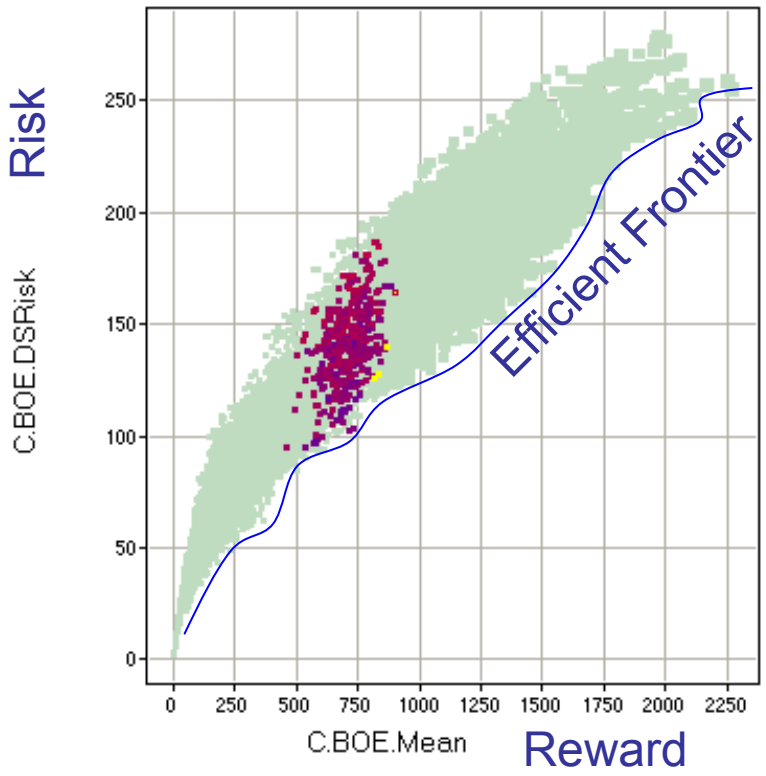
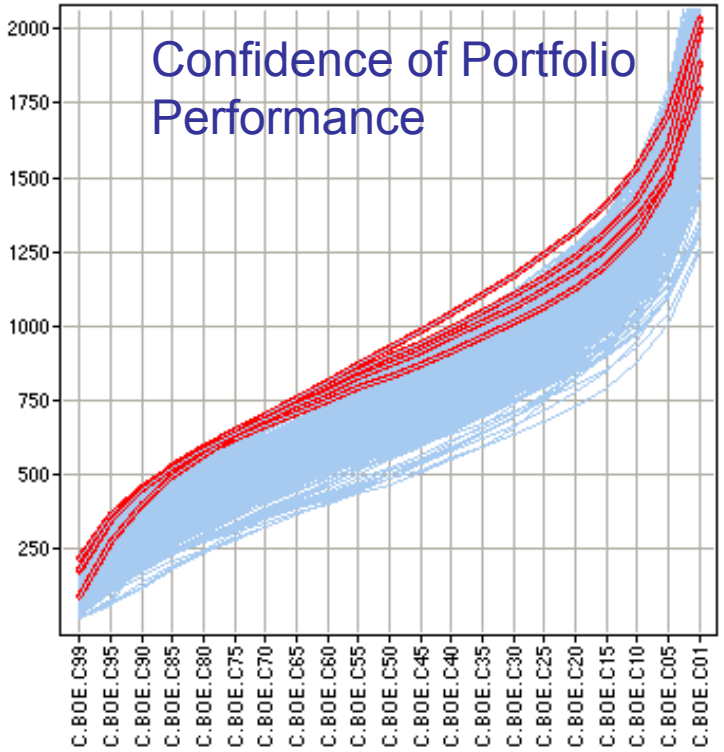
Spotfire Communicates Portfolio Analysis of Investment Opportunities on Efficient Frontiers of Many Measures

Dr. Stephen M. Rasey, Director, WiserWays LLC
for Spotfire London Users Meeting, May 20, 2003





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)

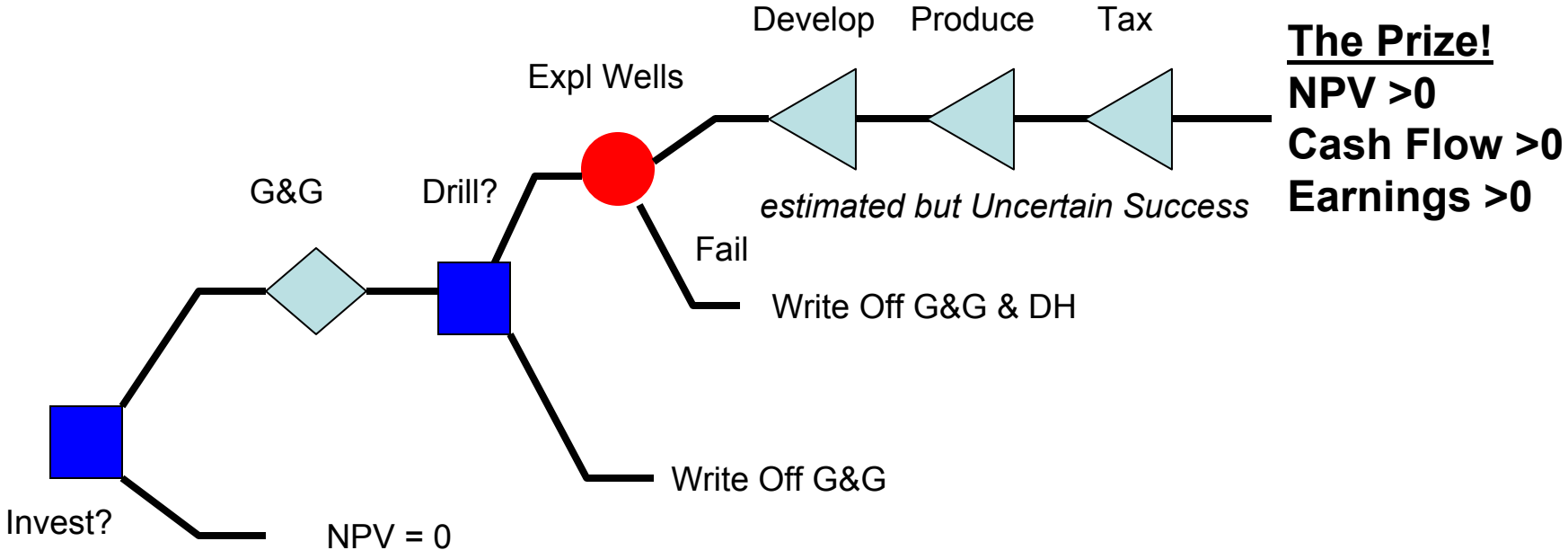
Portfolio Analysis

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

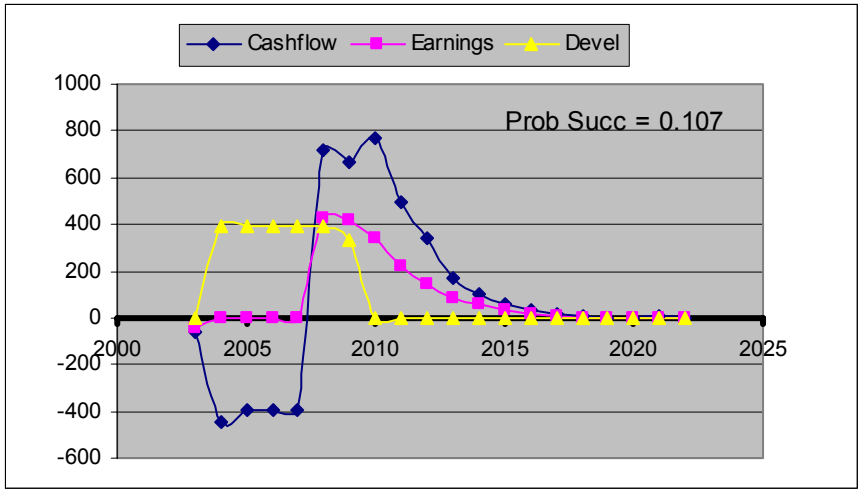
- Acceptable Candidate Portfolios must satisfy Investors Requirements:
  - Operational – Physically doable
    (rig avail, lead time, partners, Working Interest availability)
  - Political – (BU Capex avail, Maximum $ exposure)
  - Resource – Budget, People
  - Performance – Resources found, Production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

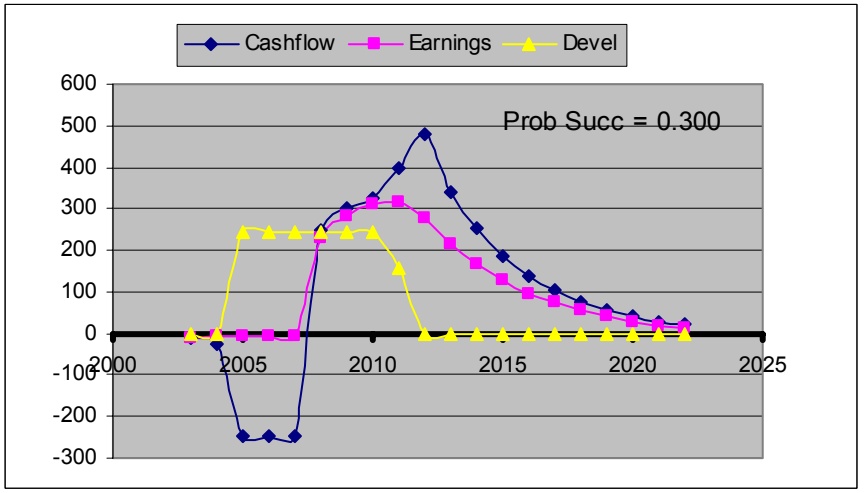
Investment Opportunities

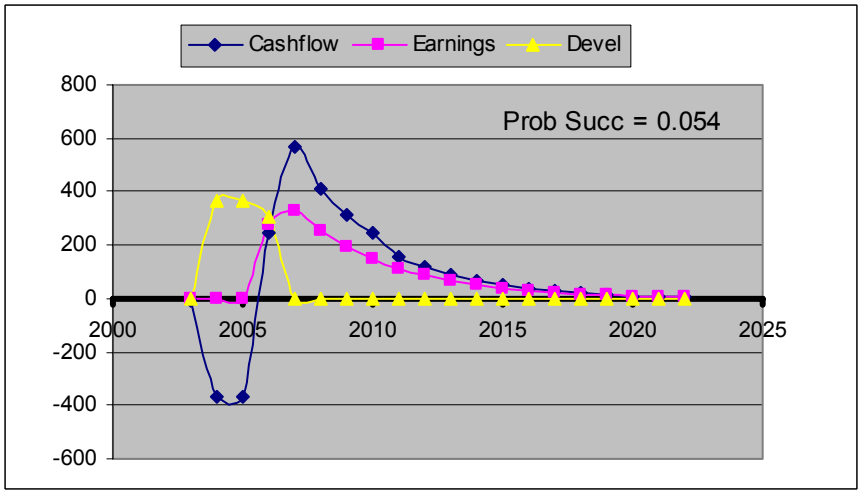
- Projects where you have an opportunity to invest capital with estimated, but uncertain, profitable returns in the future.
- Example here: Exploration Projects

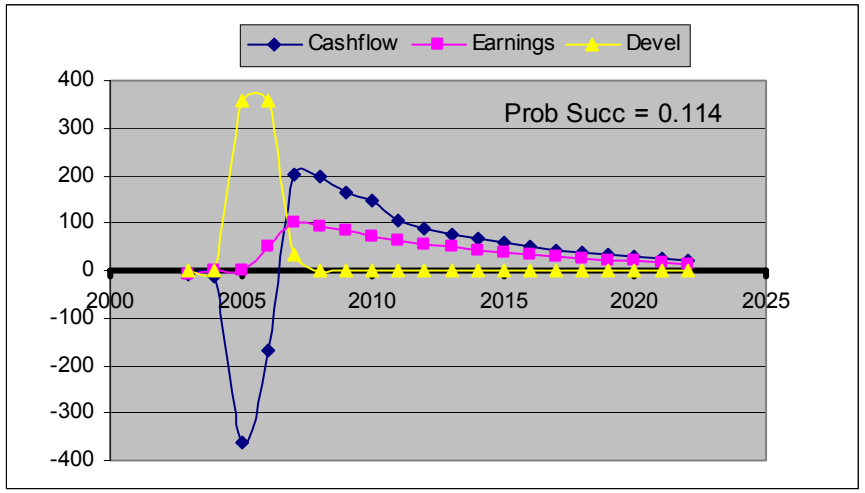


Types of Projects available to fund in this example

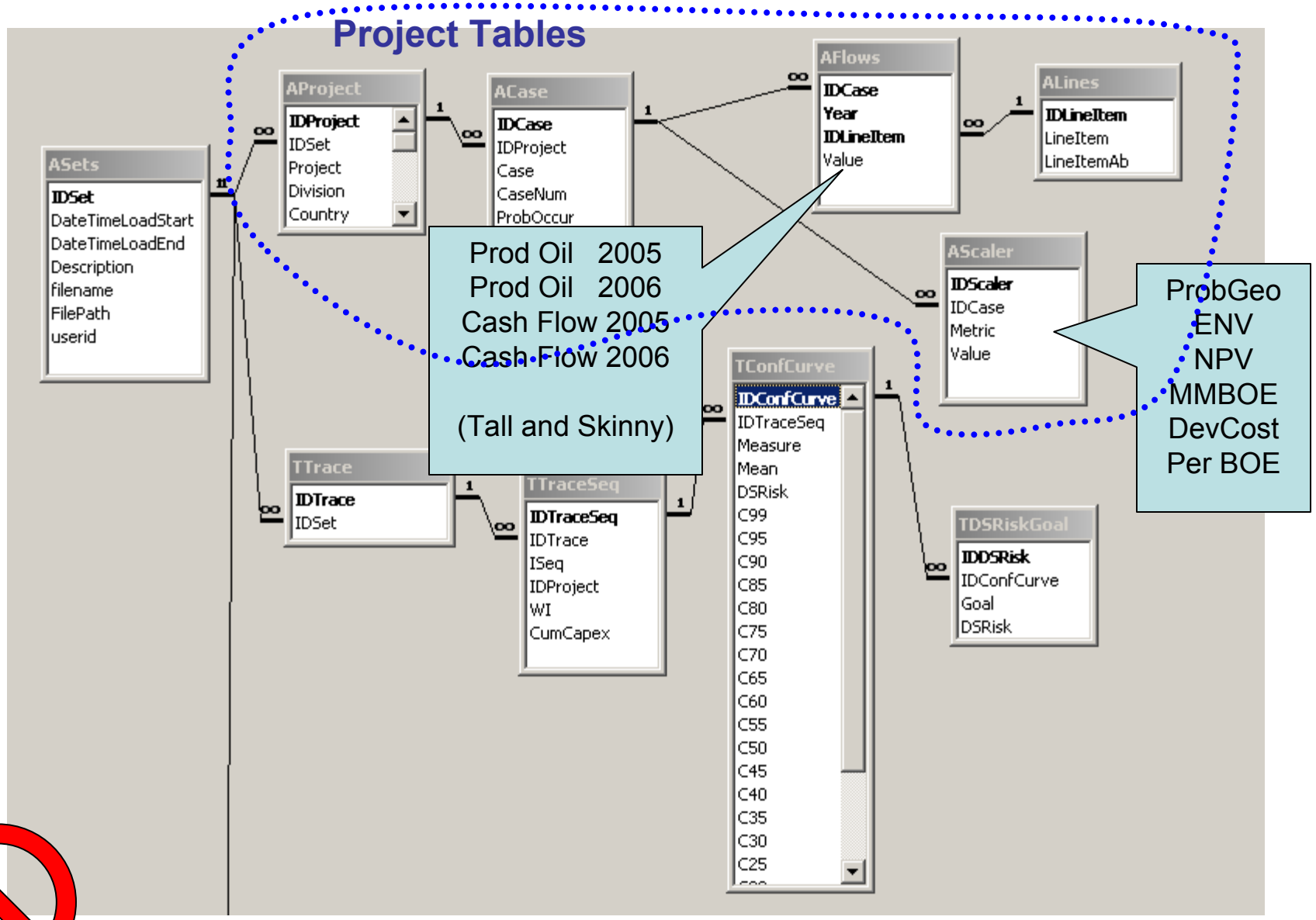




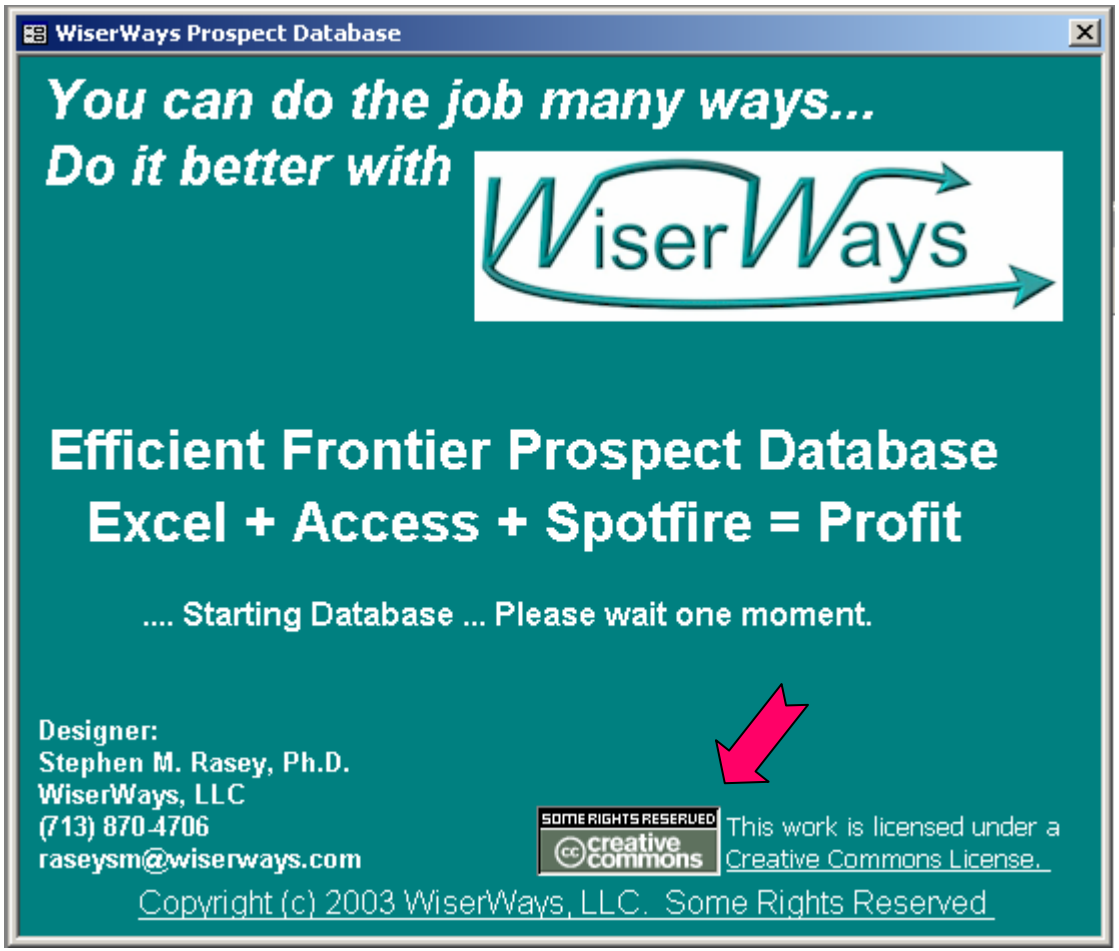




Data Base Schema (Projects)



Use the Access Database to prepare Queries for Spotfire

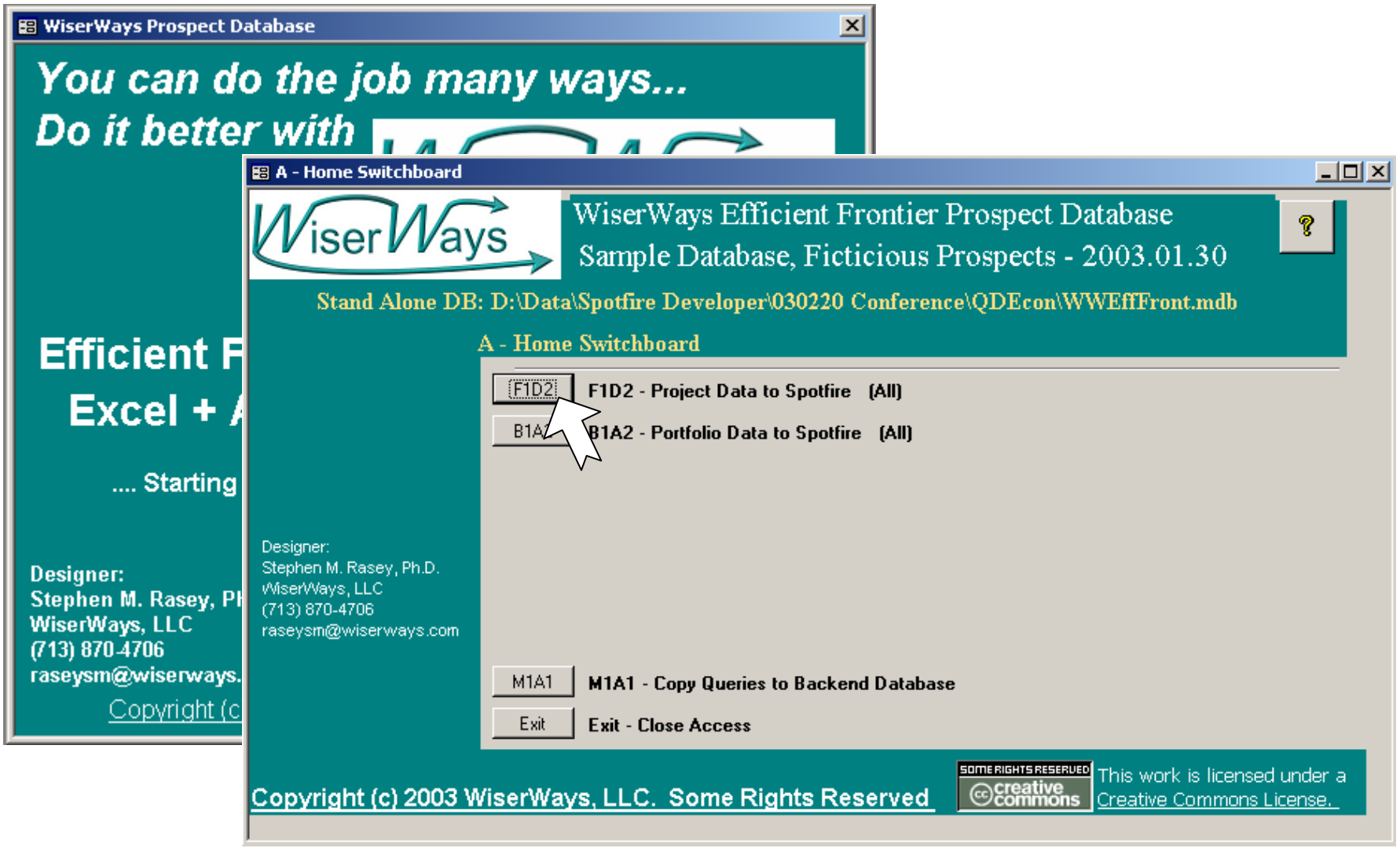


A "Plug" for CreativeCommons.org

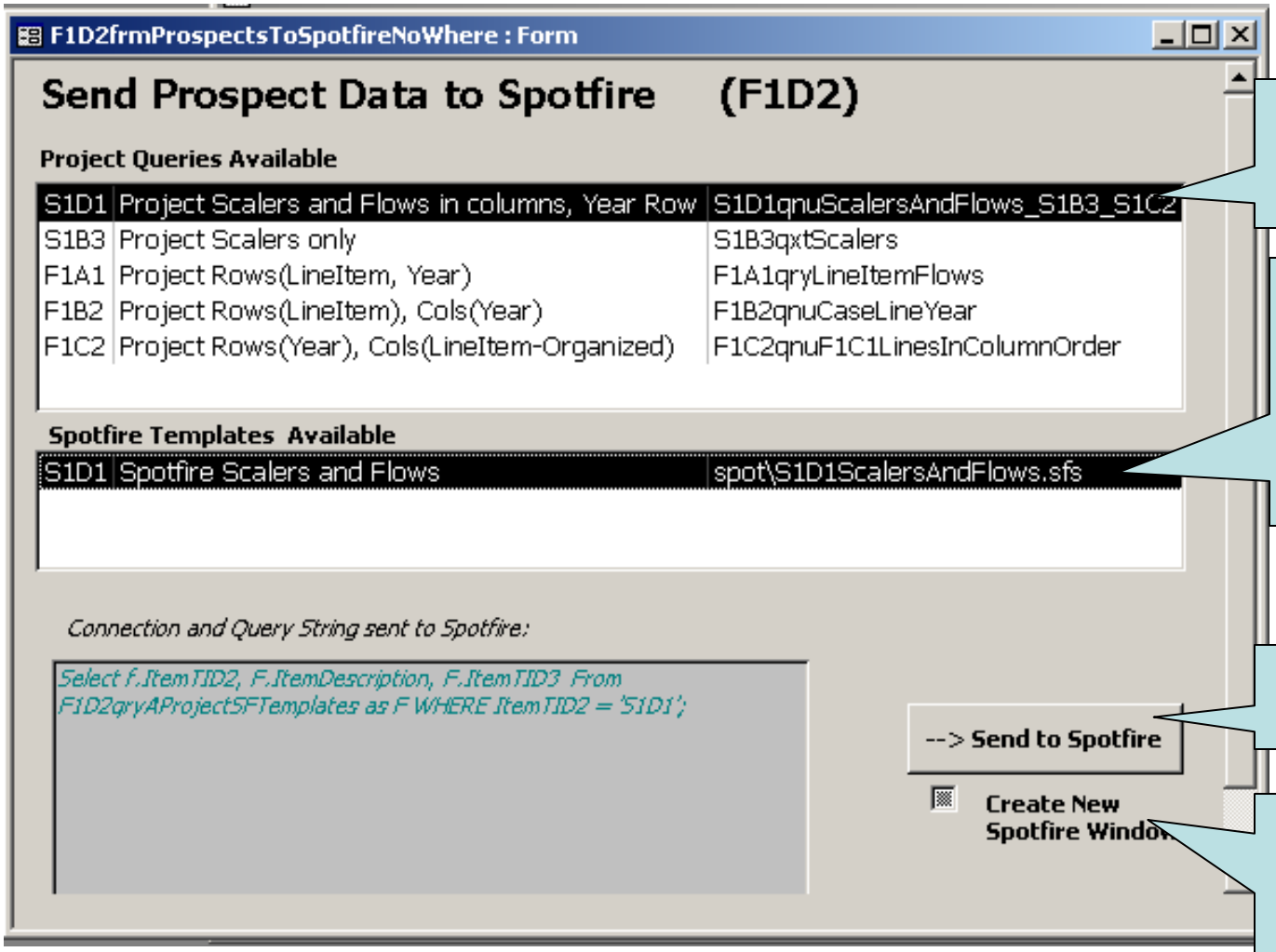
A group trying to bring common sense to copyright practices in a digital age.

I view it as a starting point for "Object Oriented Legal agreements for Copyrights"

Use the Access Database to prepare Queries for Spotfire



F1D2 – Choose Canned Queries to send to Spotfire



Choose the Query

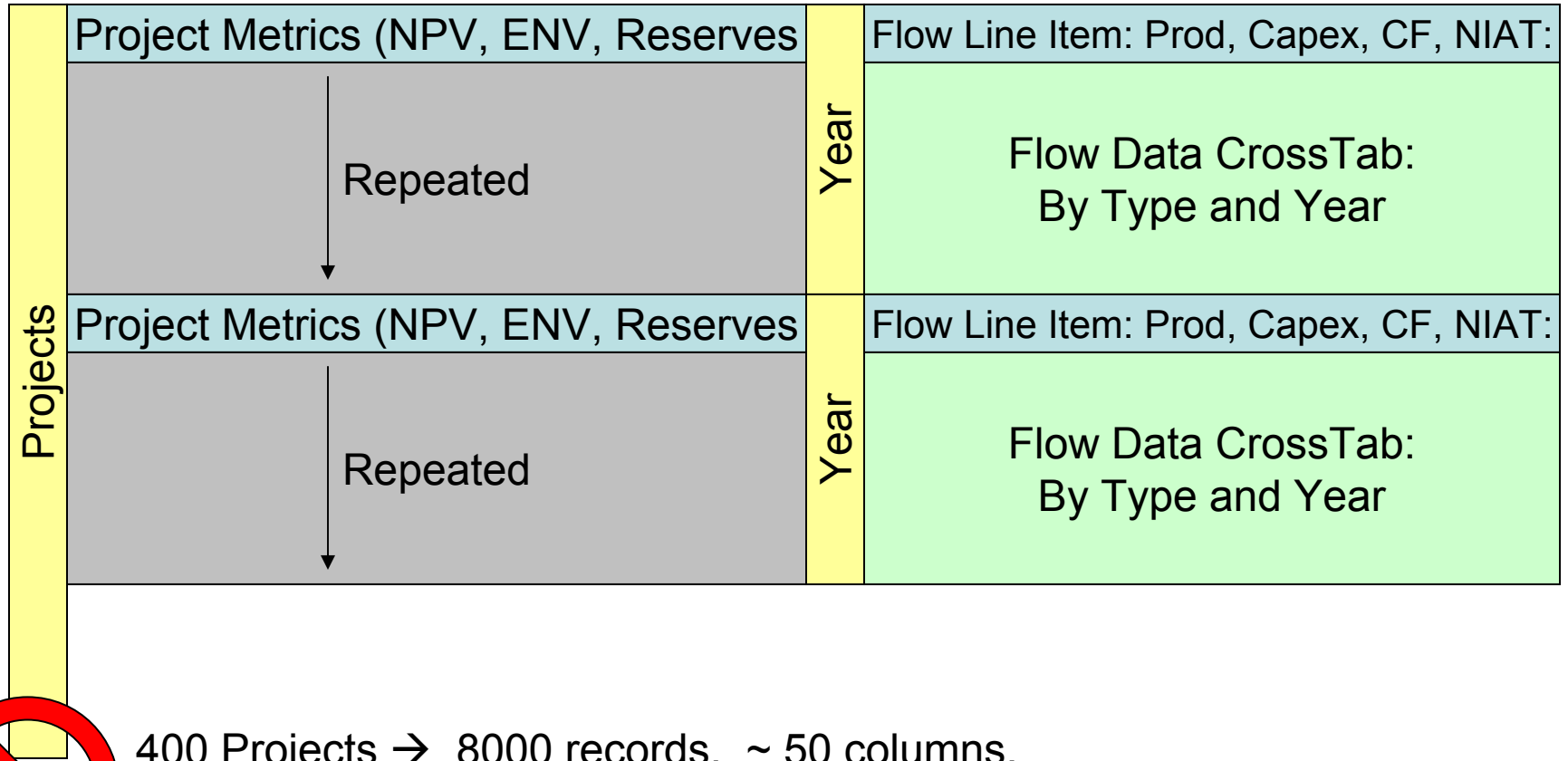
Choose a Spotfire Template that is compatible with the query

Launch the Query

Use an existing instance of Spotfire or create a new one

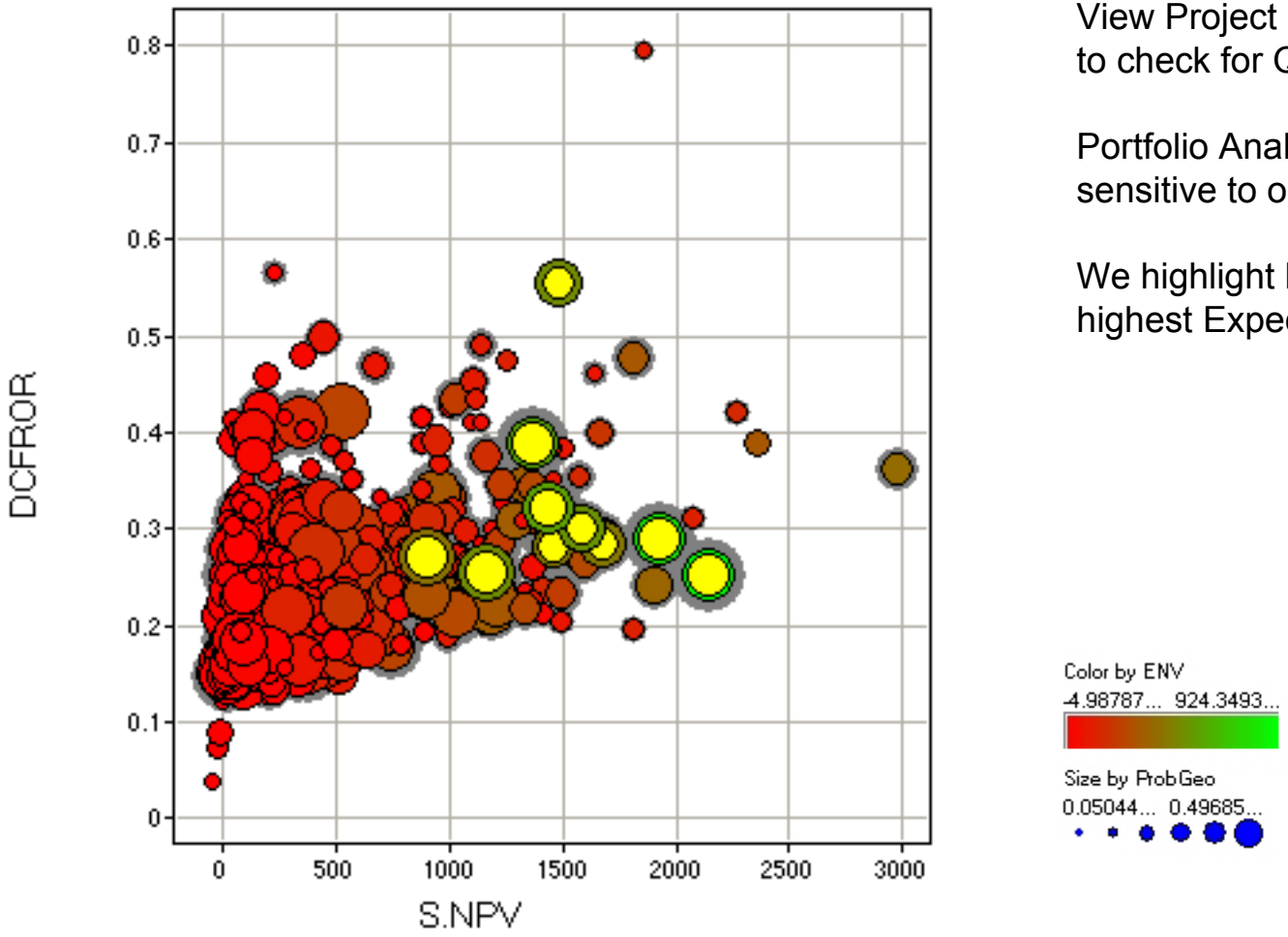
View the Project Metrics and Flows.

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



400 Projects → 8000 records, ~ 50 columns.

ROR vs NPV color:Env Size:Prob

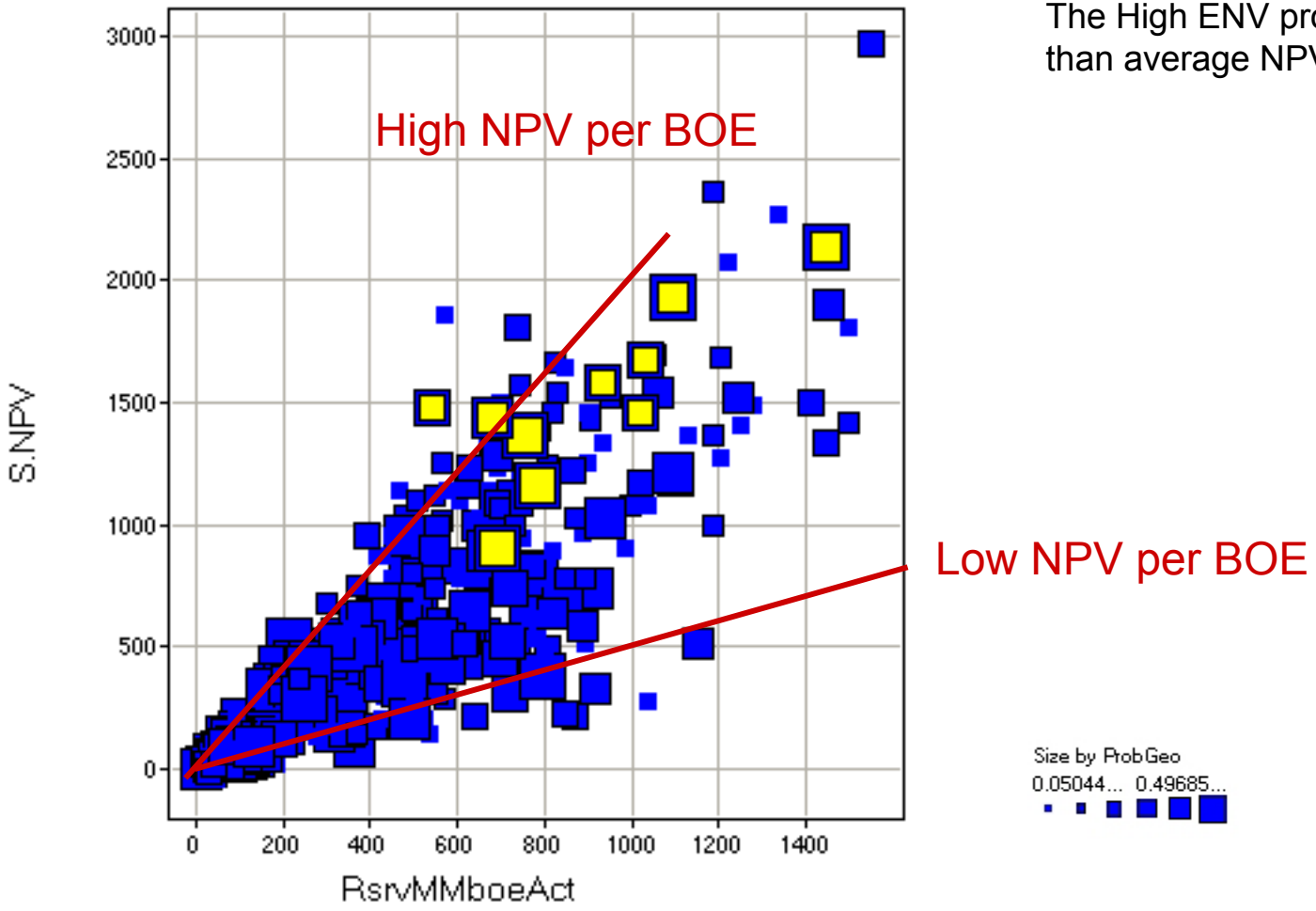


View Project Metrics in the inventory to check for Quality of the input data.

Portfolio Analysis is particularly sensitive to optimistic estimates.

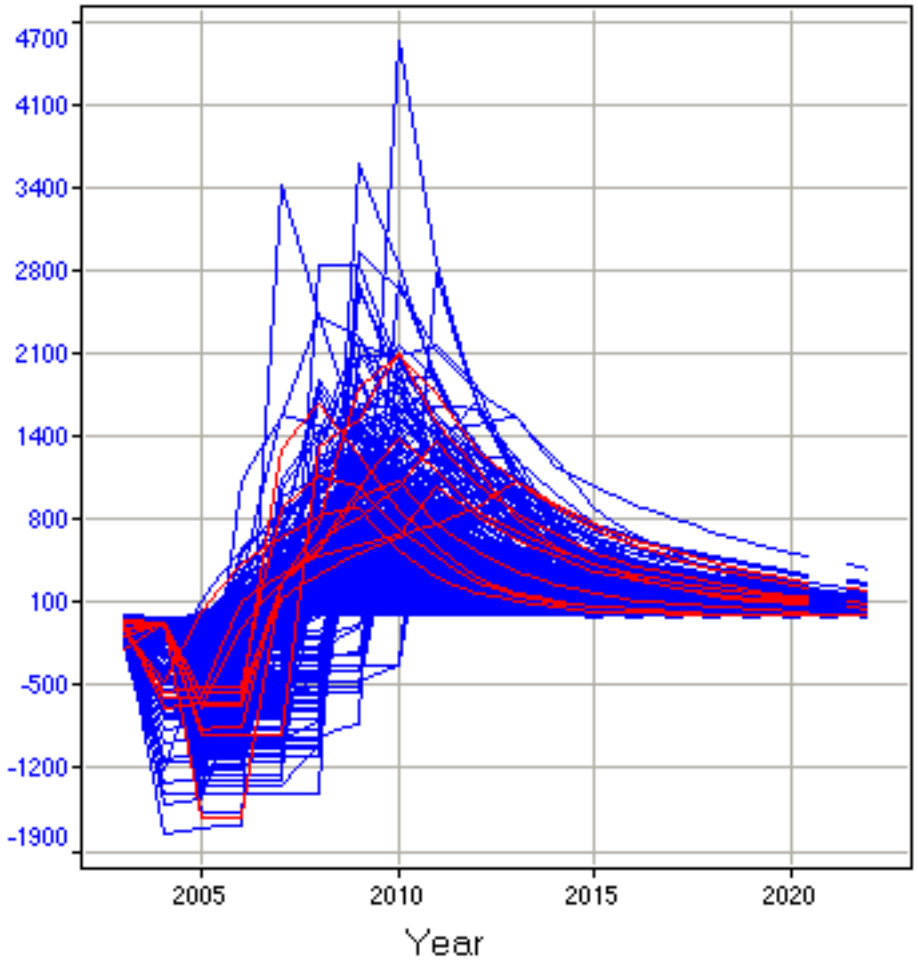
We highlight here 10 project with the highest Expected NPV

NPV vs MMBOE



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

If Success Cash Flow After Tax by year



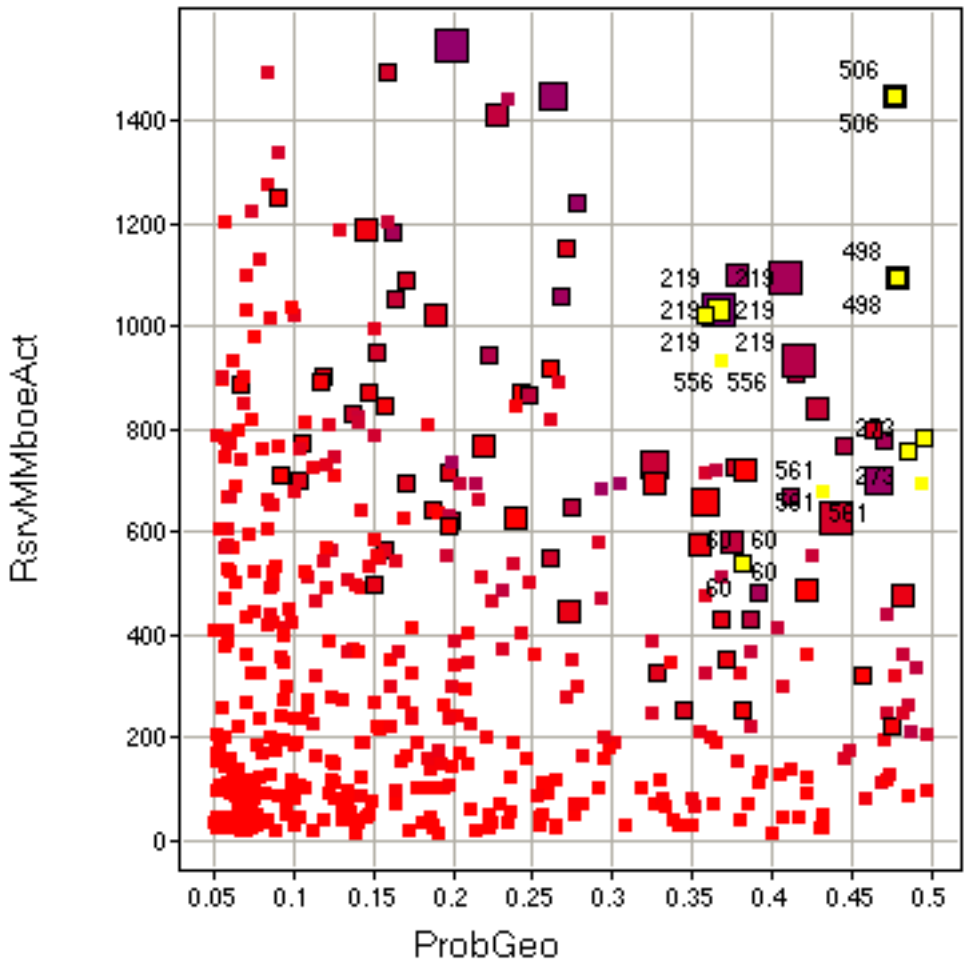
A Line Chart is a much better way to show theFlow data.

All columns use individual scales.

CashFlow

Markers are connected by IDProject, and ordered by Year.

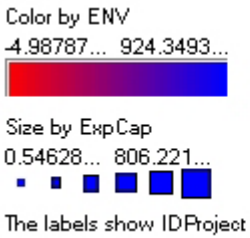
MMBOE vs ProbGeo



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.

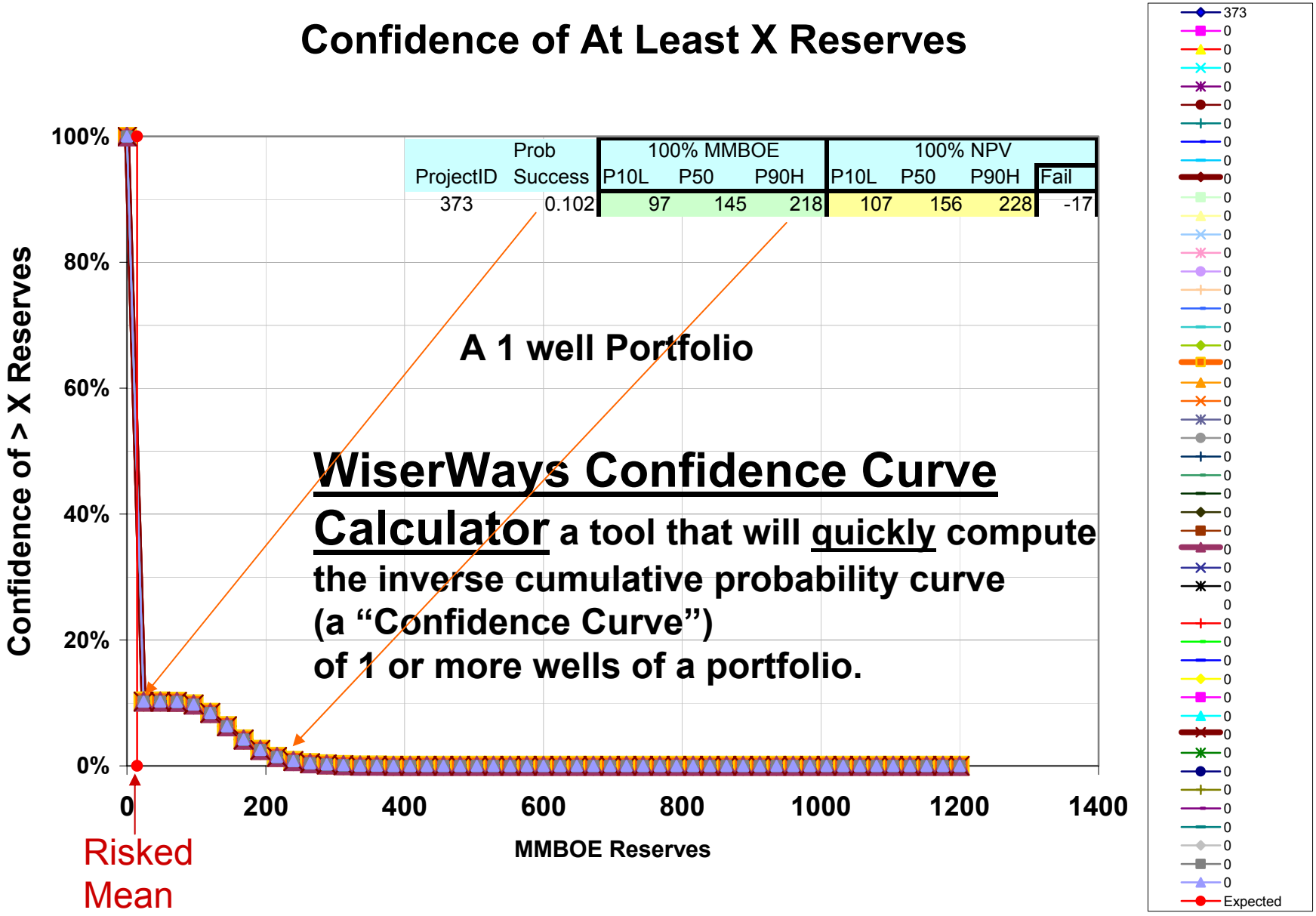


Building a Candidate Portfolio

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

More ↓

Confidence of At Least X Reserves



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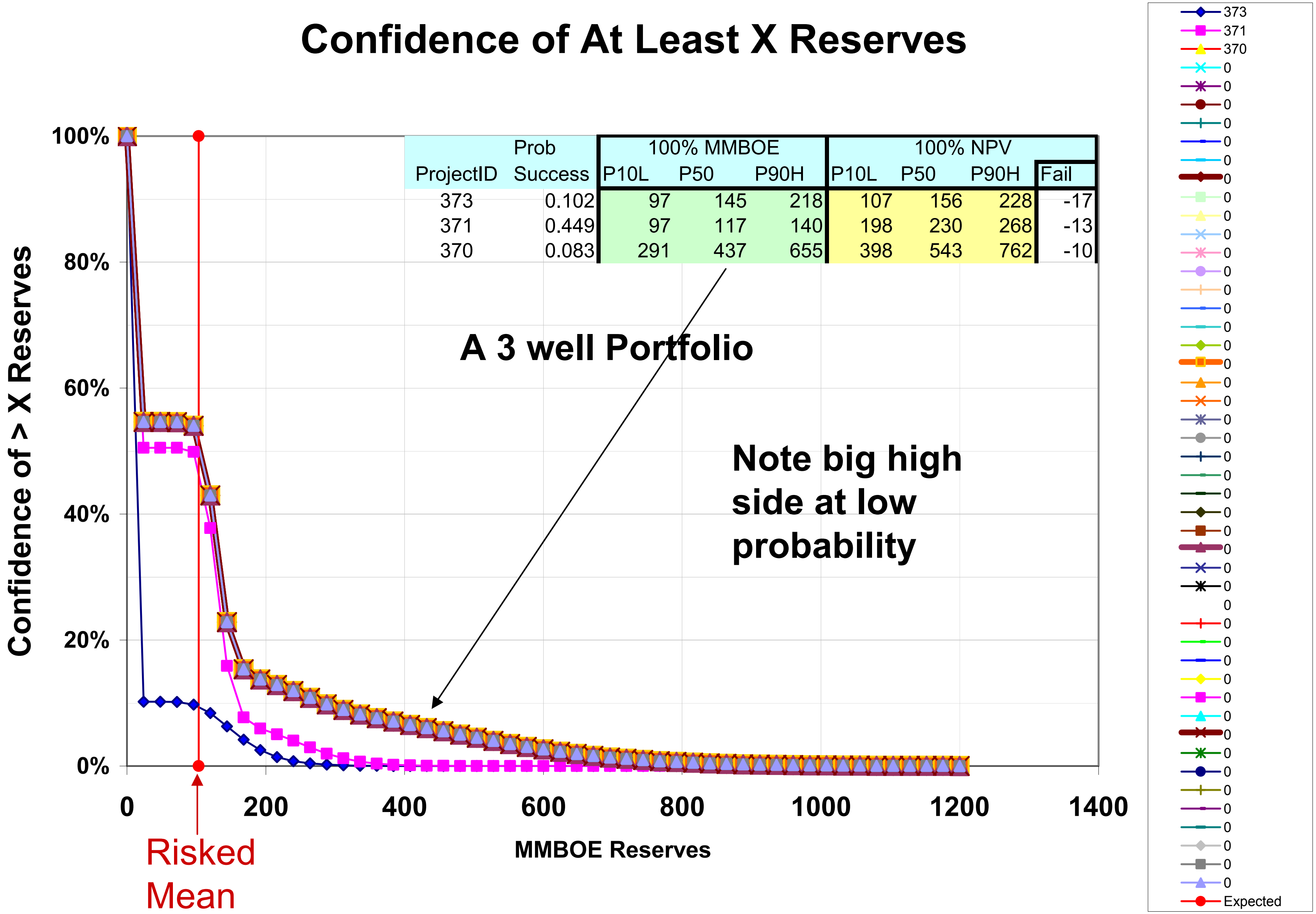

ProjectID	Prob Success	100% MMBOE P10L	100% MMBOE P50	100% MMBOE P90H	100% NPV P10L	100% NPV P50	100% NPV P90H	Fail
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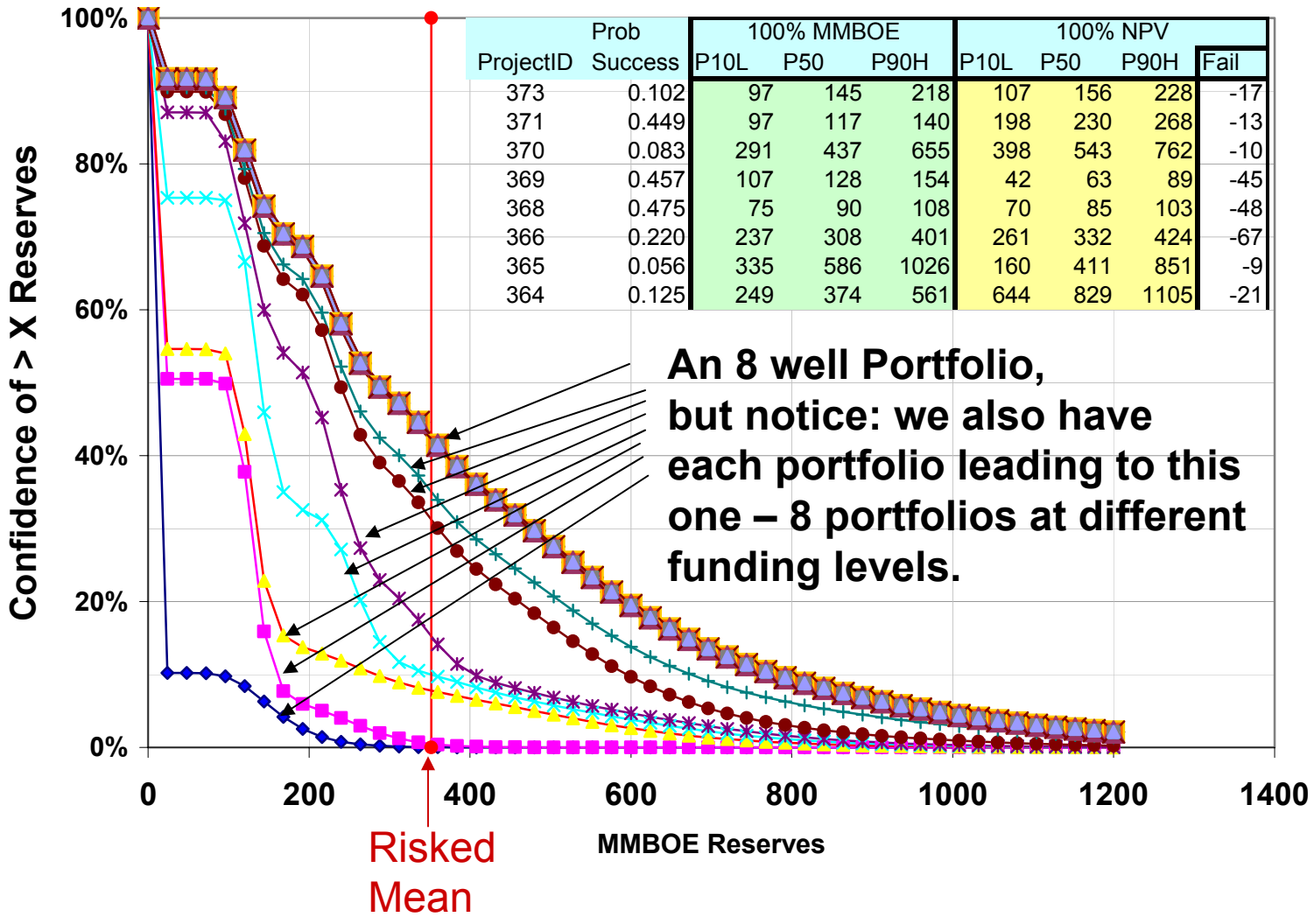
369	0.457	107	128	154	42	63	89	-45
368	0.475	75	90	108	70	85	103	-48
366	0.220	237	308	401	261	332	424	-67
365	0.056	335	586	1026	160	411	851	-9
364	0.125	249	374	561	644	829	1105	-21



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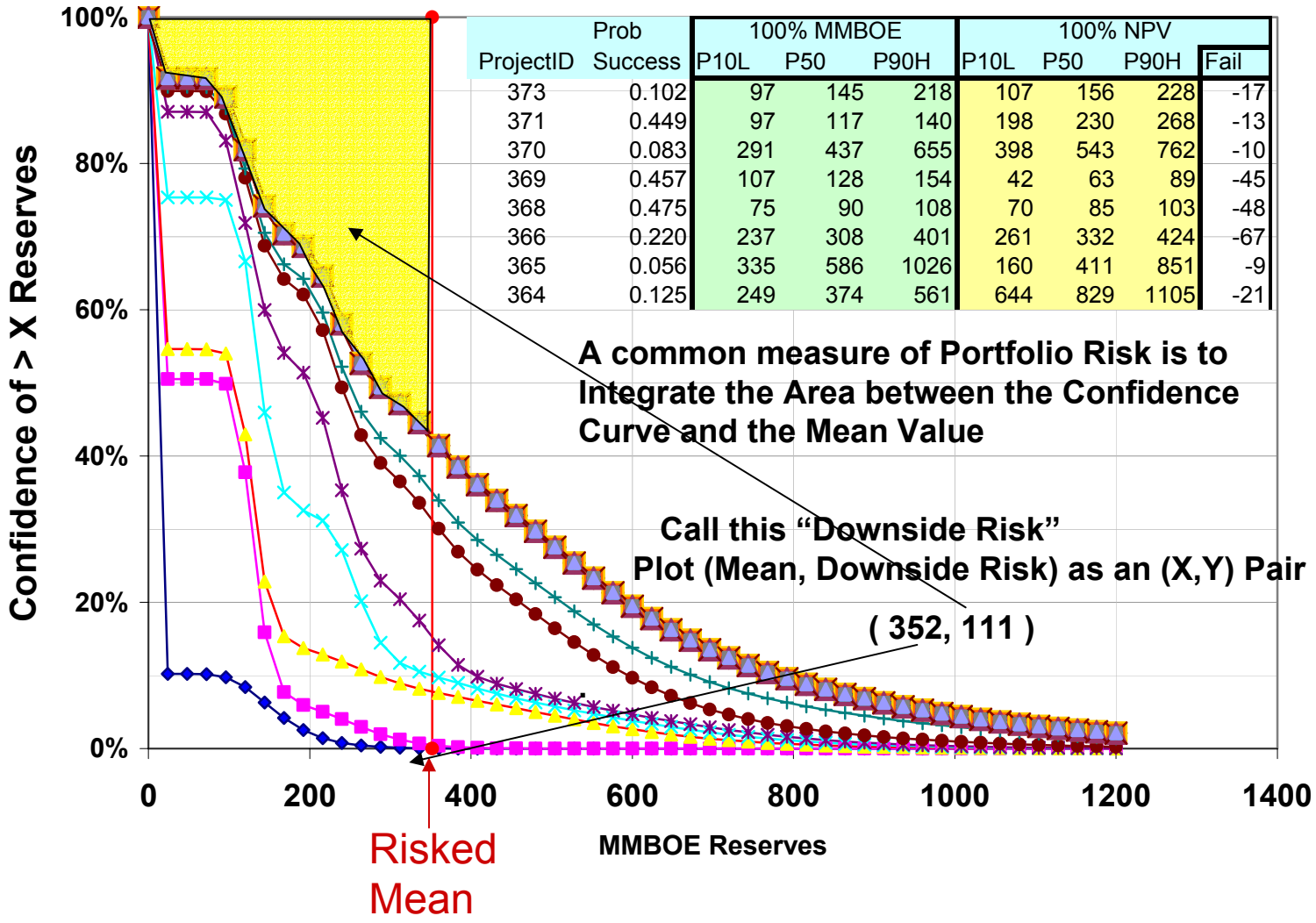
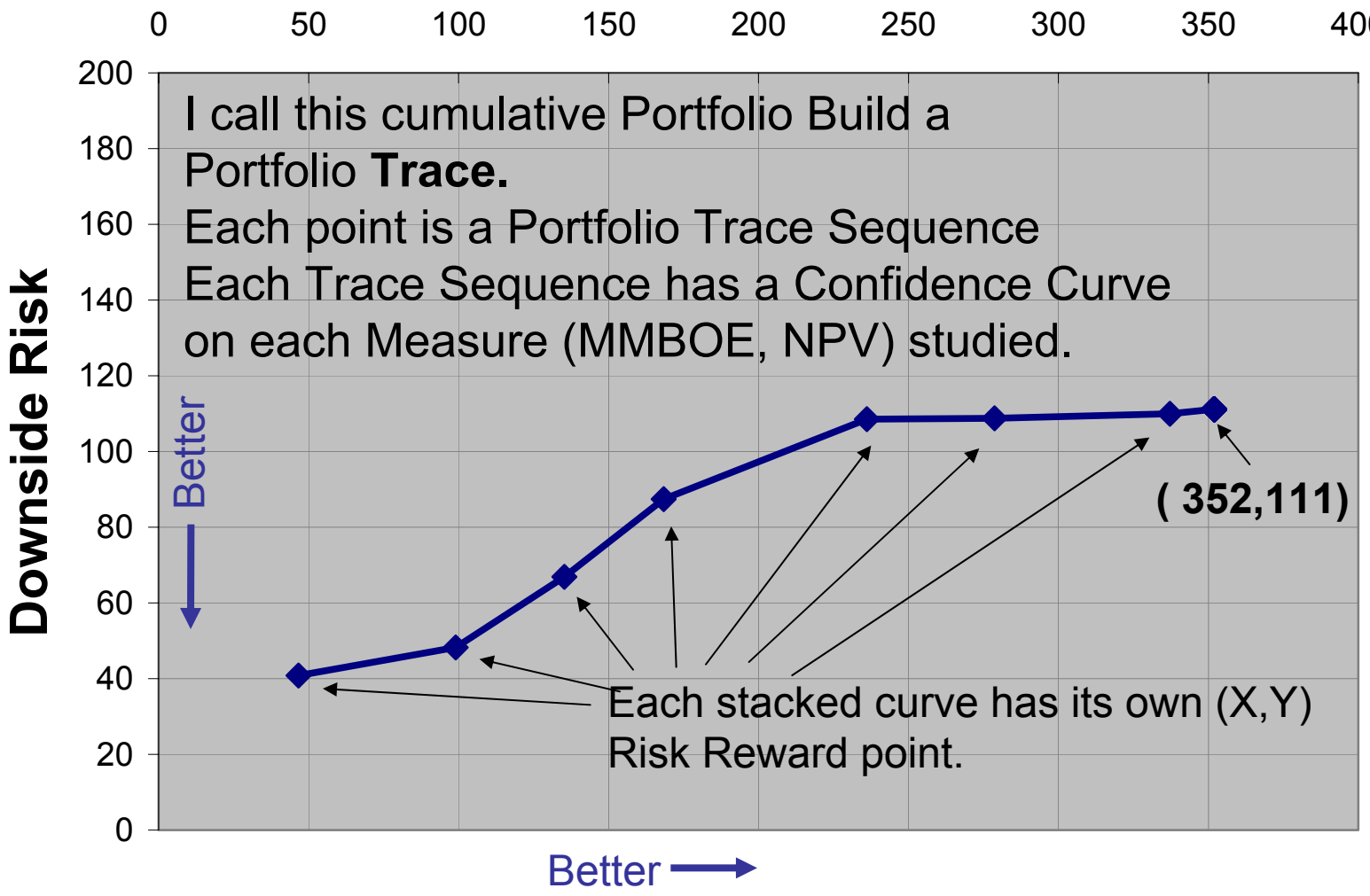
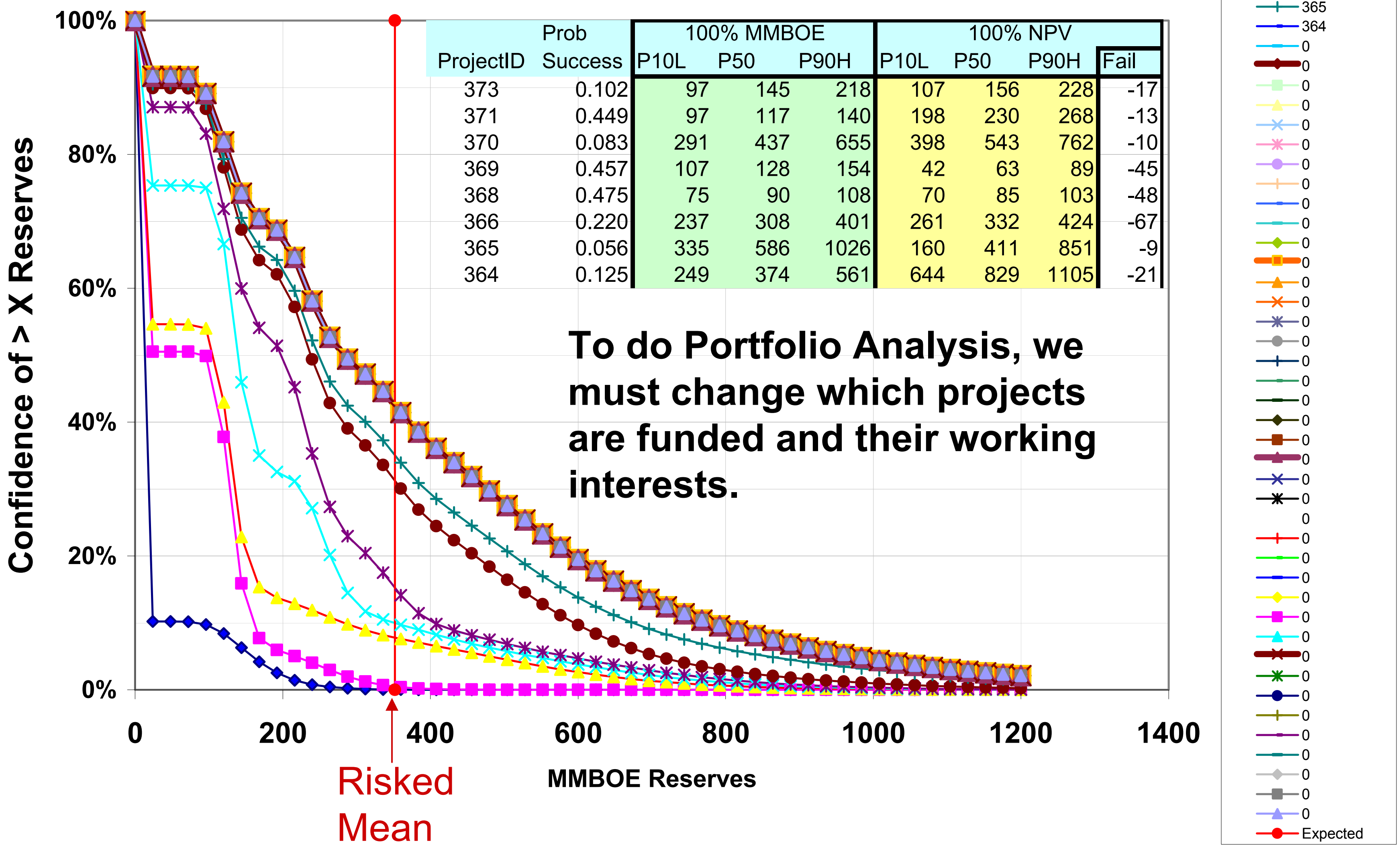


Risk Reward Plot for a Portfolo Trace



Confidence of At Least X Reserves



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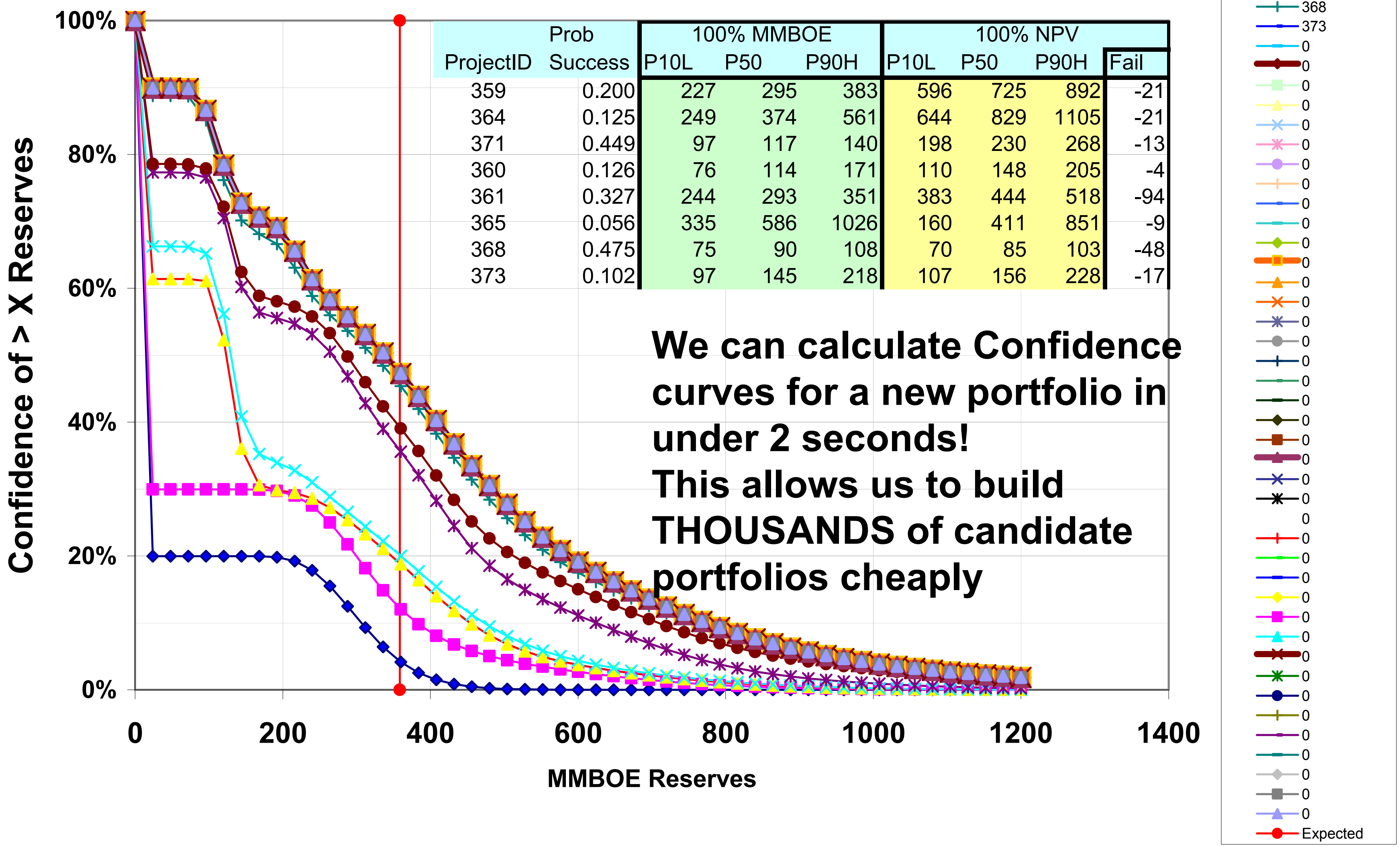
To do Portfolio Analysis, we must change which projects are funded and their working interests.

Confidence of At Least X Reserves



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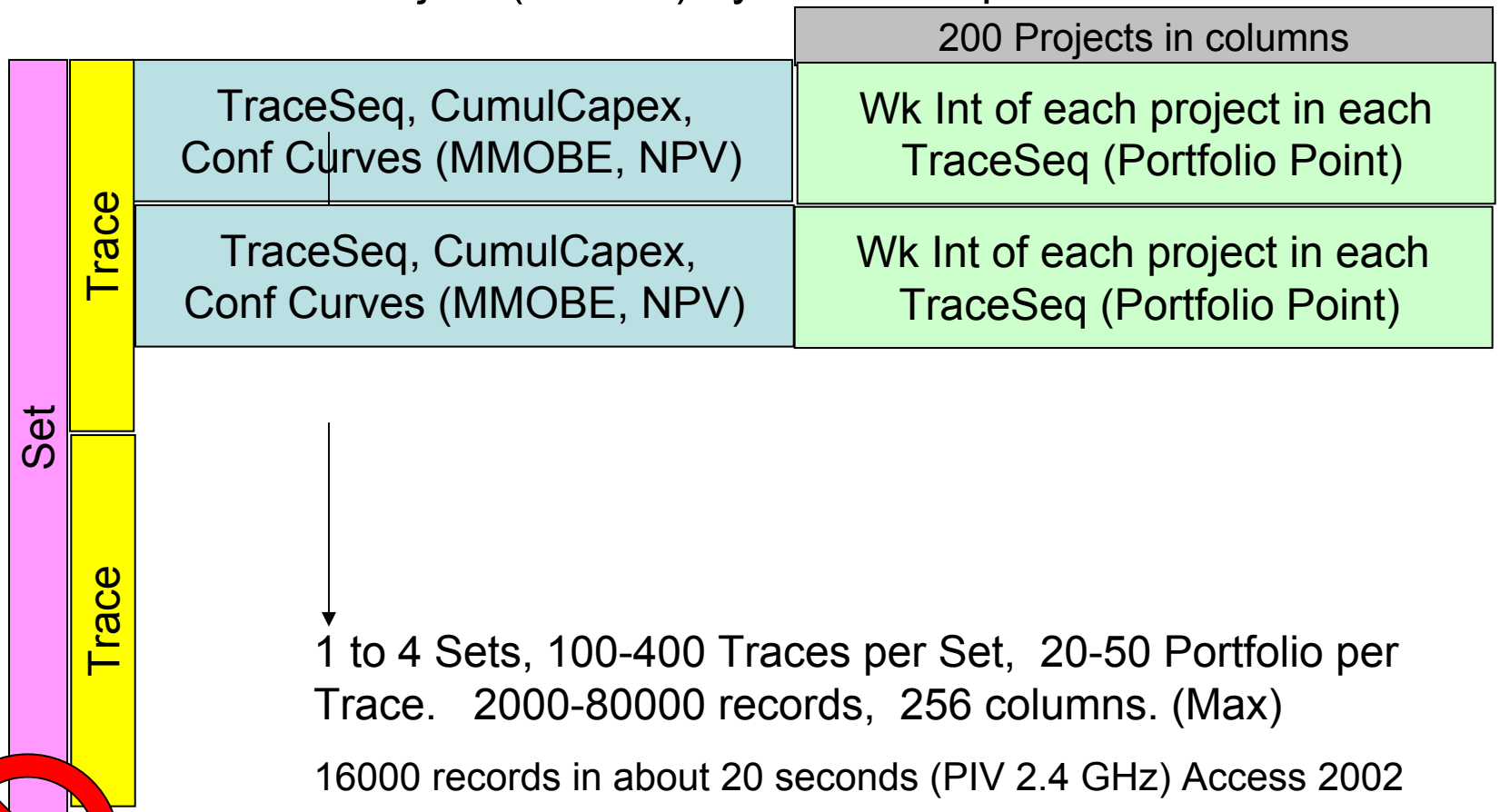
We can calculate Confidence curves for a new portfolio in under 2 seconds!
This allows us to build THOUSANDS of candidate portfolios cheaply

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. (2.4Ghz Pentium IV)
- Confidence Curves calculated directly without simulation
- Available for sale from WiserWays.

View the Portfolio Confidence Curves and Project Funding.

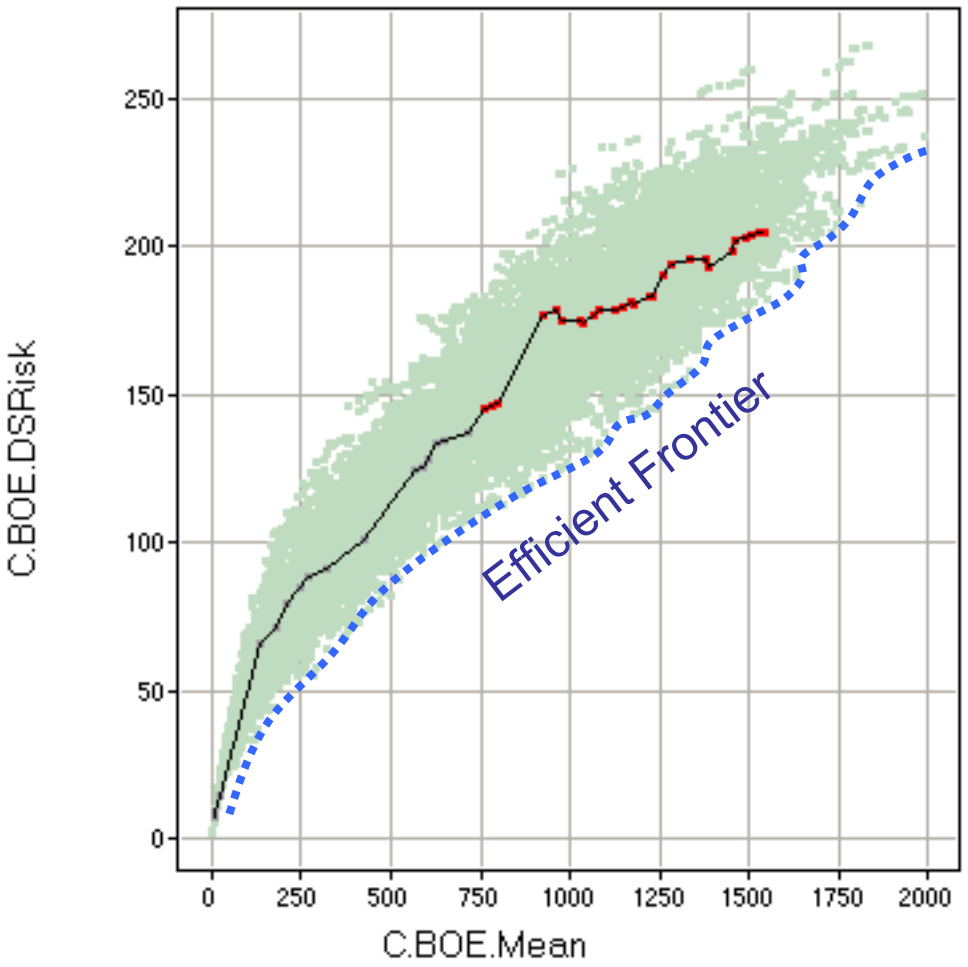
- T1D5 Query: Confidence Curves (MMBOE, NPV) and Funding level Each Project (Wk.Int.) by Trace Sequence Number



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 GHz) Access 2002

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.

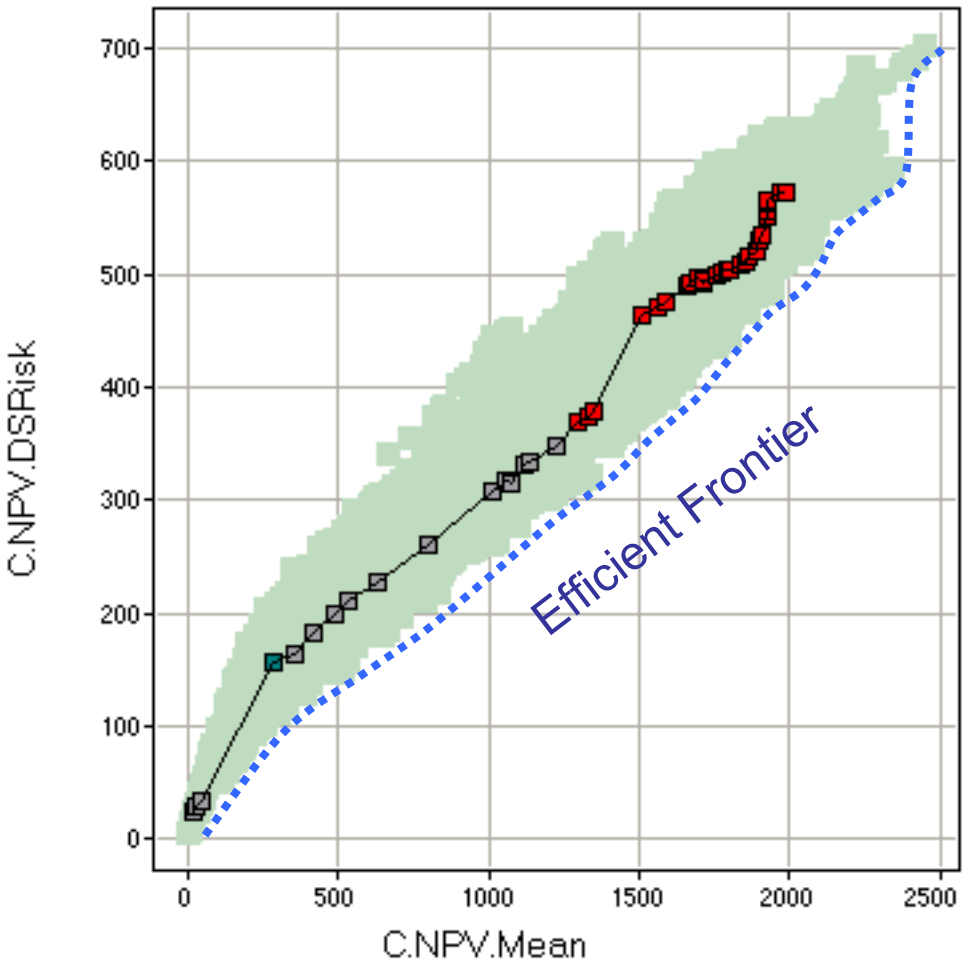
These portfolios are not particularly close to the Efficient Frontier.

Color by 422

- 0.333333343267441
- 0.5
- 1
- (Empty)

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

NPV Risk Reward (Scatter Plot), Trace 602



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

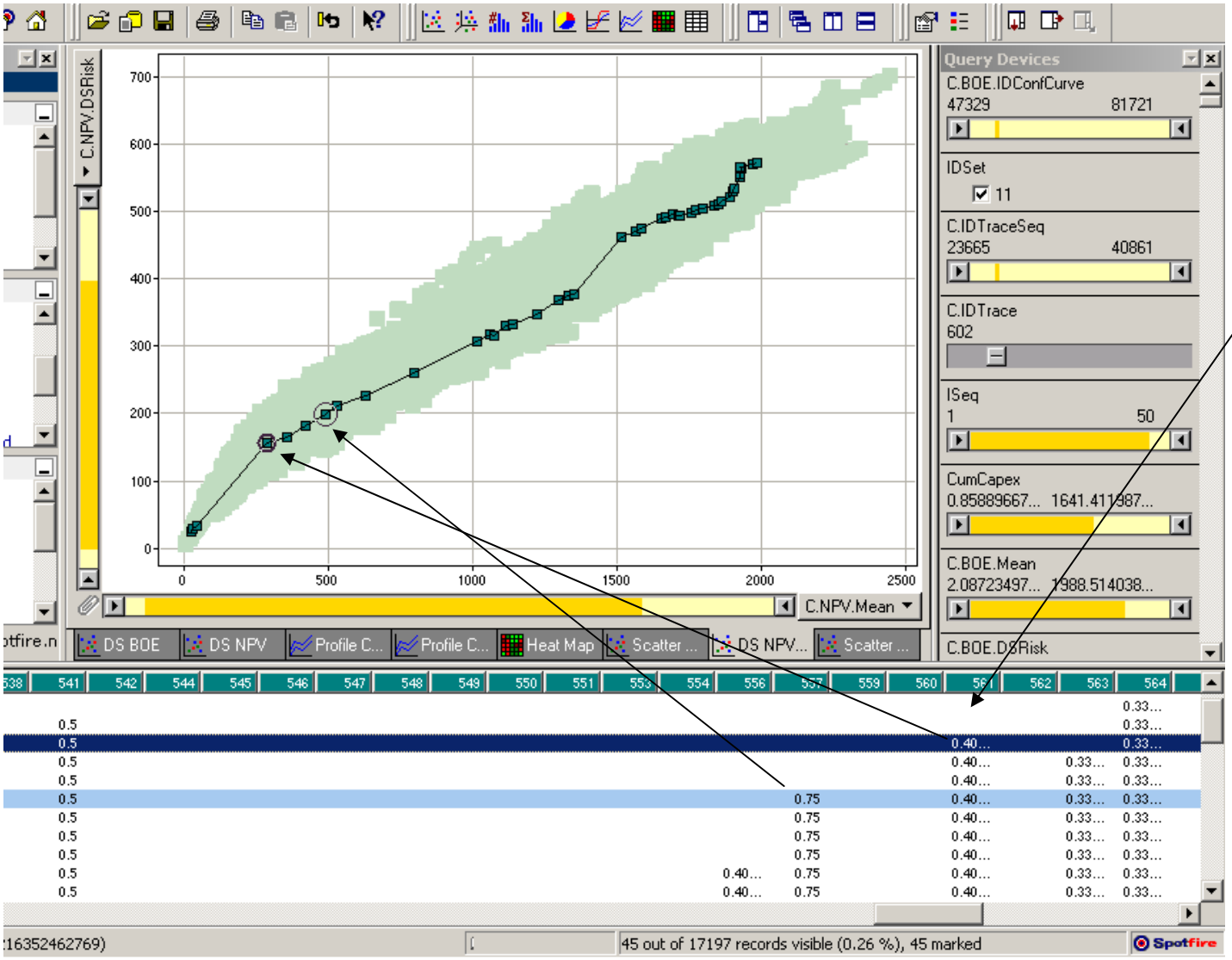
Also showing just the portfolios along Trace number 602 against a background of all portfolio points (Shown deselected).

Color by 422

- 0.333333343267441
- 0.5
- 1
- (Empty)

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

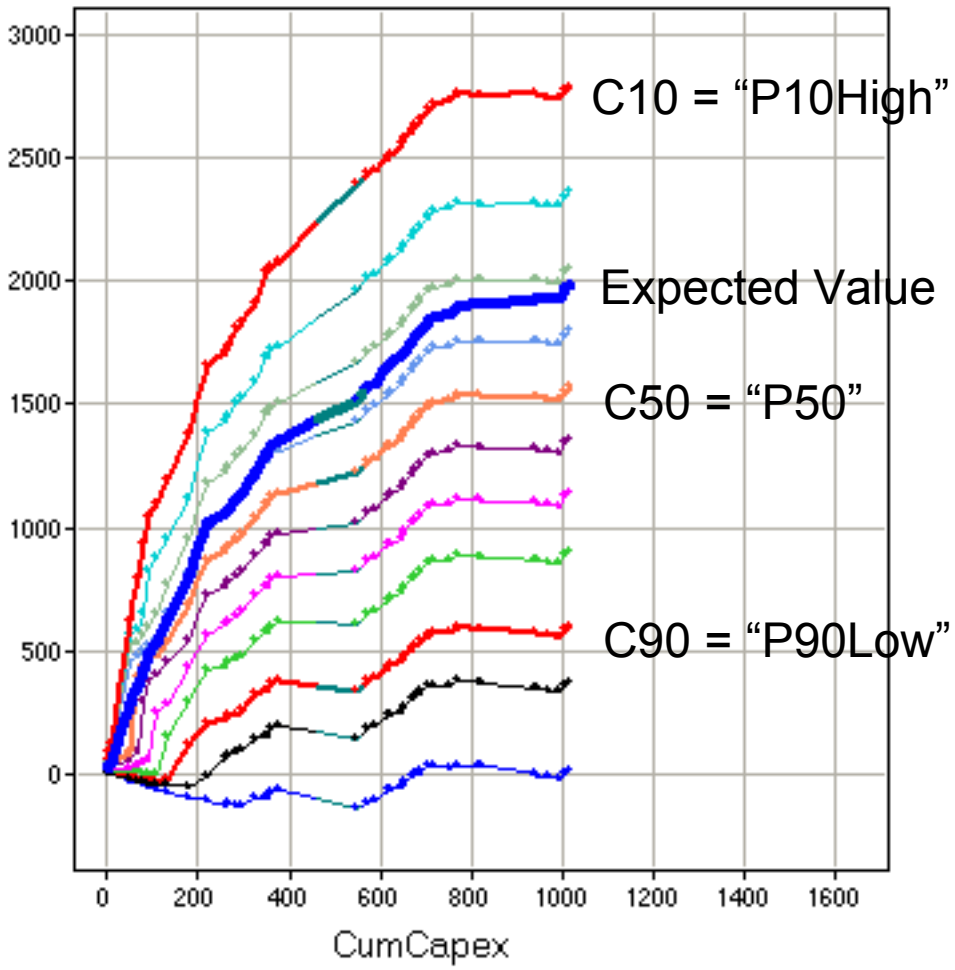
NPV Risk Reward, Trace 602, with Details of Project WI



Trace 602 Shown

Spotfire's **Details on Demand** shows you the working interest of each project (a column) in a portfolio (row)

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 projects are funded.

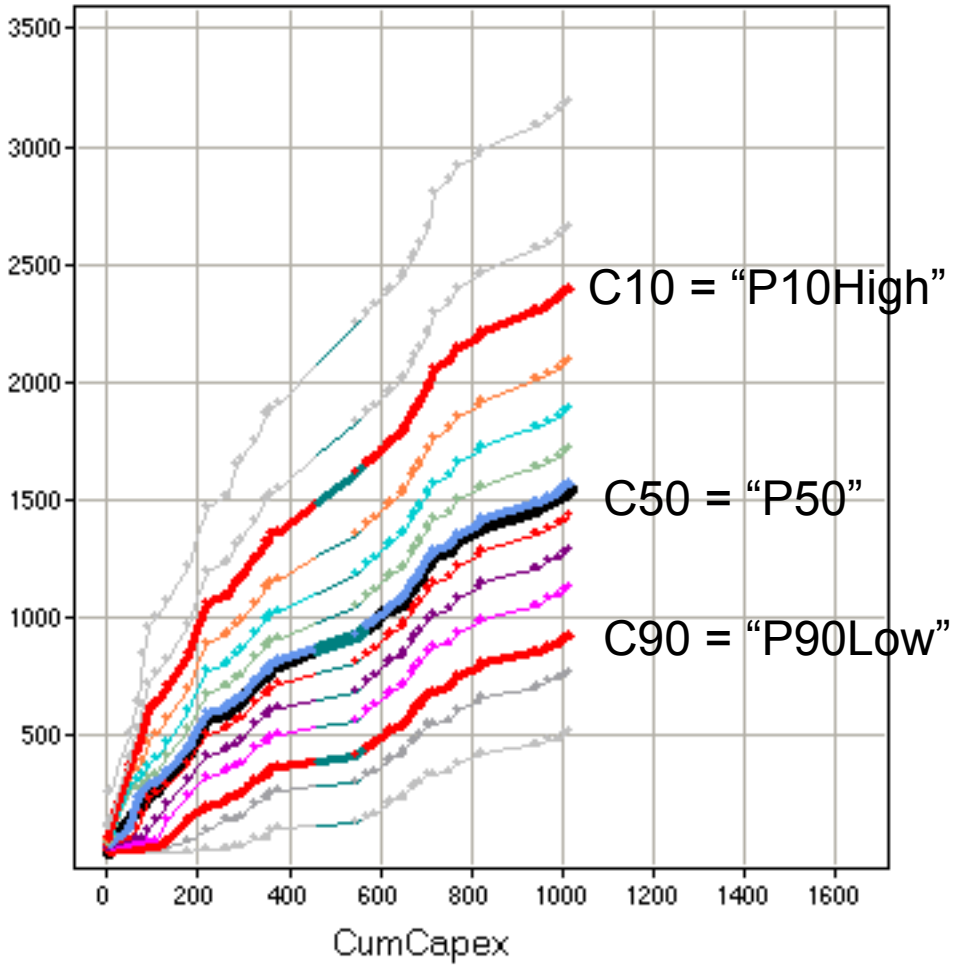
This Metric is Portfolio NPV

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.

MMBOE Prob by Cumul Capex



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

Here we display each Confidence Level as more projects are funded.

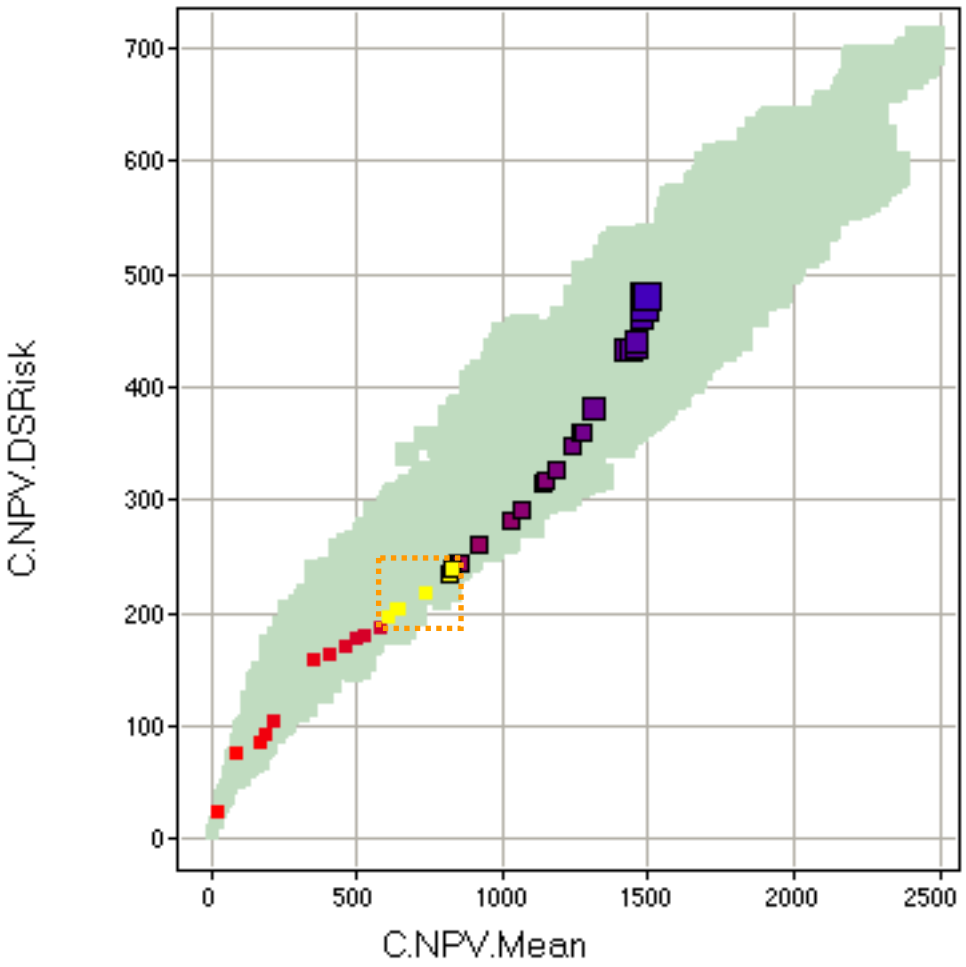
This Metric is Portfolio MMBOE

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

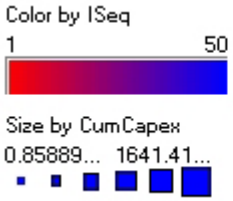
Markers are connected by C.IDTrace, and ordered by CumCapex.

NPV Risk Reward -Trace 616

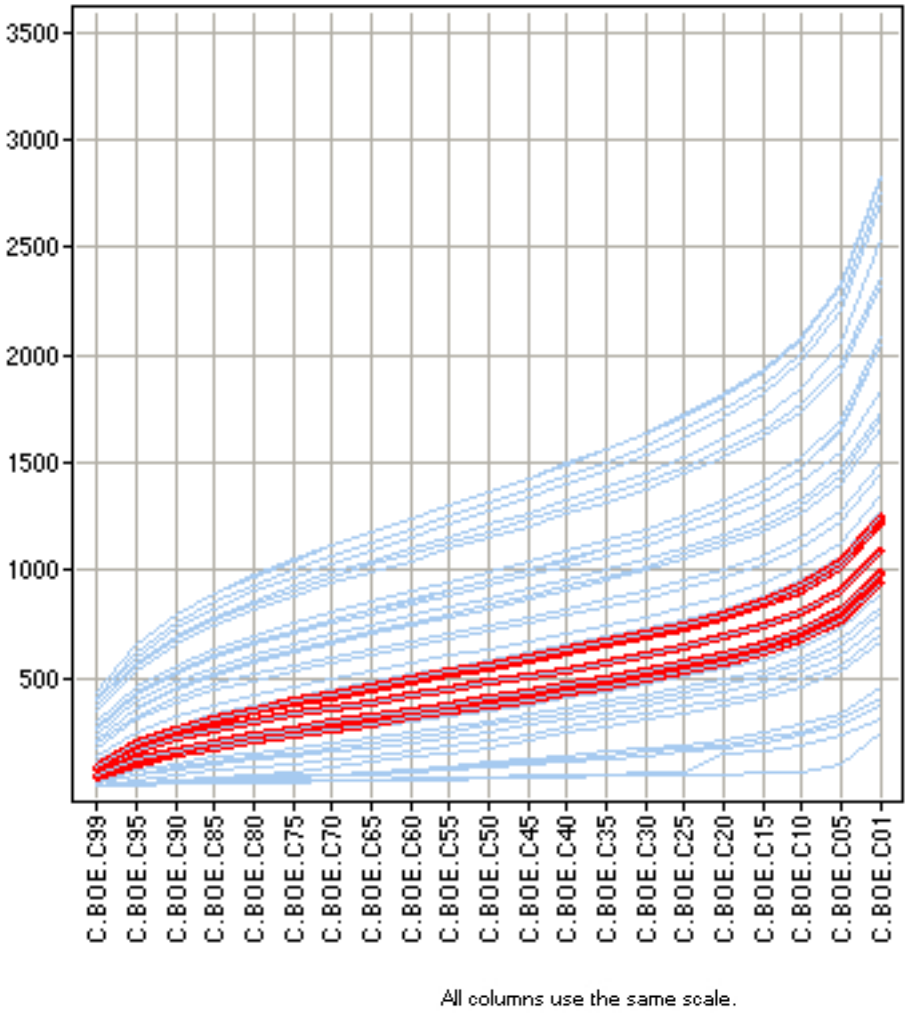


Also pretty close to the NPV efficient Frontier

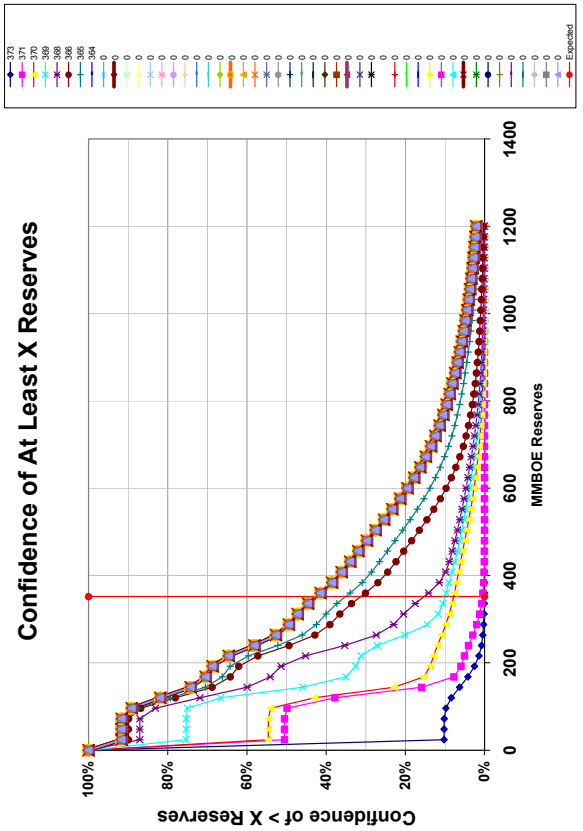
We mark 7 portfolios near the efficient frontier



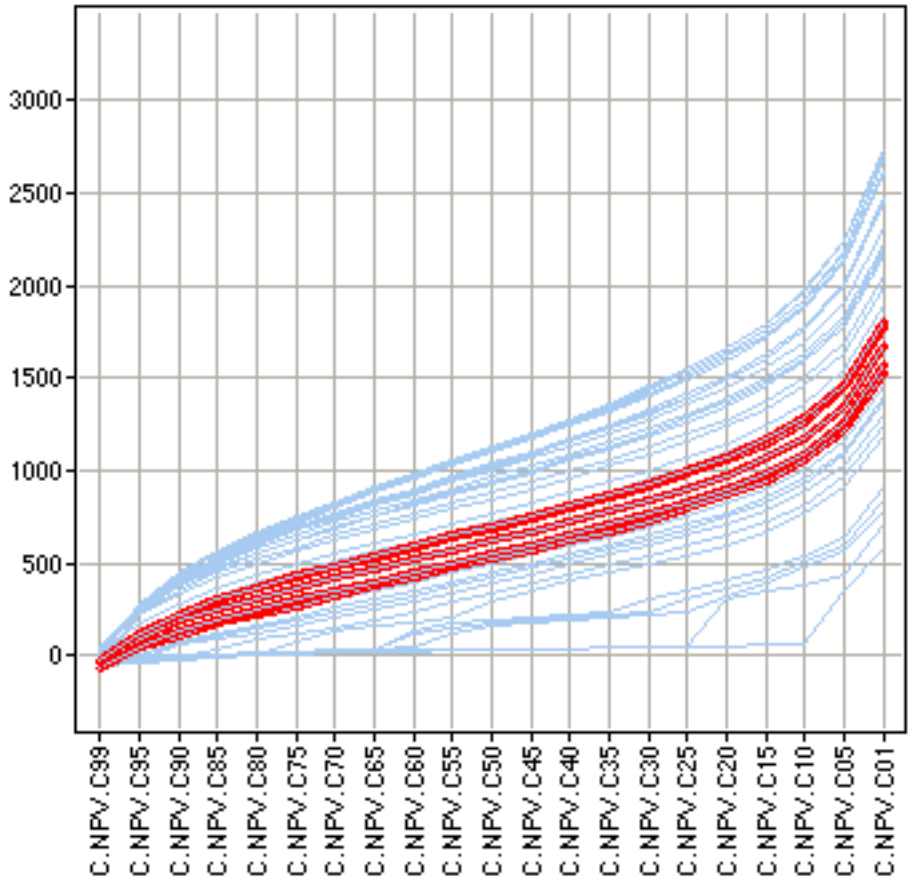
MMBOE Confidence Curve - Profile Chart - Trace 616



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



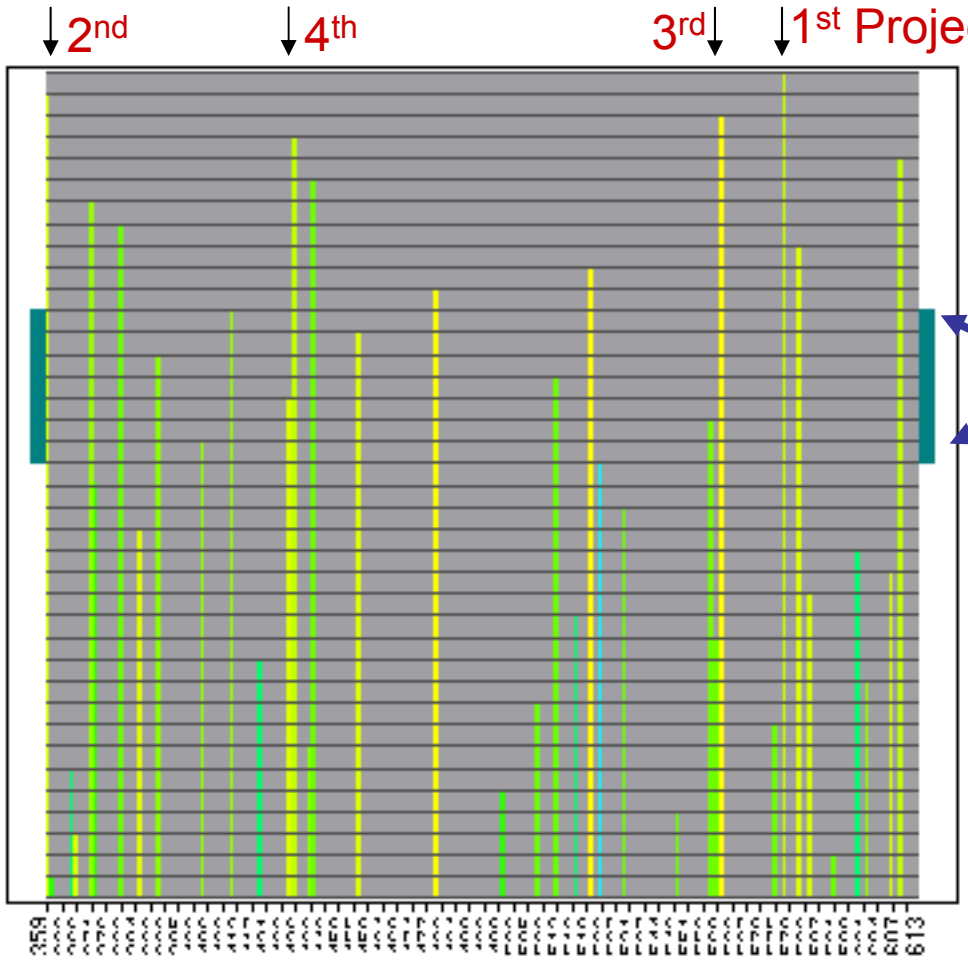
NPV Confidence Curve - Profile Chart - Trace 616



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

All columns use the same scale.

Heat Map Trace 616



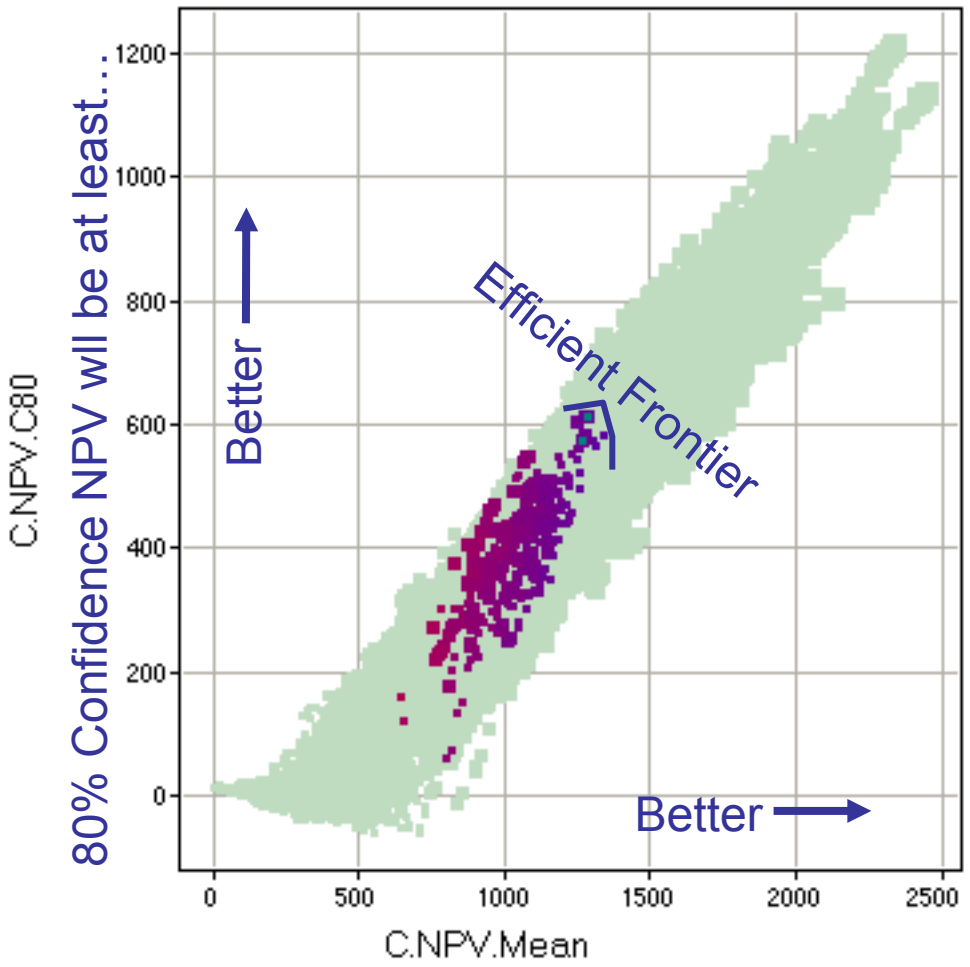
The Heat map shows which projects are funded at each portolio.

The projects funded at the selected portfolios

Increasing Capex

Order by C.IDTraceSeq

You can use any measure of risk

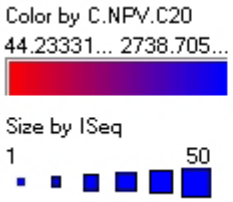


80% Confidence NPV vs Mean NPV.

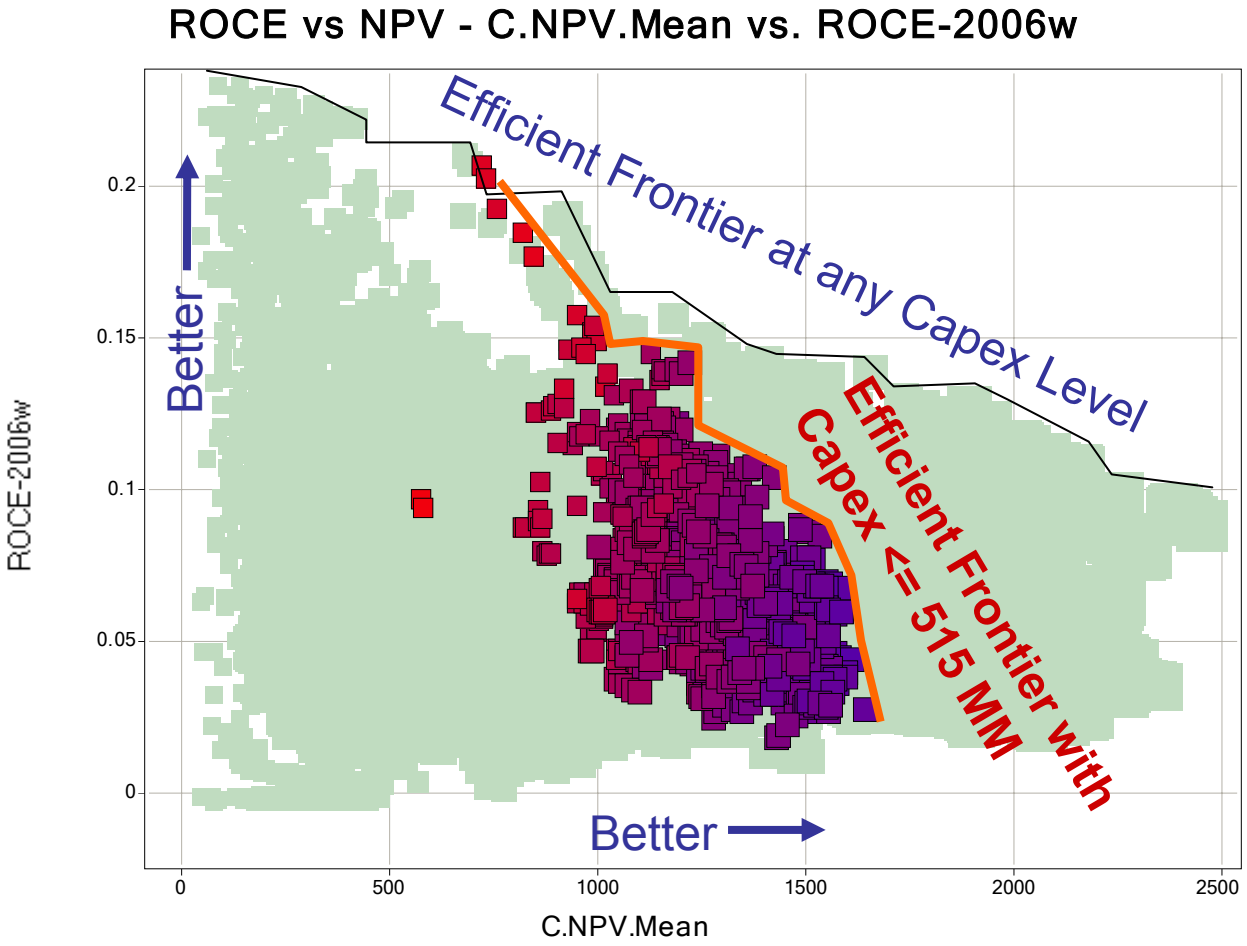
Higher levels of 80% Confidence NPV are better than low levels.

Higher Mean NPV are better than Lower Means.

The Efficient Frontier is where you trade one measure for another.



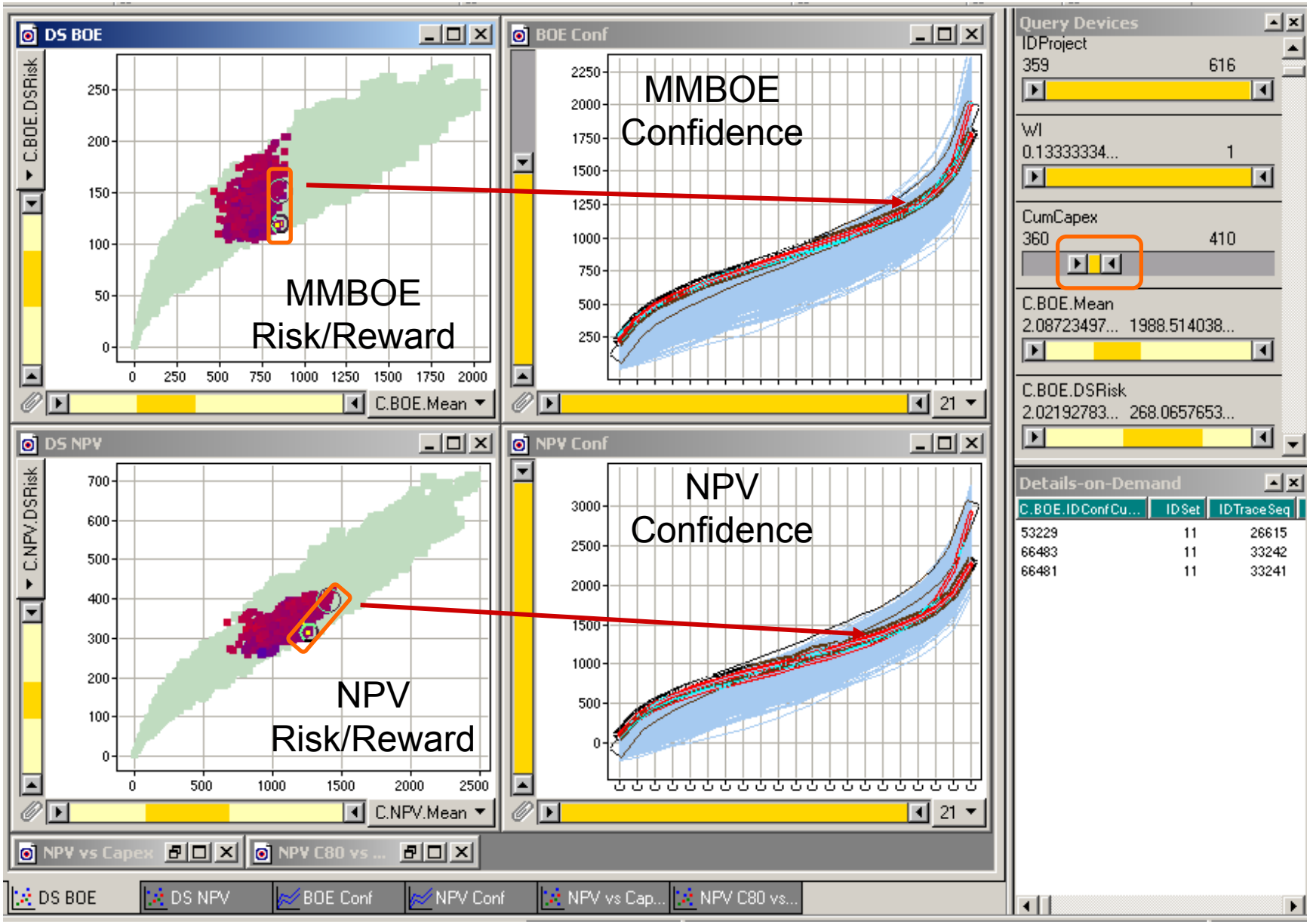
Efficient Frontiers can also compare trade-offs between conflicting goals

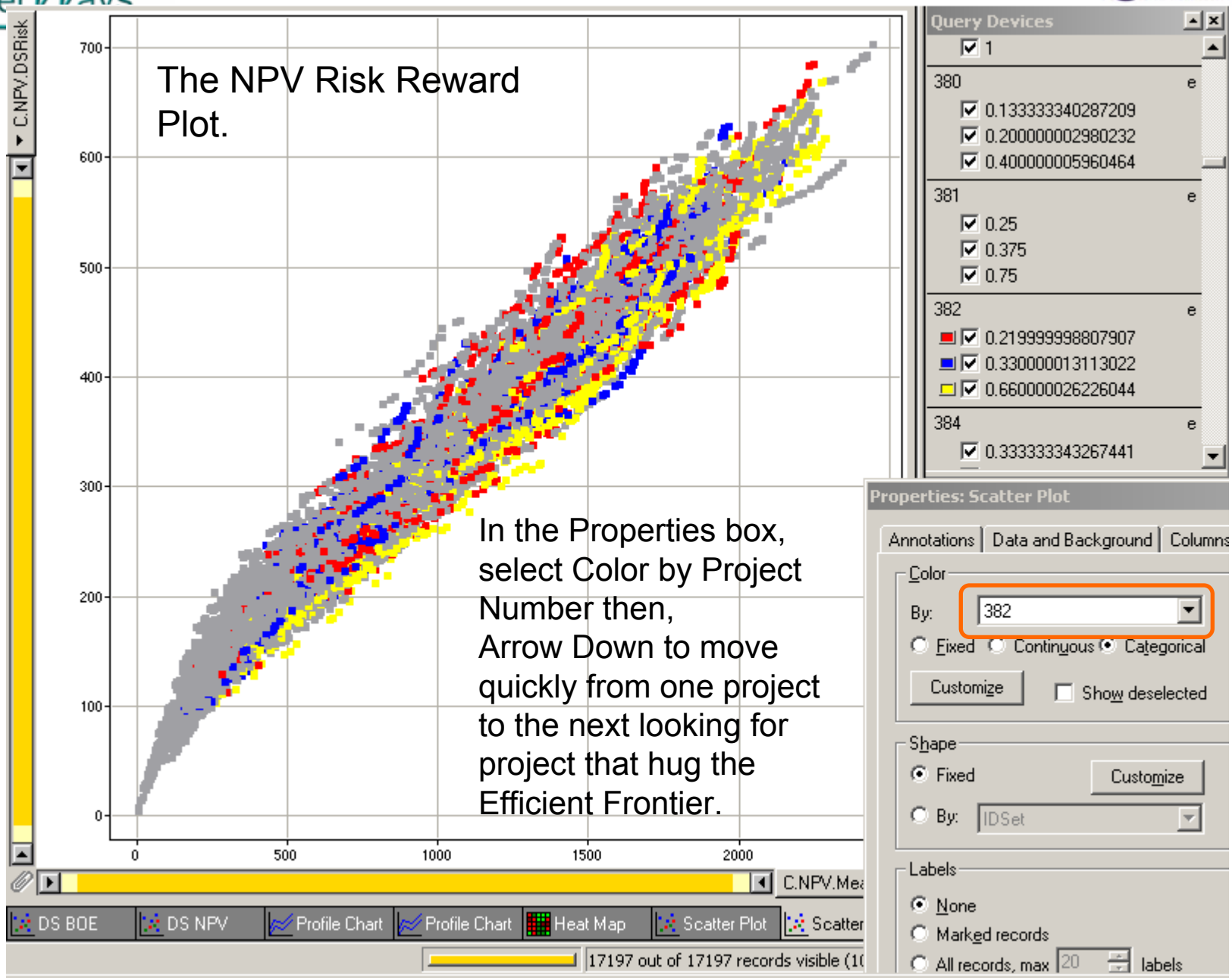


Here we compare Return on Capital Employed in 2006 vs Portfolio NPV (in 2003)

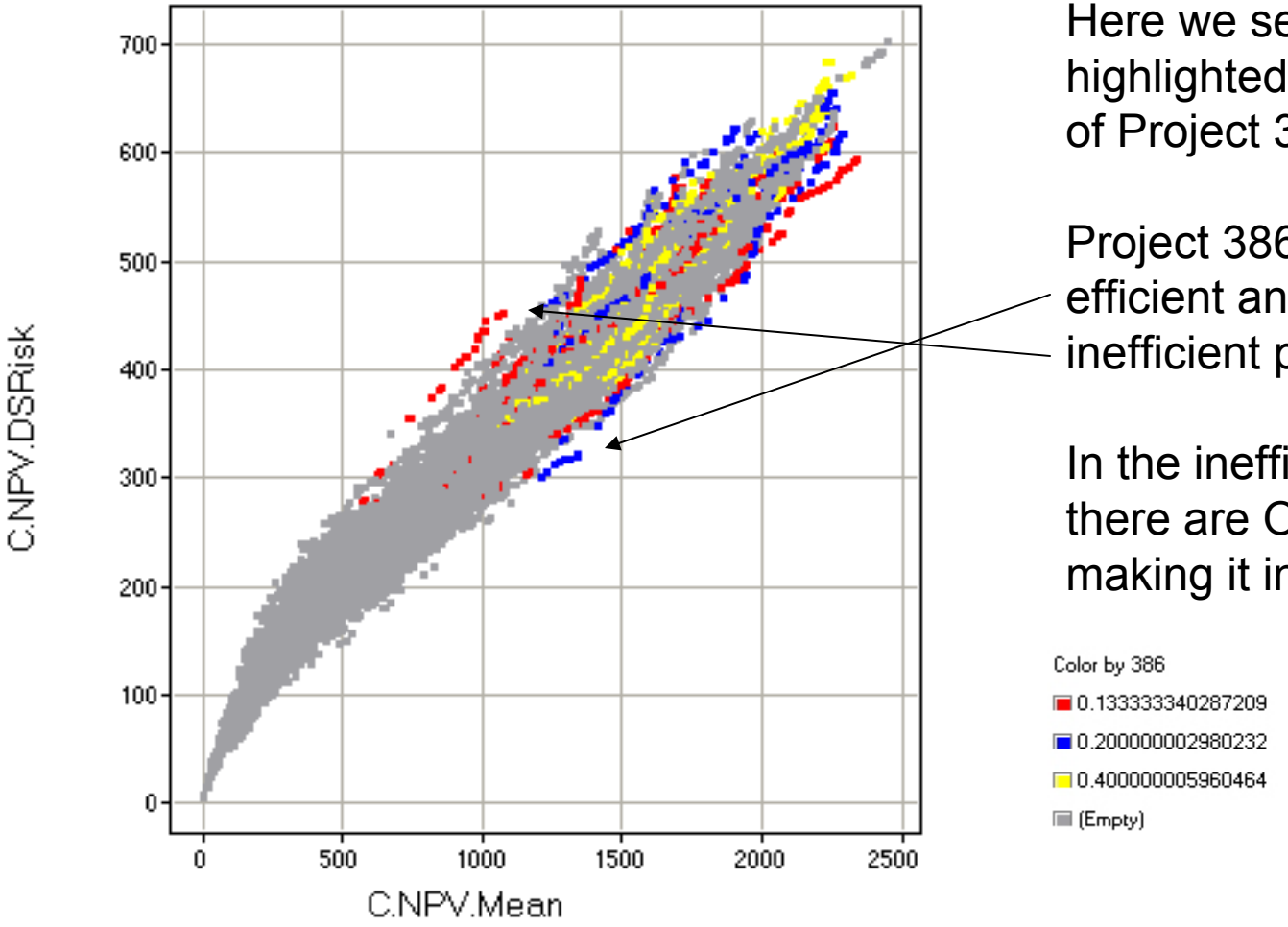
The selected points (red-blue) are constrained by CumCapex between 450 and 515 $MM

4 Panel View: 400 MM Capex





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

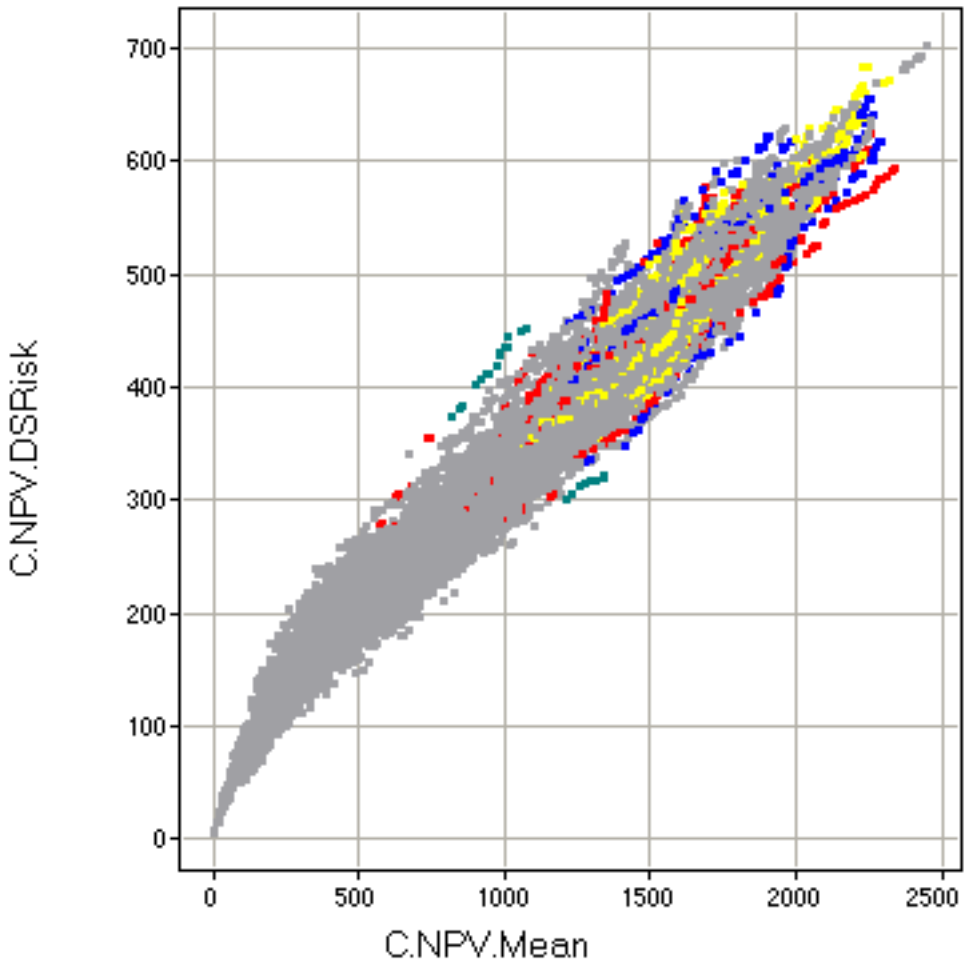


Here we see the portfolios highlighted by funding levels of Project 386.

Project 386 is in both efficient and very inefficient portfolios.

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

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"

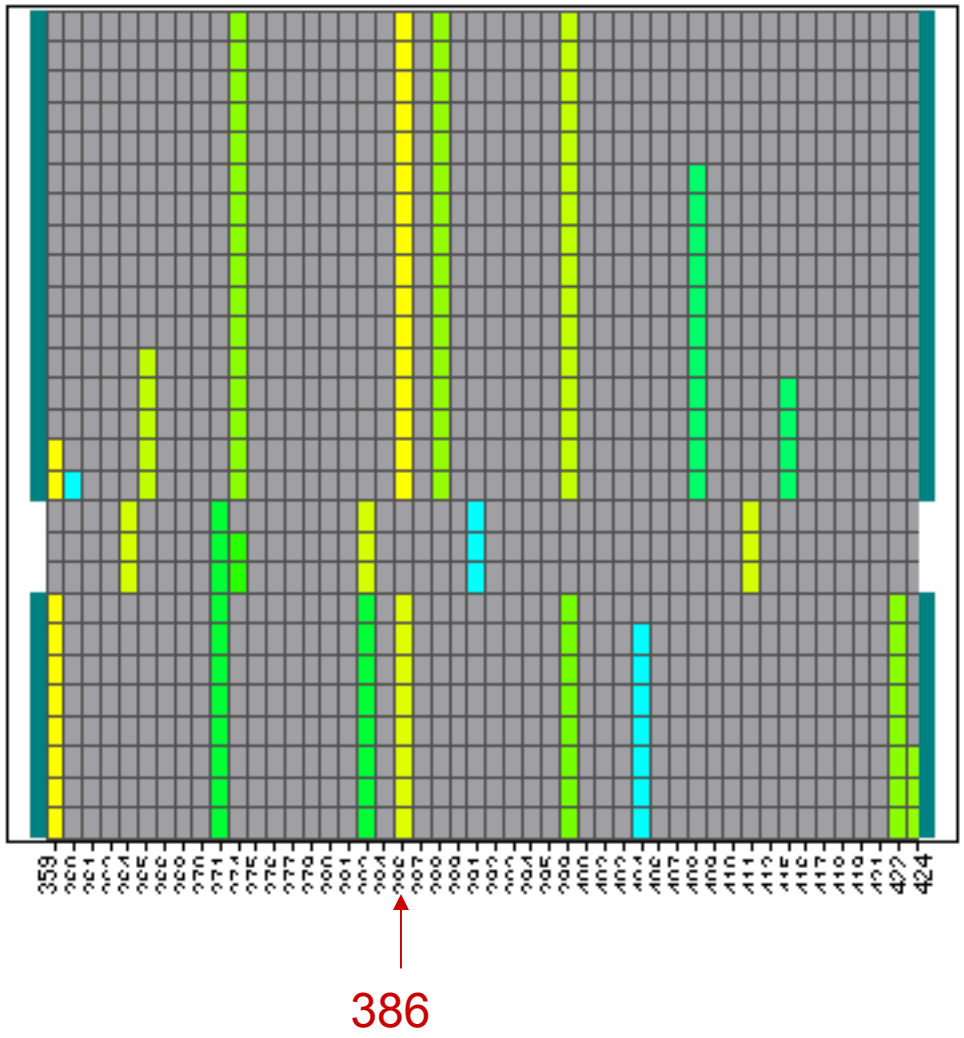
Select only 386Difference = yes
View the Heat map.

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

Heat Map

Candidates for Poor performing Projects

More



Look for differences in the project selections.
What projects are in the poor portfolios that are not in the good ones

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

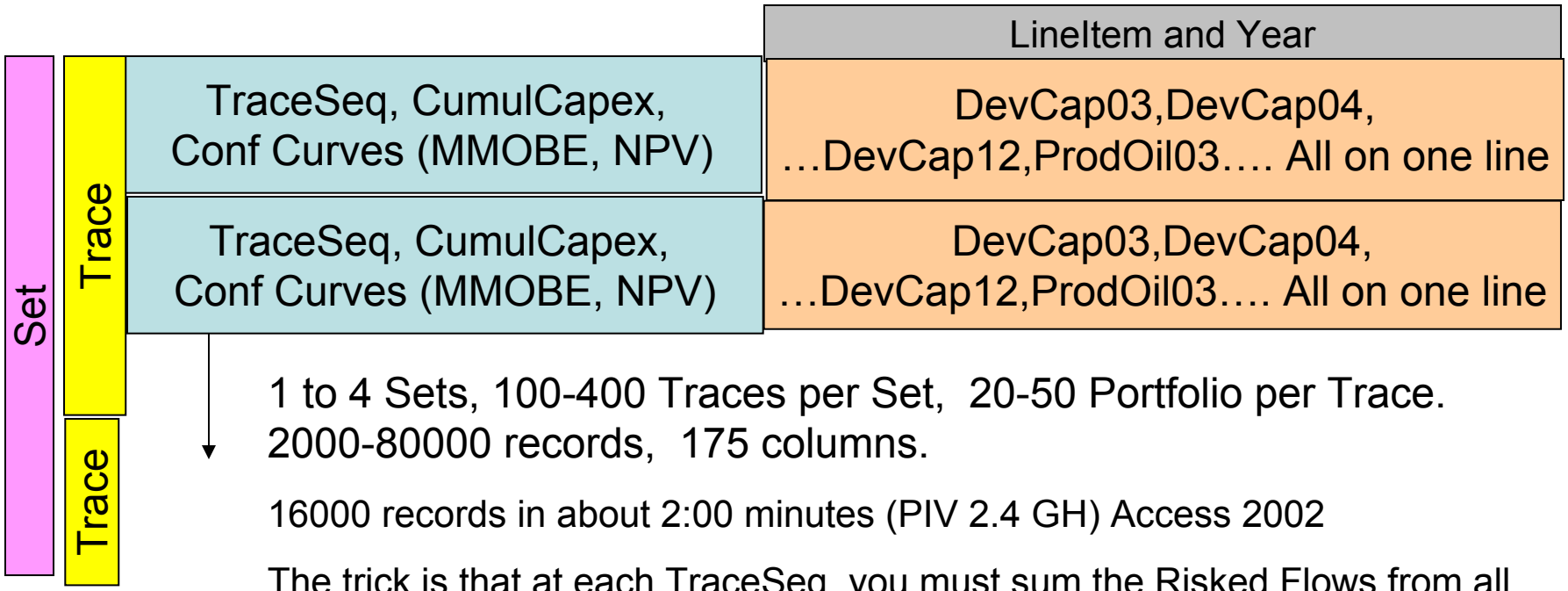
Inefficient Points

Efficient Points without 386 caught up in the selection

Efficient Points

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)



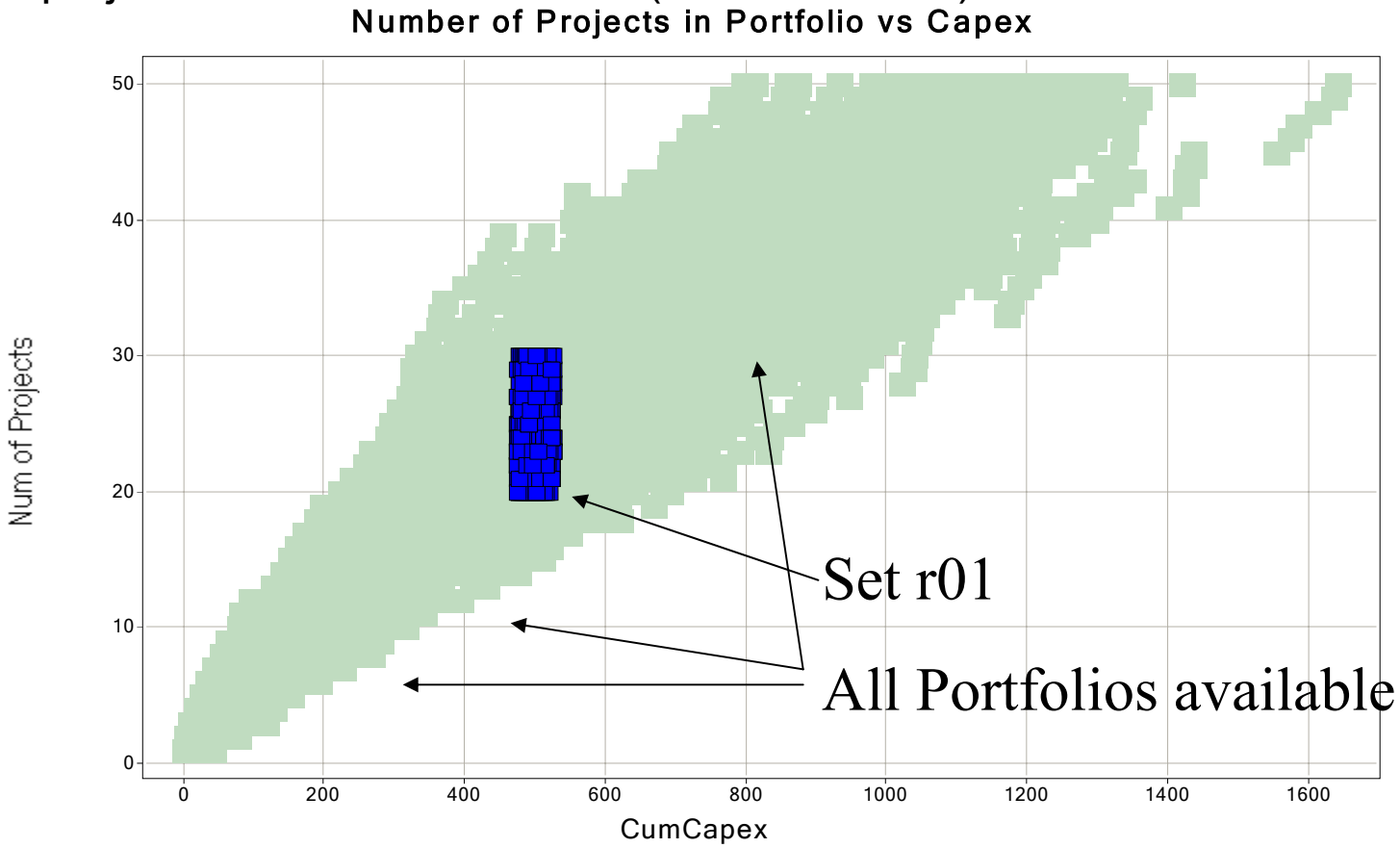
1 to 4 Sets, 100-400 Traces per Set, 20-50 Portfolio per Trace. 2000-80000 records, 175 columns.

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

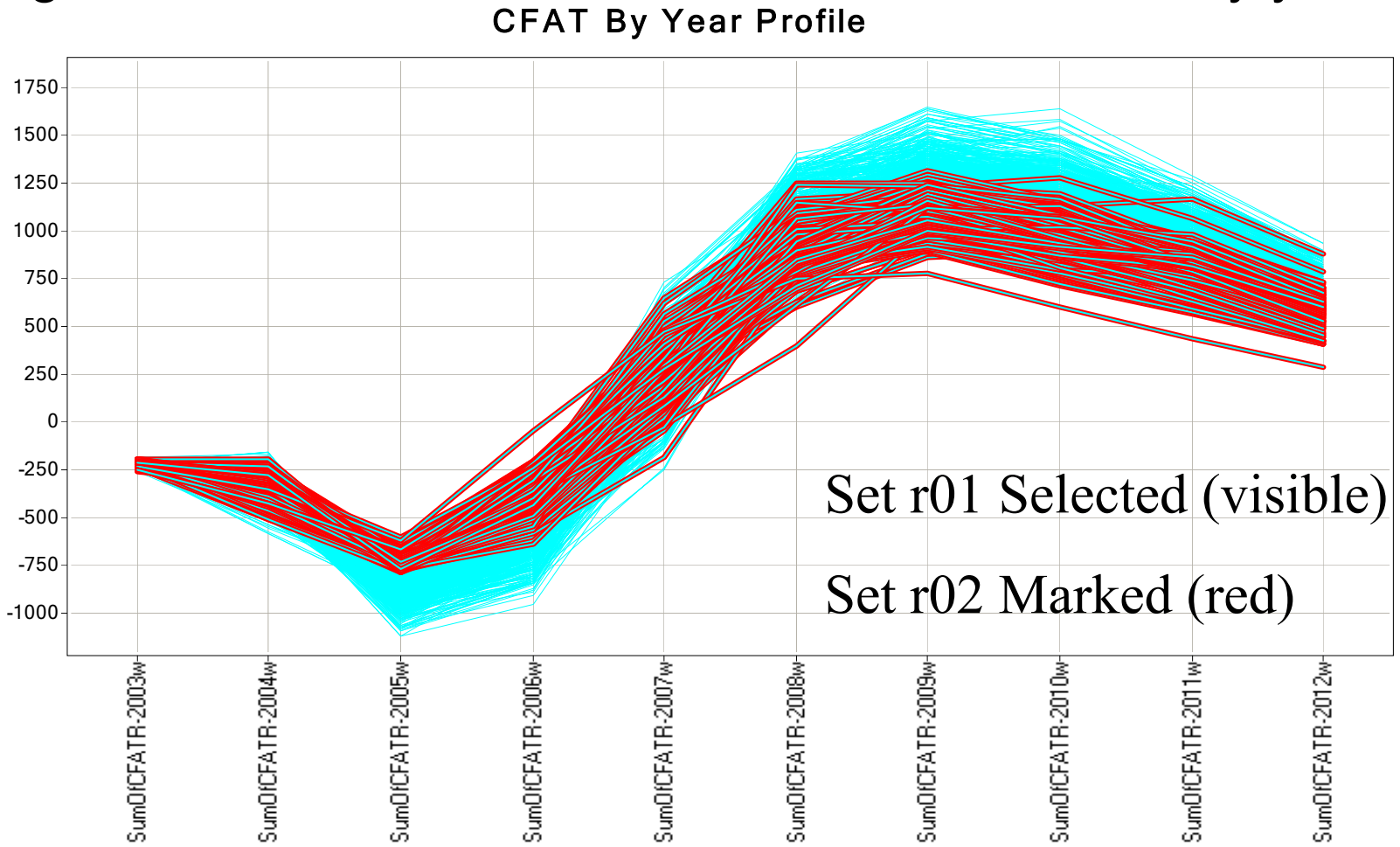
The trick is that at each TraceSeq, you must sum the Risked Flows from all funded Projects (times their Working interests) at each Portfolio Point (TraceSeq record)

Case Study: Select Portfolios using Capex, Cash Flow, Return on Capital Employed (ROCE), and Efficient Frontier constraints.

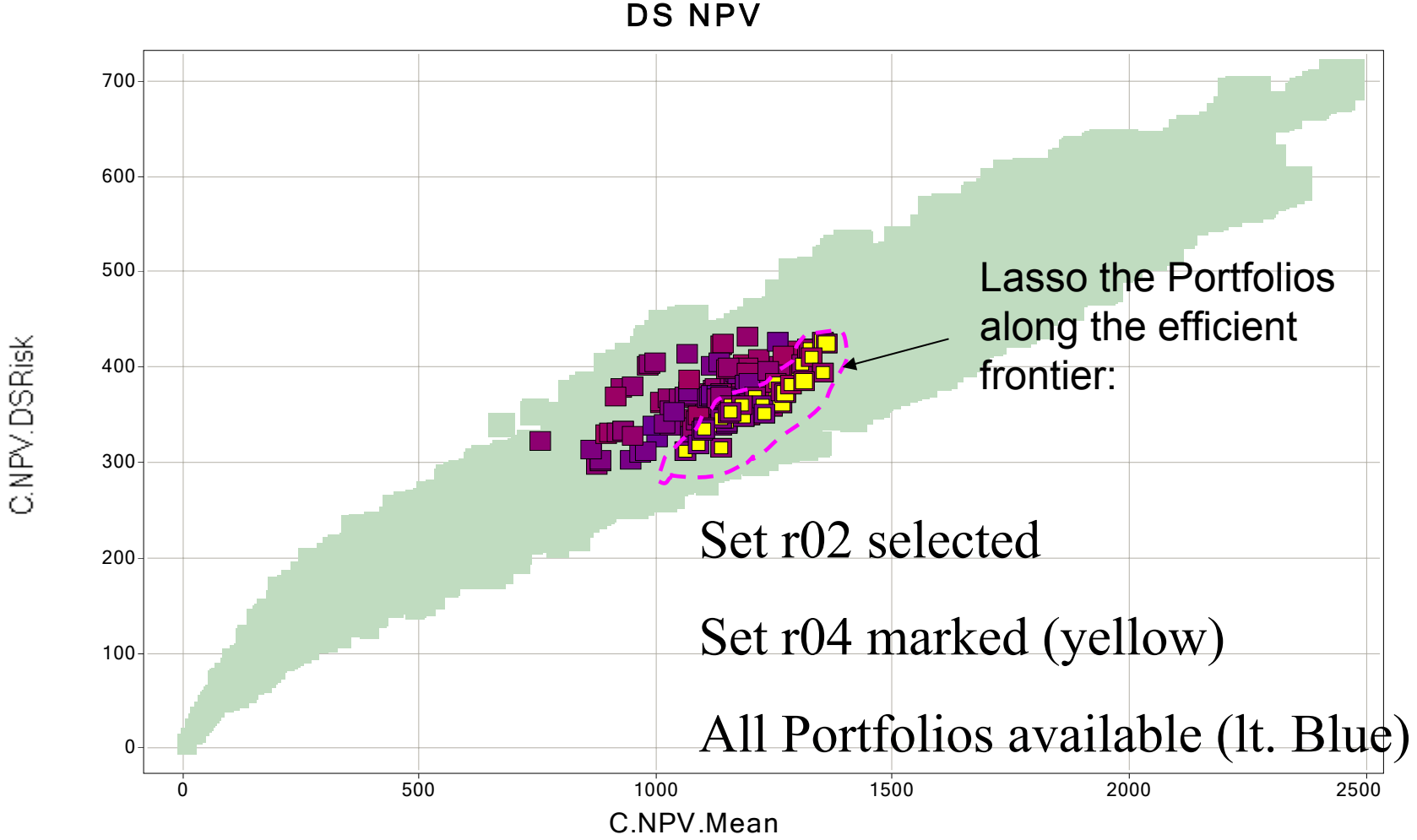
1. Select Portfolios of about $500 MM Capex and a manageable number of projects with our current staff (about 20 to 30)



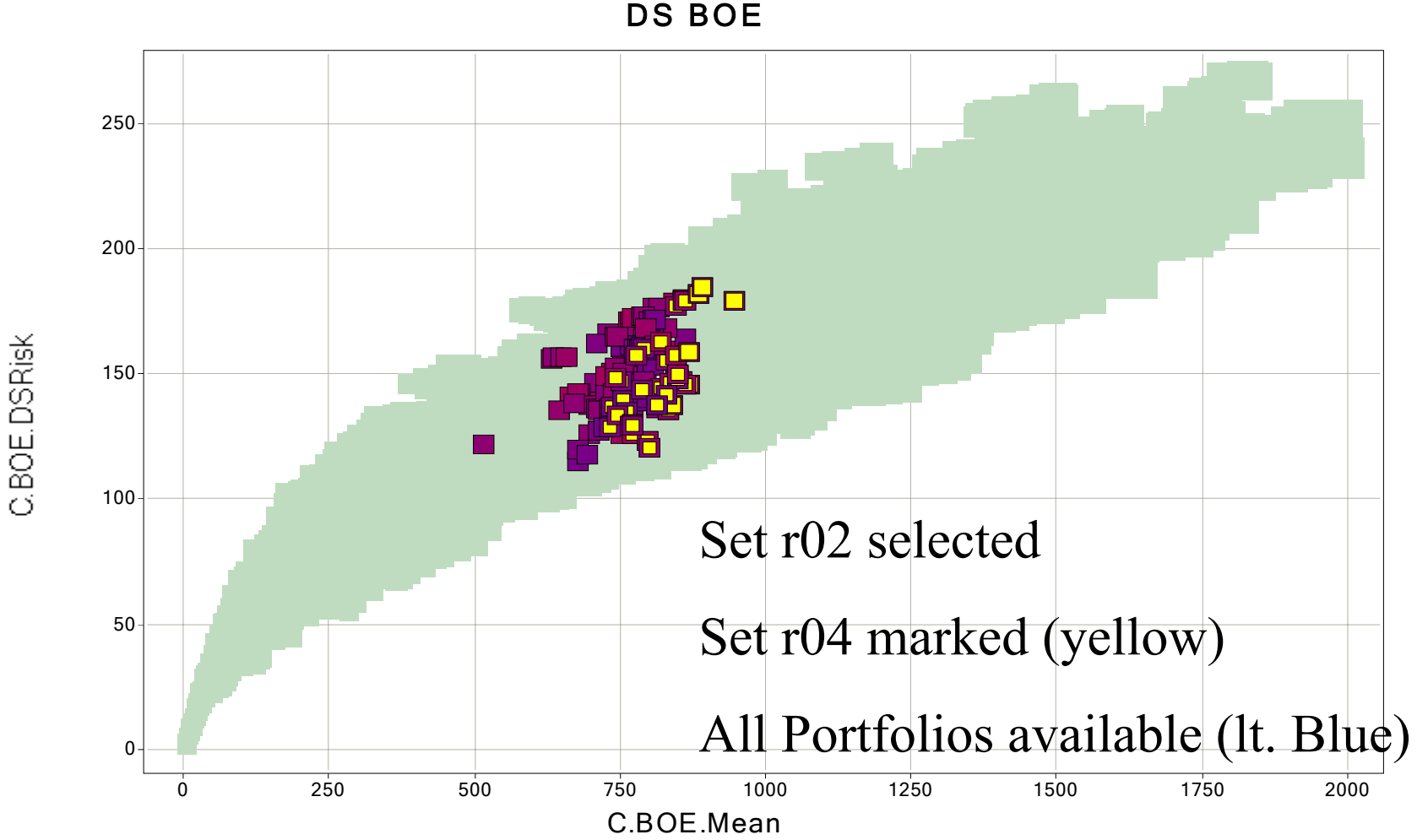
Looking at the Cash Flow Profiles, we decide $750 MM in negative Cash Flow is the most we can stand in any year.



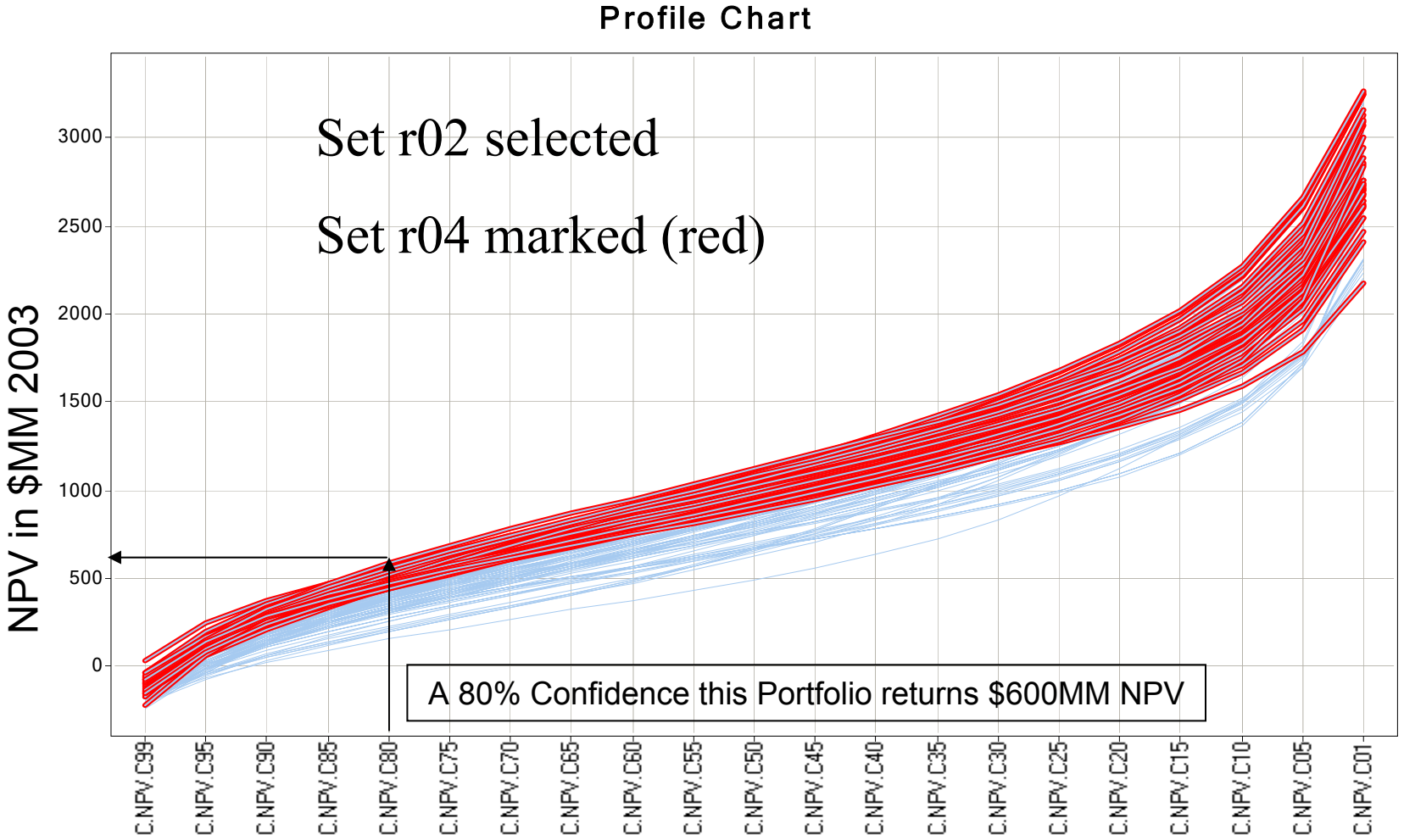
We choose the ¼ closest to the efficient frontier of the NPV – Downside Risk plot.



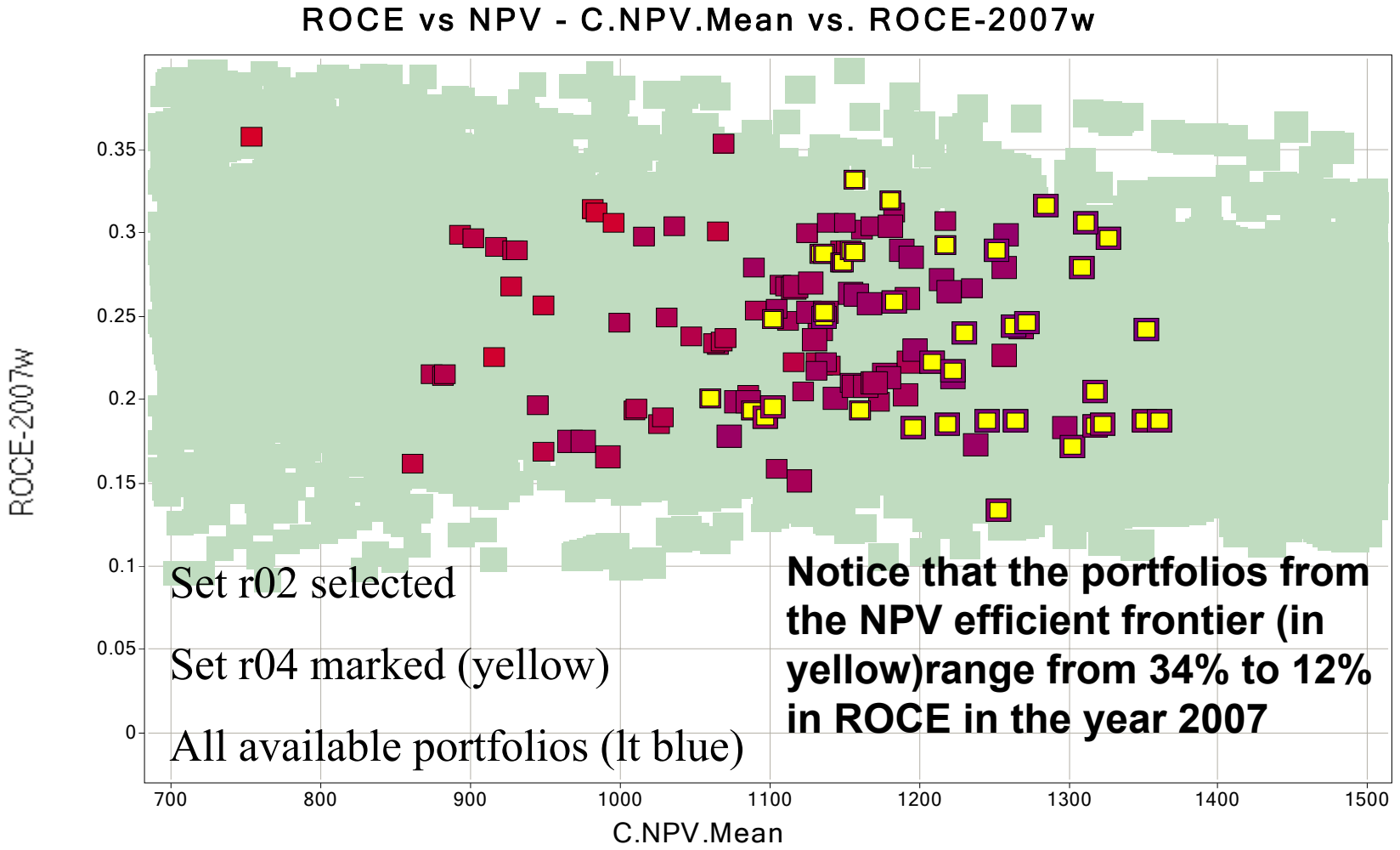
Most of those selected are on the efficient frontier of the Reserves DS Risk Plot.



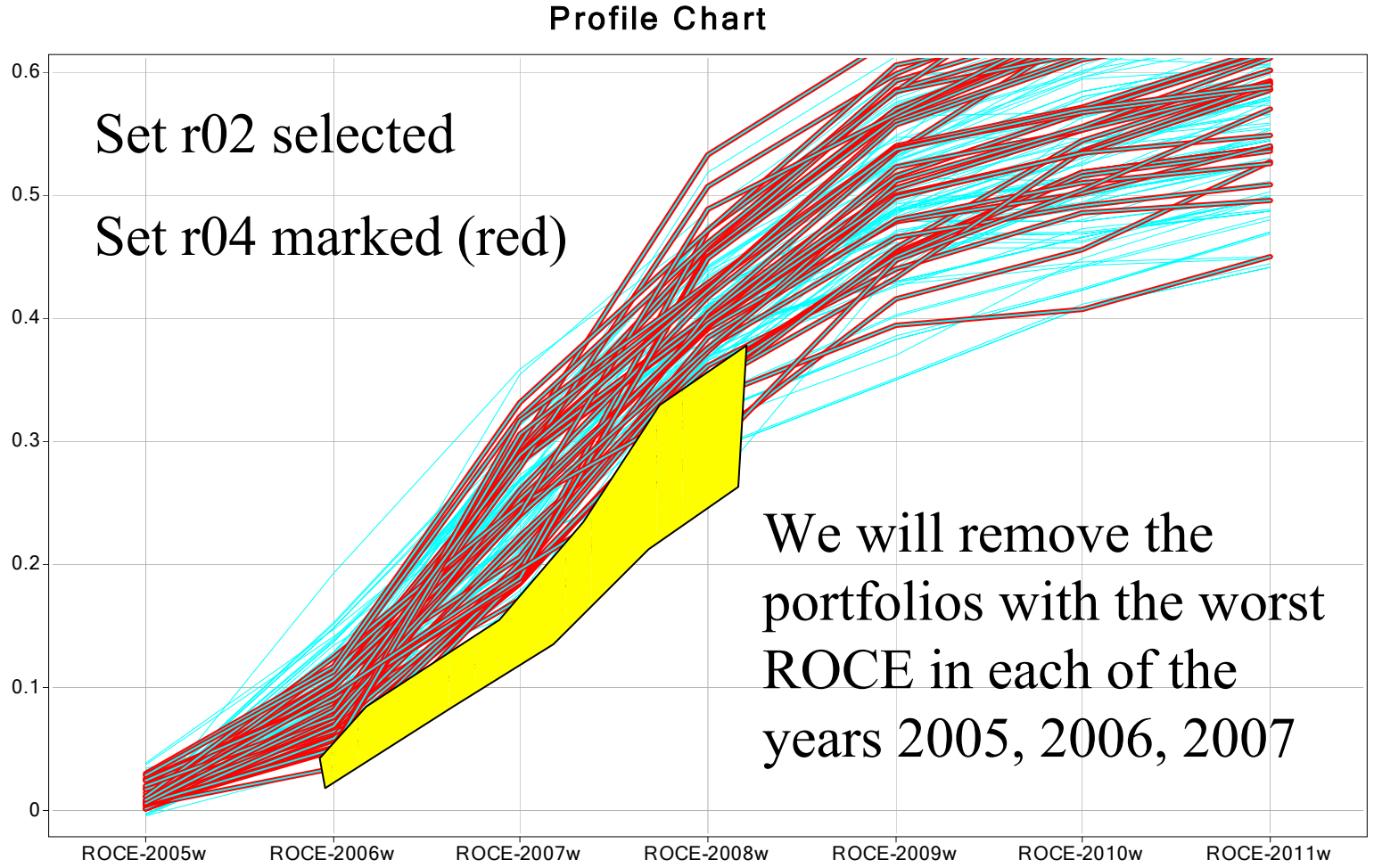
Next we inspect the NPV Confidence Curves.



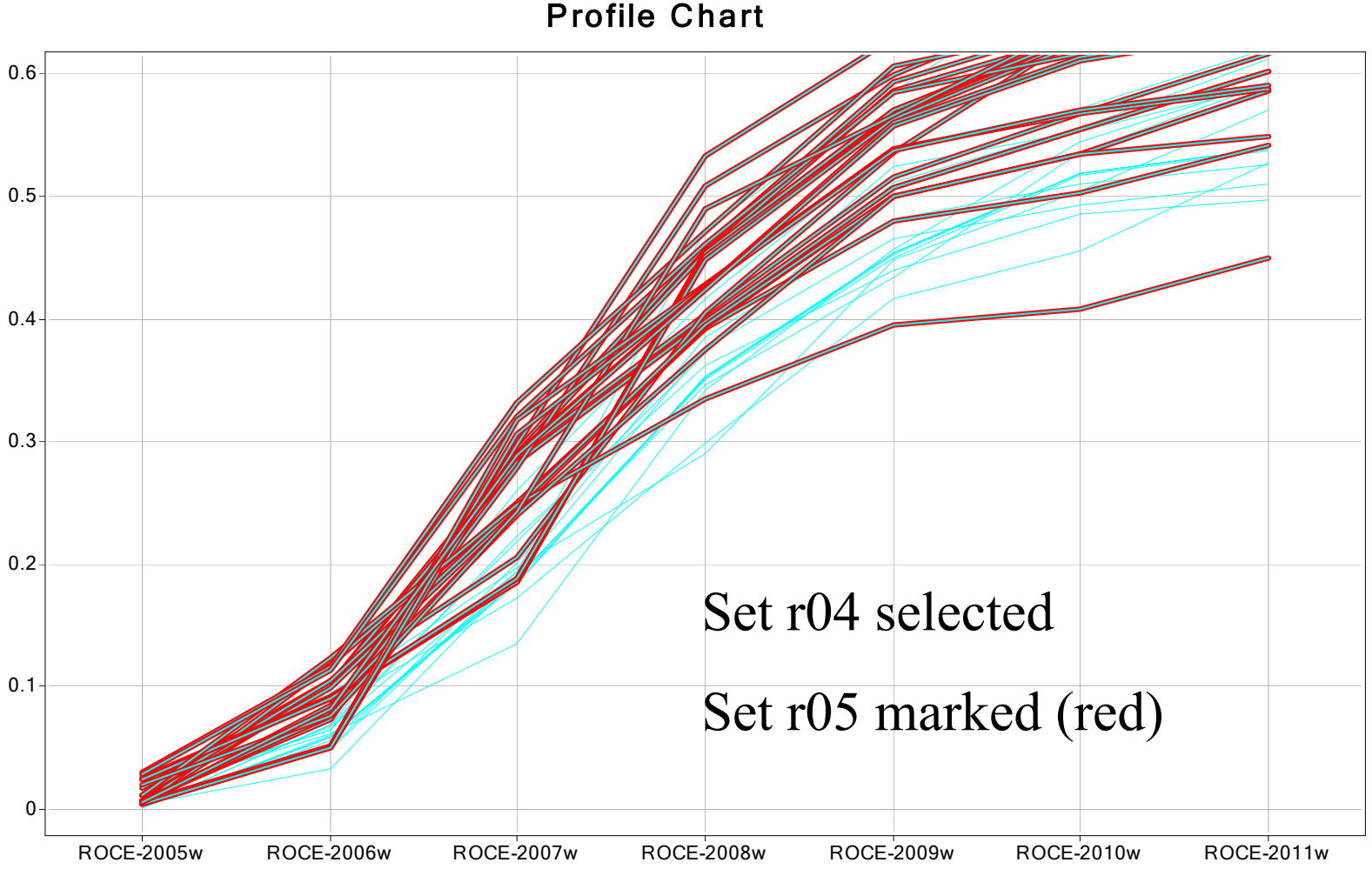
Now we inspect ROCE for year 2007 against NPV.



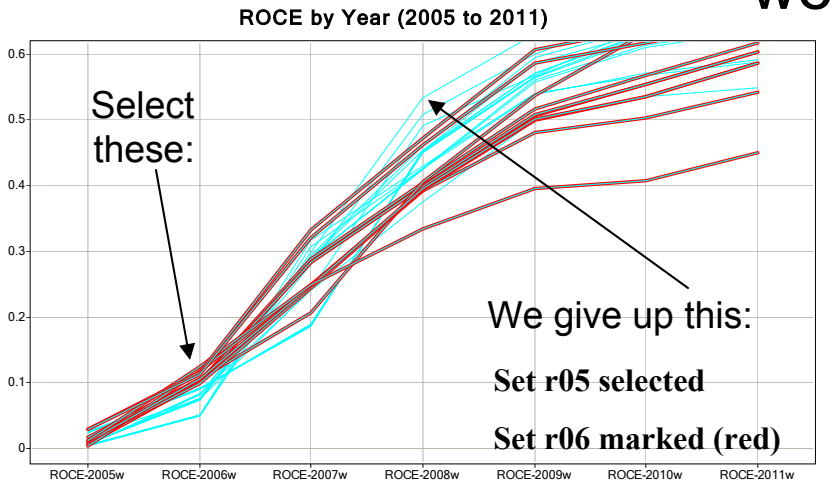
Looking at ROCE by year, we see that for efficient frontier NPV portfolios, we have to give up the highest ROCE in 2005, 2006

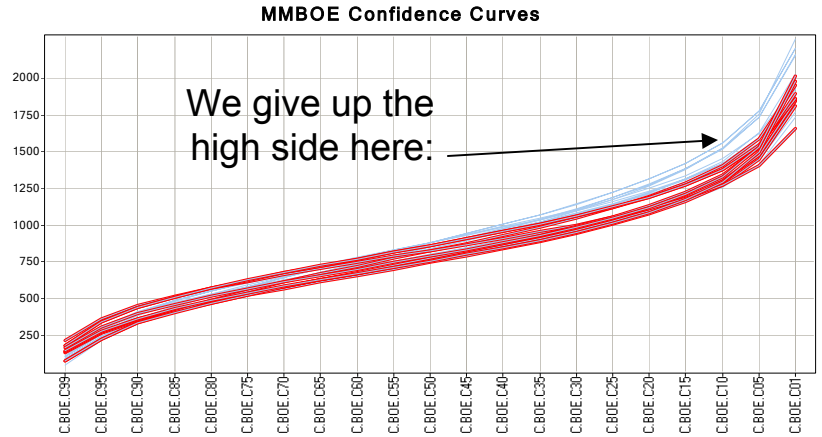


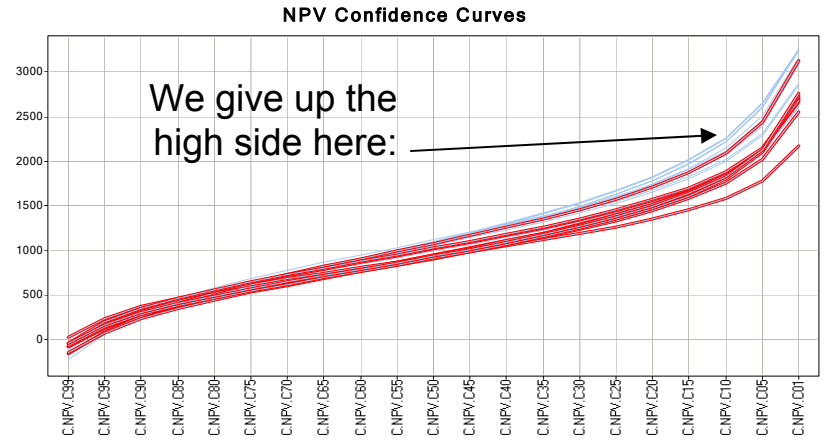
Whittle away the worst ROCE's for each year
Now down to 24 marked portfolos (Set r05)

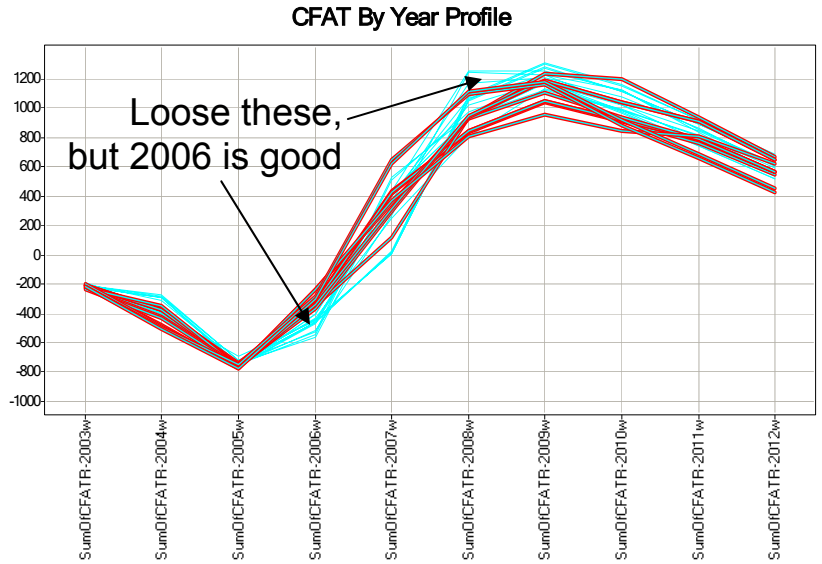


We now ask, what if we need 2006 ROCE > 10%, what do we give up?









Of the ten portfolios left,
there are 6 different “traces” or Portfolio Builds.

Table

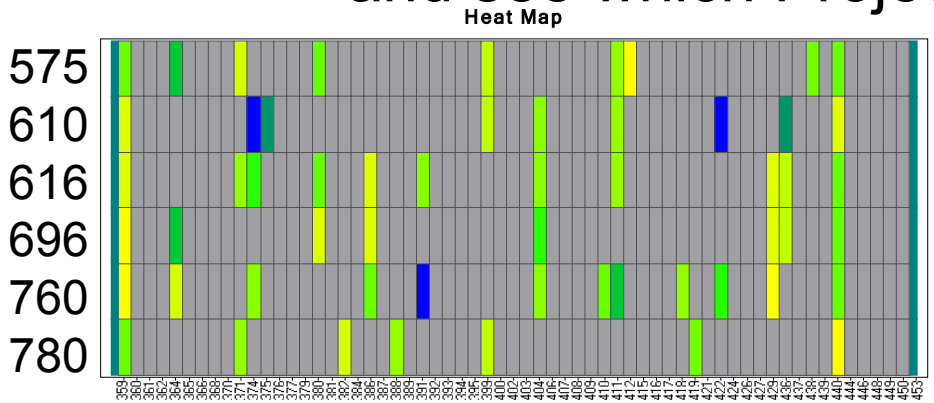
IDSet	IDTrace	IDTraceSeq	Num of Projects	CumCapex	C.BOE.Mean	C.NPV.Mean	SumOfGG-2003w	SumOfDH-2003w	SumOfDH-2
11	575	24735	26	477.25320...	736.1962280...	1135.580322...	275.563966632456	38.4587989449501	149.281718
11	575	24736	27	484.38806...	752.4970703...	1147.064331...	279.131400108904	38.4587989449501	152.84915
11	575	24737	28	487.09838...	754.7551879...	1148.64453125	280.486556172938	38.4587989449501	154.204308
11	610	26206	22	481.40316...	810.6066894...	1317.304809...	302.117780522326	37.6879809833421	124.798190
11	616	26460	24	476.92929...	798.1918945...	1135.750732...	271.292815477522	43.2639275527848	133.417469
11	696	29798	22	510.40905...	833.2089233...	1262.020019...	315.89616097869	32.8223877549171	135.495923
11	696	29799	23	517.77758...	839.5418090...	1270.981689...	319.580428022757	36.5066547989845	135.495923
11	760	32527	23	477.58227...	775.0878295...	1101.823974...	260.738898600674	45.9896689032436	146.51267
11	780	33405	23	476.66961...	745.1303100...	1156.191040...	271.904602221468	52.1037935614586	115.616733
11	780	33406	24	488.30630...	769.0993041...	1180.717895...	277.722949094667	52.1037935614586	121.435080

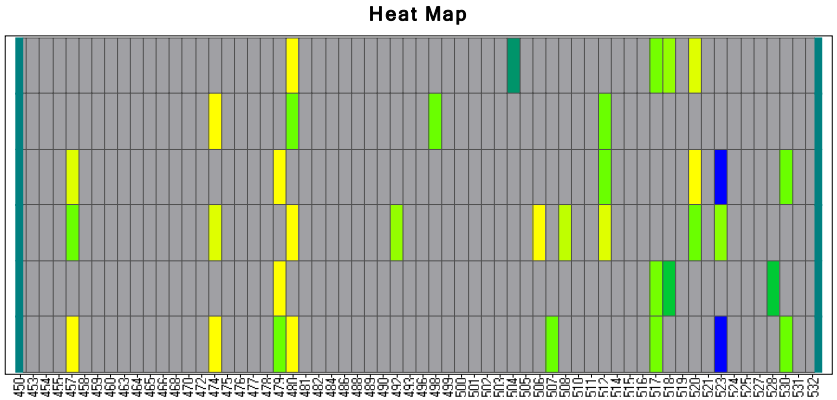
A “TraceSeq” is an individual portfolio

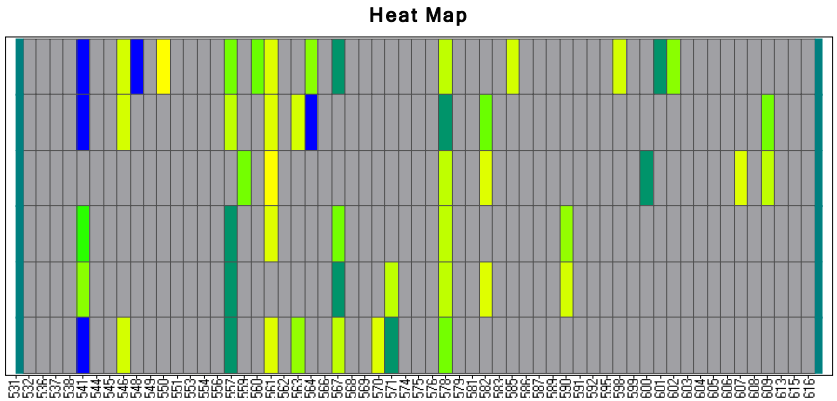
IDTraces (i.e. Portfolio Builds)
575, 610, 616, 696, 760, 780 are the survivors.
We should now look at the prospects that make up these portfolios and see which ones are common.

Saved Spotfire:
T1F6-030507ROCE.sfs

Use the Spotfire Heat Map to determine which Projects are funded in some or most Portfolios and see which Projects are never funded.





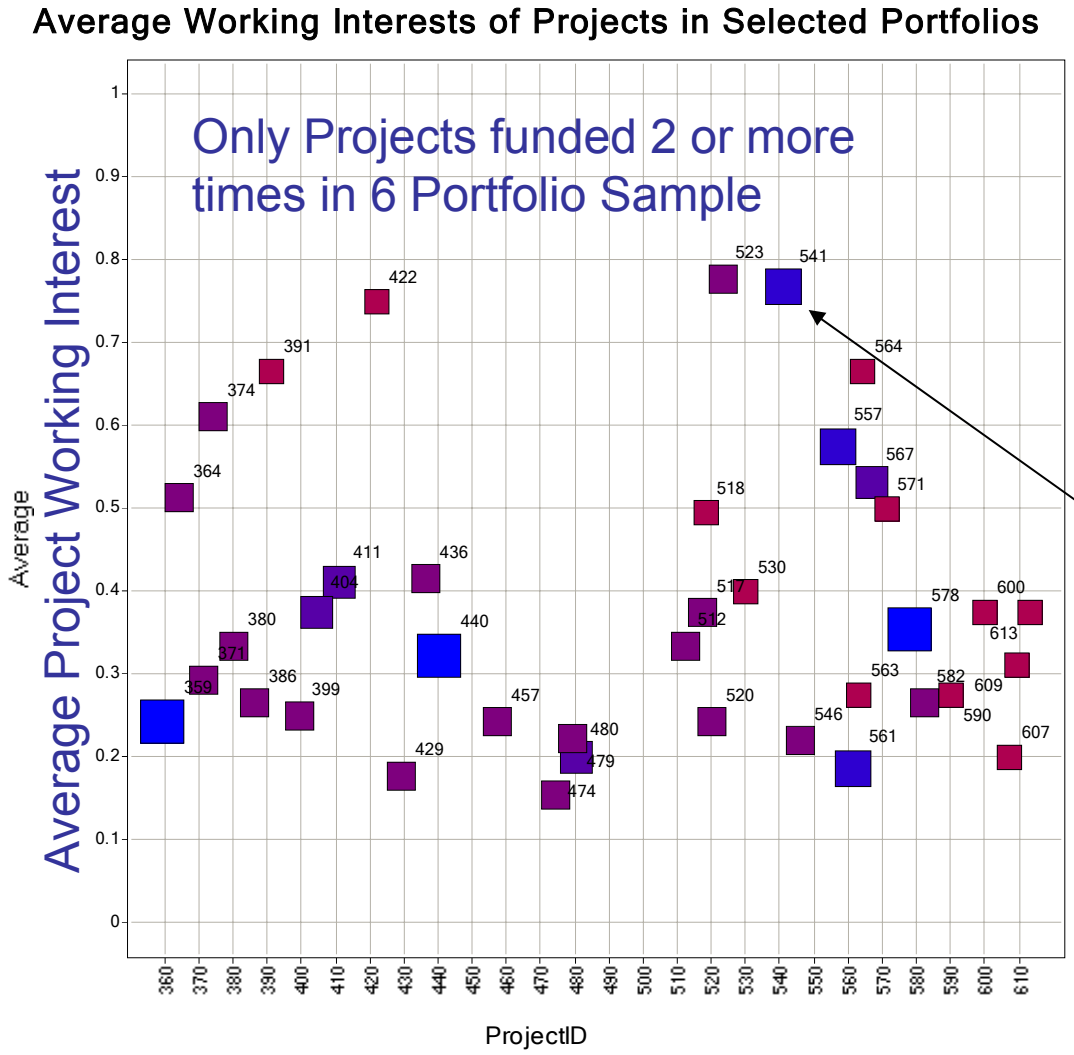


Prospect numbers are along the bottom.
Portfolios are in rows.
Color indicates the working interest the Project is funded in a Portfolio
Grey: not funded
Gradational: Yellow at 0%, Green at 50%, Blue at 100%

Vertical stripes are prospects funded in most portfolios. Grey stripes are prospects NEVER funded.

Remember: these are portfolios that ALL give acceptable results.

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. And run the Heat Map Census macro.
3. Copy the output cells and paste into a NEW INSTANCE of Spotfire.

Proj 541 picked 5 out of 6 at about 75% working Interest

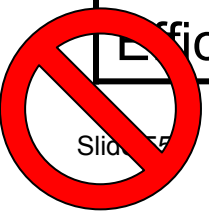
WiserWays-Spotfire Portfolio Analysis Process

- Define the population of potential Projects to fund
- Define a set of Strategies for funding candidate portfolios.
- Use an automated process to generate thousands of candidate portfoilos according to the different strategies.
- Load the candidate Portfolios into Spotfire
- Apply/change constraints by sliding Spotfire query devices.
- Select many good portfolios that are close to the Efficient Frontiers of many different measures.
- Find the projects most often funded in these good portfolios.

  If happy with plan, Fund these projects, Execute Plan
- Change and Negotiate Goals.
- Refine Strategies.

Comparison of Analysis Methods

Traditional LP/IP Portfolio Optimization	WiserWays Spotfire Visualization
Best for fungible assets (like stocks) that can be bought or sold repeatedly in any increment.	Good for Portfolios where assets are available in chunks and only once.
Provides comparatively few solution points	Visually compares thousands of possible solutions.
Good for choosing single best solution for a single goal	Best for choosing many GOOD solutions to satisfy many goals.
The most optimistic data will drive the optimization.	Less sensitive to bad data because you build many candidate portfolios to test.
Provides one portfolio AT the Efficient Frontier	Provides MANY portfolios NEAR the Efficient Frontier



Comparison of Analysis Methods

Traditional LP/IP Portfolio Optimization	WiserWays Spotfire Visualization
Process: Establish Goals, Build optimum Portfolios, Present Solution.	Process: Define rules for Good Portfolios. Build lots of Portfolios quickly, Use Spotfire filters to Analyze and Discuss the many portfolios that fit.
Changes to Goals means run new portfolio optimizations to be ready tomorrow.	Changes to goals can be done immediately in the one review meeting by changing the Spotfire Filters.
Will naturally want to fund lots of projects at low working interests	Will work with the projects at only the working interests you specify.
Has little trouble with hundreds of decision variables	Heuristic rules need to guess at the important decision variables

Comparison of Analysis Methods

Traditional LP/IP Portfolio Optimization	WiserWays Spotfire Visualization
Goals drive the optimization. Strategy plays no part.	Strategies build Portfolios to be tested against Goals.
You cannot enter every real world "constraint" into the model.	You can analyze the candidate portfolios against sensible operational constraints that come from your experience.
Many constraints are fuzzy.	You can visually see how much a portfolio violates a "goal" and decide if it should be forgiven.
Solutions are theoretical funding levels that must be cajoled actual funding levels available.	You start with thousands of realistic portfolios and chose among the best of these.

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 does not 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.

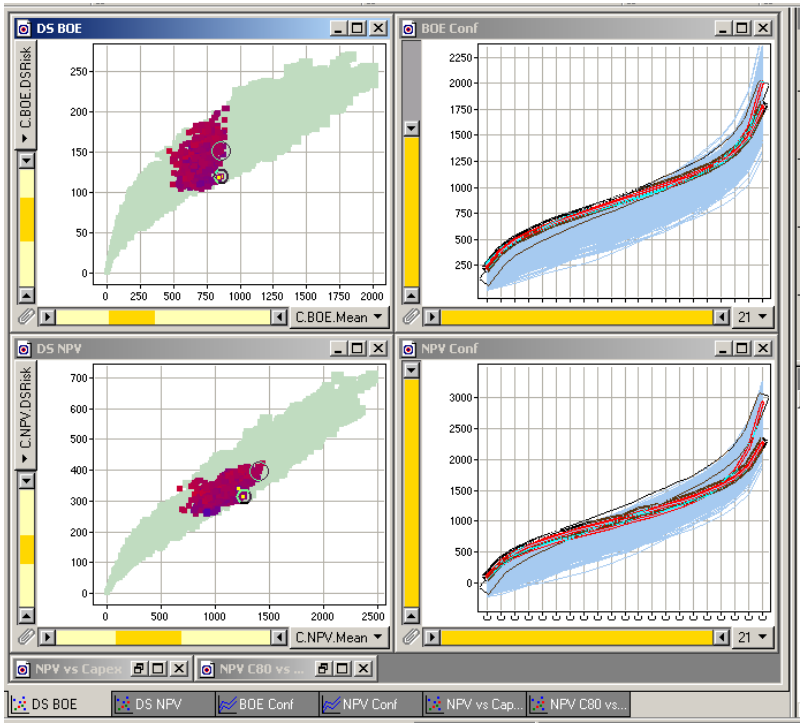
*Dr. R. E. D. Woolsey, Professor of OR/MS, Colorado School of Mines
Woolsey & Swanson, Operations Research for Immediate Applications, Harper & Row, 1974.

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.

- You can change your constraints in the conference room for real-time turnaround.

- Understandable.
  Quick. Easy. Inexpensive.



Thanks to

- Spotfire
  - For the opportunity to speak here and for the work we have done together since 2001.
- David Bailey, Spotfire
- Joe Taylor, Spotfire (Houston)
  - For helping me debug the Access-Spotfire interaction.
- Dr. Ian Learch (Prof. U. of S. Carolina)
  - Who in 1997 triggered my insight in how to develop the WiserWays Multifield Confidence Curve Portfolio Calculator.

And Thank You for your attention.

- This presentation is available on-line at
  http://wiserways.com/downloads/030520Spotfire.pdf

You can do the job many ways….
Do it better with

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