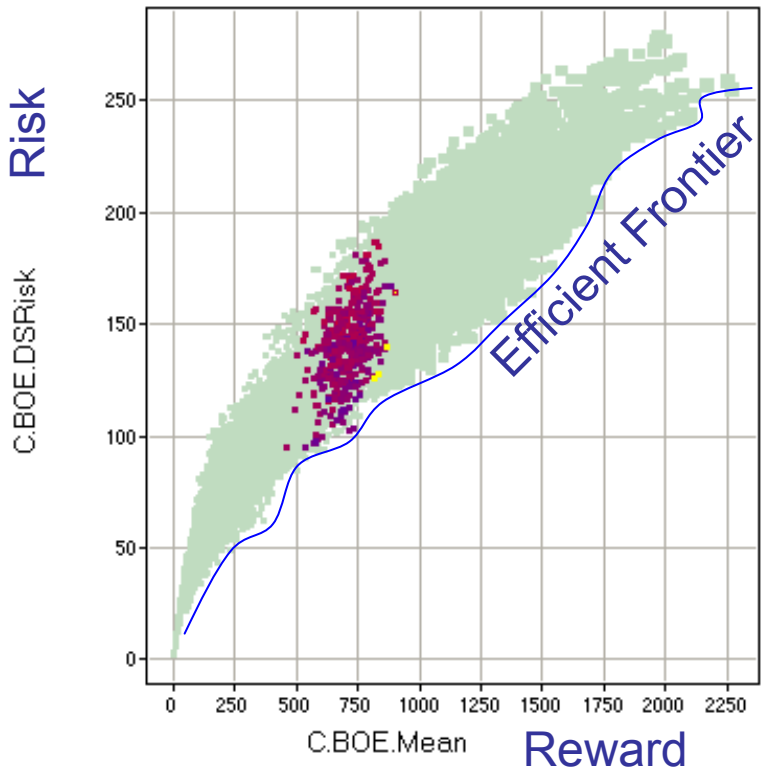
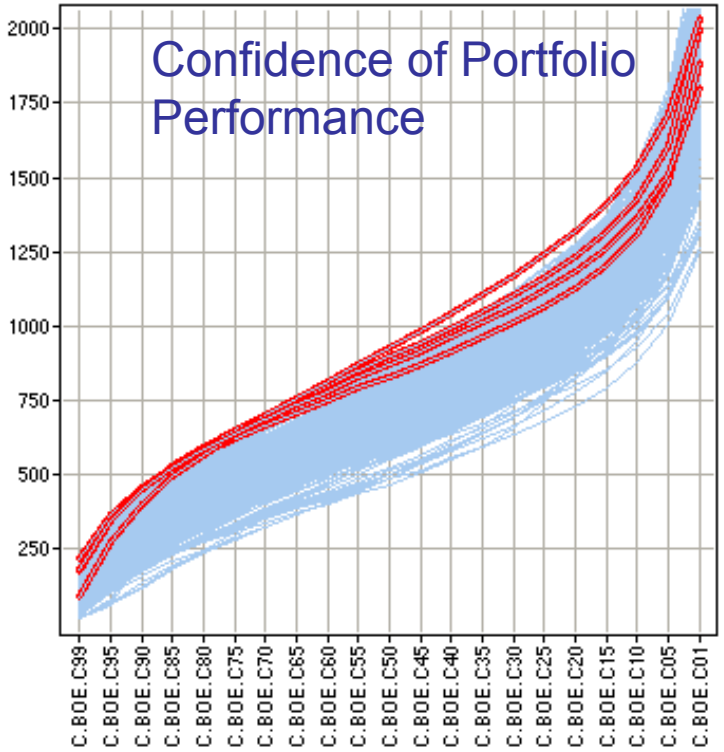
Spotfire Enables Portfolio Analysis of Investment Opportunities on Efficient Frontiers of Many Measures

Dr. Stephen M. Rasey, Director, WiserWays LLC

for Spotfire Energy Users Meeting, Feb. 20, 2003, The Woodlands, TX.





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Definitions

- Portfolio
  - A **collection of investments** all owned by the same individual or organization.
- Efficient Portfolio
  - A portfolio that provides the greatest expected return for a given level of risk, or equivalently, the lowest risk for a given expected return. **also called** optimal portfolio.
- Efficient Frontier
  - The line on a risk-reward graph comprised of all efficient portfolios.
  - (Source: http://www.investorwords.com)

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Portfolio Analysis

- A search for Efficient *candidate* Portfolios from a collection of *potential Investment Opportunities*.

- Acceptable Candidate Portfolios must satisfy Investors Requirements:
  - Operational – Physically doable
    (rig avail, lead time, partners, Working Interest availability)
  - Political – (BU Capex avail, Maximum $ exposure)
  - Resource – Budget, People
  - Performance – Resources found, Production & Earnings Goals, Minimum acceptable results.

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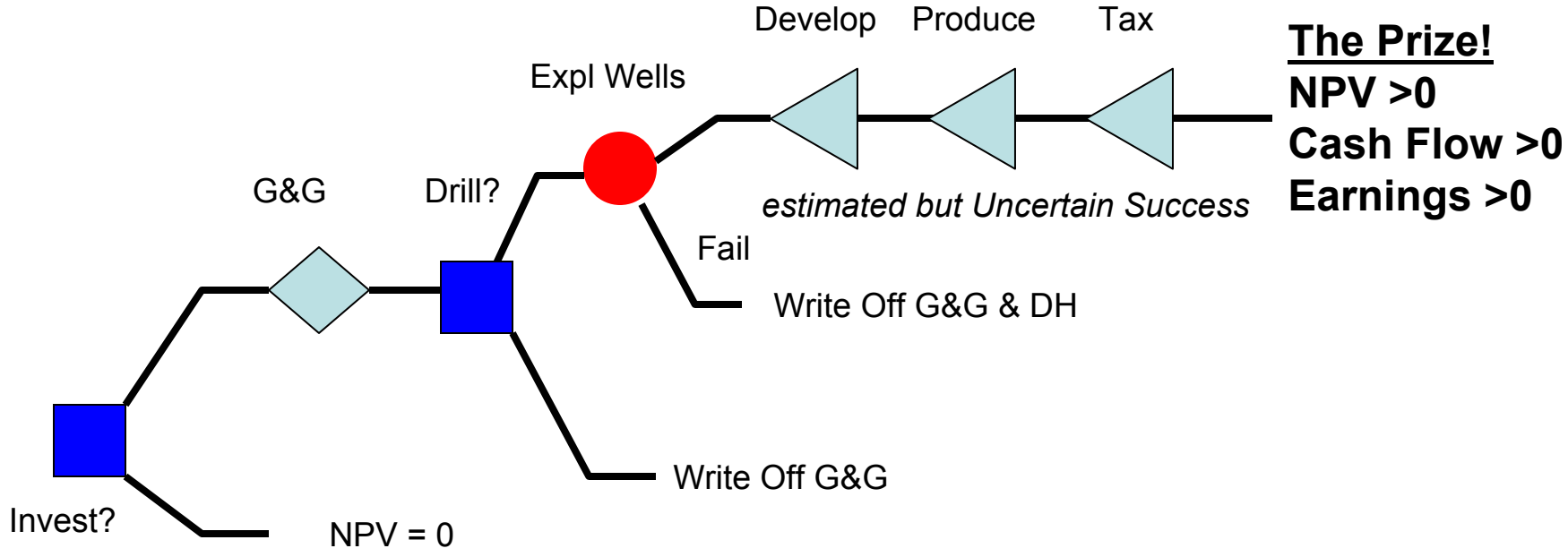
Investment Opportunities

- Projects where you have an opportunity to invest capital with estimated, but uncertain, profitable returns in the future.
- Example here: Exploration Projects



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Key Parameters of Exploration Investments

- Cost of Entry
- Probability of Entry
- Cost of G&G (Geological and Geophysical) + Overhead
- Cost of Exploratory Wells
- Probability of Success
- Recoverable Resource Size
- Cost and Timing of Development and Production
- Prices

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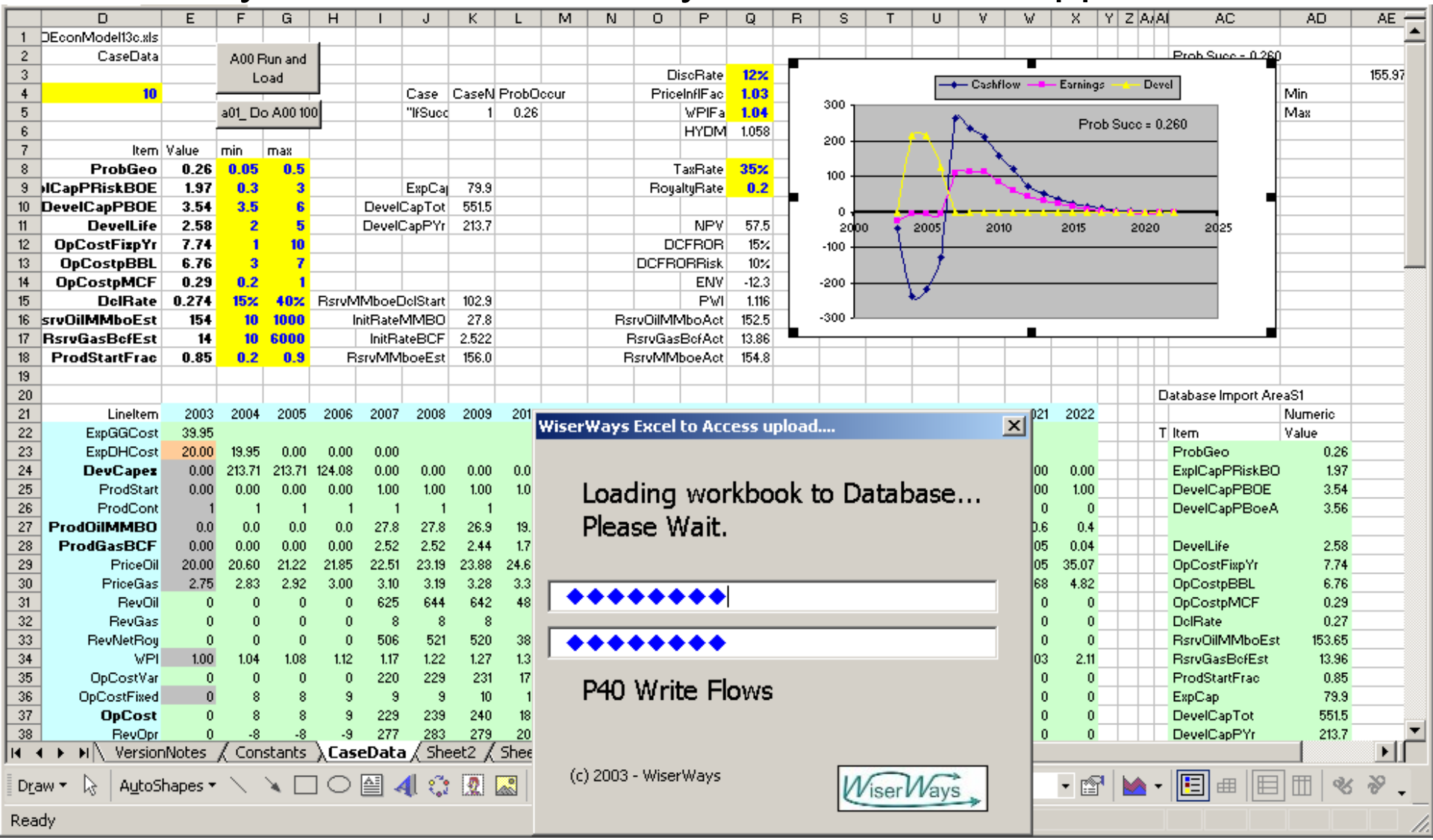
A way to build an inventory of Investment Opportunities



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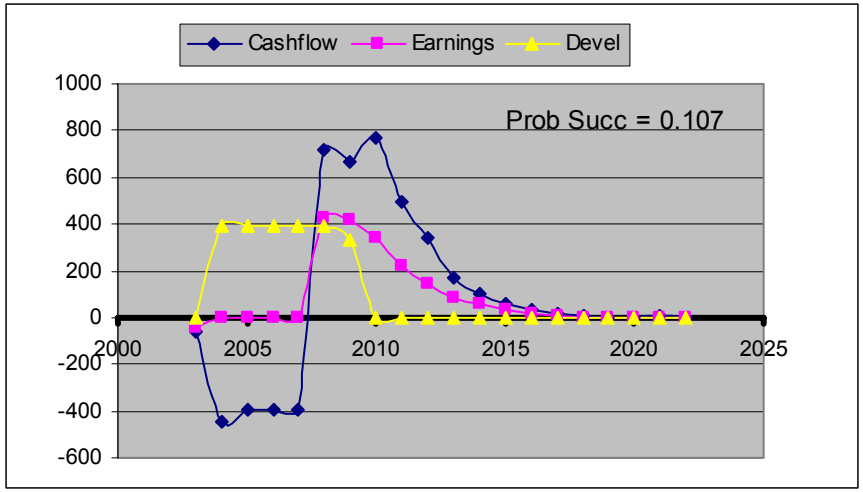
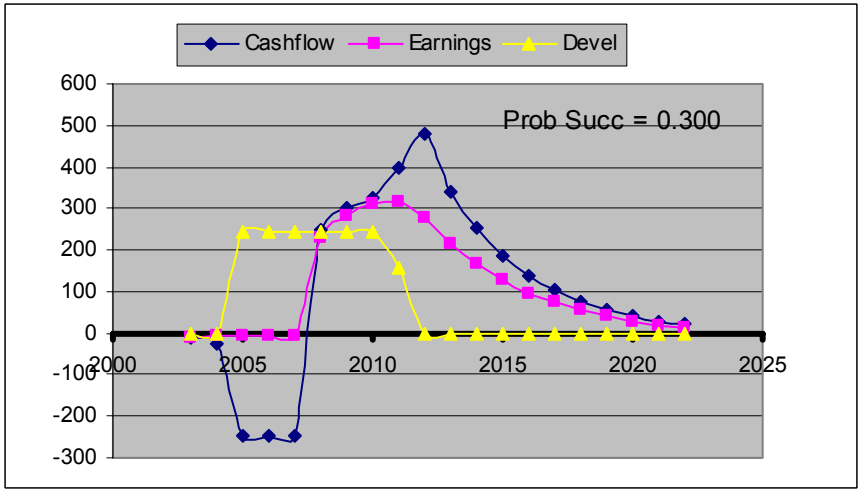
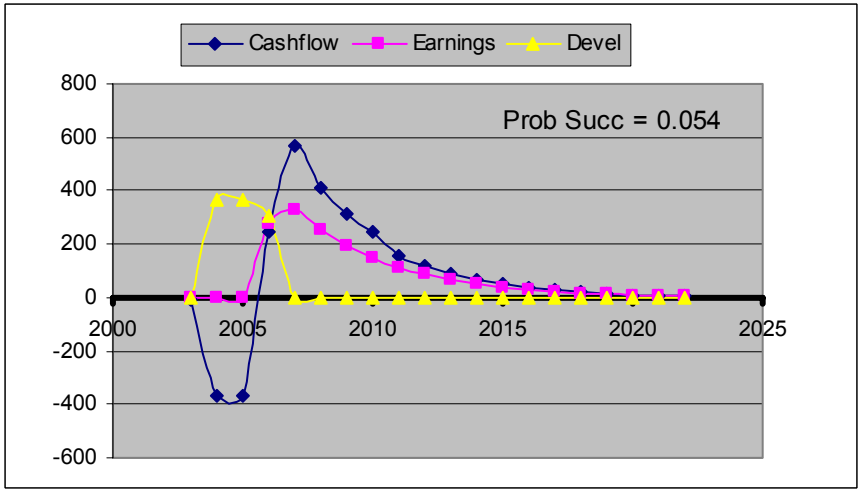
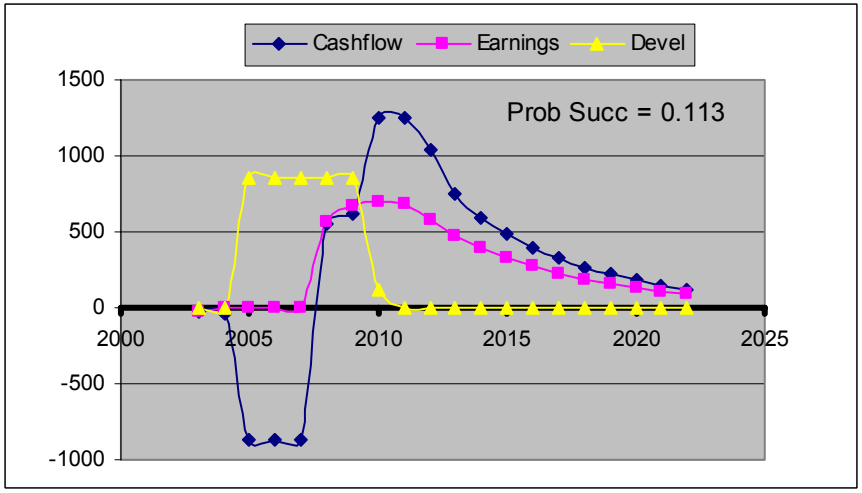
Types of Projects in this example









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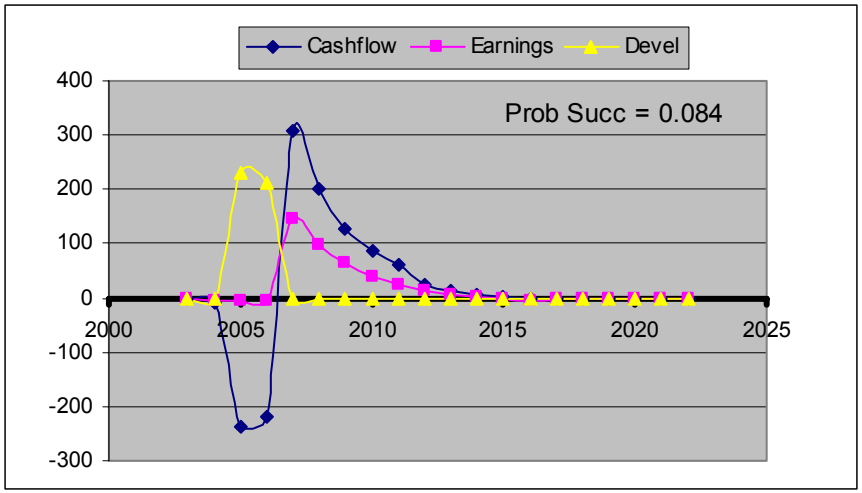
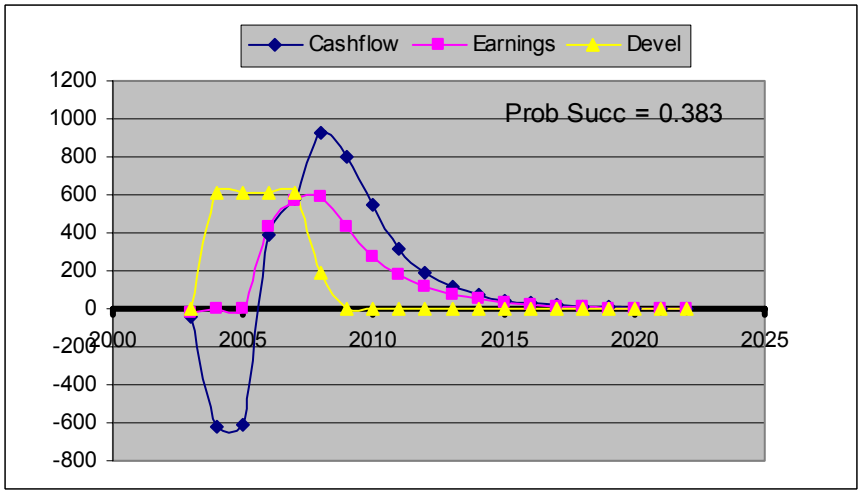
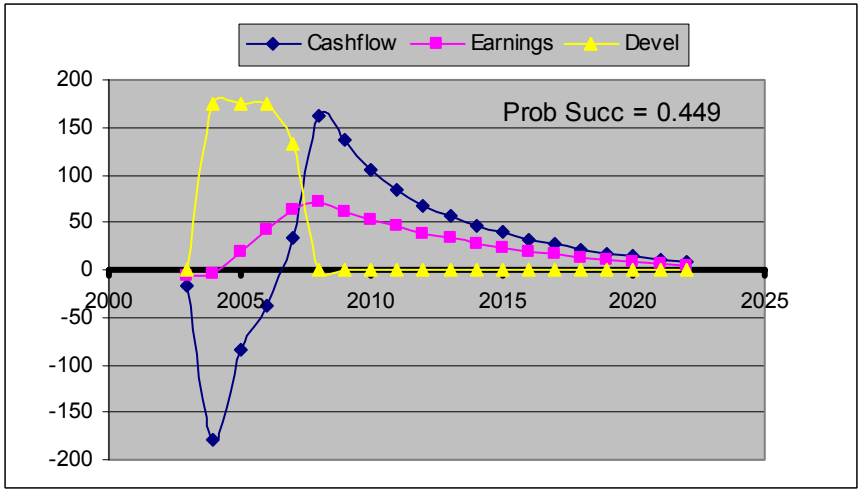
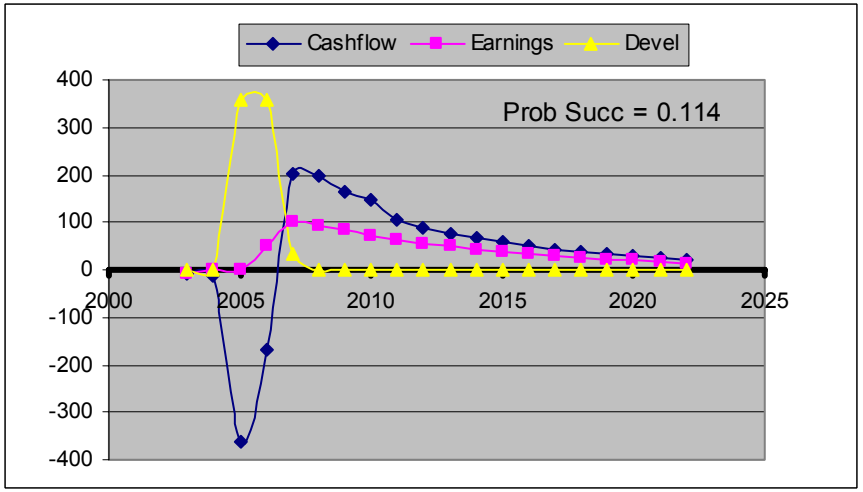
Types of Projects in this example









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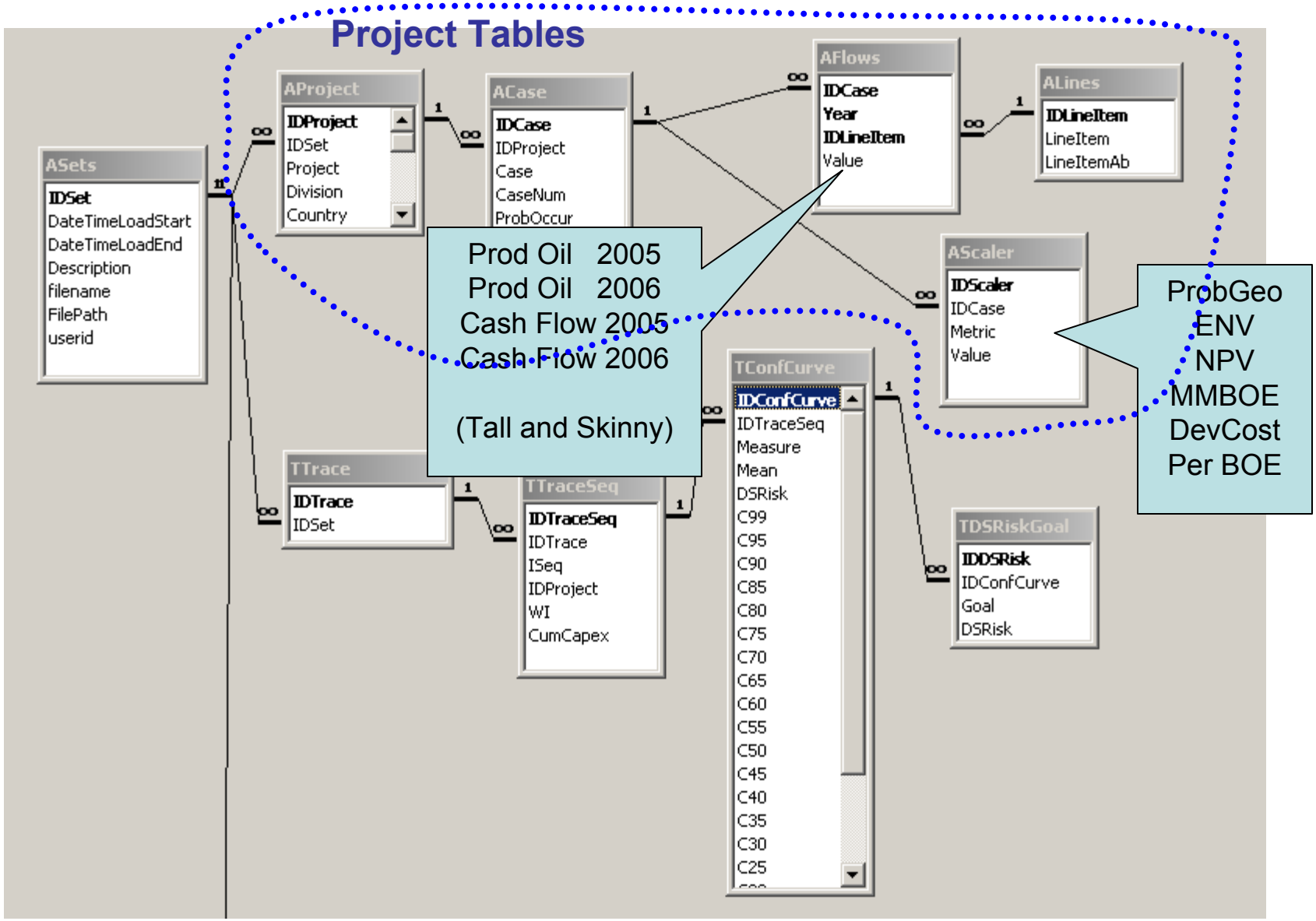
Data Base Schema (Projects)



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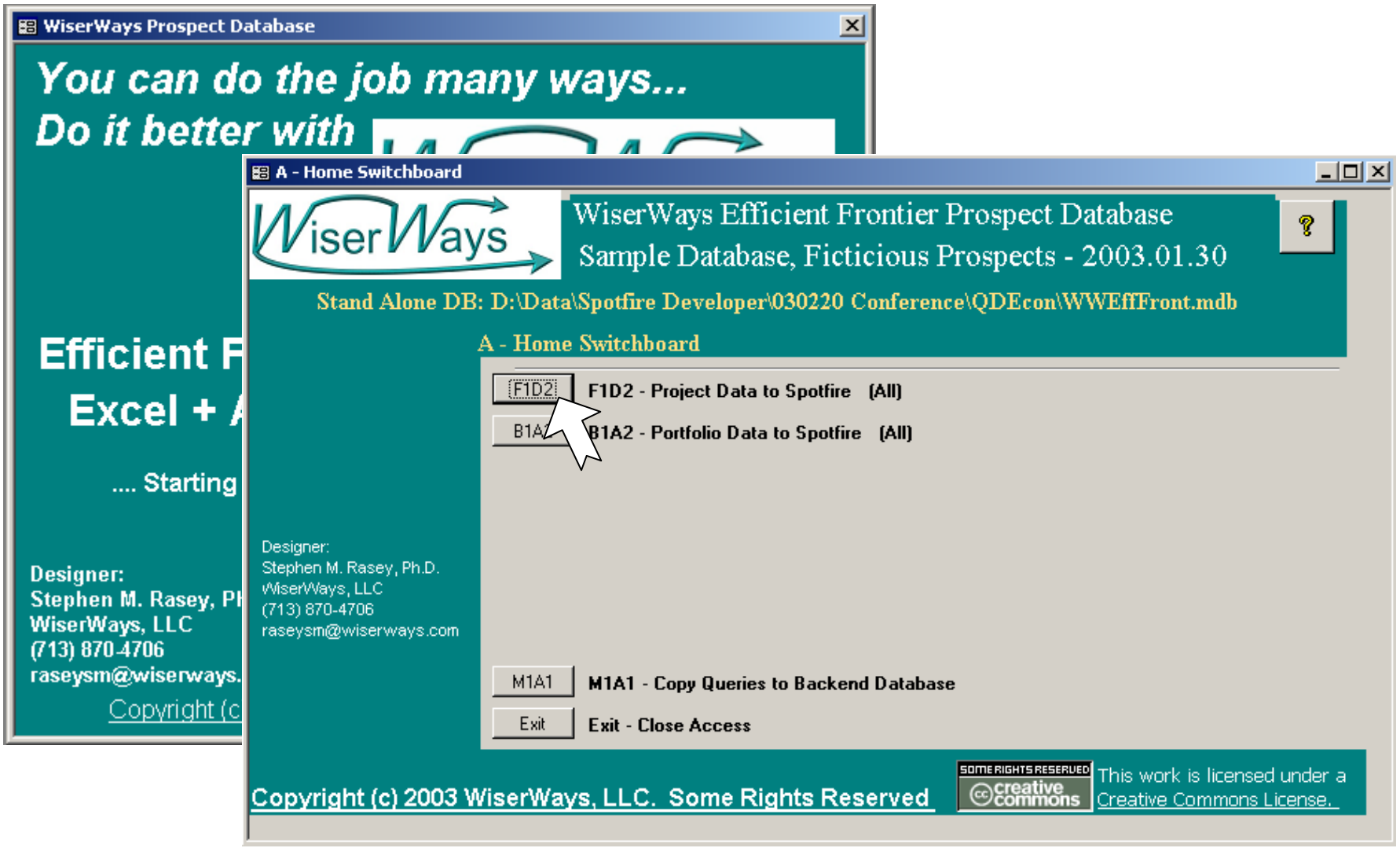
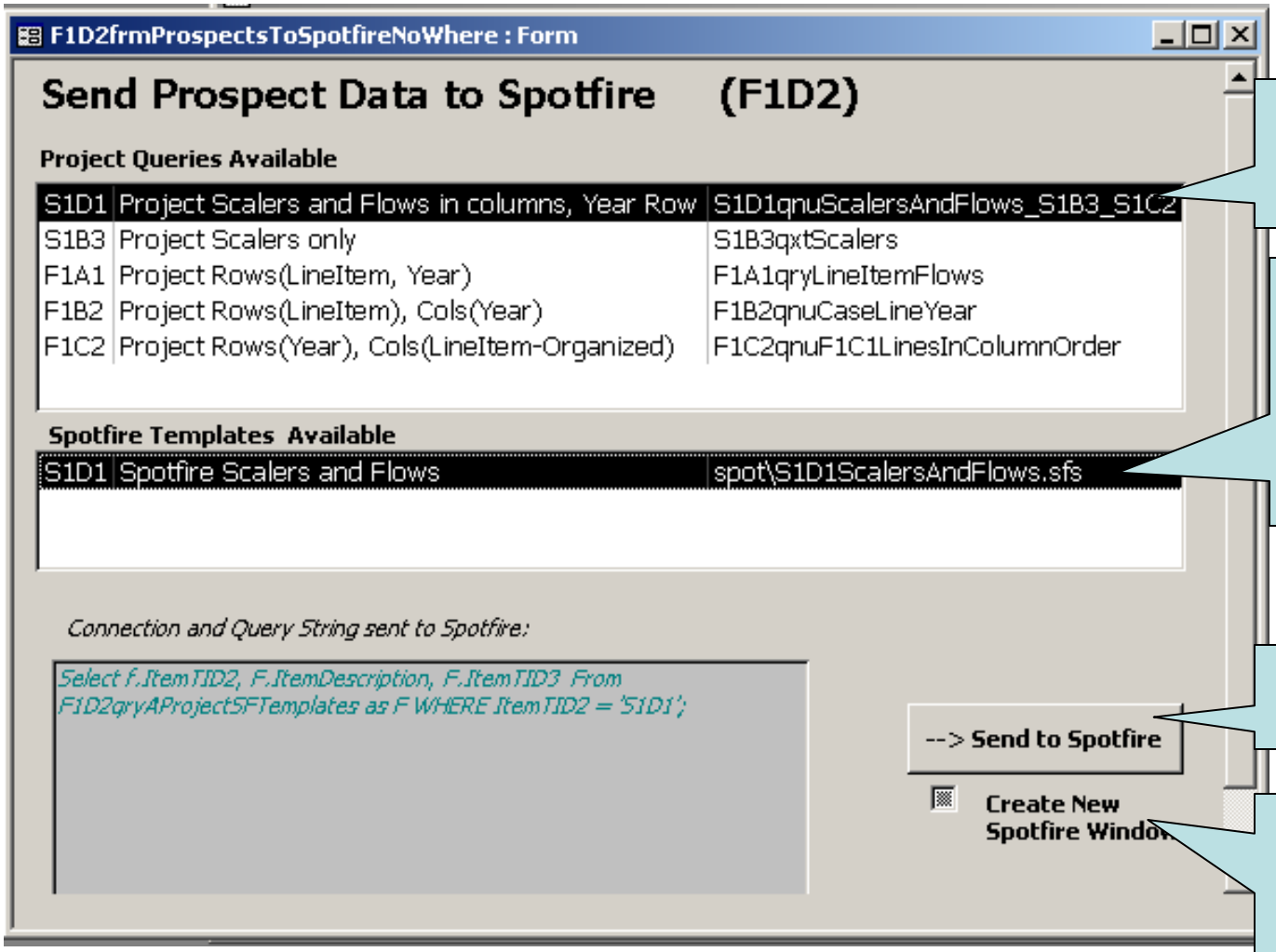
Use the Access Database to prepare Querys for Spotfire



F1D2 – Choose Canned Queries to send to Spotfire



Choose the Query

Choose a Spotfire Template that is compatible with the query

Launch the Query

Use an existing instance of Spotfire or create a new one

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Typical VBA to send a Query to Spotfire to read data and apply a template.

```
'Get a Spotfire application
  Set appSF = wwSpotfireDSAny()
  appSF.Visible = True

  sqlQname = lbxQueries.Column(2)
  strSFTempl = lbxSpotfire.Column(2)

'Spotfire OpenODBC    Works, but you must use a backend .mdb containing tables and queries.

  strProv = "Provider=Microsoft.Jet.OLEDB.4.0;"
  mdbpath = gstrDBNameBack
  mdbpath = strPathTemplate & "\" & mdbpath   'Differes between Access 97 and 2002.
  mdbpath = "Data Source=" & mdbpath & ";"
  strConn1 = strProv & mdbpath

  sql1 = "Select * from " & sqlQname

  strStep = "Close ActiveVisualization"
  appSF.ActiveVisualization.Close False   'close without saving

  strStep = "Spotfire OpenODBC"
  appSF.OpenODBC strConn1, 0, sql1

  strStep = "Apply Template: " & strSFTempl
   appSF.ActiveVisualization.ApplySettings strPathTemplate & "\" & strSFTempl
```

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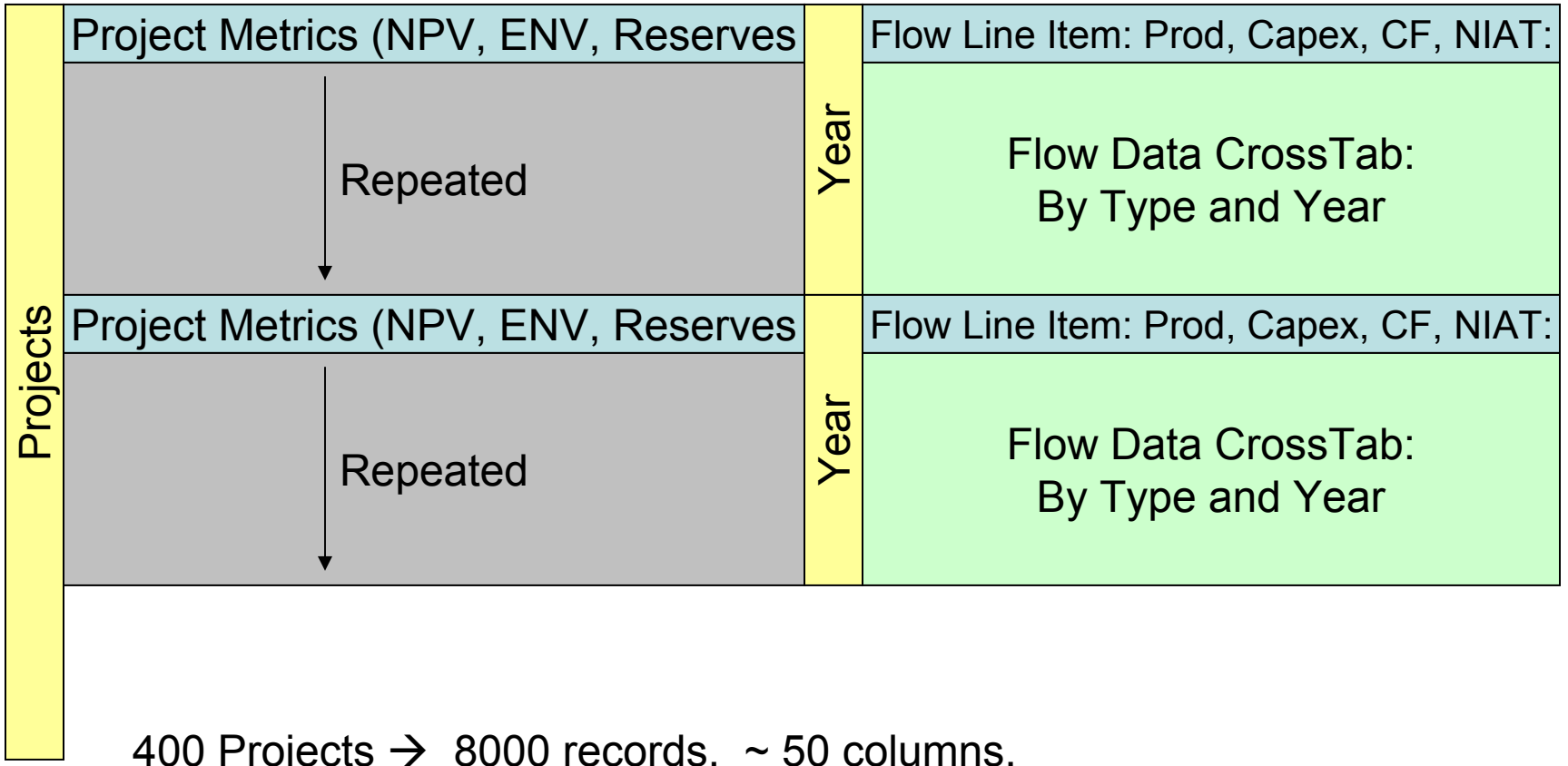
View the Project Metrics and Flows.

- S1D1 Query: Project Scalers with Flow Data oriented with Line Items in Columns, Years in rows.



400 Projects → 8000 records, ~ 50 columns.

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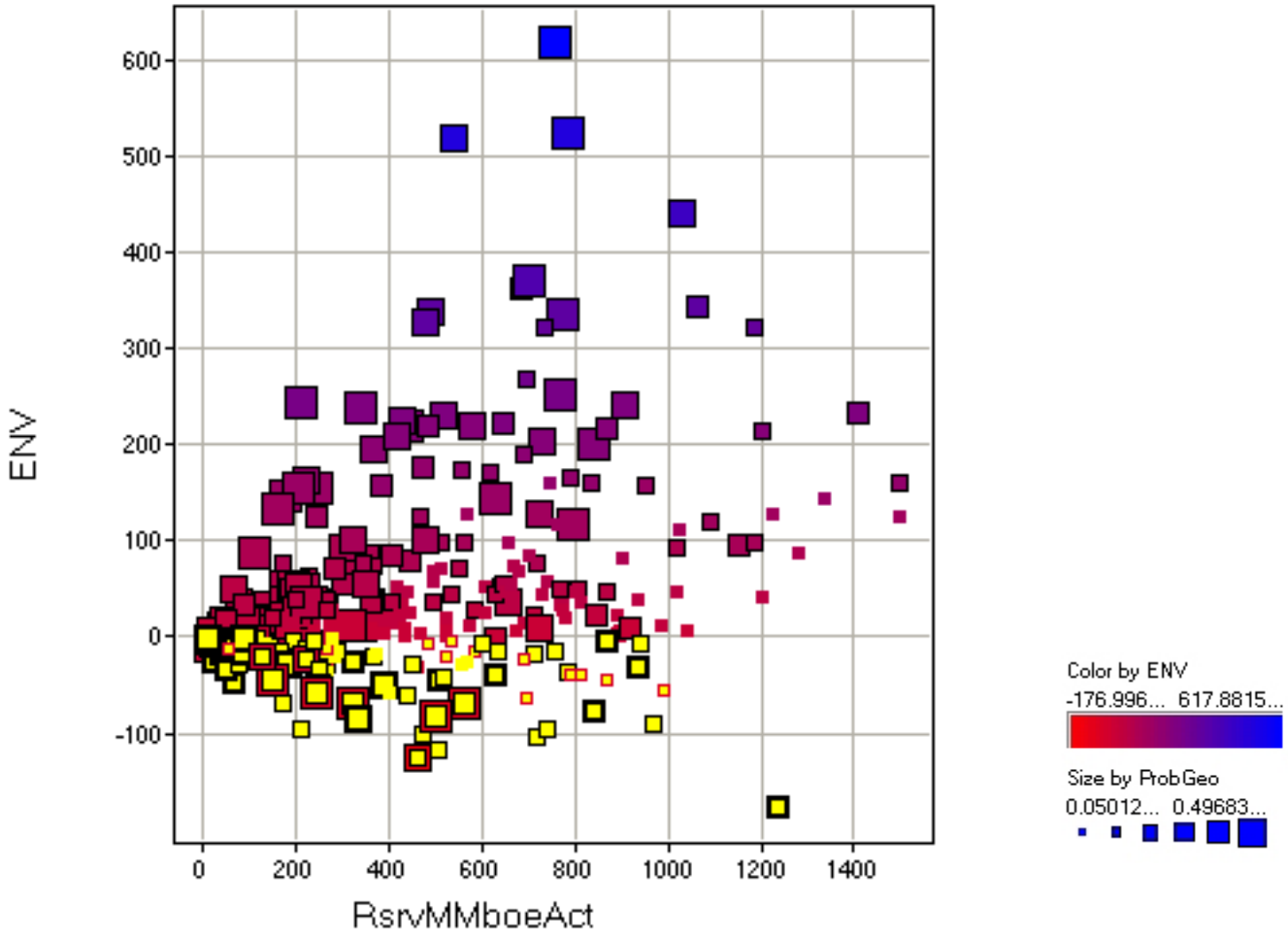
ENV vs MMBOE, Color NPV, Size ProbGeo



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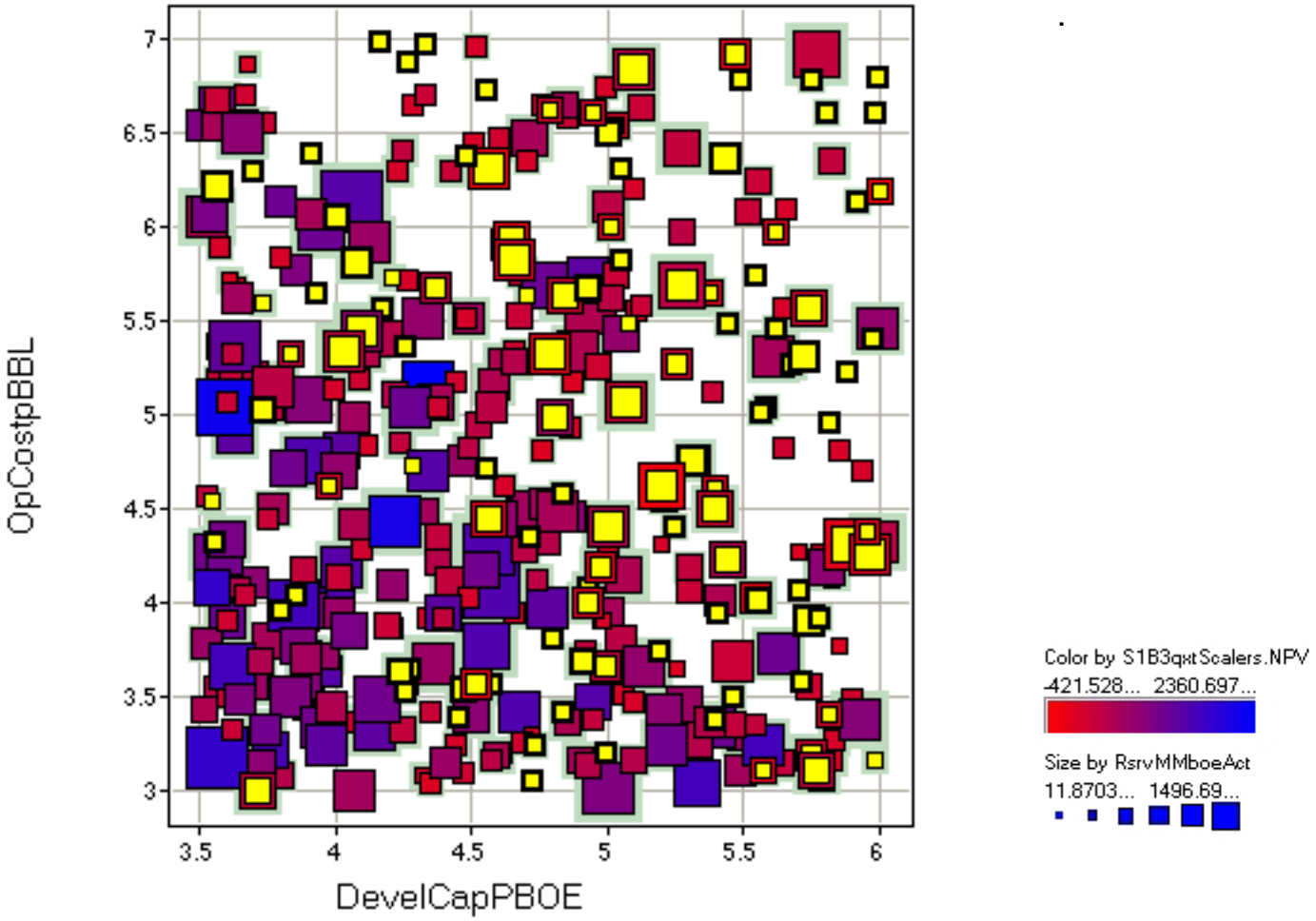
Op vs Dev



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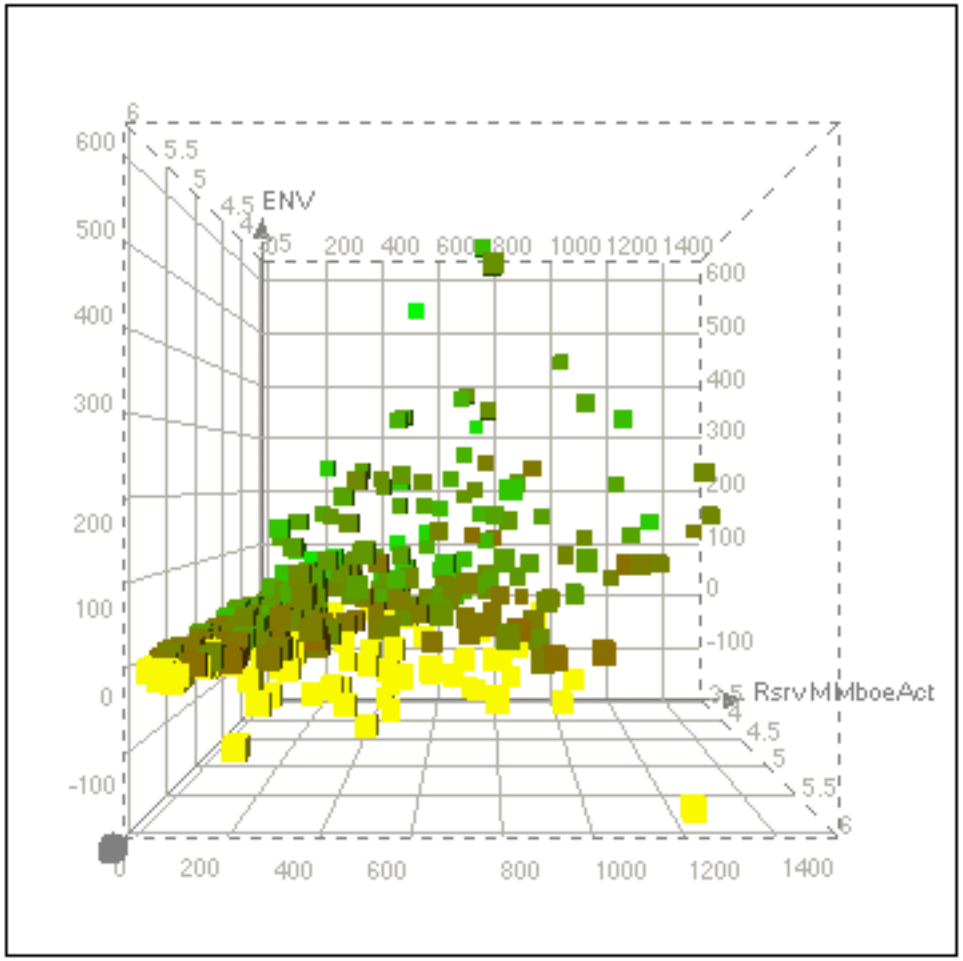
ENV vs DevCapex/BOE vs MMBOE Produced Full Life -



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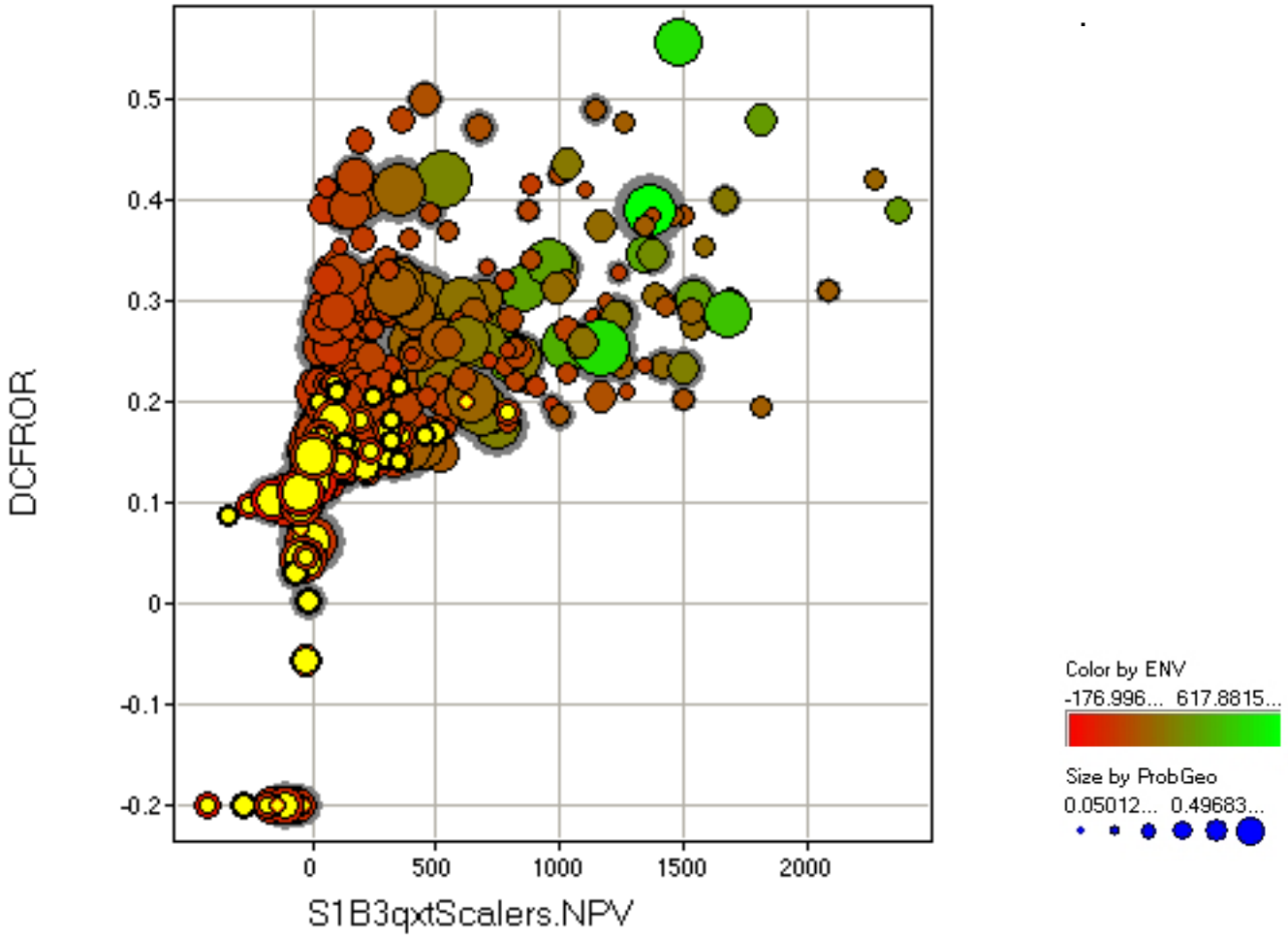
ROR vs NPV color:Env Size:Prob



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Remove all Projects with ENV < -5 from the database

-

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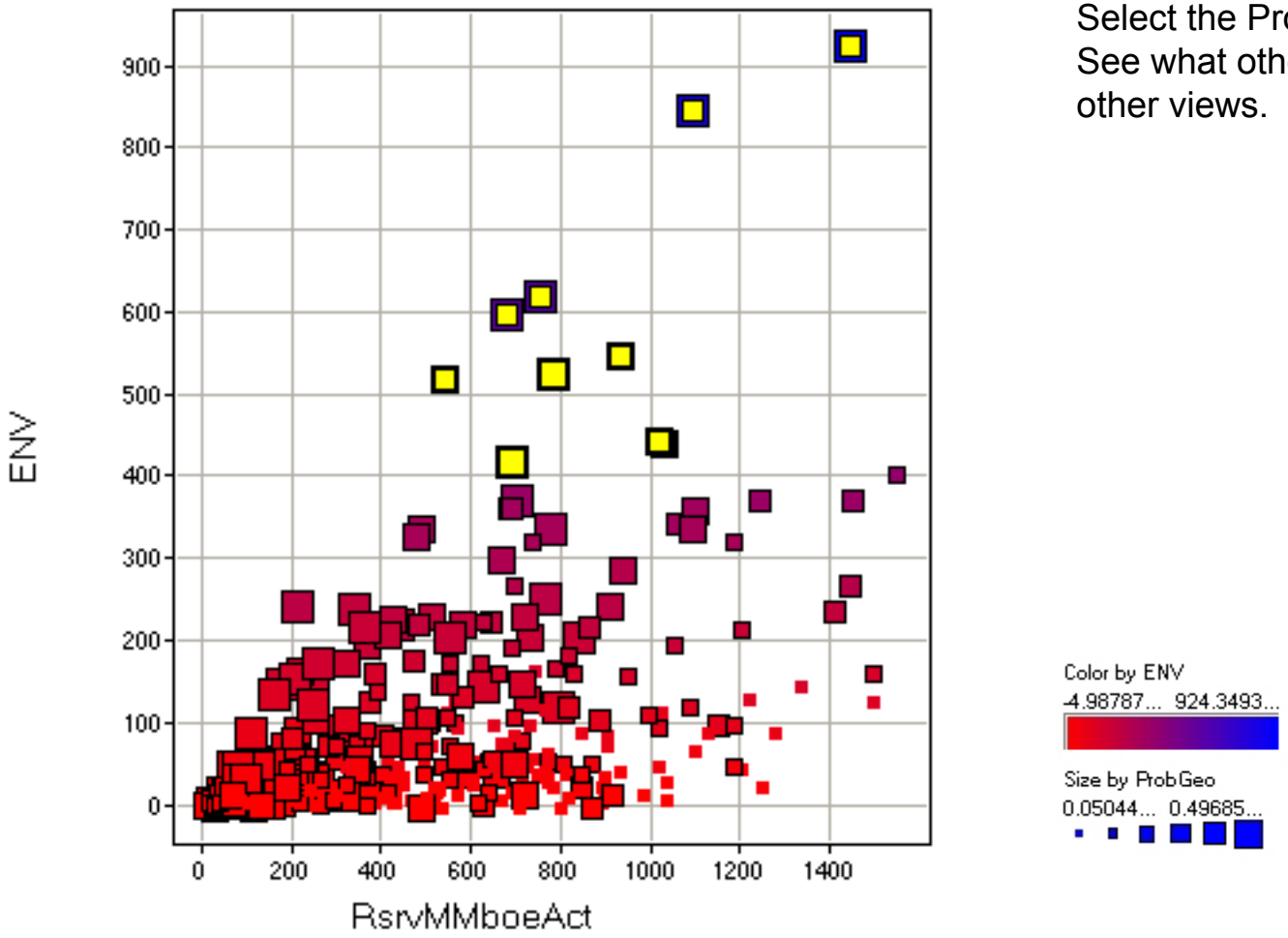
MMBOE vs ENV, Color NPV, Size ProbGeo



Select the Projects with ENV > 400. See what other attributes the have in other views.

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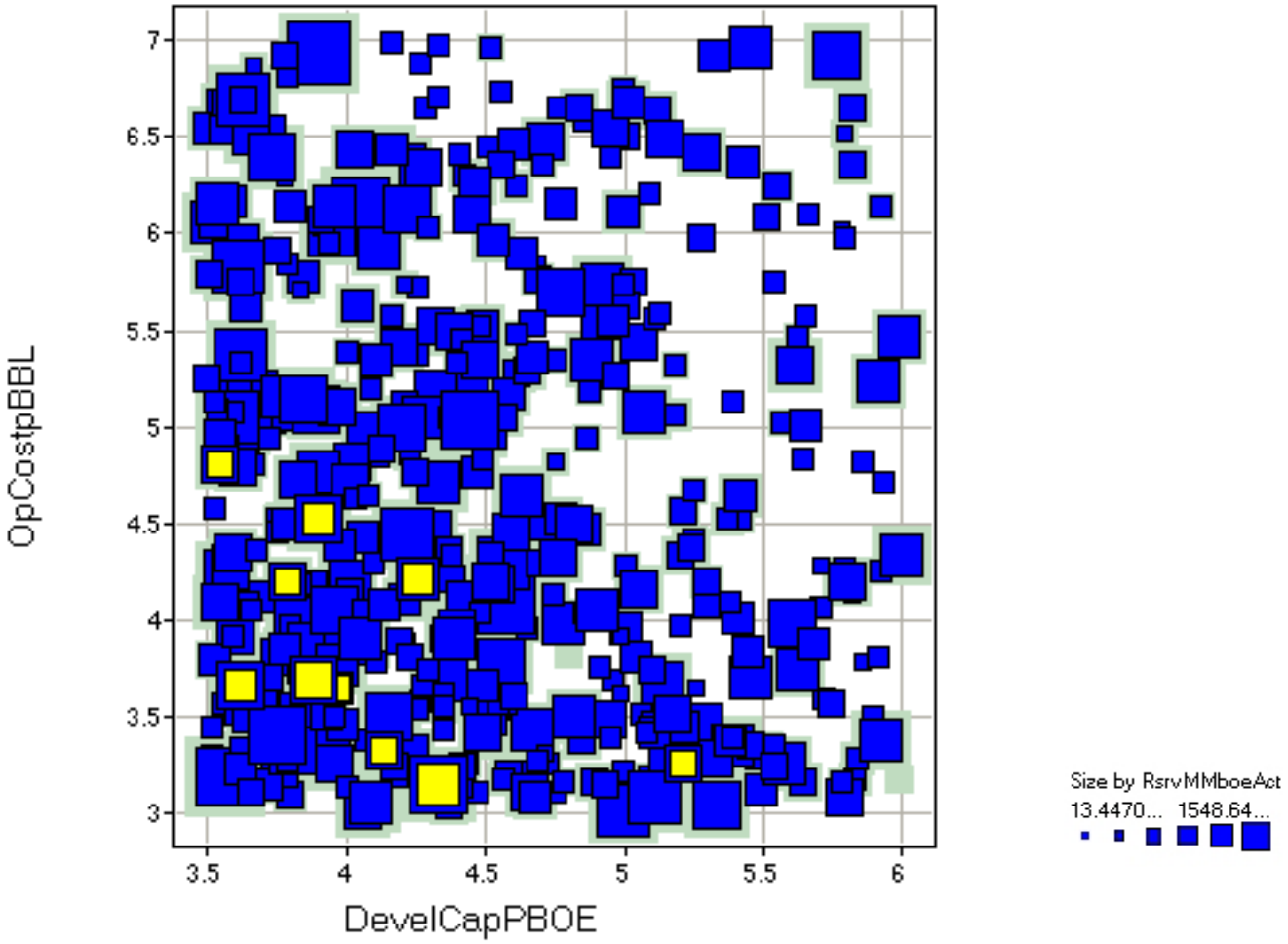
Op Cost / BOE vs Dev Cost / BOE



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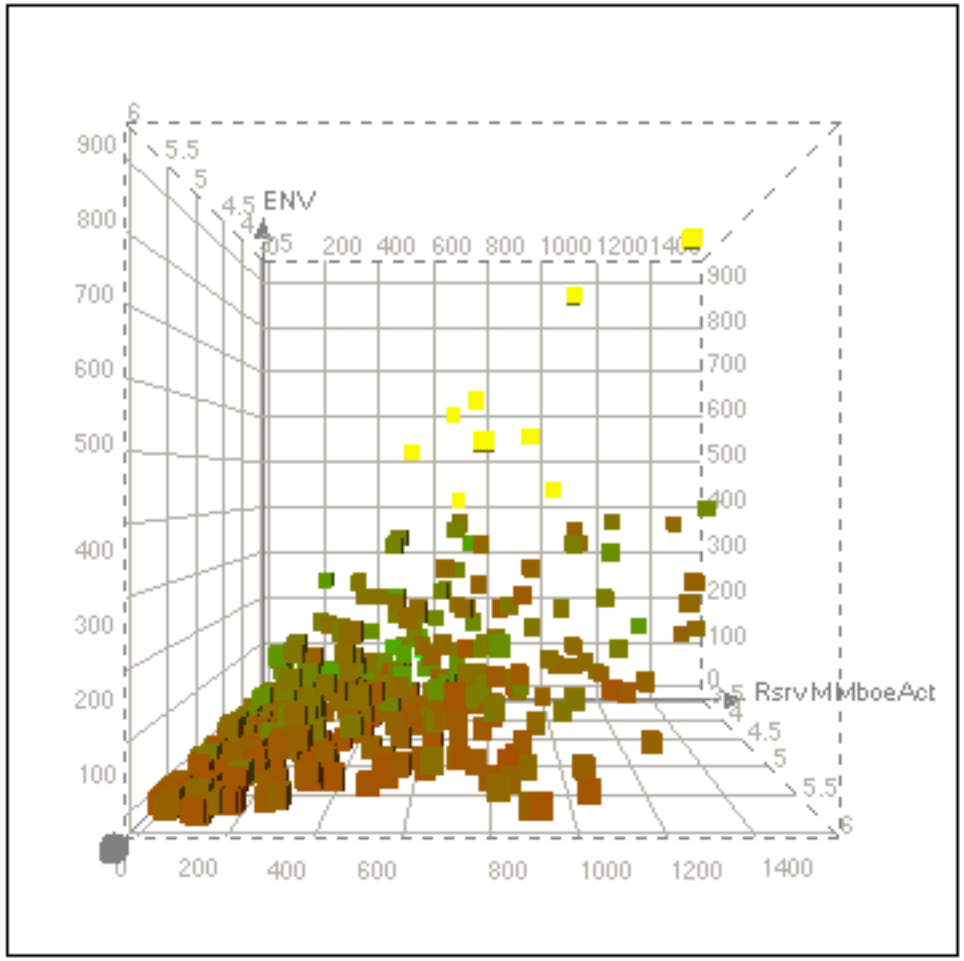
ENV vs DevCapex/BOE vs MMBOE Produced Full Life - RsrvMMboeAct vs. ENV vs. DevelCapPBOE



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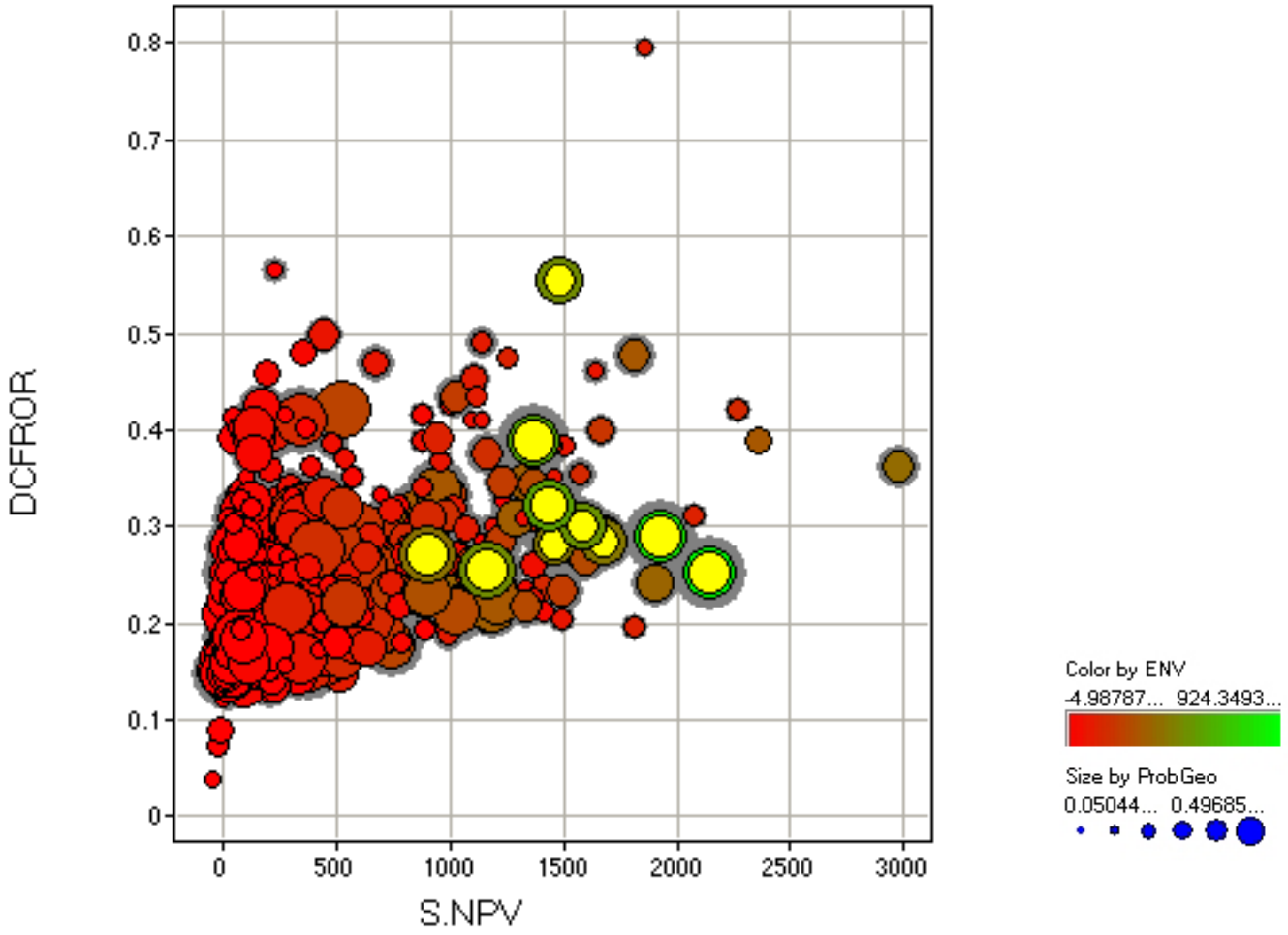
ROR vs NPV color:Env Size:Prob



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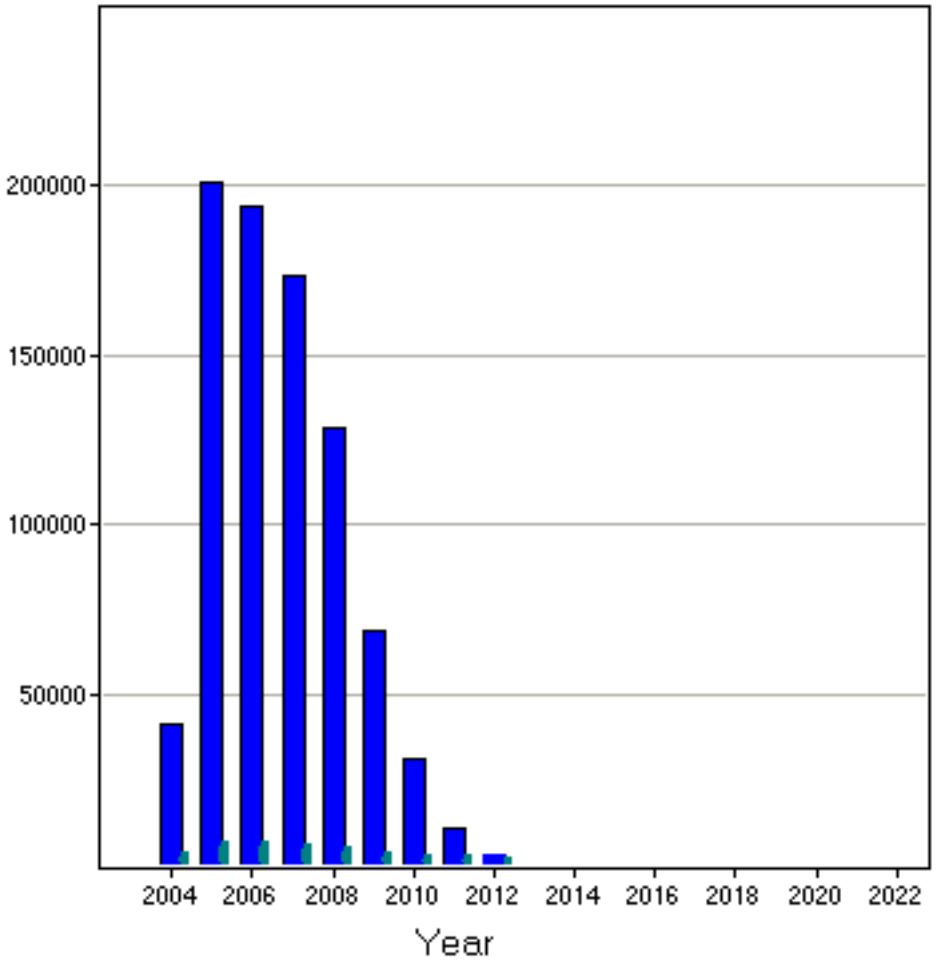
Devel Capex Bar Chart - Year



This chart would be more meaningful if I plotted RISKED Development Cost.

Summing by selected projects gives a real-time Portfolio Sum

This is a Summation Bar chart using Year as the X dimension as a variable and the Devel Capex Metric (in a column) for the sum.

The height of a bar represents the sum of 'DevCapex'

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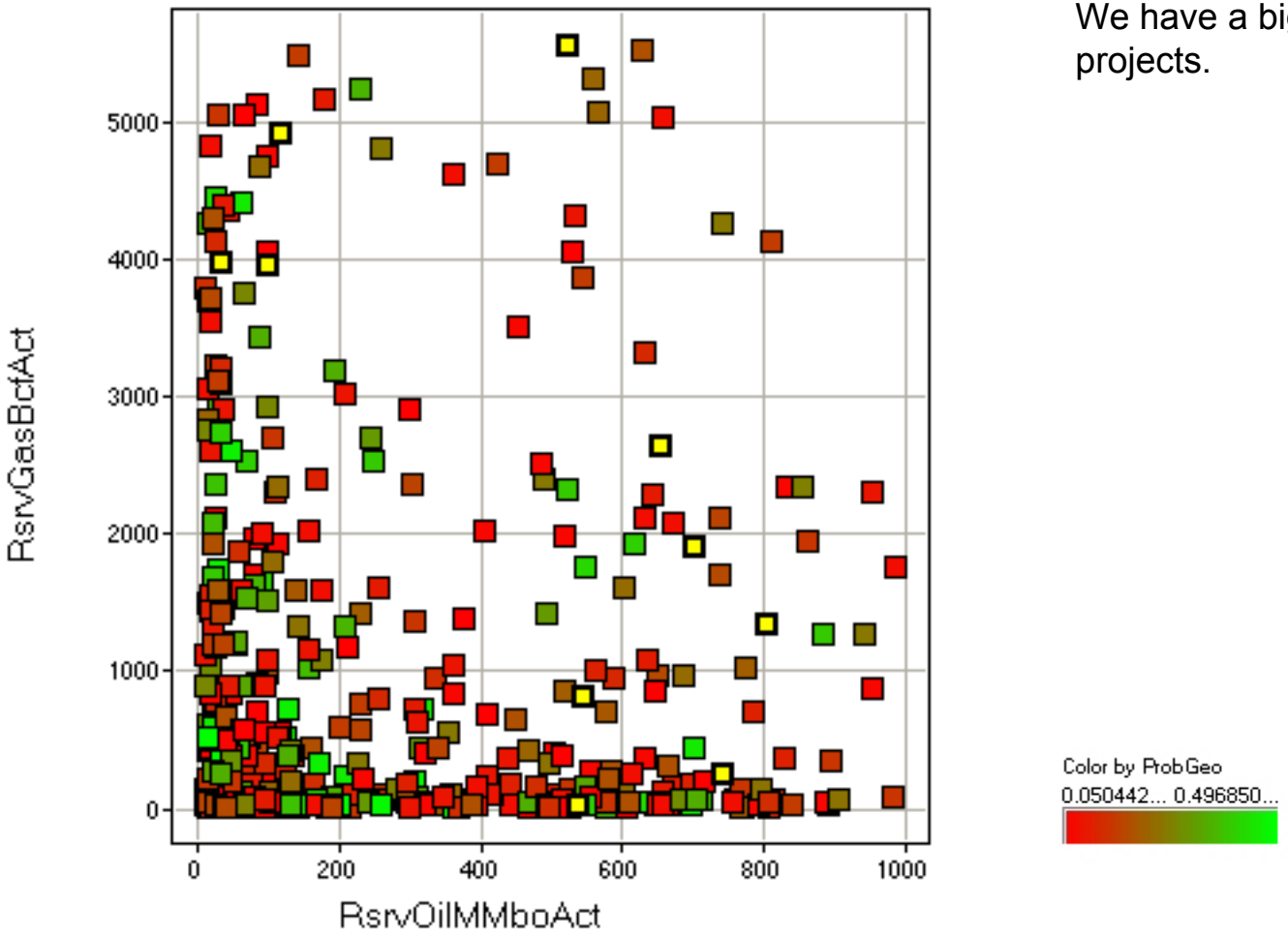
Gas vs Oil



We have a big mix of Oil and Gas projects.

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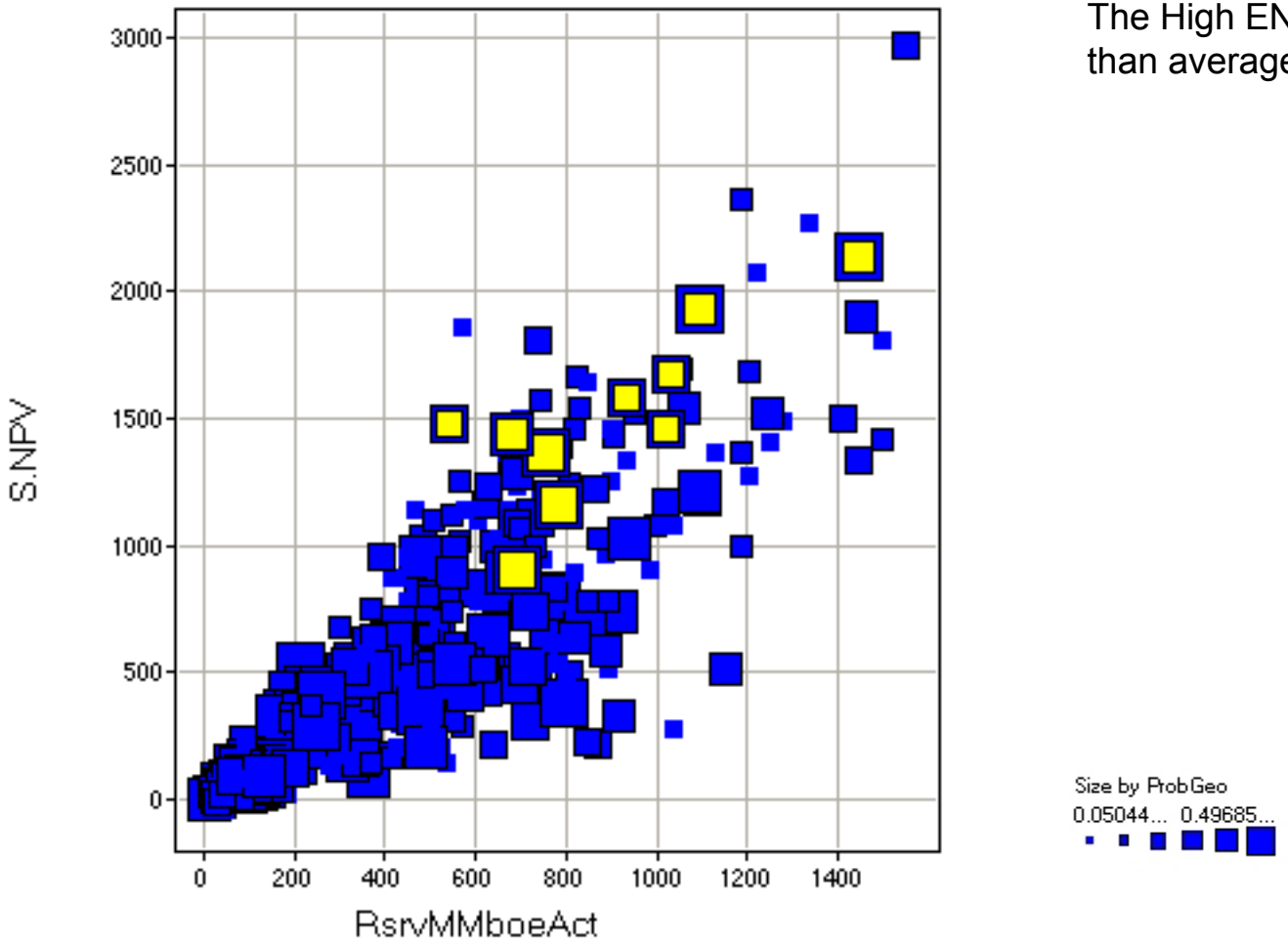
NPV vs MMBOE



The High ENV projects have higher than average NPV/BOE.

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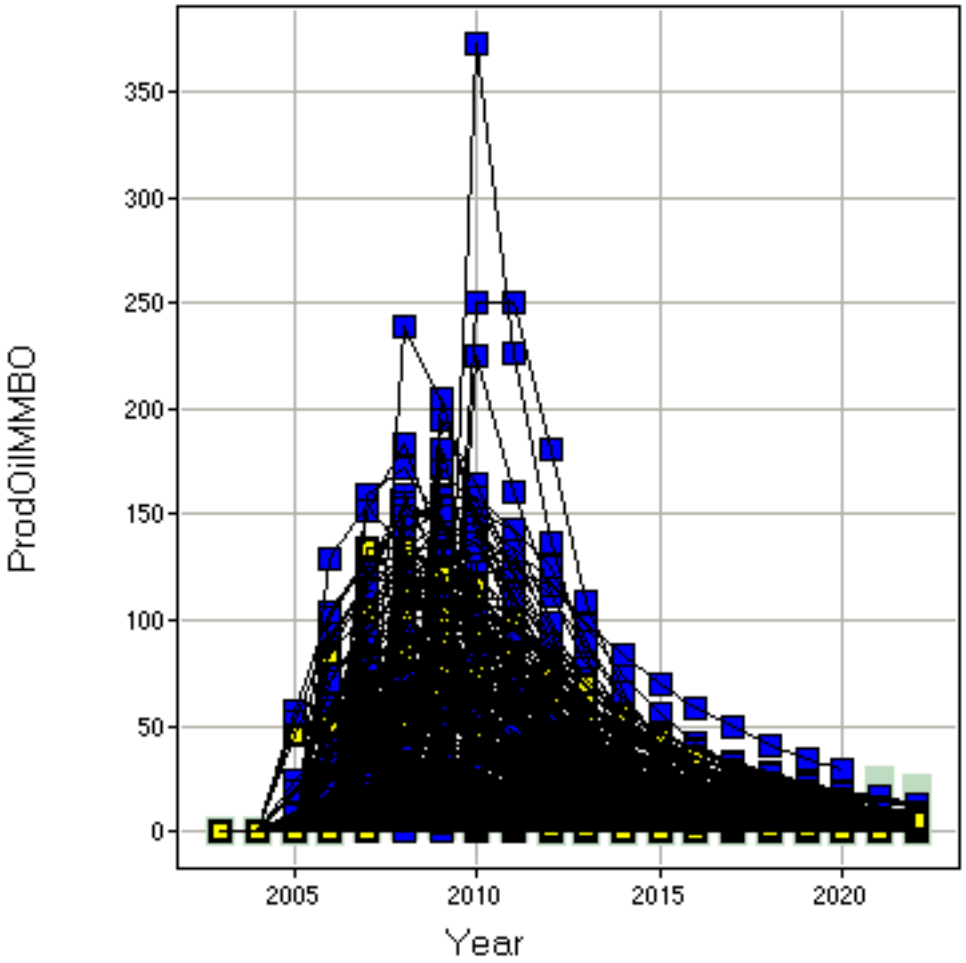
Prod Oil vs Year



This is a Scatter Plot using lines to connect Portfolios ordered by year.

It is tough to make out the selected projects with all the lines, but the lines are necessary.

Markers are connected by IDCase, and ordered by Year.

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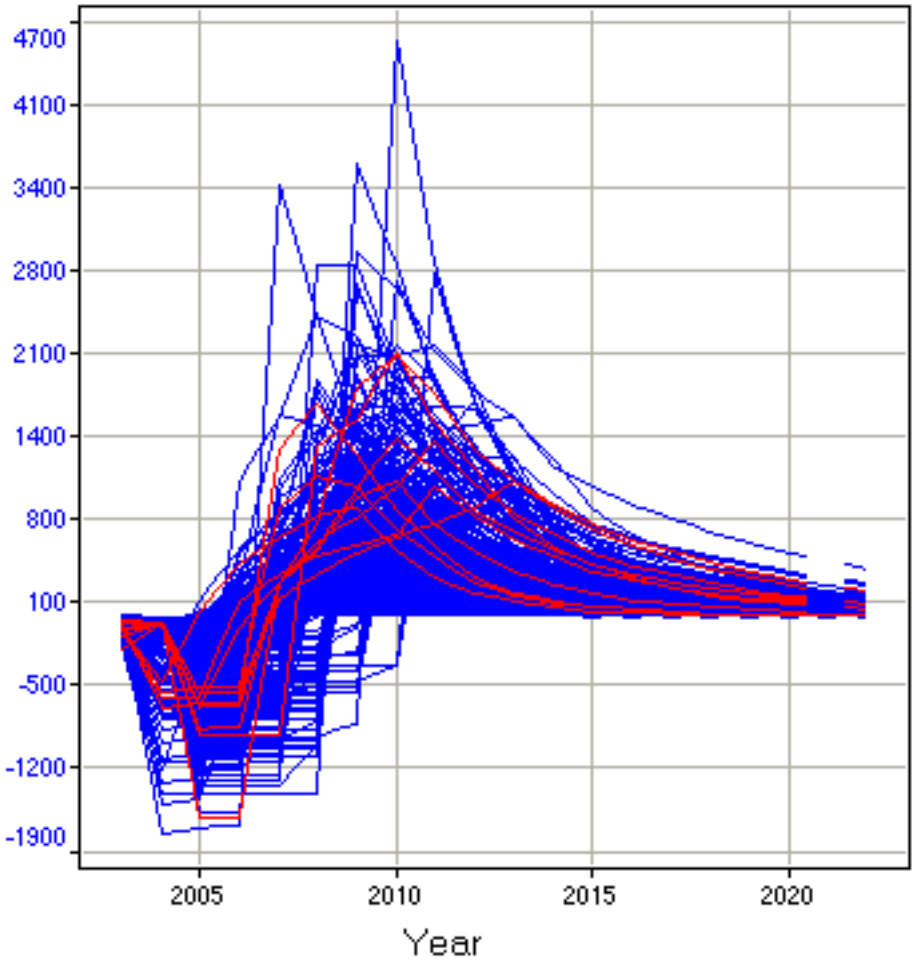
If Success Cash Flow After Tax by year



A Line Chart is a much better way to show theFlow data.

All columns use individual scales.

CashFlow

Markers are connected by IDProject, and ordered by Year.

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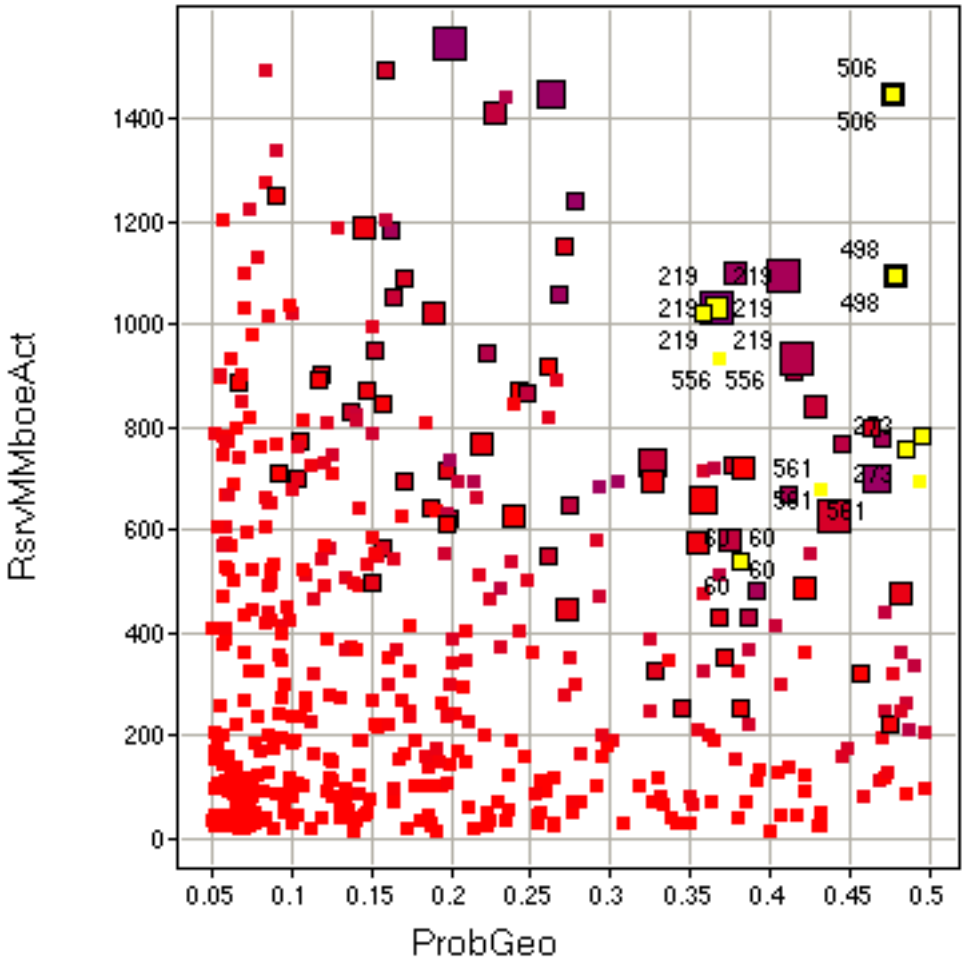
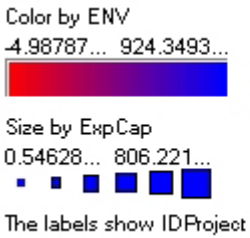
MMBOE vs ProbGeo



The High ENV Projects are, not surprisingly, at high Probabilities of Success.

Note that the color scale is not particularly useful because most of the ENV's are very low.

Size is by Exploration Capex.



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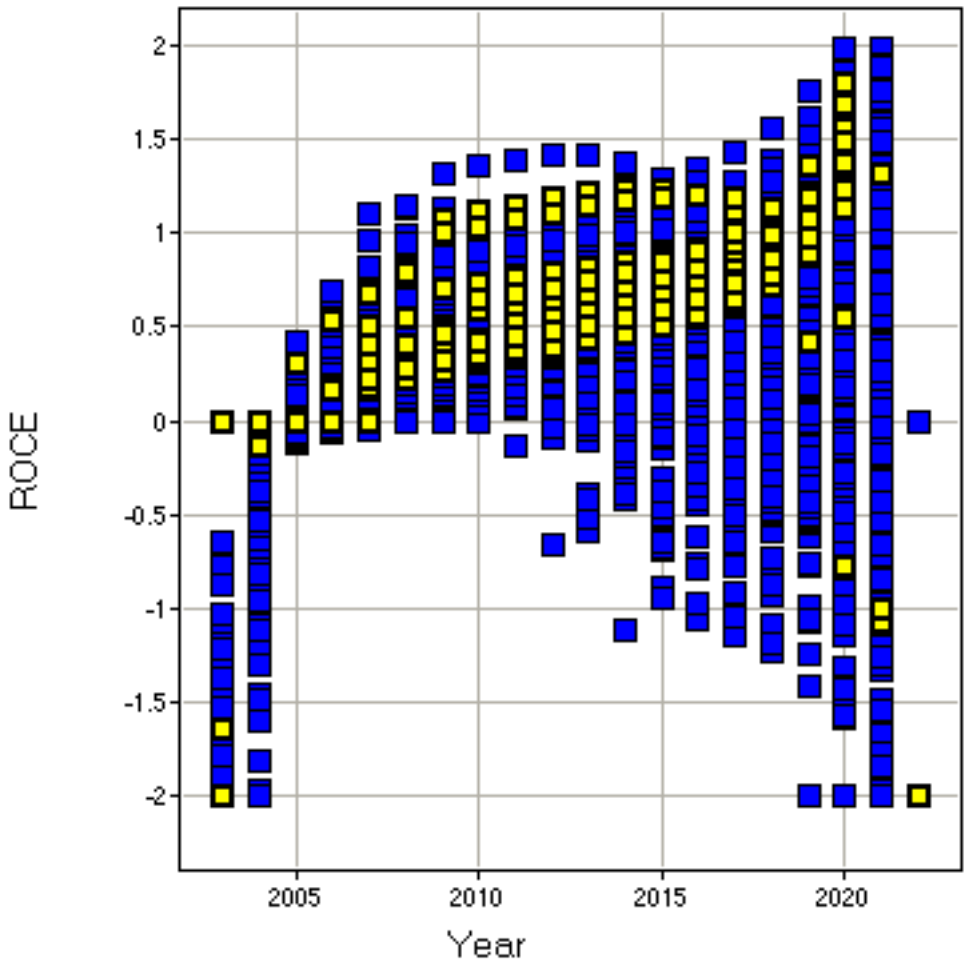
ROCE by Year



If Success Return On Capital Employed.

See how they trend up toward the end of the project life?

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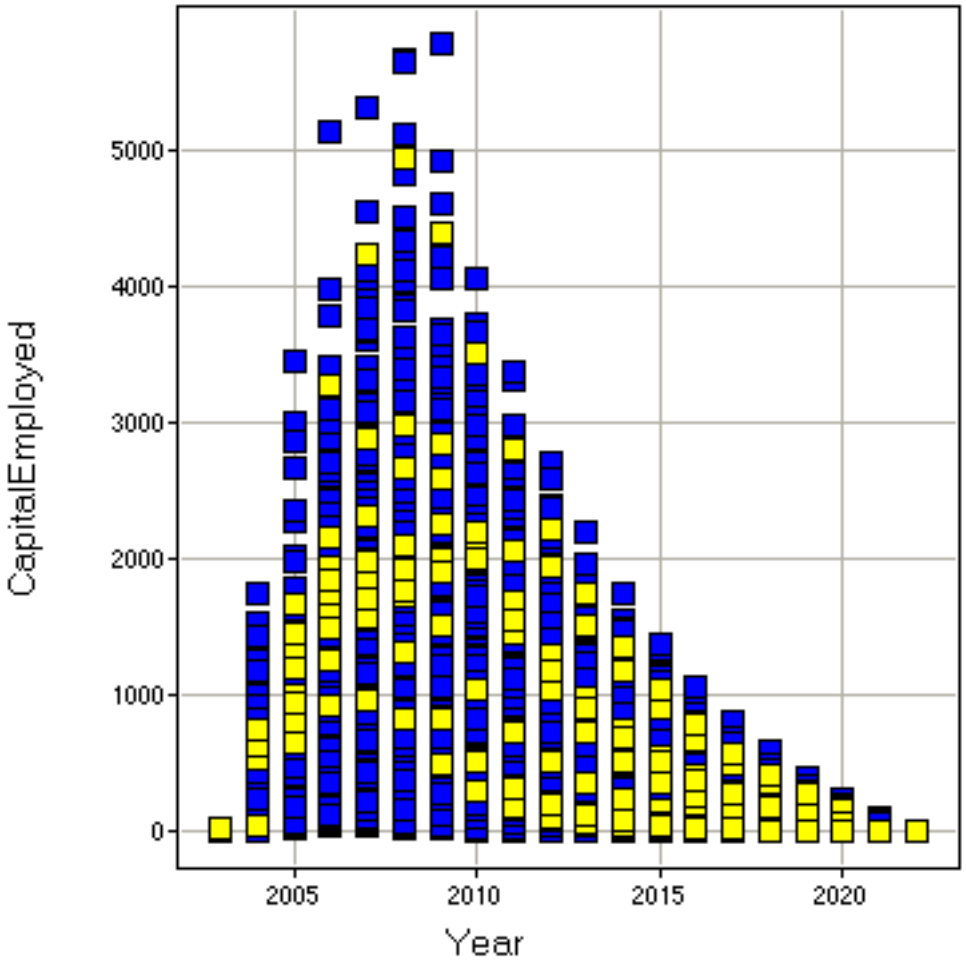
Capital employed



It's because the Capital Employed is dropping fast..

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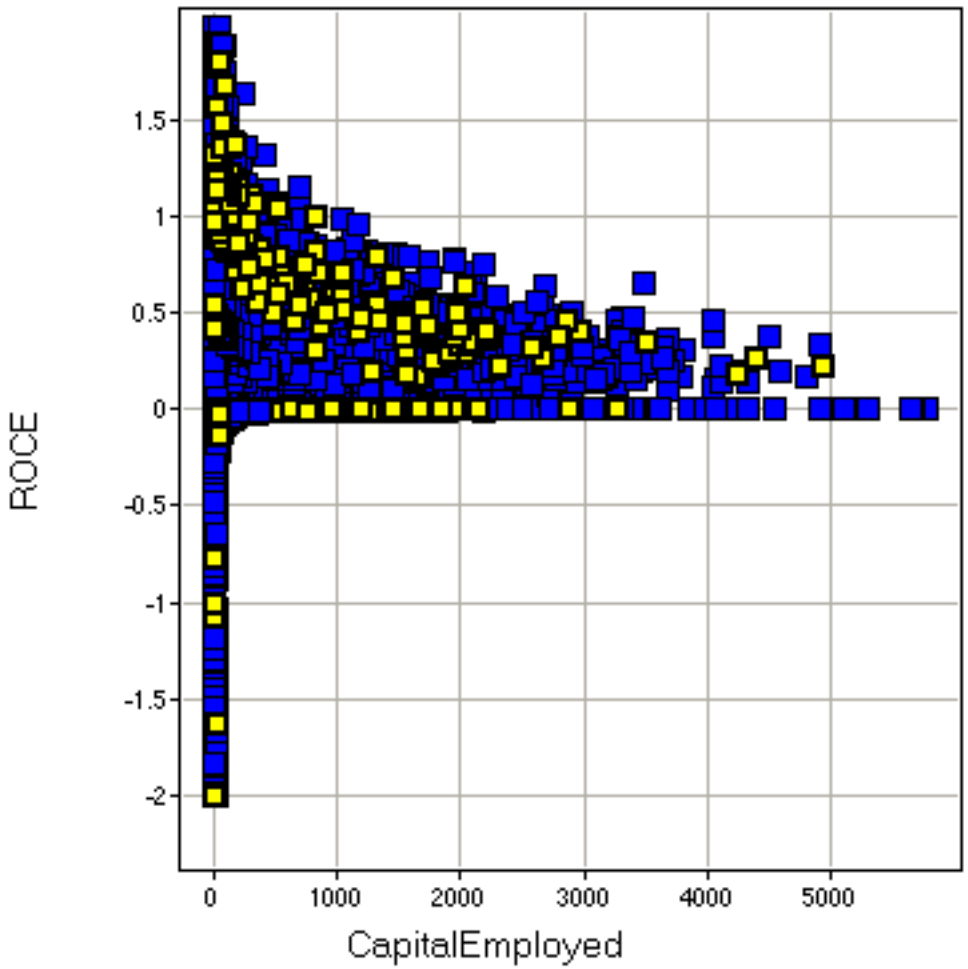
Scatter – ROCE vs. CapitalEmployed



Cross plot ROCE vs Capital Employed.

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Building a Candidate Portfolio

ProjectID	Prob Acquire	Prob Success	100% MMBOE P10L	100% MMBOE P50	100% MMBOE P90H	100% NPV P10L	100% NPV P50	100% NPV P90H	Fail
359	1	0.102	97	145	218	107	156	228	-17
360	1	0.449	97	117	140	198	230	268	-13
361	1	0.083	291	437	655	398	543	762	-10
362	1	0.457	107	128	154	42	63	89	-45
364	1	0.475	75	90	108	70	85	103	-48
365	1	0.220	237	308	401	261	332	424	-67
366	1	0.056	335	586	1026	160	411	851	-9
368	1	0.125	249	374	561	644	829	1105	-21
369	1	0.209	205	266	346	187	249	329	-36
370	1	0.327	244	293	351	383	444	518	-94
371	1	0.126	76	114	171	110	148	205	-4
373	1	0.200	227	295	383	596	725	892	-21

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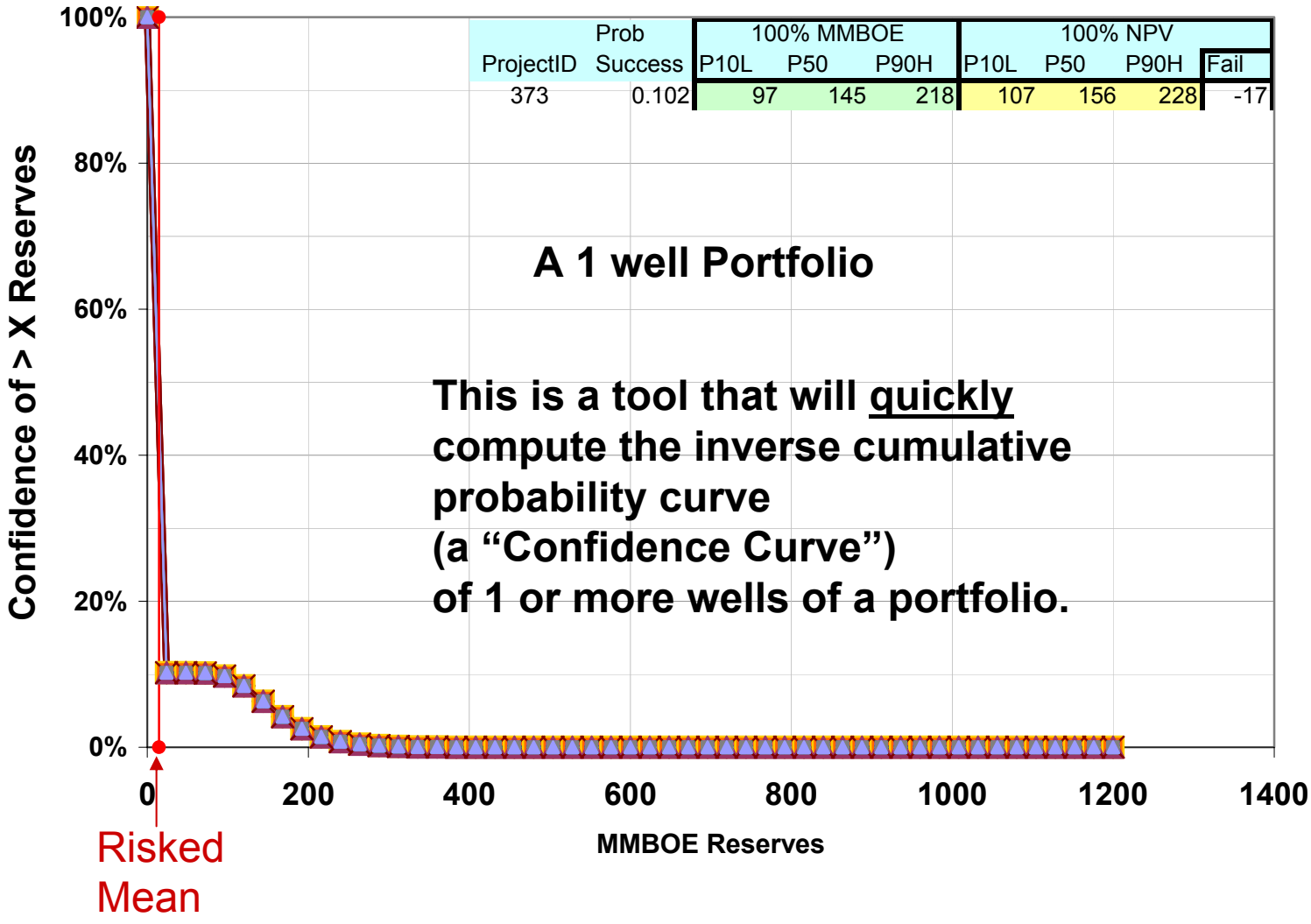
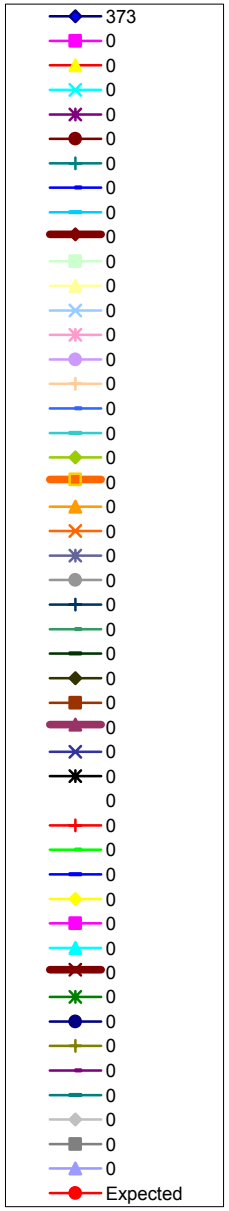
Confidence of At Least X Reserves

ProjectID	Prob Success	100% MMBOE P10L	100% MMBOE P50	100% MMBOE P90H	100% NPV P10L	100% NPV P50	100% NPV P90H	Fail
373	0.102	97	145	218	107	156	228	-17





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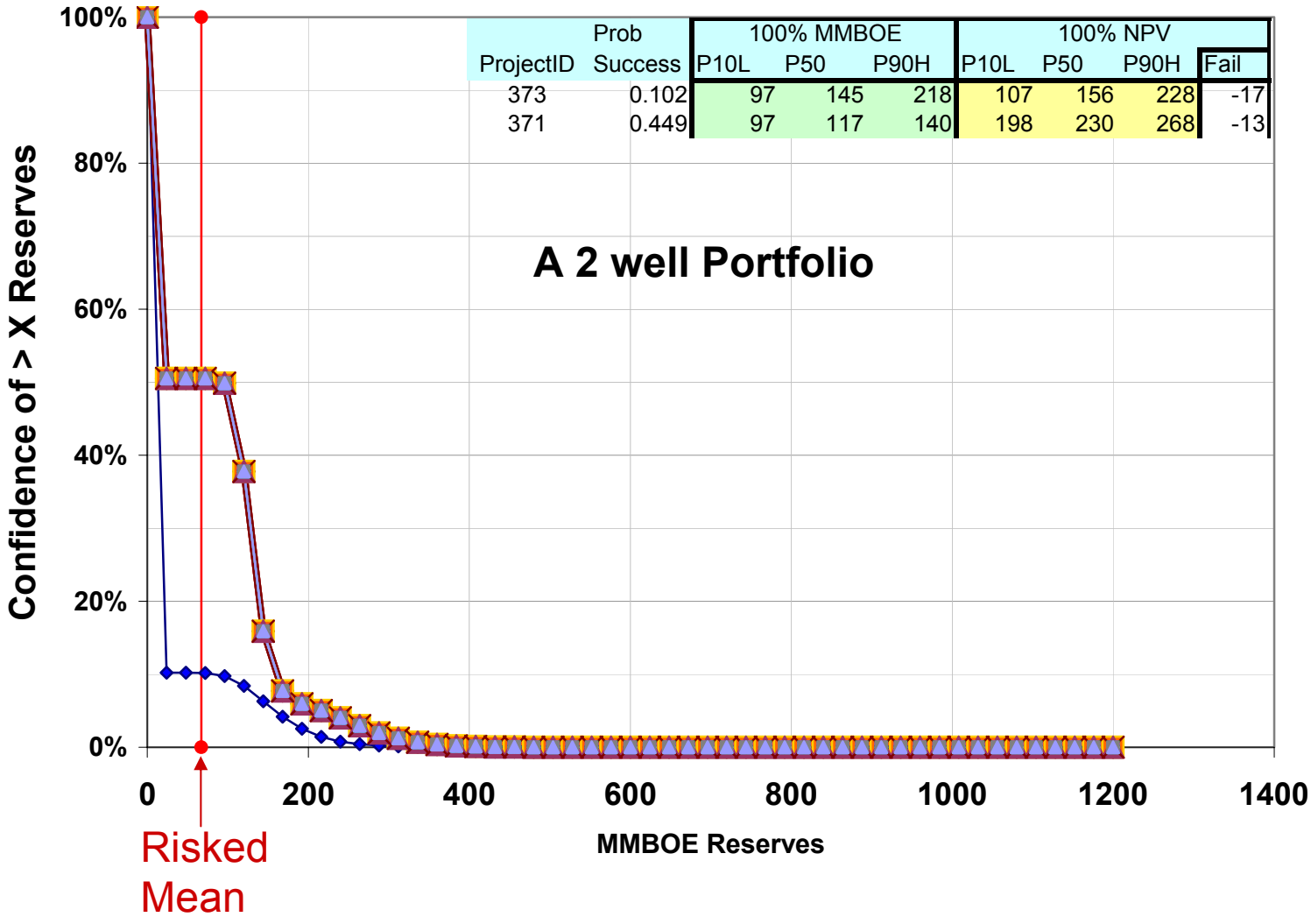
Confidence of At Least X Reserves

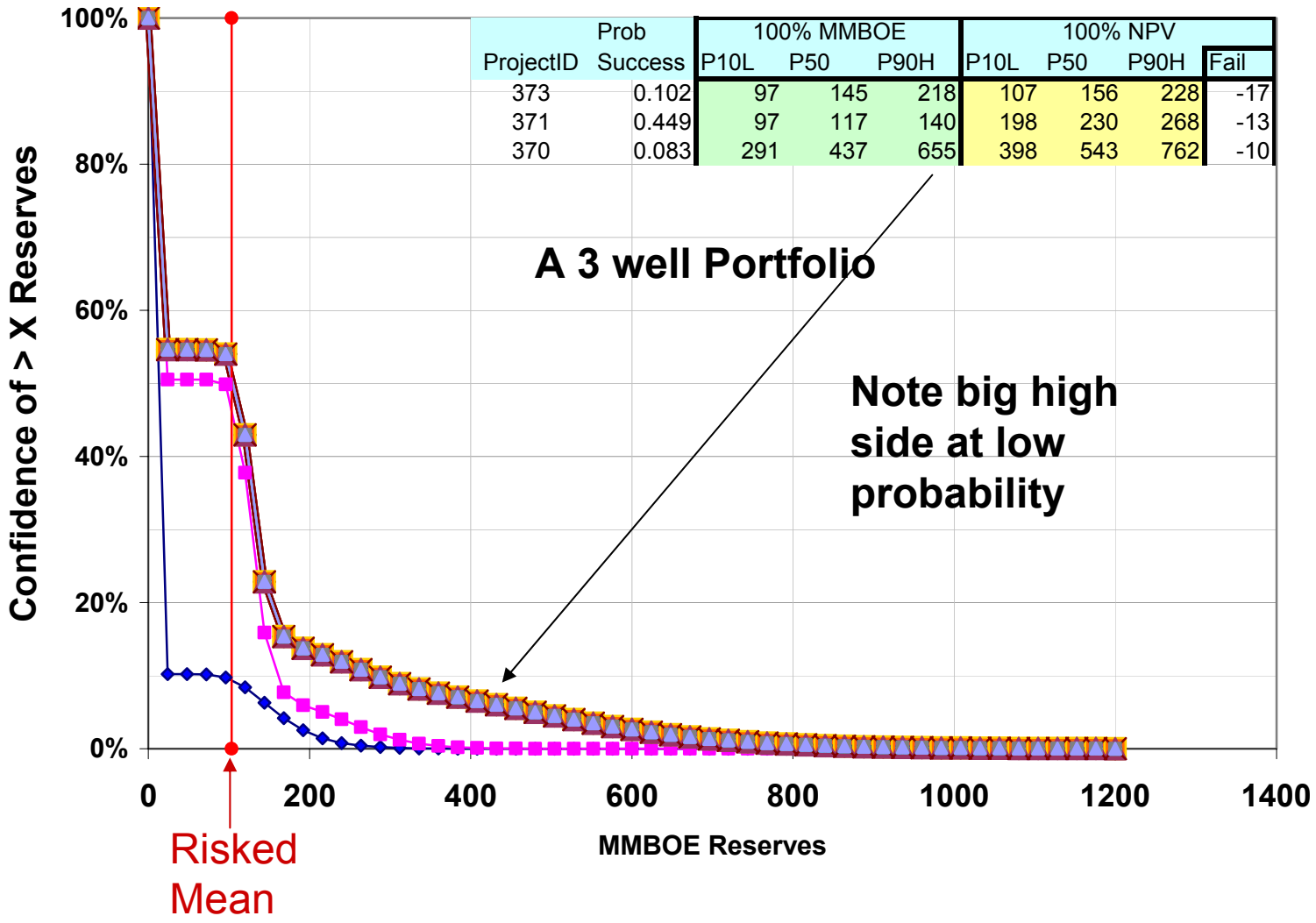
ProjectID	Prob Success	100% MMBOE P10L	100% MMBOE P50	100% MMBOE P90H	100% NPV P10L	100% NPV P50	100% NPV P90H	Fail
373	0.102	97	145	218	107	156	228	-17
371	0.449	97	117	140	198	230	268	-13



373
371
0
0
0

Confidence of At Least X Reserves

ProjectID	Prob Success	100% MMBOE P10L	100% MMBOE P50	100% MMBOE P90H	100% NPV P10L	100% NPV P50	100% NPV P90H	Fail
373	0.102	97	145	218	107	156	228	-17
371	0.449	97	117	140	198	230	268	-13
370	0.083	291	437	655	398	543	762	-10



373
371
370
0
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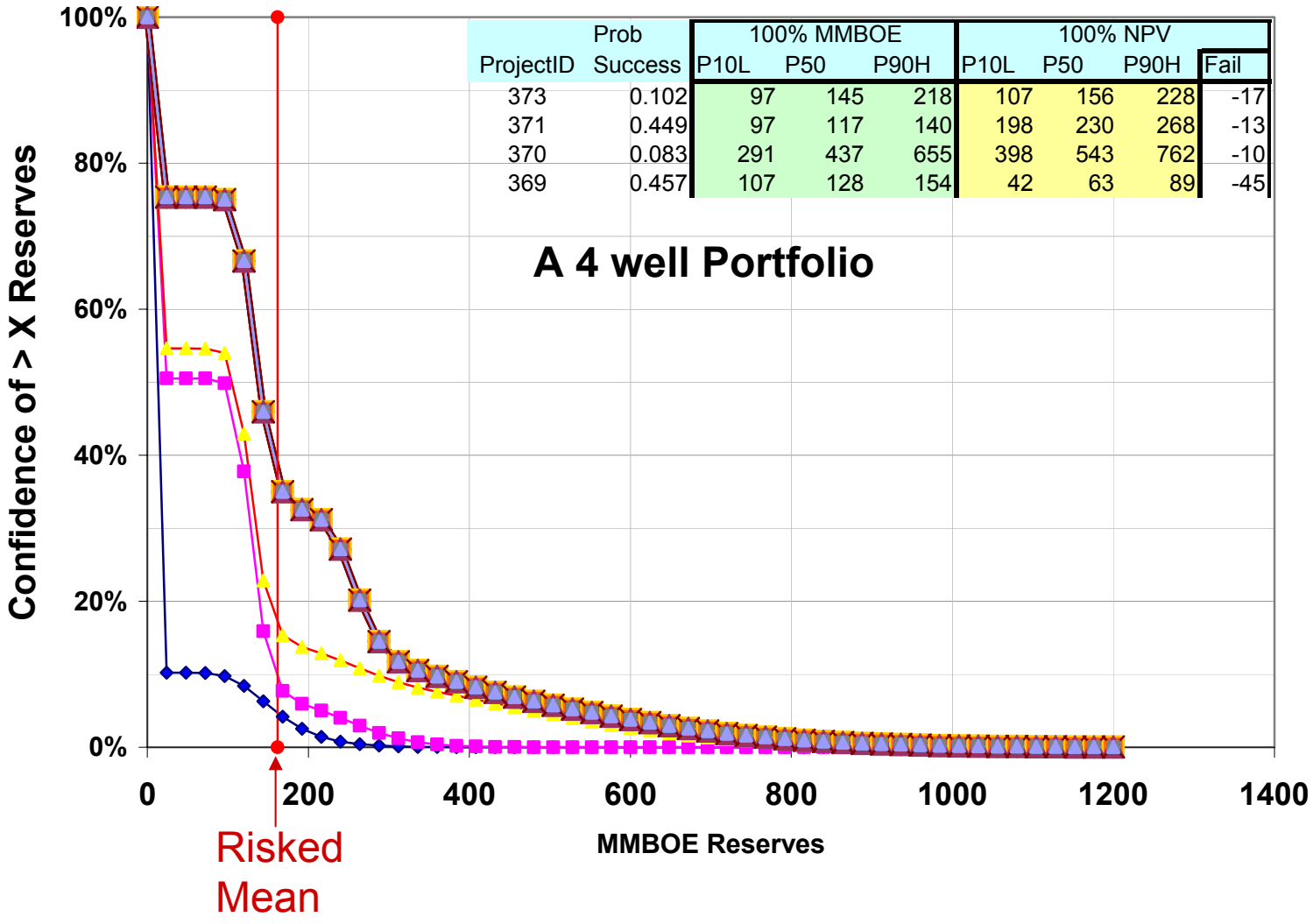
0

Confidence of At Least X Reserves

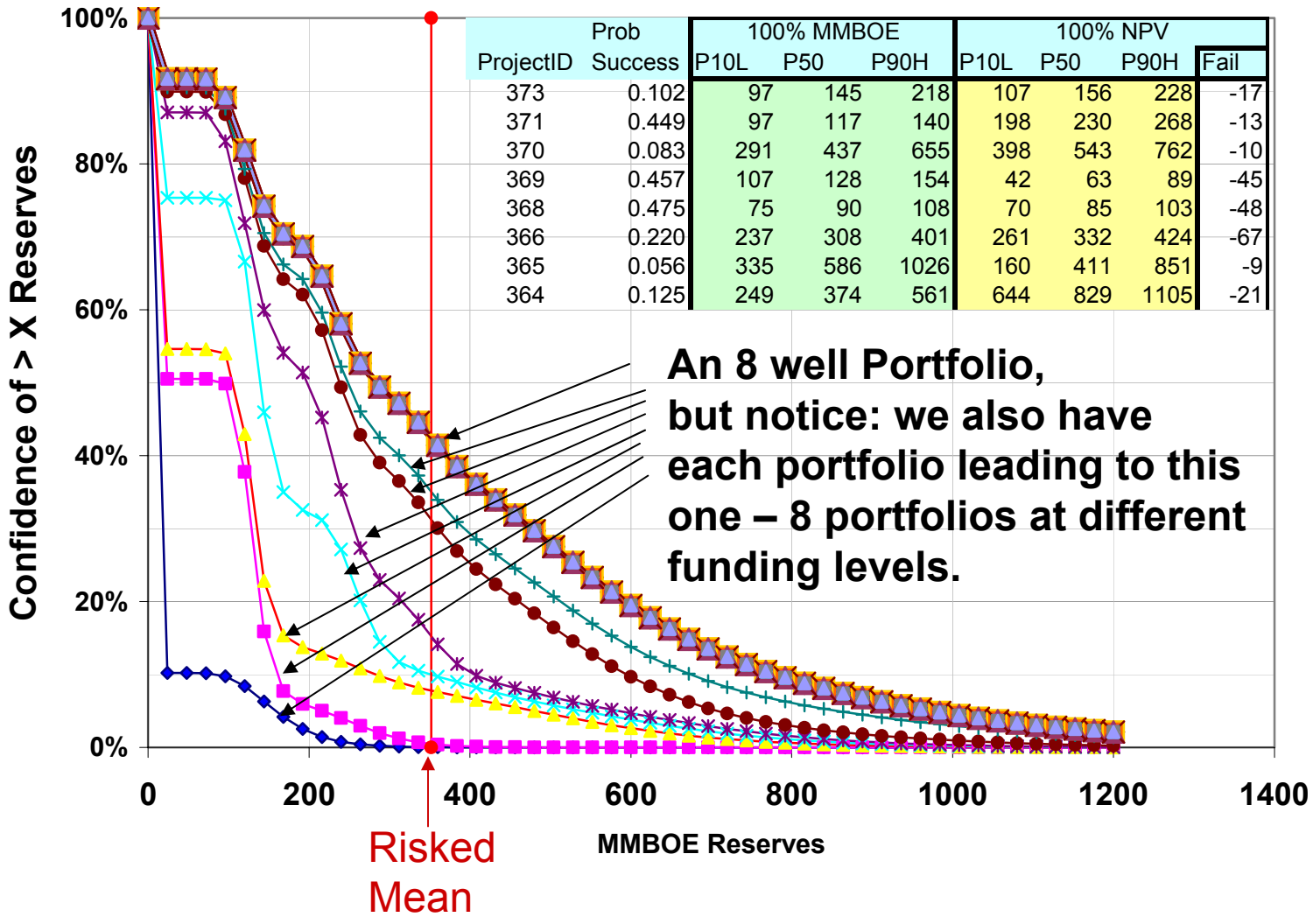
ProjectID	Prob Success	100% MMBOE P10L	100% MMBOE P50	100% MMBOE P90H	100% NPV P10L	100% NPV P50	100% NPV P90H	Fail
373	0.102	97	145	218	107	156	228	-17
371	0.449	97	117	140	198	230	268	-13
370	0.083	291	437	655	398	543	762	-10
369	0.457	107	128	154	42	63	89	-45



373
371
370
369
0
0
0

Confidence of At Least X Reserves

ProjectID	Prob Success	100% MMBOE P10L	100% MMBOE P50	100% MMBOE P90H	100% NPV P10L	100% NPV P50	100% NPV P90H	Fail
373	0.102	97	145	218	107	156	228	-17
371	0.449	97	117	140	198	230	268	-13
370	0.083	291	437	655	398	543	762	-10
369	0.457	107	128	154	42	63	89	-45
368	0.475	75	90	108	70	85	103	-48
366	0.220	237	308	401	261	332	424	-67
365	0.056	335	586	1026	160	411	851	-9
364	0.125	249	374	561	644	829	1105	-21



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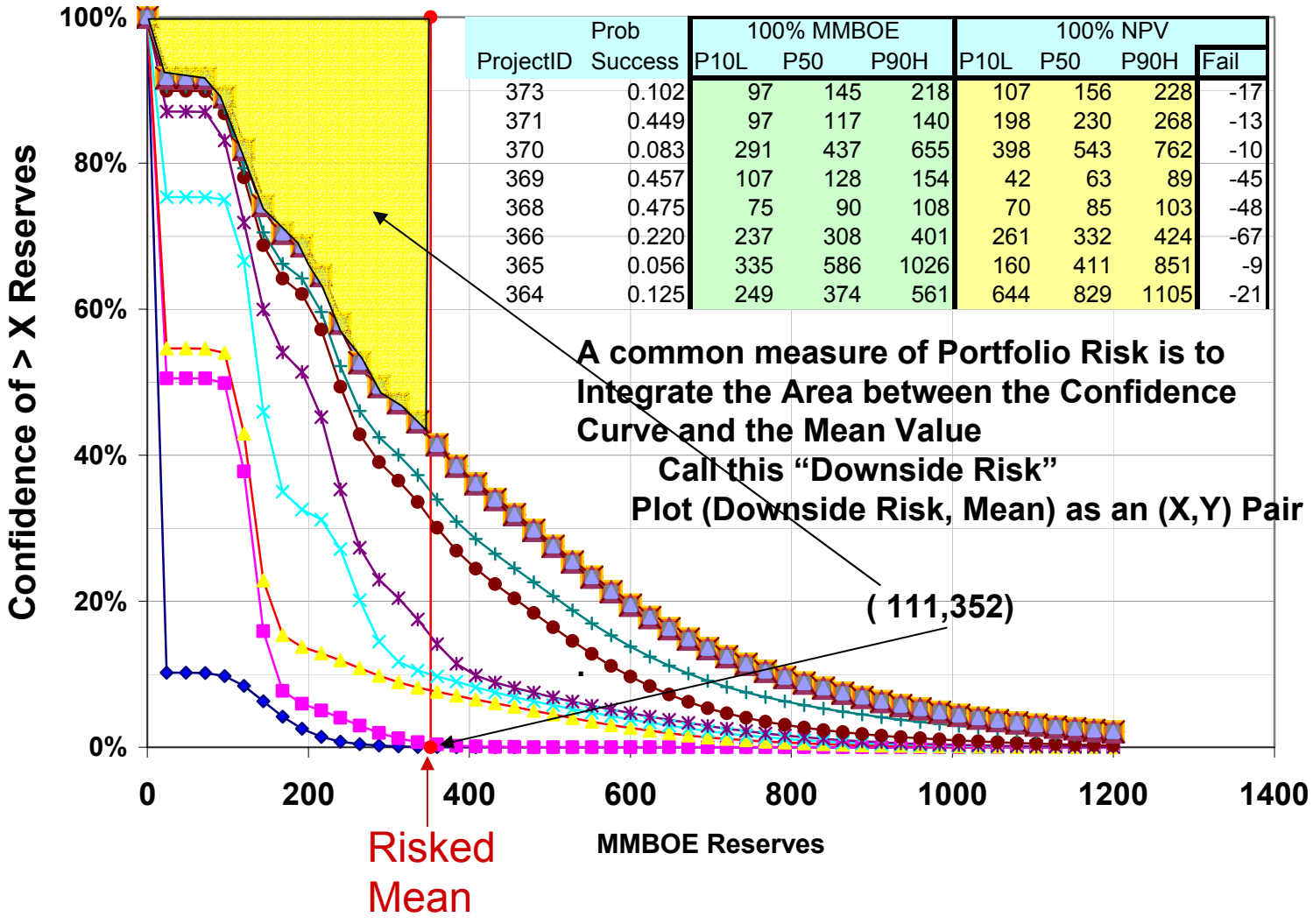
Confidence of At Least X Reserves

ProjectID	Prob Success	100% MMBOE P10L	100% MMBOE P50	100% MMBOE P90H	100% NPV P10L	100% NPV P50	100% NPV P90H	Fail
373	0.102	97	145	218	107	156	228	-17
371	0.449	97	117	140	198	230	268	-13
370	0.083	291	437	655	398	543	762	-10
369	0.457	107	128	154	42	63	89	-45
368	0.475	75	90	108	70	85	103	-48
366	0.220	237	308	401	261	332	424	-67
365	0.056	335	586	1026	160	411	851	-9
364	0.125	249	374	561	644	829	1105	-21



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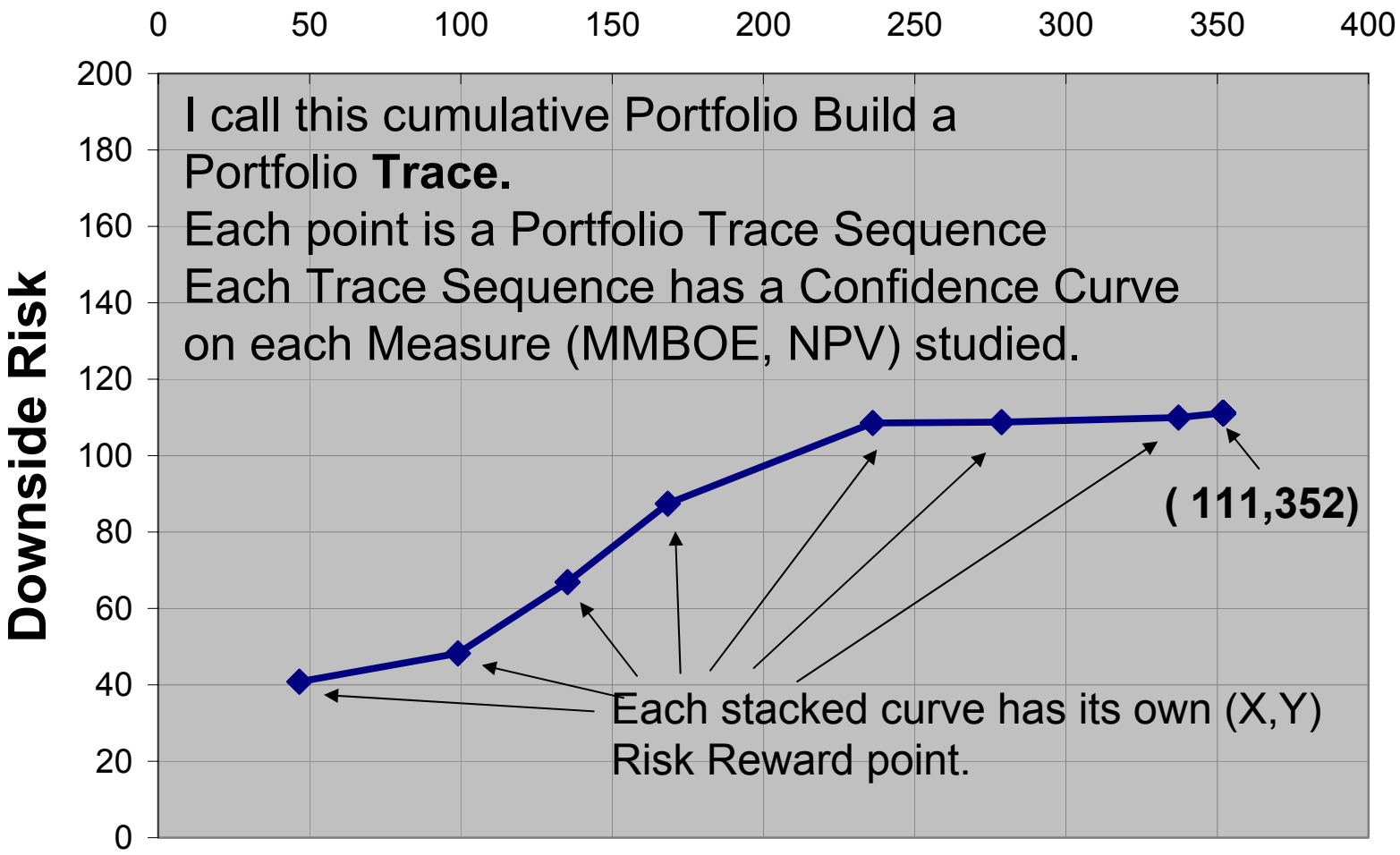
Risk Reward Plot for a Portfolo Trace



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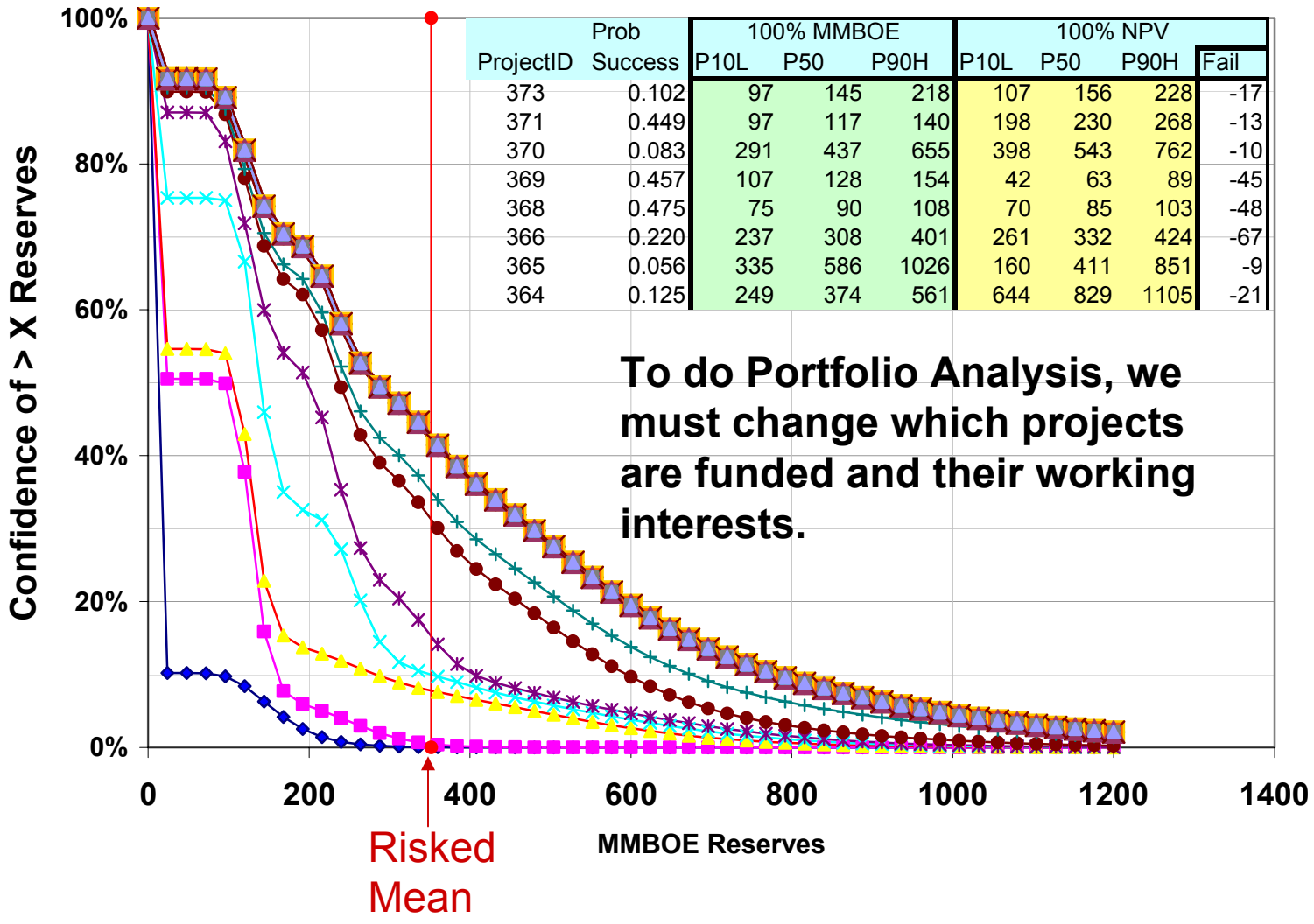
Confidence of At Least X Reserves

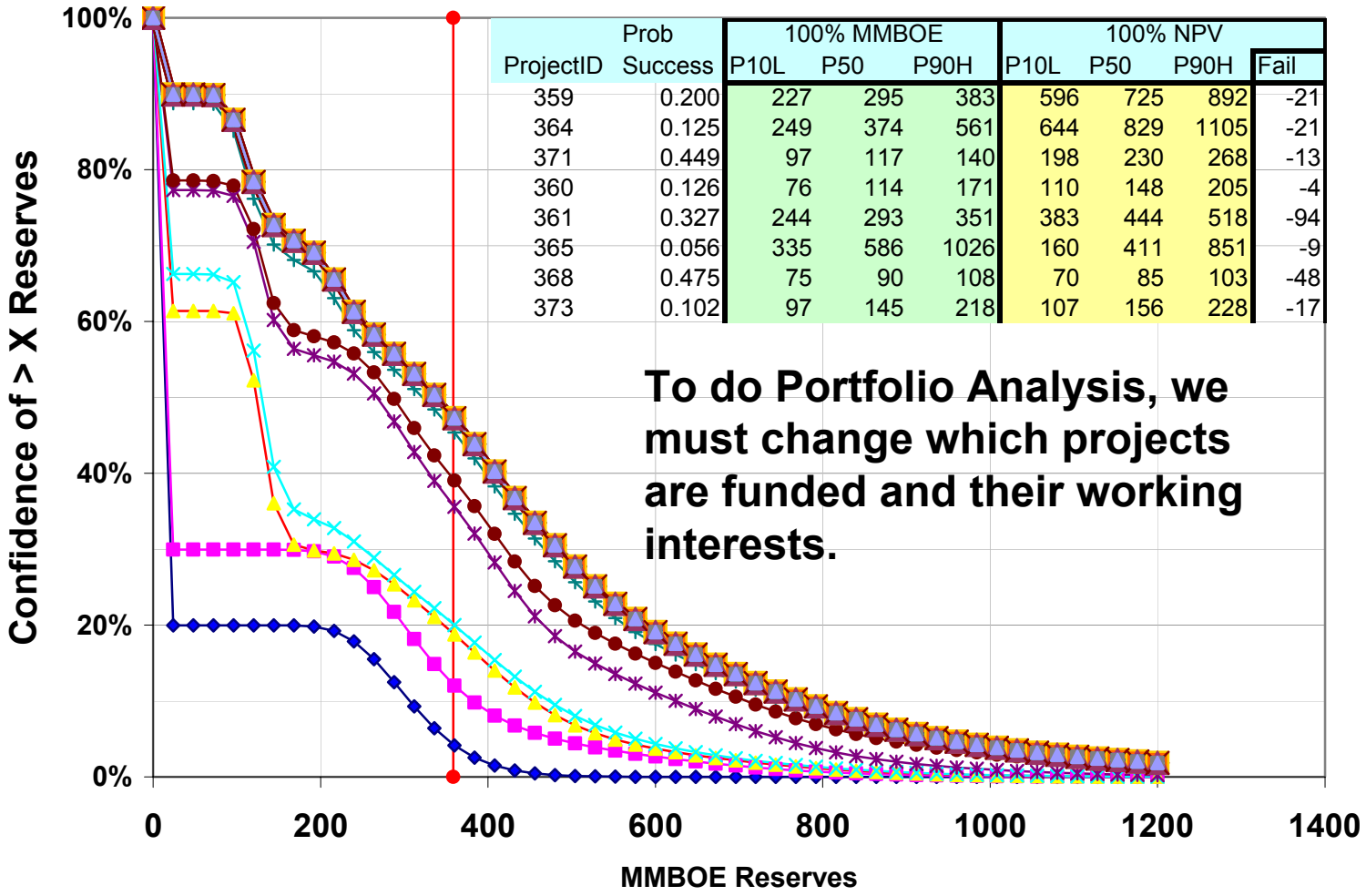


ProjectID	Prob Success	100% MMBOE P10L	100% MMBOE P50	100% MMBOE P90H	100% NPV P10L	100% NPV P50	100% NPV P90H	Fail
373	0.102	97	145	218	107	156	228	-17
371	0.449	97	117	140	198	230	268	-13
370	0.083	291	437	655	398	543	762	-10
369	0.457	107	128	154	42	63	89	-45
368	0.475	75	90	108	70	85	103	-48
366	0.220	237	308	401	261	332	424	-67
365	0.056	335	586	1026	160	411	851	-9
364	0.125	249	374	561	644	829	1105	-21

To do Portfolio Analysis, we must change which projects are funded and their working interests.

373
371
370
369
368
366
365
364
0
0
0

Confidence of At Least X Reserves

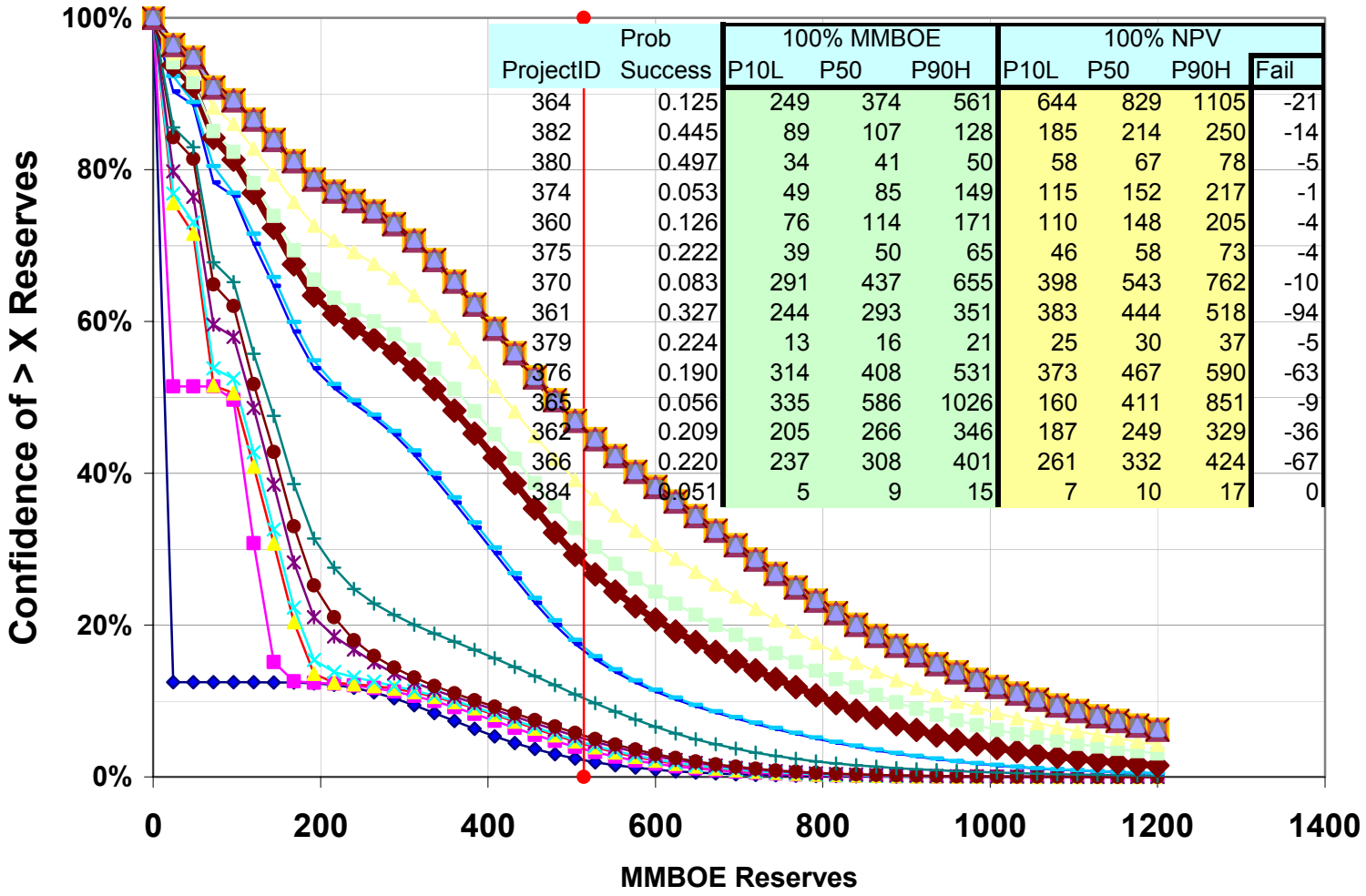


ProjectID	Prob Success	100% MMBOE P10L	100% MMBOE P50	100% MMBOE P90H	100% NPV P10L	100% NPV P50	100% NPV P90H	Fail
359	0.200	227	295	383	596	725	892	-21
364	0.125	249	374	561	644	829	1105	-21
371	0.449	97	117	140	198	230	268	-13
360	0.126	76	114	171	110	148	205	-4
361	0.327	244	293	351	383	444	518	-94
365	0.056	335	586	1026	160	411	851	-9
368	0.475	75	90	108	70	85	103	-48
373	0.102	97	145	218	107	156	228	-17

To do Portfolio Analysis, we must change which projects are funded and their working interests.

359
364
371
360
361
365
368
373
0
0
0

Confidence of At Least X Reserves



ProjectID	Prob Success	100% MMBOE P10L	100% MMBOE P50	100% MMBOE P90H	100% NPV P10L	100% NPV P50	100% NPV P90H	Fail
364	0.125	249	374	561	644	829	1105	-21
382	0.445	89	107	128	185	214	250	-14
380	0.497	34	41	50	58	67	78	-5
374	0.053	49	85	149	115	152	217	-1
360	0.126	76	114	171	110	148	205	-4
375	0.222	39	50	65	46	58	73	-4
370	0.083	291	437	655	398	543	762	-10
361	0.327	244	293	351	383	444	518	-94
379	0.224	13	16	21	25	30	37	-5
376	0.190	314	408	531	373	467	590	-63
365	0.056	335	586	1026	160	411	851	-9
362	0.209	205	266	346	187	249	329	-36
366	0.220	237	308	401	261	332	424	-67
384	0.051	5	9	15	7	10	17	0

364
382
380
374
360
375
370
361
379
376
365
362
366
384
0
0
0

WiserWays MultiField Confidence Curve Calculator

- The version used here can handle
  - a 200 Project inventory,
  - Up to 50 funded at any one portfolio
  - Up to 3 discrete working interest per project
  - Customized weighted project selection based upon good heuristics.
- Each trace calculates has up to 50 Portfolio points.
- Each Portfolio point has two confidence curves at isotiles (every 5%) for MMBOE and NPV written to the database.
- Process time: 4 seconds per trace including writing to the Database. -- 10 Portfolios per second.

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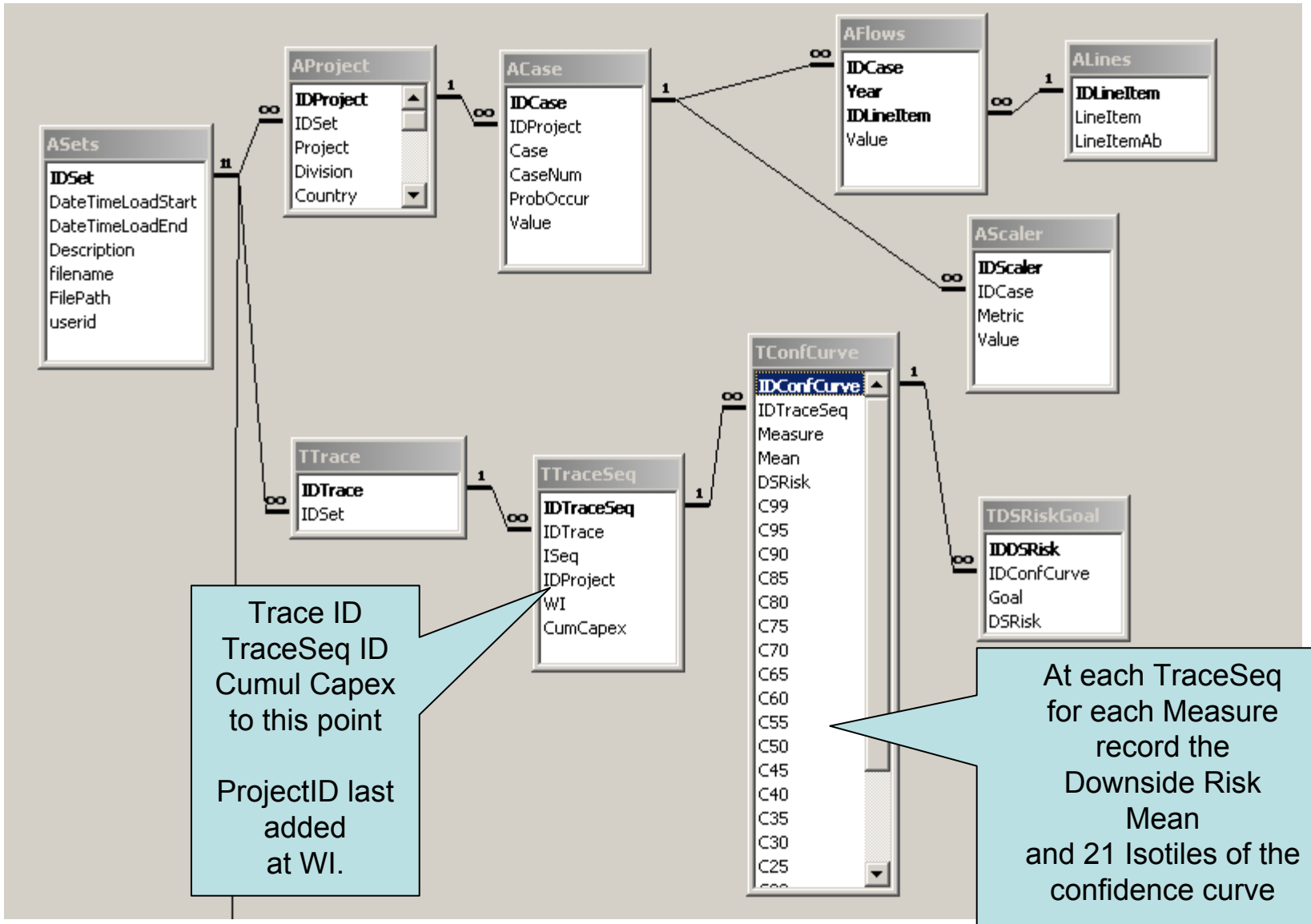
Data Base Schema (Projects)



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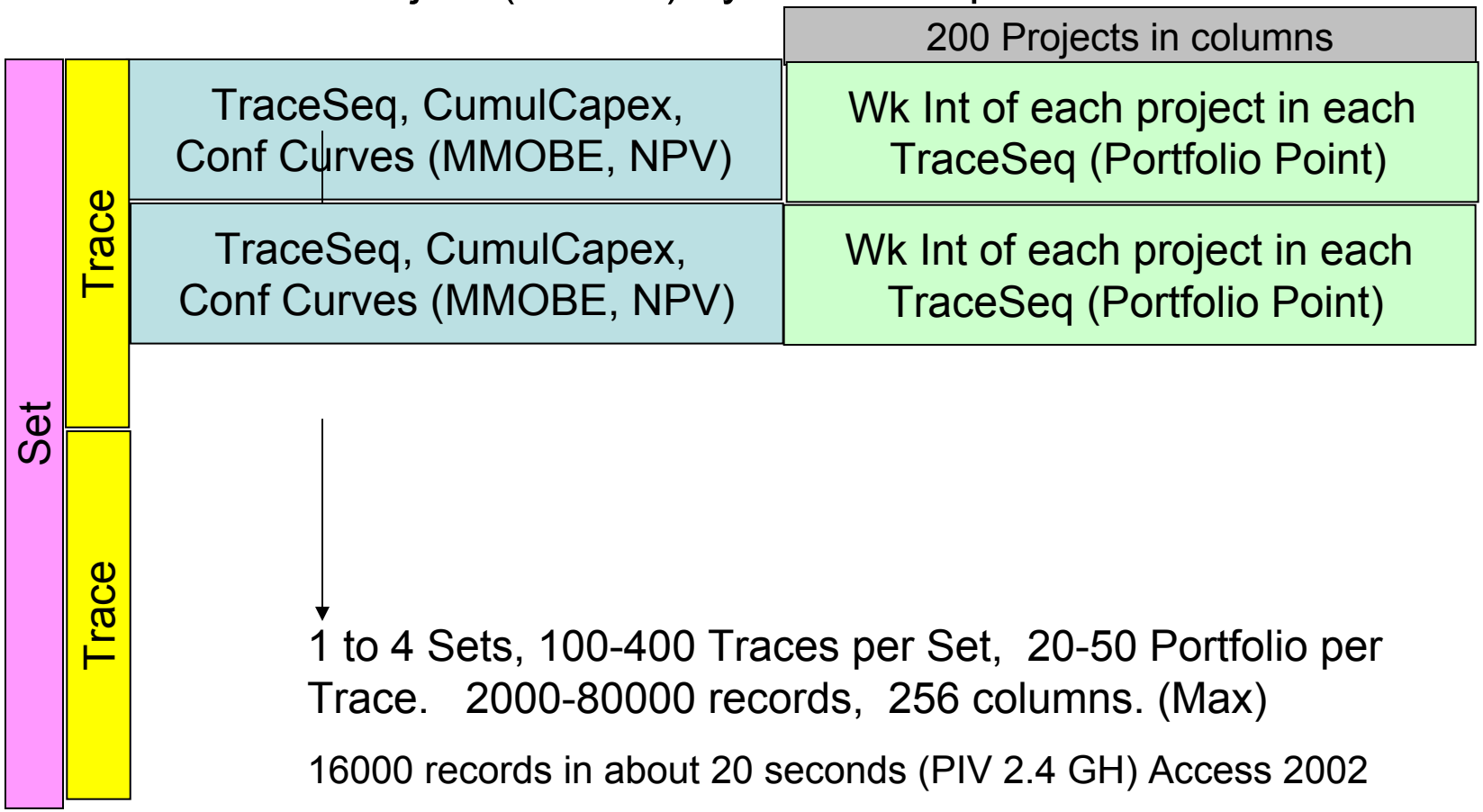
View the Portfolio Confidence Curves and Project Funding.

- T1D5 Query: Confidence Curves (MMBOE, NPV) and Funding level Each Project (Wk.Int.) by Trace Sequence Number



1 to 4 Sets, 100-400 Traces per Set, 20-50 Portfolio per Trace. 2000-80000 records, 256 columns. (Max)

16000 records in about 20 seconds (PIV 2.4 GH) Access 2002

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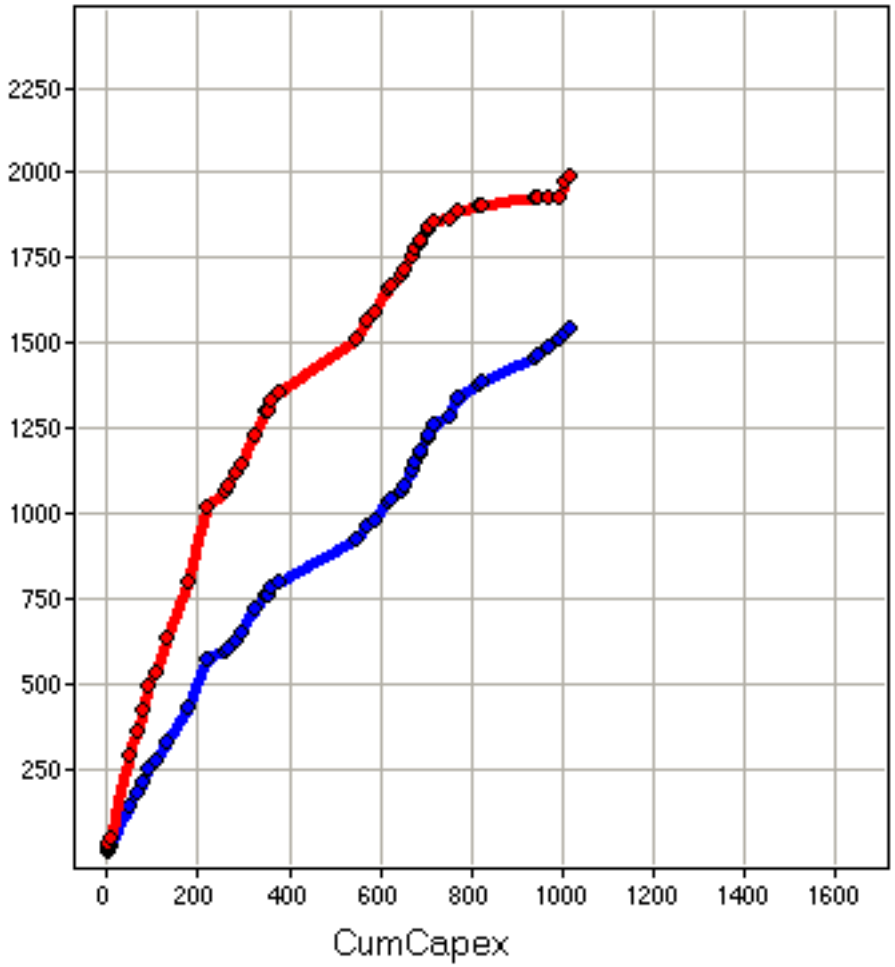
MMBOE & NPV vs Cum Capex Trace 602



All columns use the same scale.

C.BOE.Mean

C.NPV.Mean

Markers are connected by C.IDTrace, and ordered by CumCapex.

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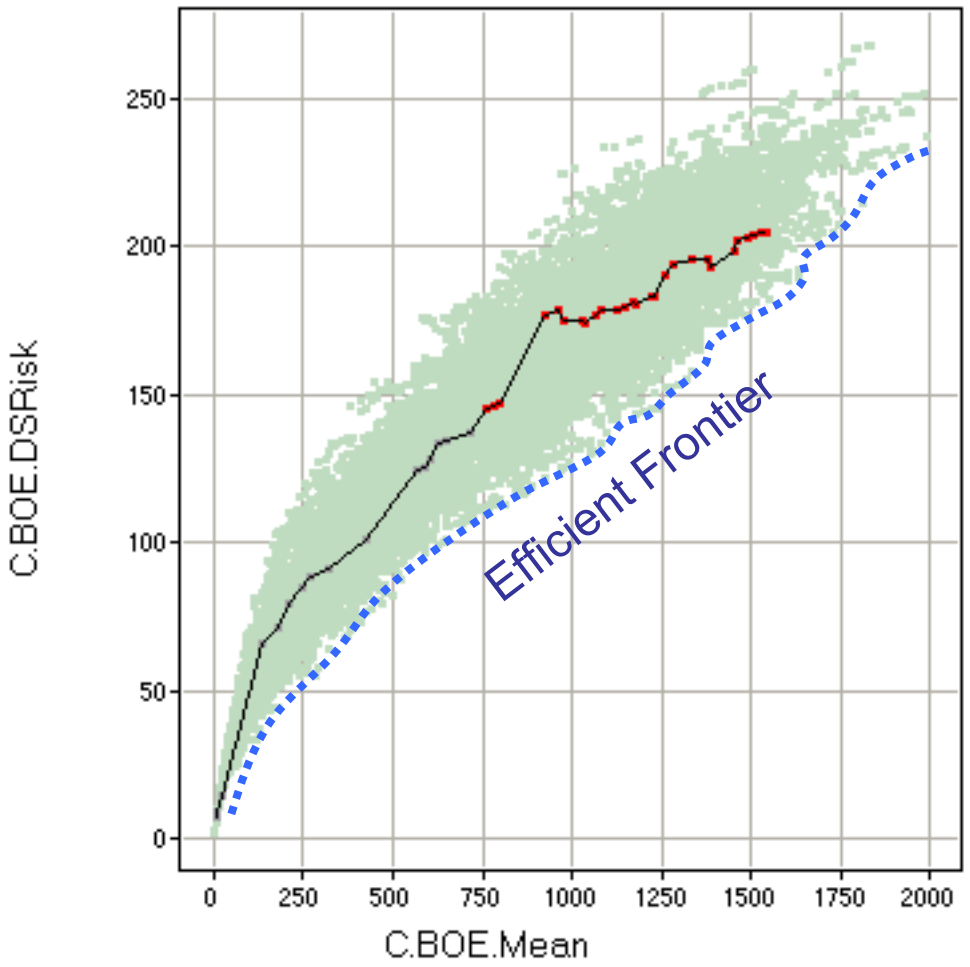
MMBOE Risk Reward (Scatter Plot) Trace 602



Pale blue grey points are “Shown deselected” points of all portfolios in all traces run.

Showing only the portfolios along Trace 602.

The red Portfolio points are those where Project 422 were funded at 33% working interest.

These portfolios are not particularly close to the Efficient Frontier.

Color by 422

- 0.333333343267441
- 0.5
- 1
- (Empty)

Markers are connected by C.IDTrace, and ordered by C.IDTraceSeq.

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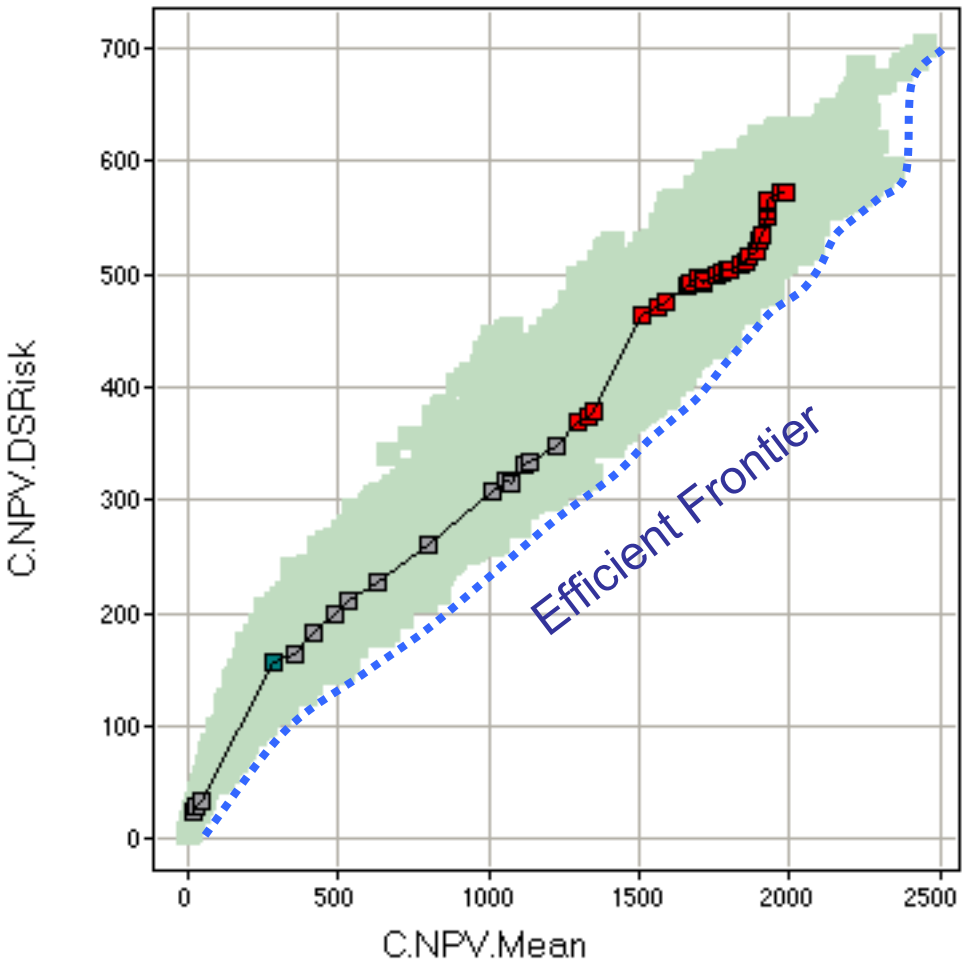
NPV Risk Reward (Scatter Plot), Trace 602



Same type of Risk / Reward plot, but this is for the NPV metric.

Also showing just the portfolios along Trace number 602 against a background of all portfolio points (Shown deselected).

Color by 422

0.333333343267441

0.5

1

(Empty)

Markers are connected by C.IDTrace, and ordered by C.IDTraceSeq.

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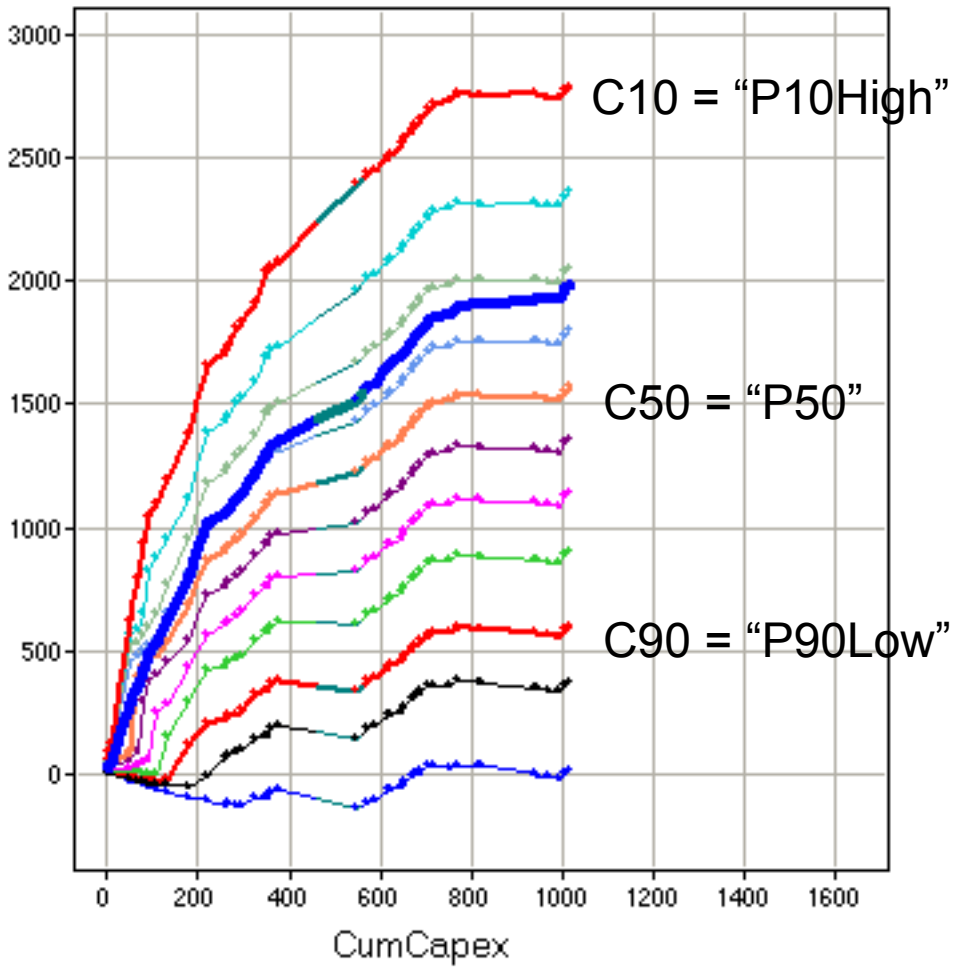
NPV Prob by Cumul Capex Trace 602



This is a Line Chart, X-Axis as Cumulative Capex.

Here we display Each confidence Level as more and more project are funded.

This Metric is Portfolio NPV

All columns use the same scale.

- C.NPV.C99
- C.NPV.C90
- C.NPV.C95
- C.NPV.C80
- C.NPV.C70
- C.NPV.C60
- C.NPV.C50
- C.NPV.C40
- C.NPV.C30
- C.NPV.C20
- C.NPV.C10
- C.NPV.Mean

Markers are connected by C.IDTrace, and ordered by CumCapex.

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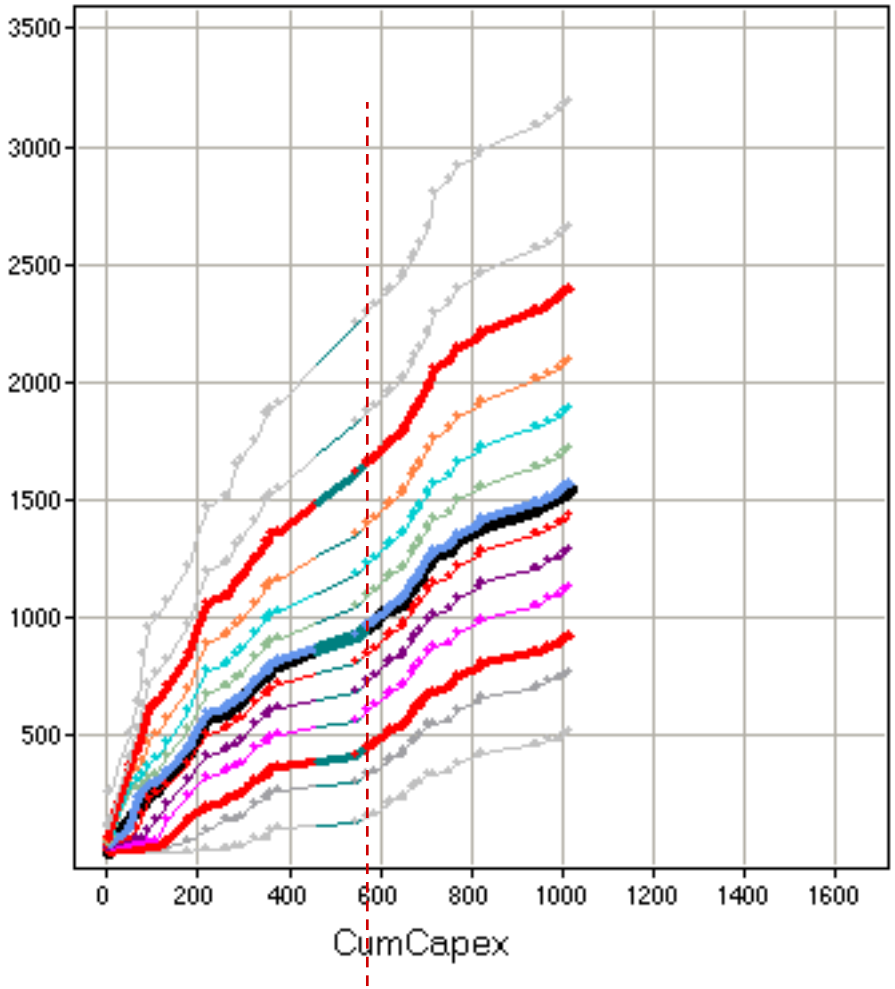
MMBOE Prob by Cumul Capex



This is a Line Chart, X-Axis as Cumulative Capex.

Here we display Each confidence Level as more and more project are funded.

This Metric is Portfolio MMBOE

All columns use the same scale.

- C.BOE.Mean
- C.BOE.C99
- C.BOE.C95
- C.BOE.C90
- C.BOE.C80
- C.BOE.C70
- C.BOE.C60
- C.BOE.C50
- C.BOE.C40
- C.BOE.C30
- C.BOE.C20
- C.BOE.C10
- C.BOE.C05
- C.BOE.C01

Markers are connected by C.IDTrace, and ordered by CumCapex.

Pick a funding level, see the range of results

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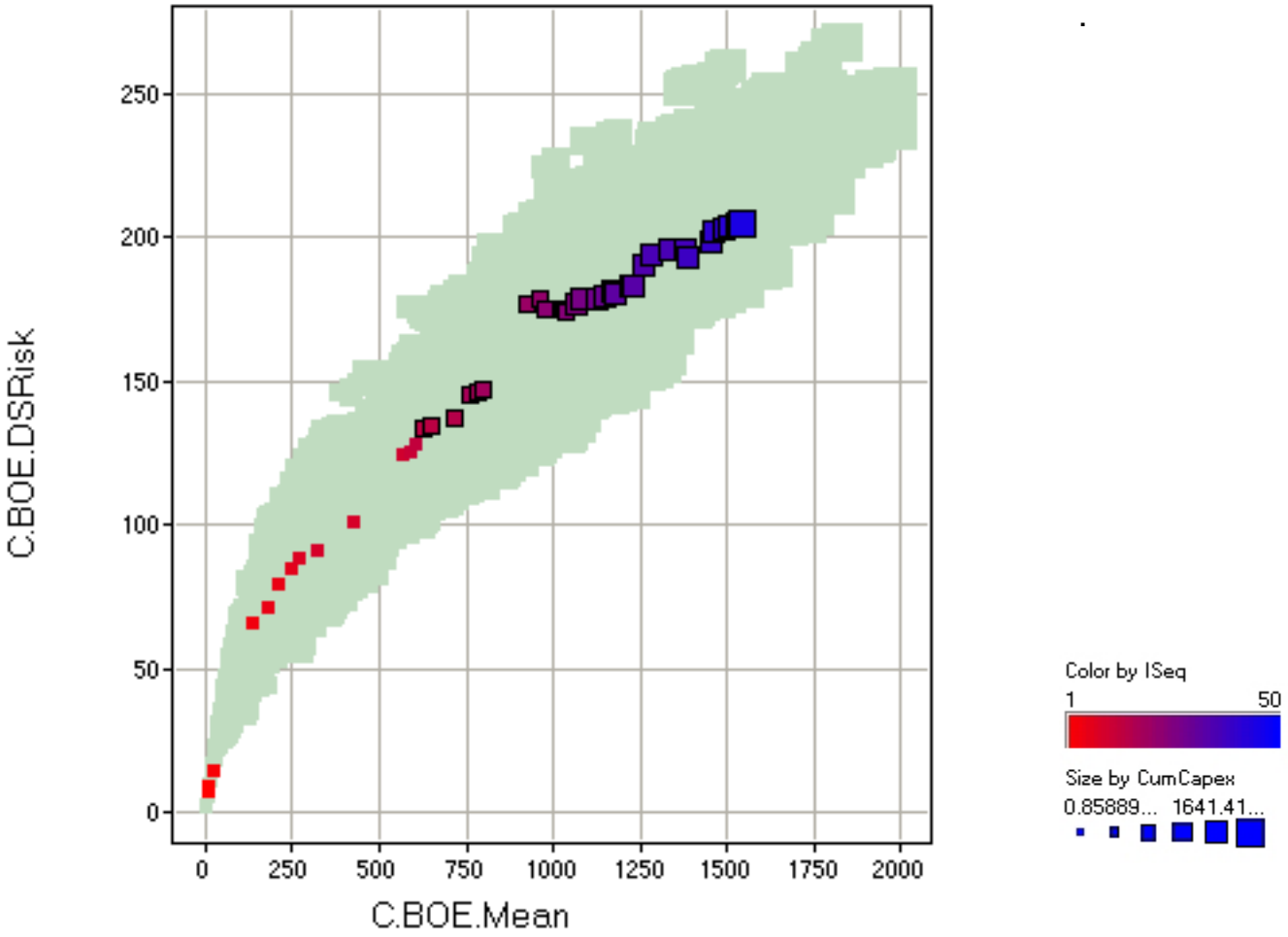
DS BOE



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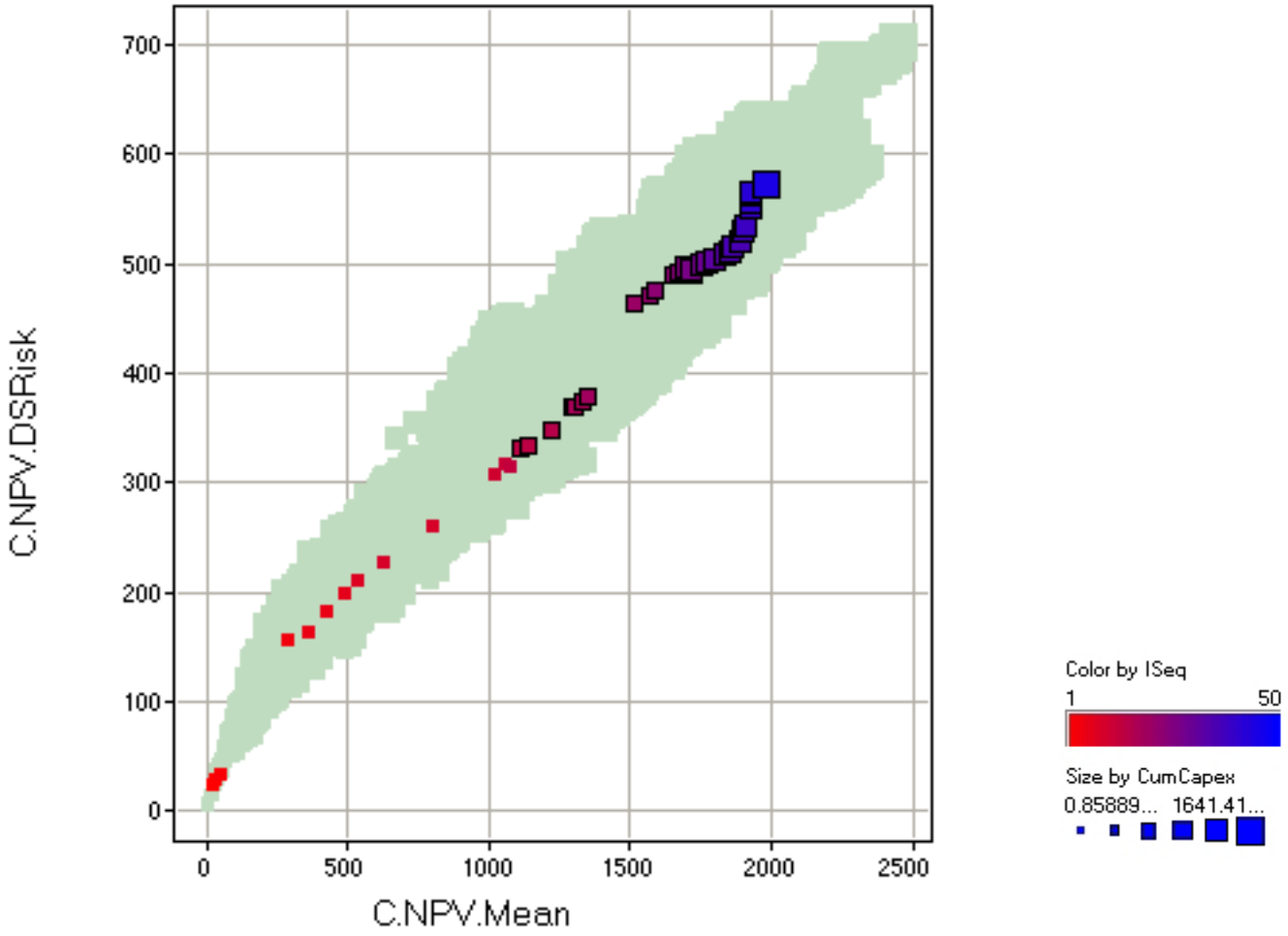
DS NPV



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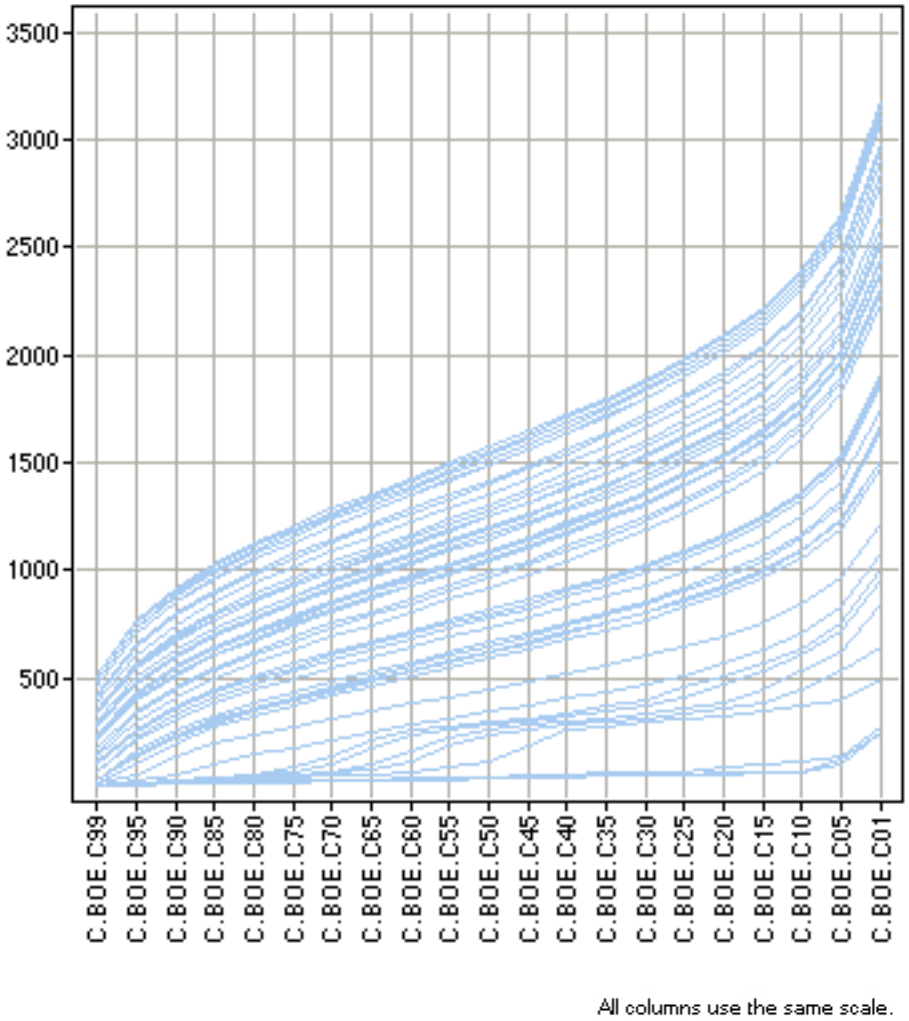
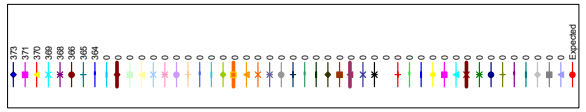
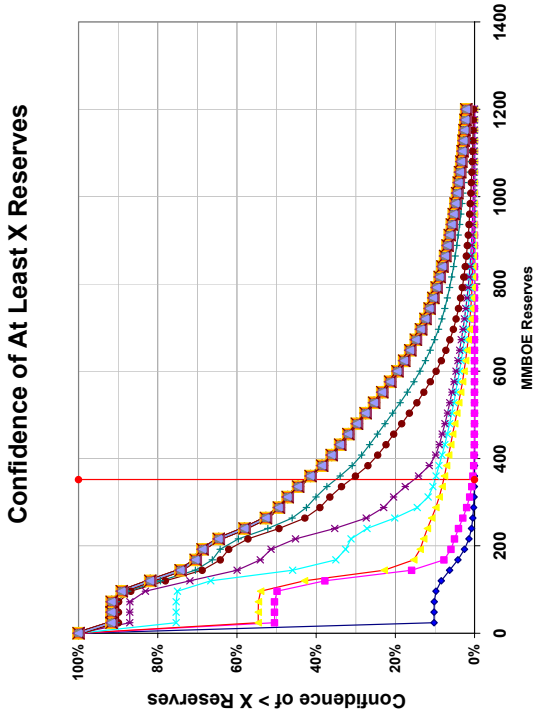
MMBOE Confidence Curves



All columns use the same scale.

Spotfire requires we use a Line Chart on the 21 columns of confidence levels. There fore the plot is rotated from





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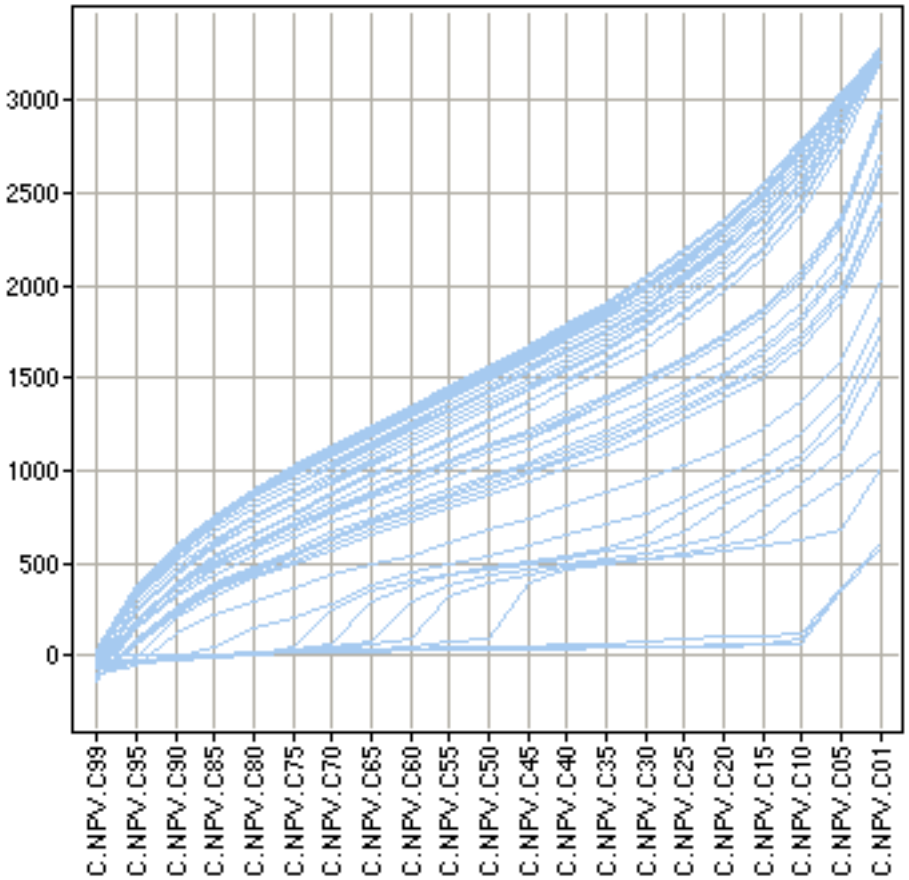
NPV Confidence Curves



All columns use the same scale.

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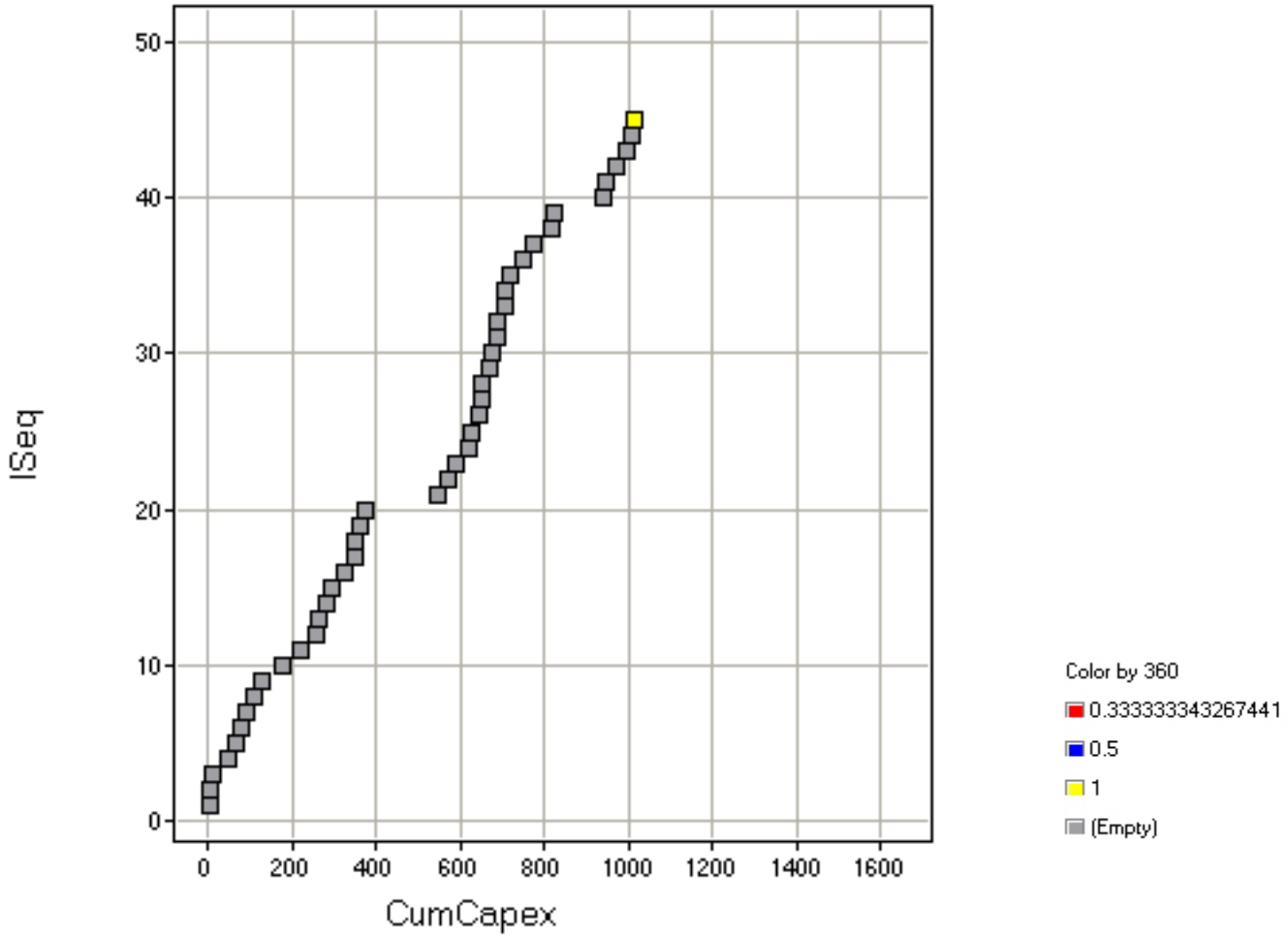
ISeq (sequence number within a Trace)



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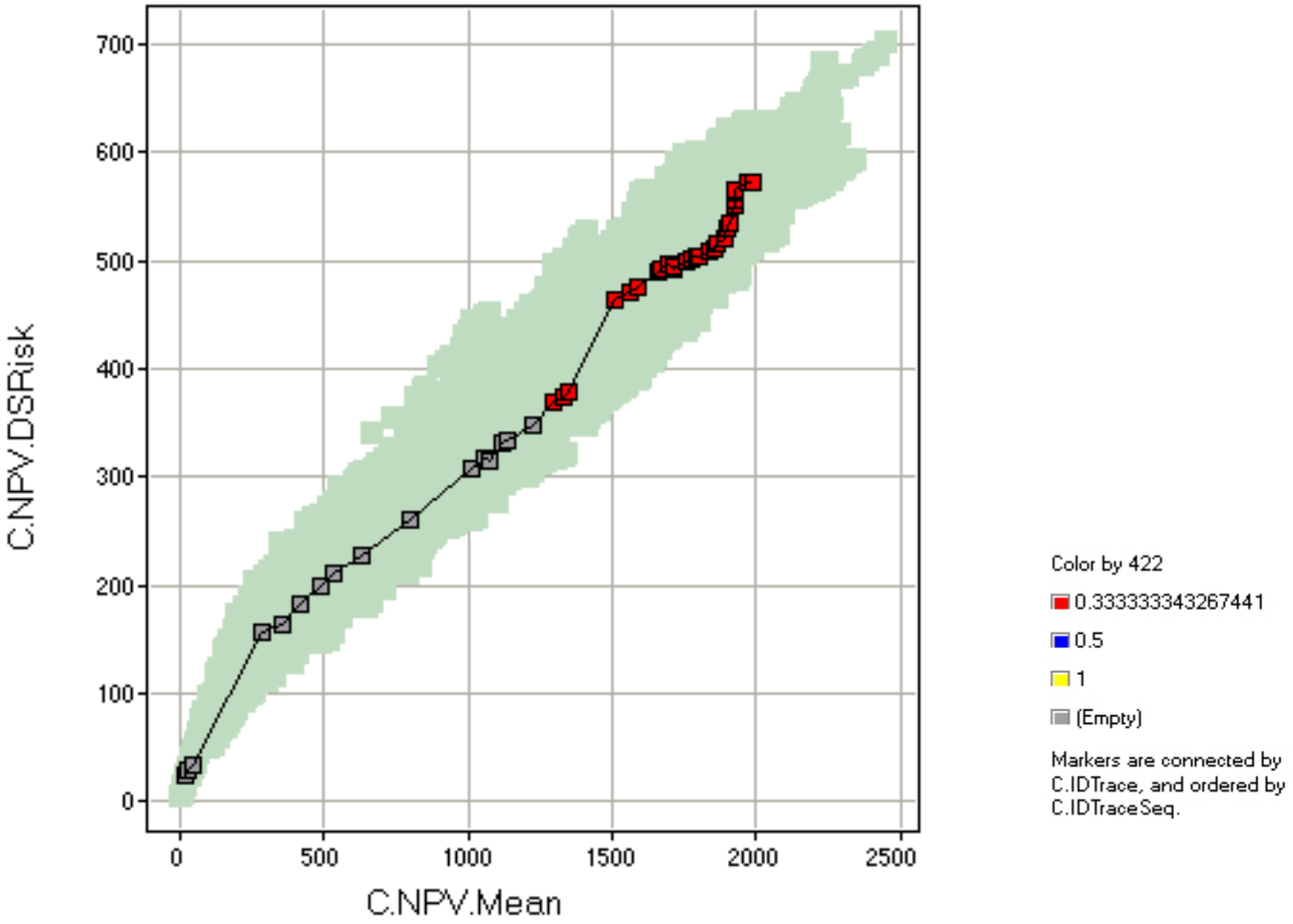
DS NPV - Color by WI of 1 Project -



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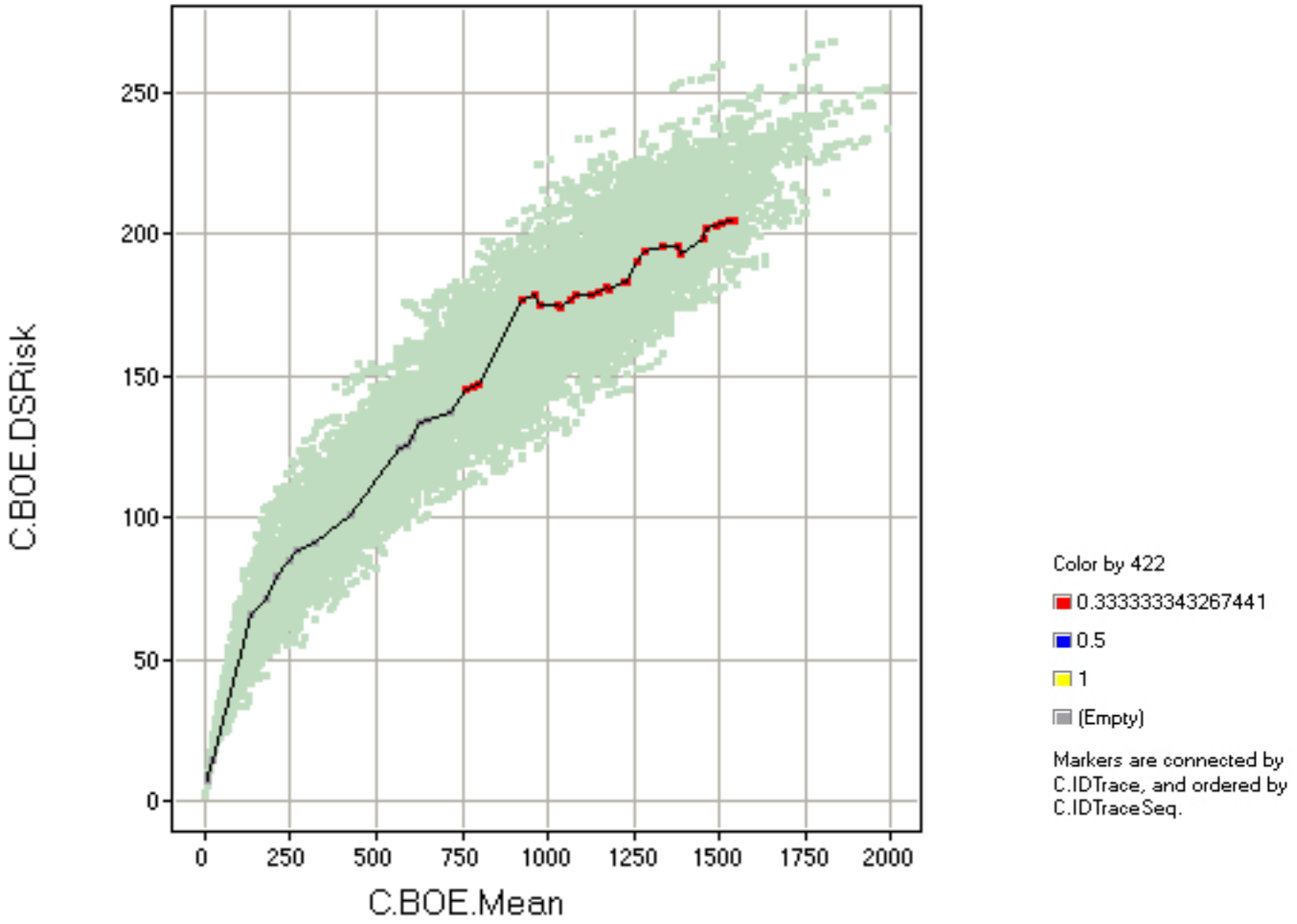
Scatter Plot



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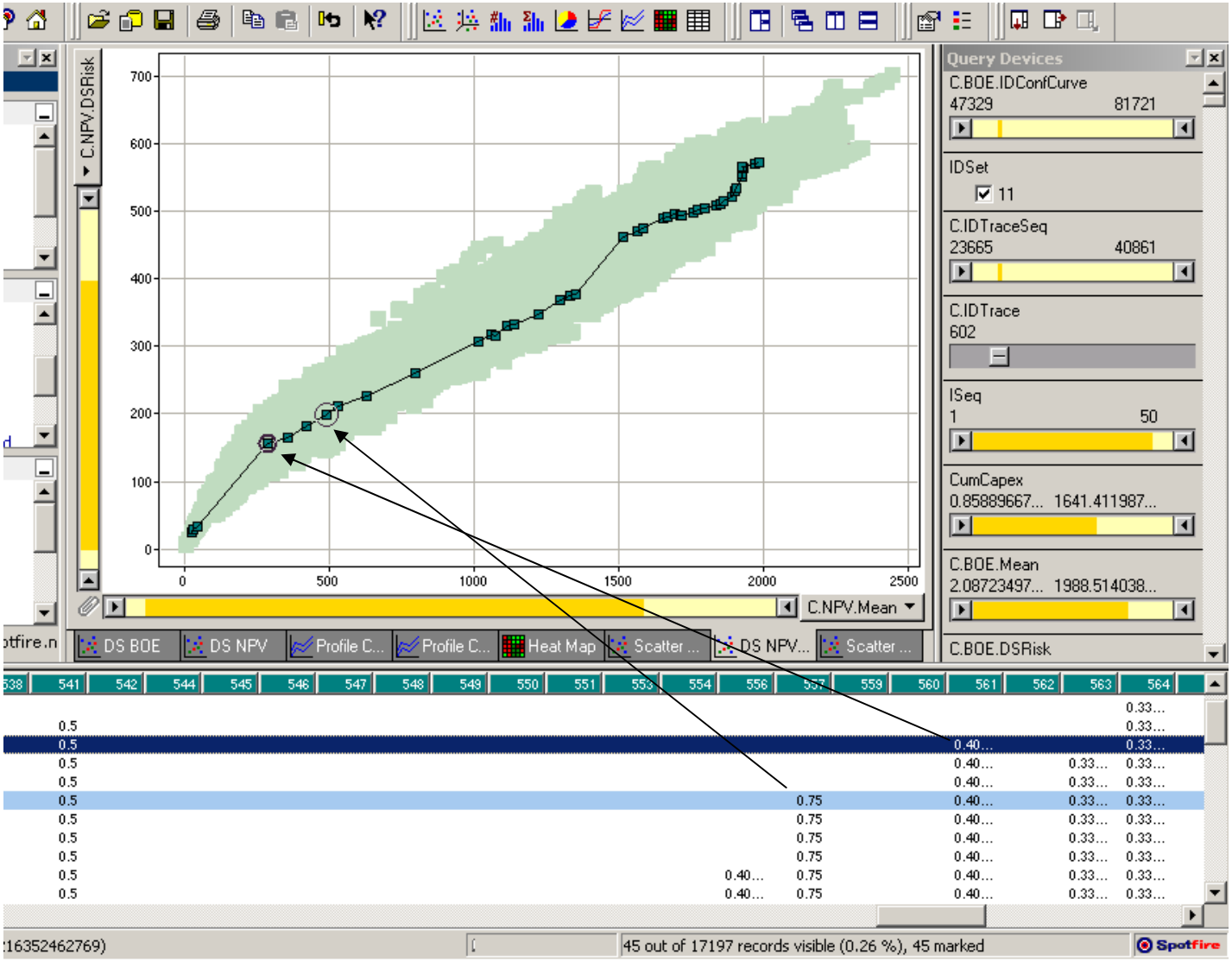
NPV Risk Reward, Trace 602, with Details of Project WI



Trace 602 Shown

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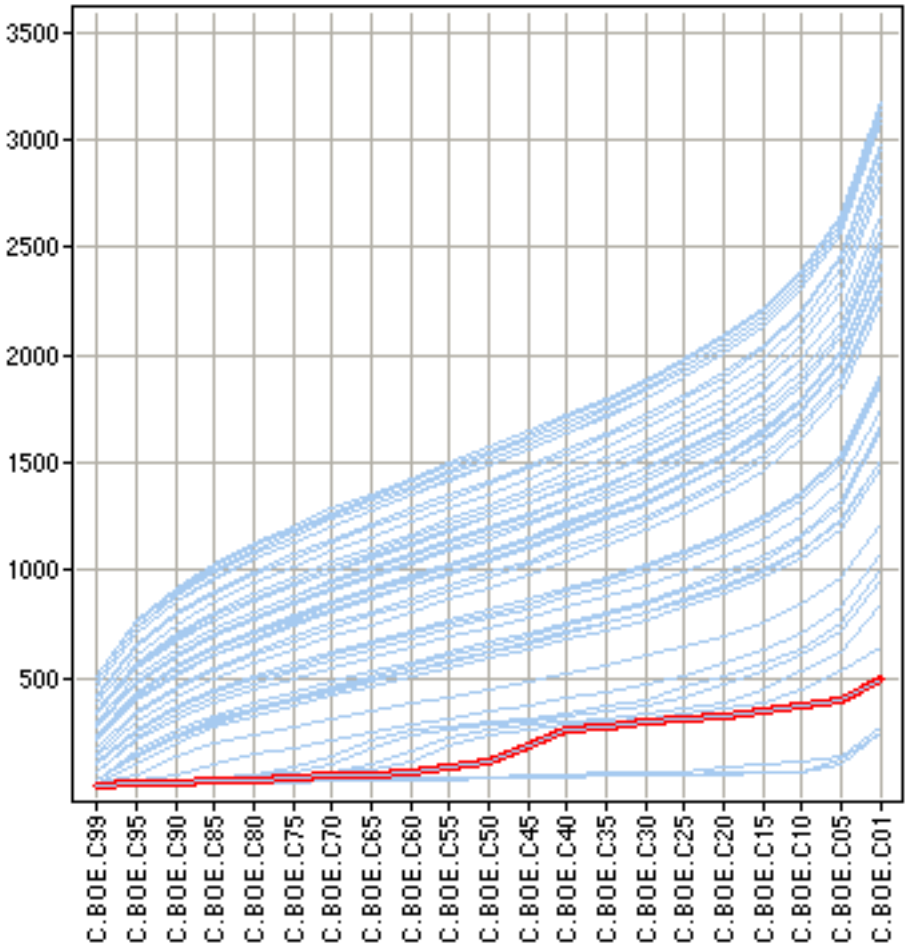
MMBOE Confidence (Profile Chart) Trace 602



All columns use the same scale.

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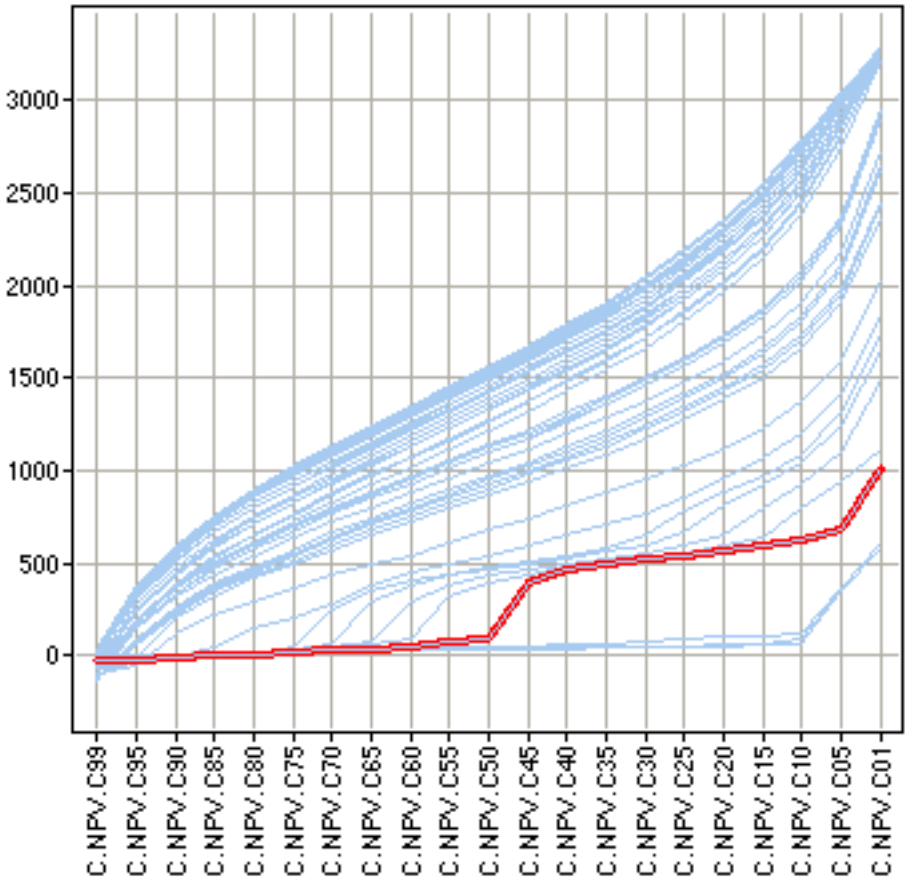
NPV Confidence (Profile Chart) Trace 602



All columns use the same scale.

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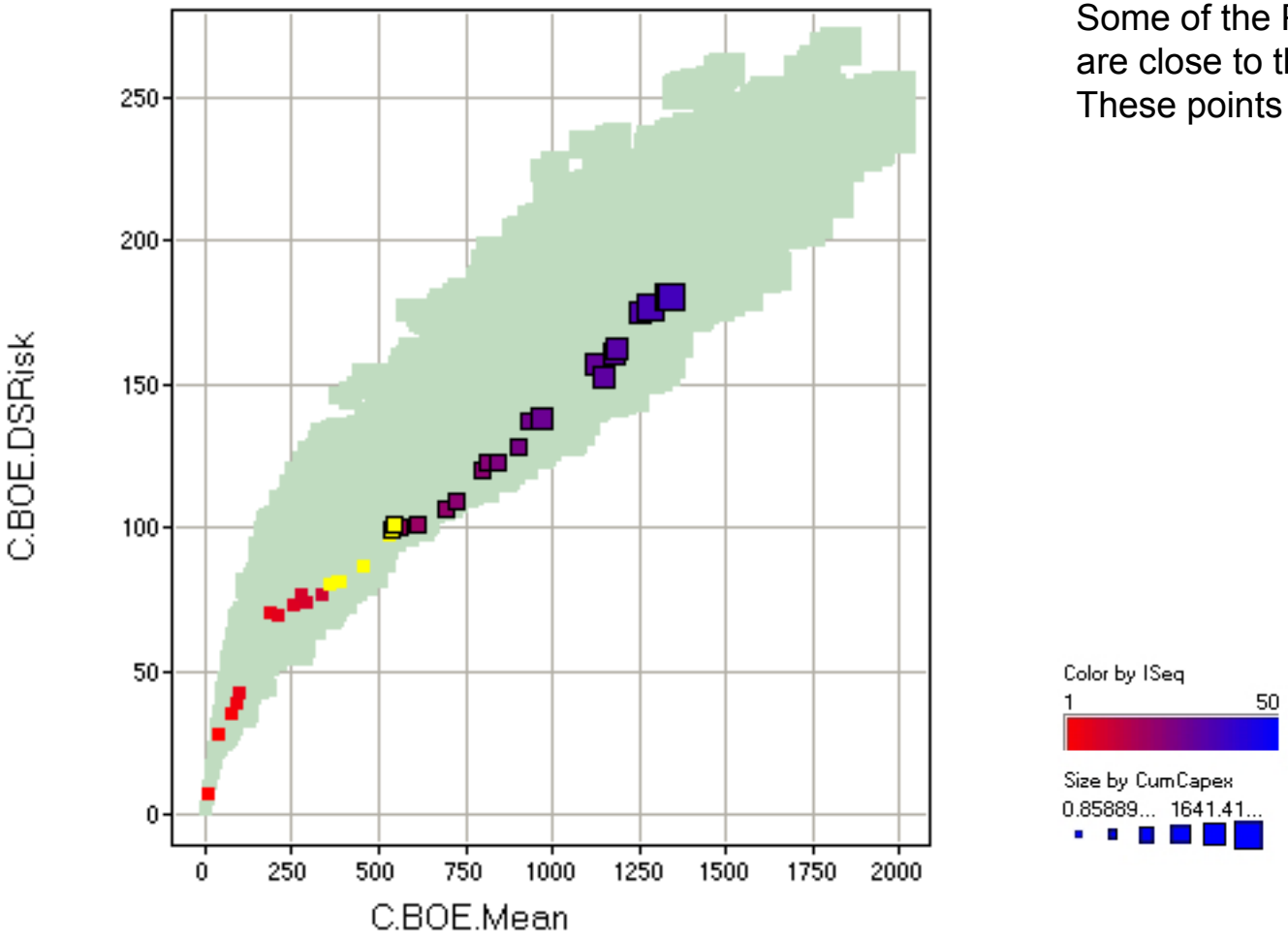
DS BOE Trace 616



Some of the Portfolios in Trace 616 are close to the efficient frontier These points are selected.

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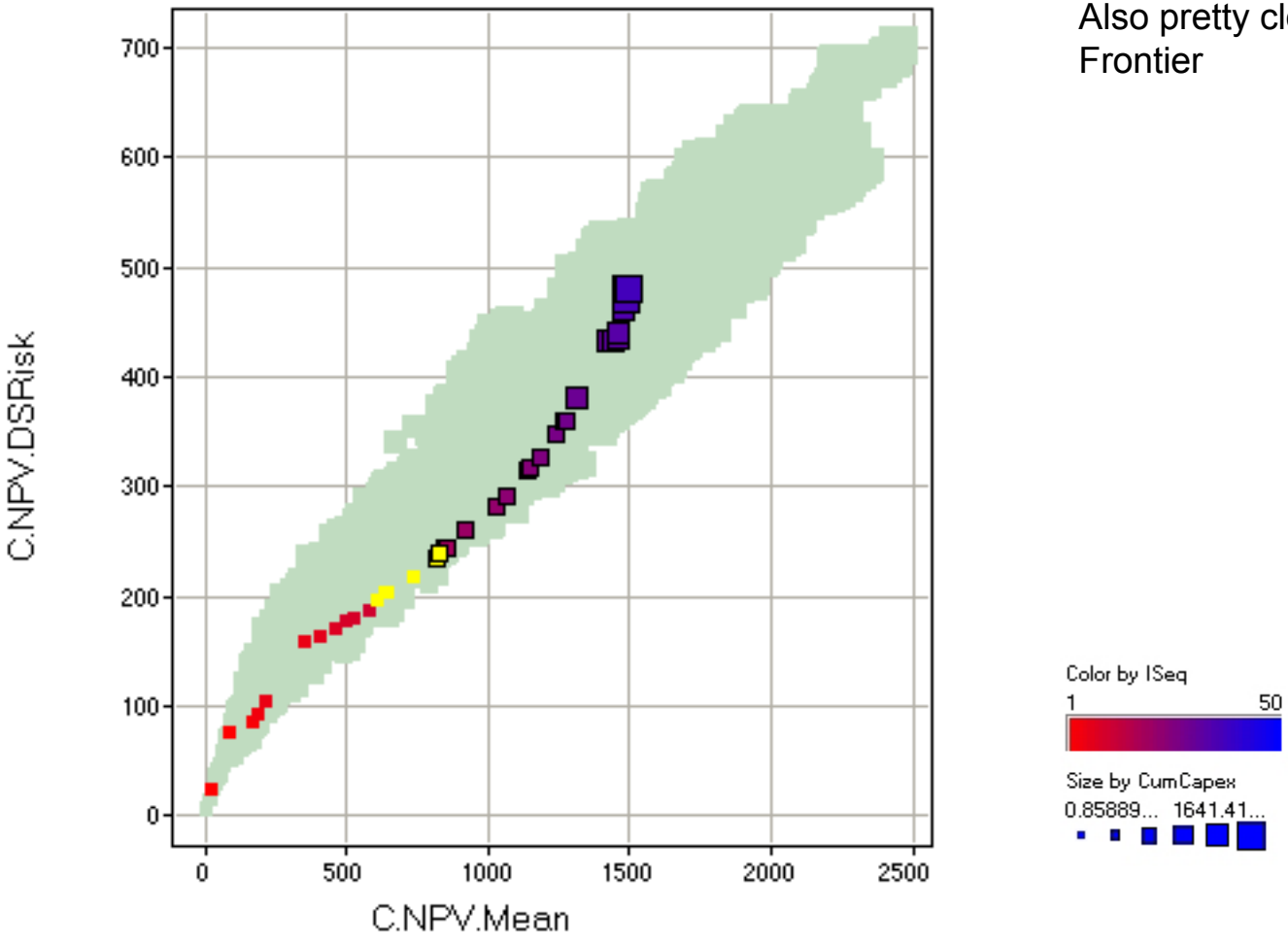
DS NPV Trace 616



Also pretty close to the NPV efficient Frontier

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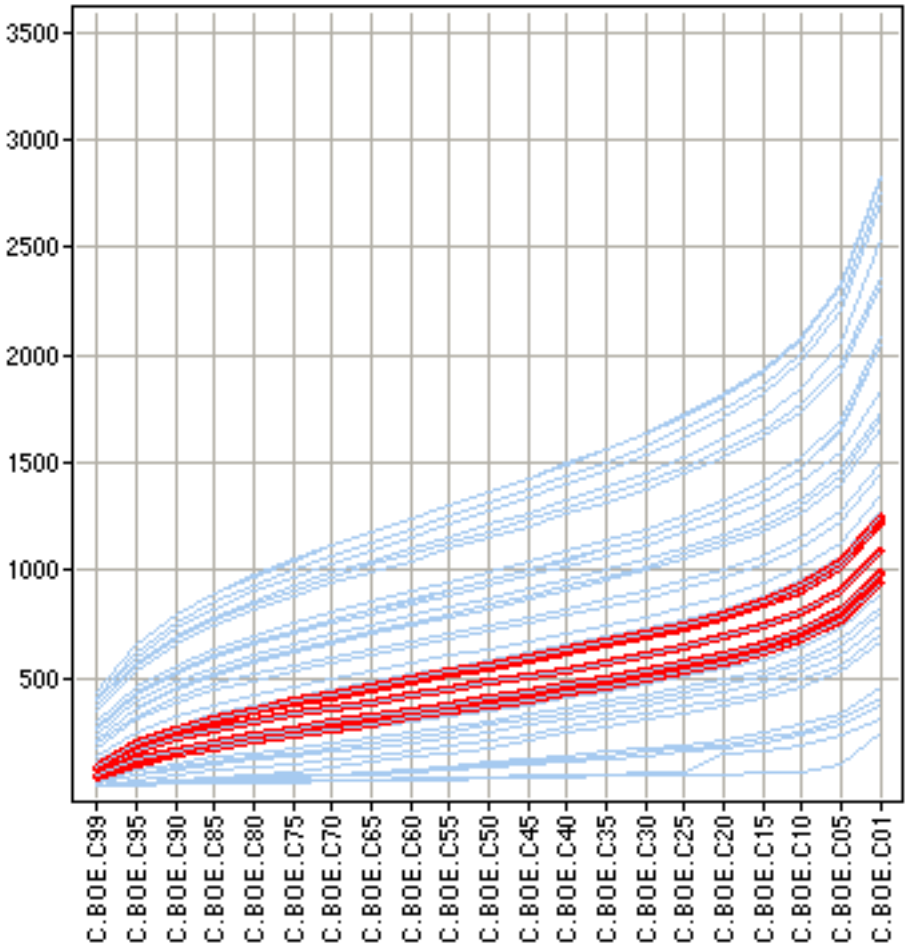
Profile Chart Trace 616



Those selected points seen with their confidence curves. BOE.

All columns use the same scale.

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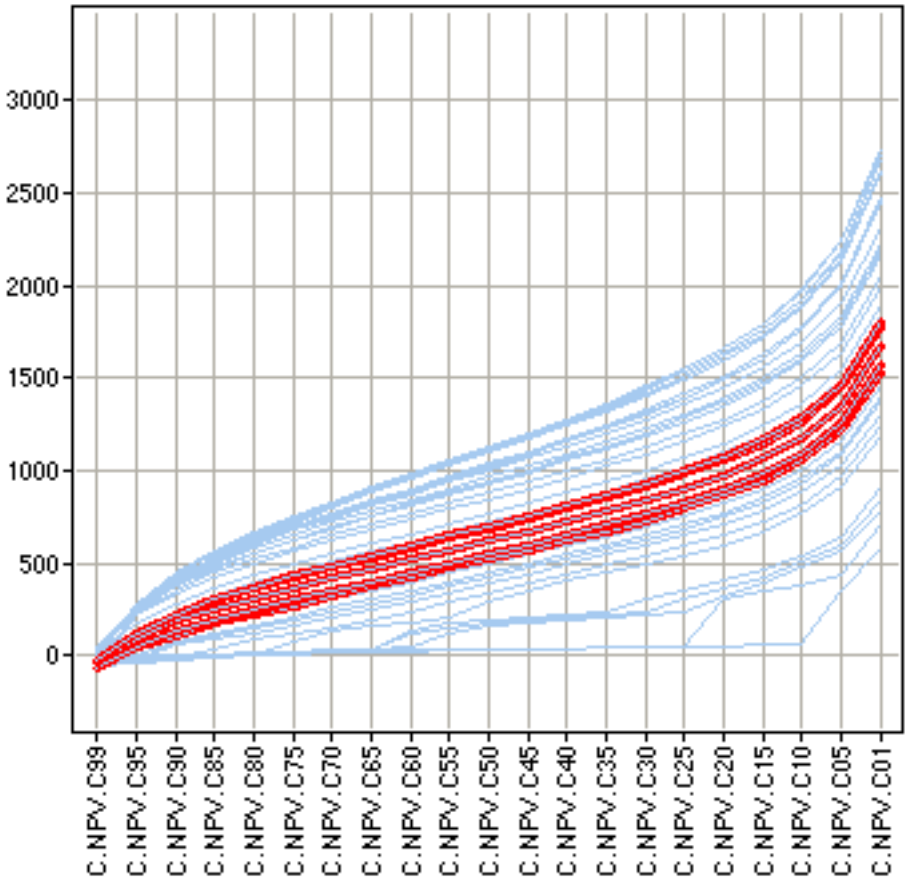
Profile Chart Trace 616



And the selected points seen in their confidence curves of NPV.

All columns use the same scale.

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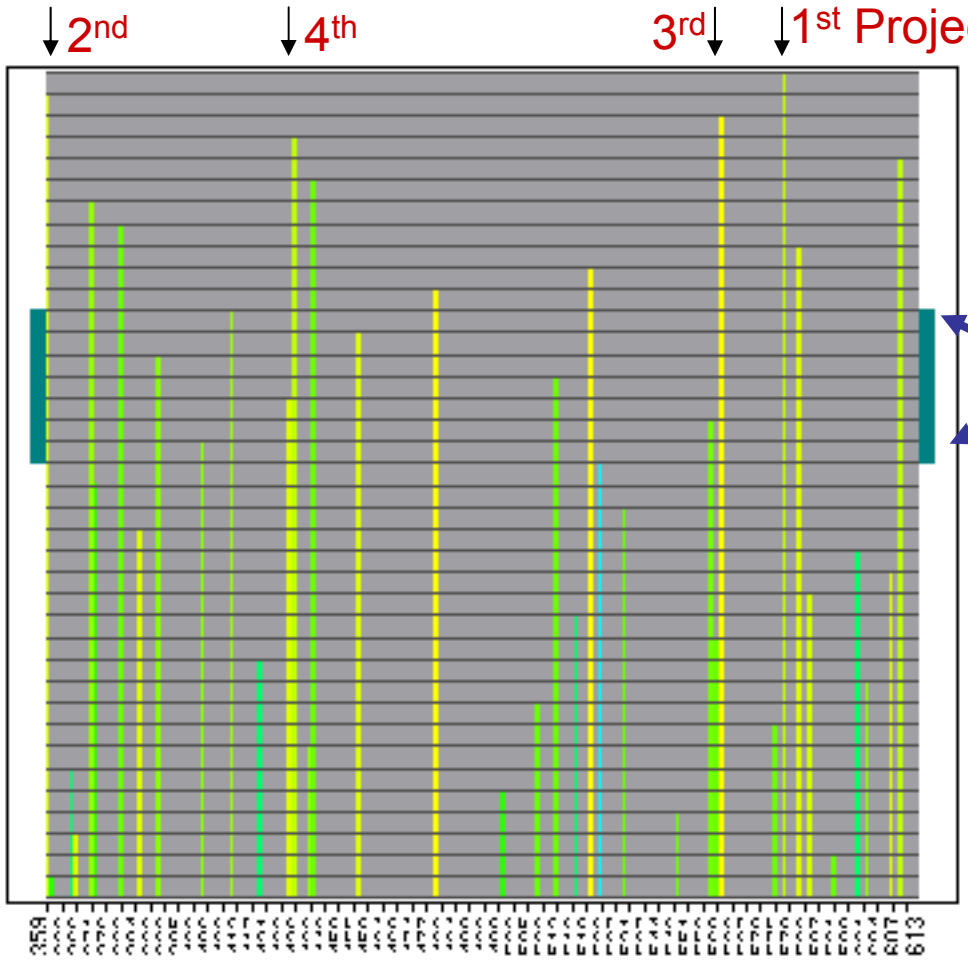
Heat Map Trace 616



The Heat map shows which projects are funded at each portolio.

The projects funded at the selected portfolios

Increasing Capex

Order by C.IDTraceSeq

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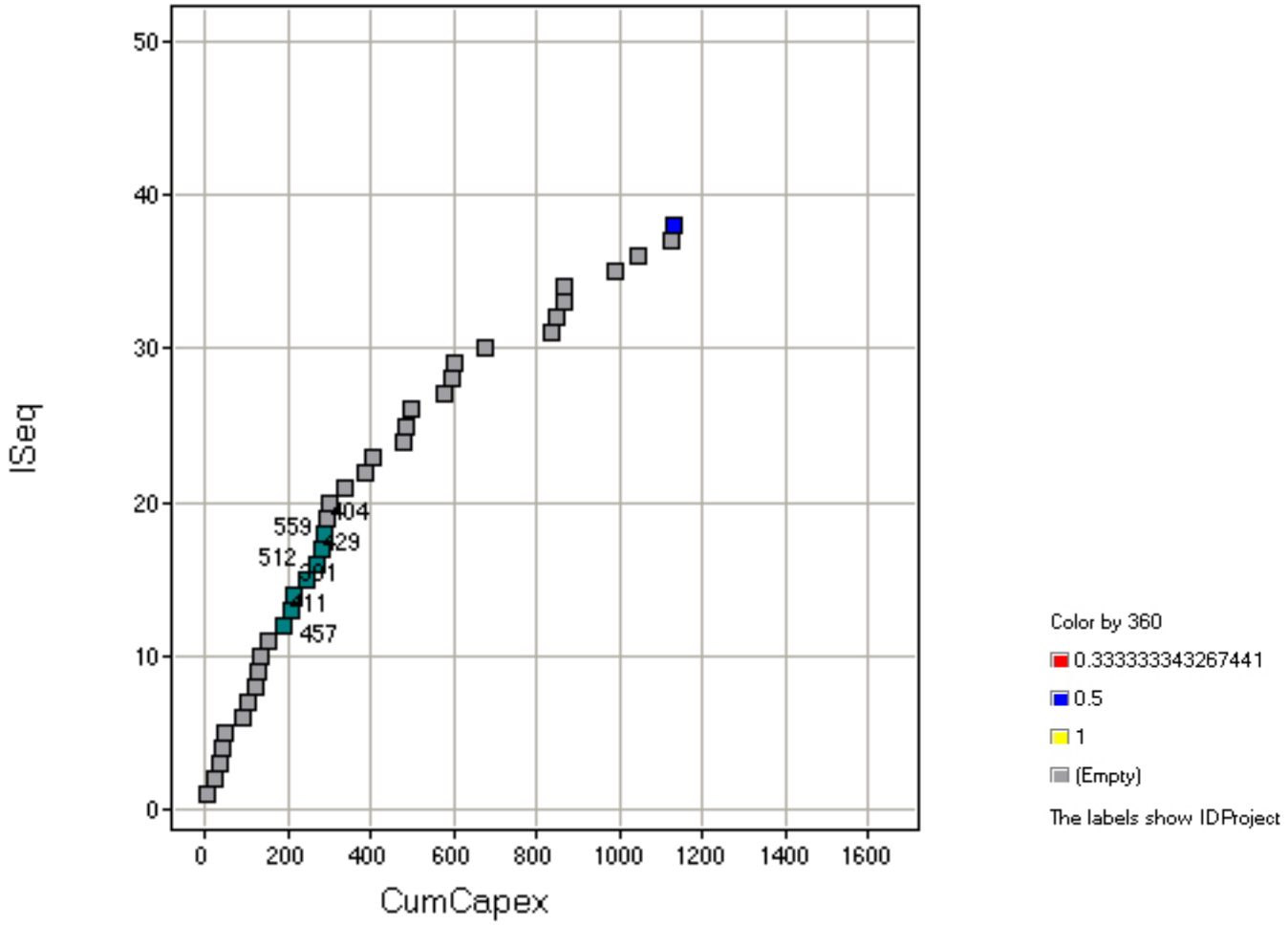
Scatter Plot Trace 616



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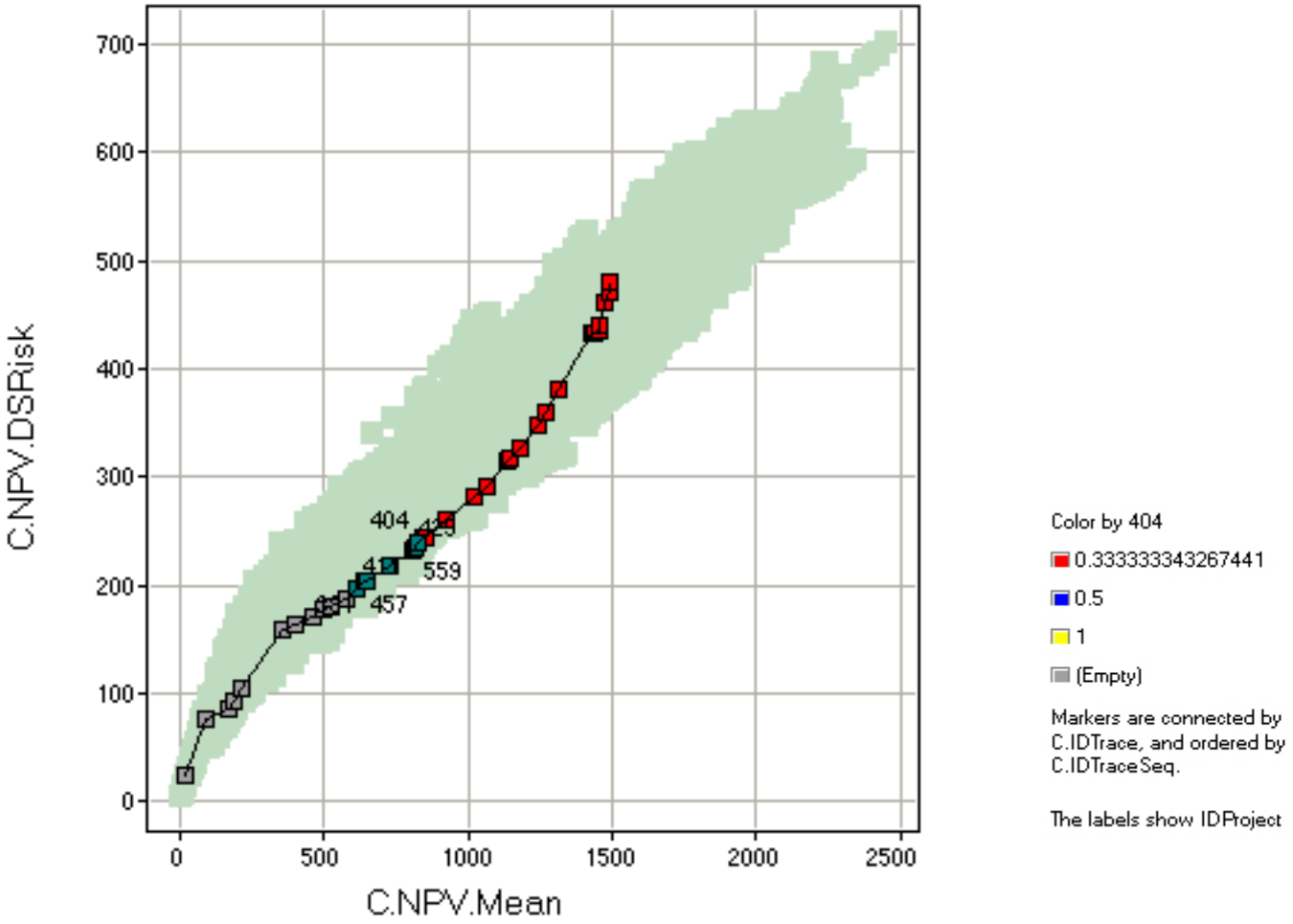
DS NPV - Color by WI of 1 Project - C.NPV.Mean vs. C.NPV.DSRisk Trace 616



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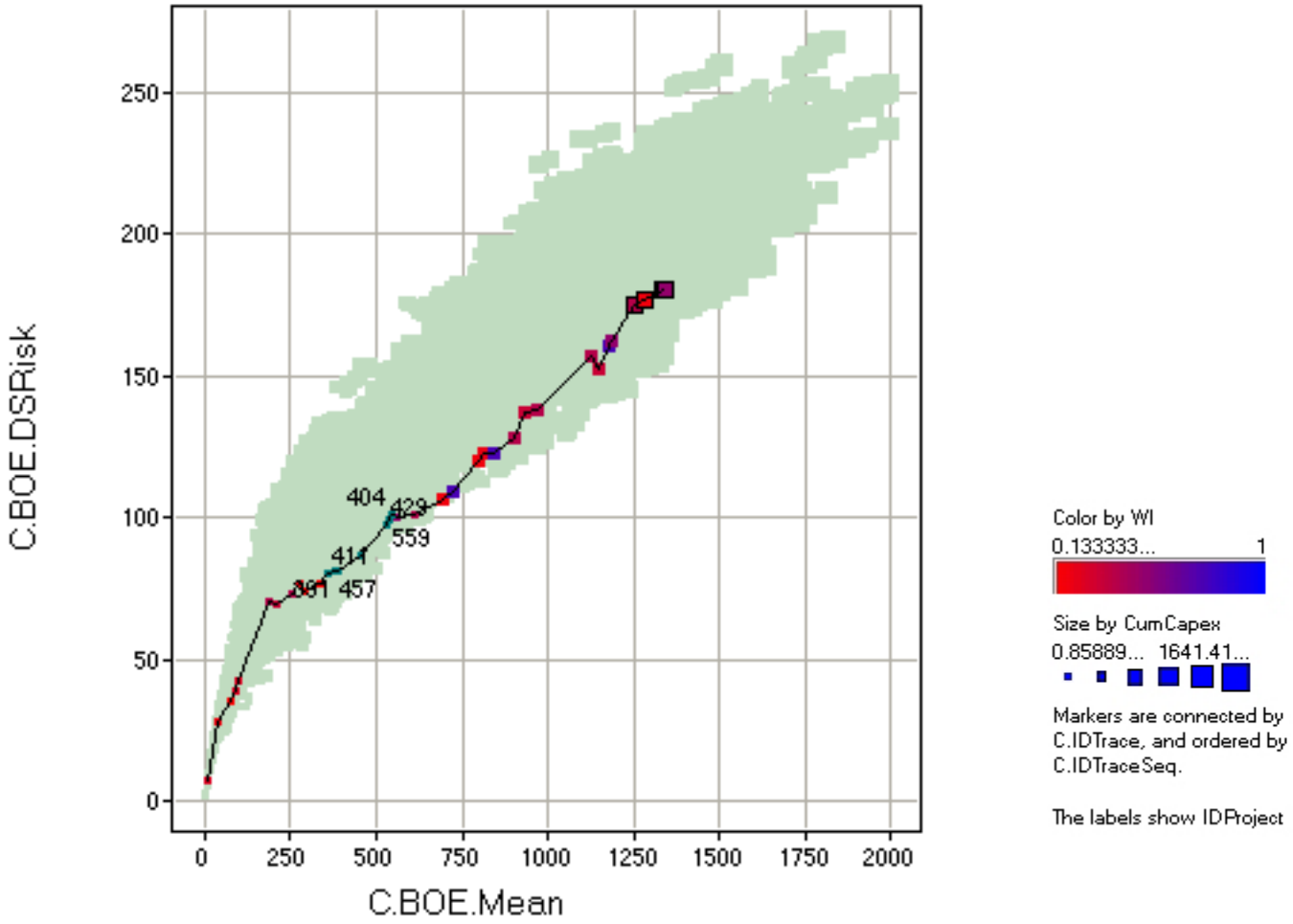
Scatter Plot Trace 616



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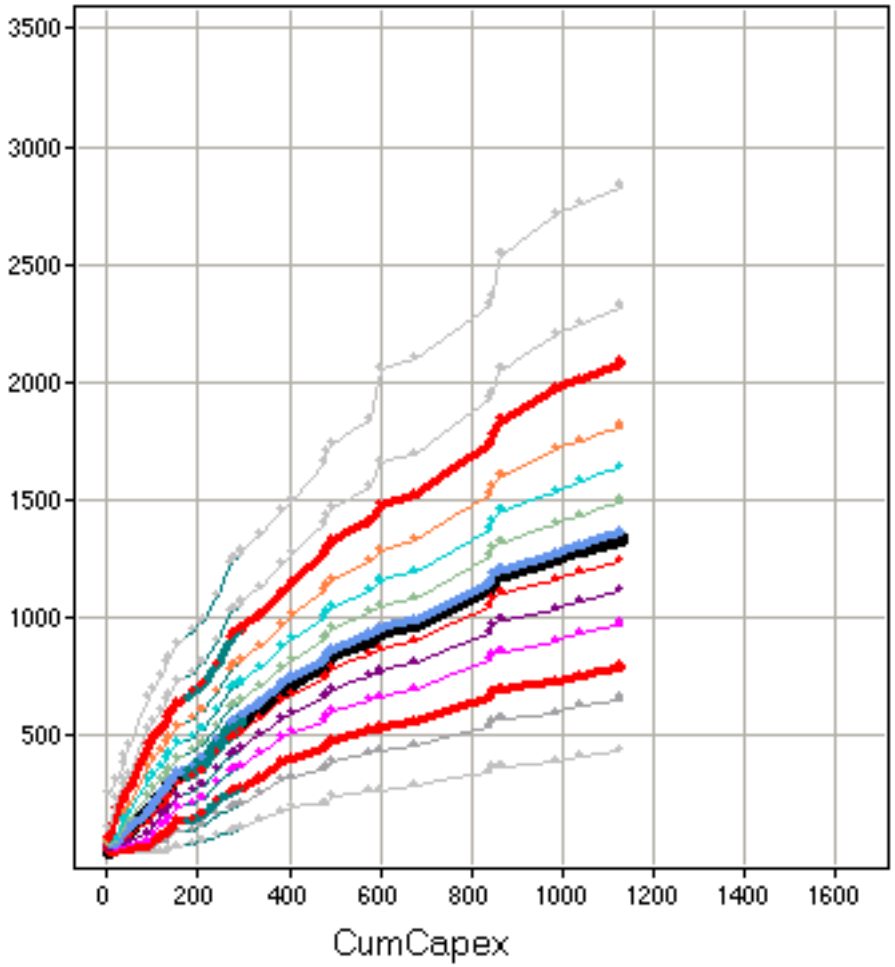
MMBOE Prob by Cumul Capex Trace 616



All columns use the same scale.

- C.BOE.Mean
- C.BOE.C99
- C.BOE.C95
- C.BOE.C90
- C.BOE.C80
- C.BOE.C70
- C.BOE.C60
- C.BOE.C50
- C.BOE.C40
- C.BOE.C30
- C.BOE.C20
- C.BOE.C10
- C.BOE.C05
- C.BOE.C01

Markers are connected by C.IDTrace, and ordered by CumCapex.

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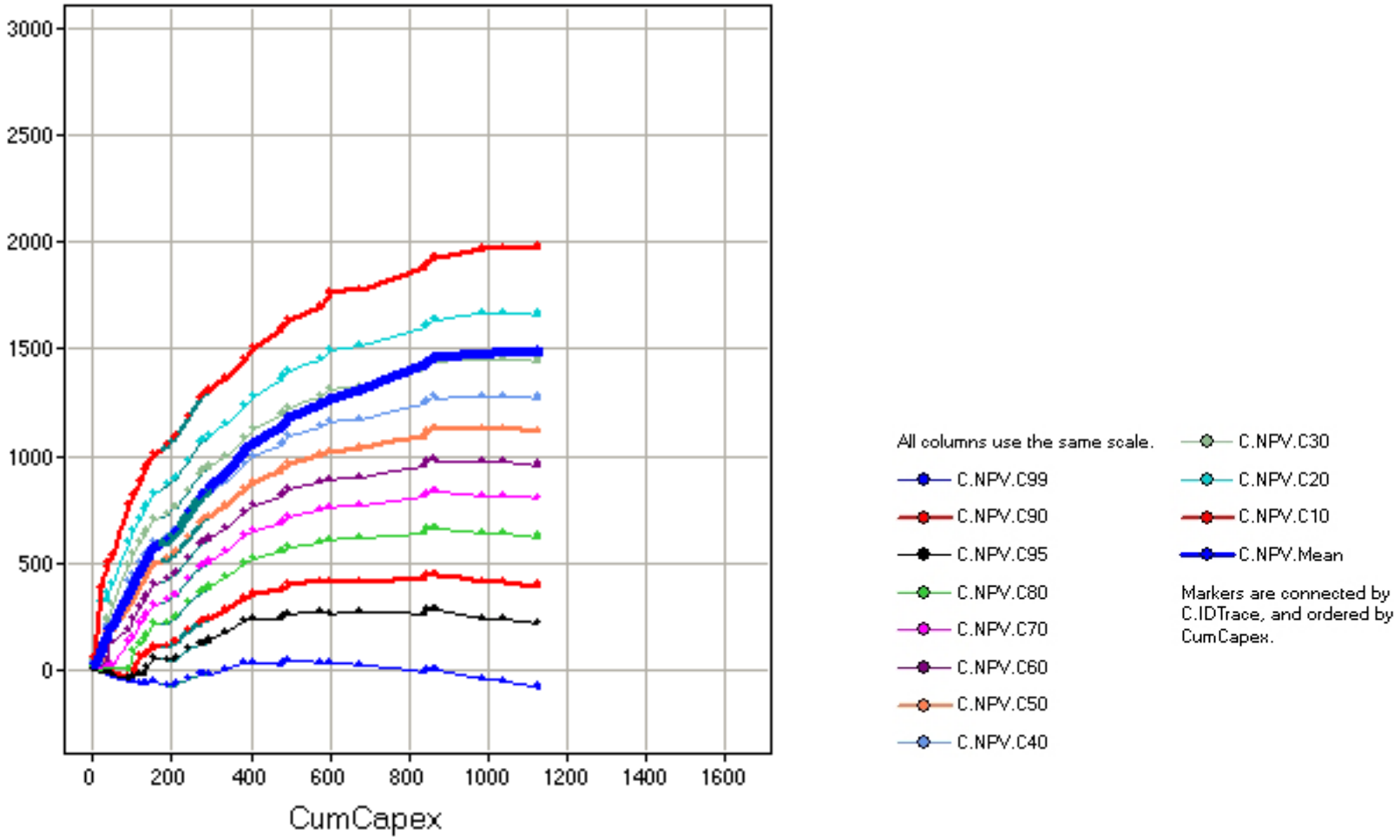
NPV Prob by Cumul Capex Trace 616



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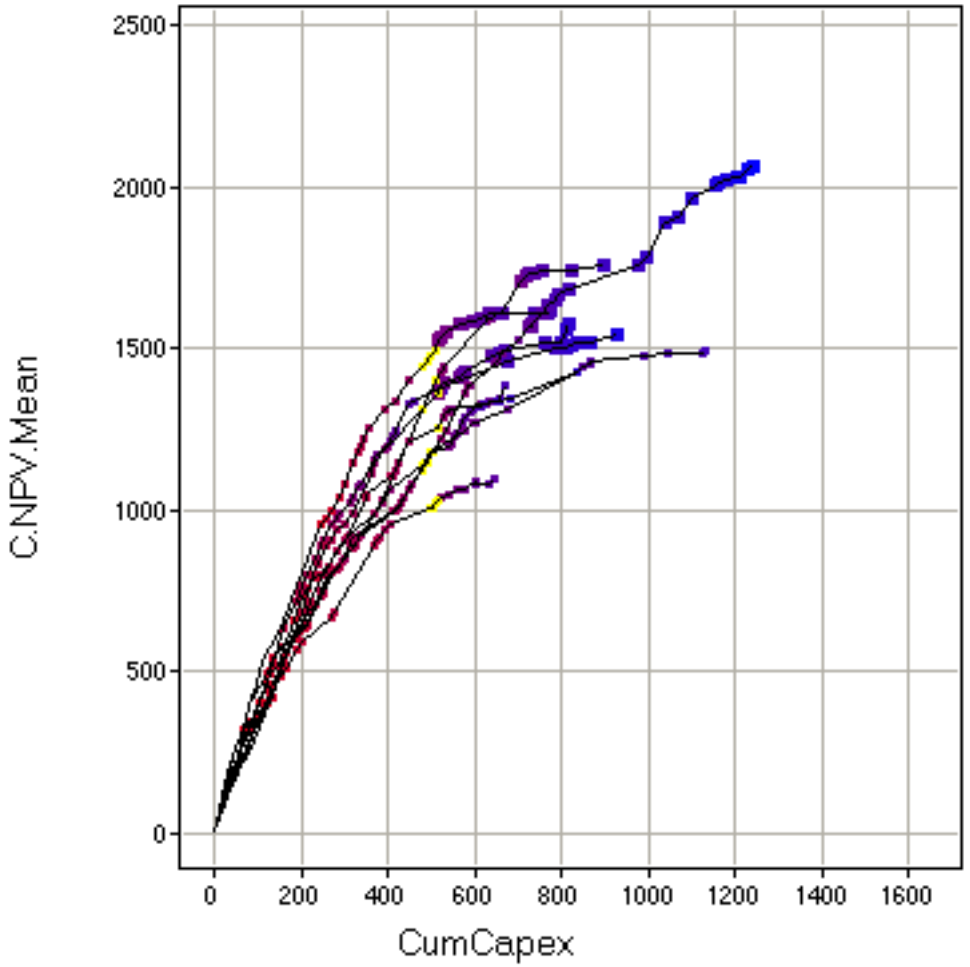
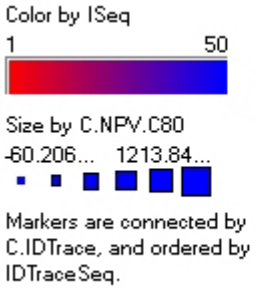
Some individual Portfolio Build Traces



Highlighted points are approx 500 $500 MM Capex



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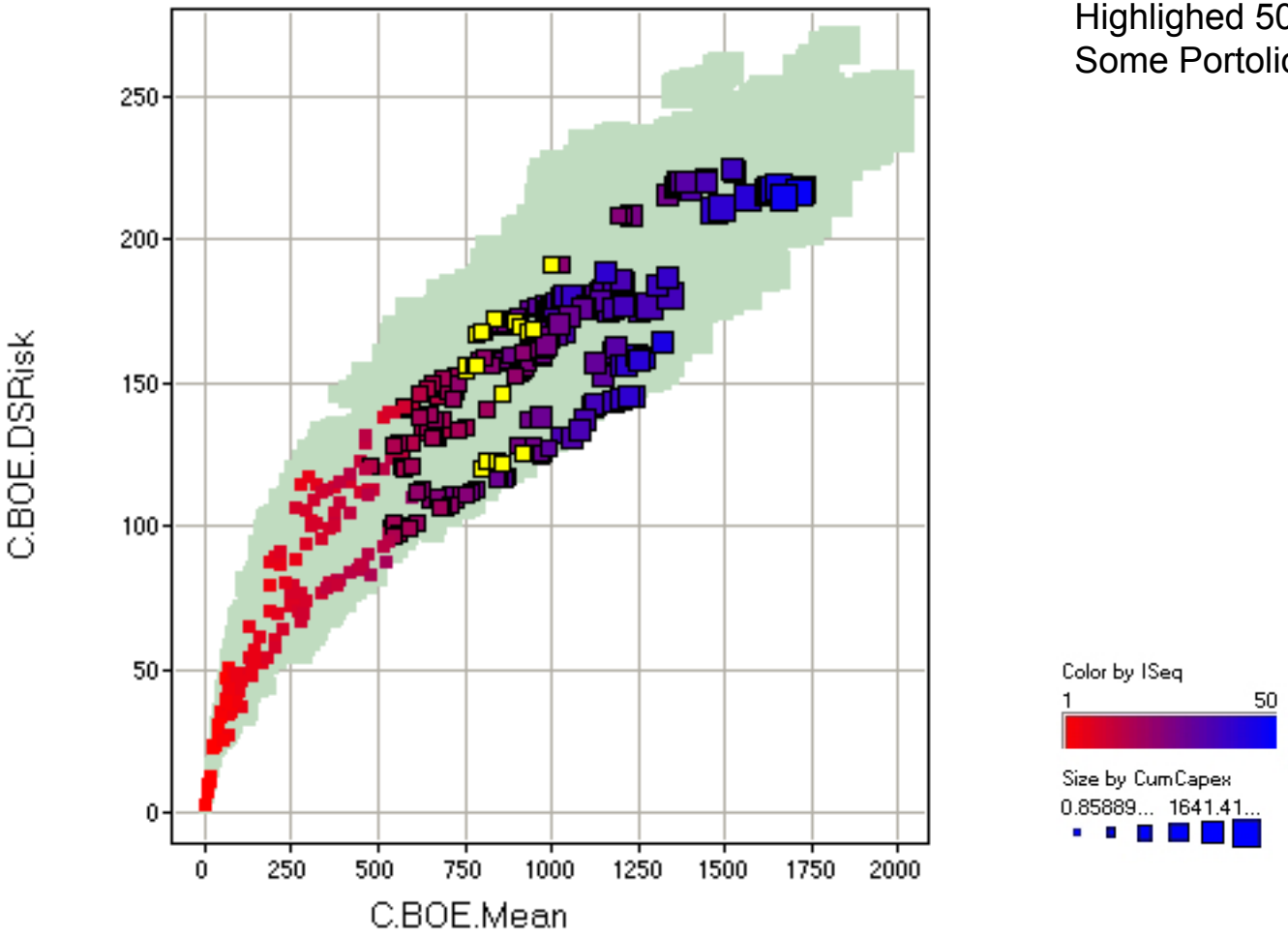
DS BOE



Highlighed 500 MM Capex.
Some Portolio build traces (615-623)

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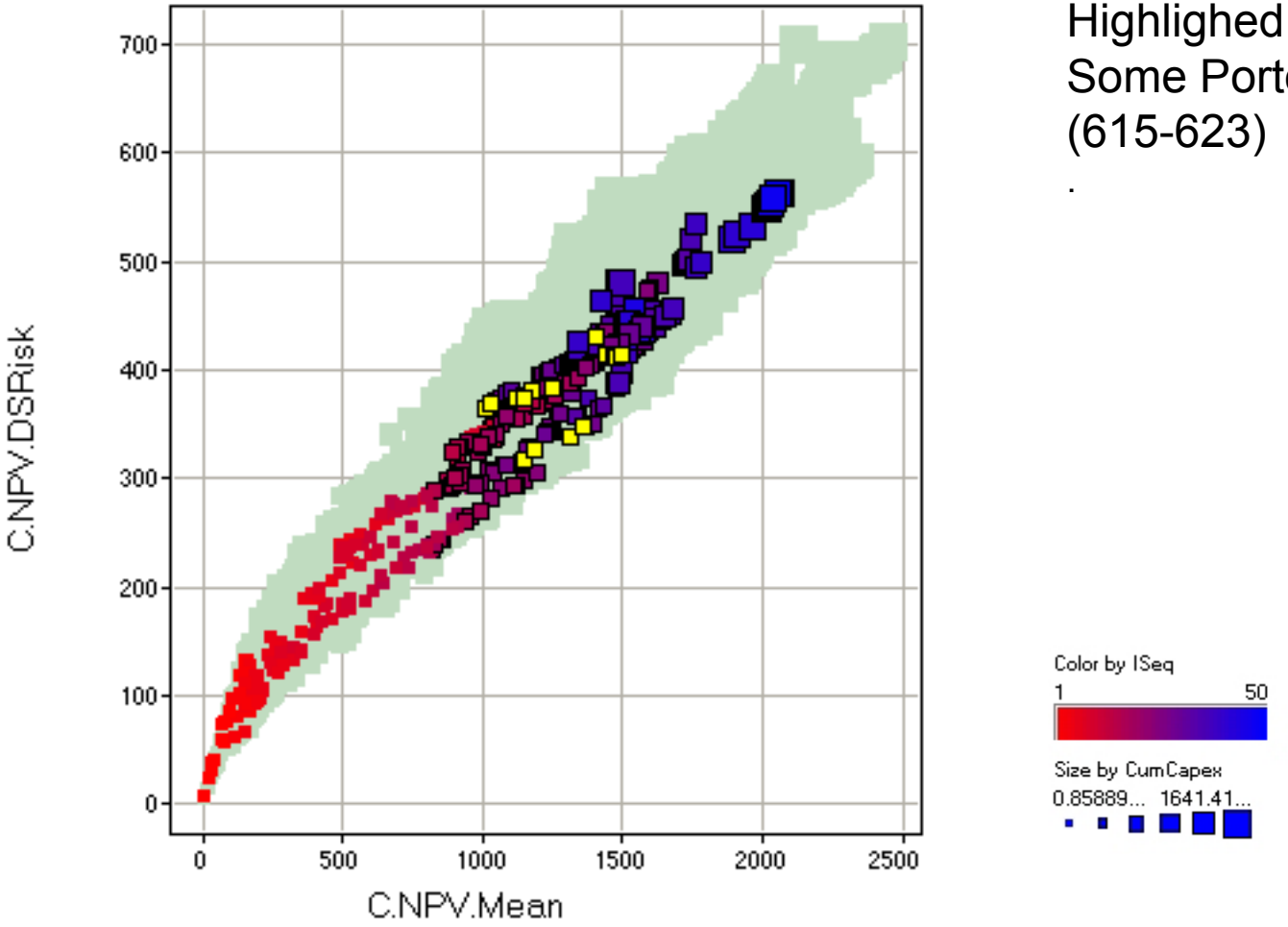
DS NPV



Highlighed 500 MM Capex. Some Portolio build traces (615-623)

.

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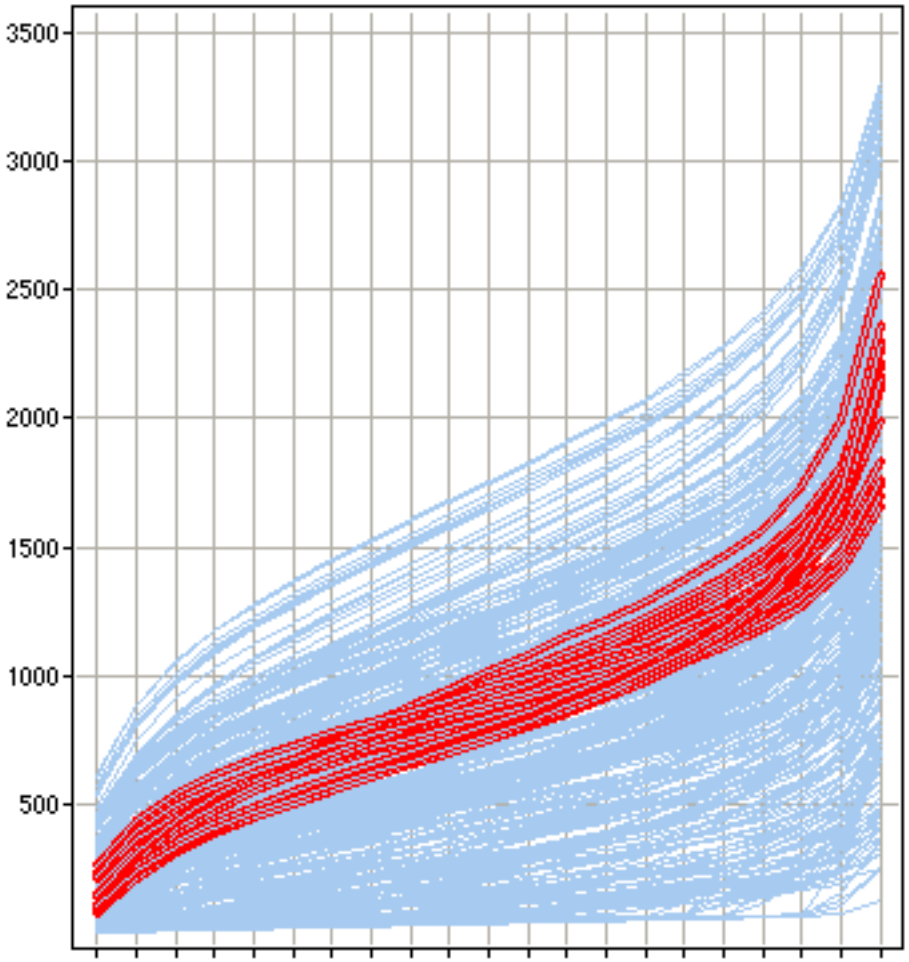
Profile Chart



Highlighed 500 MM Capex.
Some Portolio build traces (615-623)
.

All columns use the same scale.

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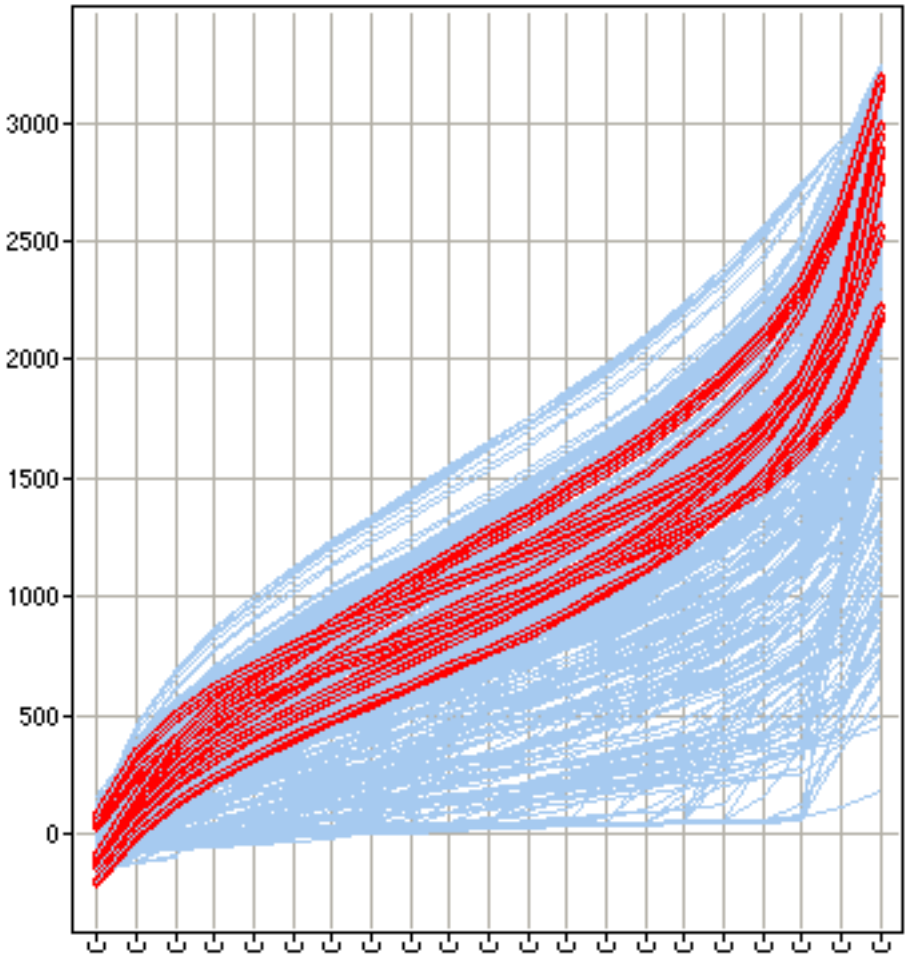
Profile Chart



Highlighed 500 MM Capex.
Some Portolio build traces
(615-623)

All columns use the same scale.

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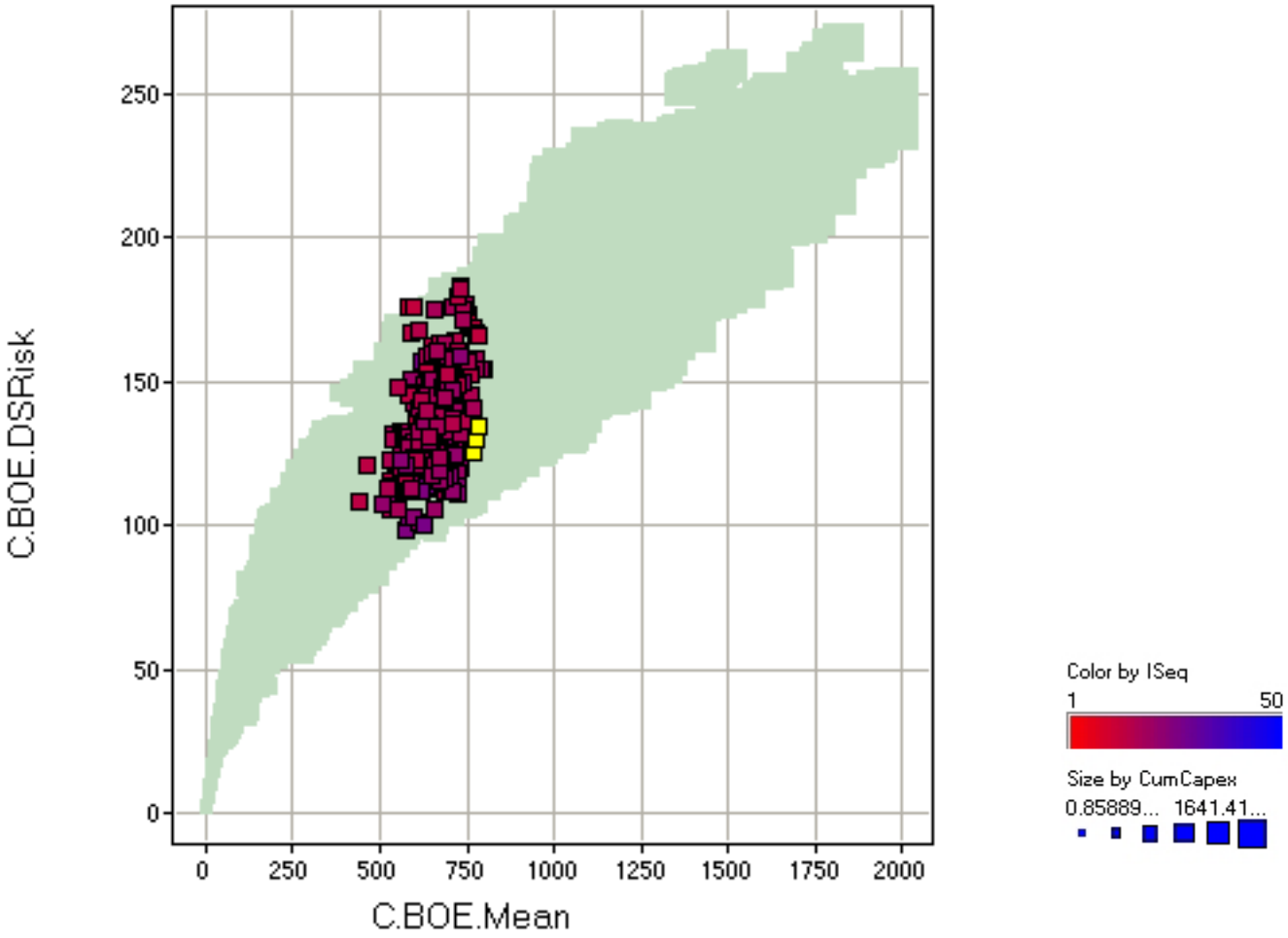
DS BOE



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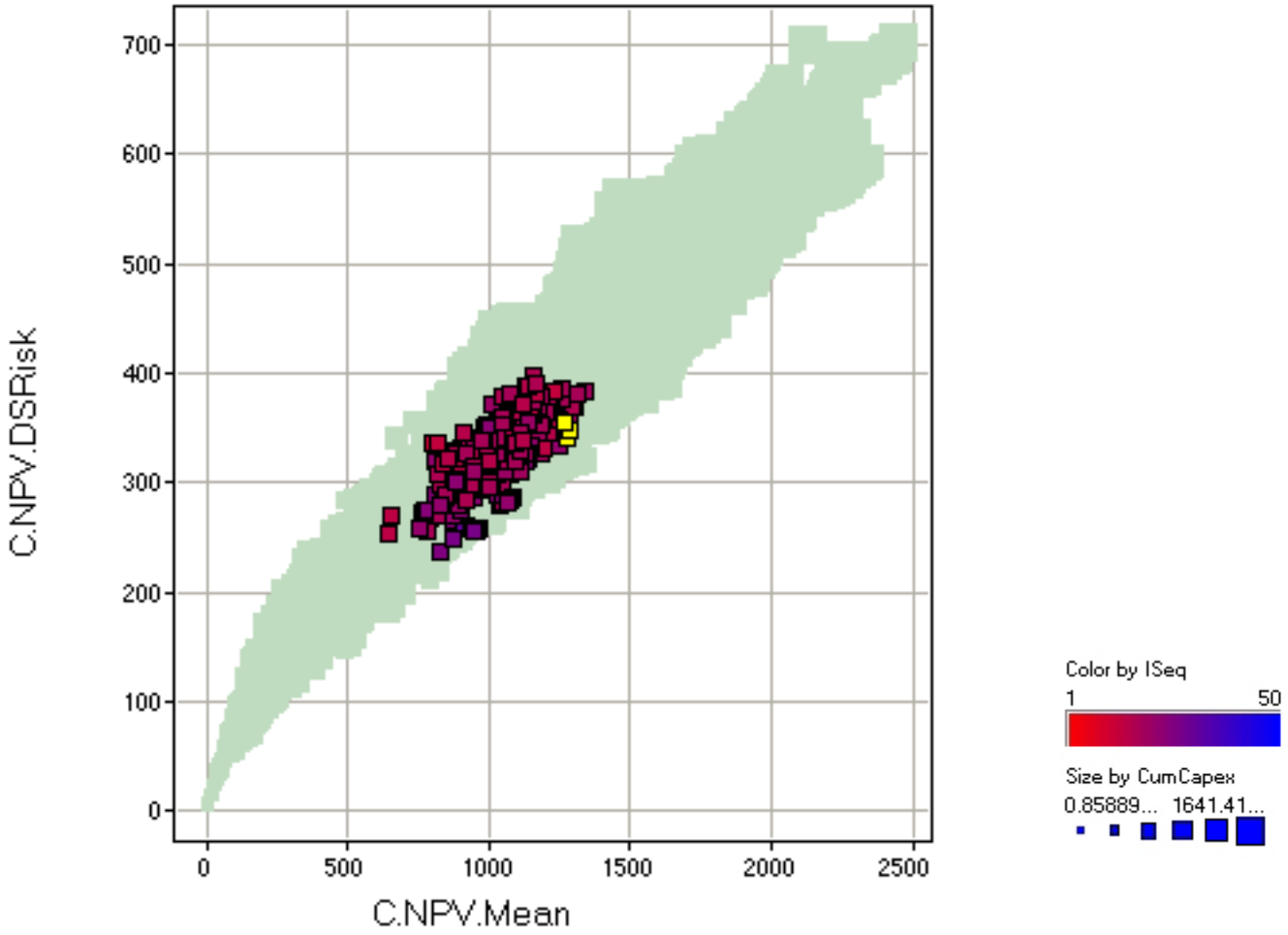
DS NPV



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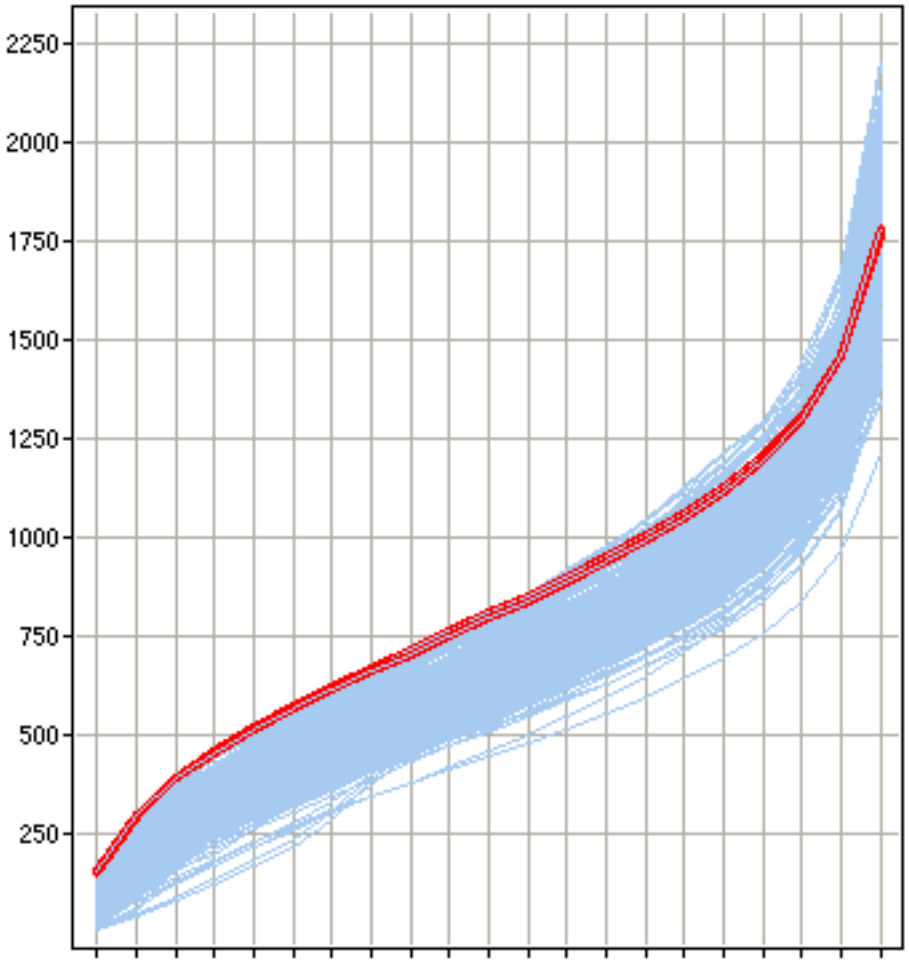
BOE Conf



All columns use the same scale.

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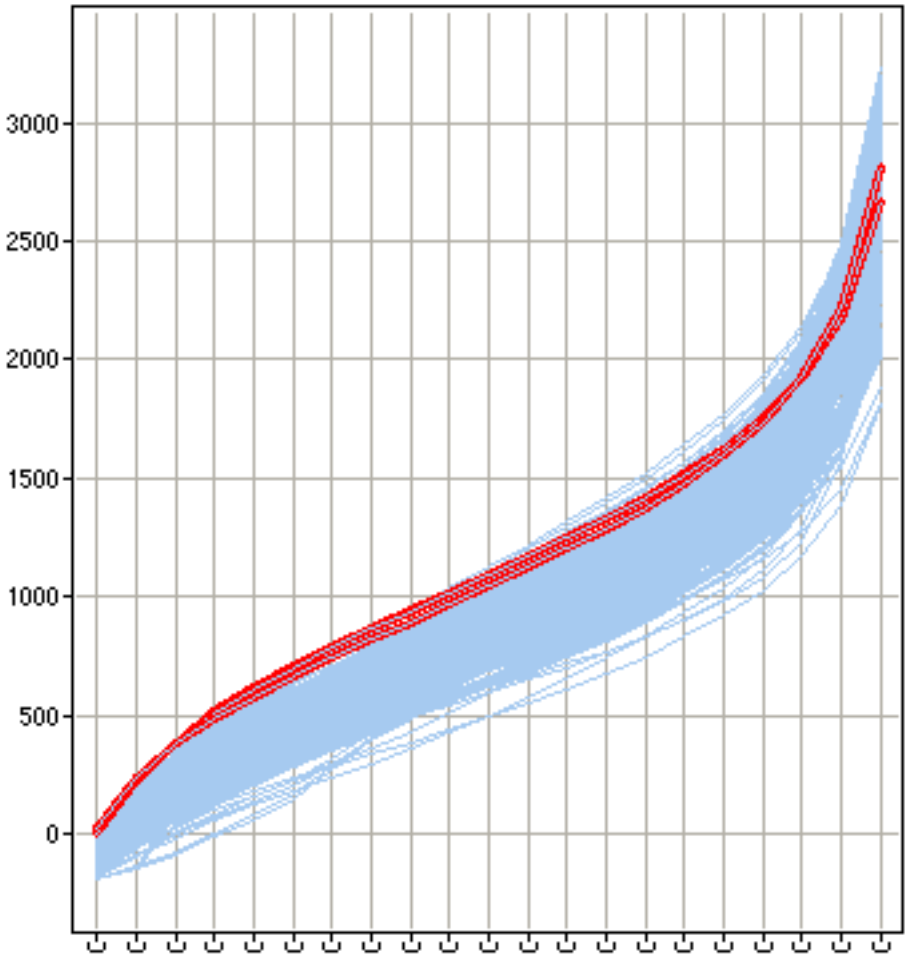
NPV Conf



All columns use the same scale.

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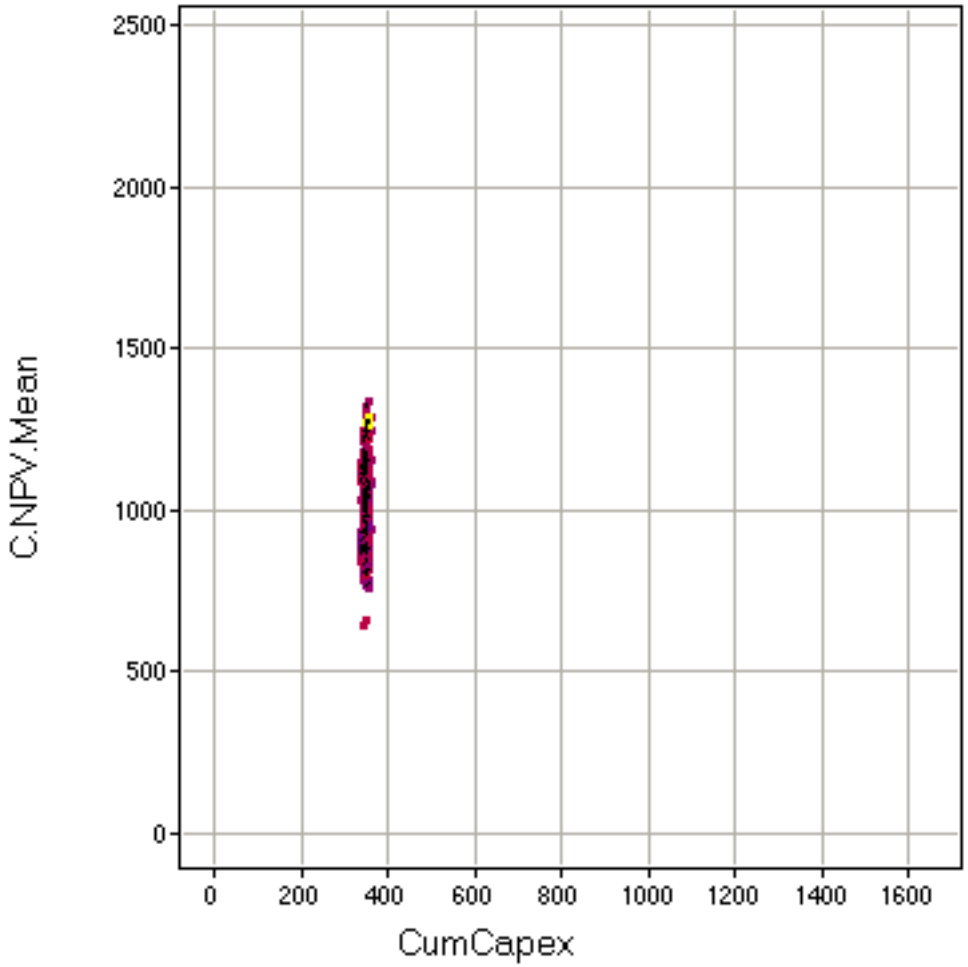
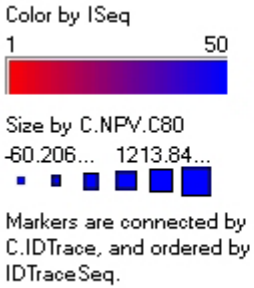
NPV vs Capex



This may be a dumb looking chart, but it comes in very handy. It is the only thing to tell you the Capex range selected when you output to PowerPoint.

Note to Spotfire Developers: You should offer the option to output the SQL to PowerPoint as you do with a web page. It is far easier to delete a PPT object than to add notes later.

BTW: Kudos for the PowerPoint writer!!!!



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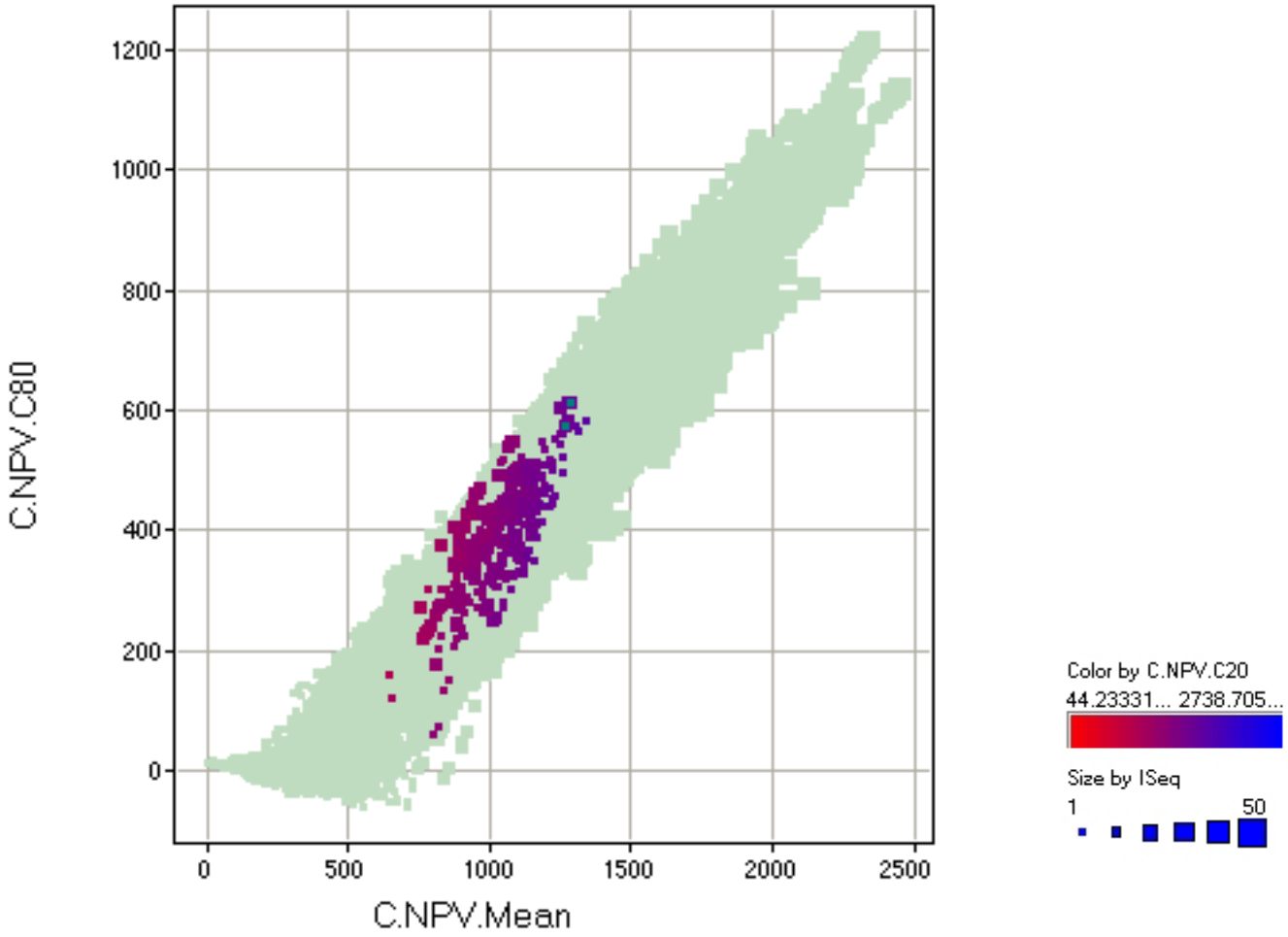
NPV C80 vs Mean



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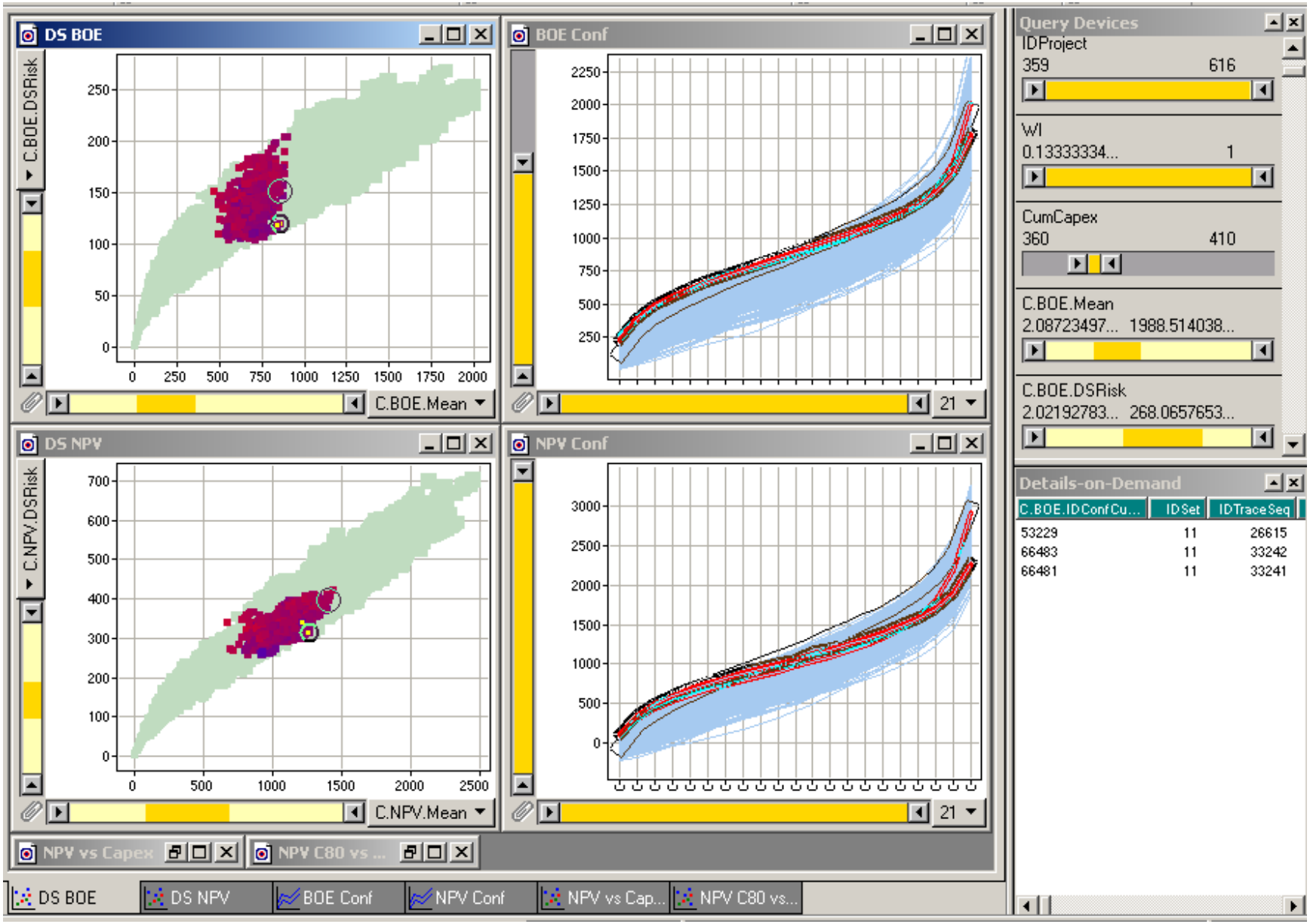
4 Panel View: 400 MM Capex



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VBA to Sumarize Marked Records of a Heat Map.

```
Dim appSF As Spotfire.Application
Dim shmH1 As Spotfire.HeatMap
Dim svisCur As Spotfire.Visualization
Dim hmc As HeatMapColumn
Dim srec As Spotfire.Record

Sub S00_main()
    S10_Get_AppSF
    Dim sum(1 To 1000, 3) As Single 'index2: 1: running sum, 2: count, 3: average
    Dim nHMcols As Integer
    Dim value As Variant
    Dim i As Integer

    Set svisCur = appSF.ActiveVisualization
    Set shmH1 = svisCur.Views("HMProj")
    nHMcols = shmH1.Columns.count


    For Each srec In svisCur.MarkedRecords
        If srec.Marked = True Then
            i = 0
            For Each hmc In shmH1.Columns
                i = i + 1
                value = srec.Field(hmc.Column)
                If IsNull(value) Then
                Else
                    sum(i, 1) = sum(i, 1) + value
                    sum(i, 2) = sum(i, 2) + 1
                End If
            Next
        End If
    Next
    For i = 1 To nHMcols
        If sum(i, 2) > 0 Then
            sum(i, 3) = sum(i, 1) / sum(i, 2)
        Else
            sum(i, 3) = 0
        End If
        With ActiveWorkbook.ActiveSheet
            .Cells(5 + i, 1).value = _
                svisCur.Records.Columns( _
                shmH1.Columns(i).Column).Name
            .Cells(5 + i, 2).value = sum(i, 1)
            .Cells(5 + i, 3) = sum(i, 2)
            .Cells(5 + i, 4) = sum(i, 3)
        End With
    Next
End Sub
```

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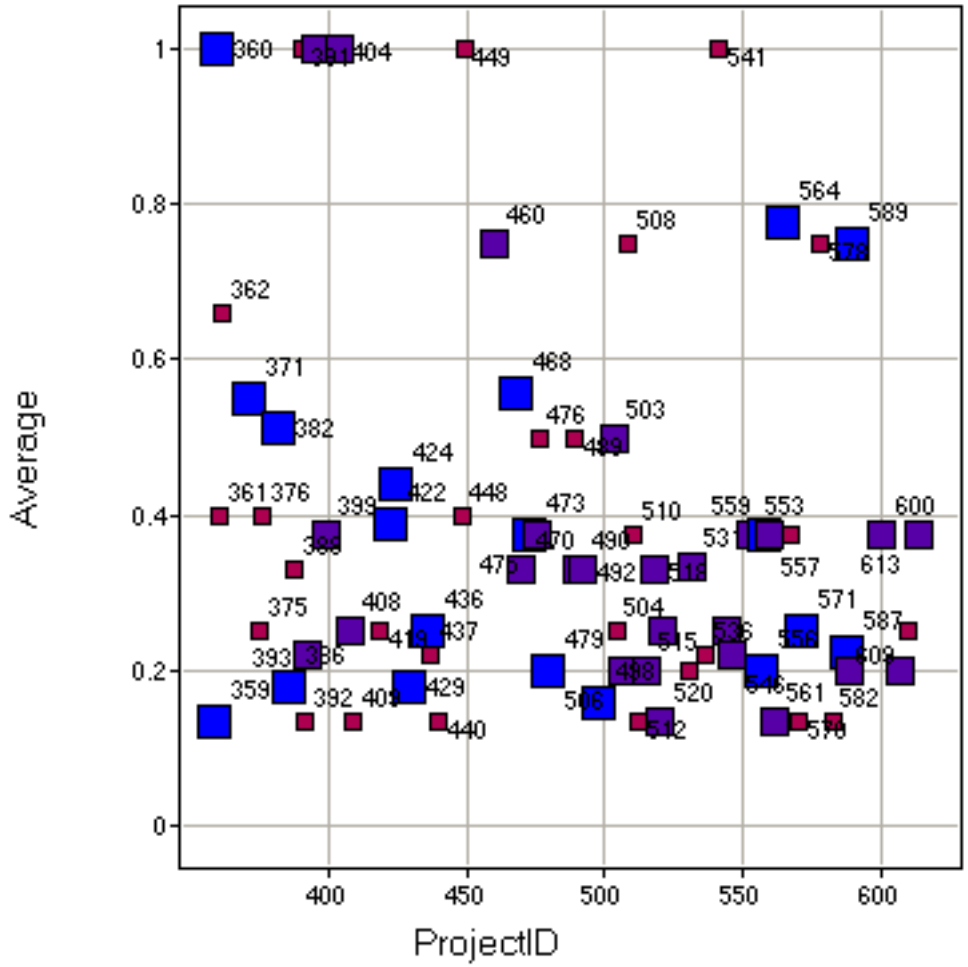
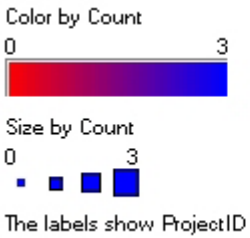
The Projects, and how many times selected in the marked portfolios and at what average working interest.



The Process:

1. Use the T1D5 template to pick a few portfolio points of interest.
2. Open HeatMapReader.xls.
3. Run the VBA macro (from the previous slide).
4. Copy the output cells and paste into a NEW INSTANCE of Spotfire.



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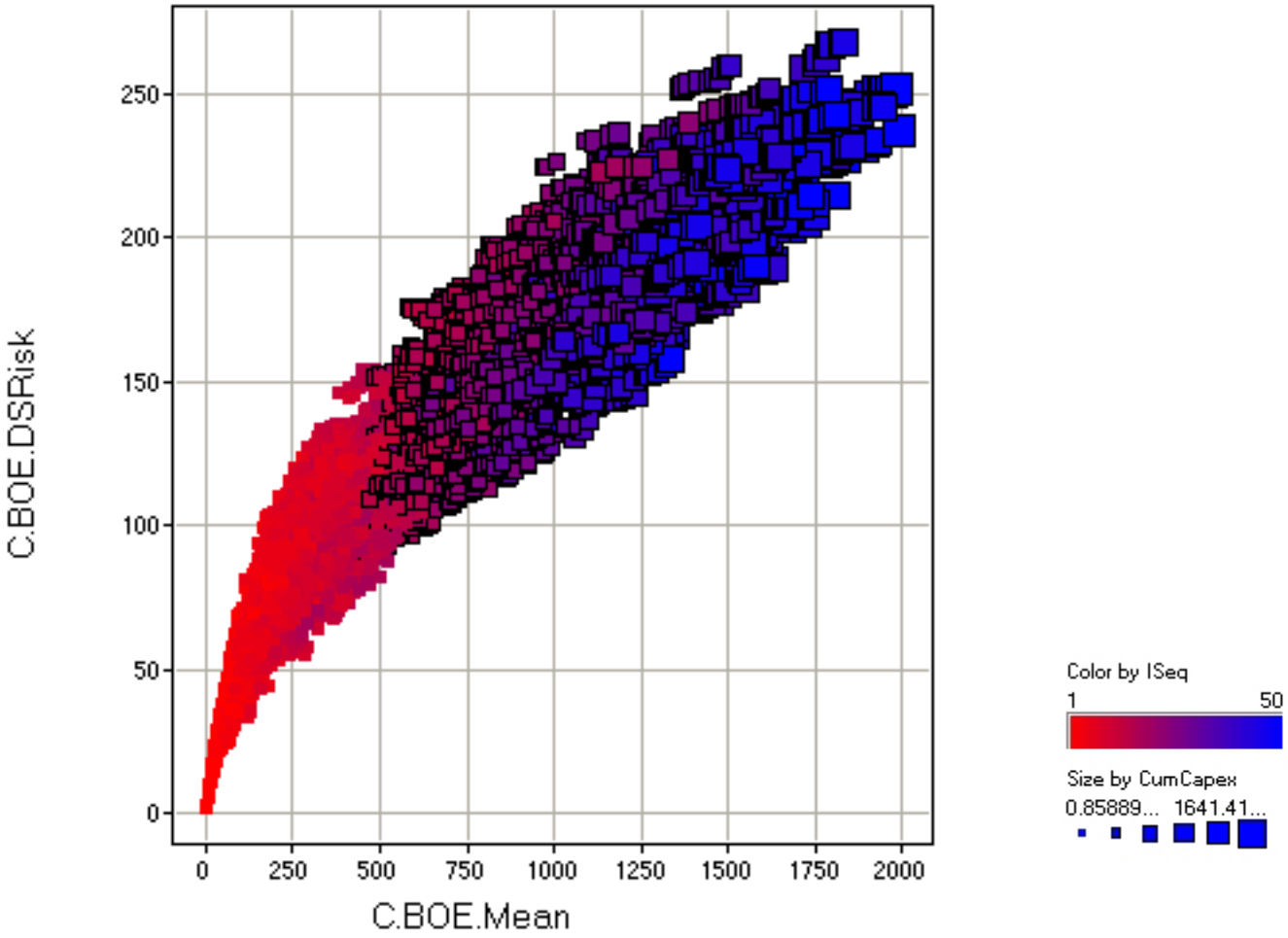
DS BOE



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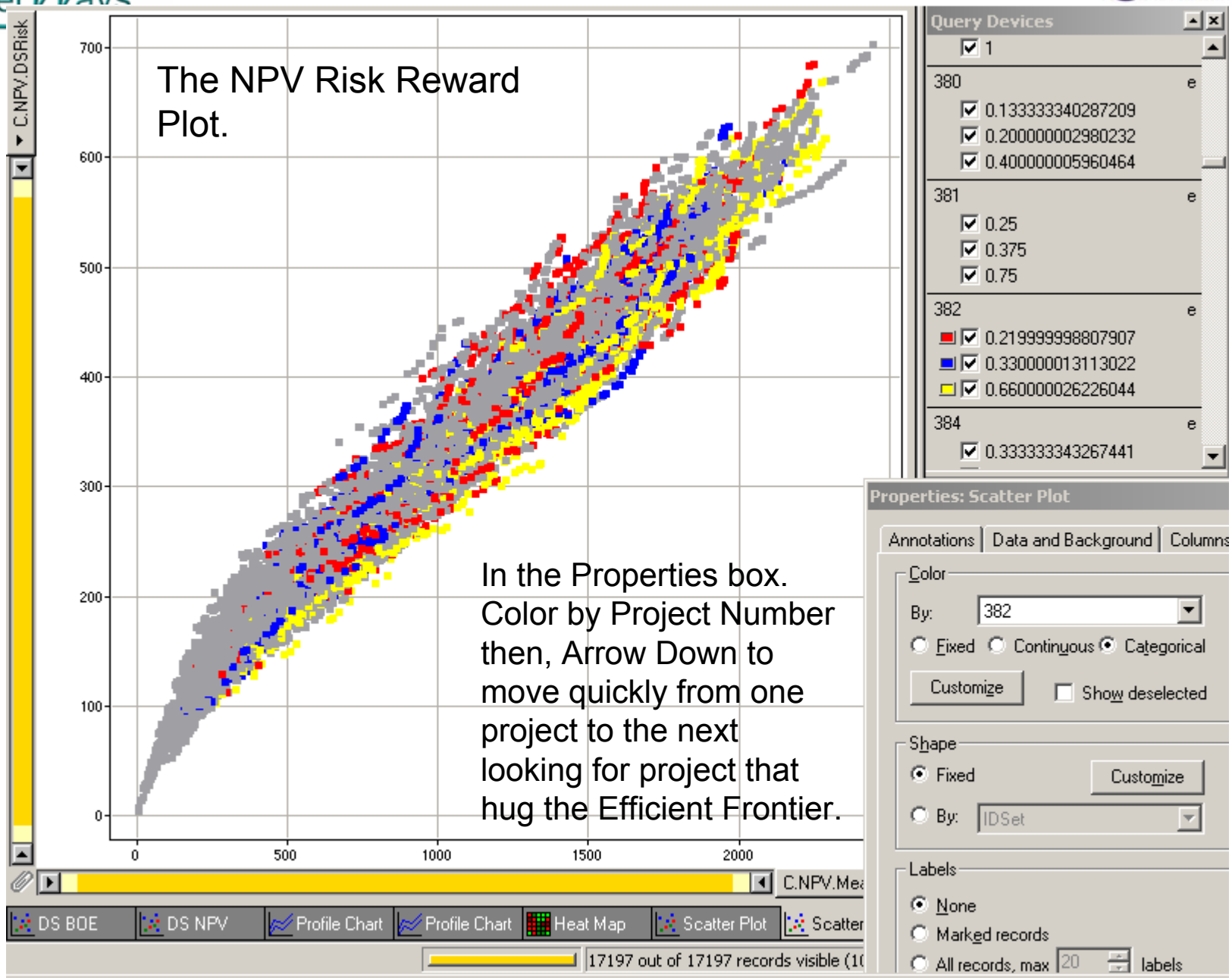
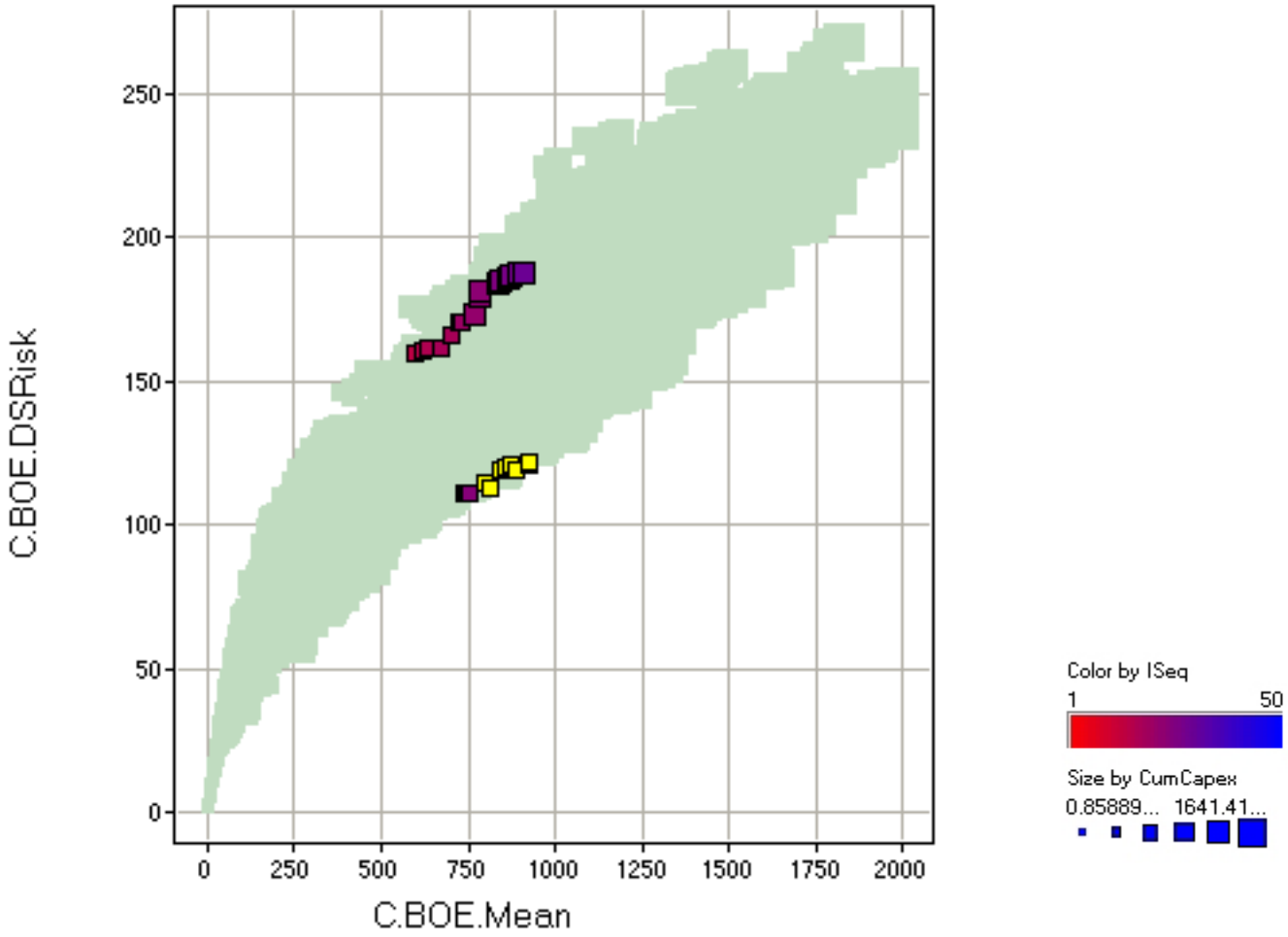

The NPV Risk Reward Plot.
In the Properties box. Color by Project Number then, Arrow Down to move quickly from one project to the next looking for project that hug the Efficient Frontier.
C.NPV.DSRisk
Query Devices
Properties: Scatter Plot
Annotations
Data and Background
Columns
Color
By: 382
Fixed
Continuous
Categorical
Customize
Show deselected
Shape
Fixed
Customize
By: IDSet
Labels
None
Marked records
All records, max 20 labels
DS BOE
DS NPV
Profile Chart
Profile Chart
Heat Map
Scatter Plot
17197 out of 17197 records visible

DS BOE



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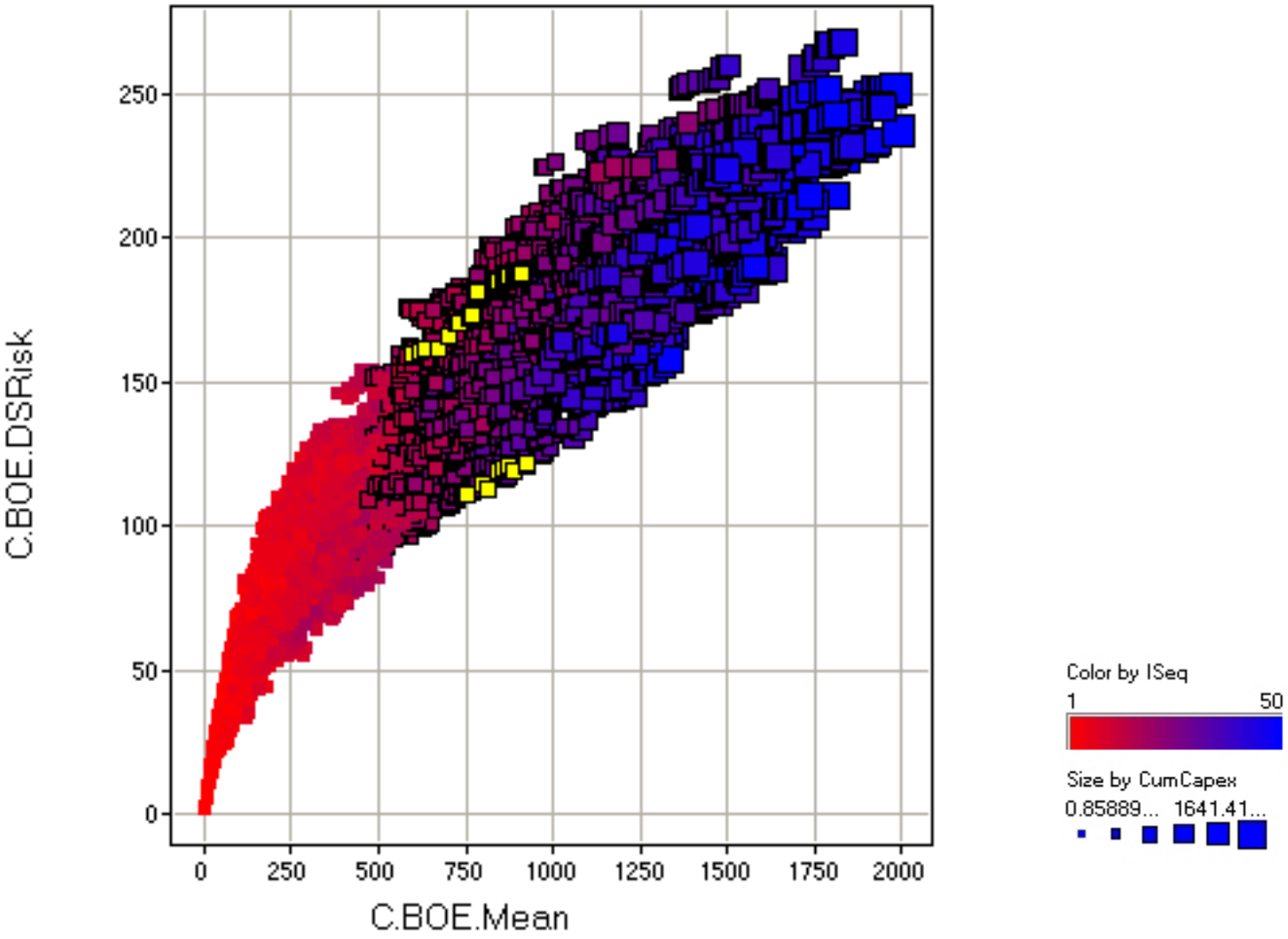
DS BOE



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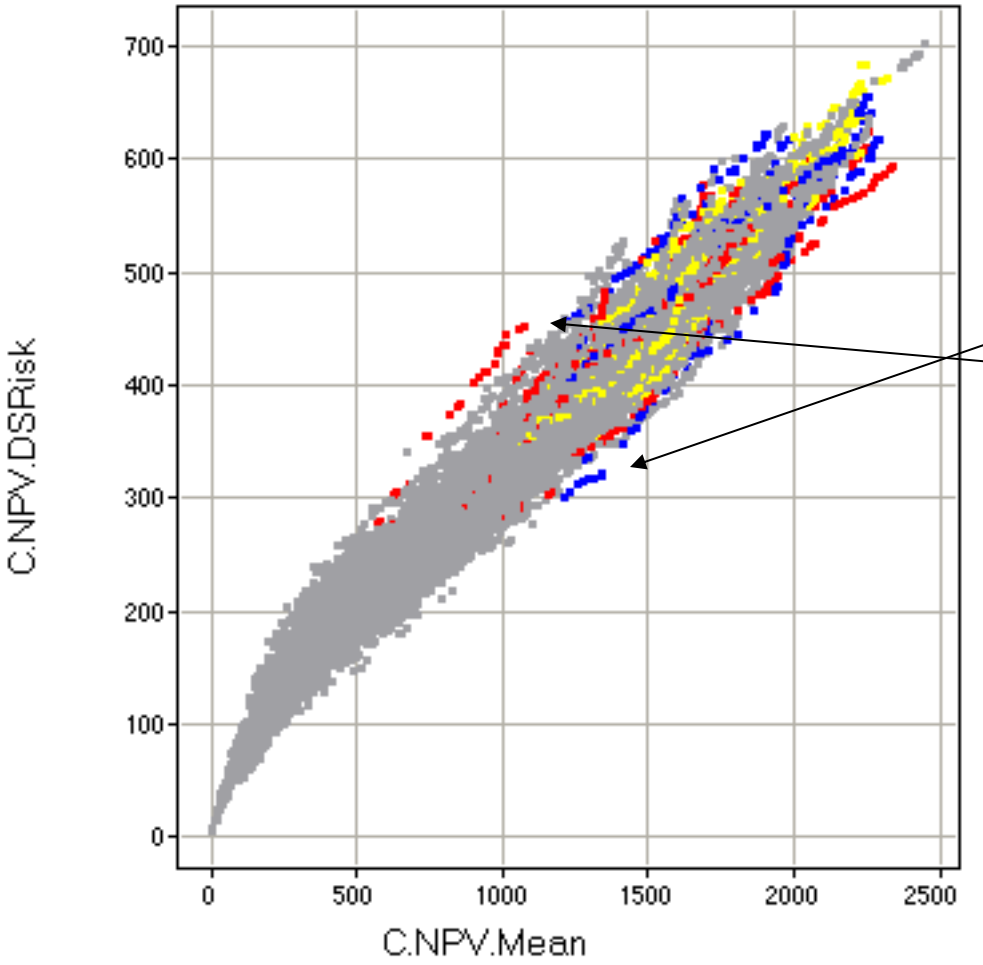
DS NPV - Color by WI of 1 Project (386)



Here we see the portfolios highlighted by funding levels of Project 386.

This project is in both efficient and very inefficient portfolios.

In the inefficient portfolio, there are OTHER projects making it inefficient.

Color by 386
0.133333340287209
0.200000002980232
0.400000005960464
(Empty)

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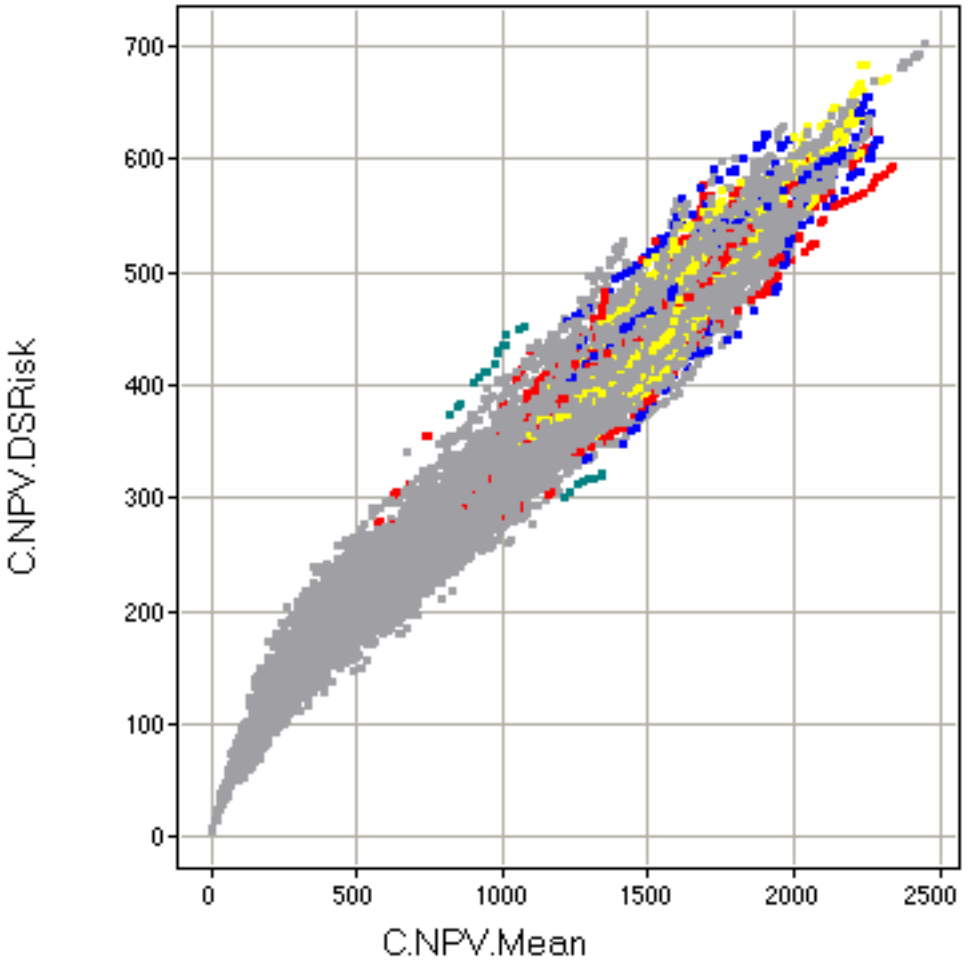
DS NPV - Color by WI of 1 Project (386)



Here we see the portfolios highlighted by funding levels of Project 386.

Highlight the good and bad. Create a new column on Marked Records "386Difference"

Select only 386Difference = yes
View the Heat map.

Color by 386
- 0.133333340287209
- 0.200000002980232
- 0.400000005960464
- (Empty)

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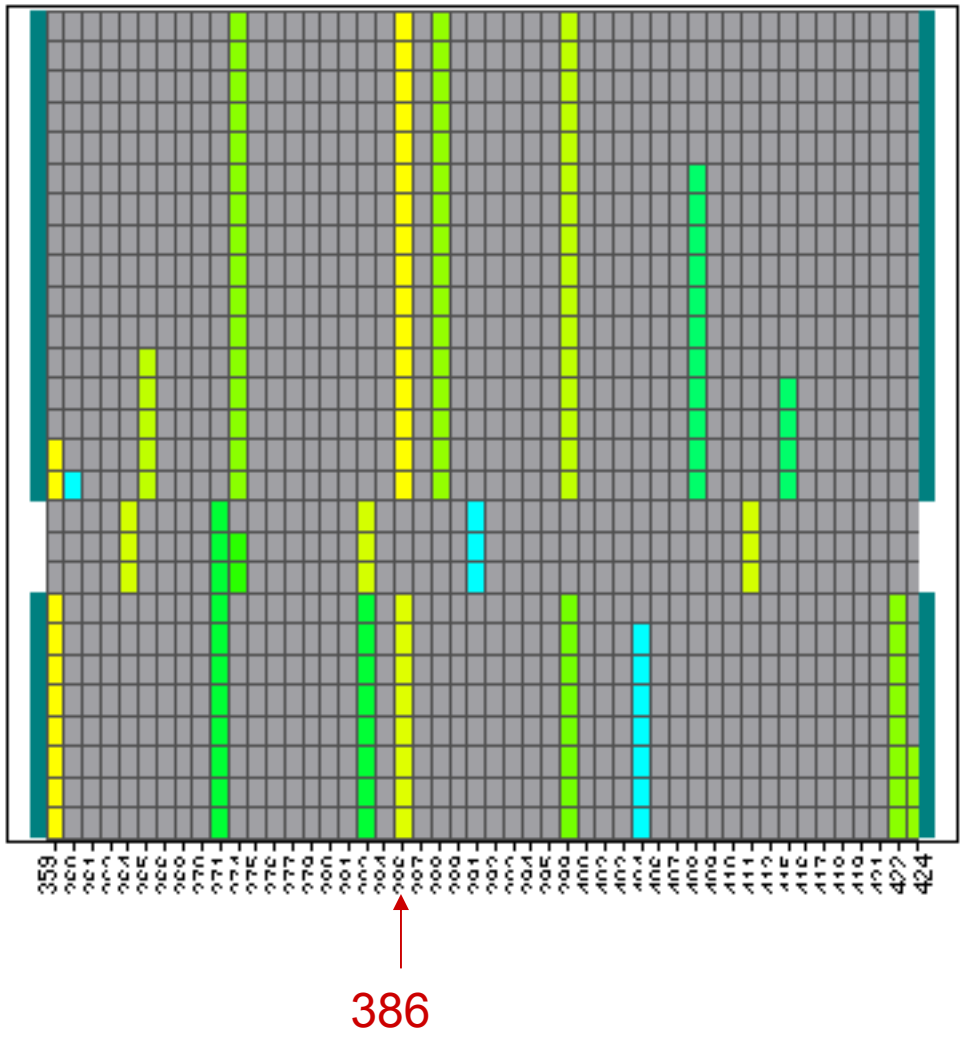
Heat Map

Candidates for Poor performing Projects

More



Look for differences in the project selections.

The longer the stripe, the earlier the project is picked in the Portfolio Trace

Inefficient Points

Efficient Points without 386 caught up in the selection

Efficient Points

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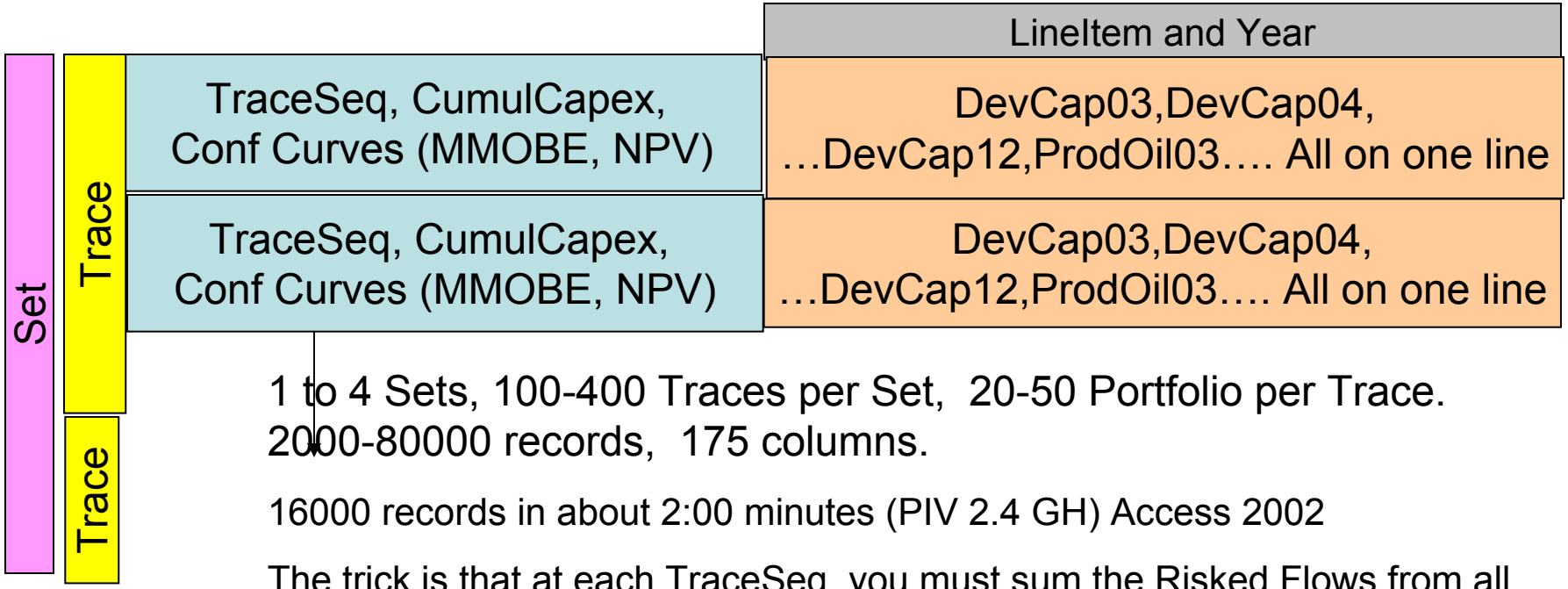
View the Portfolio Confidence Curves and Portfolio Flow Data (Production, Devel Capex, CFAT, NIAT, CapEmpl) on a Risked Basis

- T1F6 Query: Confidence Curves (MMBOE, NPV) and Portfolio Flow data (Years 2003 through 2012)



1 to 4 Sets, 100-400 Traces per Set, 20-50 Portfolio per Trace. 2000-80000 records, 175 columns.

16000 records in about 2:00 minutes (PIV 2.4 GH) Access 2002

The trick is that at each TraceSeq, you must sum the Risked Flows from all funded Projects (times their Working interests) at each Portfolio Point (TraceSeq record)

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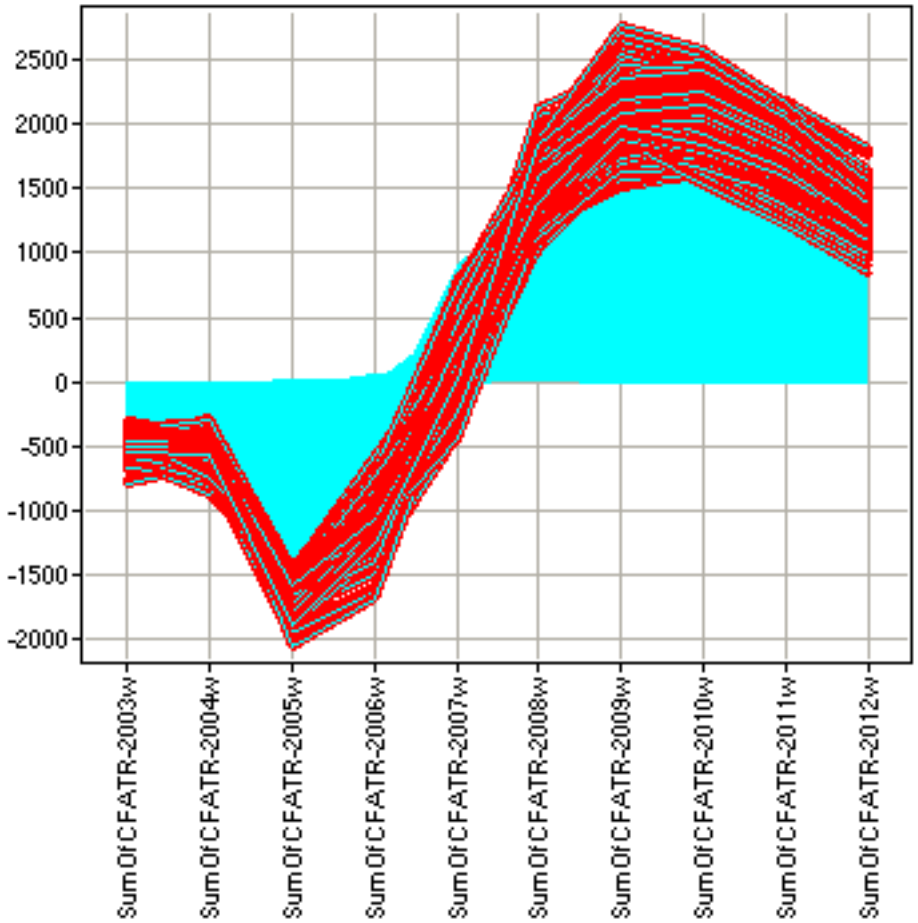
Cash Flow After Tax Line Chart (T1F6)



We highlight all portfolios that exceed a mean expected $1.4 Billion negative cash flow in any year.

All columns use the same scale.

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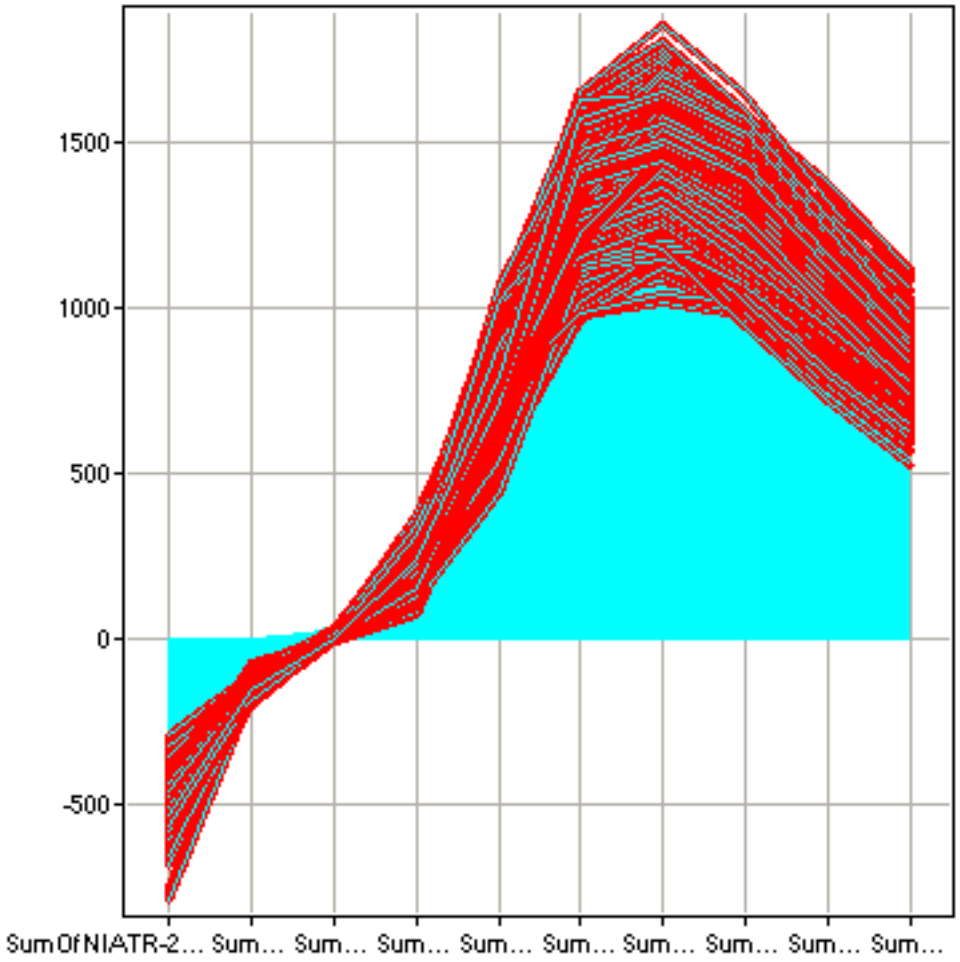
NIAT by Year Line Chart



The projects we selected are, surprise, surprise, the project that have the highest earnings in the production years.

All columns use the same scale.

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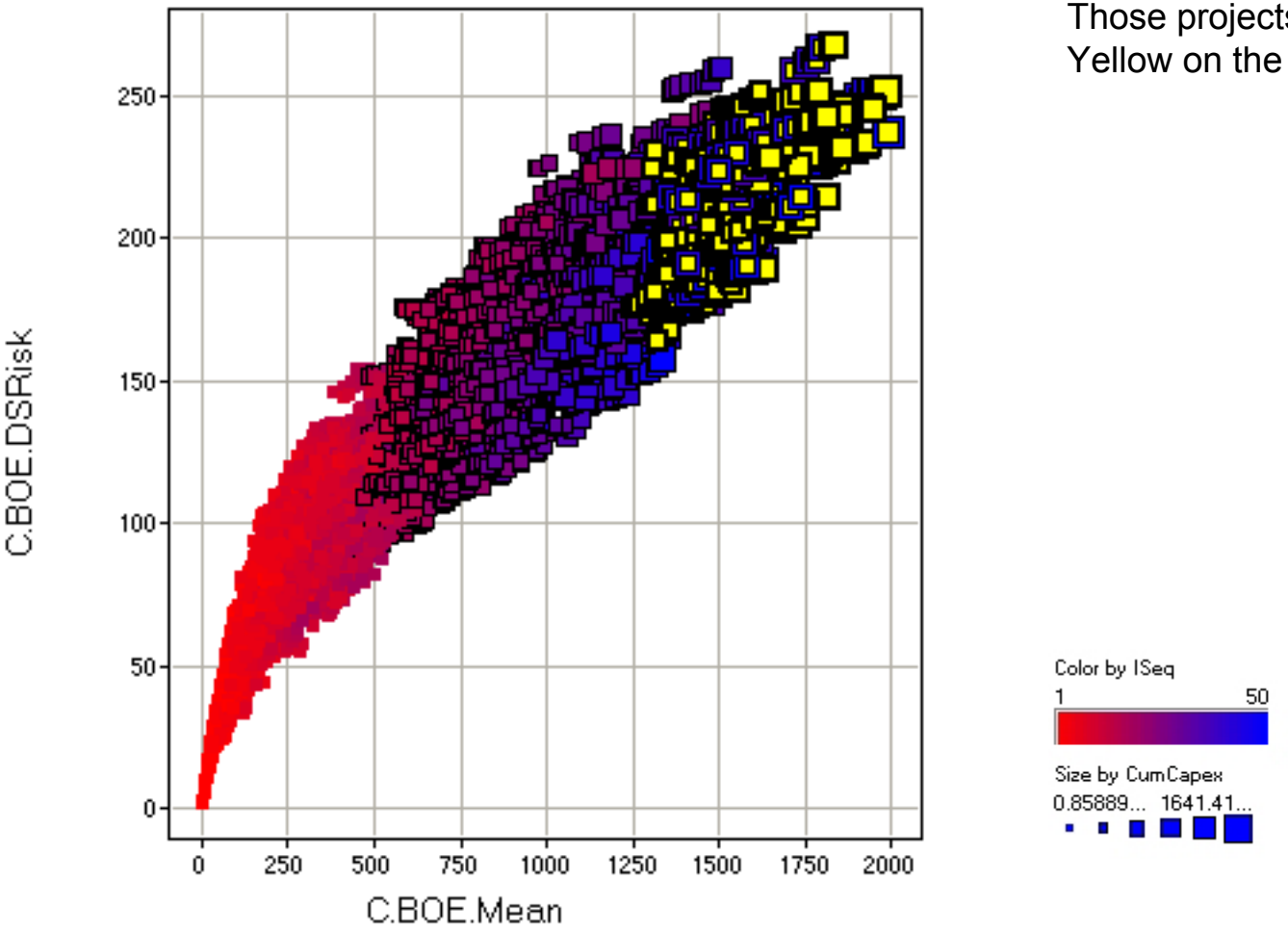
DS BOE Risk / Reward



Those projects are highlighted in Yellow on the Risk Reward plot.

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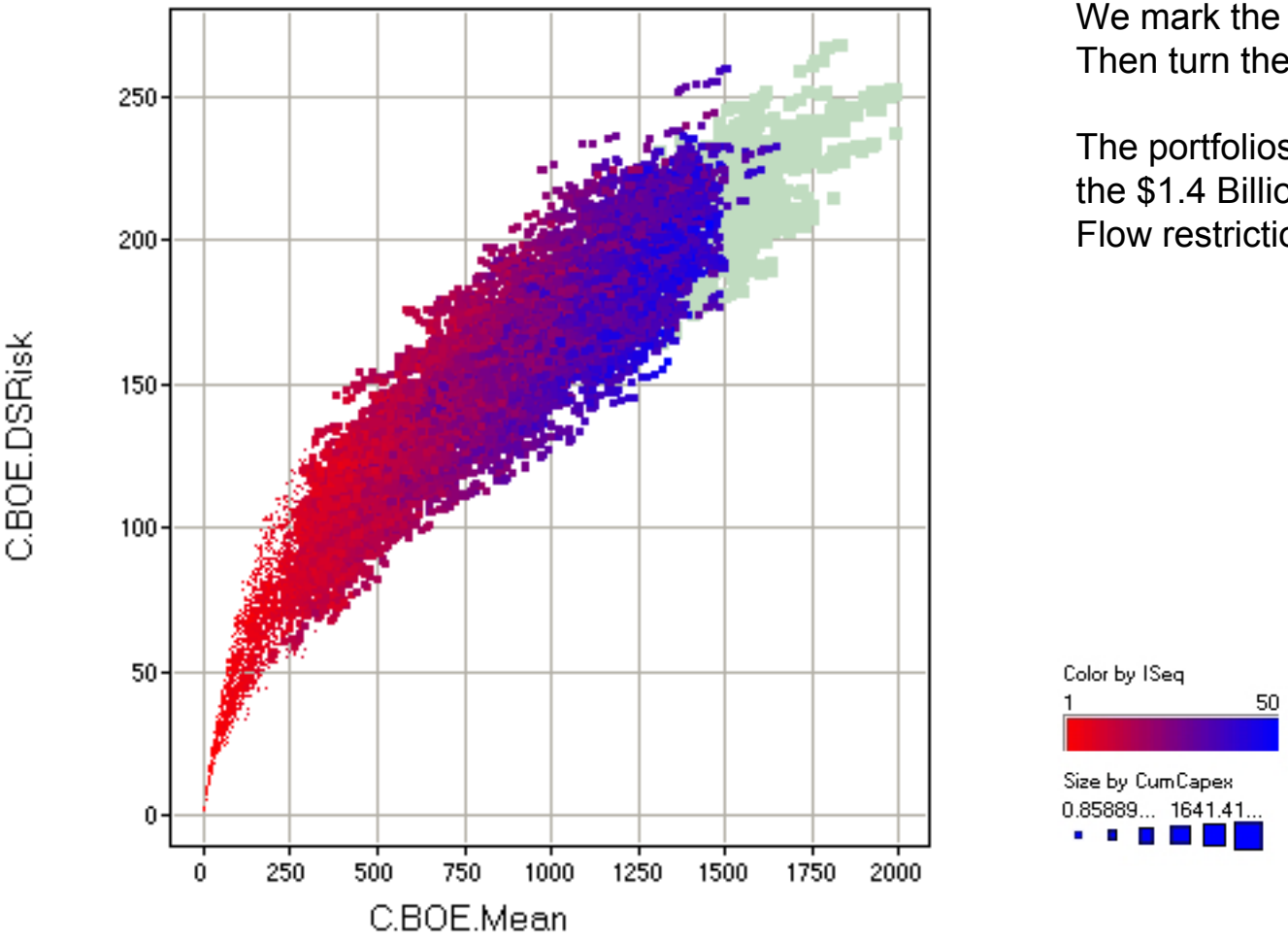
DS BOE Risk / Reward



We mark the records selected.
Then turn them off.

The portfolios that remain stay within the $1.4 Billion negative Risk Cash Flow restriction.

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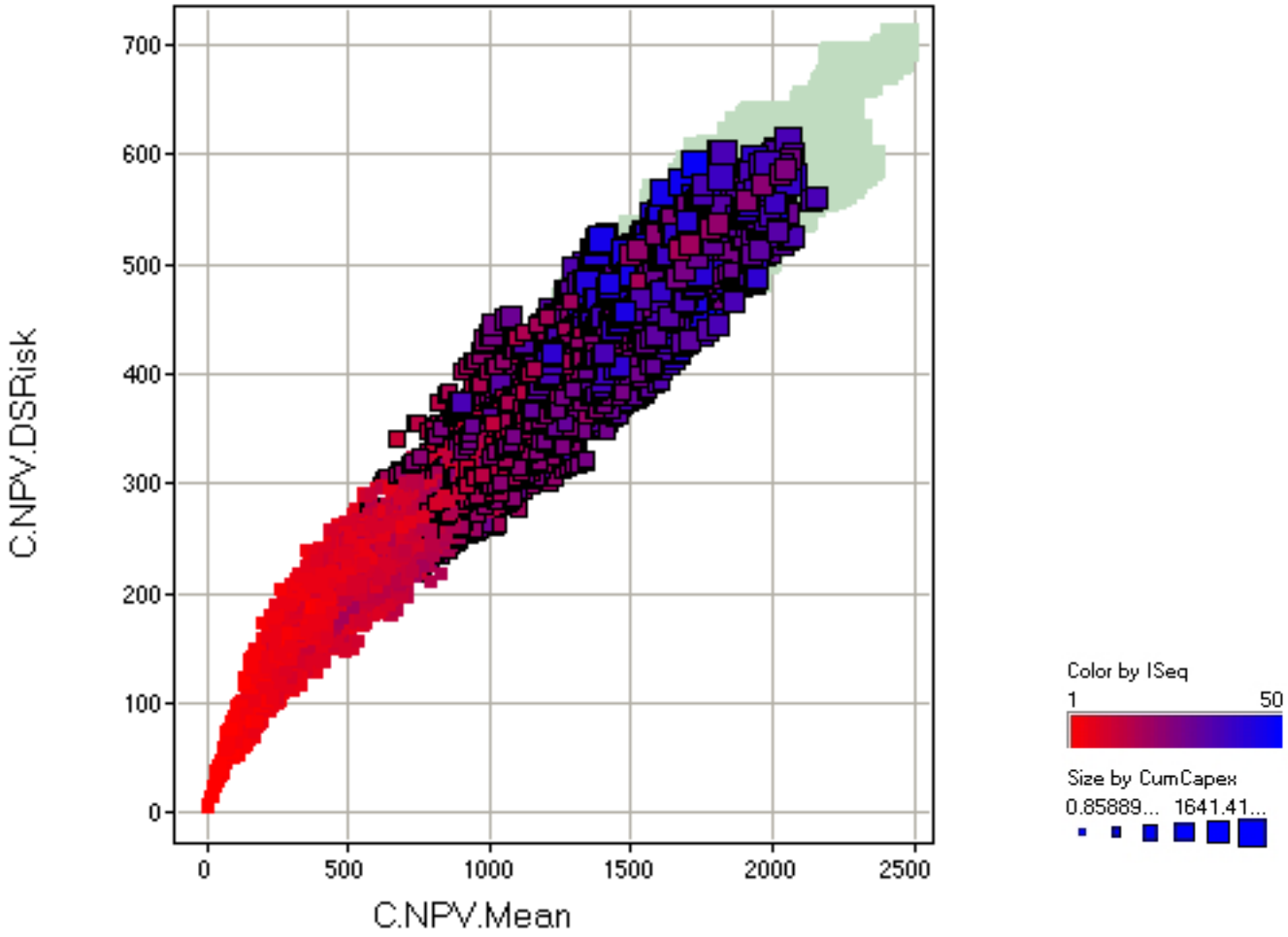
DS NPV Risk / Reward



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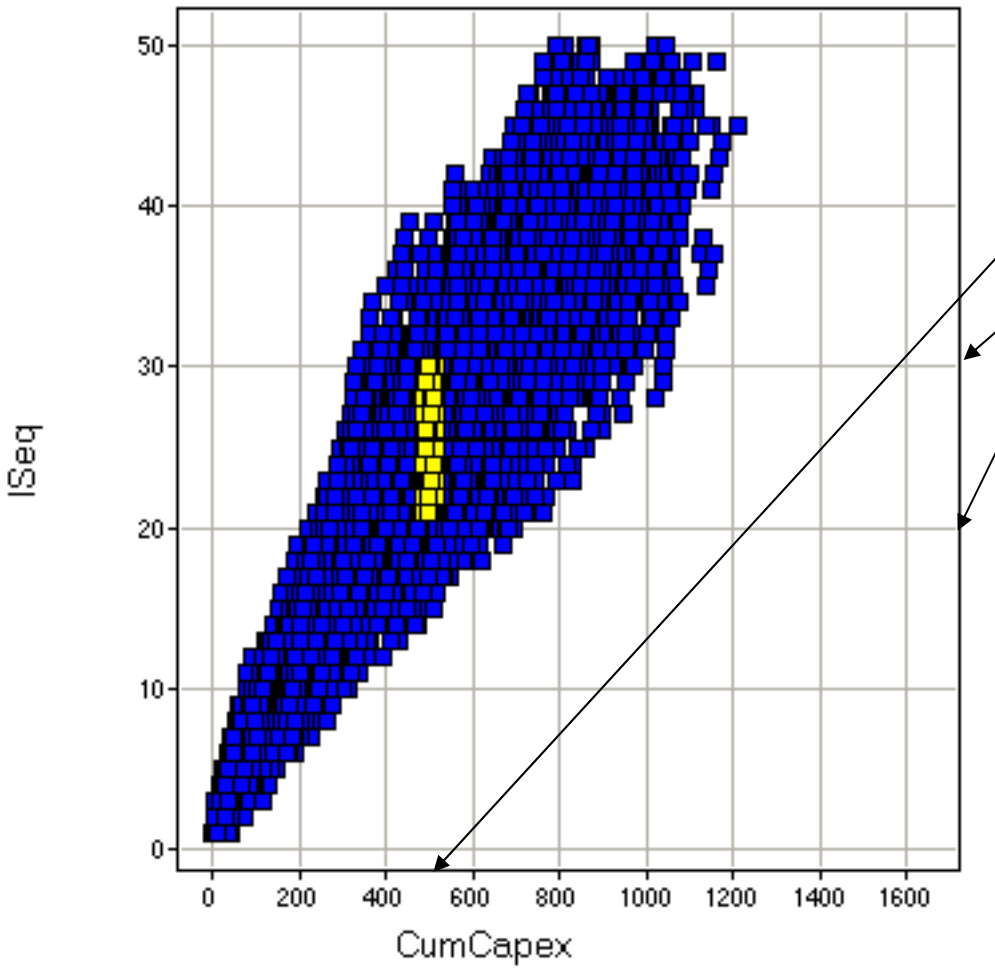
Scatter Plot Sequence Number vs Cum Capex



Let's look at the remaining portfolios that we fund at

About $500 Capex and

20 to 30 Projects
(because there are limits to the number of projects we can manage with our available staff)

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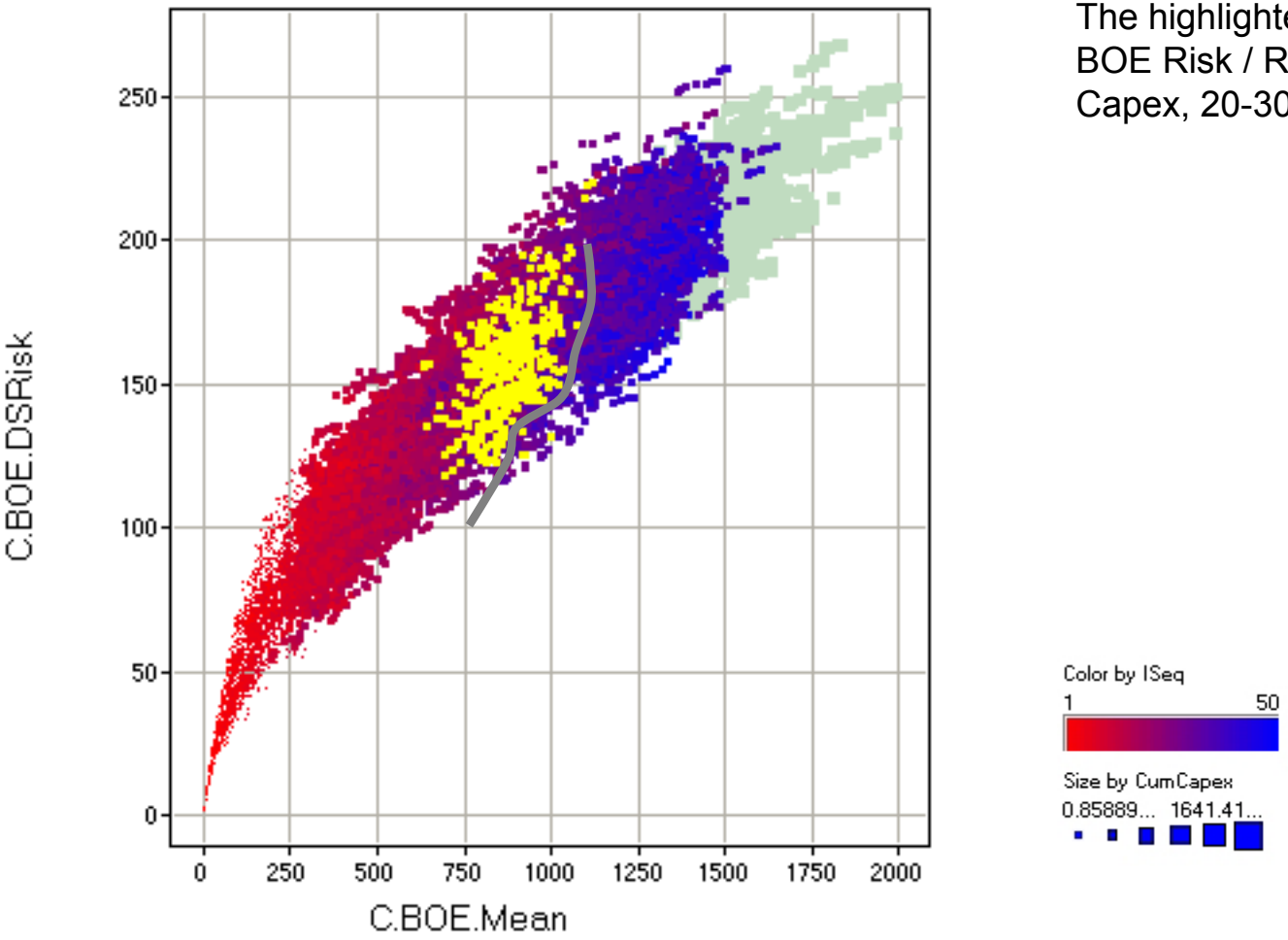
DS BOE



The highlighted portfolios in the this BOE Risk / Reward abid by the $500 Capex, 20-30 project limit.

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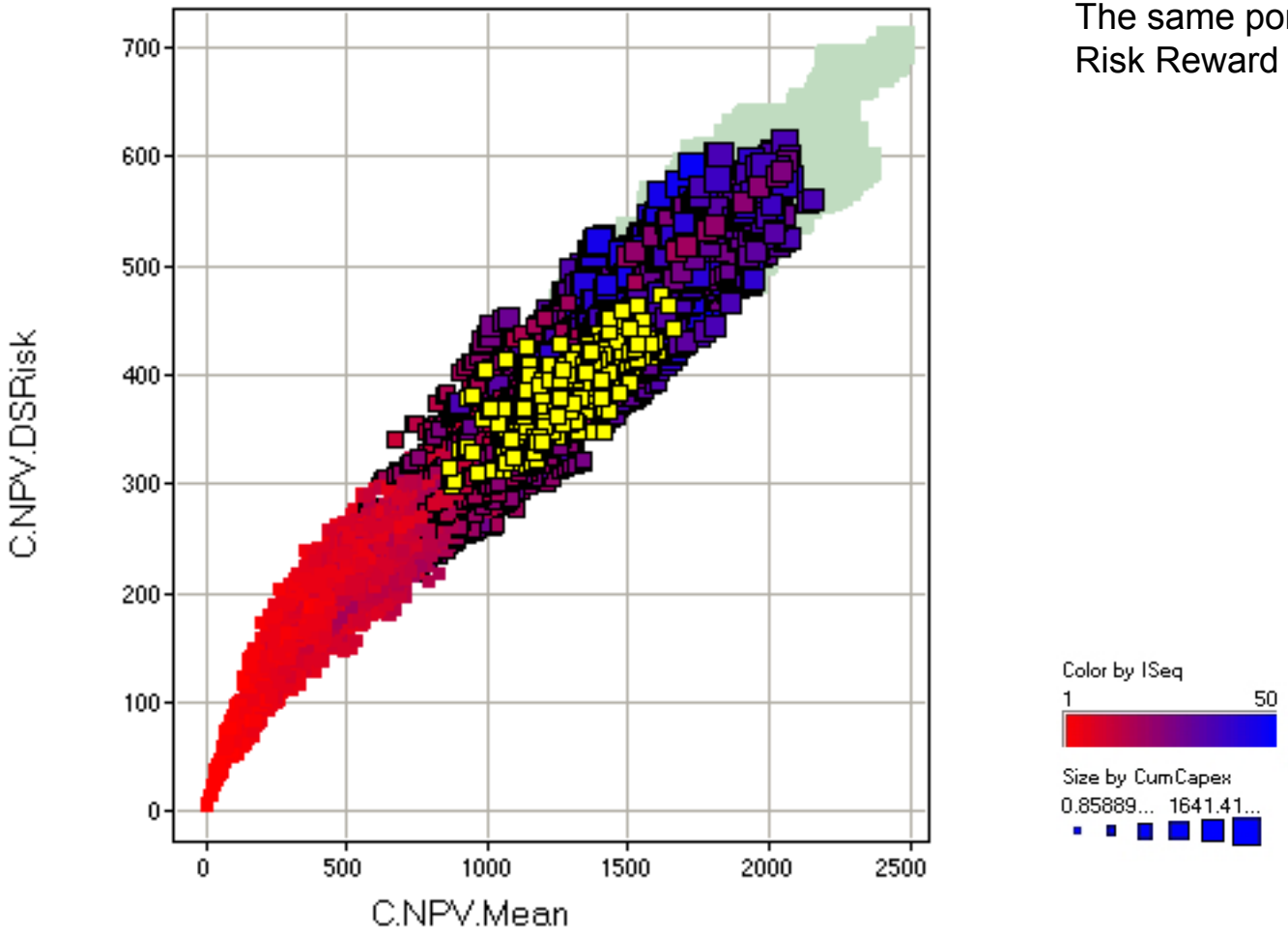
DS NPV Risk/Reward



The same portfolios seen in the NPV Risk Reward plot

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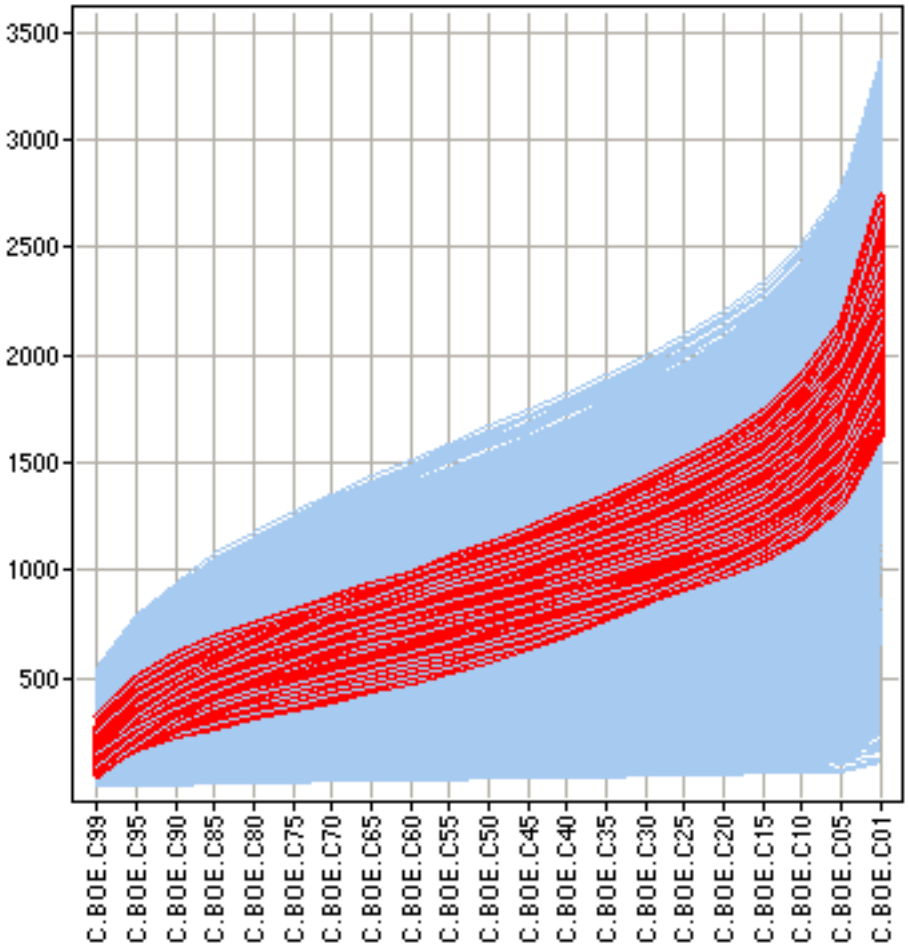
MMBOE Confidence Profile Chart



All columns use the same scale.

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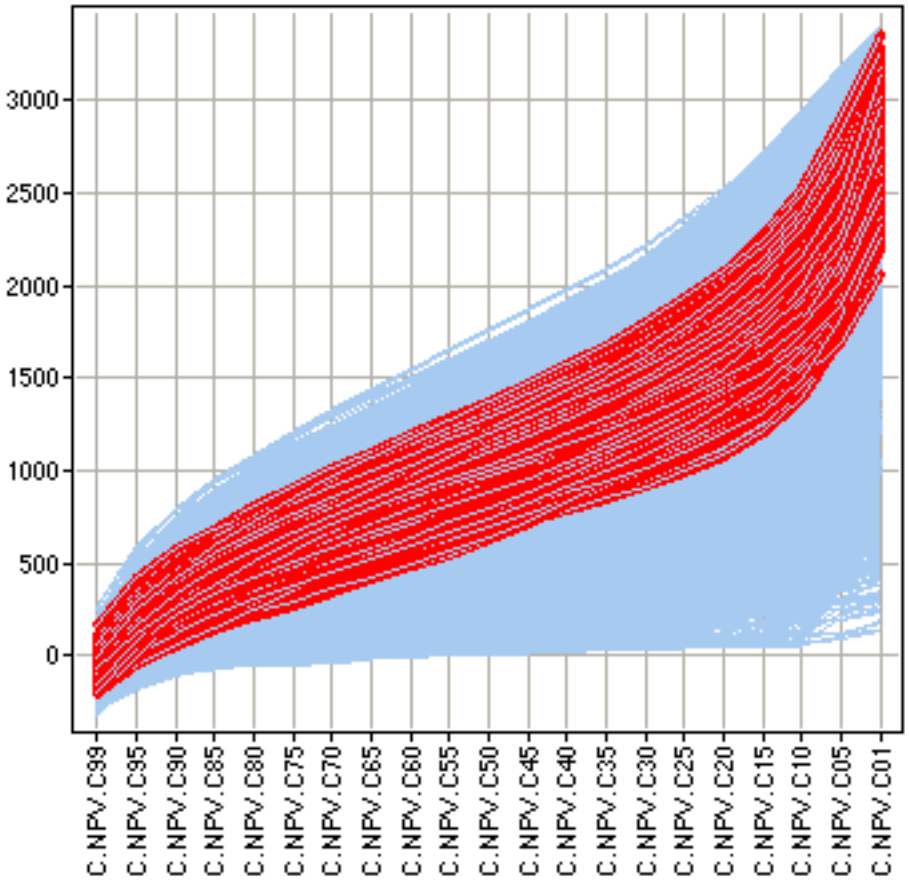
NPV Confidence Profile Chart



All columns use the same scale.

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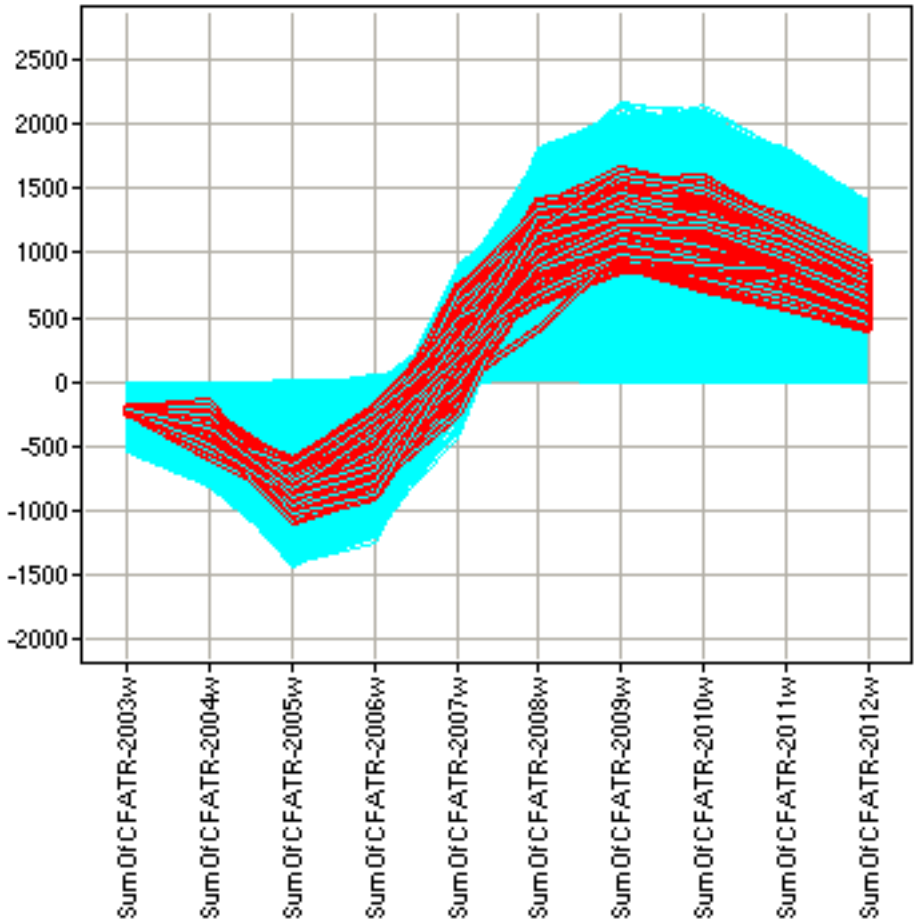
CFAT Profile Chart



All columns use the same scale.

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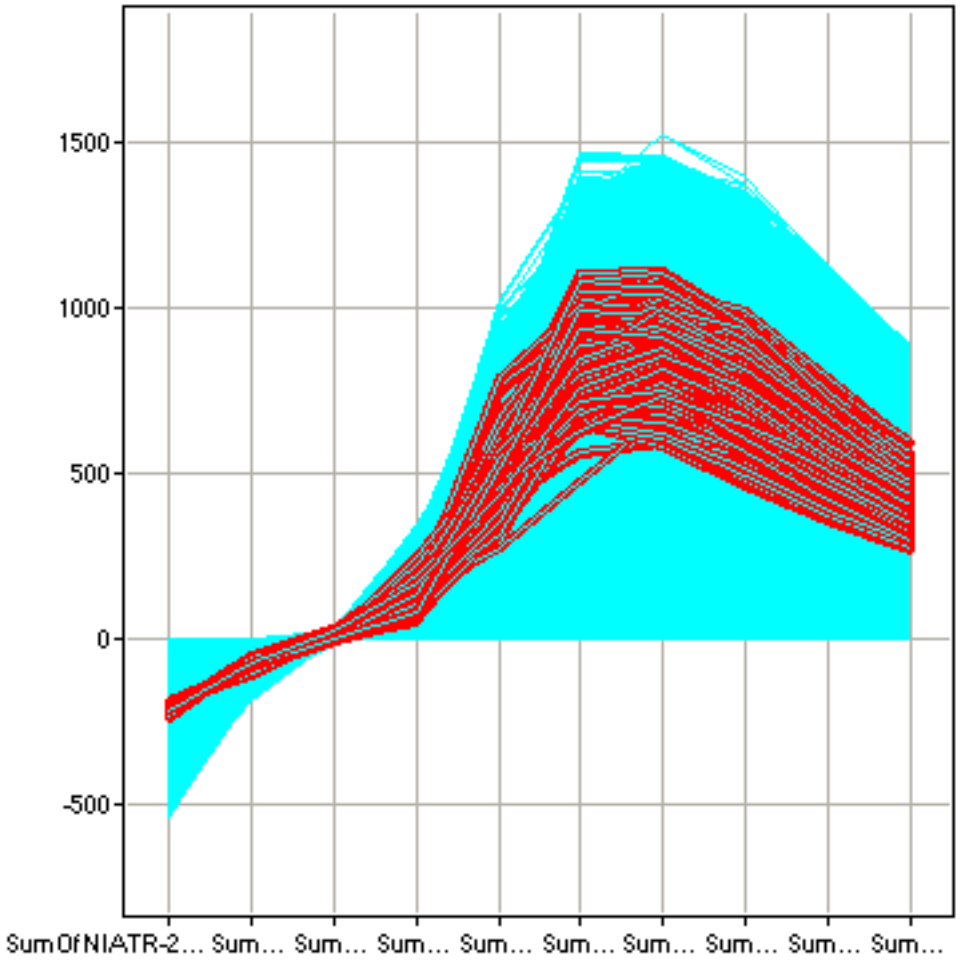
NIAT by Year Line Chart



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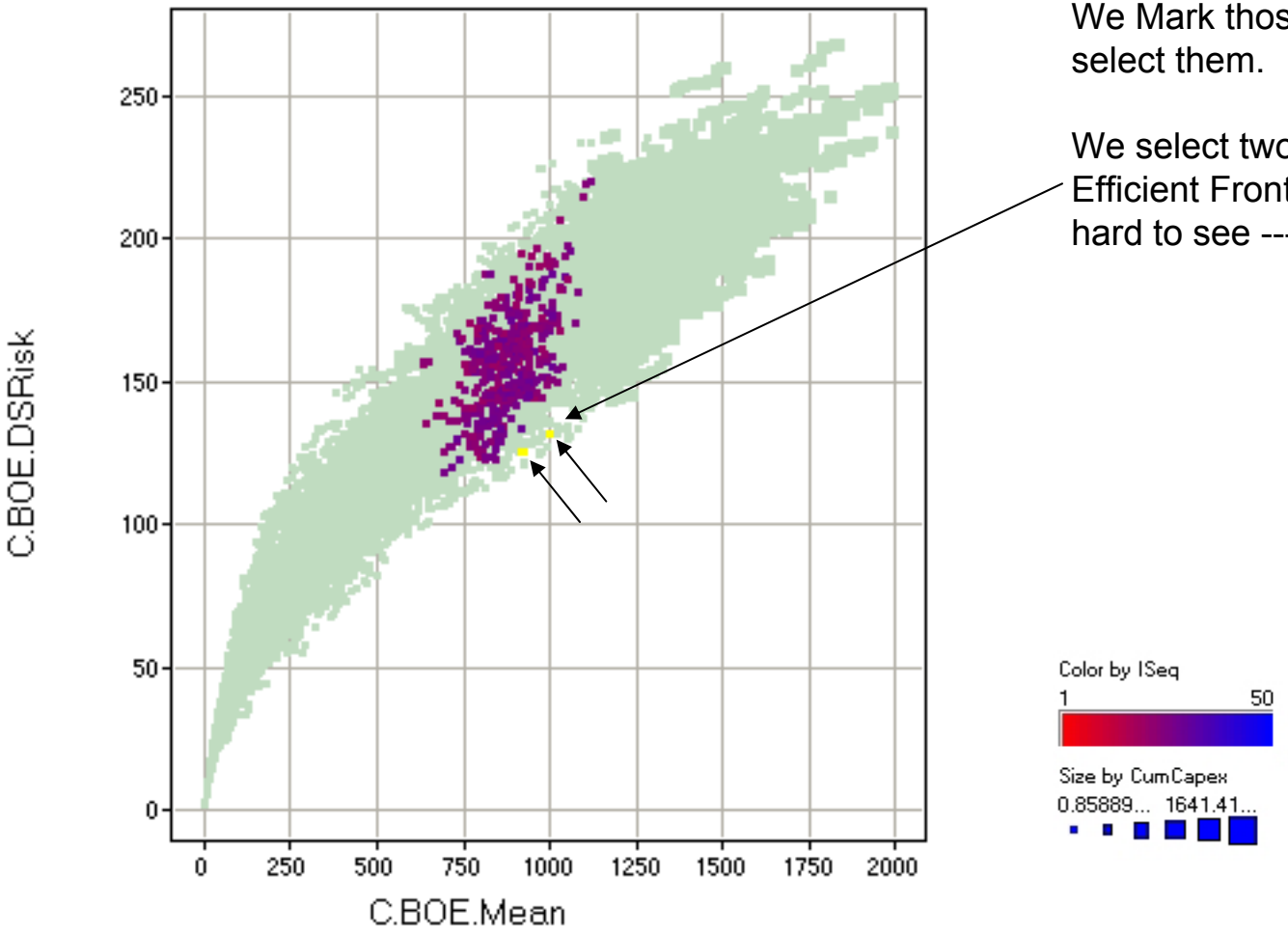
DS BOE



We Mark those project and only select them.

We select two portfolio nearest the Efficient Frontiers (yes, the yellow is hard to see --- sorry.)

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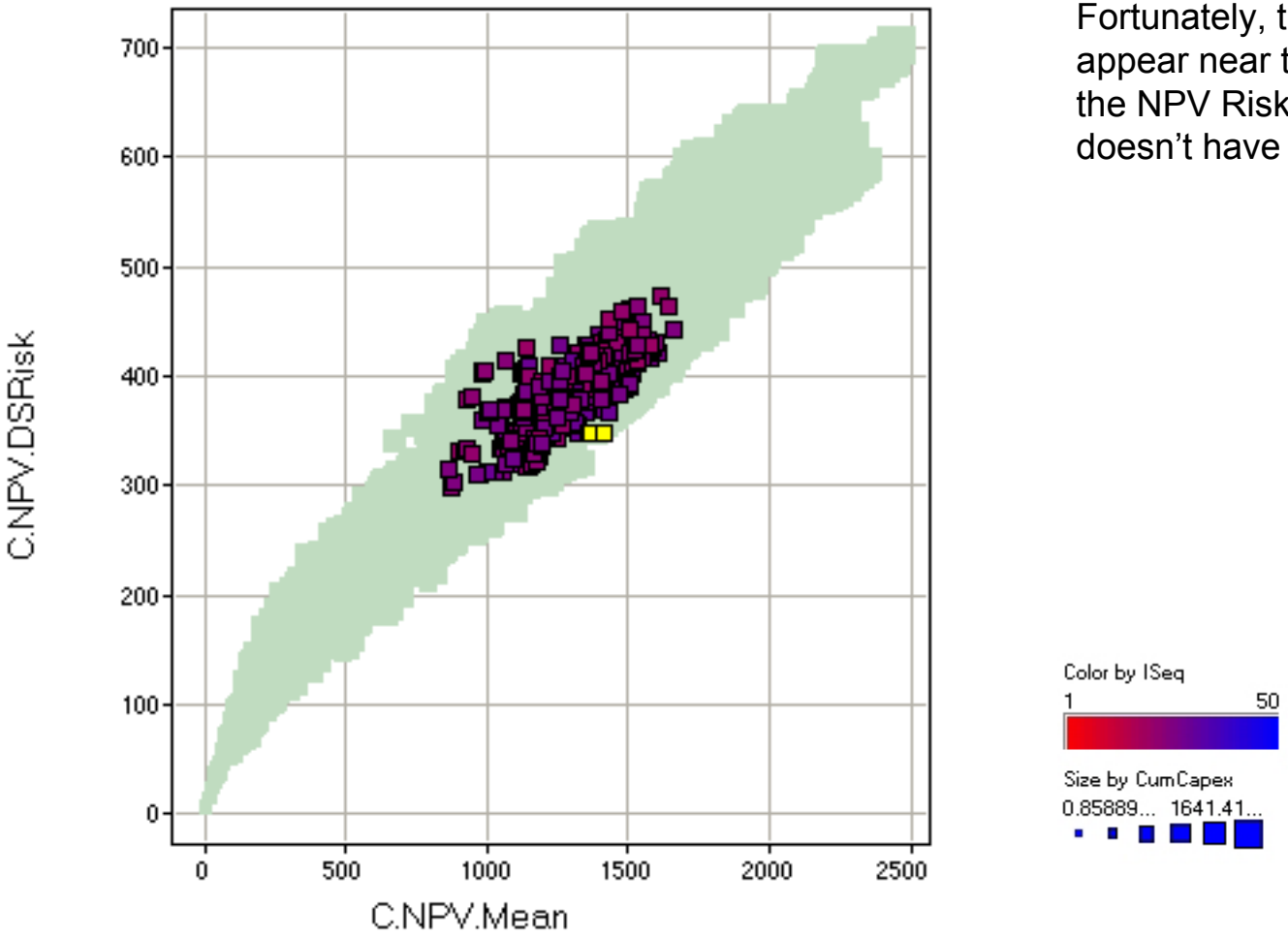
DS NPV



Fortunately, those project also appear near the efficient frontier of the NPV Risk Reward plot. (It doesn't have to be).

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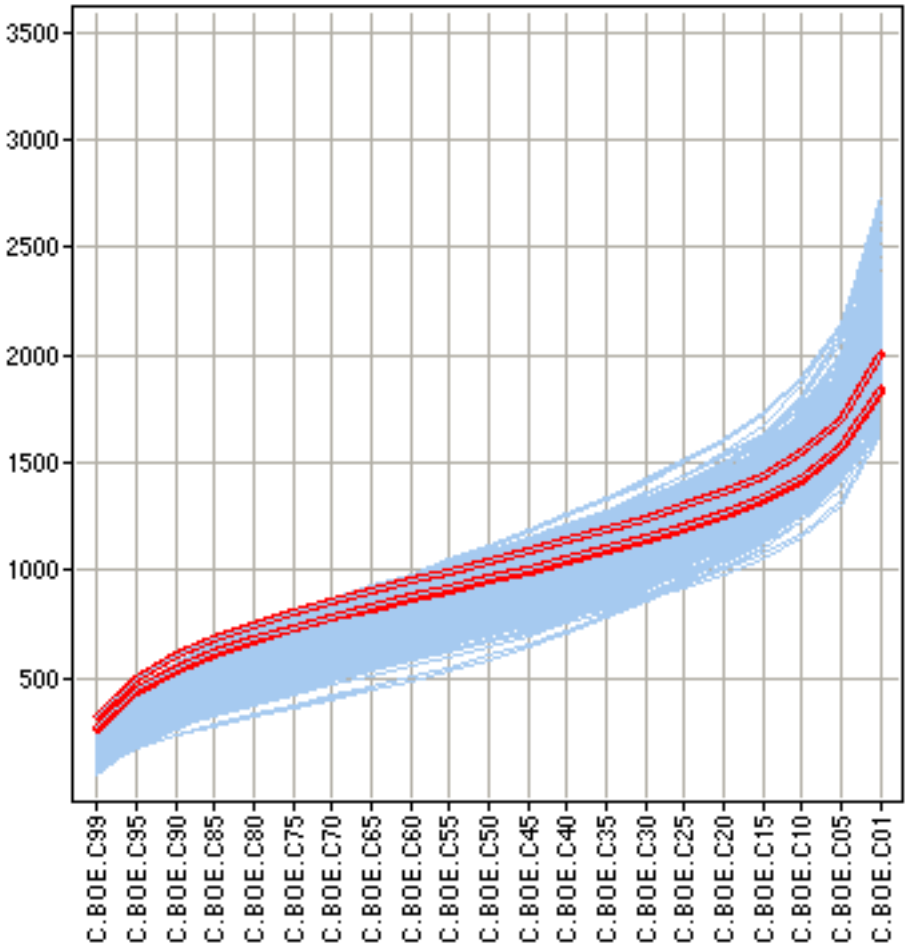
BOE Confidence Curve Profile Chart



Those projects have relatively good performance at high confidence,

But don't have as great an upside as other points.

(Only the $500 MM Capex, 20-30 project Portfolios are displayed in blue. All other portfolios are hidden.)

All columns use the same scale.

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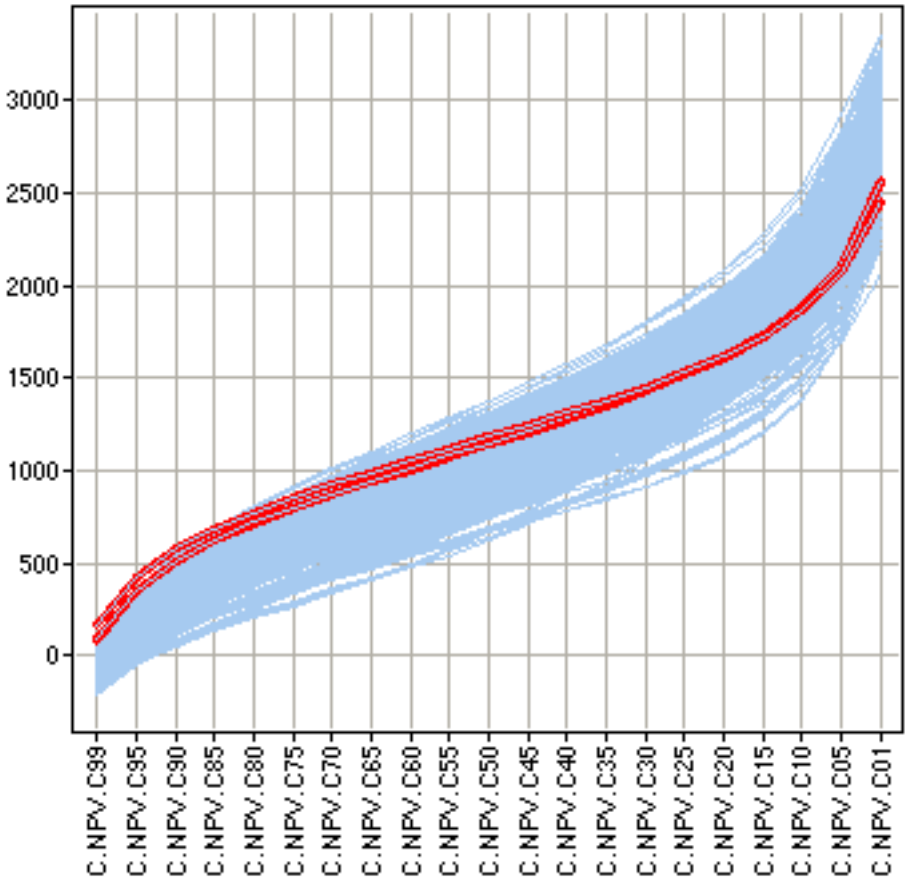
NPV Confidence Curves Profile Chart



Likewise for the NPV Confidence curves

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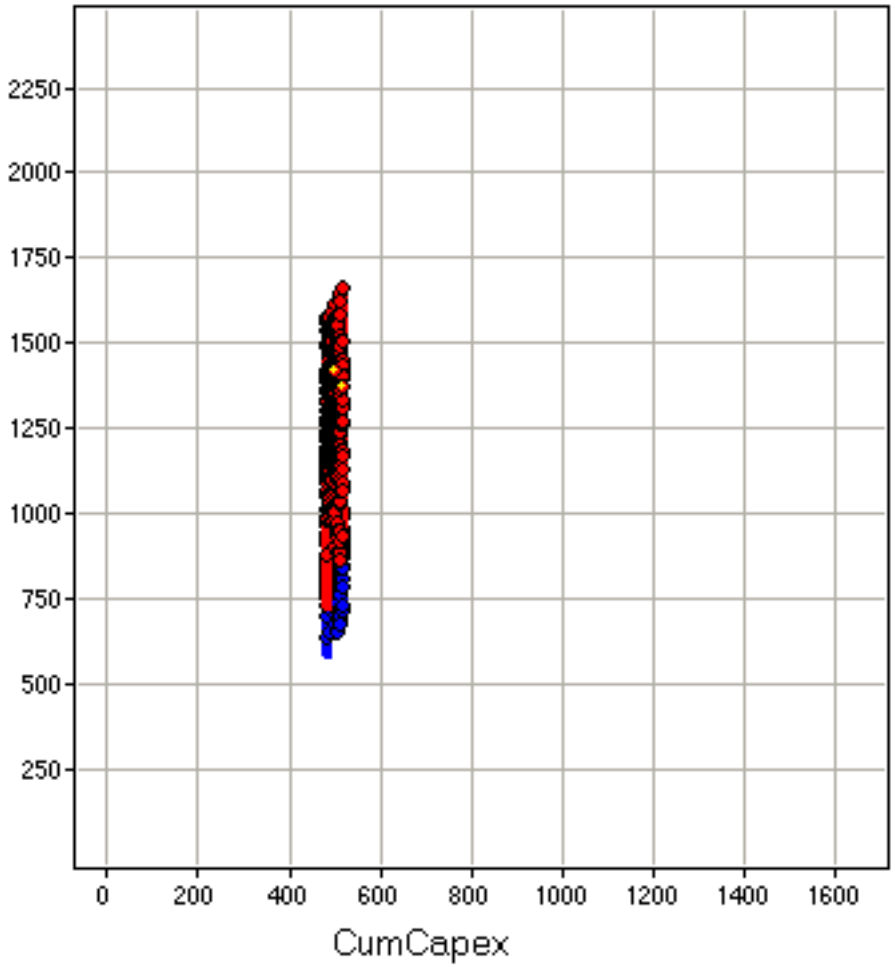
MMBOE & NPV vs Cum Capex



All columns use the same scale.

C.BOE.Mean

C.NPV.Mean

All markers are connected and ordered by CumCapex.

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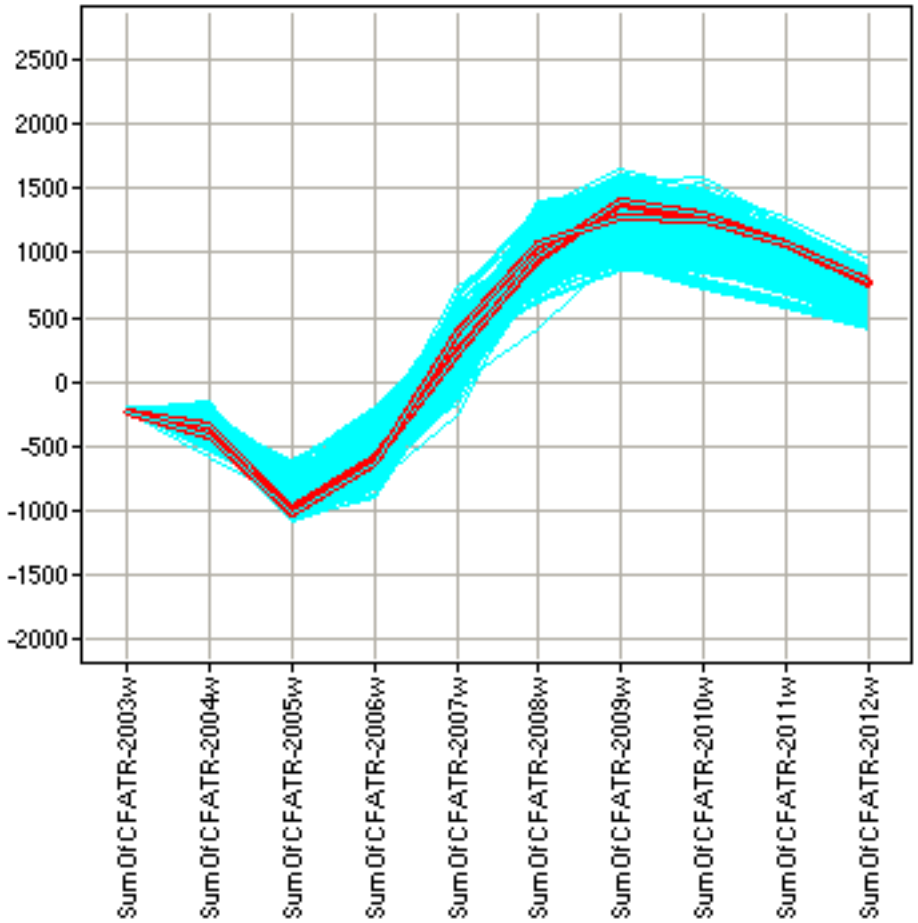
CFAT by year Profile Chart



For the two selected portfolios.

Can we stand it? A management call.

If not, we select additional portfolios to exclude and analyze what is left.

All columns use the same scale.

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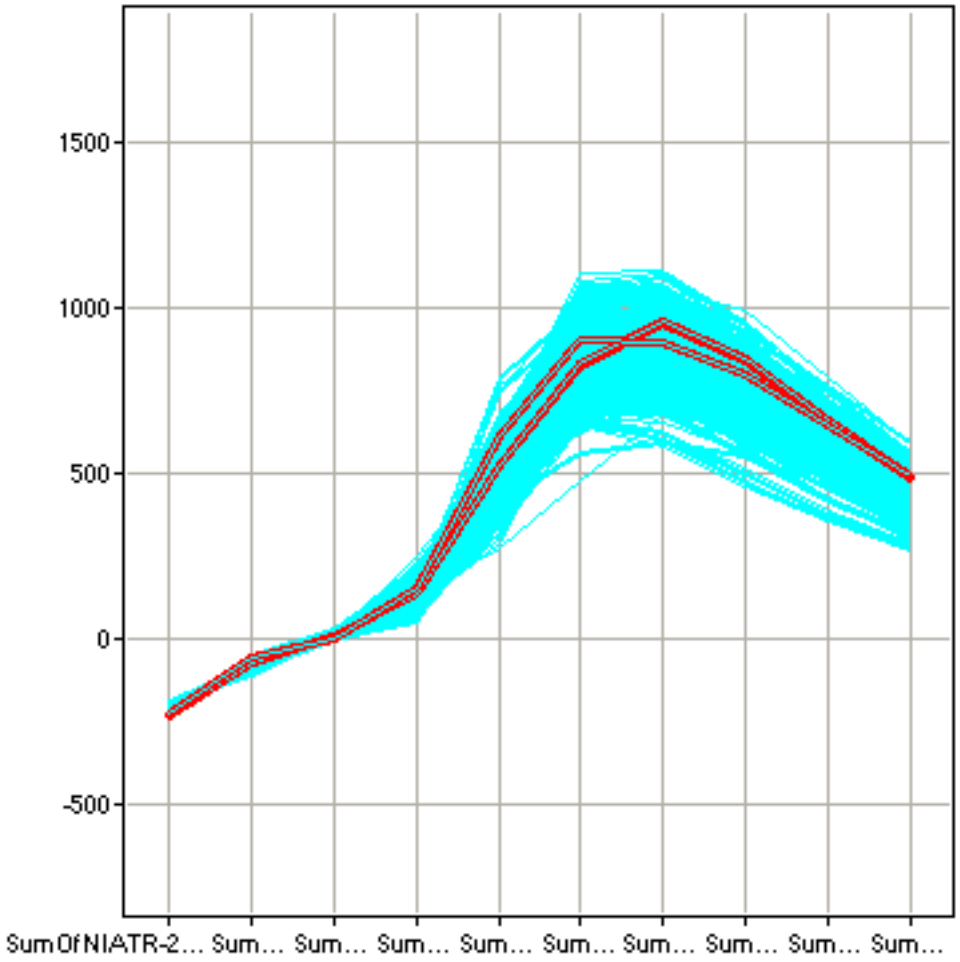
NIAT by Year Line Chart



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Spotfire Sheds Light on a Complicated Problem

- Woolsey's 1st Law
  - "A Manager would rather live with a problem he cannot solve than accept a solution he cannot understand."

- Woolsey's 2nd Law
  - "A Manager does not want, and will not pay for, an OPTIMUM solution. He wants to be better off now, as quickly and as cheaply as possible.

* R. E. D. Woolsey, Professor of OR/MS, Colorado School of Mines

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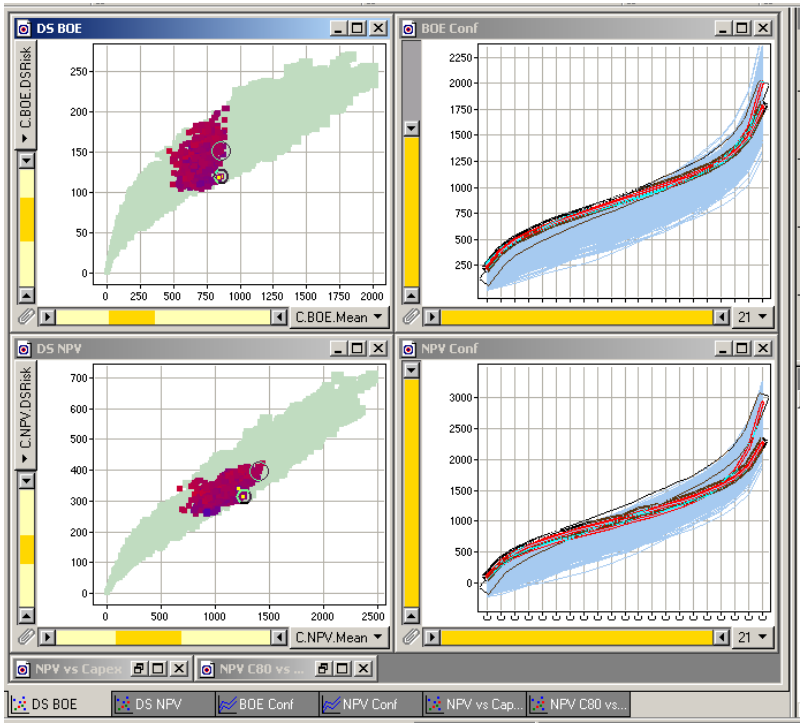
WiserWays Portfolio Calculator and Analyzer

- By making <u>VISIBLE</u> the potential funding opportunities, DECISION MAKERS can see available alternatives and the degree of difference (or equivalence) between them.

- Understandable. Quick. Easy.



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Thanks to

- Spotfire
  - For the opportunity to speak hear and for the work we have done together.
- Joe Taylor
  - For helping me debug the Access-Spotfire interaction.
- Ian Learch (Prof. U. of S. Carolina)
  - Who in 1997 catalyzed my development of the Confidence Curve Calculator.

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And Thank You for your attention.

- This presentation is available on-line at
  http://wiserways.com/downloads/030220Spotfire.pdf

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Do it better with

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