Sampling XOR Instrumentation? Or both?

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Overview

- Introduction and existing approaches
- Recording and data formats
- Analysis of samples and events combined
  - Timeline visualization
  - Statistics
- Conclusions

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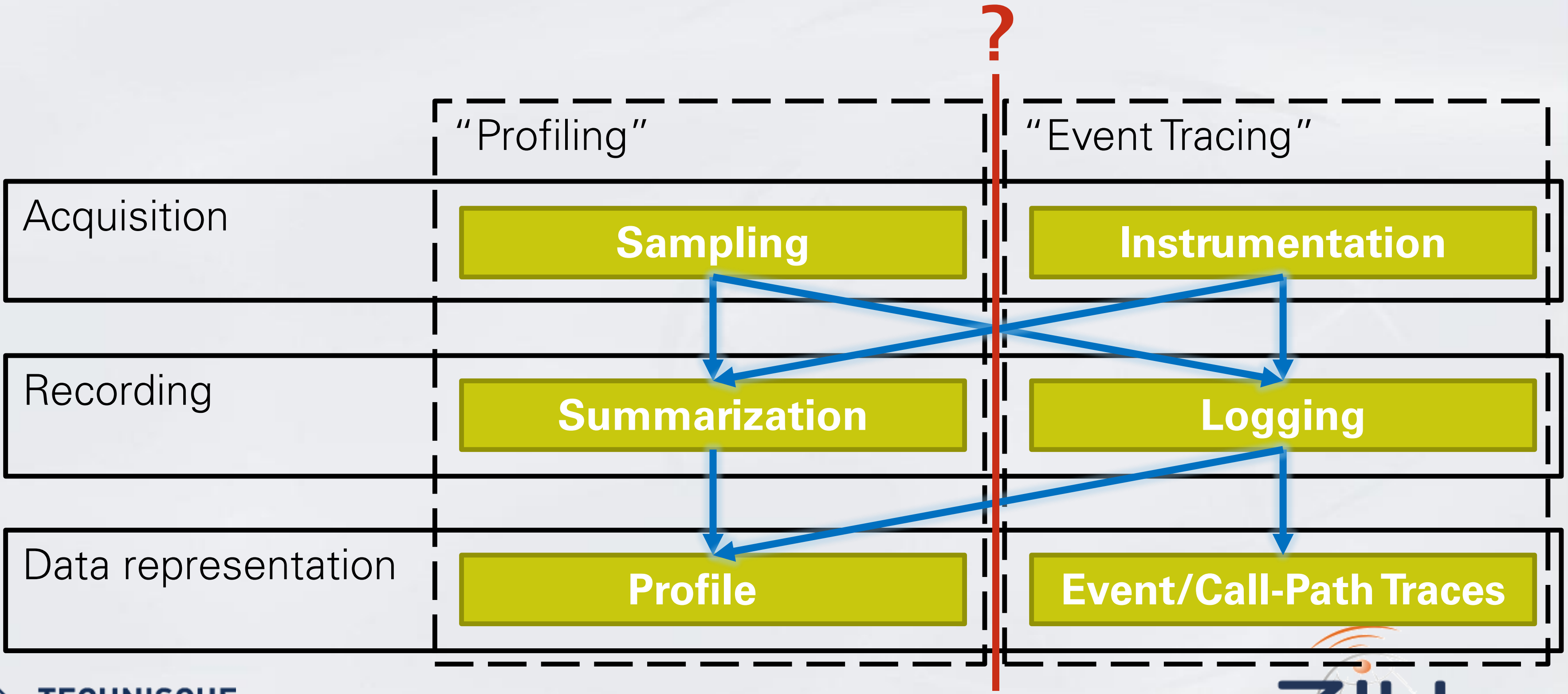
Definitions

- Certain terms are used almost synonymously even though they aren't



Existing Combinations:

- Sample one thing, instrument another:
  - Sampling of user routines or call-path tracing, instrumentation of MPI [Tallent et.al. 2011, Ilsche et.al. 2014]
  - Sampling of hardware counters, instrumentation of user routines and MPI
- Sampling of energy consumption next to instrumentation-based performance monitoring [Hackenberg et. al. 2014]
- Instrumentation maintains shadow stack, sampling reads it as shortcut of a stack walk [Iwainsky et.al. 2014]
- Very coarse-grained sampling, then "folding" over many repeated instances, instrumentation is only guiding the folding mechanism, instrumented events are not recorded [Servat, Ph.D. thesis 2015]

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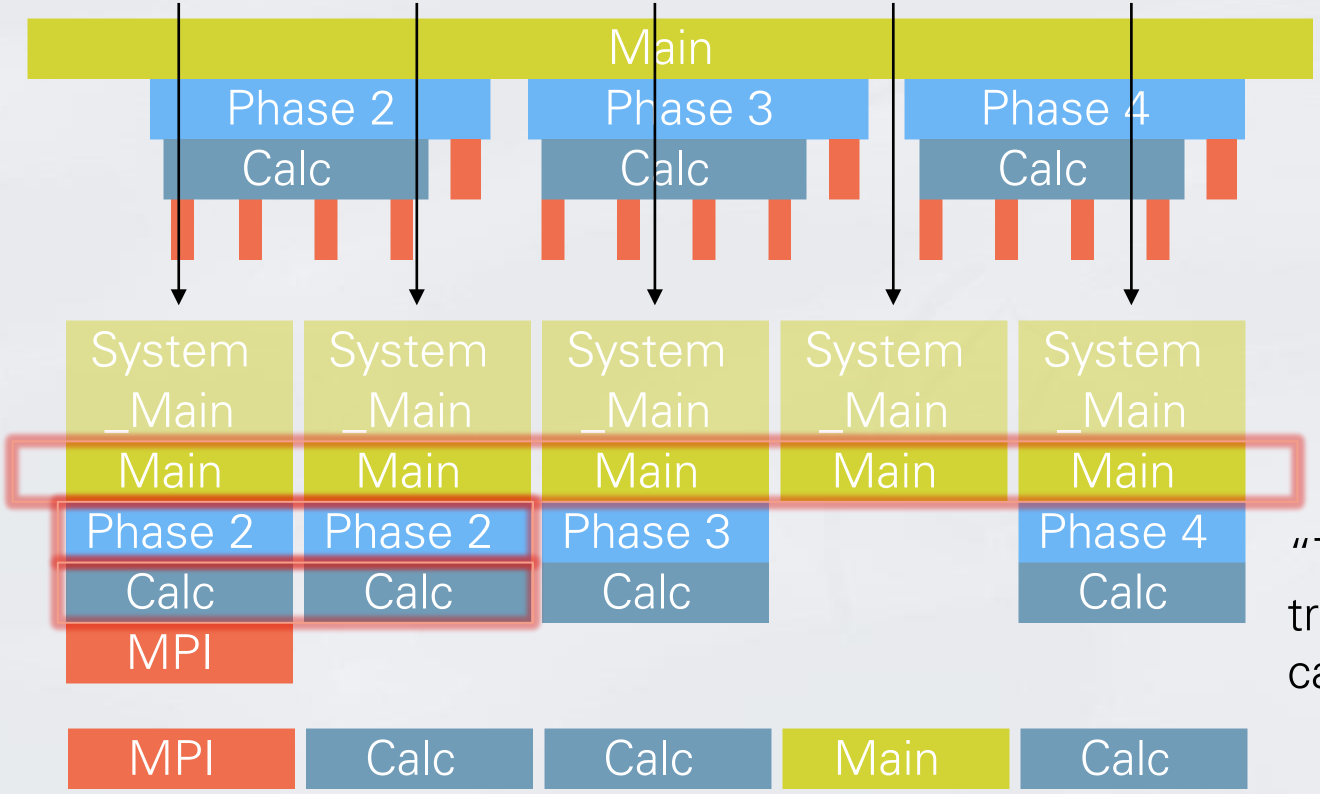
Example with Instrumentation and Sampling



Fine-grained call timeline from instrumentation

Call-stack representation

“Trampolines” allow tracking uninterrupted calls, reduce overhead

Flat representation

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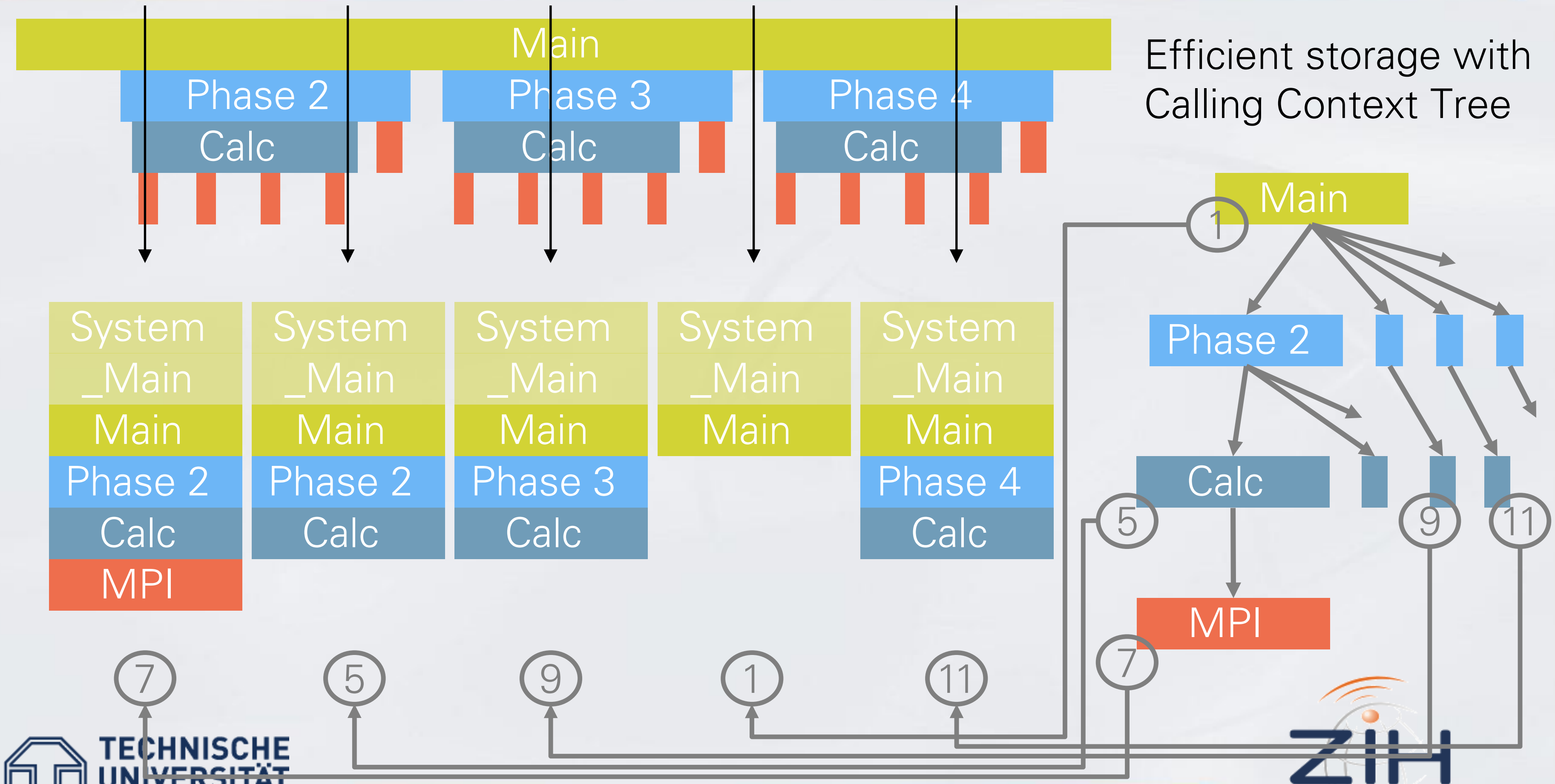
Samples with Calling Context Tree

Efficient storage with Calling Context Tree



Representation in OTF2: CCT and Sample Points

- Define calling context nodes recursively:

```
DefCallingContext {
    CallingContextRef         self,
    RegionRef                 region, // Routine or function
    SourceCodeLocationRef     sourceCodeLocation,
    CallingContextRef         parent }
```

- Use them at a sample point to specify entire call stack by single ID:

```
CallingContextSample {
    <process>, <time>,
    CallingContextRef         callingContext,
    uint                      unwindDistance,
    InterruptGeneratorRef     interruptGenerator }
```

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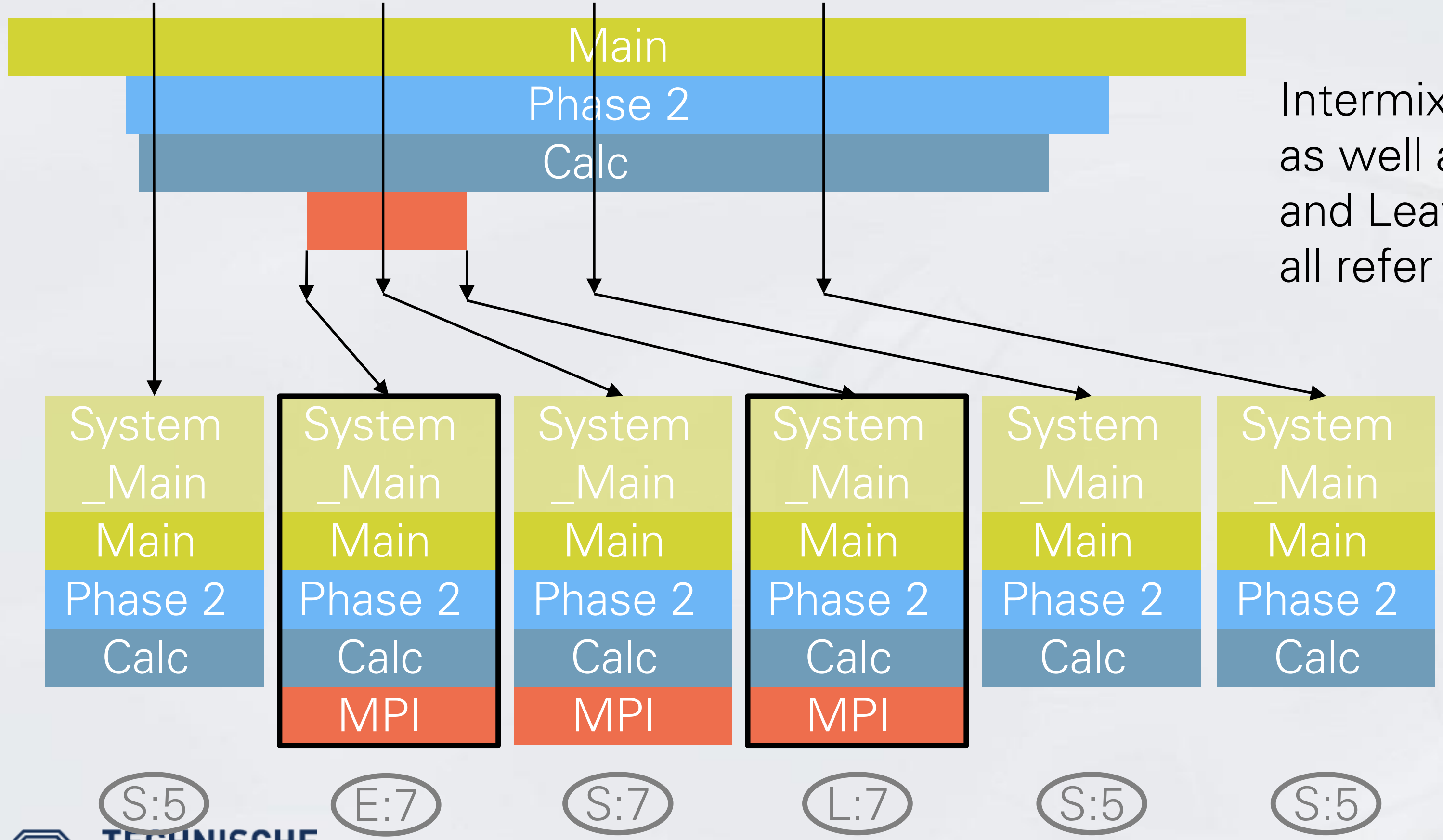
Now add Events from Instrumentation



Intermix Samples (S) as well as Enter (E) and Leave (L) events, all refer to the CCT

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Representation in OTF2: Special Enter/Leave Events

- Introduce new form of enter and leave events:

```
CallingContextEnter {
    <process>, <time>,
    CallingContextRef   callingContext,
    uint32_t            unwindDistance }

CallingContextLeave {
    <process>, <time>,
    CallingContextRef   callingContext );
```

- Refer to CCT, easily converted to old mode for legacy purposes if needed
- Little to no storage overhead, but more information (e.g., hidden stack entries)
- … no reason to keep the old enter/leave event records referring to routines

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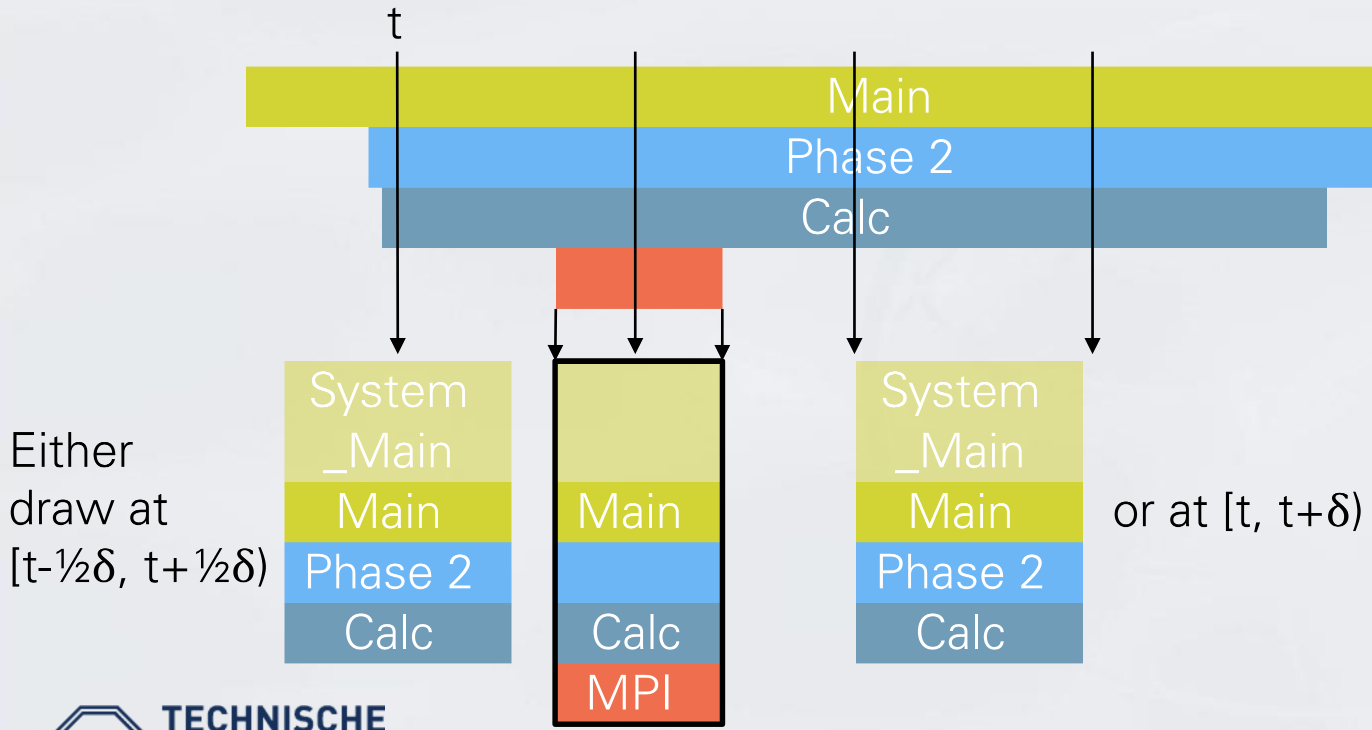
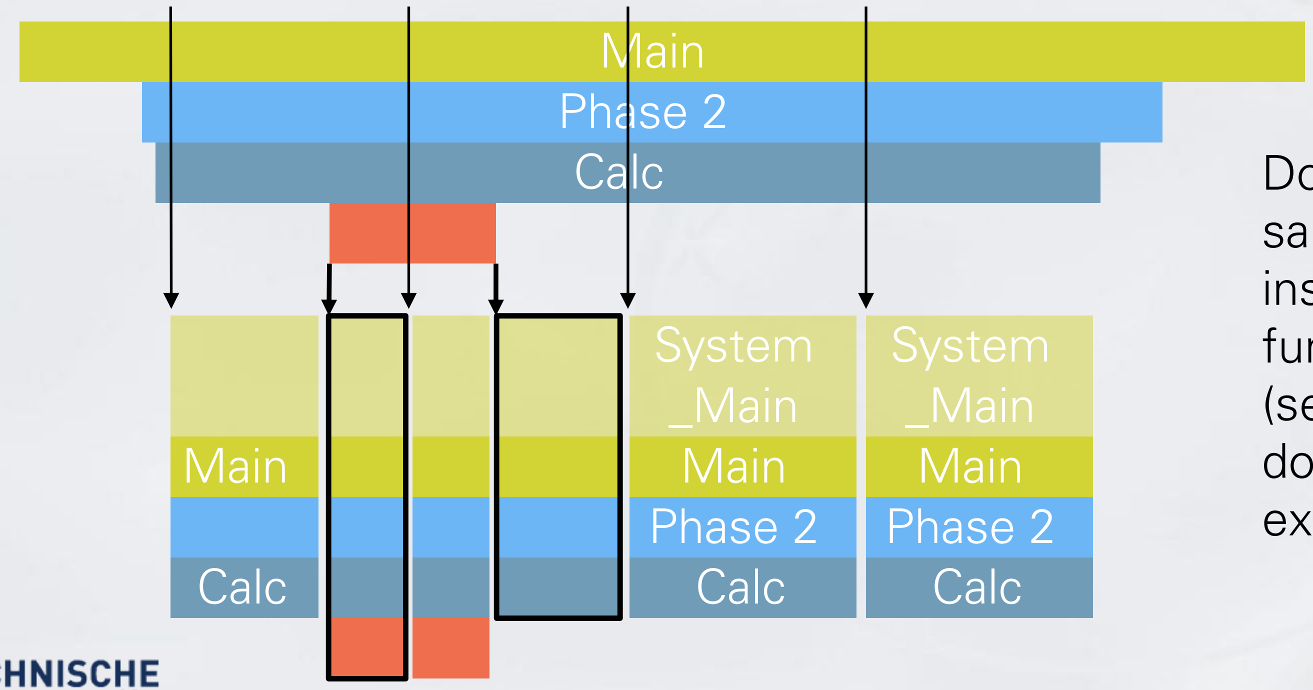
Combined Visualization in Timeline

- Events are status changes, usually drawn from “now” until “following event”
- Samples are points in time, but usually drawn 1δ wide (with sample distance δ)



Combined Visualization in Timeline: Shift by ½δ

- Unified strategy for events and samples:
  - draw from "now" until "following event or sample"



Do not suppress samples in instrumented function calls (see below), but do optimize the extra stack walk

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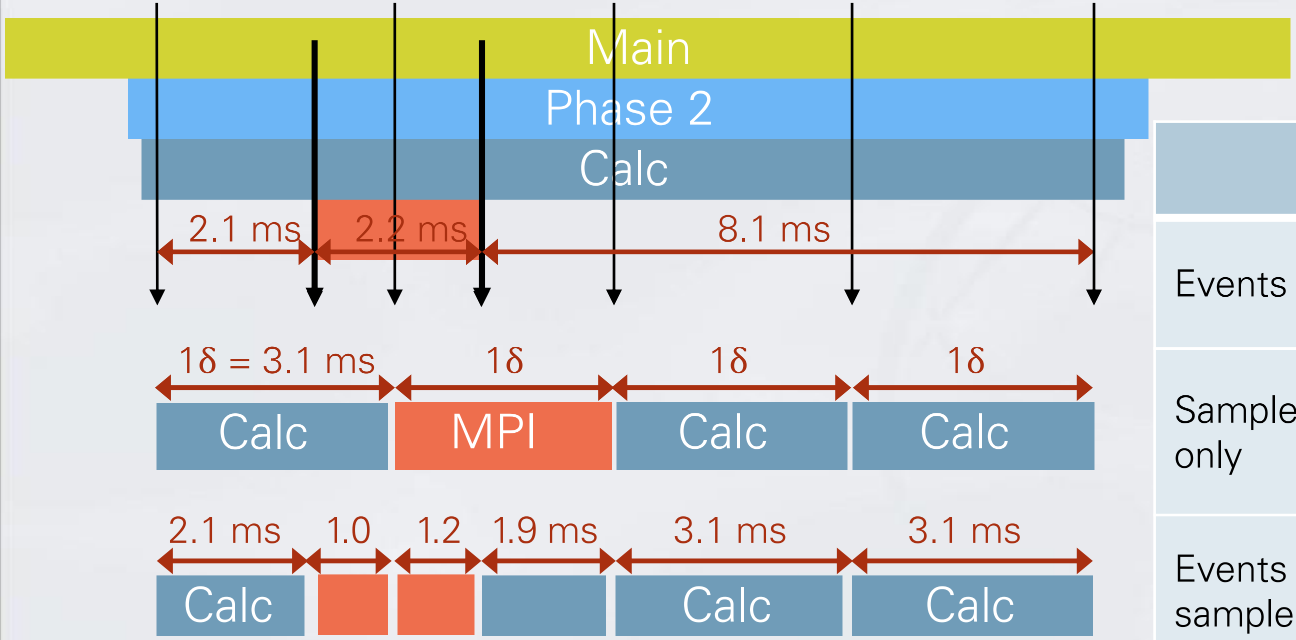
How to Compute Run-Time Statistics?

- From samples alone or from samples and events combined?



	Time for Calc	Time for MPI	Sum time
Events only	(10.2)	2.2	(12.4)
Samples only	9.3 = ¾	3.1 = ¼	12.4
Events AND samples	10.2	2.2	12.4
Events OR samples	9.3	2.2	11.5

How to Compute Run-Time Statistics?

- Cannot compute from events alone with selective instrumentation
- Do not compute some from events and some from samples (cherry picking)
- Compute from samples only: produces statistically correct results
  - Don't expect sampling to be more precise than 1δ in the first place
- Compute from samples and events combined: produces different correct result!
  - It is not more accurate than the one from sampling (max. error is the same)
  - Different granularity for instrumented calls may become evident
- What is easier to comprehend by users? What is easier to explain?
  Which is the expected model that brings the lesser surprise?

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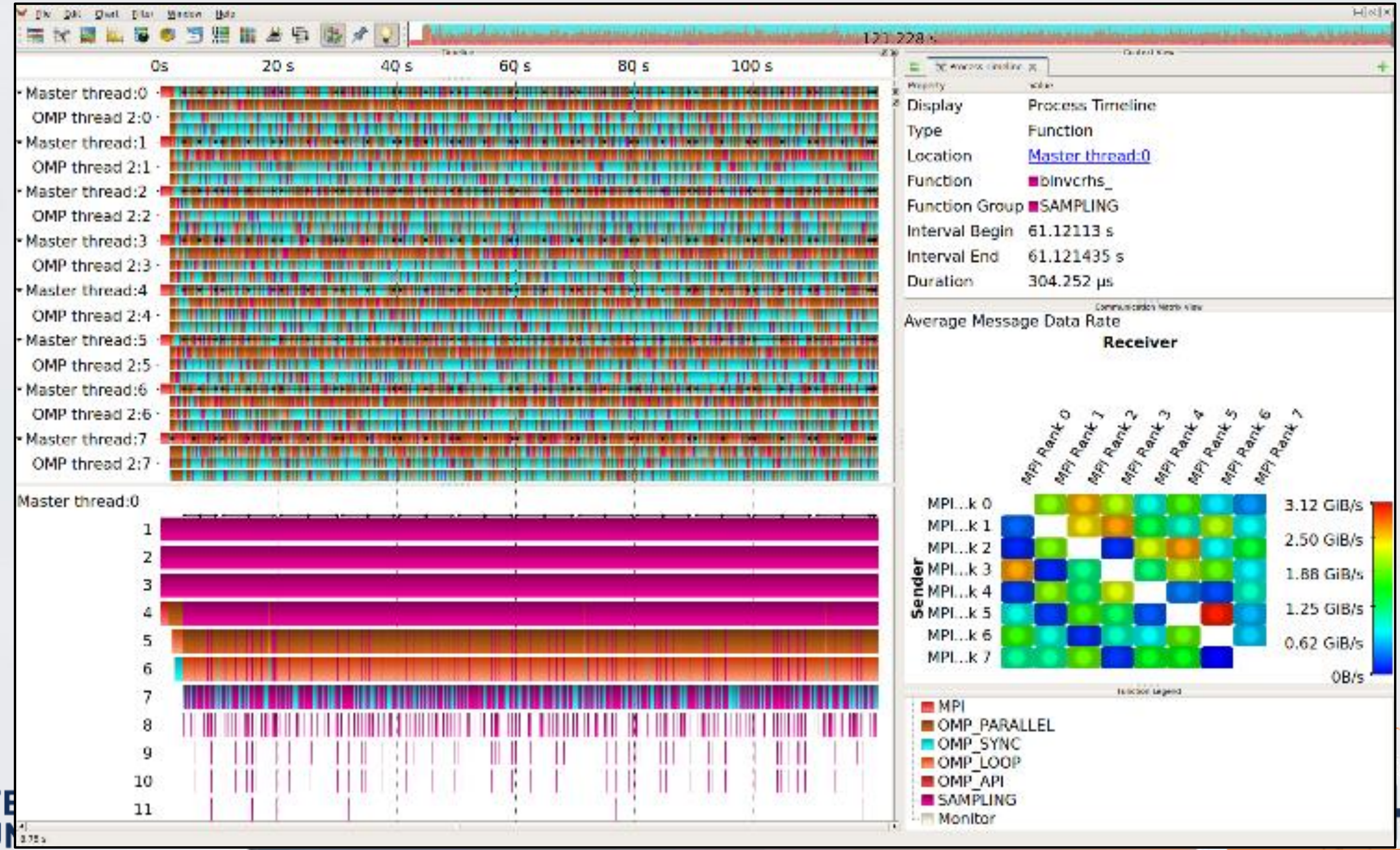
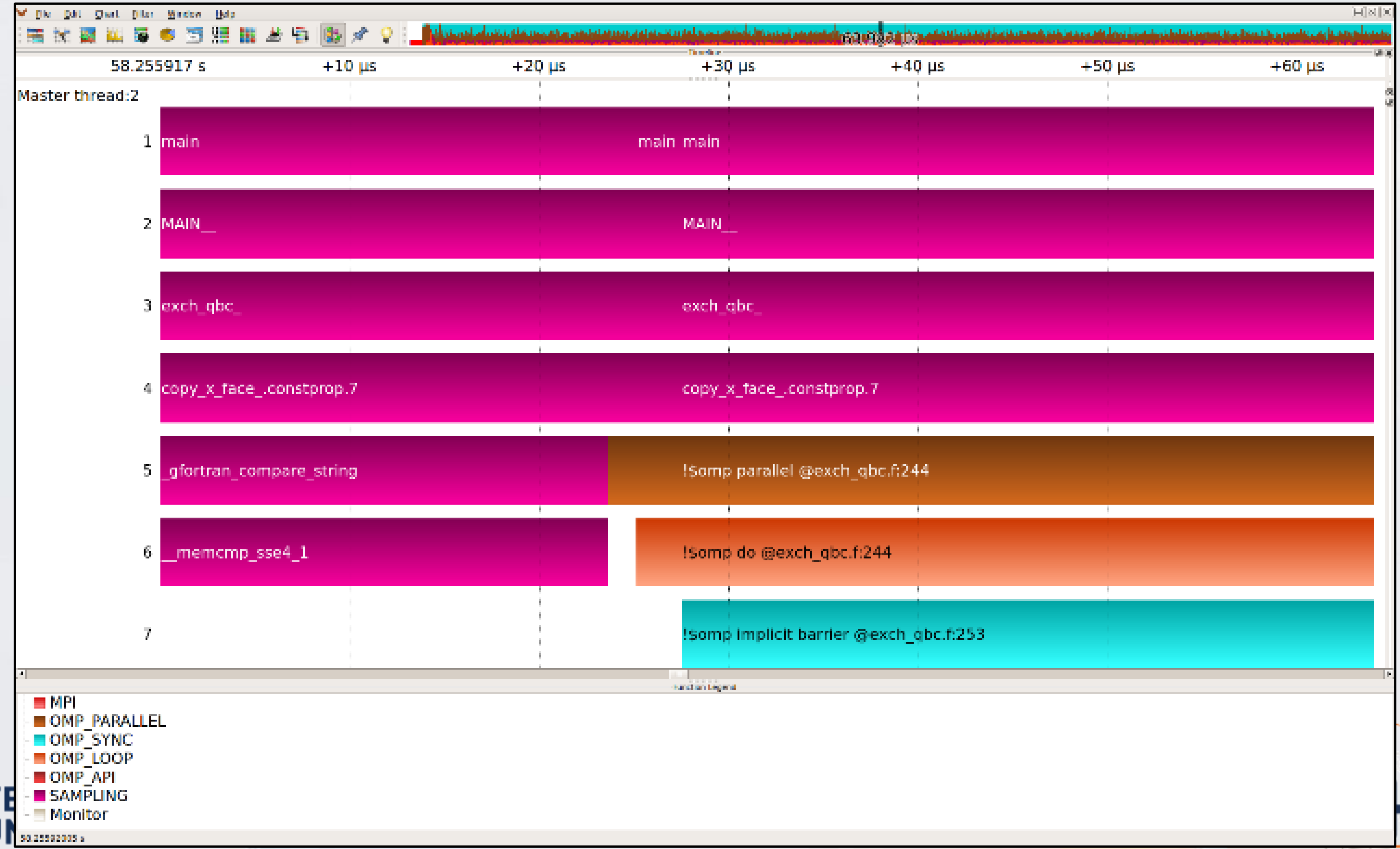
Impressions



Display	Process Timeline
Type	Function
Location	Master thread:0
Function	binvcrhs_
Function Group	SAMPLING
Interval Begin	61.12113 s
Interval End	61.121435 s
Duration	304.252 µs

- 🟥 MPI
- 🟫 OMP_PARALLEL
- 🟦 OMP_SYNC
- 🟧 OMP_LOOP
- 🟥 OMP_API
- 🟪 SAMPLING
- ⬜ Monitor

Impressions



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Conclusions & Outlook

- Sampling and Instrumentation should be combined
  - Allow a completely flexible mix from samples and events
  - Event tracing should adopt favorable event representation via CCT
  - Make sure to present it in a clear way
- Release plans:
  - Sampling records already part of OTF2
  - Include sampling in next Score-P release
  - Visualization in Vampir release version at SC’15

Advertisements

- 9th Parallel Tools Workshop in Dresden, 2-3 September
  https://tools.zih.tu-dresden.de/2015/

- Extreme Scale Programming Tools Workshop (ESPT) at SC'15
  http://www.vi-hps.org --> News
  Deadline extended until 14 August

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