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INVOICE

Recipient

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

Electronic payment information   Wells Fargo - Account number 8094382838 - Routing number 102000076

Invoice Number	Date	Payment Due	Project Name
AAA202410200	October 20, 2024	October 30, 2024	Charge Plus Optimization

ITEM	TIME [min]	RATE [$/minute]	SUBTOTAL
September			
EMA3D-1418			
Transfer new test case files from Koi with modifications. Include test case in test suite and run to check that no `NaN`'s are present. The case run successfully in 50min. Transfer output back in case Bryon wants to take a look.	10	5	$50.00
EMA3D-1418			
Instrumentation of `PIC::UpdateNew()` separated in meaningful sections. Will report relevant line sections and time percentages. Had to deal with an instability on Linux where the code stalls, will report it back to Bryon and continue to try to find the key line producing it.	120	5	$600.00
EMA3D-1418			
Instability associated to `Rate Preprocess = True` identified and reported in comment. Tip of `branch1` has been modified in such a way that the instability no longer appears, so working with new commit until further notice about the issue.	60	5	$300.00
EMA3D-1418			
Identification of repeated calls to `vector <double> efield = RN.fem_->EFE(el_num,xval)` as the source of **40%** of the time in `PIC::UpdateNew(double)` investigating algorithmic improvements for reading `efield`.	30	5	$150.00
October			
EMA3D-1418			
Identification of unnecessary code in `TE4SubStruct::GradValues`, plus improvements in constness and redirection led to a **70%** speedup in the call to `RN.fem_->EFE` inside `PIC::UpdateNew(double)`, and overall ∼**20%** in `PIC::UpdateNew(double)`.	90	5	$450.00
EMA3D-1418			
Bring the code actually being executed to obtain `efield` for the `RF_cube` case provided by Bryon out of the virtual table lookup. Result is **330%** speedup to obtain `efield` and **42%** speedup overall in `PIC::UpdateNew(double)` Report to Bryon through JIRA.	180	5	$900.00
EMA3D-1418			
New measurements indicate the ∼**2 million calls per timestep** to `int ReadNew::PIC::CurrentElement(vector <double>)`, now take **20%** of the time in void `ReadNew::PIC::UpdateNew(double)`. Looking into the necessity of the costly search performed in that function.	60	5	$300.00
EMA3D-1418			
New measurements on Bryon's last commit as of today on Linux, confirming a **200%** speedup of `ReadNew::PIC::UpdateNew(double)` after `efield` optimization. Reporting back to Bryon with answer to inquiry about space filling curves with bibliography.	30	5	$150.00
EMA3D-1418			
Analyzed `int ReadNew::PIC::CurrentElement(vector <double>, vector <double>, Uint)`. Found out that it spends most of the time querying a `vector <double> kElemMap` and not a lot can be gained modifying the code as it stands for now. Shifted focus to other parts of the code.	60	5	$300.00

EMA3D-1418

Simplifying the calculation of `energy_1`, `energy_2` and `energy_3` and taking away branching for vectorization led to **35%** speedup measured. Informed Bryon on comment.	120	5	$600.00

EMA3D-1418

New timings breakdown, identification of new main objectives of optimization, report to Bryon through JIRA.	60	5	$300.00

		Total	$4,100.00