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INVOICE

Recipient

Electro Magnetic Applications Inc.	143 Union Blvd #900, Lakewood, CO, 80228, United States of America	Timothy McDonald tim@ema3d.com

Invoice Number	**Date**	**Payment Due**	**Project Name**
AAA202409200	September 20, 2024	September 30, 2024	Charge Plus Optimization

ITEM	**TIME [min]**	**RATE [$/minute]**	**SUBTOTAL**
August			
EMA3D-1876 Backlog of configurations required to run charge on Linux. Fix problems with license, problems with transferring files into the Linux machine (WinSCP). Familiarize with modifications in the test suite regarding execution scripts and locations of files until successful execution of tests. Tests are needed to guarantee that the version used is not only correct but also compiled correctly. General overlook of data structures in VectorSolve , identify coverage of the given test, time properly.	180	5	$900.00
September			
EMA3D-1876 Time measurements and determination of the time bottlenecks in `FemQS::VectorSolve`. Discovery of main bottleneck due to the usage of CSR-Format data structures that was underperformant in the past when working with `FemMatrix::parvector` to optimize `FemMatrix::BiCGStabVectorSolve`.	120	5	$600.00
EMA3D-1876 New `FemQS.cpp` file created with loop simplification to improve vectorization. **Measurements give 70% speed-up on `FemQS::UpdateGlob` and 40% speed-up on `FemQS::VectorSolve`.**	120	5	$600.00
EMA3D-1876 Microsoft Teams chat, delivered new `FemQS.cpp` for testing, explained changes involved and impact of loop simplifications. Agreed on concentrating in `FemQS::BuildForce`, `FemQS::BuildGrad` and `FemQS::GradSolve`.	65	5	$325.00
EMA3D-1876 Study of `FemQS::BuildForce`. Identification of critical loop and assignments. Findings show a high amount of branching, recommendations issued.	120	5	$600.00
EMA3D-1876 Microsoft Teams conversation about the usage of `MPI_AllReduce` in `ReadNew::PIC::VectorAll`. Recommeded usage of `MPI_Reduce` instead to reduce operations by a factor of 2 since no redistribution of the final result is needed for writing results to disk.	30	5	$150.00
EMA3D-1876 Chat with Bryon, informed me about the implementation of the changes I suggested in the comments, regarding FemQS::BuildForce and FemQS::VectorSolve. **Test case runs 2x faster on Linux** Informed Bryon that `FemQS::BuildForce` still needs work in all the parts it uses `ReadNew::NodalForce` and `ReadNew::BasisArea` that also cause branching. Proposed a solution involving explicit template class instantiation, discussed it, provided running examples to Bryon. Bryon concluded he'll take a look at them and get back to me. Concluded we'll shift focus to PIC for now (**EMA3D-1418**).	80	5	$400.00
EMA3D-1418 Setup workspace with new test. Instrument `ReadNew::PIC::UpdateGlob()` First timings done. Issued question to Bryon on first observations.	60	5	$300.00
EMA3D-1418 Pulled the most recent `branch1` by Bryon's request. Launched tests again, still getting very slow code and nan's, not suitable to start optimizing, checked again that my files coincide with the files given by Bryon, exported files to Koi for Bryon to take a look. Issued comment on Jira and will await further directions.	20	5	$100.00
		Total	$3,975.00