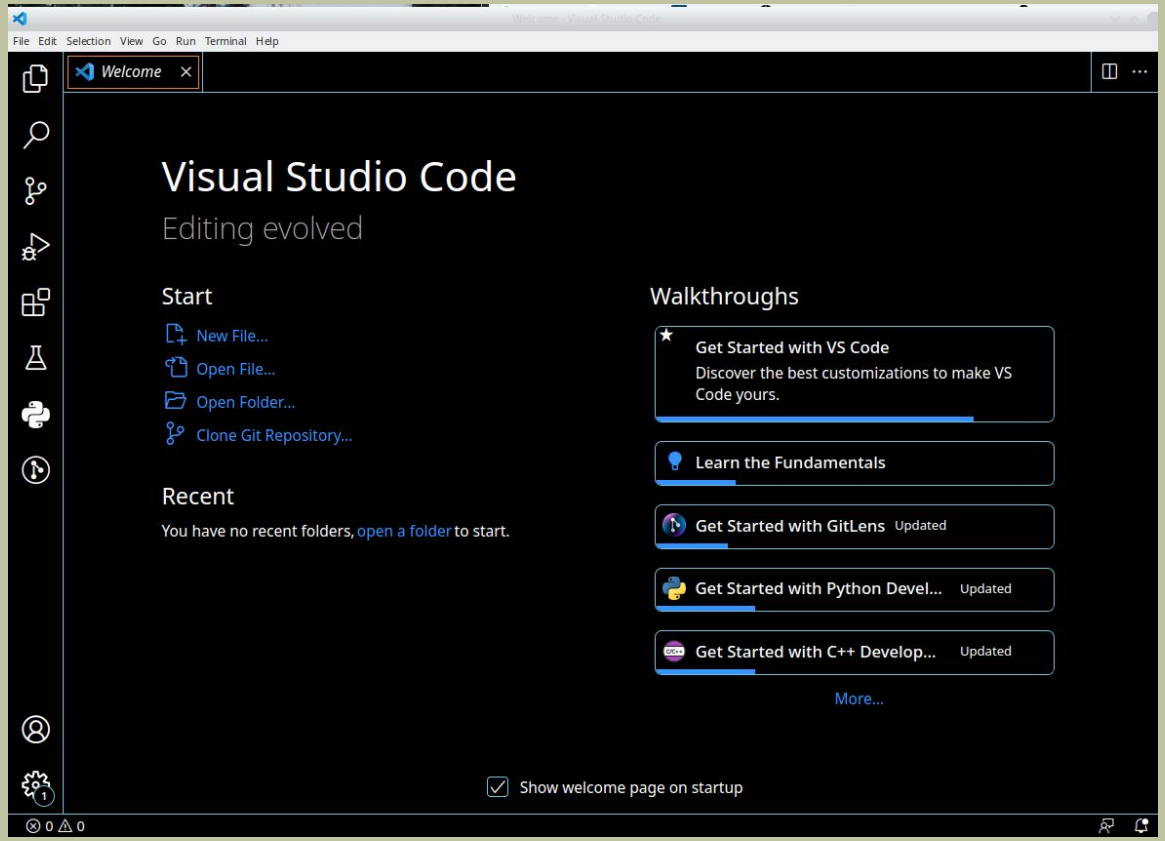
Nsight Eclipse Plugins

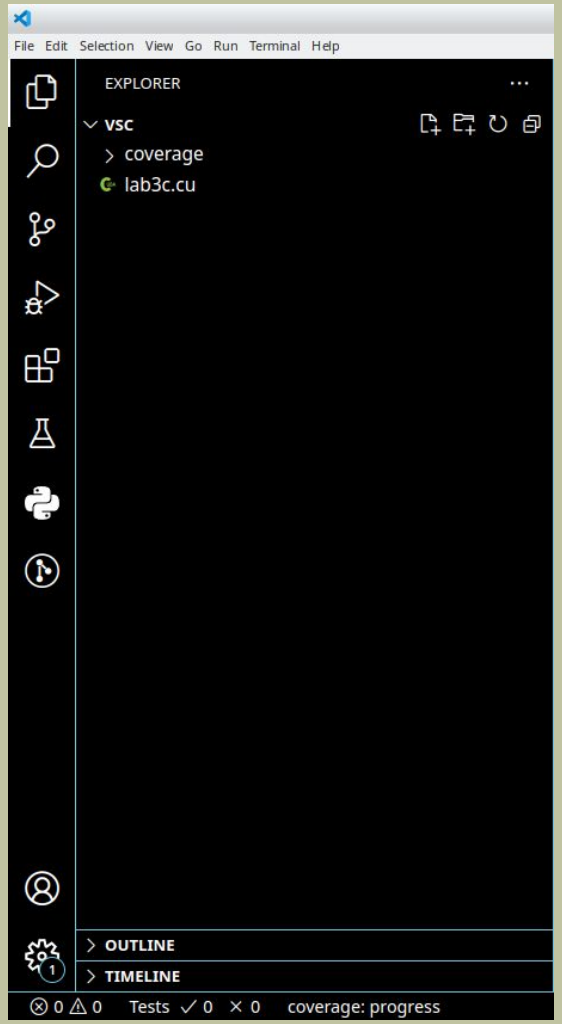


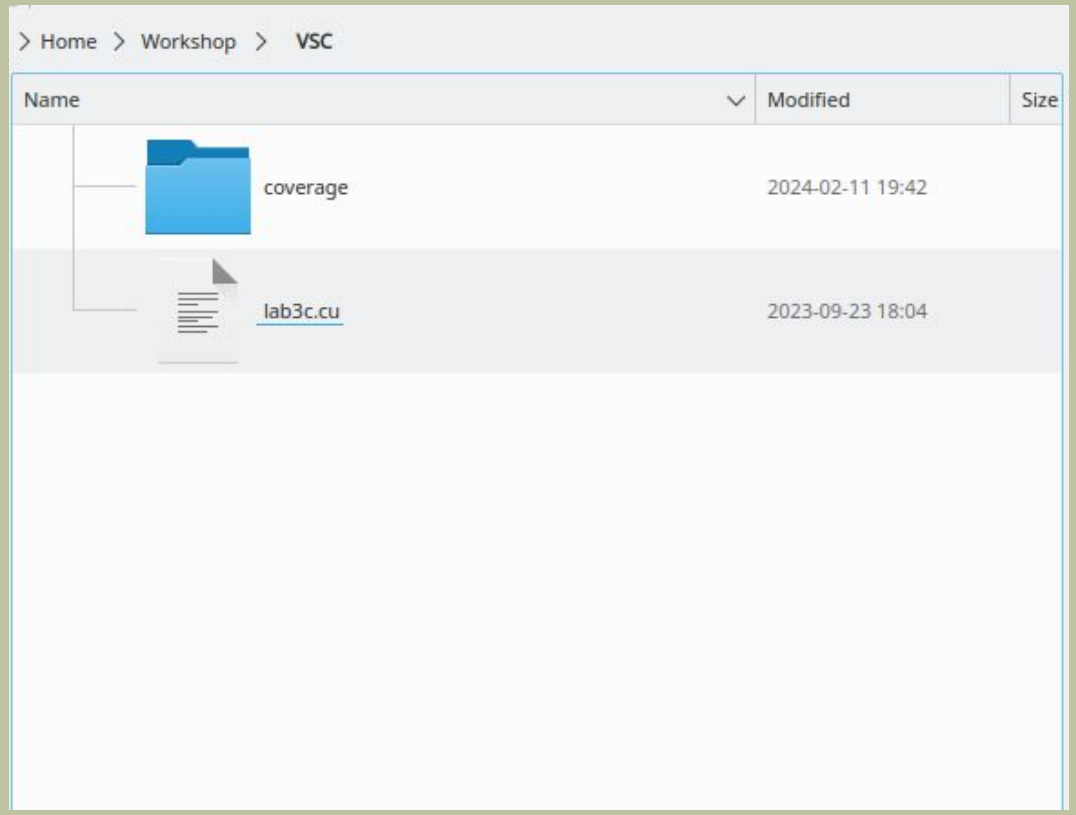
Nsight Visual Studio Code Edition

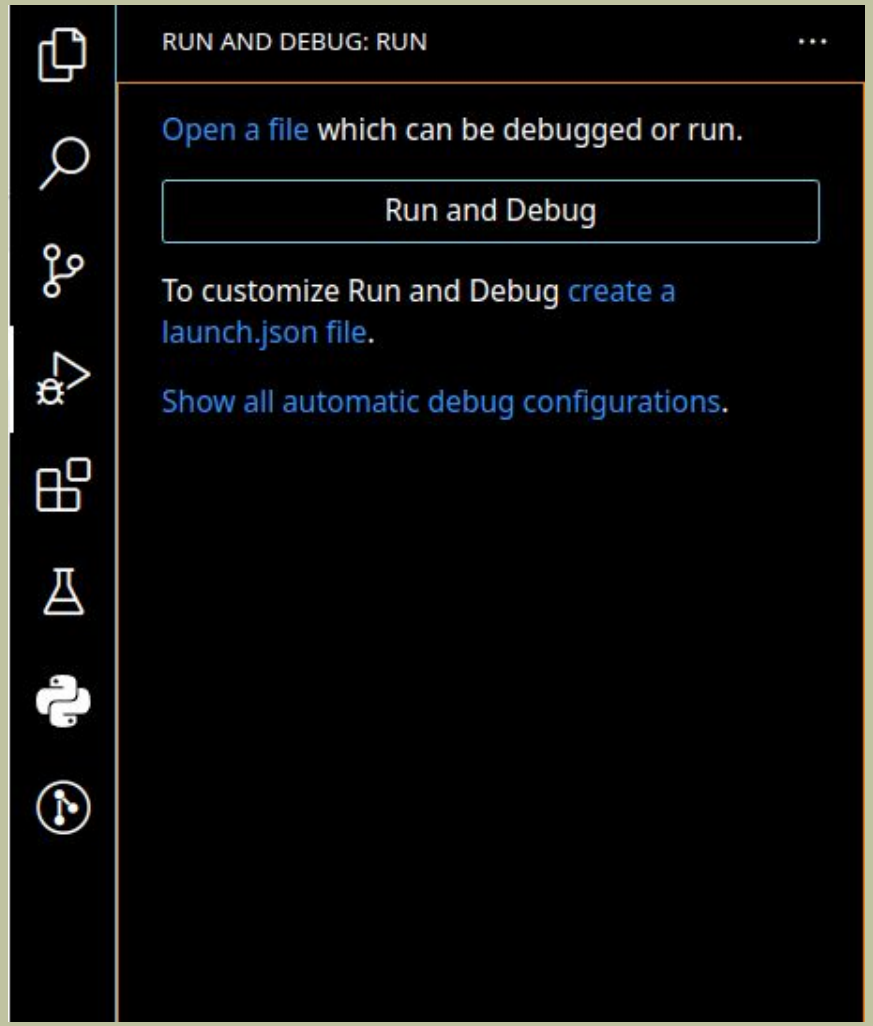
https://developer.nvidia.com/**nsight-visual-studio-code-edition**

https://docs.nvidia.com/**nsight-visual-studio-code-edition**/cuda-debugger/index.html



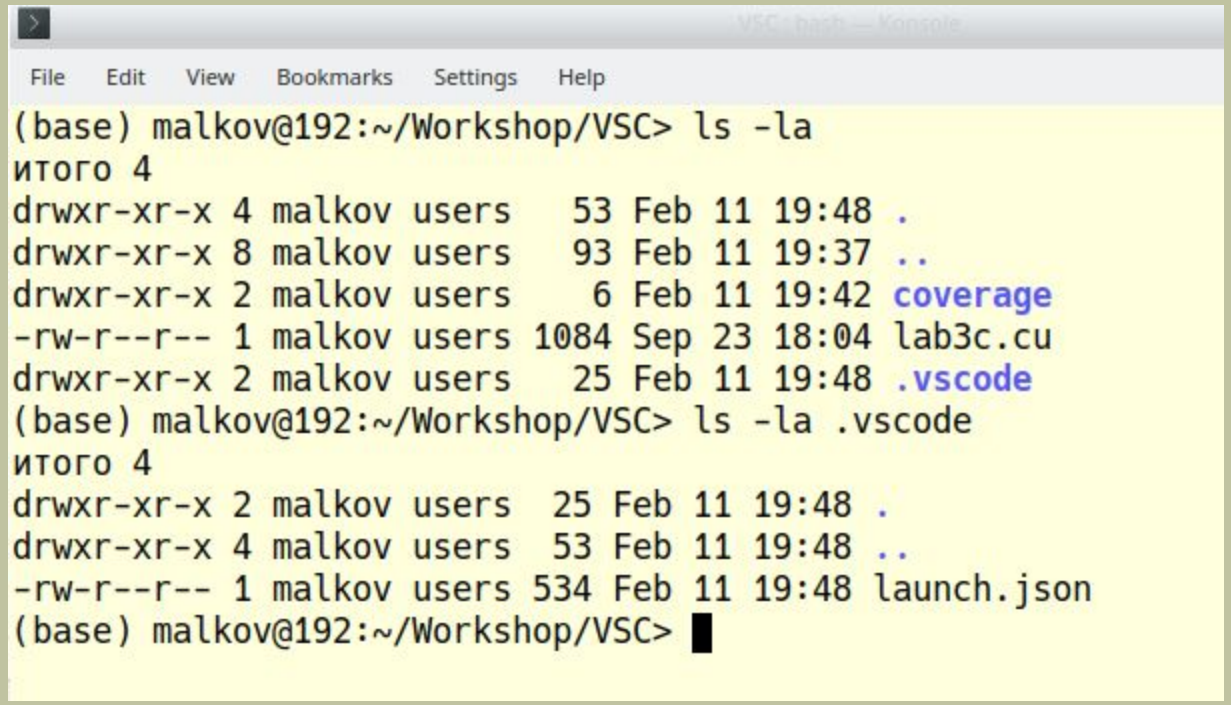

File Edit Selection View Go Run Terminal Help
EXPLORER
vsc
coverage
lab3c.cu
OUTLINE
TIMELINE
0 0 Tests 0 0 coverage: progress

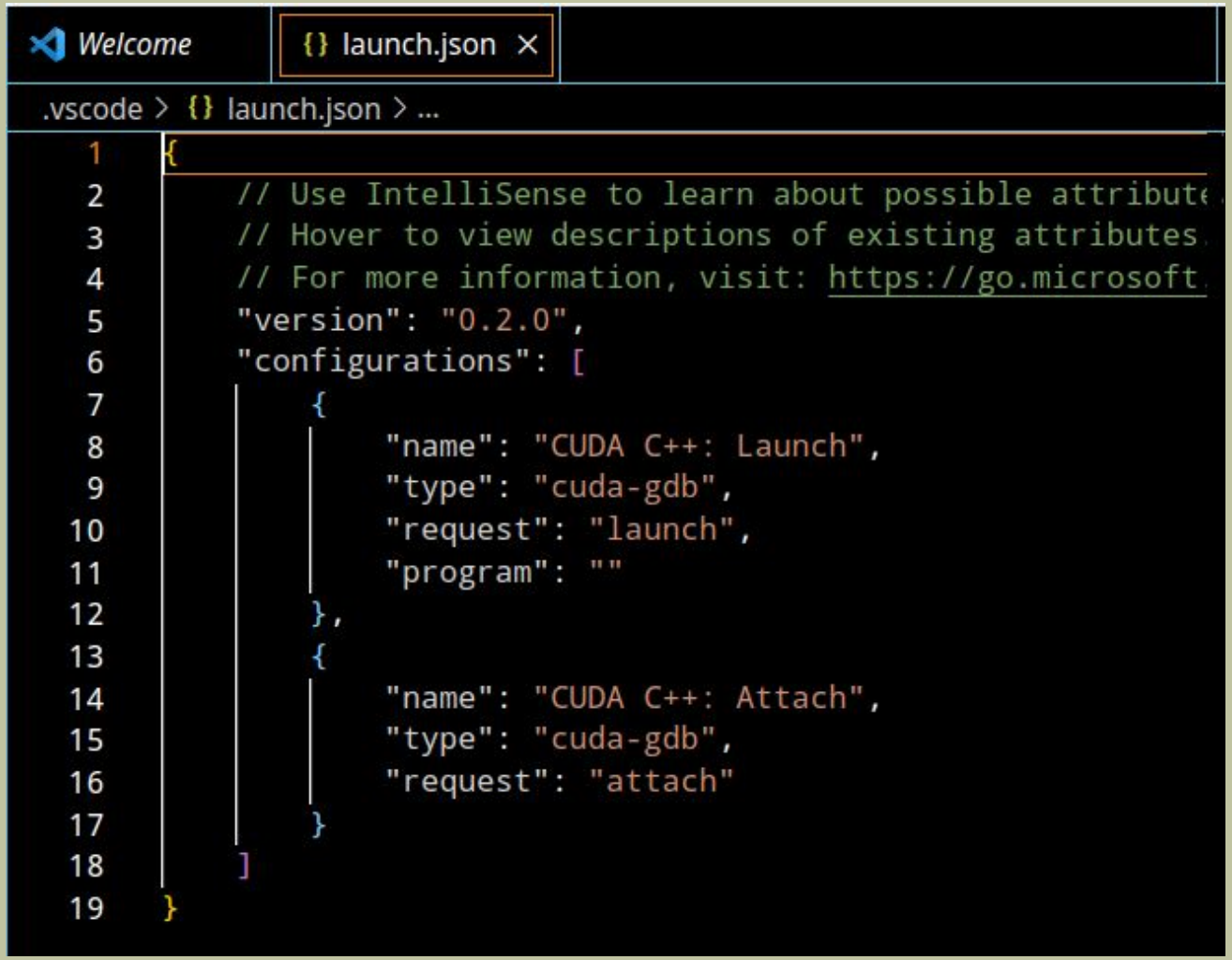

Home > Workshop > VSC
Name
Modified
Size
coverage
2024-02-11 19:42
lab3c.cu
2023-09-23 18:04

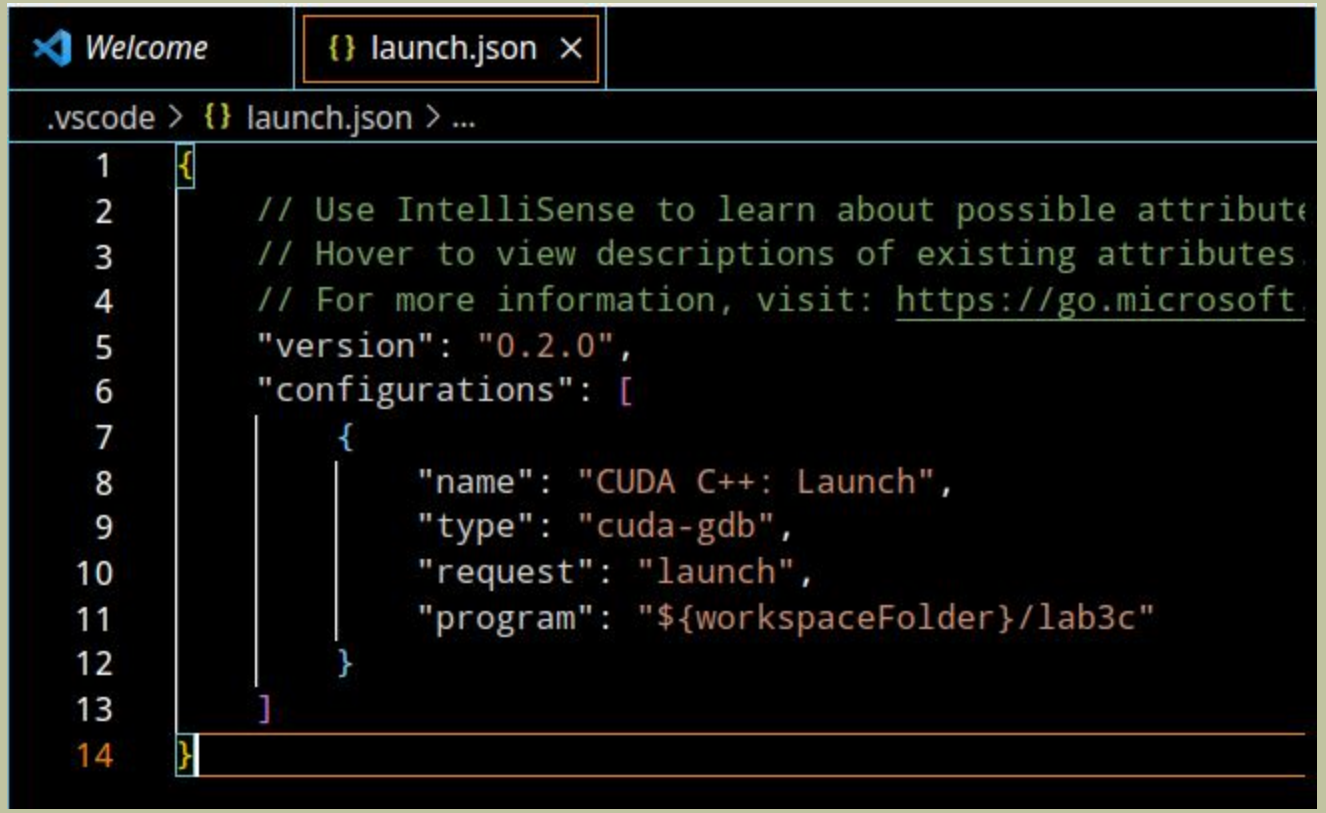

RUN AND DEBUG: RUN
Open a file which can be debugged or run.
Run and Debug
To customize Run and Debug create a launch.json file.
Show all automatic debug configurations.

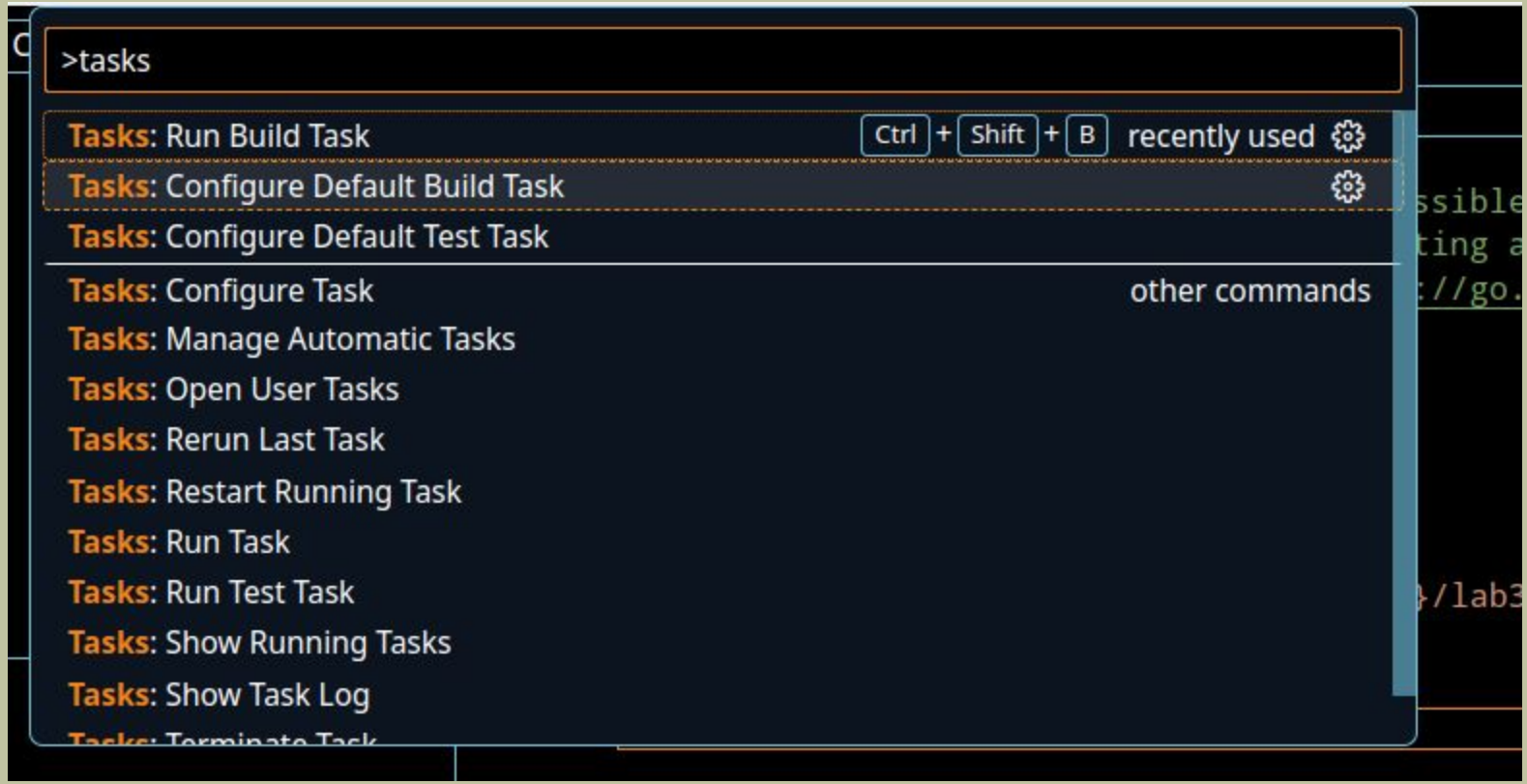

RUN AND DEBUG: RUN
Open a file which can
Run a
To customize Run and
launch.json file.
Show all automatic de
Extensions (Ctrl+Shift+X)
Select debugger
CUDA C++ (CUDA-GDB)
CUDA C++ (CUDA-GDBSERVER)
CUDA C++ QNX (CUDA-GDBSERVER)
CMake Debugger
Node.js
Python
Web App (Chrome)
Web App (Edge)
Install extension...

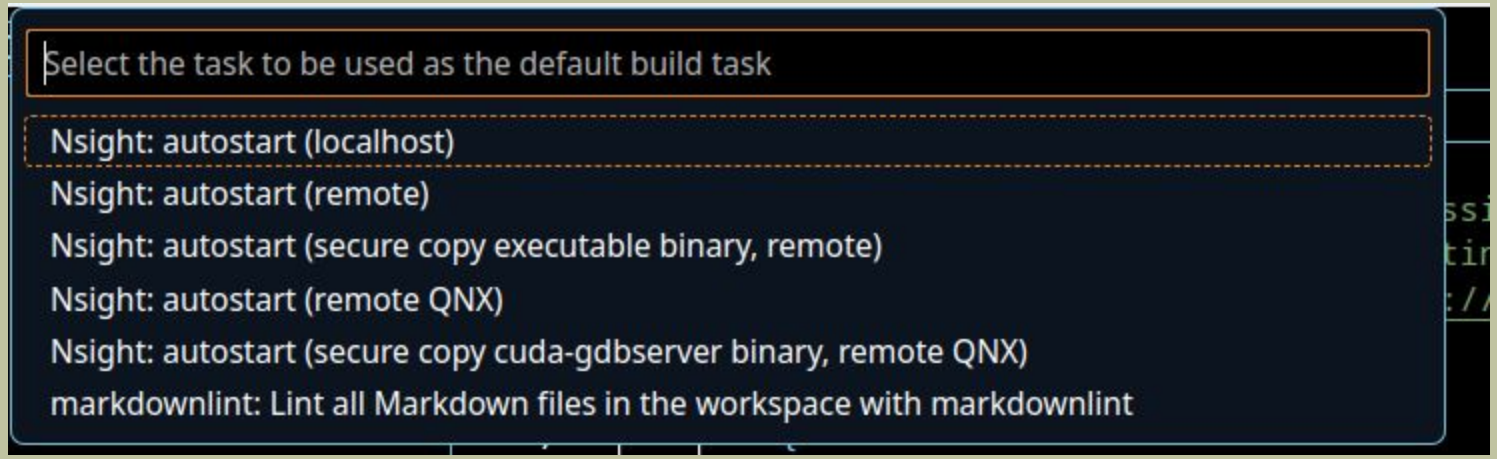

RUN AND DEBUG: RUN
Open a file which can
Run a
To customize Run and
launch.json file.
Show all automatic de
Select debugger
CUDA C++ (CUDA-GDB) Suggested
CUDA C++ (CUDA-GDBSERVER)
CUDA C++ QNX (CUDA-GDBSERVER)
CMake Debugger
Node.js
Python
Web App (Chrome)
Web App (Edge)
Install extension...

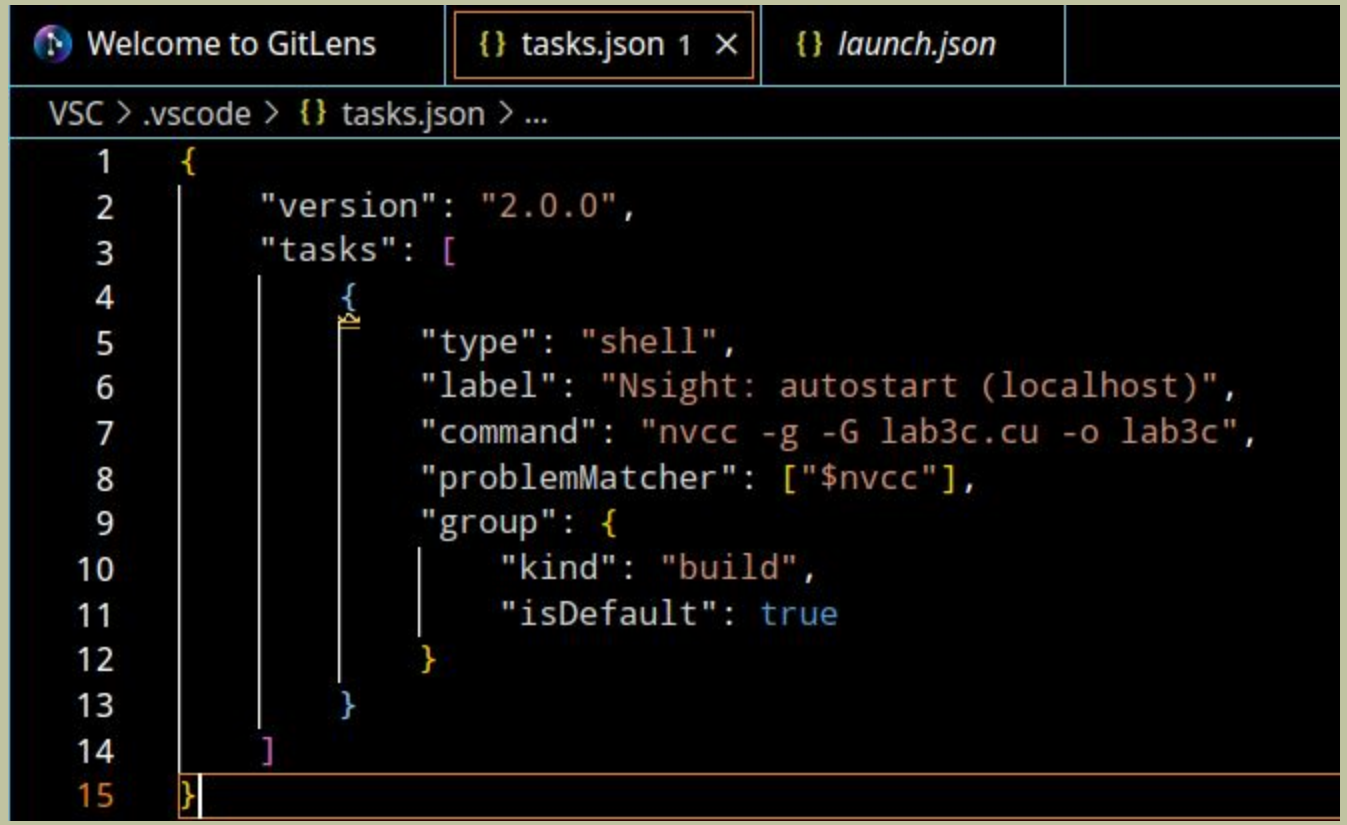

File Edit View Bookmarks Settings Help
(base) malkov@192:~/Workshop/VSC> ls -la
итого 4
drwxr-xr-x 4 malkov users   53 Feb 11 19:48 .
drwxr-xr-x 8 malkov users   93 Feb 11 19:37 ..
drwxr-xr-x 2 malkov users   6 Feb 11 19:42 coverage
-rw-r--r-- 1 malkov users 1084 Sep 23 18:04 lab3c.cu
drwxr-xr-x 2 malkov users   25 Feb 11 19:48 .vscode
(base) malkov@192:~/Workshop/VSC> ls -la .vscode
итого 4
drwxr-xr-x 2 malkov users 25 Feb 11 19:48 .
drwxr-xr-x 4 malkov users 53 Feb 11 19:48 ..
-rw-r--r-- 1 malkov users 534 Feb 11 19:48 launch.json
(base) malkov@192:~/Workshop/VSC>

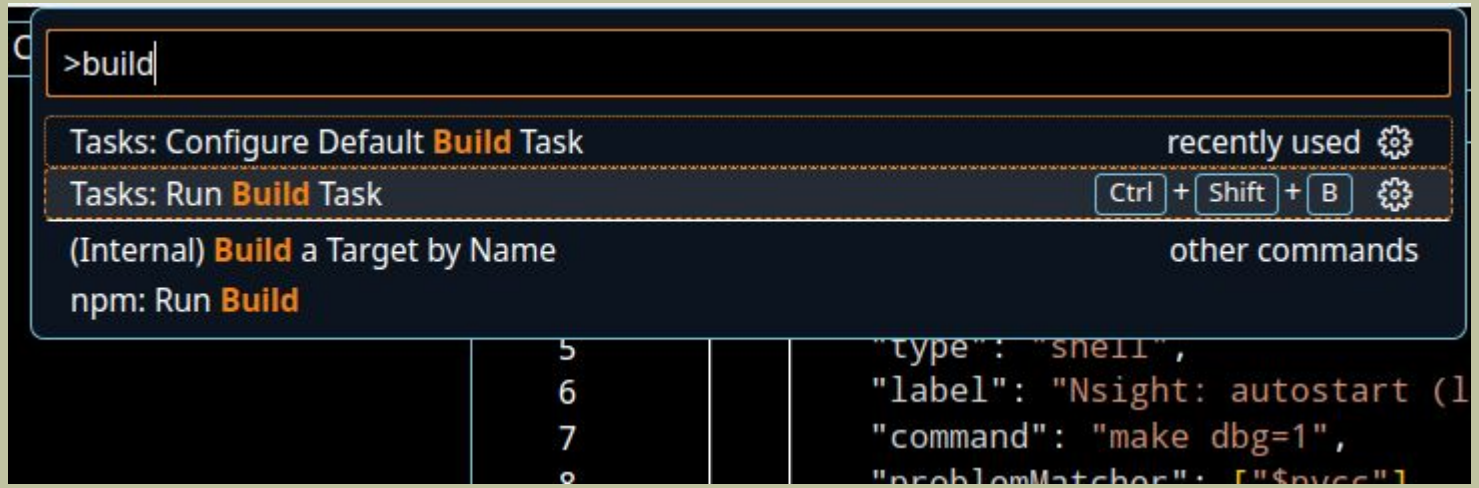

Welcome
{} launch.json
.vscode > {} launch.json > ...
{
// Use IntelliSense to learn about possible attribute
// Hover to view descriptions of existing attributes
// For more information, visit: https://go.microsoft
"version": "0.2.0",
"configurations": [
{
"name": "CUDA C++: Launch",
"type": "cuda-gdb",
"request": "launch",
"program": ""
},
{
"name": "CUDA C++: Attach",
"type": "cuda-gdb",
"request": "attach"
}
]
}

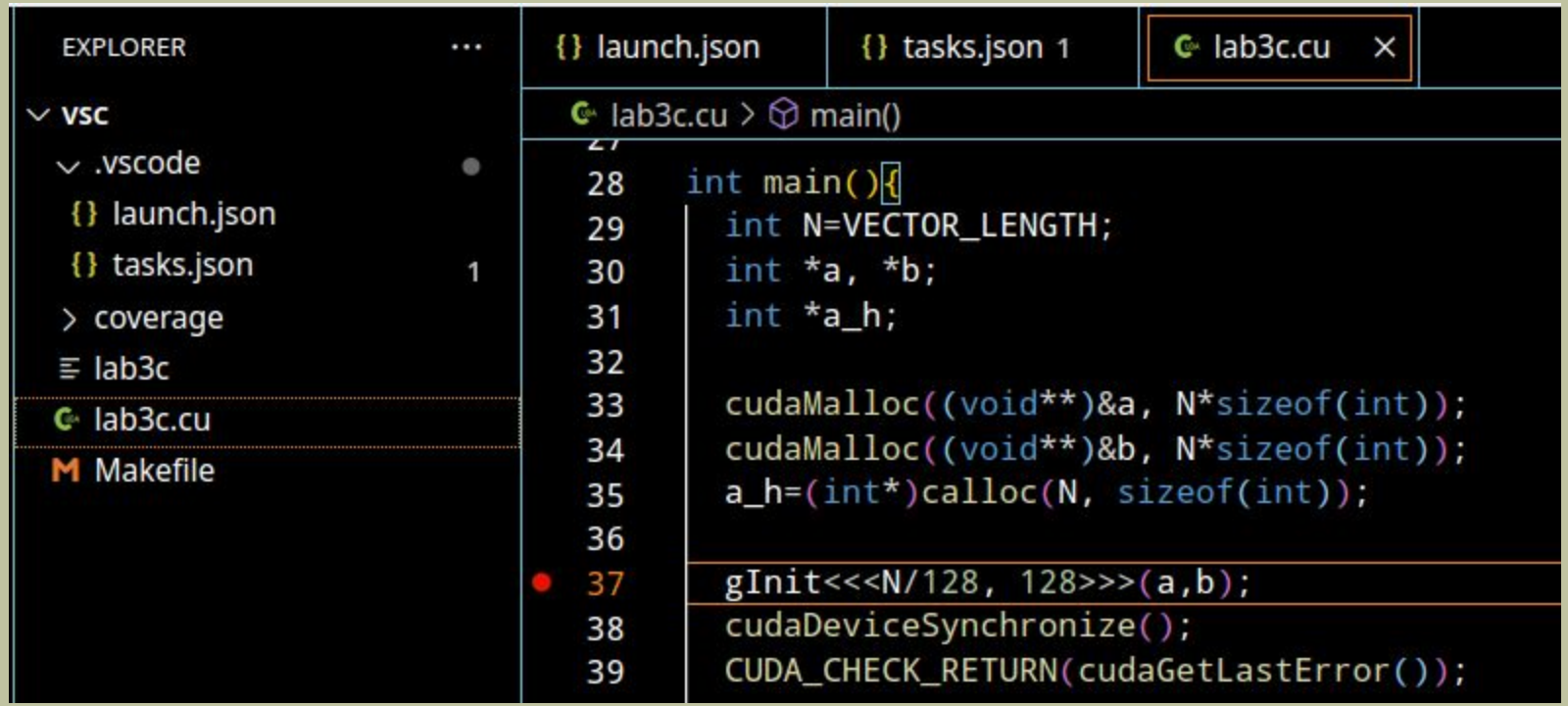

Welcome
launch.json
.vscode > launch.json > ...
{
// Use IntelliSense to learn about possible attribute
// Hover to view descriptions of existing attributes.
// For more information, visit: https://go.microsoft.
"version": "0.2.0",
"configurations": [
{
"name": "CUDA C++: Launch",
"type": "cuda-gdb",
"request": "launch",
"program": "${workspaceFolder}/lab3c"
}
]
}

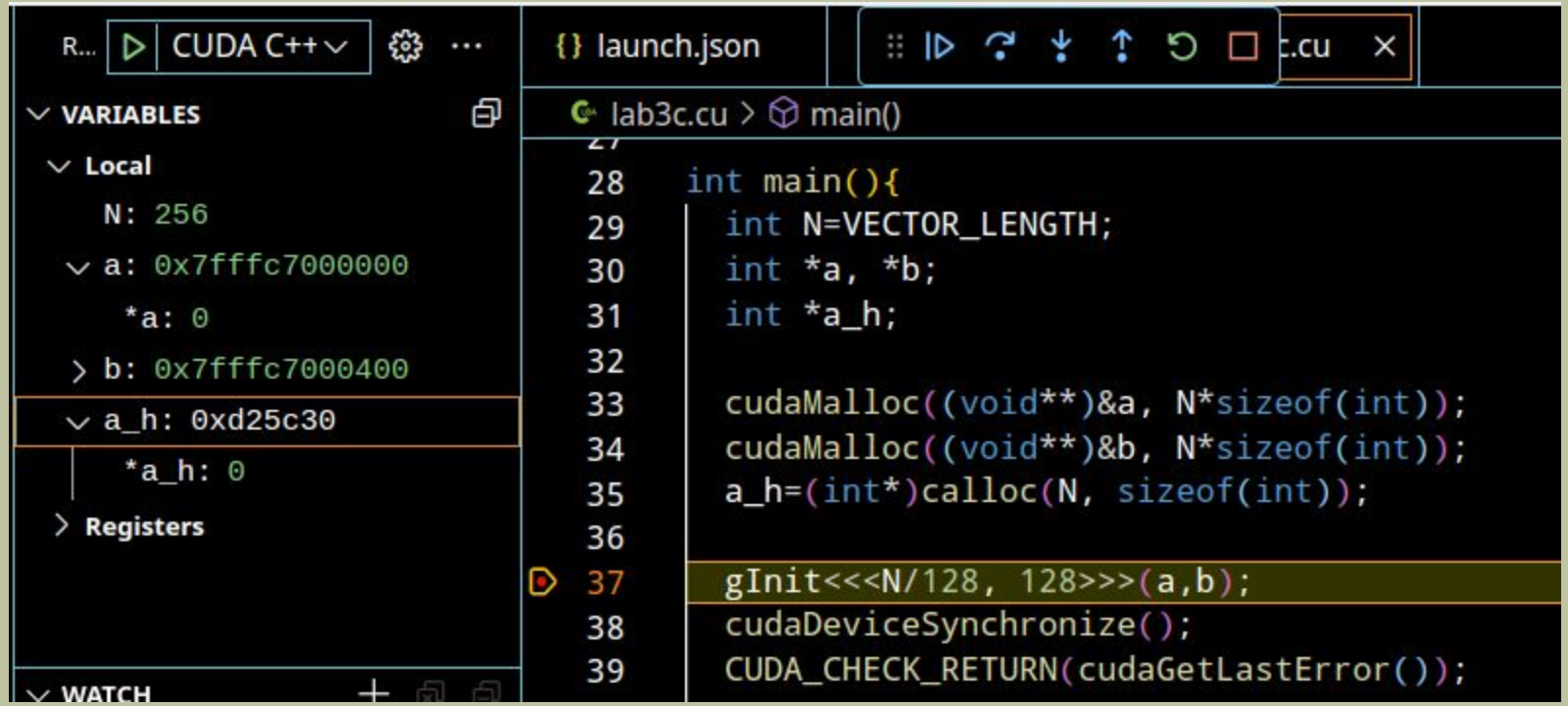

>tasks
Tasks: Run Build Task
Ctrl + Shift + B
recently used
Tasks: Configure Default Build Task
Tasks: Configure Default Test Task
Tasks: Configure Task
other commands
Tasks: Manage Automatic Tasks
Tasks: Open User Tasks
Tasks: Rerun Last Task
Tasks: Restart Running Task
Tasks: Run Task
Tasks: Run Test Task
Tasks: Show Running Tasks
Tasks: Show Task Log


Select the task to be used as the default build task
Nsight: autostart (localhost)
Nsight: autostart (remote)
Nsight: autostart (secure copy executable binary, remote)
Nsight: autostart (remote QNX)
Nsight: autostart (secure copy cuda-gdbserver binary, remote QNX)
markdownlint: Lint all Markdown files in the workspace with markdownlint


Welcome to GitLens
{} tasks.json 1
{} launch.json
VSC > .vscode > {} tasks.json > ...
{
"version": "2.0.0",
"tasks": [
{
"type": "shell",
"label": "Nsight: autostart (localhost)",
"command": "nvcc -g -G lab3c.cu -o lab3c",
"problemMatcher": ["$nvcc"],
"group": {
"kind": "build",
"isDefault": true
}
}
]
}


>build
Tasks: Configure Default Build Task
recently used
Tasks: Run Build Task
Ctrl + Shift + B
(Internal) Build a Target by Name
other commands
npm: Run Build
5
6
7
"type": "shell",
"label": "Nsight: autostart (l
"command": "make dbg=1",


EXPLORER
launch.json
tasks.json 1
lab3c.cu
vsc
.vscode
launch.json
tasks.json 1
coverage
lab3c
lab3c.cu
Makefile
lab3c.cu > main()
int main(){
int N=VECTOR_LENGTH;
int *a, *b;
int *a_h;
cudaMalloc((void**)&a, N*sizeof(int));
cudaMalloc((void**)&b, N*sizeof(int));
a_h=(int*)calloc(N, sizeof(int));
gInit<<<N/128, 128>>>(a,b);
cudaDeviceSynchronize();
CUDA_CHECK_RETURN(cudaGetLastError());


R...
CUDA C++
launch.json
.cu
VARIABLES
Local
N: 256
a: 0x7fffc7000000
*a: 0
b: 0x7fffc7000400
a_h: 0xd25c30
*a_h: 0
Registers
WATCH
lab3c.cu > main()
int main(){
int N=VECTOR_LENGTH;
int *a, *b;
int *a_h;
cudaMalloc((void**)&a, N*sizeof(int));
cudaMalloc((void**)&b, N*sizeof(int));
a_h=(int*)calloc(N, sizeof(int));
gInit<<<N/128, 128>>>(a,b);
cudaDeviceSynchronize();
CUDA_CHECK_RETURN(cudaGetLastError());