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ExaMA Work Package 3 -- Feedback Session

Solvers

WP3 Vincent Faucher, Luc Giraud, Frédéric Nataf

January 21, 2026 – NumPEx General Assembly

ExaMA – Exa-scale Methodologies and Algorithms

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Key Takeaways

Key Takeaways from the GA

Takeaway 1 Monthly meetings are useful and a satisfactory WP management framework for the participants

Takeaway 2 Some contributors involved in the WP with no direct funding from NumPEx, in the very spirit of the targeted community building

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Discussions Summary

Main Discussion Points

Discussion 1 Fault tolerance and resilience also as a significant contribution of the WP: silent errors, general protection strategies (checkpoint-restarts, checksums verifications and advanced detections combined into innovative patterns)

Discussion 2 General objectives of NumPEx and production pipeline explained for recently arrived students, from demonstrative algorithms to benchmarked software packages

Discussion 3 Theoretical ground for mixed-precision Krylov solvers, actual memory savings whether a full double-precision version of the data has to be kept for further use or not, potential link with the prophesized disappearance of double precision units in upcoming hardware?

Discussion 4 Precision autotuning, Promise implementation and stochastic arithmetics made clear for all

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Adjustments

Adjustments to WP3 Plans

Adjustment 1 Go deeper into energy topics related to algorithms, including static and energy consumption; in strong connexion with PC2

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Conclusion

Summary and Next Steps

- Main outcomes from the GA: confirmation of the collective implication and motivation of hired personnel, opportunity to provide context and perspectives
- Push energy topics into the proposed research wherever relevant, including criteria for autotuning and automatic optimization of components anytime reliable measurements are available
- Keep monthly meetings and WP dynamics

Thank you!

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ExaMA Work Package 3

Breakout Session with Composyx

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Key Takeaways

Key Takeaways from the GA

Takeaway 1 Composyx emphasizes on composability and flexibility to offer a quick and reliable way to design and test innovative algorithms in the framework of ExaMA WP3

Takeaway 2 An open project and community, with benefits from the crossed experiences allowed by NumPEx and ExaMA, including systematic benchmarking in association with WP7

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Discussions Summary

Main Discussion Points

Discussion 1 Composyx is designed to provide extended control to the user/developer ; example of Flexible GMRES and general abstraction given for matrix-vector product, allowing fine control including GPU implementation, reduced-precision where needed or high-precision to characterize round-off errors

Discussion 2 Focus on composability and flexibility to prototype ideas and algorithms in support of research ; advanced design by combination of small components in a full pipeline compatible with task-based parallelism ; widely open environment for everyone to contribute, add its preferred software in addition to preexisting solutions

Main Discussion Points

Discussion 3 Reproducibility and resilience: the team has work on the design of numerical detectors for silent errors while leveraging the cost of such measurements; however, observed decreasing activity regarding resilience, NumPEx can give a new push for these topics in the context of Energy savings (cf. WP3 feedback), benefiting also from its natural connexion with mixed-precision arithmetics

Discussion 4 Composyx and other linear solution software in ExaMA: a little more flexibility than PETSc, but no direct competition and benefit from the mutual experiences and research developments within ExaMA's community, some missing features top priority in Composyx to offer the same range of services (such as distributed multi-grid solver) ; nothing yet regarding Trilinos, path to follow possibly to test promising solvers like Muelu

Main Discussion Points

Discussion 5 Matrix-free interface for Krylov solvers in Composyx? Natural since a matrix is an operator, easily fusable with any kind of accelerated techniqques and without attachment to the matrix structure itself ; in-session tutorial to show how to quickly write an operator

Discussion 6 GenEO and Composyx? Available proof to make GenEO composable, with same instanciation of every matrix (follw-up of the work of Nicole Spillane and Frédéric Nataf)

Discussion 7 Increasing connection with WP7 with synchronized expectations regarding integration and systematic benchmarcking for the mutual benefit

Discussion 8 End of session dedicated to demonstrations regarding build (including CMake superbuild) through online tutorials and examples

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Conclusion

Summary and Next Steps

- Encouragement to go and test Composyx yourself for your algorithmic research!
- Share experience, results and expectations within ExaMA community for the common progress

Thank you!

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ExaMA Work Package 3

Breakout Session with Feel++

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Key Takeaways

Key Takeaways from the GA

Takeaway 1 Feel++ offers a framework to test algorithms and methods of WP3 at scale, including GenEO and its various on-going implementations

Takeaway 2 Feel++ offers options to test autotuning strategies for multiphysical partitioned coupling, to be discussed early in 2026

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Discussions Summary

Main Discussion Points

Discussion 1 GenEO for saddle points problems and other innovative implementations: FreeFem++ is the natural testing environment, but some benchmarks can be advantageously shared with Feel++ (same test, compared different implementations)

Discussion 2 Transient multiphysics and autotuning: need to have simple systems exhibiting some well understood dependency to some given parameters (such as stop criteria, inner time scheme parameters) to design robust and reliable autotuning strategies within the time iterations; after a building block phase to acquire knowledge and stick to CEA promoted solutions, Feel++ can offer alternatives and broaden the applicative range

Main Discussion Points

Discussion 3 Transport equation: early discussions regarding explicit scheme in space with the parallel challenge of managing multiple resolution fronts ; Feel++ possibly makes it possible to test numerical schemes such as DG/HDG/HHO

Discussion 4 Composyx for dense linear algebra, internal language to manage matrices, possibly replacing eigen (no more French contribution, but relay taken from the community, including tensor computation)

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Conclusion

Summary and Next Steps

- Composyx as a backend for Feel++
- PETSc in HPDDM, same benchmarks with FreeFem, other benchmarks either partitioned or monolithic
- Upcoming meeting for autotuning and partitioned coupling adding Feel++ to the scope of the current work
- GenEO on schur complement, some things can be explored
- Interest expressed for DG/HHO applied to elliptic problems

Thank you!