InSite Webinars

From Waveforms to Seismic Events: Seismic Data Processing Using *InSite* Seismic Processing Software.

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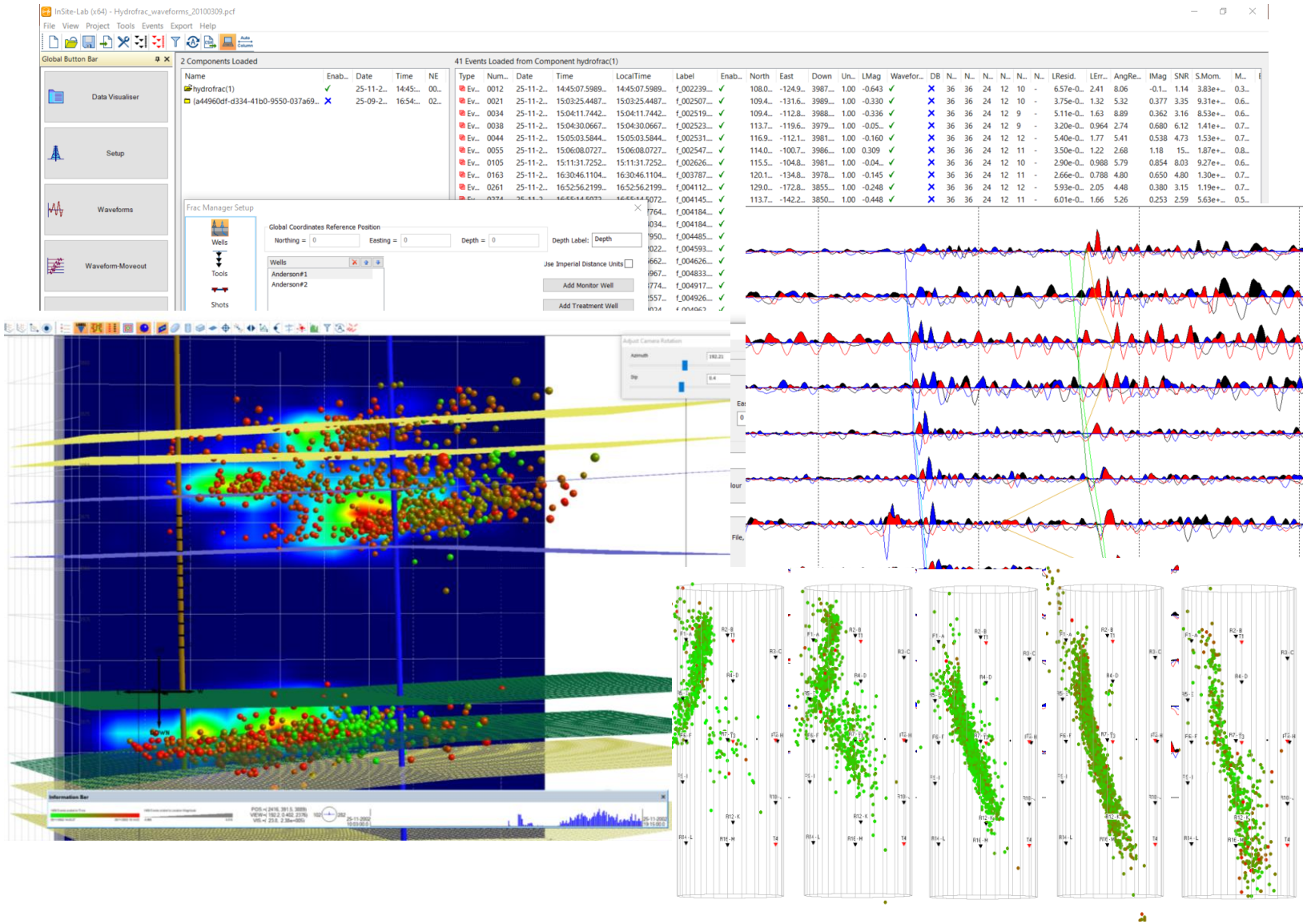
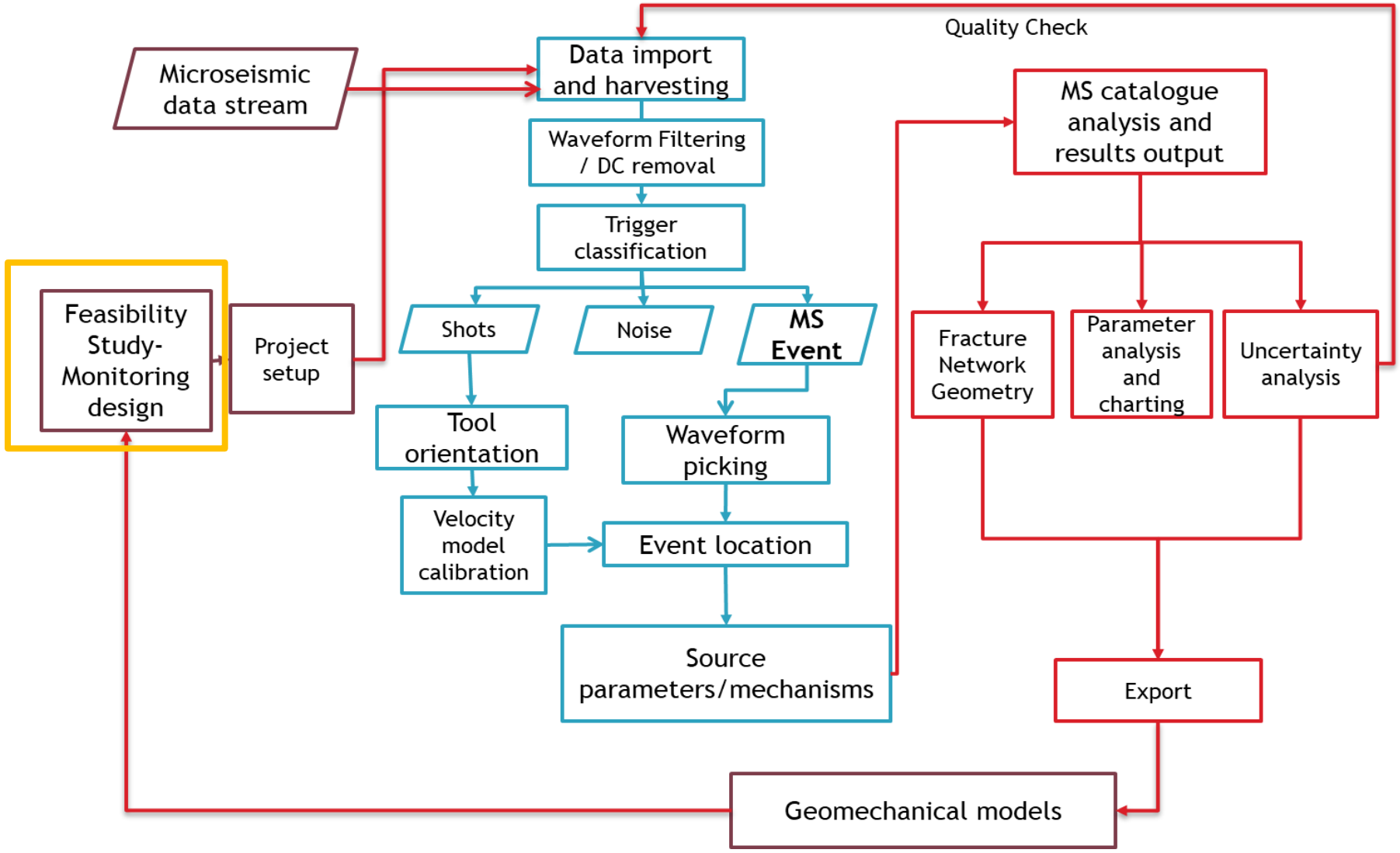
InSite Seismic Processor

- Itasca's seismic software integrating data management, processing, analysis and interpretation
- Developed over the past 20 years incorporating tools from internal R&D and collaboration projects with clients and partners
- Used at all scales of seismic and acoustic monitoring, from laboratory rock deformation tests to processing of local and regional seismicity
- Latest version 3.16.1 released March 2020

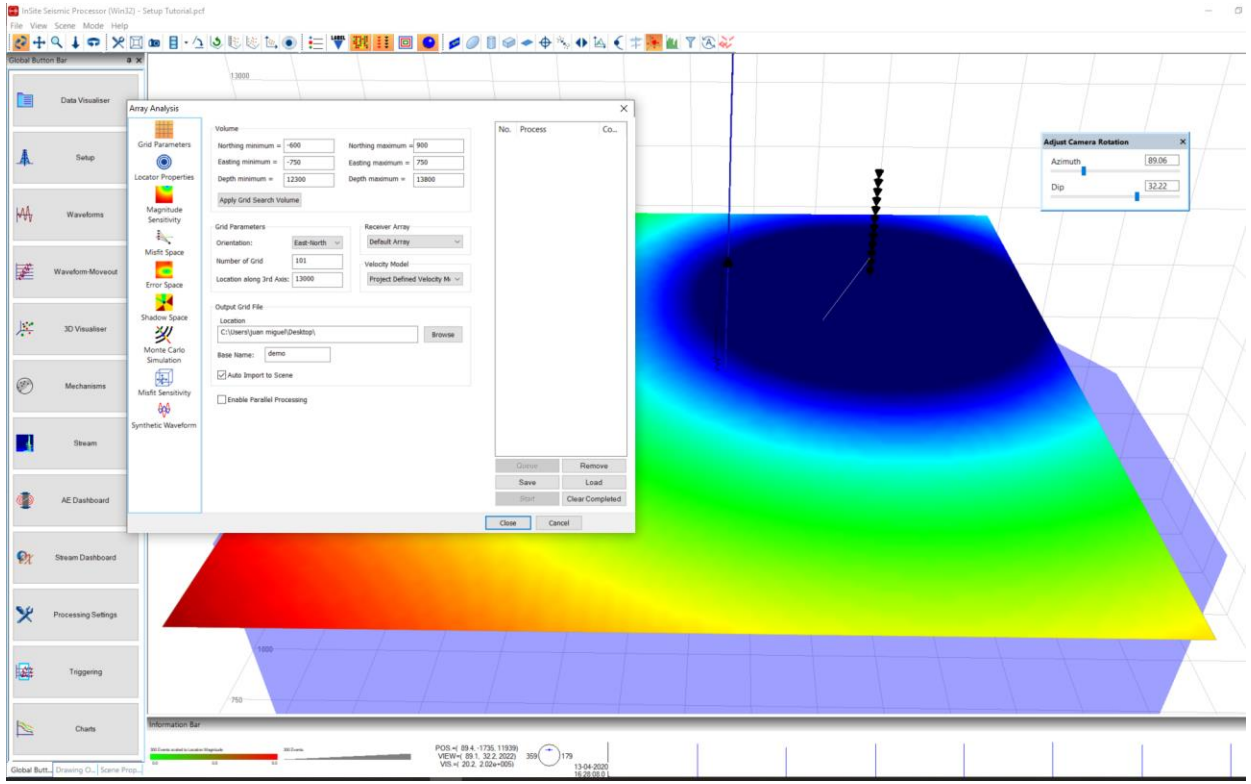


Monitoring Design

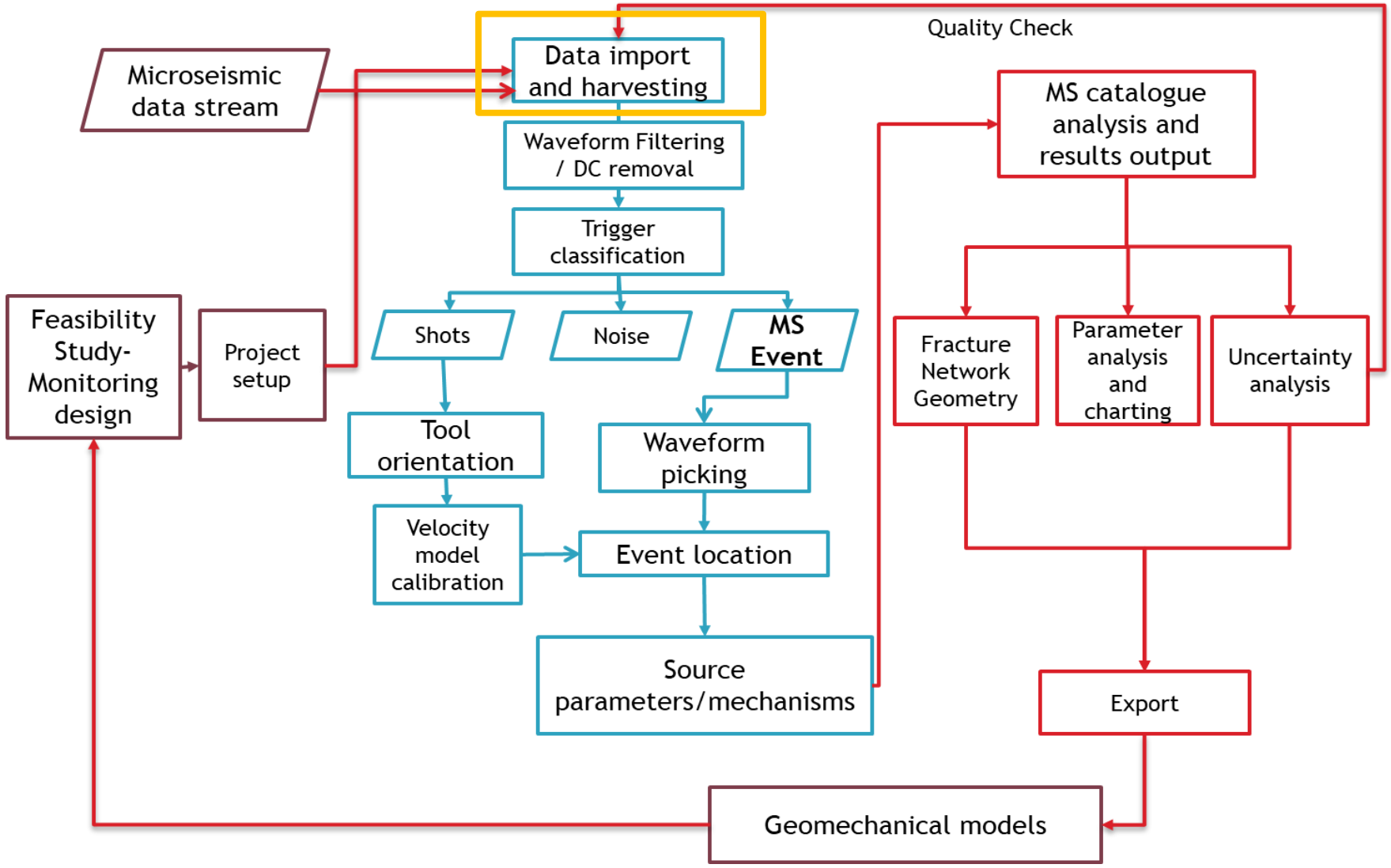


Monitoring Design

- Simulation of the performance of existing or proposed monitoring arrays
  - Distribution of threshold magnitude
  - Misfit space: topography of search space for location algorithms
  - Shadow space: distribution of the number of stations in line-of-sight
  - Monte Carlo simulation of location errors
  - Generation of modelled synthetic waveforms

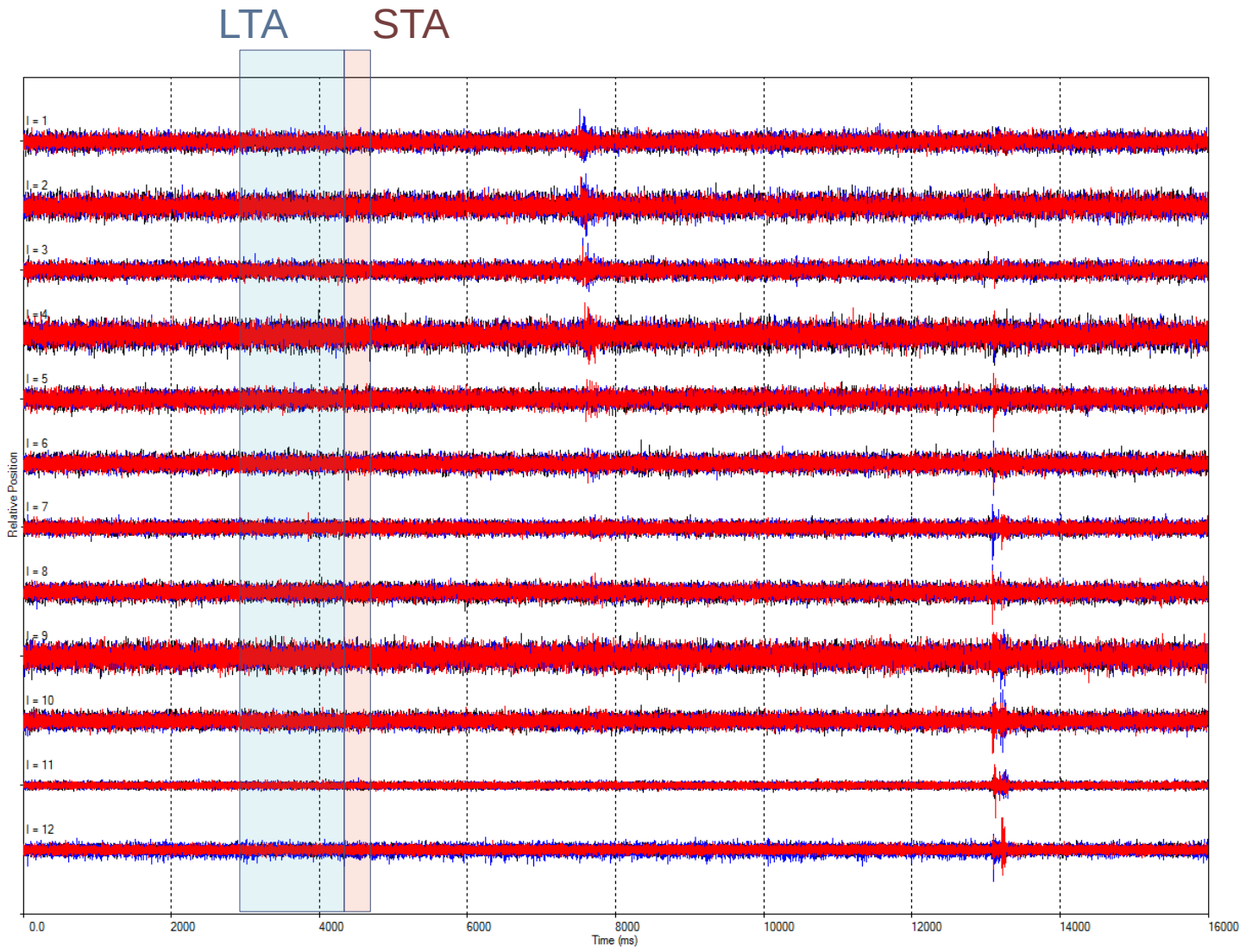


Waveform import and harvesting

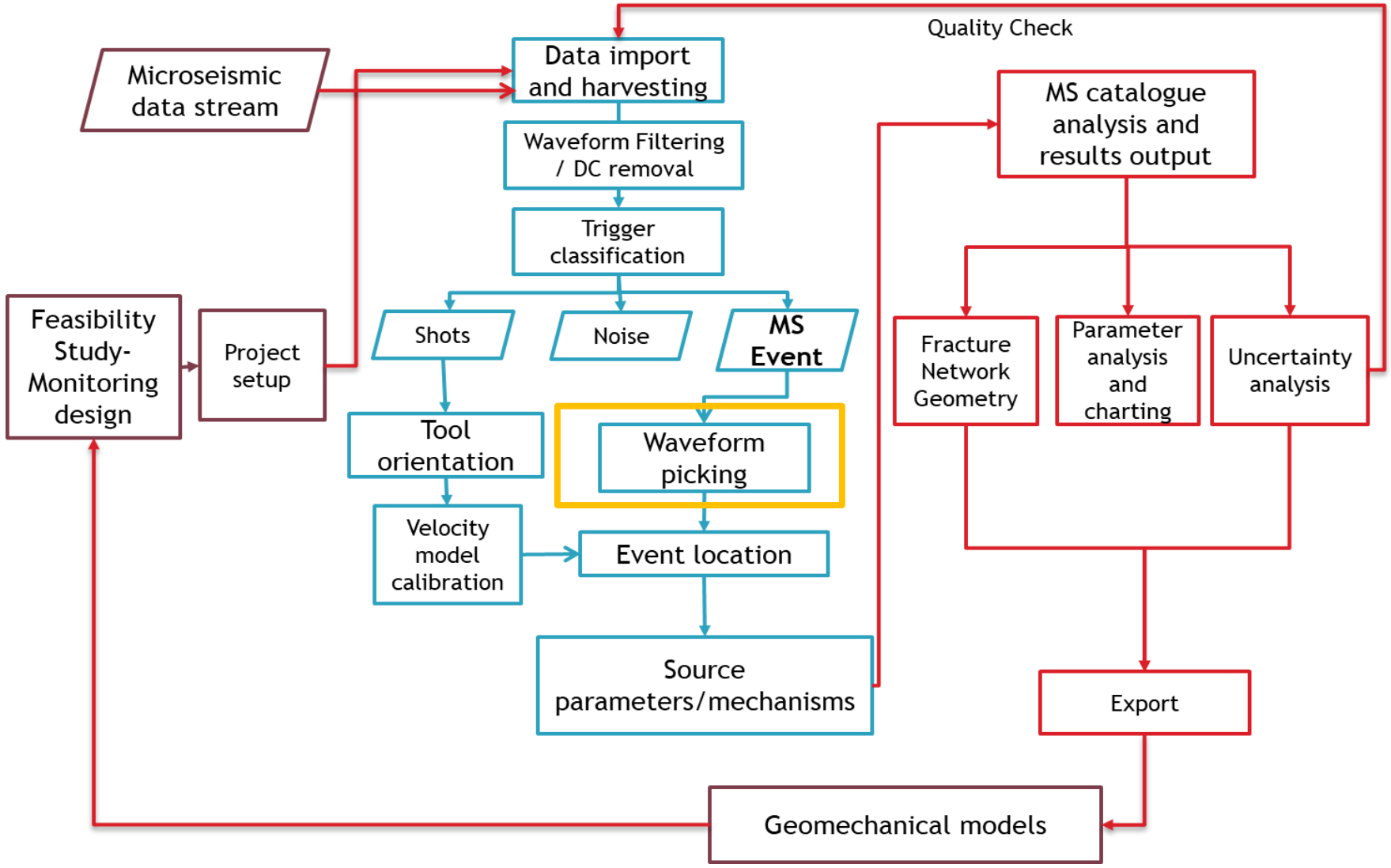


Event detection and harvesting (InSite Leach)

- First step is the detection of seismic arrivals within the recorded data stream
- Scan the microseismic stream for triggers (potential events)
- Amplitudes in STA and LTA windows are compared to identify arrivals
- Coherence accross the array is also considered

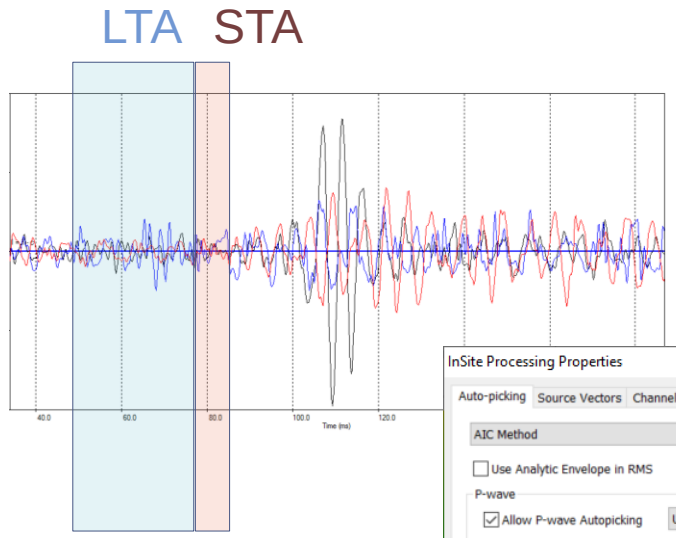


Arrival Identification and Picking

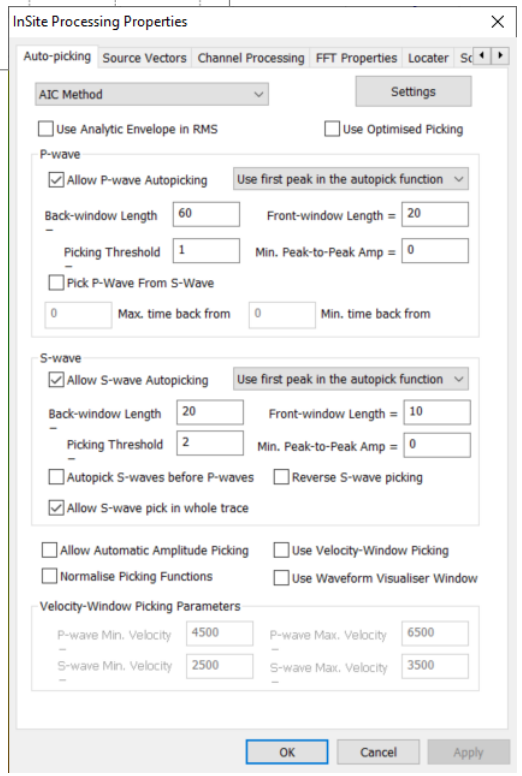


Automatic Phase Picking

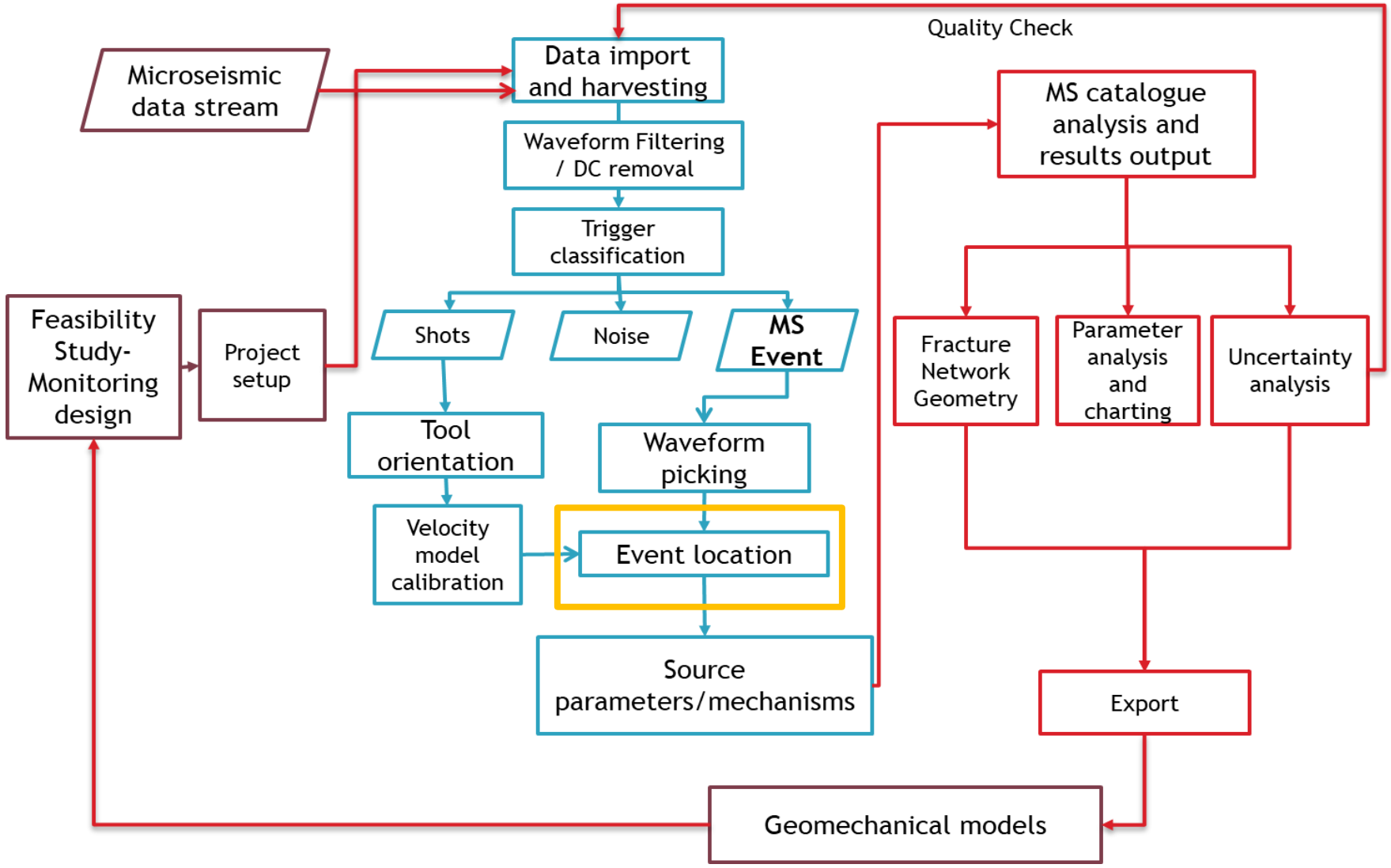
- Similar to Event harvesting, typically double window (STA/LTA) are used to automatically identify phase arrivals
- Picking function value and window sizes are determined by the signal-to-noise ratio of the signals
- Alternative options include searching for polarisation, or changes in frequency domain
- Optimised picking based on trends in linear arrays and cross correlation
- Customisable search for P and S wave arrivals



Picking function = Amp(STA) / Amp(LTA)



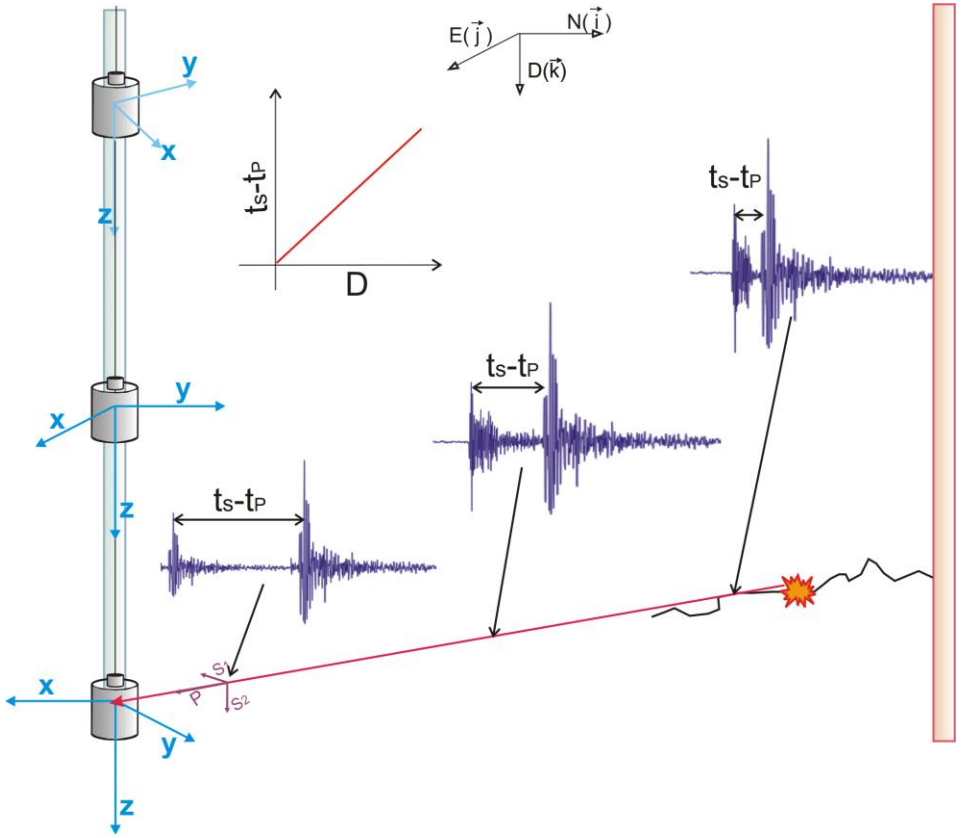
Event Location



Event Location

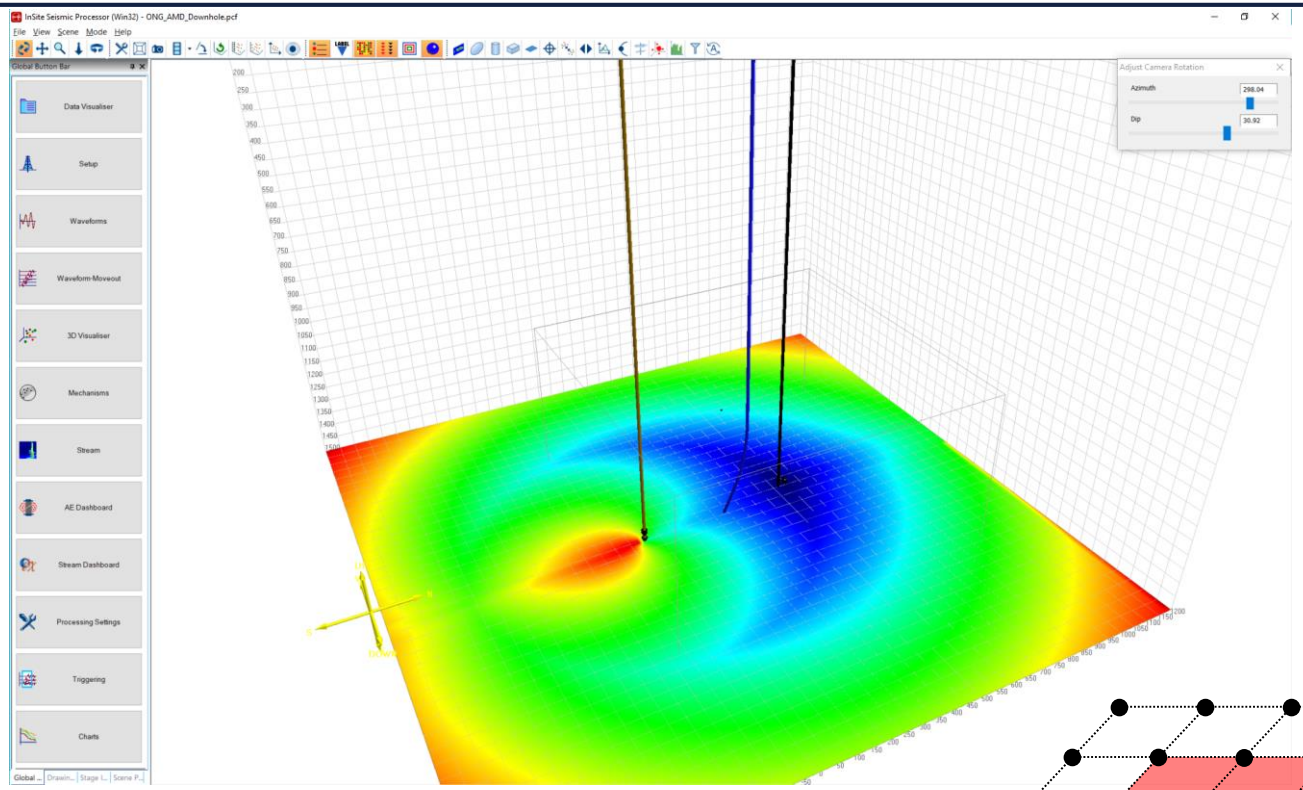
- Velocity models:
  - Homogeneous Isotropic
  - Homogeneous Transversely Isotropic
  - Layered Isotropic
  - Layered VTI
  - Complex
  - Time dependent models

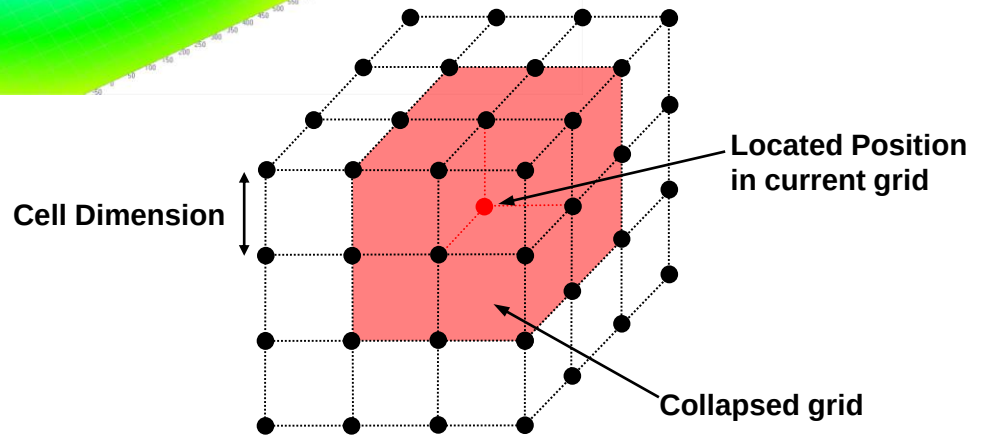
- Inversion Algorithms:
  - Homogeneous media
    - Geiger (isotropic)
    - Simplex (isotropic and VTI)
  - All media
    - Collapsing Gridsearch
    - Source Scan



Event Location: Collapsing Grid Search

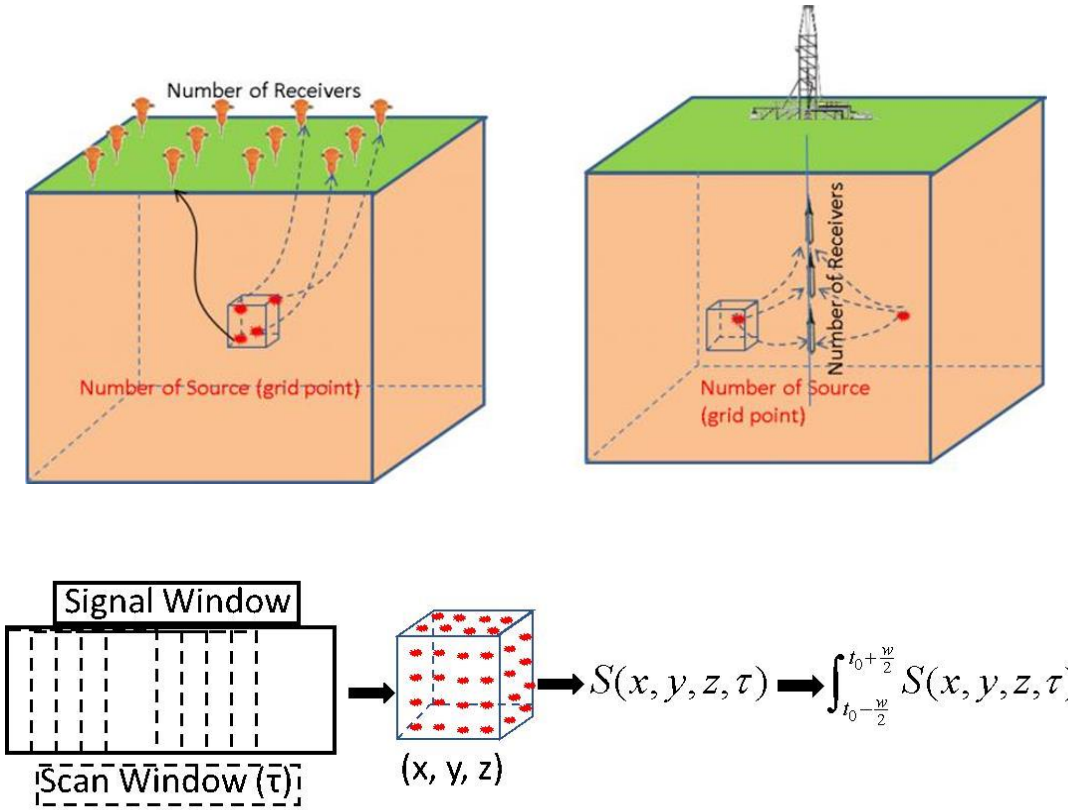
- Search for residual minimum (location) by dividing the search volume into a number of small cells to create a grid. The grid is initially “coarse” as defined by the user.
- The algorithm calculates the error space misfit at each node on the grid.
- The grid then ‘collapses’ around this node to create a finer grid.
- This process continues until the accuracy of the grid reaches the desired resolution.



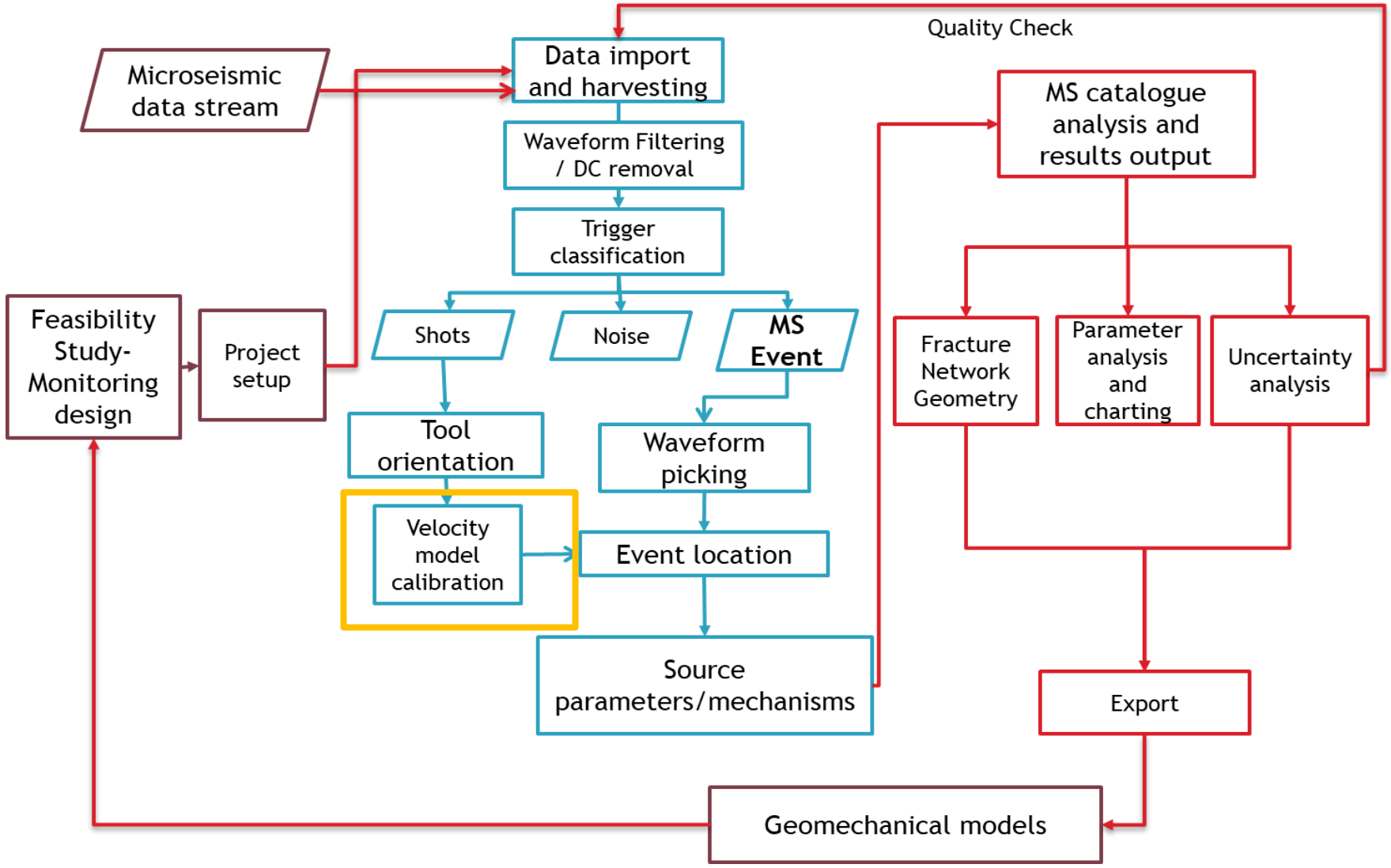


Event Location: Source Scan

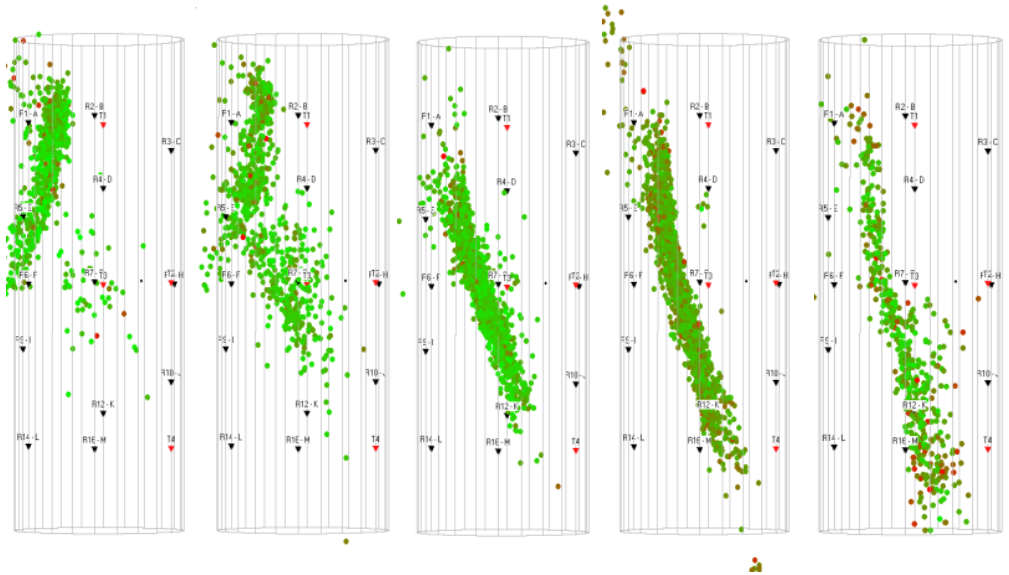
- Waveform-based method, not requiring phase picking
- Based on checking the fitness of theoretical arrivals to the waveform for every grid point in a search volume, yielding as solution the point that maximises the fitness
- The fitness function is the stack of semblance weighted auto-function of the waveform, which can be the STA/LTA based on the RMS, RMS of the envelope or the AIC trace
- Polarization of P-wave can also be used as an additional weight
- Process is accelerated using a Gaussian Particle Swarm Optimization in the search

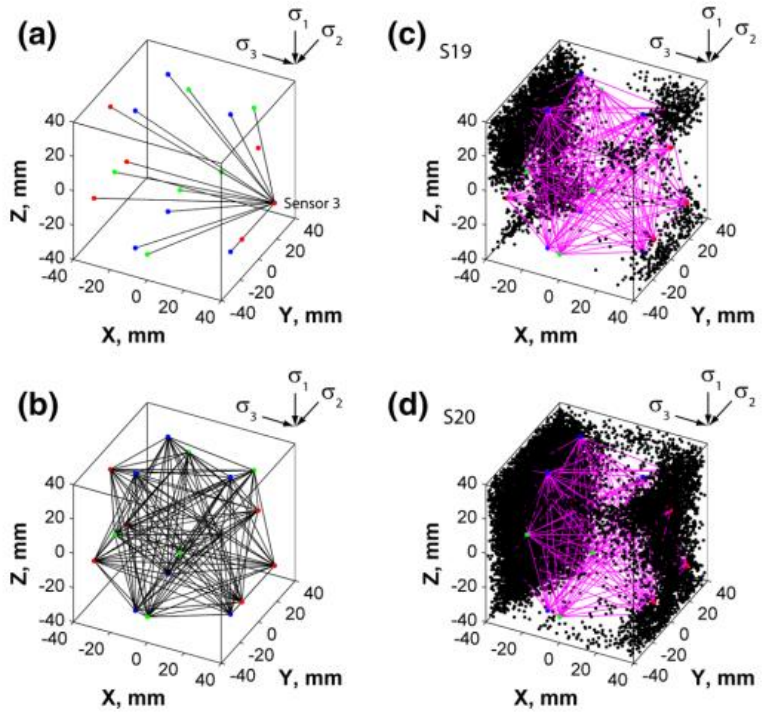


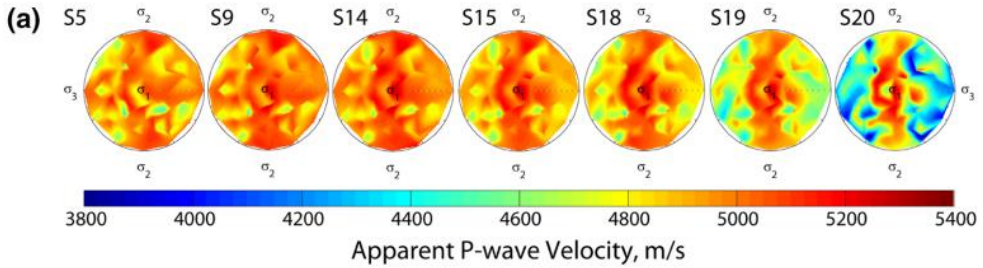
Velocity Model Calibration



Time-dependent velocity models: Velocity Surveys



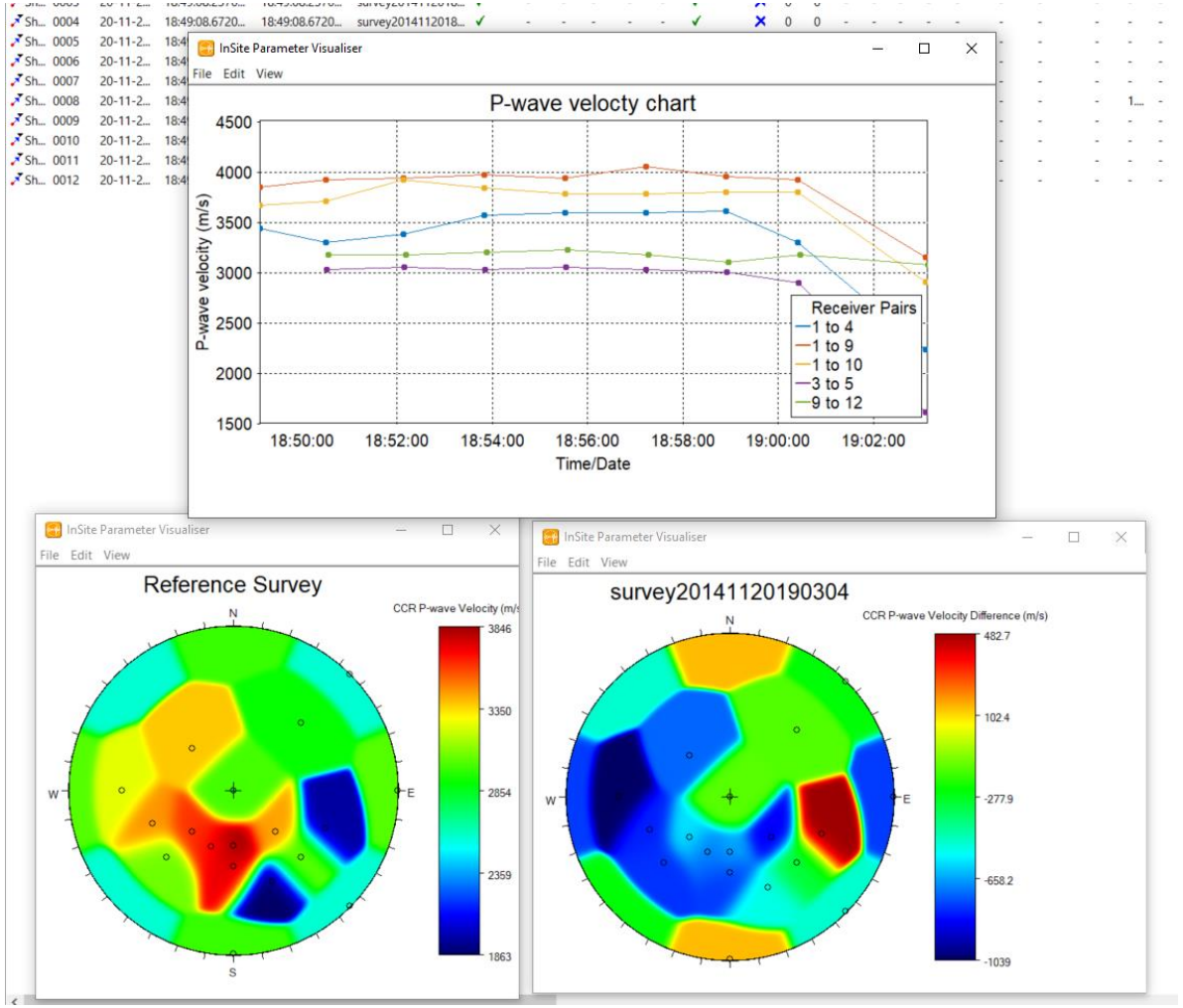




Time-dependent velocity models: Velocity Surveys

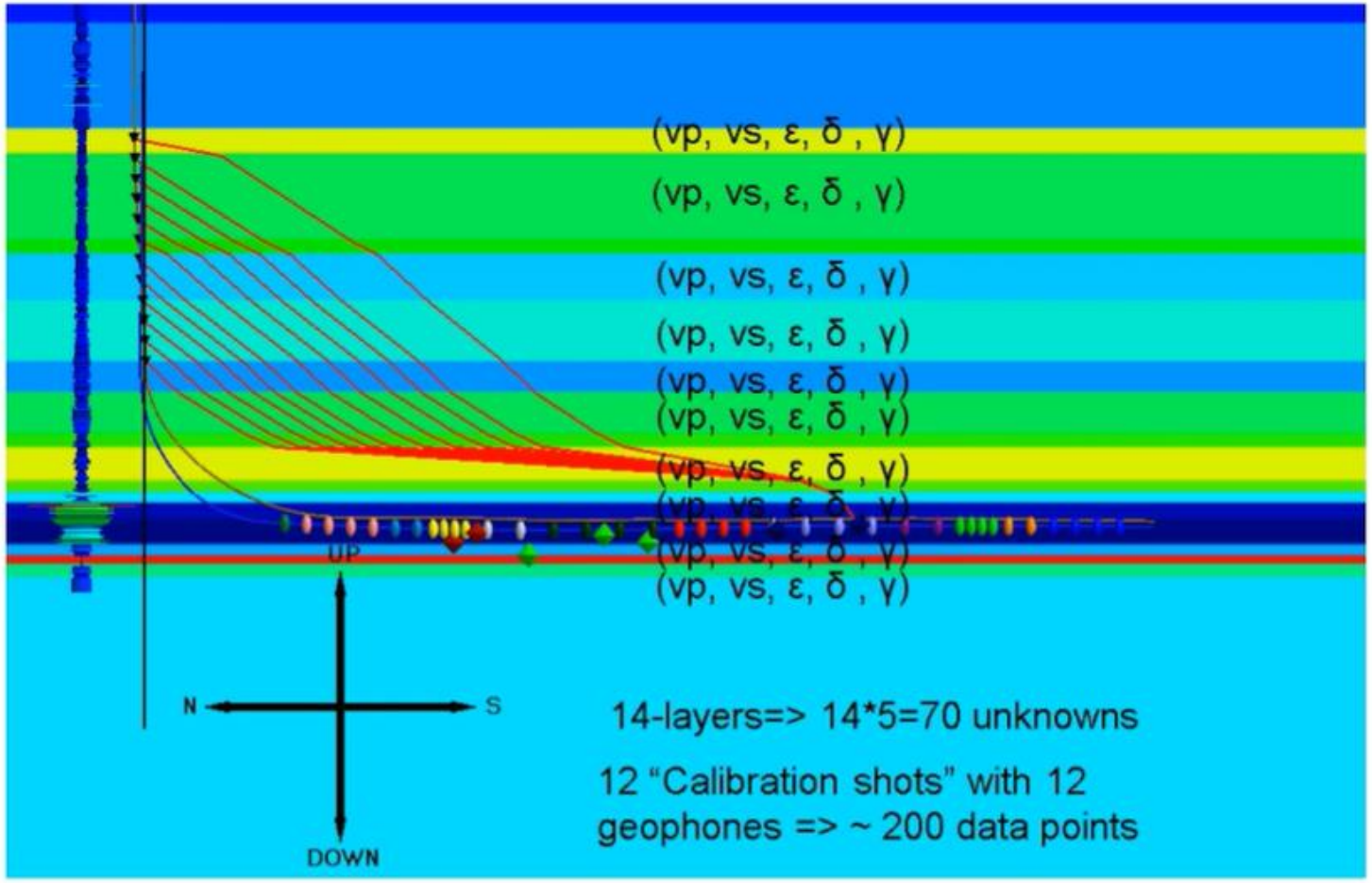
- Periodical velocity surveys covering as much of the monitored volume and as many different directions as possible allow updating the velocity model during monitoring projects

- The model applicable to each time interval can be used in event location and estimate of source parameters

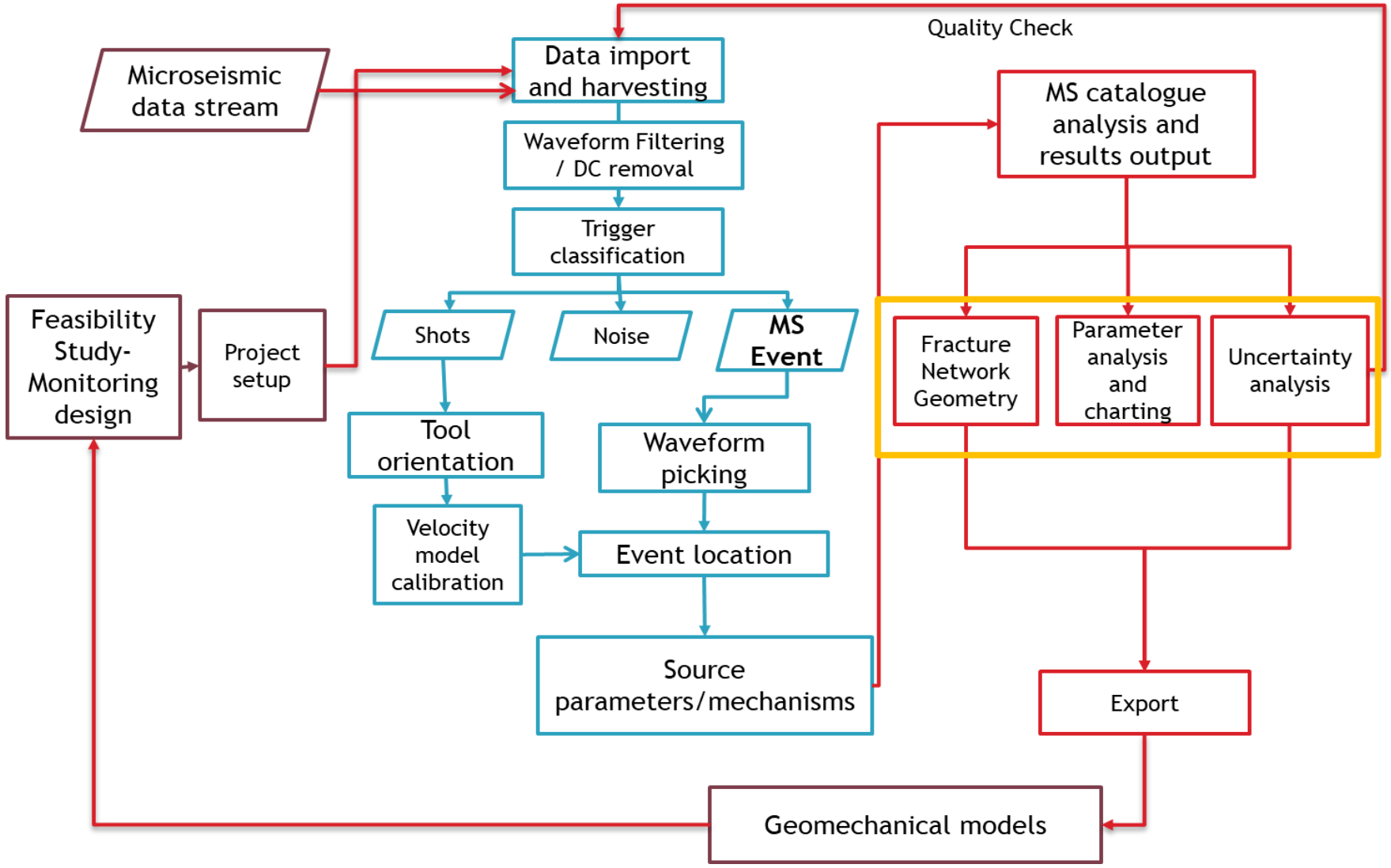


Velocity model Calibration

- Velocity models can be calibrated by optimising the location of ideally multiple known ‘events’ depending on the project and the scale:
  - Perforation shots
  - String shots
  - Surface vibes or weight drops
  - Ball drops
  - Early events

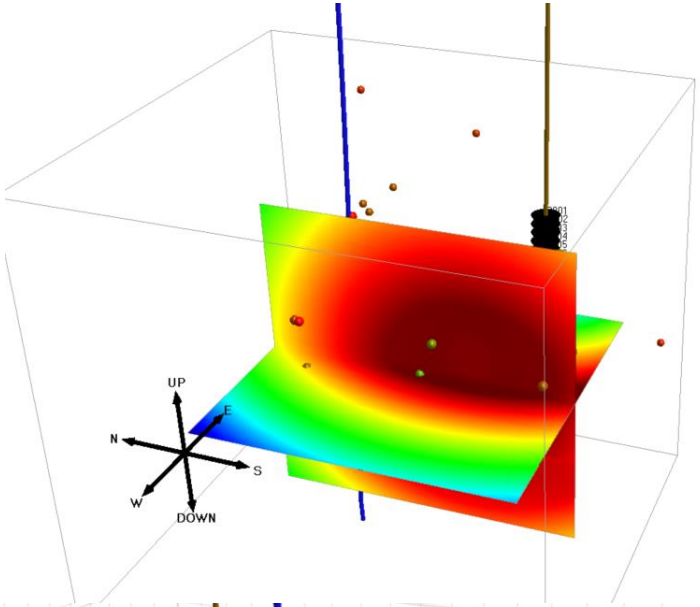


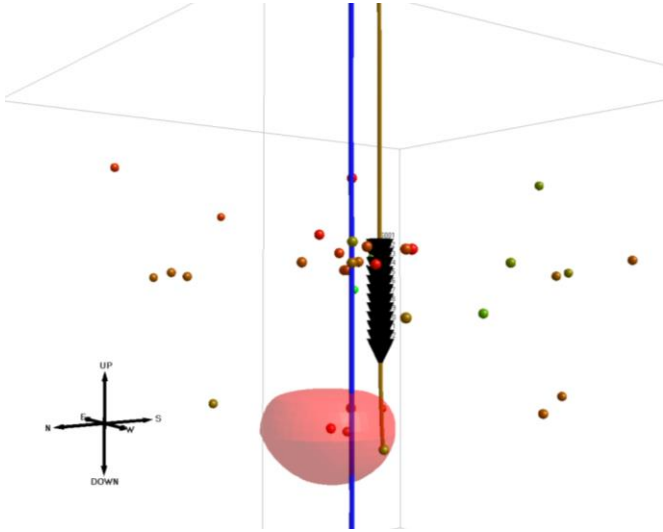
Event Results analysis

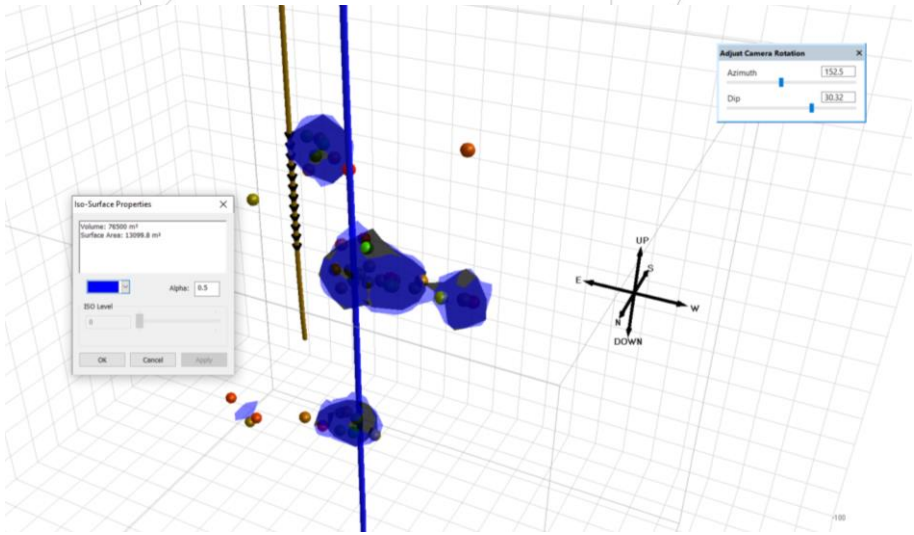


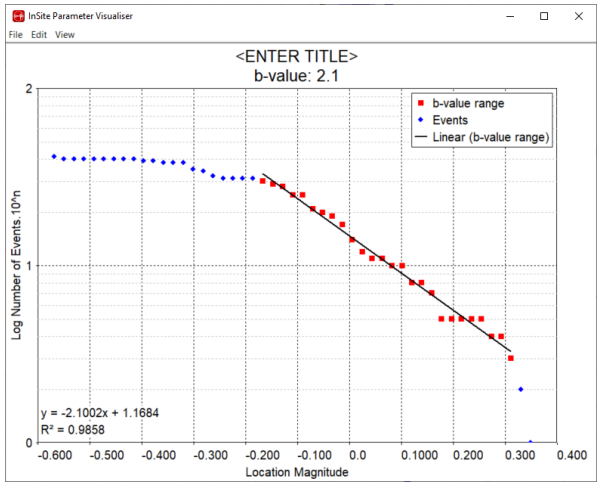
Events Results Analysis

- Analysis of processed Seismic/MS/AE events provides information on the fracturing process:
  - Fracture geometry
  - Fracturing process
  - Fracture mechanics
  - Location uncertainty









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