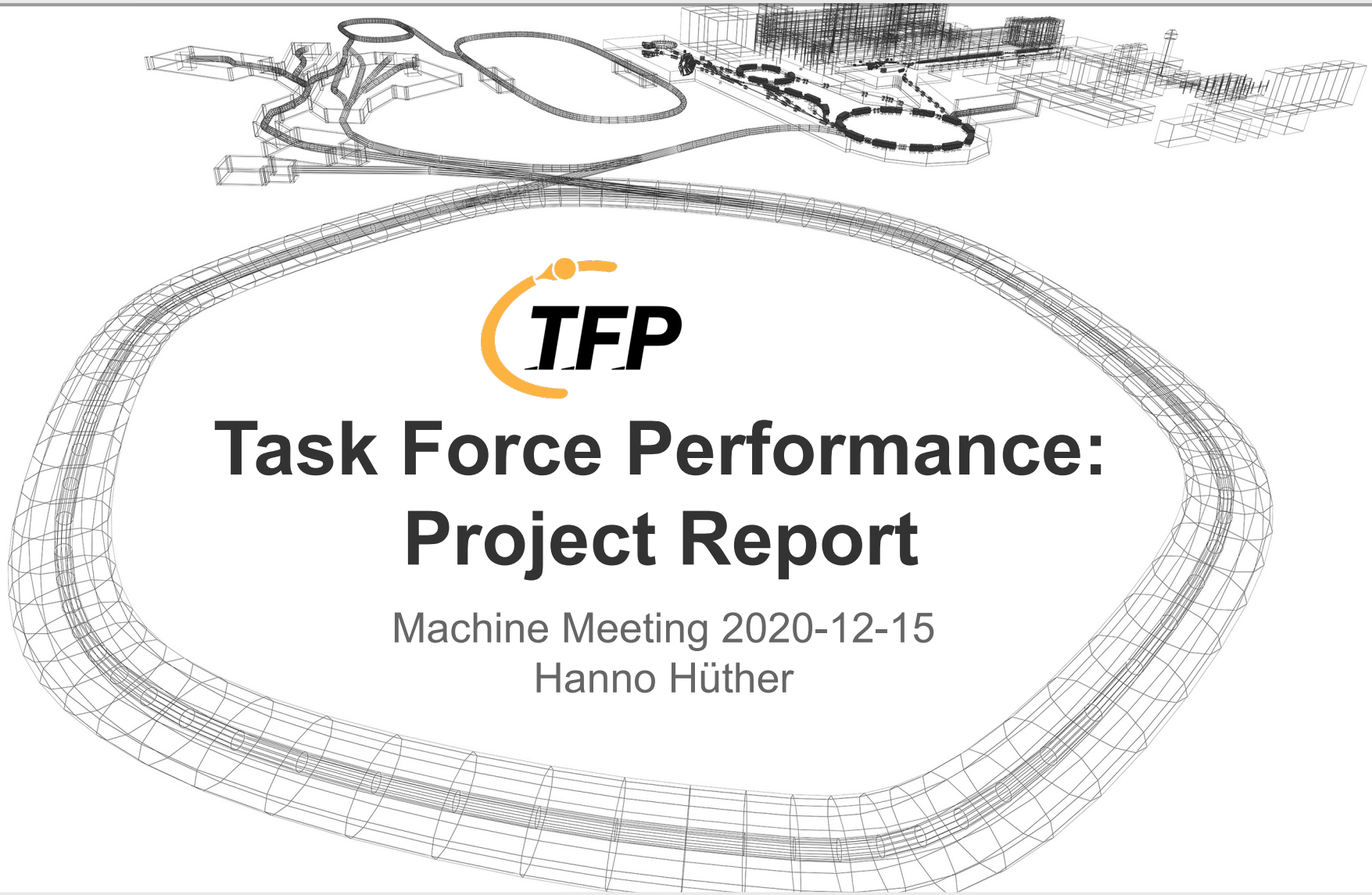


Task Force Performance: Project Report

Machine Meeting 2020-12-15

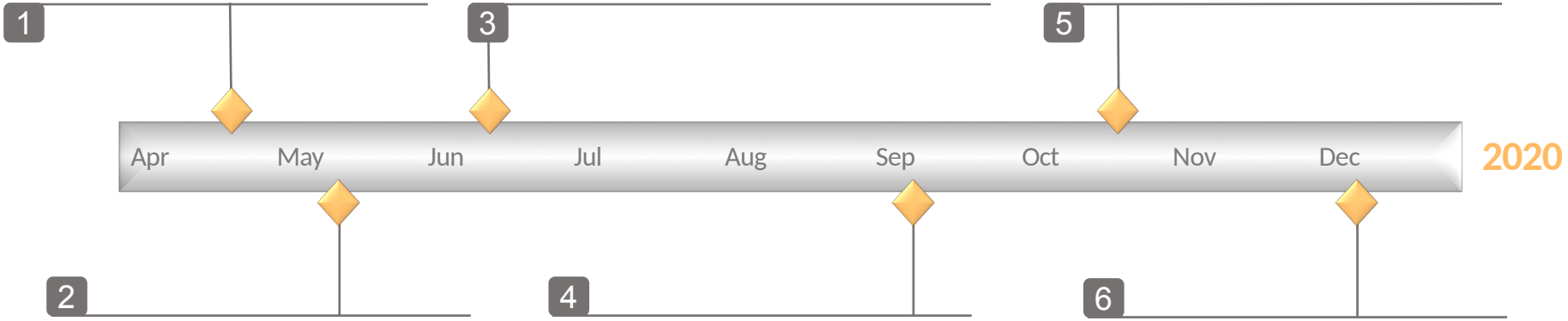
Hanno Hüther

Agenda: Project Milestones

April 23rd: „Kickoff Meeting“
- Background
- Task Force Members
- Objectives

July 15th: “Measurement Results and Improvement Options for a First Iteration”
- Baseline Measurements
- Prioritization for Efficiency

October 22nd: “Bypass Consistency Mechanisms Trim Feature”
- Simultaneous Trims
- Bypass Trim



May 15th: Use Cases, Scenarios, Requirements and Priorities
- Scenario-based Approach

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- General Speedup

December 10th: Retrospective on Iteration 2 and Touchdown
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- Overall Results
- Wrap-up & Outlook

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Background

- “Trim” performance was a known issue, but resources are limited and other tasks had higher priority (e.g. improving general reliability and implementing Storage Ring Mode)
- Focus for 2020 was planned to be put on improving performance and reducing technical debt
- The Technical Integration Meeting in March underlined the importance of performance improvements, suggested establishing a task force and helped raising awareness and acceptance for the topic
- Strong backing from both management and users to provide resources, help in the endeavor and let the development teams focus on the project was a success factor

Task Force Members

ACC	Oksana Geithner Christoph Hessler
APP	Jutta Fitzek Anne Walter
BSS	Stefan Krepp
CRYRING	Frank Herfurth
ESR	Sergey Litvinov Bernd Lorentz Markus Steck
LSA	Raphael Müller Andreas Schaller
SIS / SYS	David Ondreka Jens Stadlmann Ralph Steinhagen

- The „Task Force Performance“ consisted of controls, machine and operations experts
- Duties of non-ACO members included decision making and prioritization as well as providing use cases and Pattern templates for measurements
- Strong stakeholder involvement, including decisive influence on goals and implementation of the project was a success factor

Objectives

Primary objective:

- **Achieve substantially improved performance for currently most relevant use cases, so the facility can be operated efficiently.**

  Also consider beam-based feedback systems that are scheduled to become operational in 2021 for measurement scenarios as well as improvement measures where they are fully aligned with other use cases

  keeping in mind that time will not allow for every improvement potential to be implemented. Prioritize by importance of use case and expected benefit per effort.

Secondary objective:

- **Check for potential performance issues that may become relevant for FAIR (i.e. SIS100 and beyond)**

  but not necessarily fix them this year. Achieving target performance for FAIR will be an ongoing effort and at least partly depends on features planned for the next couple of years (e.g. transactional behavior).

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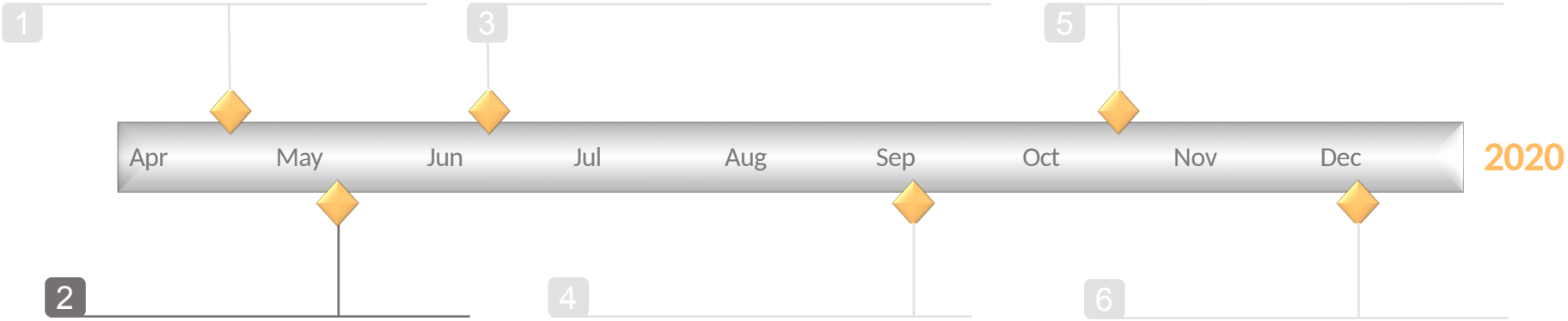

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Scenario-based Approach

- Instead of optimizing performance of “a system”, the task force took the operator’s perspective: What use case has to “become faster“?
- “Use Case Scenarios” were established to make requirements concrete and specific. Measuring these scenarios allowed for quantifying the status quo and subsequent improvements.
  That way, progress was made traceable and verifiable

		Use Case	
		1) “Regular” Trim	3) Manipulation Trim
Scenario	1) “Minimum Hierarchy”	1.1@SIS18 / 1.1@ESR / 3.1: steerer trim	
	2) “Medium Hierarchy”	1.2@SIS18 / 1.2@ESR / 3.2: tune trim	
	3) “Large Hierarchy”	1.3@SIS18 / 1.3@ESR: energy trim	

- For more information, see meeting minutes ↗

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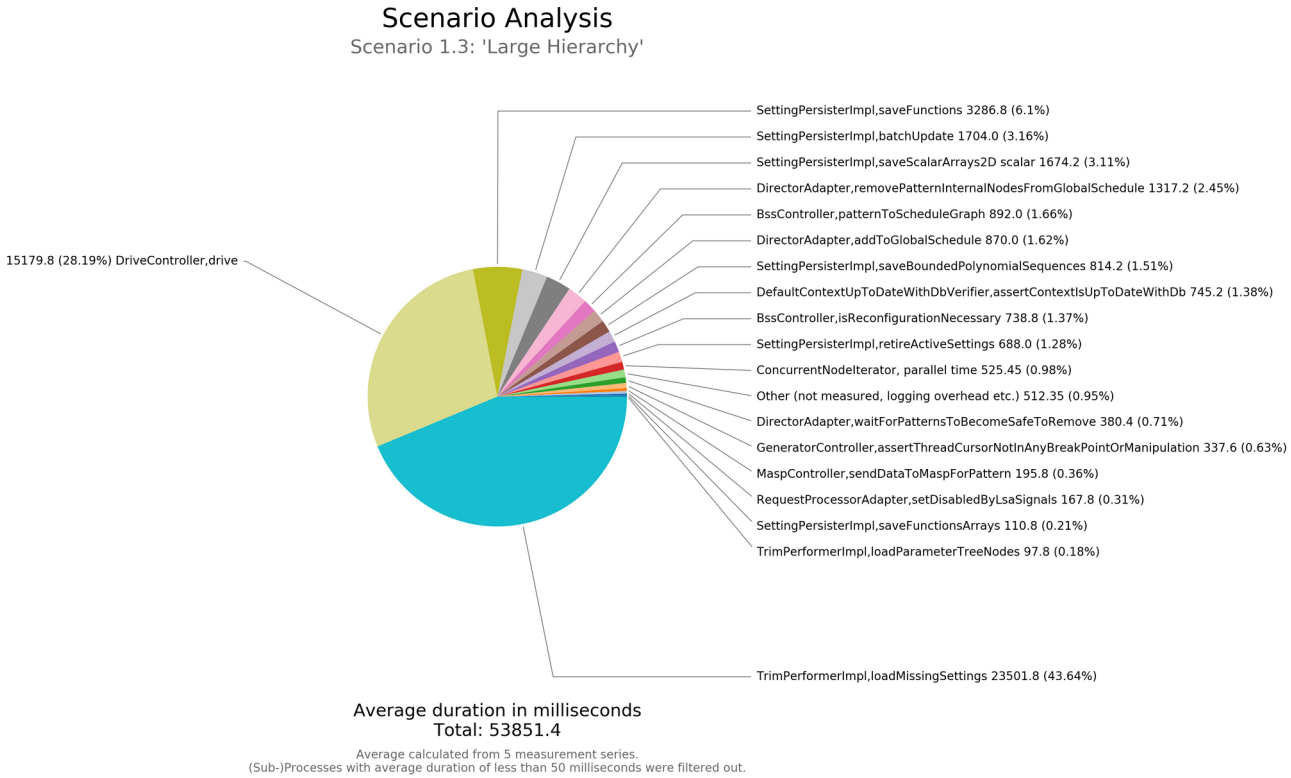
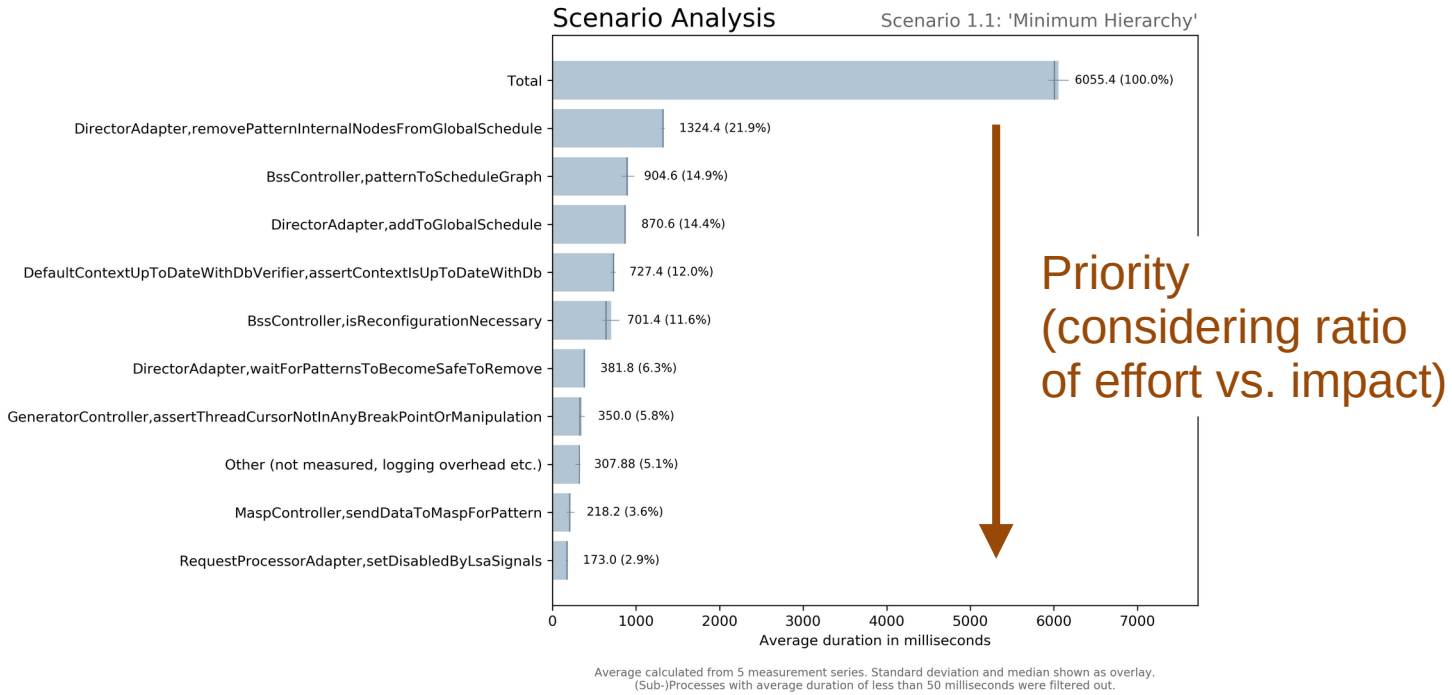
Baseline Measurements

To serve as a starting point for analyzing performance bottlenecks and to have a baseline to compare improvements against, an initial set of measurements were performed



Prioritization for Efficiency

Using measurement results as a basis to achieve a common understanding of bottlenecks in the trim process, task force members agreed on a „top time wasters“ strategy, meaning that implementers would go for optimizations with (relatively) low effort / high expected impact for “small trim“ scenarios (1.1) first



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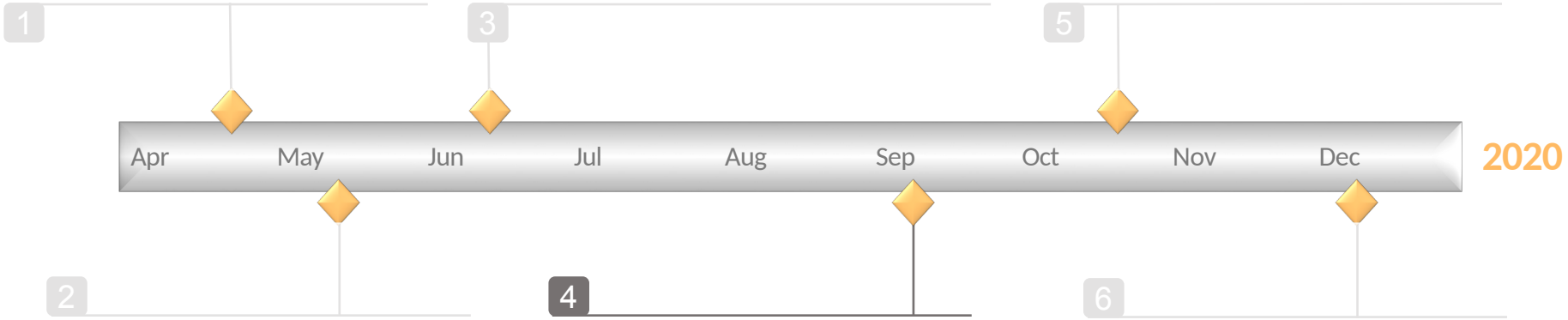

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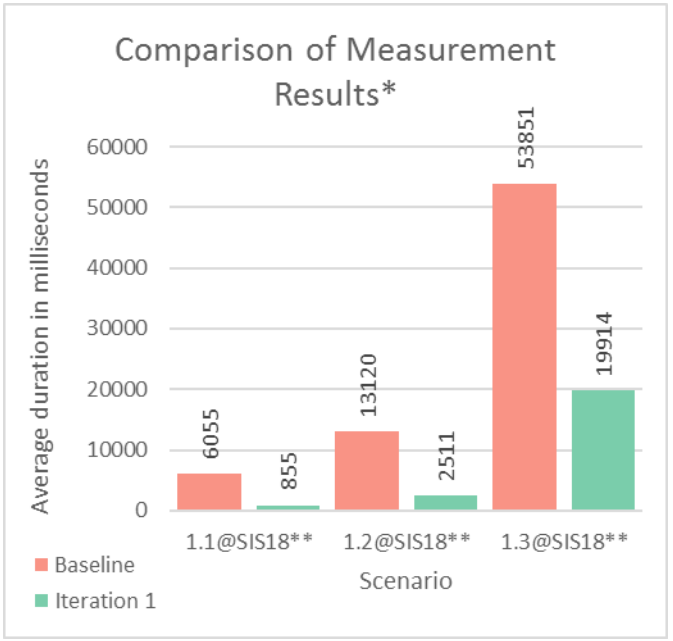
Results: General Speedup

- Measurement tooling was provided to developers on the cluster so they could easily verify expected vs. actual impact after each optimization step
- By the end of implementation phase's first iteration, trim times had been reduced by ~75% on average compared to the baseline measurements
- The scenario-based approach, prioritization by the stakeholders, a strategy for efficient implementation and adequate measurement tooling were success factors



* Please keep in mind that due to changing system environments, measurement methods and external factors, measurement runs performed at different points in time are not fully comparable. Consequently, this diagram should only be considered a rough indicator of to-be-expected performance.

** Baseline measurements are available for scenarios 1.1 to 1.3 at SIS18 only.

All TFP meeting minutes, technical documentation and results are available in the Controls Wiki (ACC account needed).

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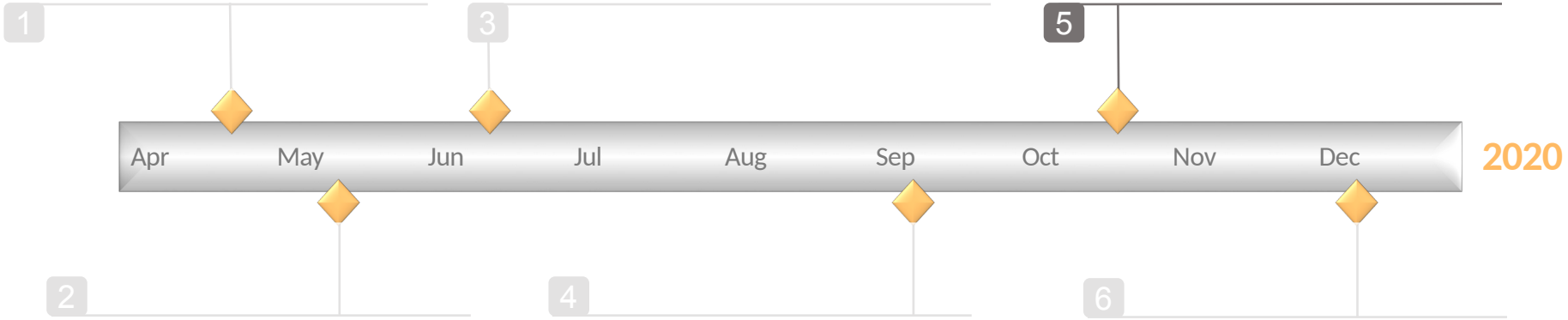

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Results: Simultaneous Trims and Bypass Trim

- In the second iteration of the implementation phase, focus lay on implementing „simultaneous trims“: It is now possible to trim multiple SIS18 Patterns (for different beams) as well as ESR and CRYRING (almost) completely in parallel
- Previously, only one “drive” (data supply) at a time was allowed and new trims had to wait for all other trims to finish, so potentially saved waiting time during busy shifts is very significant
- Important to remember when comparing trim times „in real life“ and in measurements: You still have to wait until your Pattern has finished executing (until we have transactions). Unless…
- „Bypass Trim“ allows trimming settings that are scalar on the device level (e.g. current for a „pulsed“ magnet) while the Pattern is running. Caution: Expert feature! See operator school for details ↗↗

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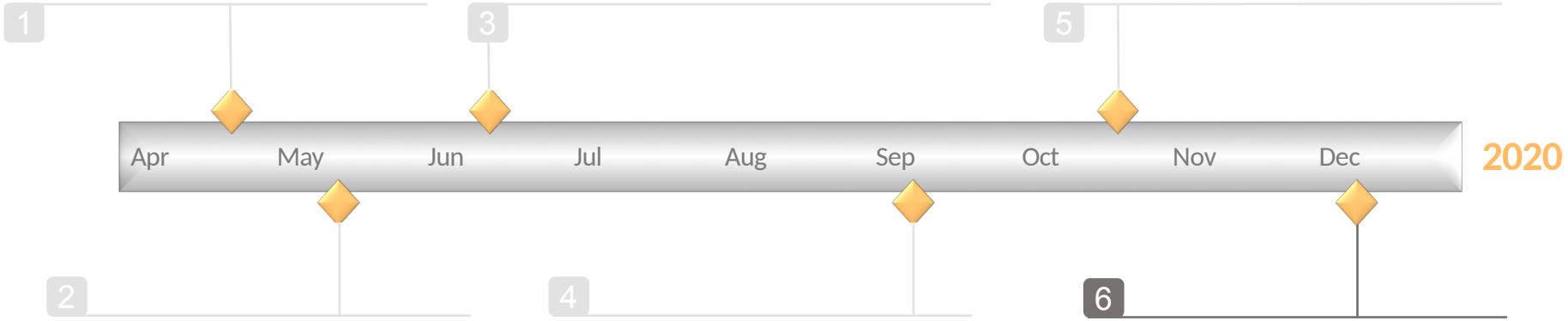

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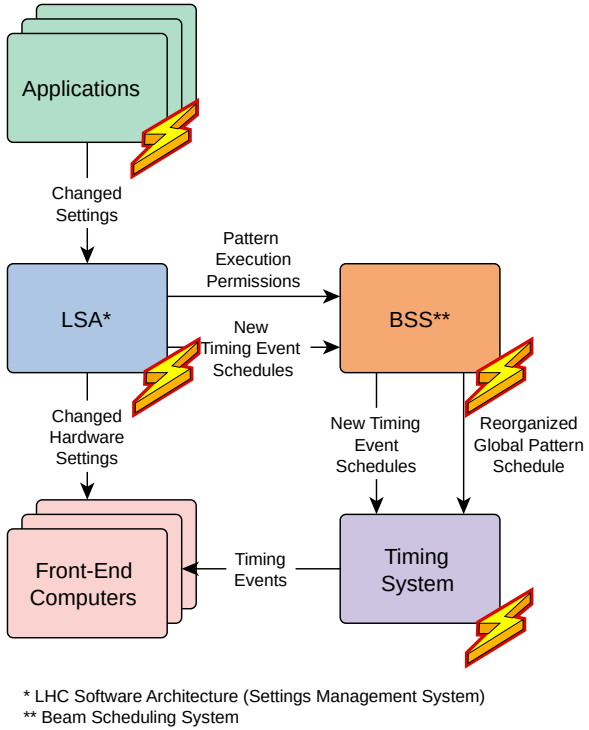
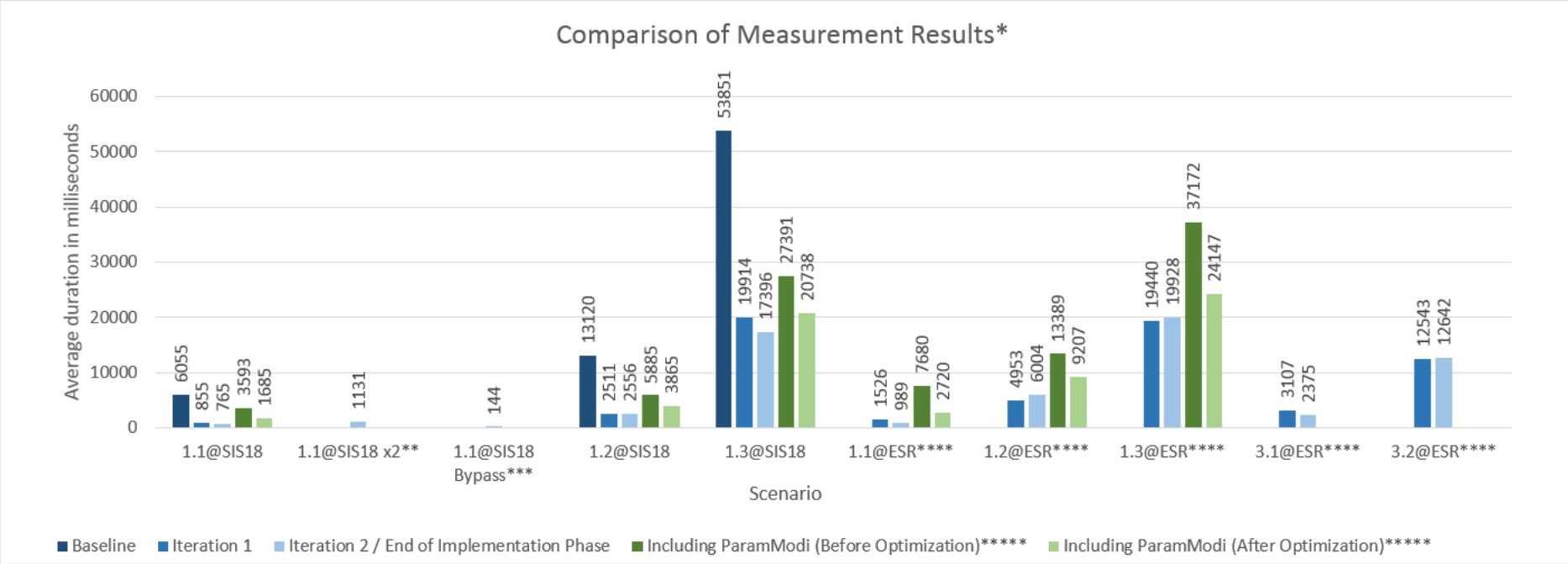
Results: ParamModi Optimizations and “Holistic View”

- Also in the second iteration, following the idea to gain a “holistic” or “end-to-end” view on the trim process as experienced by the operator, ParamModi was analyzed and optimized for performance
- When explicitly looking at ParamModi processing time: Roughly between 2 s (1.1@SIS18 ↗) and 10 s (1.3@ESR ↗) faster
- At this point, optimizations had been carried out across (almost) the whole control system stack
- Again, taking the user’s perspective was a success factor



(Final) Measurement Results From the November Dry Run



* Please keep in mind that due to changing system environments, measurement methods and external factors, measurement runs performed at different points in time are not fully comparable. Consequently, this diagram should only be considered a rough indicator of to-be-expected performance.

** The possibility to trim Patterns simultaneously has been implemented during implementation phase iteration 2, so data is available from that point on only.

*** The "Bypass Trim" feature has been implemented during implementation phase iteration 2, so data is available from that point on only.

**** Baseline measurements are available for scenarios 1.1 to 1.3 at SIS18 only.

***** Measurements including ParamModi processing time are available for scenarios 1.1 to 1.3 at SIS18 and ESR only. Measurements have been taken during the November 2020 dry run, so both "before" and "after" refer to the "Iteration 2 / End of Implementation Phase" state of underlying systems.

Objectives reviewed

Primary objective:

- **Achieve substantially improved performance for currently most relevant use cases, so the facility can be operated efficiently.**

  Also consider beam-based feedback systems […]

  - Wait times significantly reduced compared to baseline (>75% improvement on average in final measurements)
  - Beam-based feedback systems will profit from general speed-up and specific „Function Bypass Trim“ feature

Secondary objective:

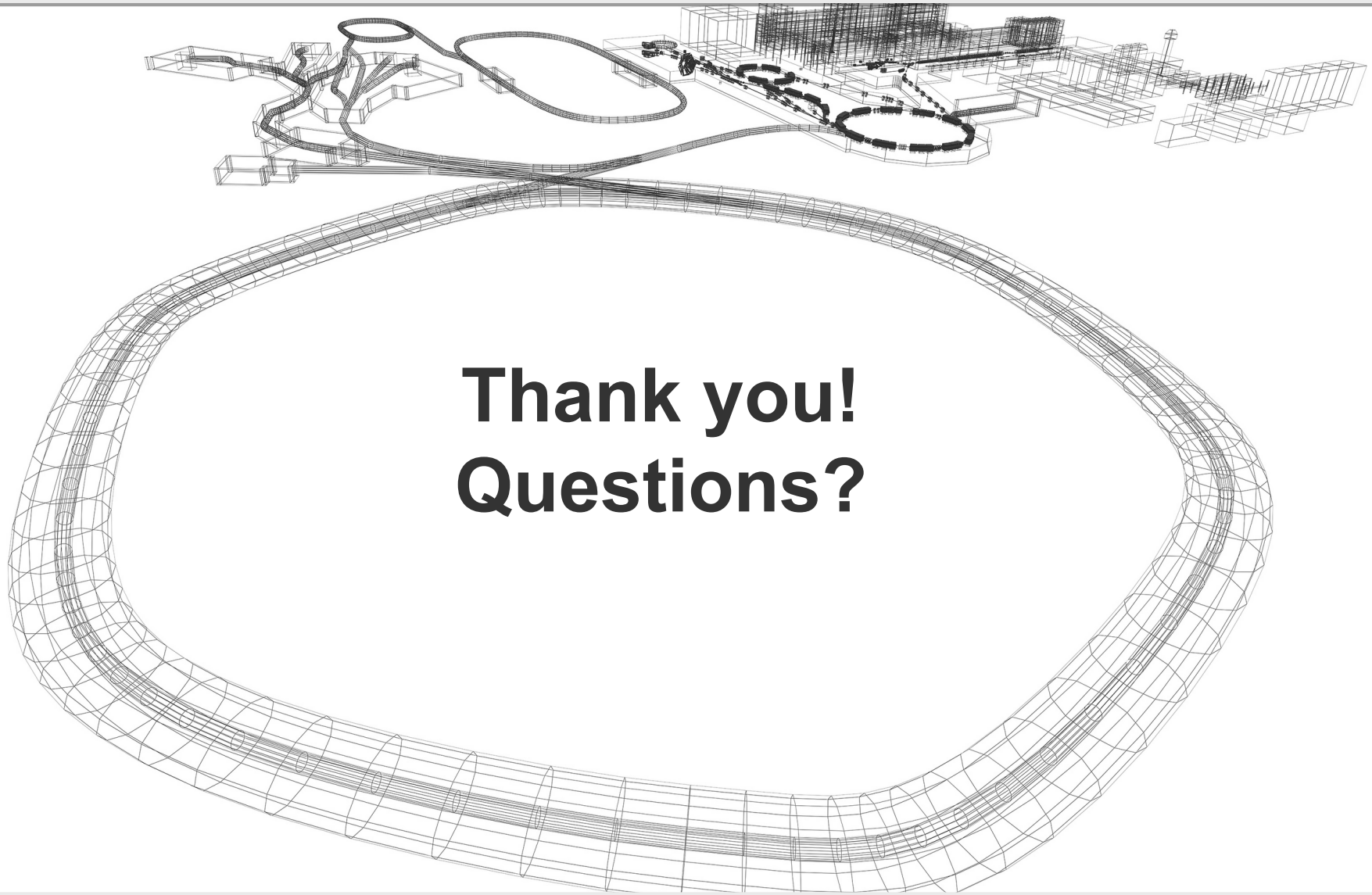
- **Check for potential performance issues that may become relevant for FAIR (i.e. SIS100 and beyond)**
  - No fundamental technical issues or architectural problems encountered

Wrap-up

- To the extent that results can be assessed through measurements, all primary and secondary objectives are considered fulfilled
- As always, operation during the beamtime will be the final test, but feedback from dry run and CRYRING suggests that the measures implemented actually translate to perceivable improvement for operators, machine modelers and developers
- These achievements come at a cost: Some of the activities targeted at reducing technical debt had to be postponed and will have to be considered for prioritization of tasks for 2021 and beyond
- The Task Force Performance has been „officially“ disbanded, with the option to seek advice regarding performance-related questions in the future if needed

Outlook

- Follow-up: “Real-world measurement snapshots“ to be taken during the coming beam time (as workload and diagnostic logging capacity allows) to validate performance improvement results
  - Evaluation using existing tools / on a best effort basis (raw data will be made available, as always)
  - Suggestions on interesting time frames are welcome
- Maintaining performance will be an ongoing activity: New features (like having multiple Chains in one Pattern) as well as additional machines (e.g. UNILAC and SIS100) will introduce new challenges
- On the other hand, experience gained both in ACO and other departments will prove beneficial to overcome these challenges
- Reevaluation is foreseen after implementing transactions (2024?)



Thank you!
Questions?