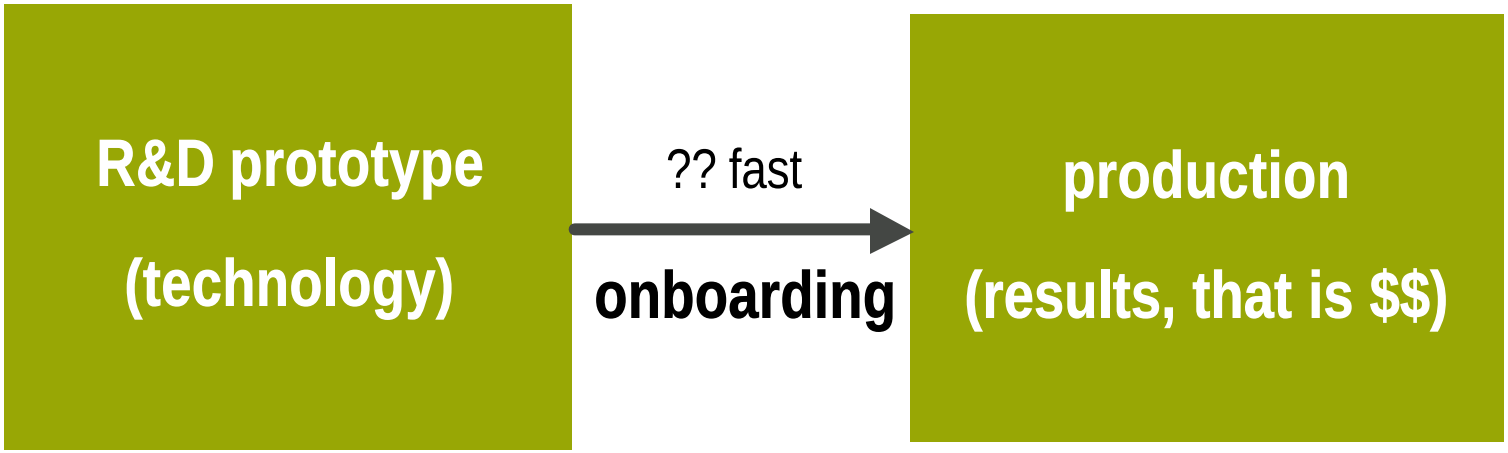
Java based distributed processing on a Linux cluster and data visualization of a Metropolis algorithm for petroleum exploration

Michael Glinsky, William Ryan, Guy Duncan, Neil Gaynor, Matthew Lamont (BHP Billiton)

James Gunning (CSIRO, Australian National Lab)

Synthia Kong and Olivier Lhemann (Interactive Network Technologies)

How do you get results from technology?



Questions to keep in mind

- What facets of this strategy could cause it to succeed, what could cause it to fail and need to be changed?
- What part of this strategy could be applied to nuclear weapons design?
- What changes would need to be made to the strategy to apply it to nuclear weapons design?

Outline

- Strategy
- Tactical plan
- Implementation
  - INTviewer
  - Configurable XML editor
  - DELIVERY (Metropolis model based seismic inversion)

Environmental changes

- Java
  - 25% to 30% development time and cost
  - Easy to port to new hardware platforms
  - Extendable (10-20x more than C or Fortran)
  - Performance rivals that of C and Fortran
    - 400 Mflop/s performance per Linux processor (Colt dense matrix benchmark), 60 Mflop/s (Linpack benchmark)
    - CERN Colt library
    - Insignificant object oriented overhead, performance determined by FFT speed (same as optimized C and Fortran program)
- OpenSource maintenance
- Linux clusters with LSF
  - Low cost
  - Robust distribution

Strategy

- Exploit superior knowhow
  - Increase the value of our assets
- Rapid technology development and onboarding
  - Maximize the rate of technology change

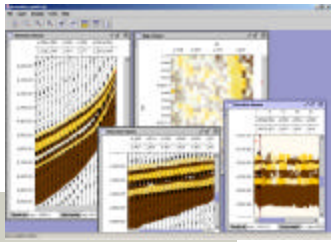
Tactical plan

- 100% Java based development
- OpenSource maintenance whenever possible
- Seismic Unix backbone
- INTviewer
  - servlet-applet, multi-tier structure
  - Java, XML saveset of view
  - Multidimentional 2D viewer, 3D in future
- Linux cluster with LSF
- General XML editor for parameters and distribution
  - Behavoir determined by xsd
  - Servlet-applet infrastructure

Software architecture supporting fast implementation

external consortia and vendors $$$

internal development



Delphi

Colorado School of Mines

advanced migration, model building with uncertainty

Monte Carlo driven map migration

seismic unix

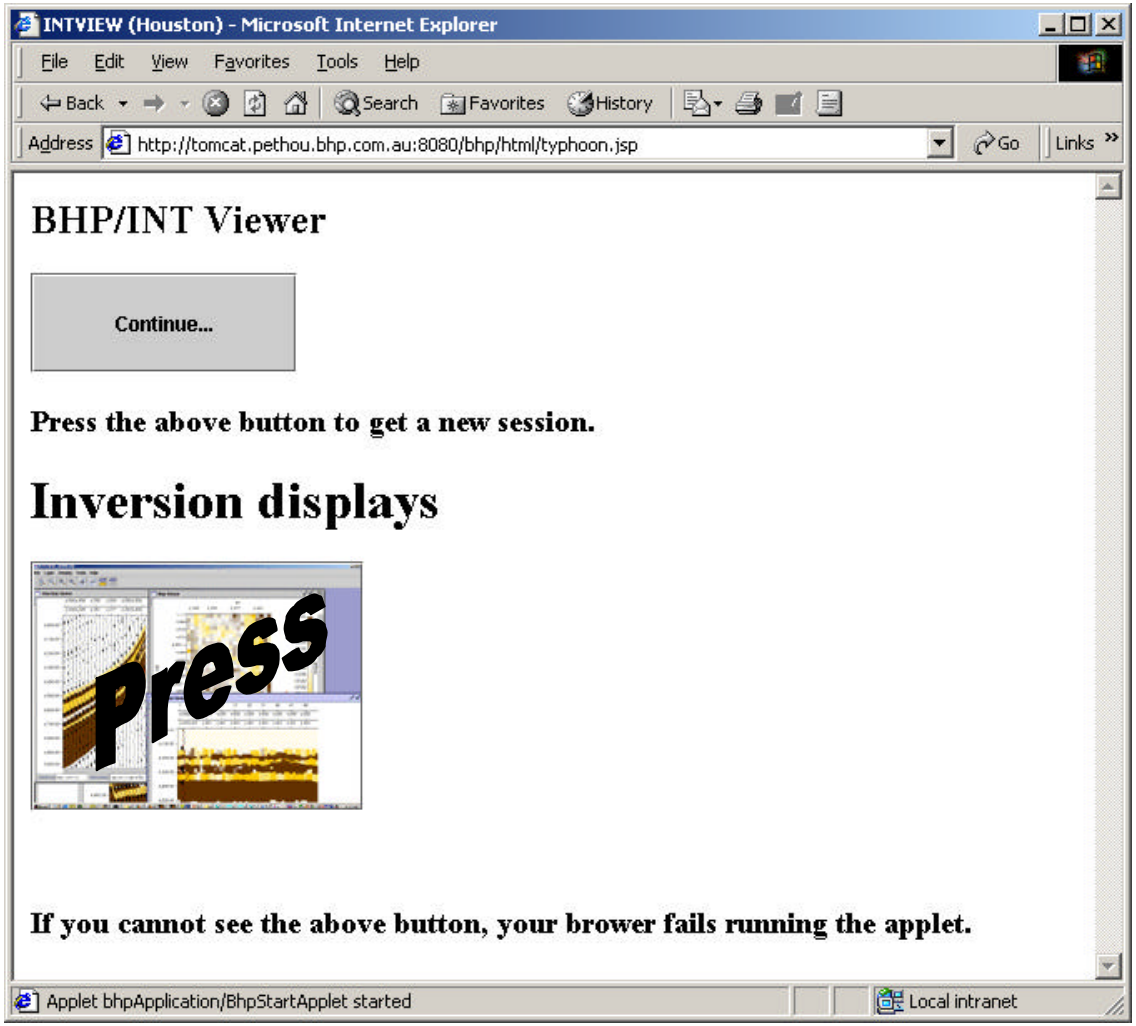
(seismic horizon, model, random access)

Java viewer

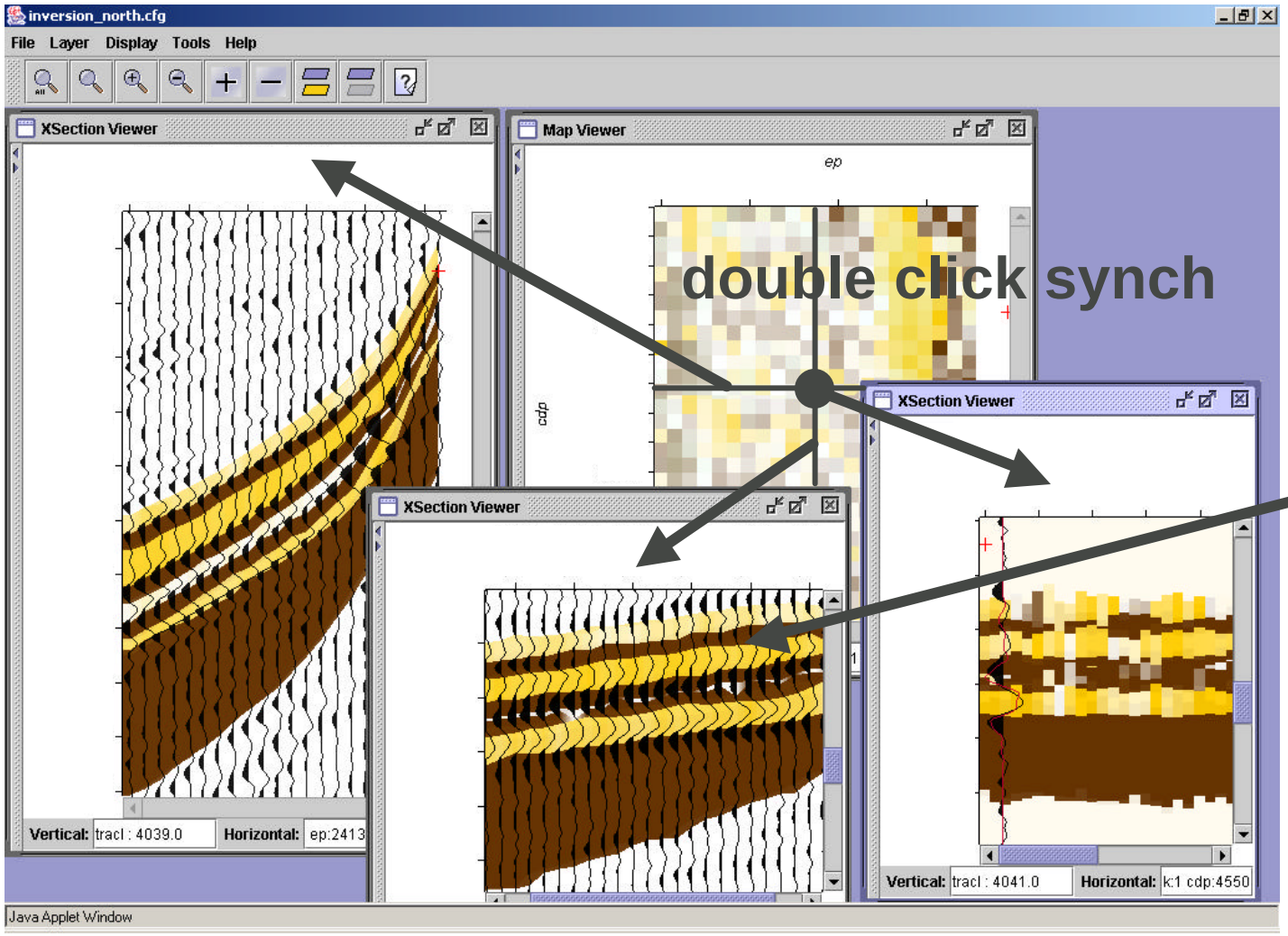
stochastic model based seismic inversion

wavelet based reservoir ID

Web page access to results – a picture that can be browsed



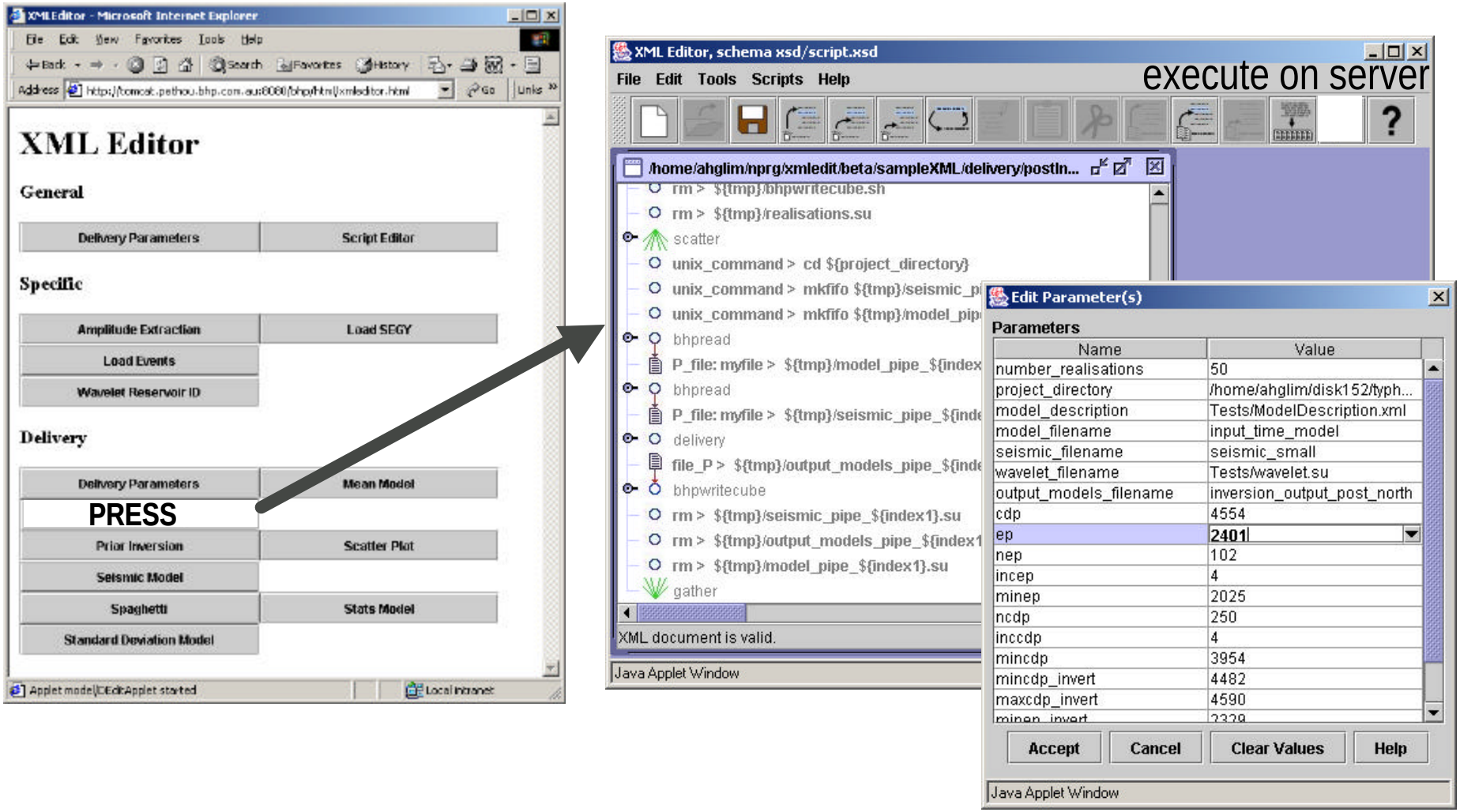
Synchronized viewer



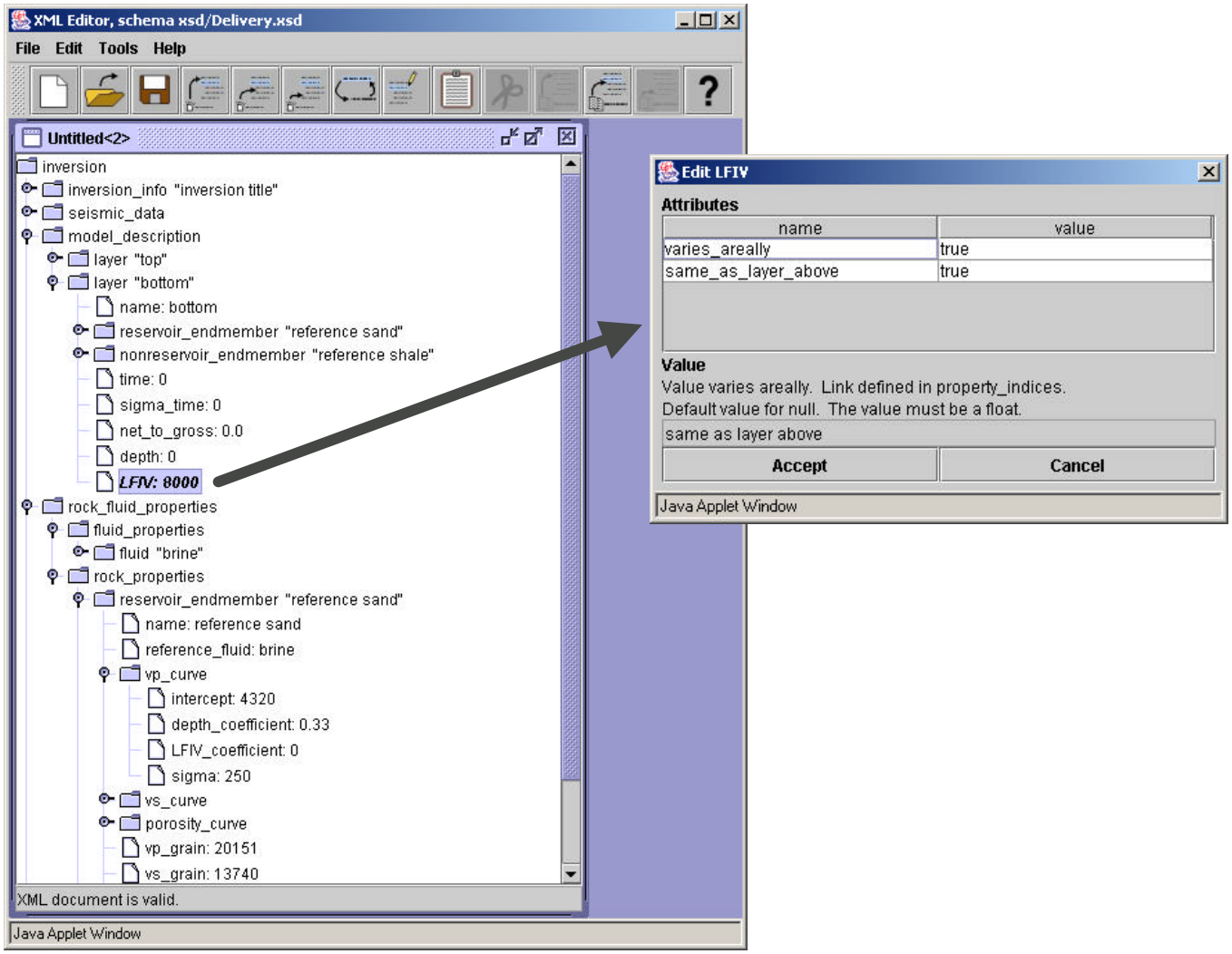
double click synch

model behind seismic wiggles

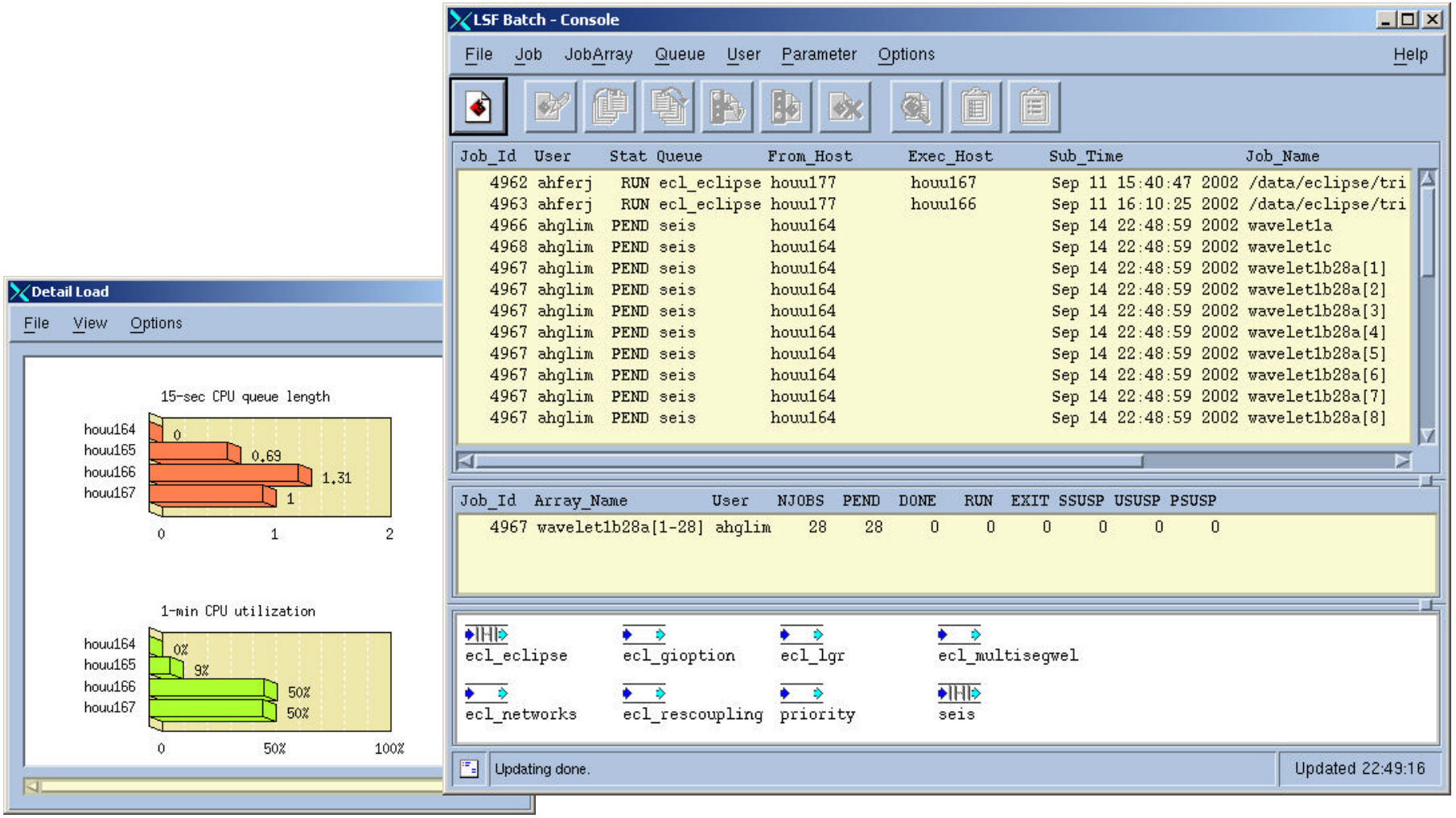
XML distribution via the web interface with application specific Java help



XML explorer of parameter file

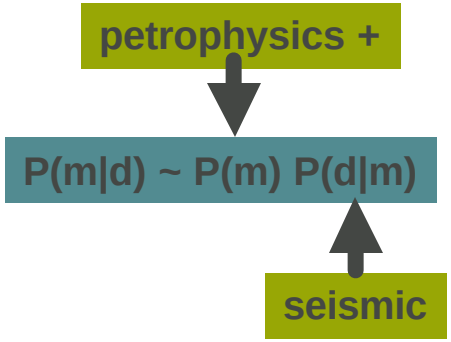


Distributed on Linux cluster using LSF



Metropolis based Baysian update is lynchpin of system

Bayes rule $P(d \wedge m) = P(d)\,P(m|d) = P(m)\,P(d|m)$



d ° seismic data

m ° model (e.g., N/G, vp-sand, porosity, vp-mud, density-mud for each layer)

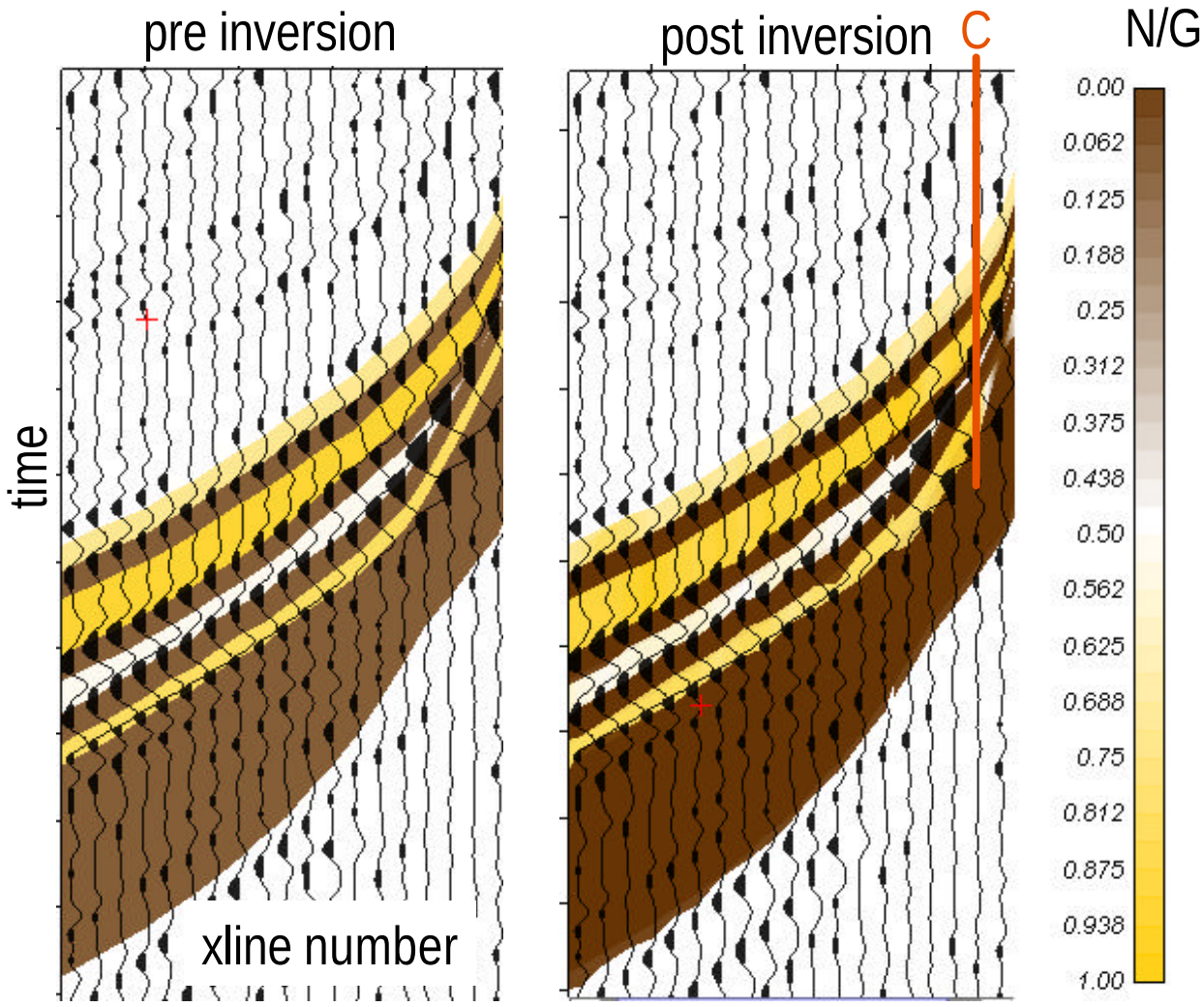
s(m) ° synthetic seismic given the model

P(m) incorporates petrophysics, well information and geologic senarios

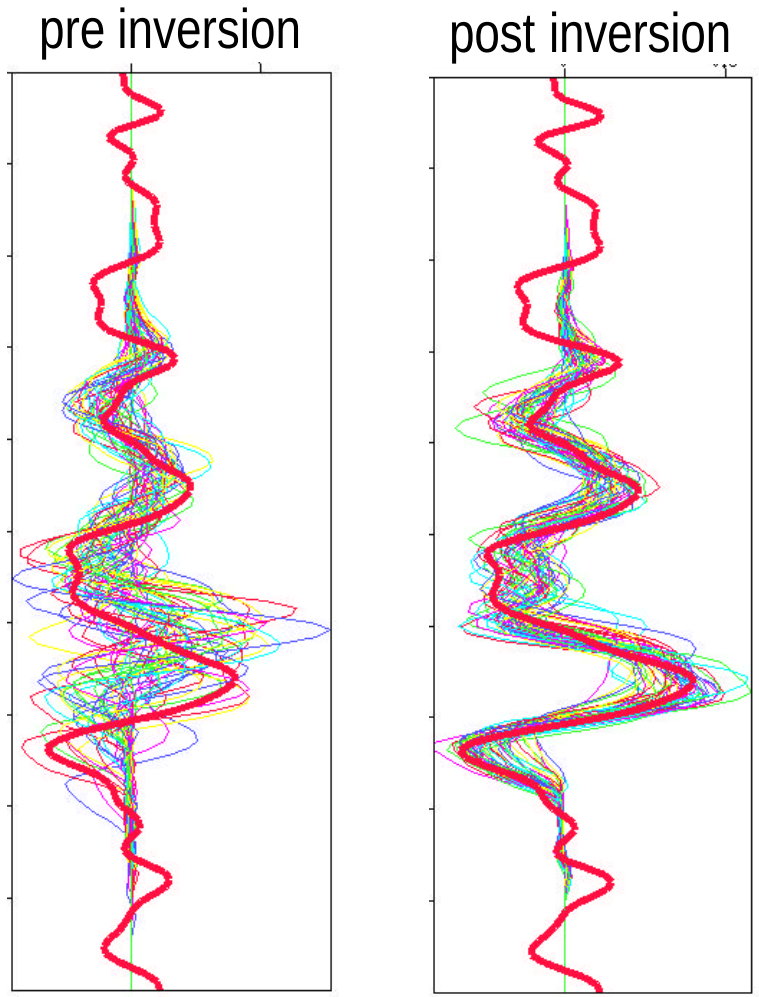
$P(d|m) \sim \exp[-(d - s(m))^2 / 2\,\sigma^2]$, where σ ° seismic noise level

Use Metropolis method to get {m} distributed according to P(m|d), then $\langle f \rangle = \int f(m)$

Layer based prior model is constructed

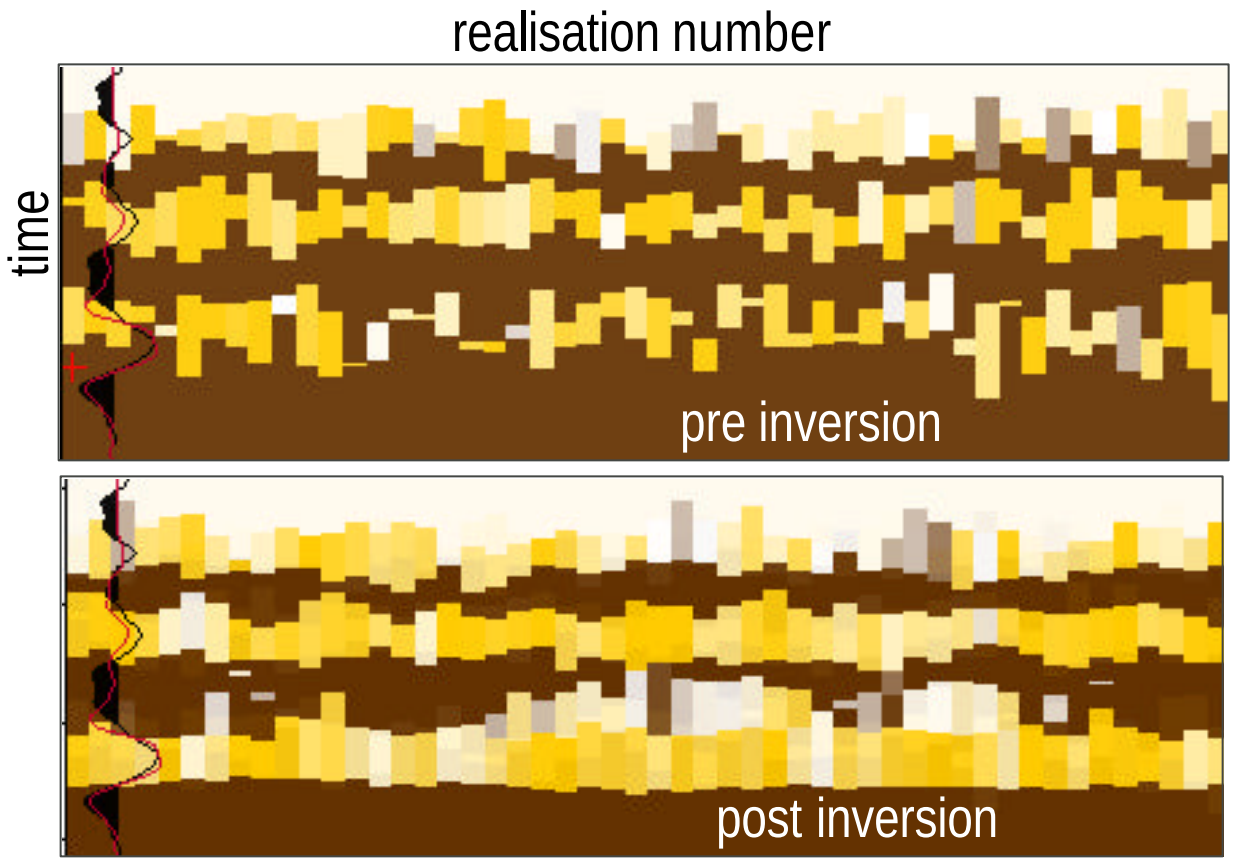


Models generated by a Metropolis algorithm that are consistent with measured seismic



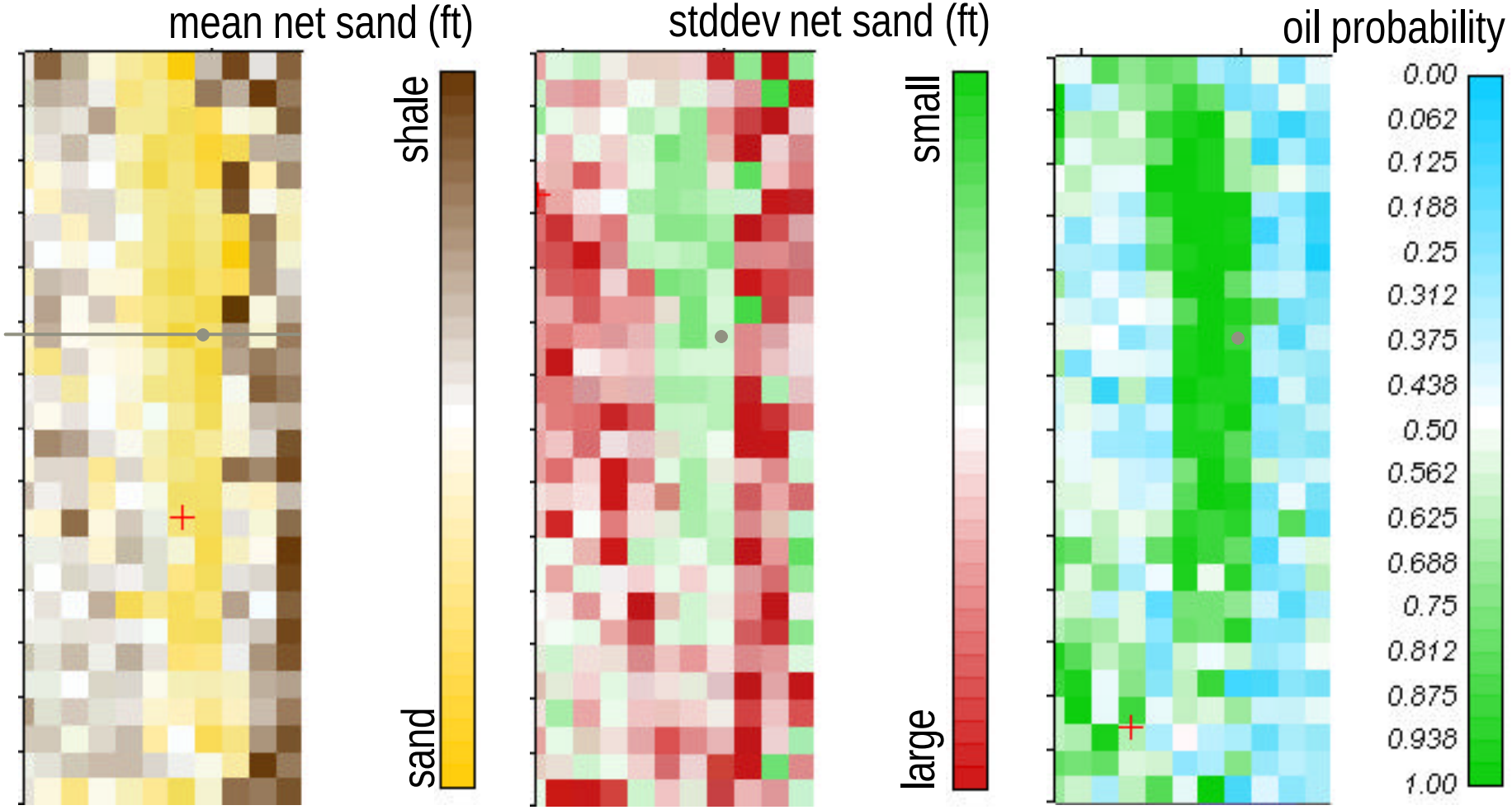
thick red trace = seismic data
thin multi-colored traces = synthetic seismic of each realisation

Statistical realisations at C location

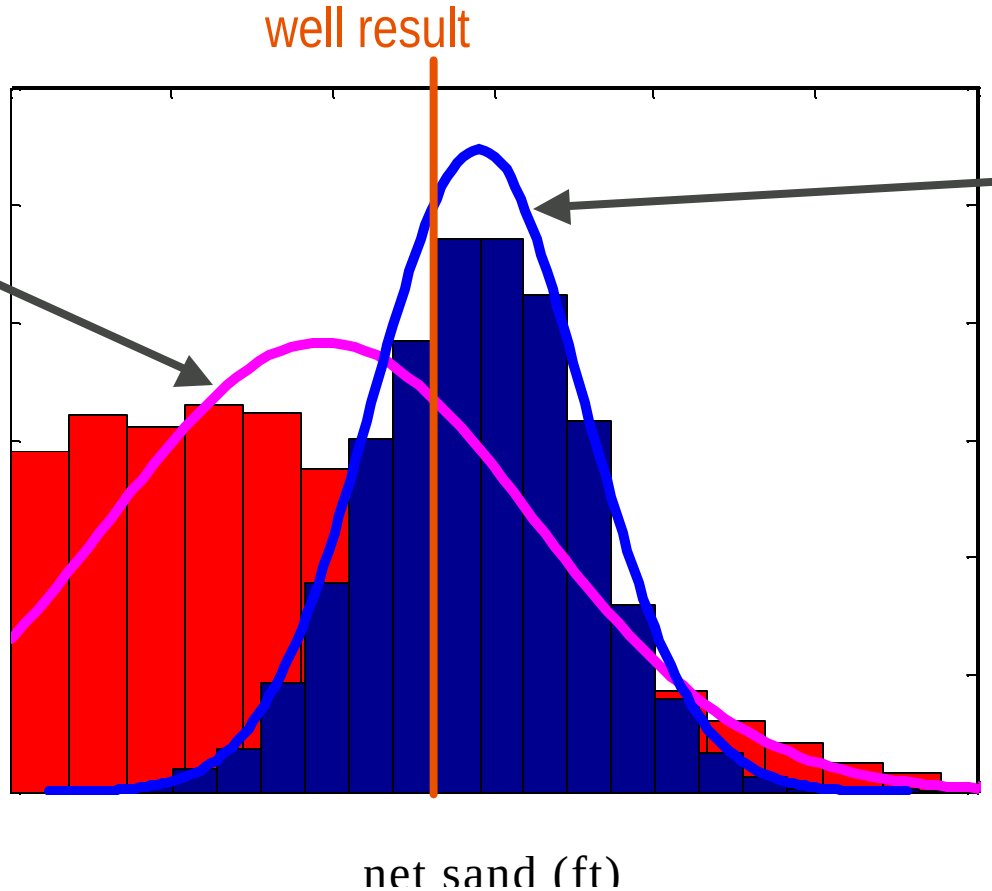


black trace = seismic data, red trace = synthetic seismic P50 model

Maps of statistical moments post inversion



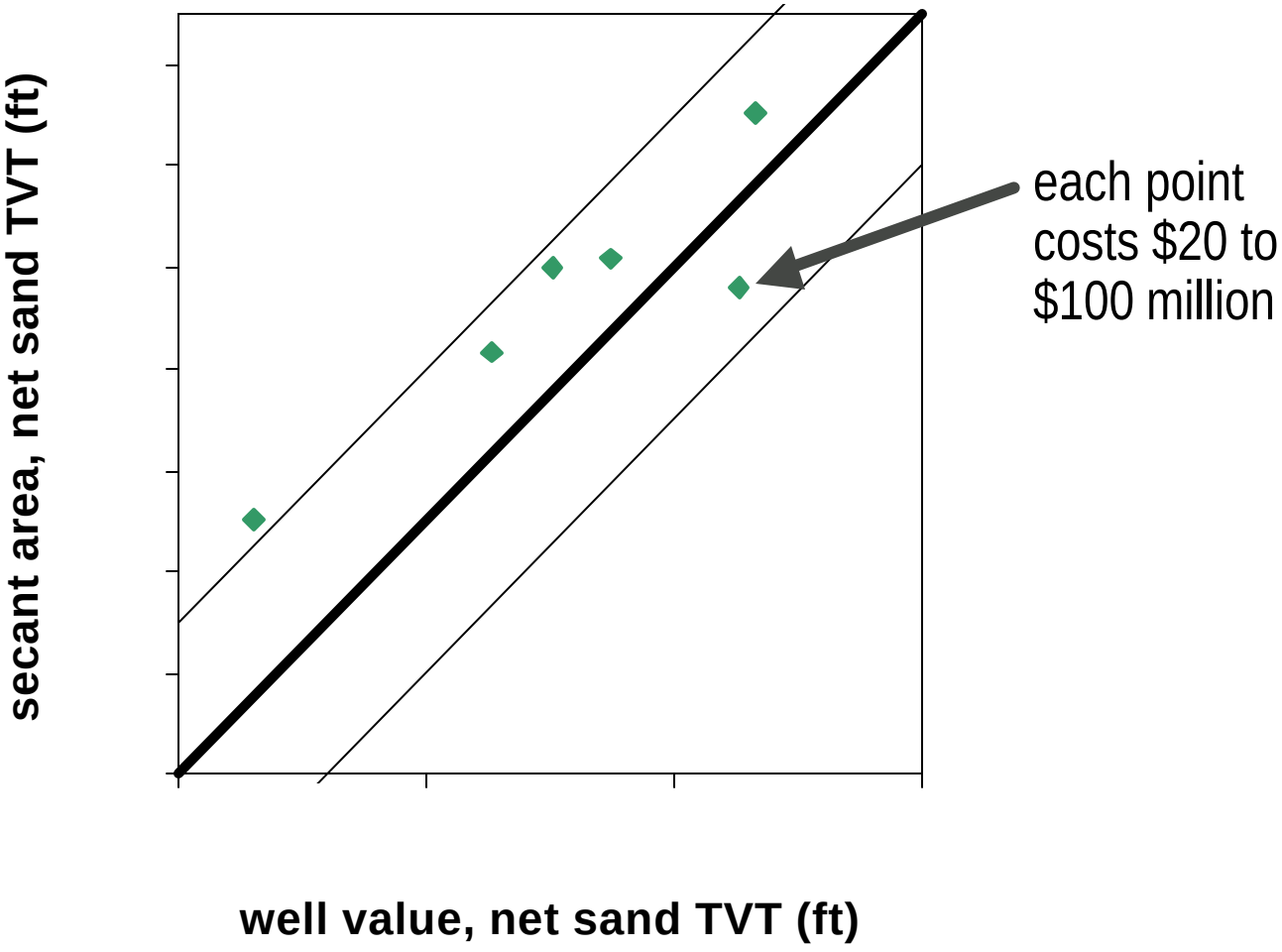
Net sand, pre and post inversion



pre inversion
mean = 200 ft
stddev = 130 ft
P90 = 40 ft
P10 = 400 ft
P(>80 ft) = 77%
P(>150 ft) = 57%
P(oil) = 50%

post inversion
mean = 300 ft
stddev = 60 ft
P90 = 200 ft
P10 =360 ft
P(>80 ft) = 99.9%
P(>150 ft) = 98%
P(oil) = 91%

Calibration of estimated uncertainty



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