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Center for Information Services and High Performance Computing (ZIH)

The Benefit of GCC's open structure on instrumentation in the HPC area

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Intstrumentation

Definition:

”In context of computer programming, instrumentation means to enrich the source code of a program with additional information.”

(acc. de.wikipedia.org)

Our approach

enrich source code:

- insert function call at beginning & end of function
- calls to ”instrumentation functions”

additional information:

- assign id of function
- collect list of function metadata (name, scl...)
- time-stamp of execution-point

The GCC approach

enrich source code:

- implementation of:
  `__cyg_profile_func_enter(...)`
  `__cyg_profile_func_exit(...)`
- compile with: *-finstrument-functions*

additional information:

- you get address of function
- function metadata has to be computed from symbol table

Tracing

Tracing

Definition:

”In software engineering, tracing is a specialized use of logging to record information about a program’s execution.”

(en.wikipedia.org)

Our approach

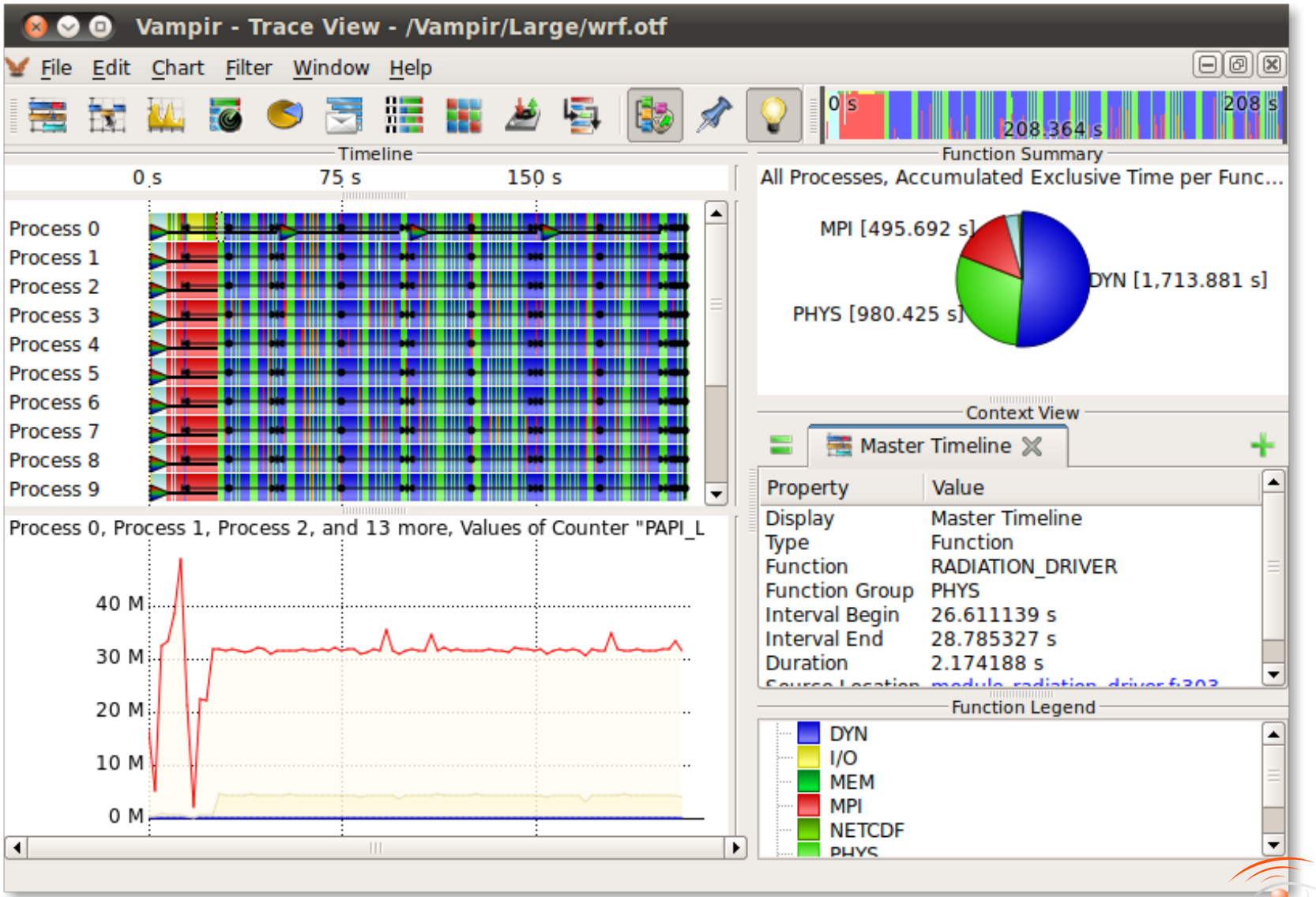
after execution you get an time ordered list of events

- we only provide function call tracing
- tracing though library wrapping

it is used for:

- runtime analysis of functions
- analysis of process concurrency
- visualization of program behavior
- ...

Visualization with Vampir



Pros & Cons

difficulties

- execution-time slowdown
- program perturbations
- amount of data volume

advantages

- very detailed
- summarized information can be computed for arbitrary time intervals
- useful for both performance tuning and debugging

Importance of good filtering

The GCC way

filtering in GCC

- *-finstrument-functions-exclude-file-list*=...
- *-finstrument-functions-exclude-function-list*=...

problems

- based on substring matching
- no wildcards
- no whitelisting
- filtering is imprecise

Test setup

- currently done during runtime
- proof of concept for new approach
- expensive instrumentation to guarantee compatibility

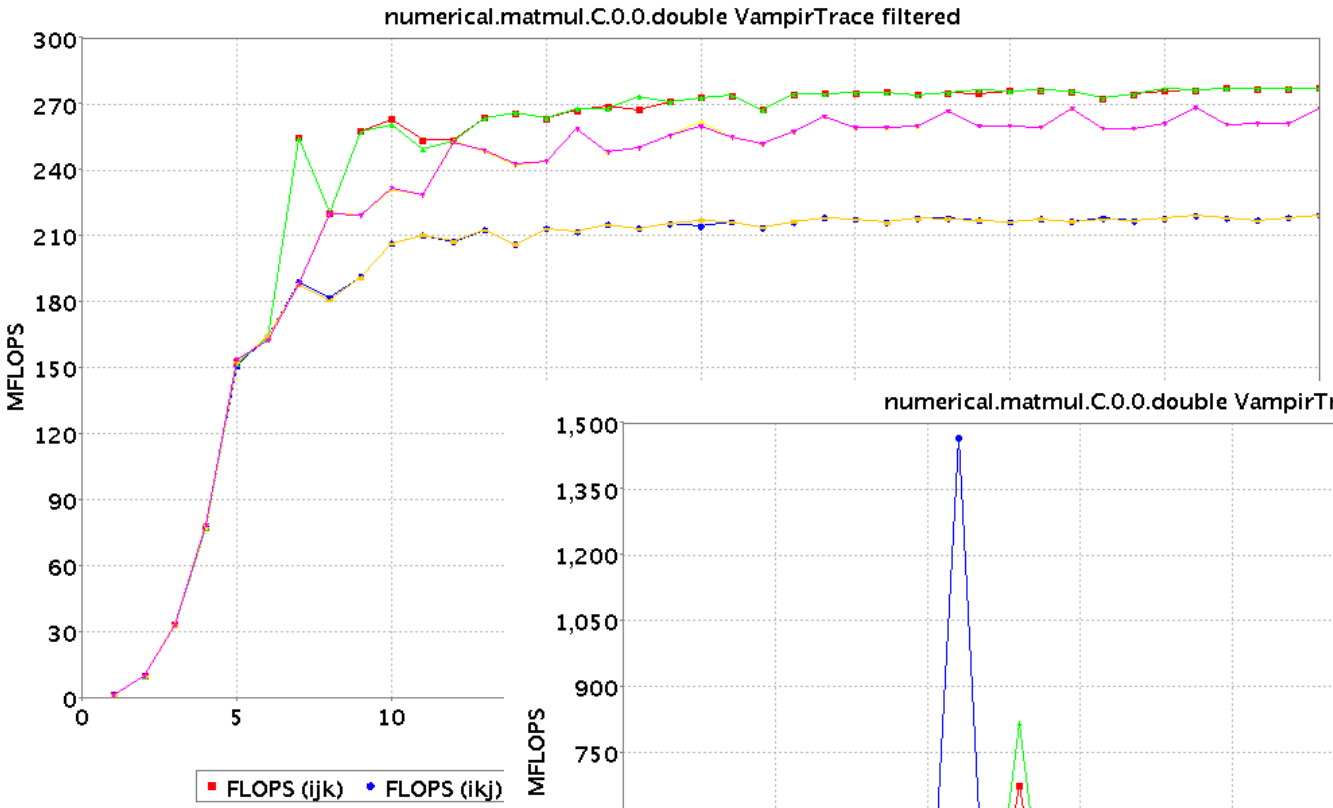
- SGI Altix 4700, Intel Itanium II Montecito 1.6 GHz
- measurement of matmul benchmark-kernel (single core)
- matrices of size 1x1 to 40x40, 150 iterations each

- use cases:
  - not instrumented
  - instrumentation via current approach filtered & unfiltered
  - instrumentation via InterAspect filtered & unfiltered

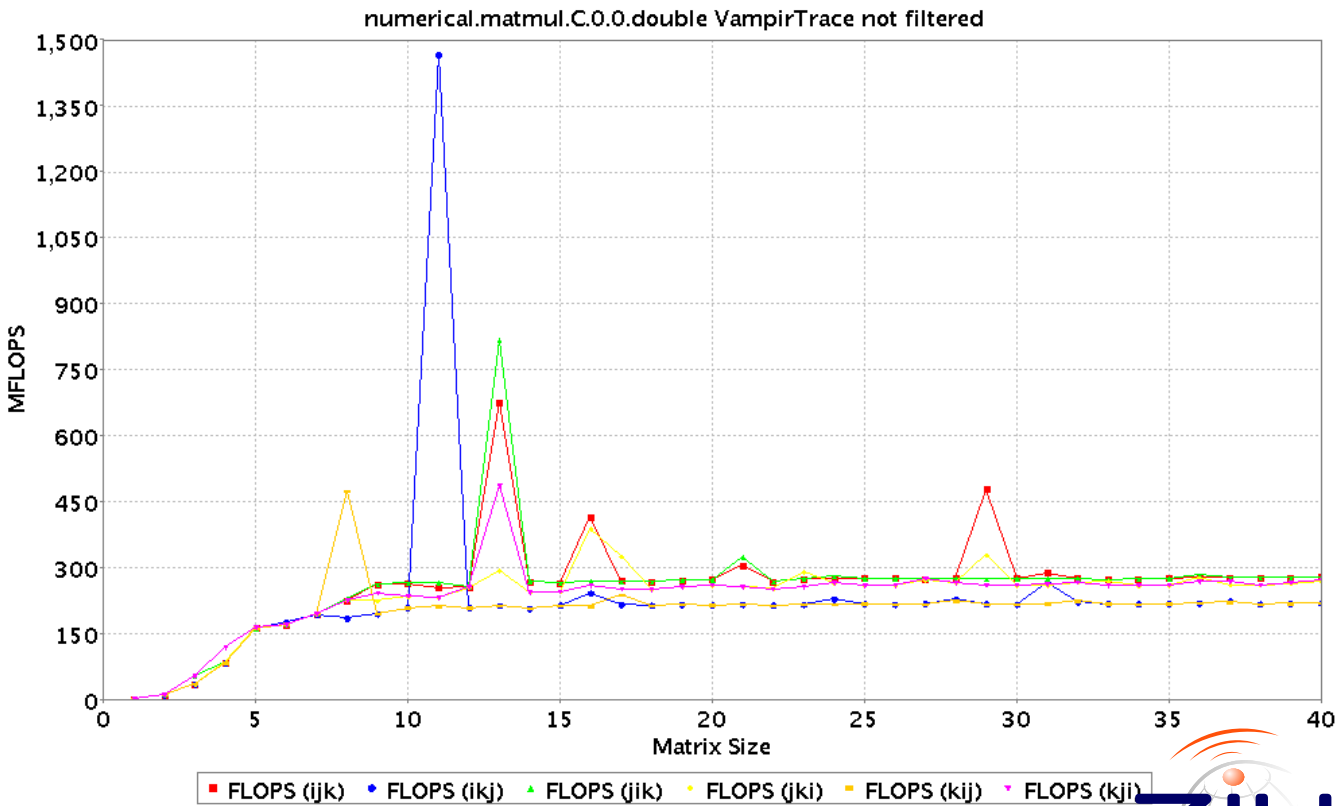
About InterAspect

- framework for code instrumentation
- developed by Stony Brook University NY
- current version: 1.0
- works with aspect-oriented programming
- creates GCC plugins
- licensed under the GNU GPL

Current monitoring system

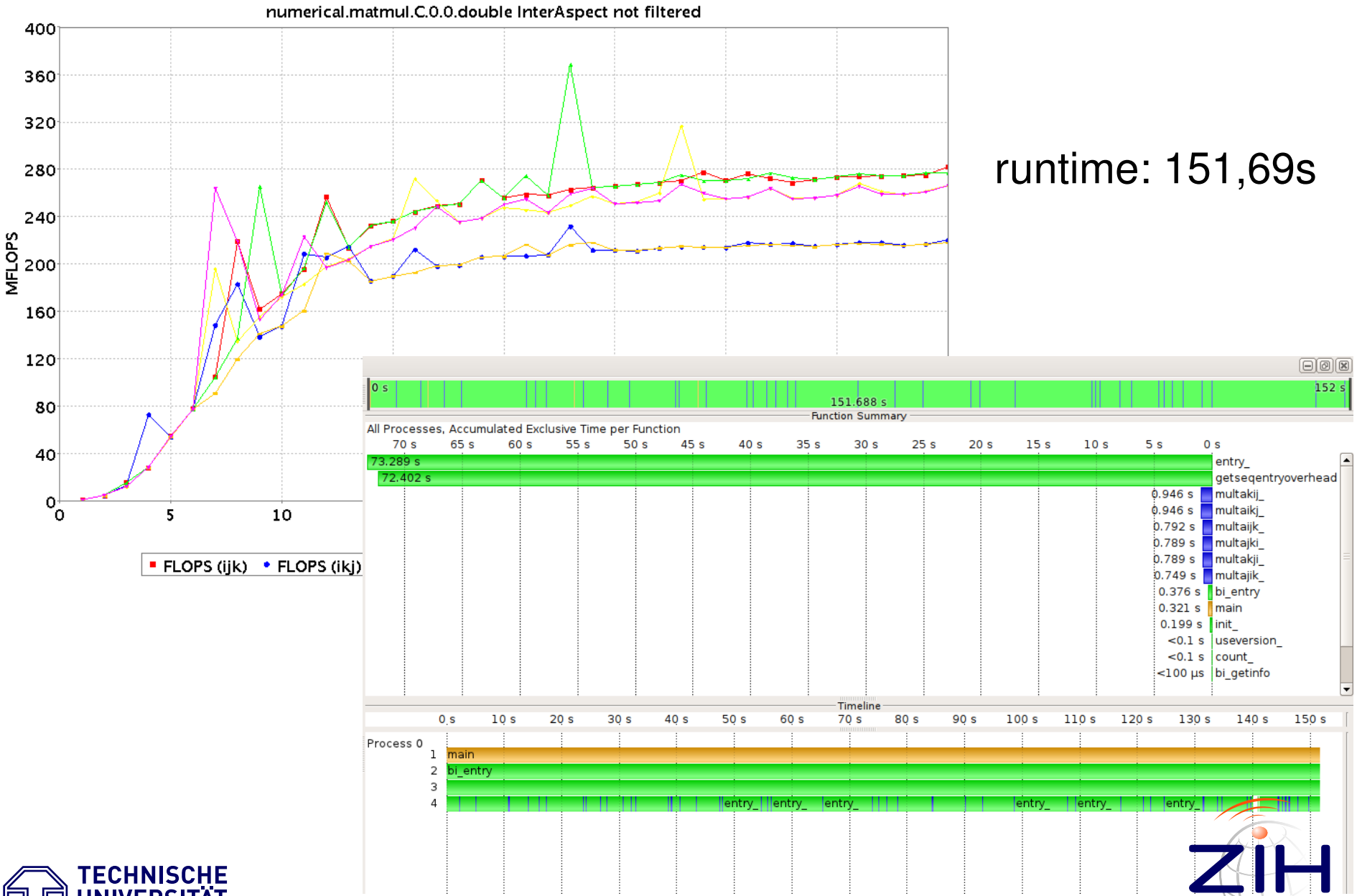


runtime: 38,45s



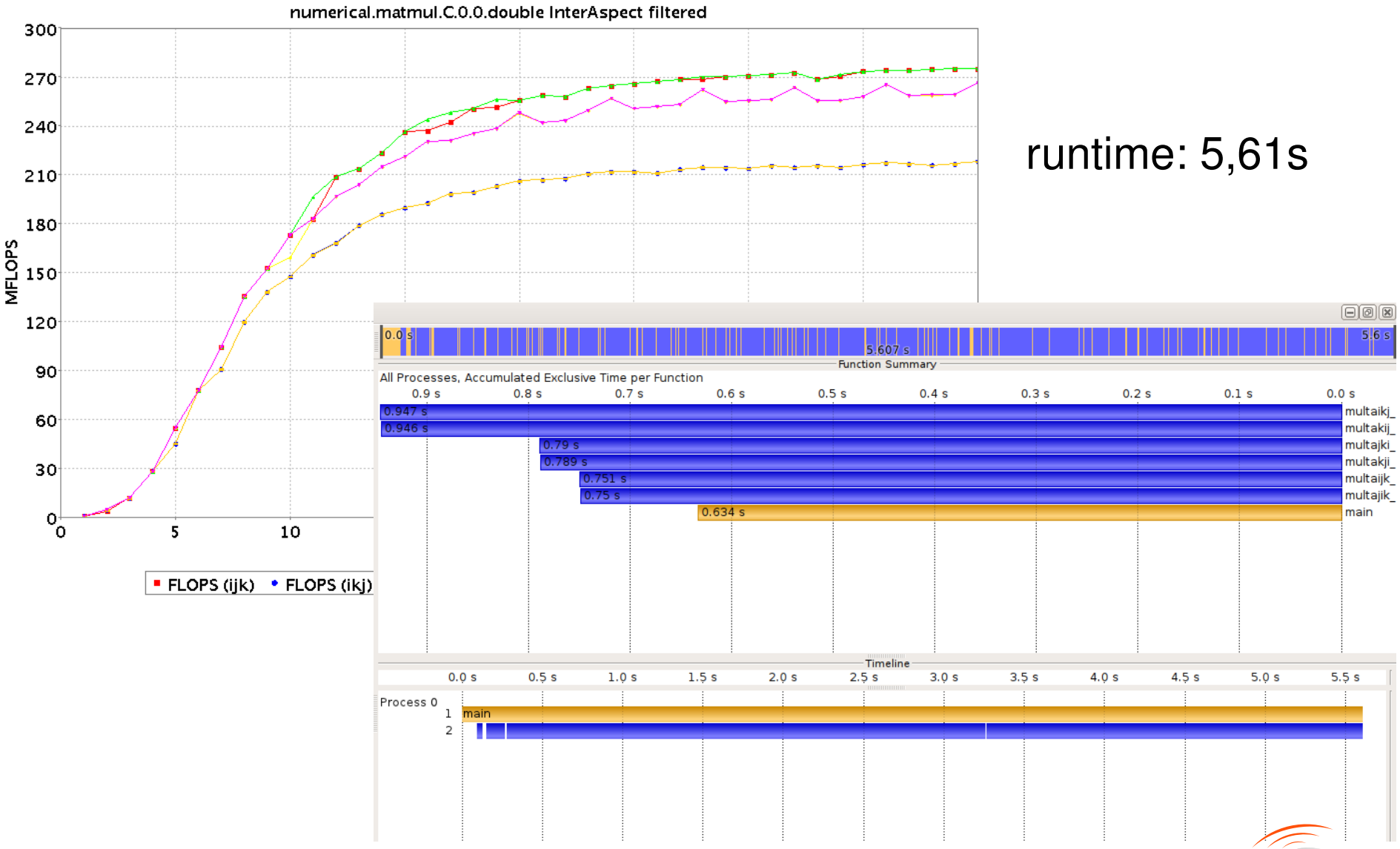
runtime: 43,32s

InterAspect unfiltered



runtime: 151,69s

InterAspect filtered



runtime: 5,61s

Importance of good filtering

- lesser data overhead generated
- only desired information are gathered (main, multa*)

- lesser result perturbations
- better reliability of results

- better runtime 5,61s vs. 151,69s (original 5,37s)

Our Vision

Why not using InterAspect anymore

- better linking between tracing environment and instrumentation
- no detour via GCC's instrumentation
- passing custom data to instrumentation functions
- more custom instrumentation of functions
- greater performance though lesser overhead

How GCC helps us

- Linux on 92% of Top500 HPC Systems
- GCC is default compiler for Linux

- an open source project
- one of few with open and extensible structure
- complicated but well documented internals

What we plan to do

- develop GCC instrumentation plugin
- joggle it with our Monitoring system
- compute function metedata during compilation

- provide filtering during compile time
- provide runtime filtering for debug purposes
- provide un-/instrumented function in binary
- switching at runtime
- (multiple optimization states based on power consumption in binary)?

Questions?