Schedule for the release of 2019 M-OSRP speedup versions of ISS IMA (internal multiple attenuation)and ISS IME (internal multiple elimination) codes for sponsors

- There are six basic deliverables that will benefit from the 2019 M-OSRP speedup : ISS IMA in 1D, 2D, and 3D, ISS IME in 1D, 2D, and 3D
- ISS IME deliverables to be released in stages, each with a different number of terms past ISS IMA. ISS IMA is the first term in the ISS IME series.
- The original ISS IMA documented codes in 1D, 2D and 3D are already in the sponsor-only website. The latter include a specific code for accommodating primaries and internal multiples in the ISS IMA input – called for when there are a very large number of multiple generators. The sponsor only website also has well documented preprocessing codes for separating the reference wave and reflection data, de-ghosting the reflection data, and ISS free surface multiple elimination in 1D, 2D and 3D. For high-end internal multiple removal, we advocate using the ISS free surface multiple elimination method (rather than SRME) to maximally and most effectively remove free surface multiples while preserving primaries and internal multiples.

ISS IMA and ISS IME in **2D** Create model and data Develop 2D ISS IME to include speedup **Test** ISS 2D IME code	**Delivery date** end September 2019
Document 2D ISS IME code Modify 2D ISS IMA to include speedup, test and document code **Release** 2D ISS IMA and ISS IME speedup codes to M-OSRP web site	end November 2019
ISS IMA and ISS IME in **1D** Create model and data Modify 1D ISS ISS IMA and ISS IME to include speedup, **test and document** code	

Release 1D ISS IMA and ISS IME codes to M-OSRP web site	end February, March 2020
ISS IMA and ISS IME in **3D** Create model and data **Modify** 3D ISS IMA to include speedup, test and document code (using 2D data) **Develop** 3D ISS IME to include speedup, test and document code (using 2D data) **Release** 3D ISS IMA AND IME codes to M-OSRP web site	Will seek sponsor collaboration/partnership to access adequate compute power for the 3D model data creation and 3D ISS IMA and ISS IME tests end January , February 2020

NOTES on the schedule

The documented codes will provide several items: (1) a step by step description of the preprocessing required before the data is ready for internal multiple removal, (2) the detailed mathematical derivation that resides behind the 2019 M-OSRP IMA and IME speed-ups, and (3) the factor that is called upon and utilized after a finite term elimination algorithm is applied to mitigate the difference between that finite term algorithm and the complete infinite term elimination sub-series, without computing higher order terms. **At this time, the latter two items will only reside within the M-OSRP sponsor-only proprietary codes, and documentation, in the sponsor only website.**

The 2019 M-OSRP ISS internal multiple speedup (pioneered and developed within M-OSRP by Dr. Fang Liu and colleagues) is totally independent of previous speed-up contributions from M-OSRP (e.g., Corrigan, Kaplan, Terengui) and all publicly available approaches with that same purpose.

The reported added value of the 2019 M-OSRP speedup for ISS IMA is measured relative to our own fastest and all current publicly available speedup approaches.

Dr. Mayhan is working with Dr. Fang Liu on the documentation.

The computation time for the 2019 M-OSRP IMA speedup implementation will be 1/n of the fastest implementation documented in all currently publicly available speed-ups, where $n=\sqrt{(n_g*n_s)}$, n_s being number of shots, n_g being the number of receivers per shot.

If we assume:

- N_{xs} and N_{xg} are samples of sources and receivers in the x-direction,
- N_{ys} and N_{yg} are samples of sources and receivers in the y-direction,
- N_{kxs} and N_{kxg} are samples of sources and receivers in the k_x-direction,
- N_{kys} and N_{kyg} are samples of sources and receivers in the k_y-direction.
- The number of samples in any direction should be (at least approximately) the same as the corresponding conjugate domain: $N_{xs} \approx N_{kxs}$, $N_{xg} \approx N_{kxg}$, $N_{ys} \approx N_{kys}$, $N_{yg} \approx N_{kyg}$,

then the critical parameter N_k can be computed as:

$N_k = \sqrt{(N_{kxs} N_{kxg})} \approx \sqrt{(N_{xs} N_{xg})}$ for 2D,

$N_k = \sqrt{(N_{kxs} N_{kxg} N_{kys} N_{kyg})} \approx \sqrt{(N_{xs} N_{xg} N_{ys} N_{yg})}$ for 3D.

Straight forward $N_k^4 N_z^4$	Kaplan $N_k^4 N_z^3$
Publicly available $N_k^3 N_z^2$	
2019 M-OSRP speedup $N_x^2 N_z^2$	

Computational cost of various implementations. N_k is the number of samples in the wavenumber k, N_x is the number of samples in lateral coordinate x, N_x should be always of the same of the magnitude of N_k. N_z is the number of samples in depth. For a typical 2D data set: $N_{xs} = 324$, $N_{xg} = 960$, $N_t = 3385$, and we take $N_k = N_x = \sqrt{(N_{xs} * N_{xg})} = 557.71$, $N_z = N_t = 3385$, the computational cost for the 2019 M-OSRP speedup for ISS IMA is approximately 550 times faster than the fastest existing publically known algorithms for ISS IMA.

The 2019 M-OSRP speed-up for the normal standard required wave theory processing of 2D and 3D data for the ISS Internal Multiple Attenuation (IMA) algorithm is below- the relative benefit will be yet greater for the ISS Internal Multiple Eliminator (IME)

For an ideal 2D data set with sufficient long offset coverage, N_{xs}=1000, N_{xg}=3000. We have n=1732, and the speedup will be 1732 times faster.

Furthermore, for an idealized 3D data set with equal coverage in both x (in-line) and y (cross-line) direction that sufficient long offset coverage: N_{xs} = N_{ys} = 1000, and

$N_{xg} = N_{yg} = 3000$. In this case we have n=1000*3000=3 million, and consequently the speed would be 3 million times faster than the fastest publicly known IMA algorithm.

Added value of the 2019 M-OSRP speed-up for ISS IME is far greater than (the already noteworthy and impressive) corresponding ISS IMA comparison

The relative added value of the 2019 M-OSRP speedup concept and methodology for the ISS IME algorithm will be enormous and much greater (than the above ISS IMA analysis and comparison) when a comparison with the current top-tier publically available ISS IMA speedup ideas and concepts would be applied to ISS IME.