

CFRM 551 Introduction to Trading Systems

System Development Techniques

Doug Service
Daniel Hanson
April 21, 2016

Applied Mathematics
University of Washington

Material from Trading Systems by Jaekle and Tomasini

Overview

- Introduction
- Luxor Idea
- Entry
- Slippage and Commissions
- Parameter Optimization
- Intraday Time Filter
- Exits
- Risk Stop Loss
- Trailing Stop
- Profit Targets
- Results Summary

Introduction

Urban Jaekle and Emilio Tomasini, Trading Systems

To use a mechanical trading system means that you need to discard widely held beliefs about finance and over all discard the “feel-good” approach to trading: everybody usually feels comfortable buying dips and uncomfortable buying the highest high, but it may be the case that just the latter methodology is the good one. **Testing a trading system could mean being forced by the brutal power of numbers to a trading attitude where you do not feel at ease. To be a fully mechanical trader means, in conclusion, to use violence against yourself.**

Luxor System – Initial Idea

Inputs: FastLength(3), SlowLength(30),

Variables:

MP(0), Fast(0), Slow(0), GoLong(False), GoShort(False), BuyStop(0),
SellStop(0), BuyLimit(0), SellLimit(0);

{3. Definition of moving averages and entry conditions}

Fast = Average(Close, FastLength);

Slow = Average(Close, SlowLength);

GoLong = Fast > Slow;

GoShort = Fast < Slow;

{4. Entry Setup}

If Fast crosses above Slow then begin

BuyStop = High + 1 point;

BuyLimit = High + 5 points;

end;

If Fast crosses below Slow then begin

SellStop = Low - 1 point;

SellLimit= Low - 5 points;

end;

If GoLong and C < BuyLimit then

Buy (“Long”) next bar at BuyStop Stop;

If GoShort and C > SellLimit then

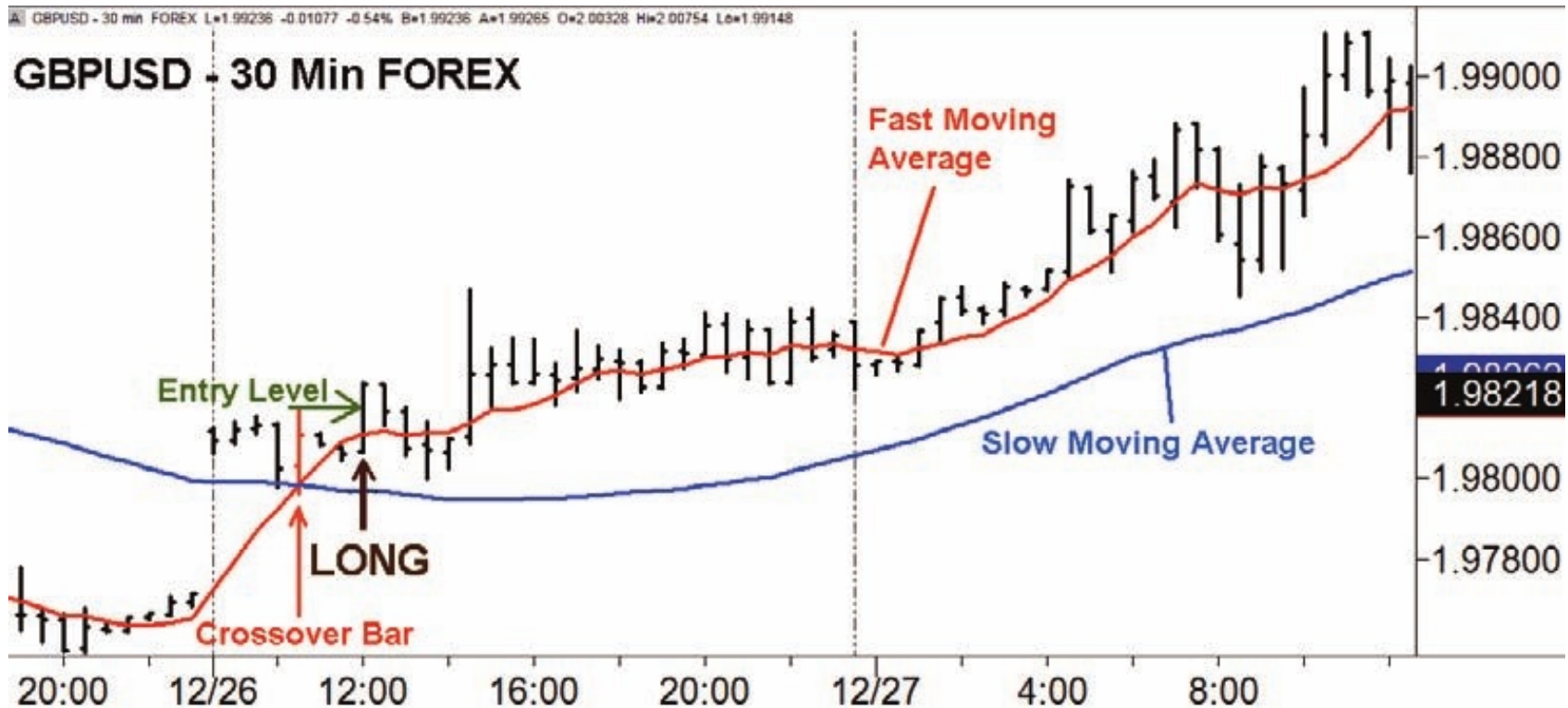
Sell Short (“Short”) next bar at SellStop Stop;

End;

{Copyright 200, Omega Research, Inc}

1 Entry

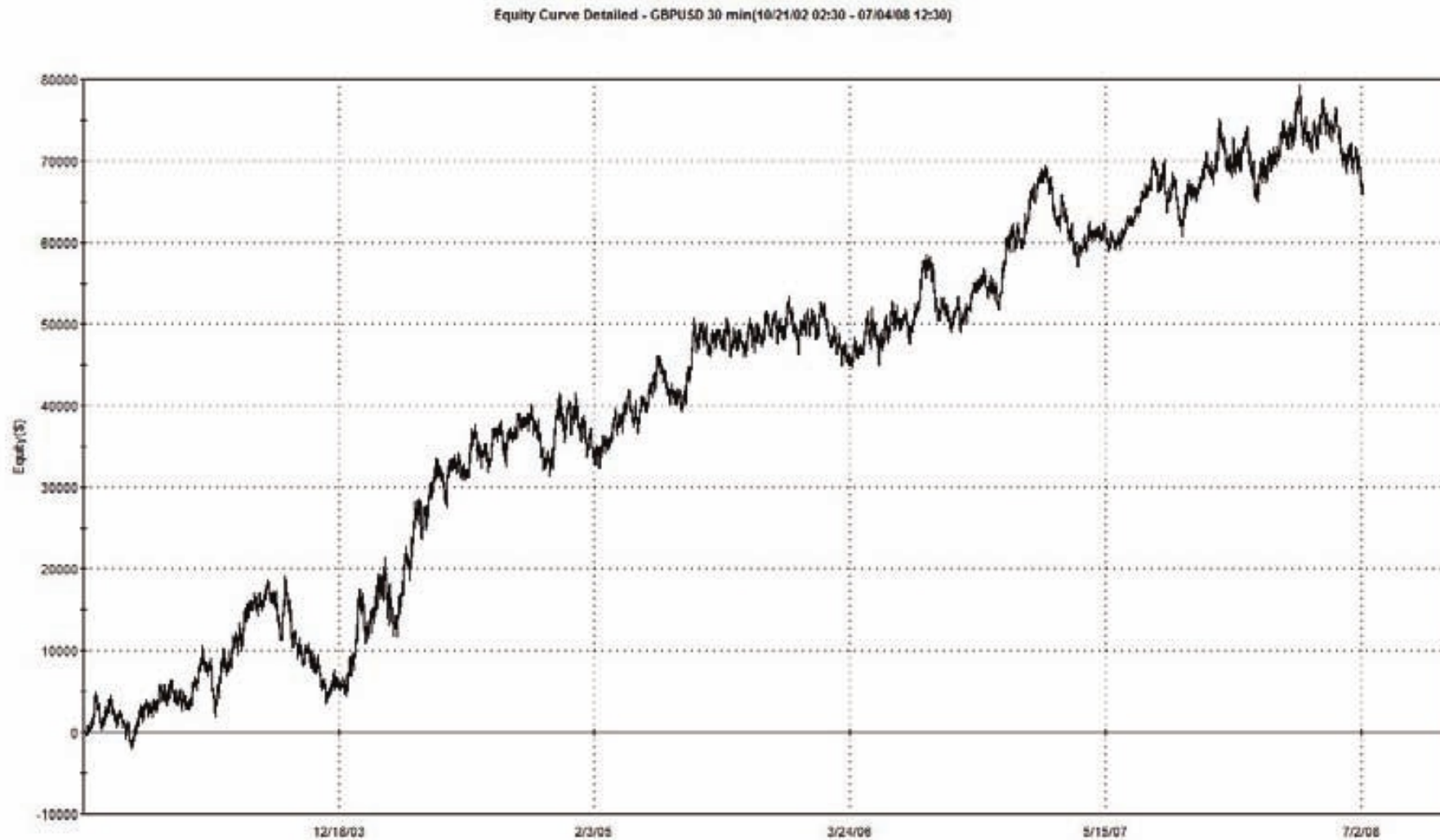
- Cross above signal is not sufficient to trigger long entry
- Additional rule requires price to exceed recent high
- Inverse is true for short entries



If Fast crosses above Slow Then EntryLevel = High;
If Fast > Slow then Buy ("Long") next bar at BuyStop Stop;

1 Entry

Detailed Equity Curve of the trading system LUXOR on British pound/US dollar (FOREX), 30 minute bars, 21/10/2002-4/7/2008. Input parameters: SLOW=30, FAST=10. System without exits, always in the market. Back-test without any slippage and commissions.



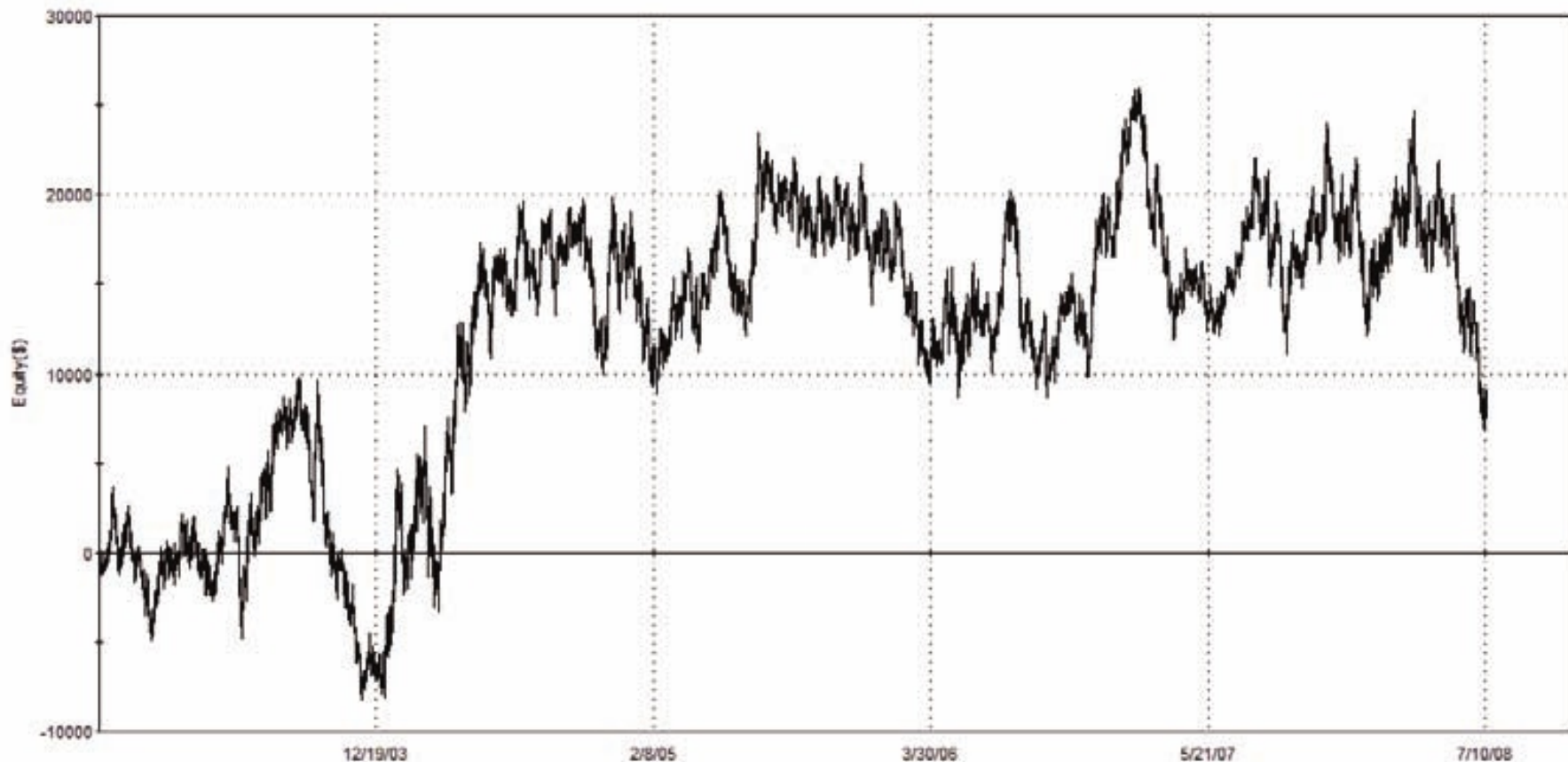
1 Entry

- Low percent profitable trades typical of trend following systems
- Note high ratio of AvgWin/AvgLoss
- Time in winning trades is 3x longer
- Number long trades approximately equal number short trades
- Total number of trades statistically significant
- Alexander, *Price Movements in Speculative Markets*
- Fama, Blume, *Filter Rules and Stock-Market Trading*

	All Trades	Long Trades	Short Trades
Total Net Profit	\$66,318	\$56,918	\$9,400
Gross Profit	\$590,530	\$310,301	\$280,230
Gross Loss	(\$524,213)	(\$253,383)	(\$270,830)
Profit Factor	1.13	1.22	1.03
Total Number of Trades	1913	957	956
Percent Profitable	36.49%	39.81%	33.16%
Winning Trades	698	381	317
Losing Trades	1215	576	639
Avg. Trade Net Profit	\$35	\$59	\$10
Avg. Winning Trade	\$846	\$814	\$884
Avg. Losing Trade	(\$431)	(\$440)	(\$424)
Ratio Avg. Win:Avg. Loss	1.96	1.85	2.09
Largest Winning Trade	\$5,628	\$5,628	\$4,338
Largest Losing Trade	(\$2,522)	(\$1,652)	(\$2,522)
Max. Consecutive Winning Trades	6	6	6
Max. Consecutive Losing Trades	16	10	11
Avg. Bars in Total Trades	37.77	39.18	36.36
Avg. Bars in Winning Trades	61.84	62.96	60.5
Avg. Bars in Losing Trades	23.94	23.45	24.38
Max. Drawdown (Intra-day Peak to Valley)	(\$15,644)	(\$11,133)	(\$19,746)
Date of Max. Drawdown	27-Nov-03		

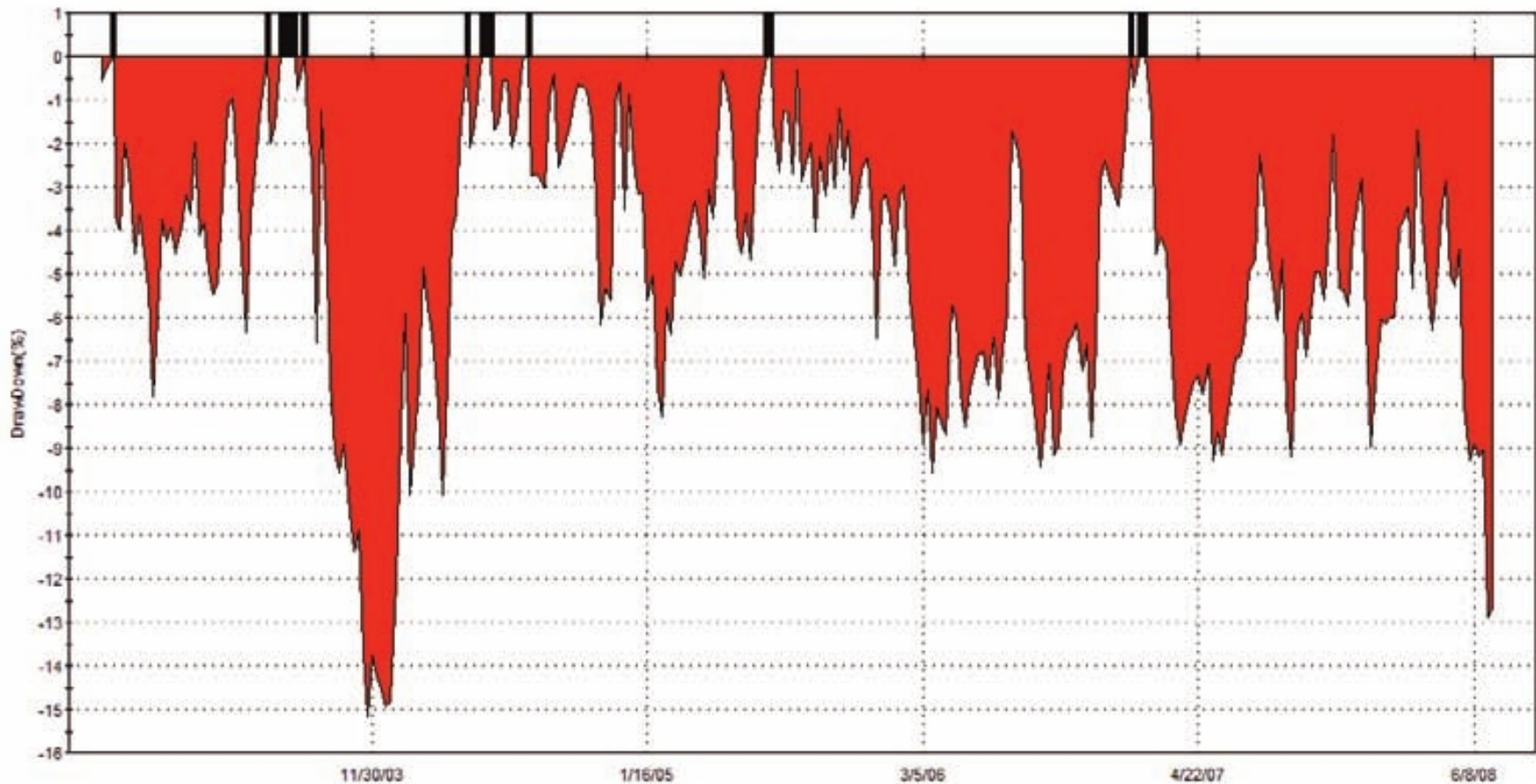
2 Slippage and Commissions

Result of the trading system LUXOR with added \$30 slippage and commission per round turn. A: Detailed equity curve; B: Underwater equity curve. British pound/US dollar (FOREX), 30 minute bars, 21/10/2002-4/7/2008. Input parameters: SLOW=30, FAST=10.



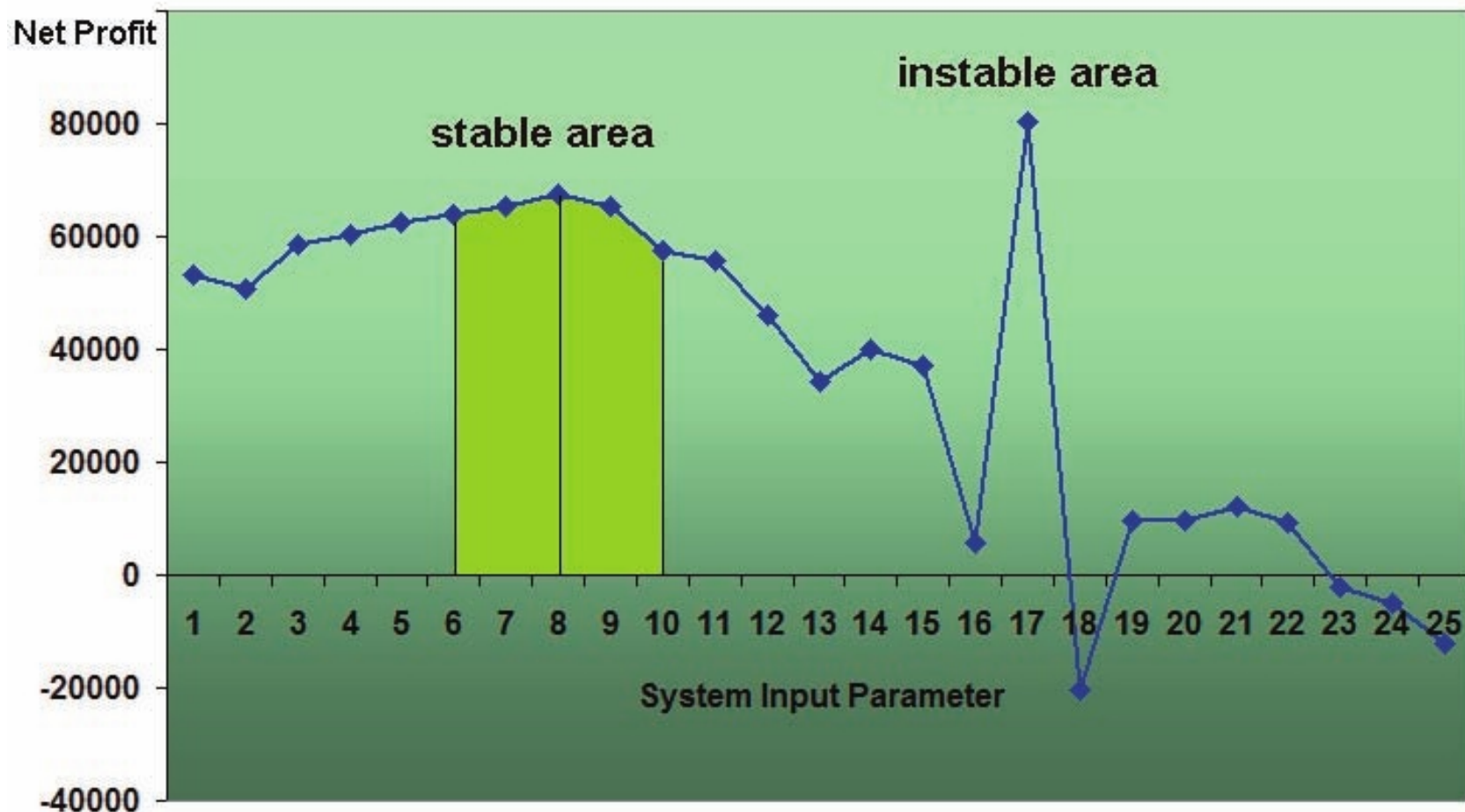
2 Slippage and Commissions

- Up to 15% drawdown for long phases



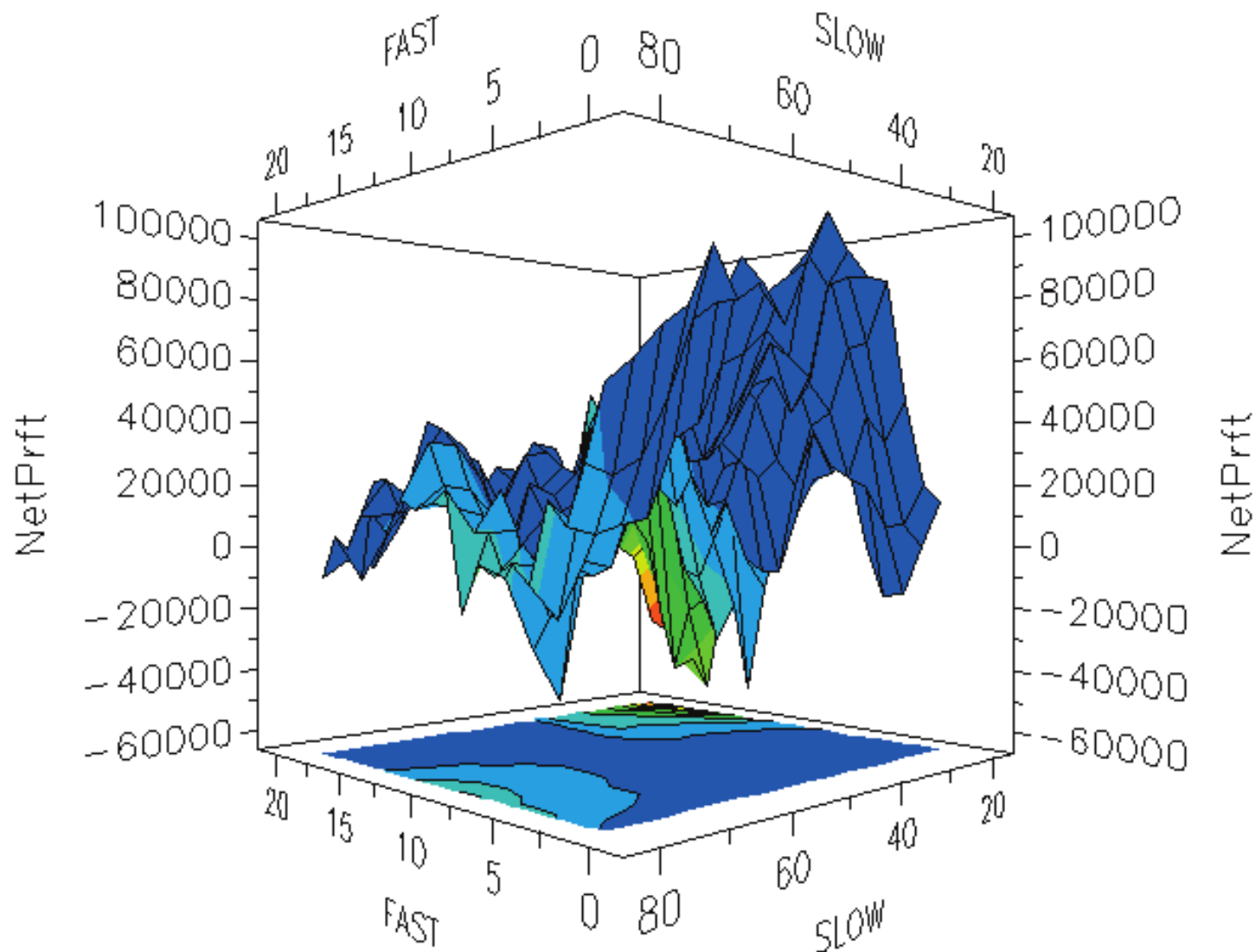
3 Parameter Optimization

Choosing stable parameters for your trading system: Net profit as a function of one system input parameter in arbitrary units. Artificially generated result of a hypothetical trading system.



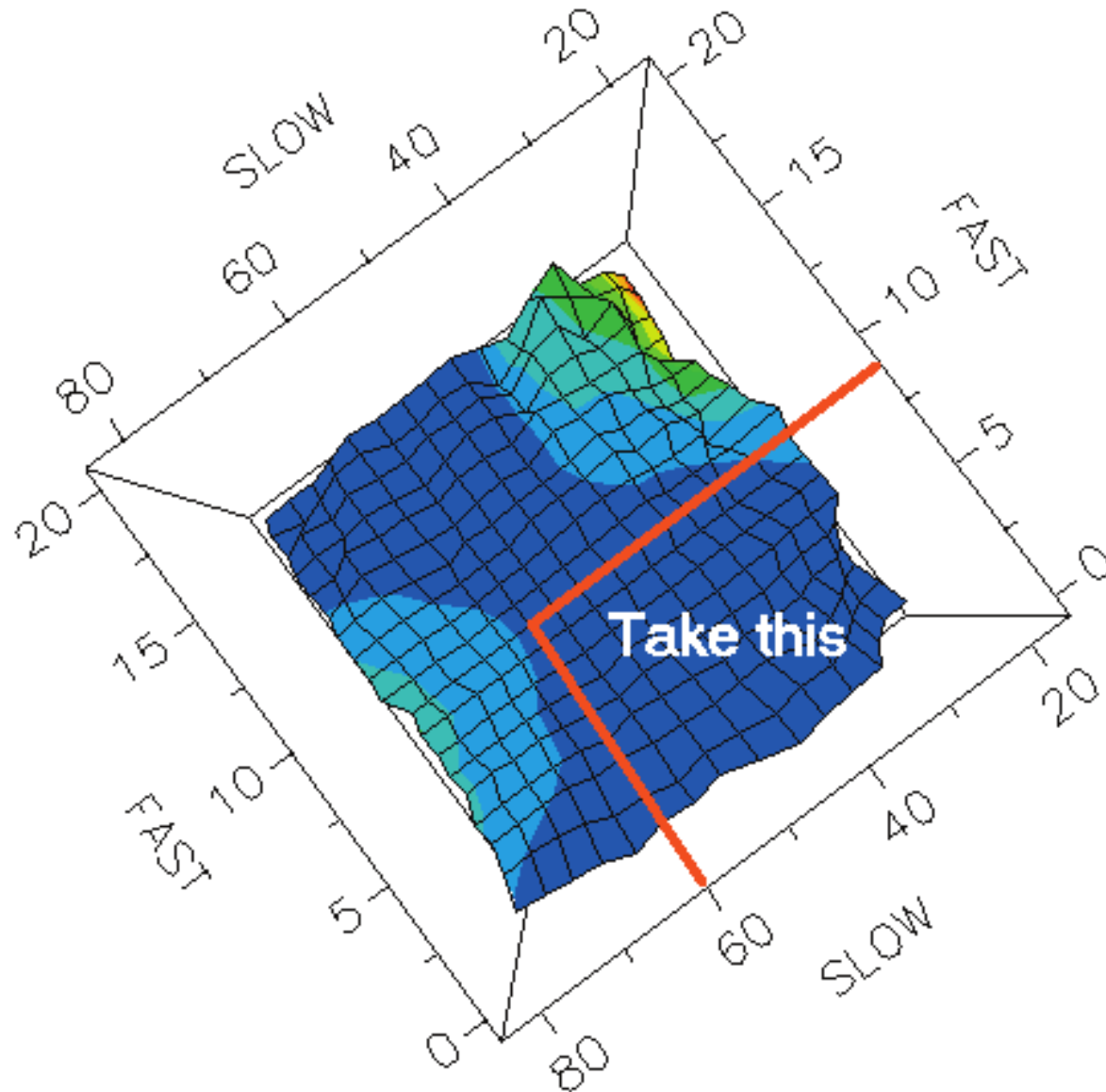
3 Parameter Optimization

Net profit in US dollars as a function of the two input parameters: fast and slow moving average. Tested on British pound/US dollar (FOREX), 30 minute bars, 21/10/2002-4/7/2008, incl. \$30 S+C per RT.



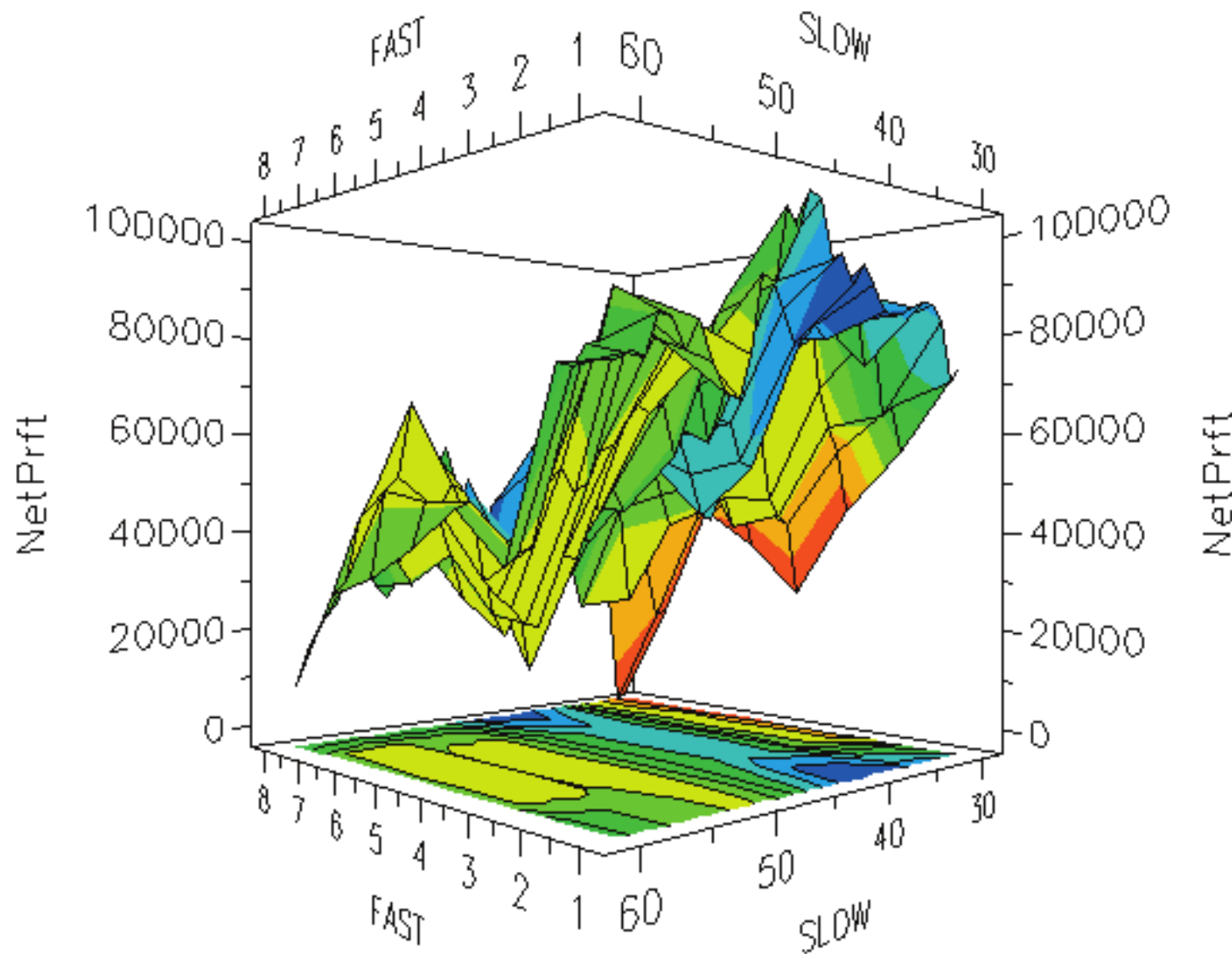
3 Parameter Optimization

- Top View - Use parameter values from center of stack



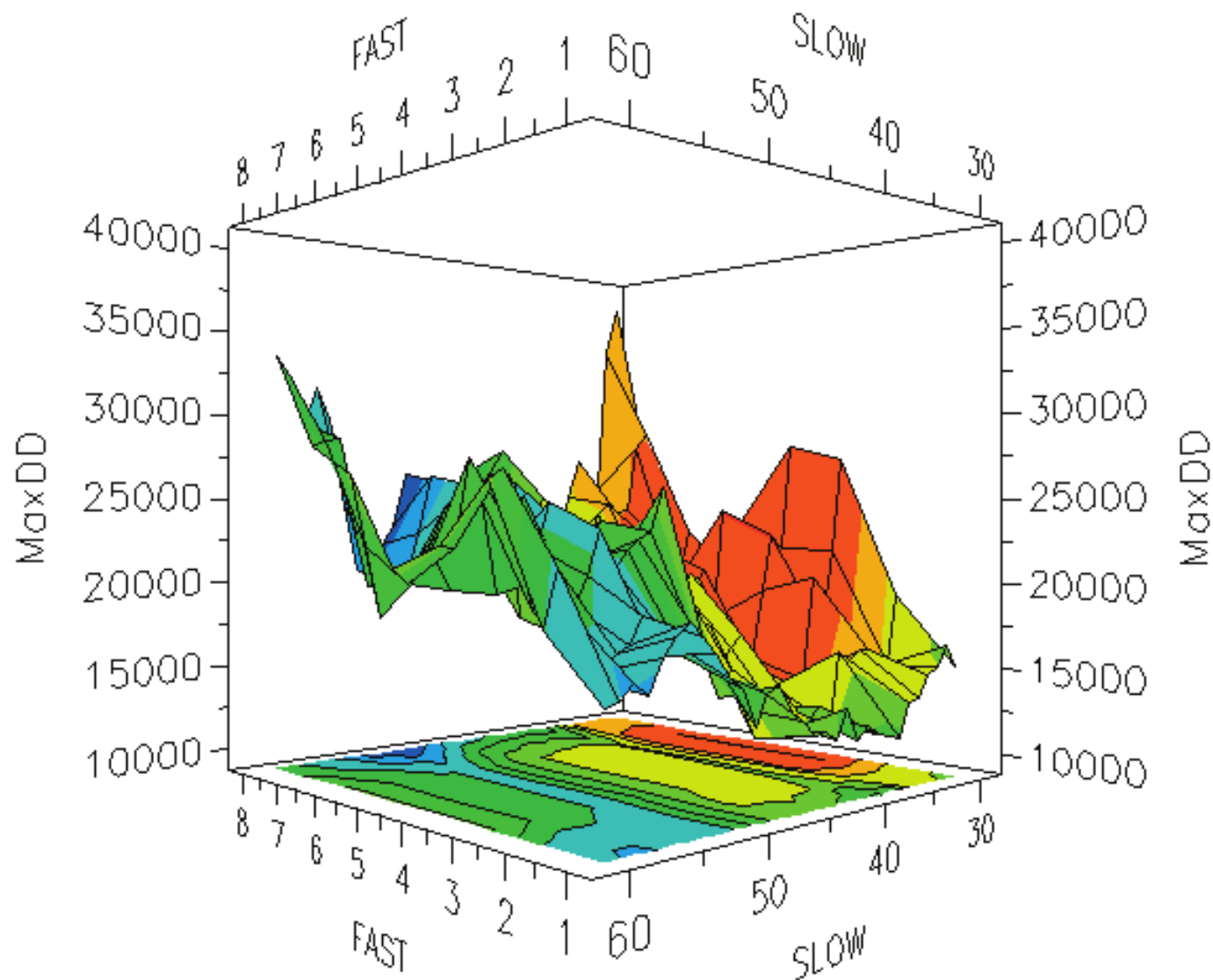
3 Parameter Optimization

Main system figures as a function of the two input parameters: fast and slow moving average. Tested on British pound/US dollar (FOREX), 30 minute bars, 21/10/2002-4/7/2008, including \$30 S+C per RT.



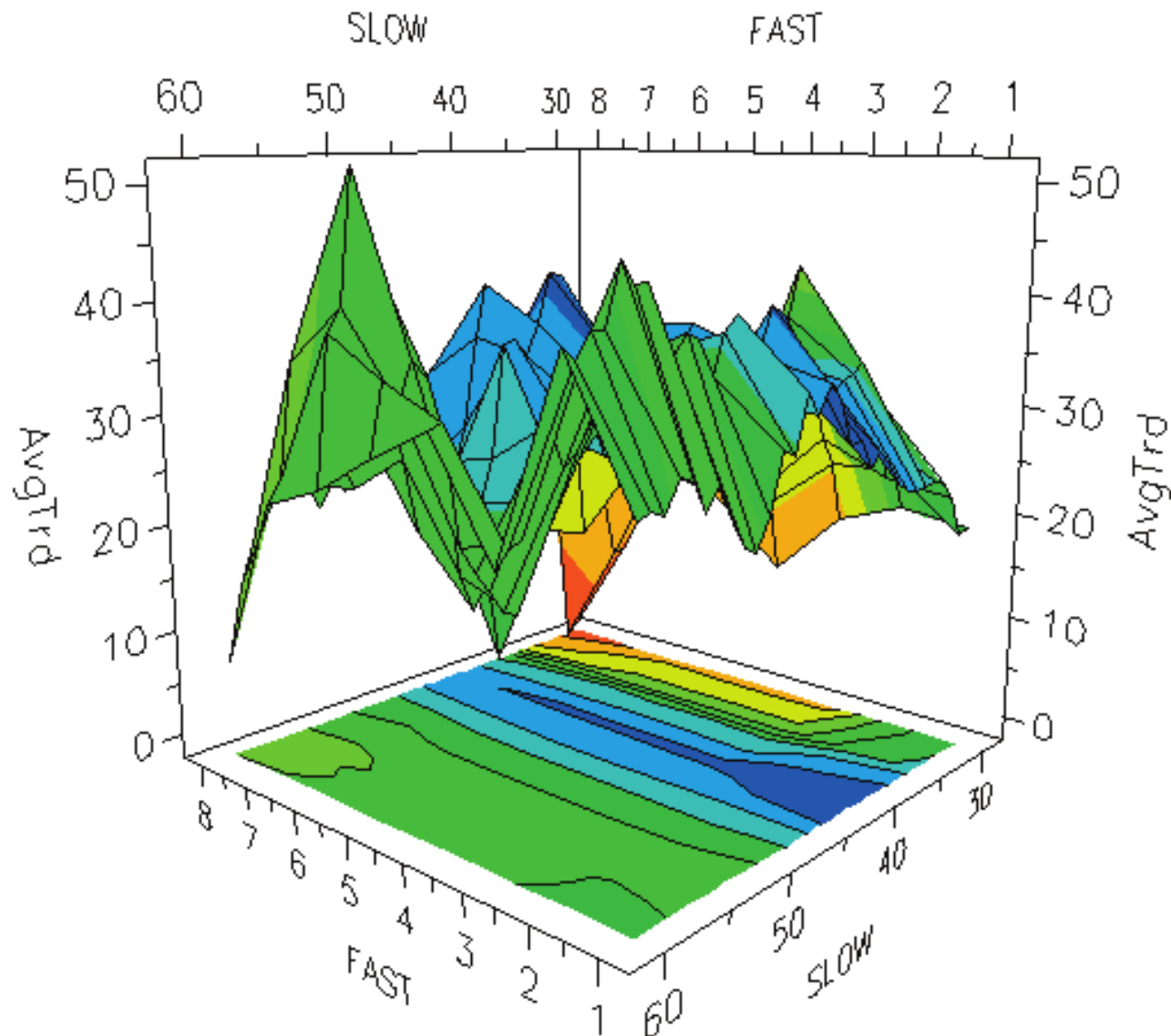
3 Parameter Optimization

Maximum intraday drawdown



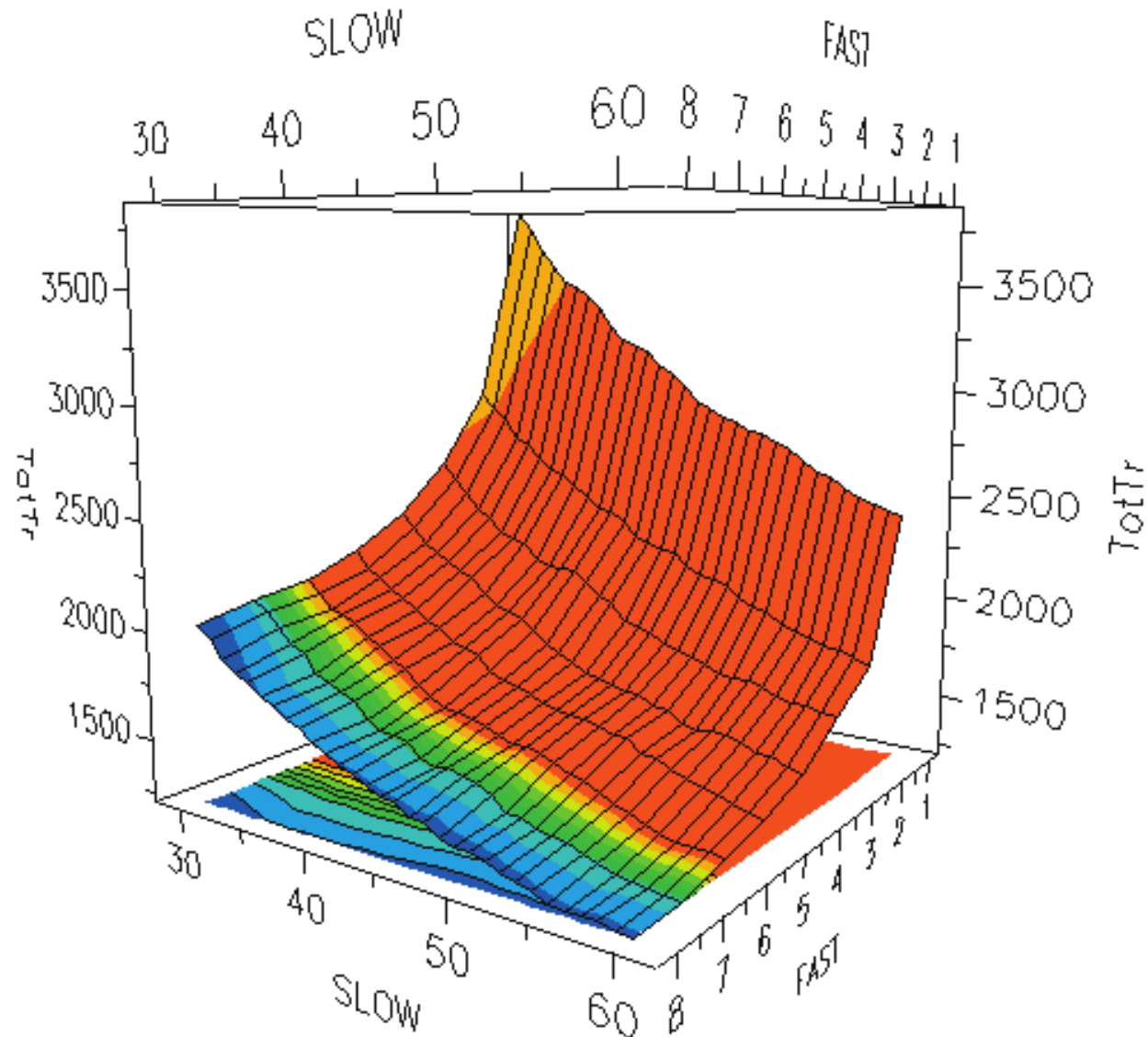
3 Parameter Optimization

Average trade net profit



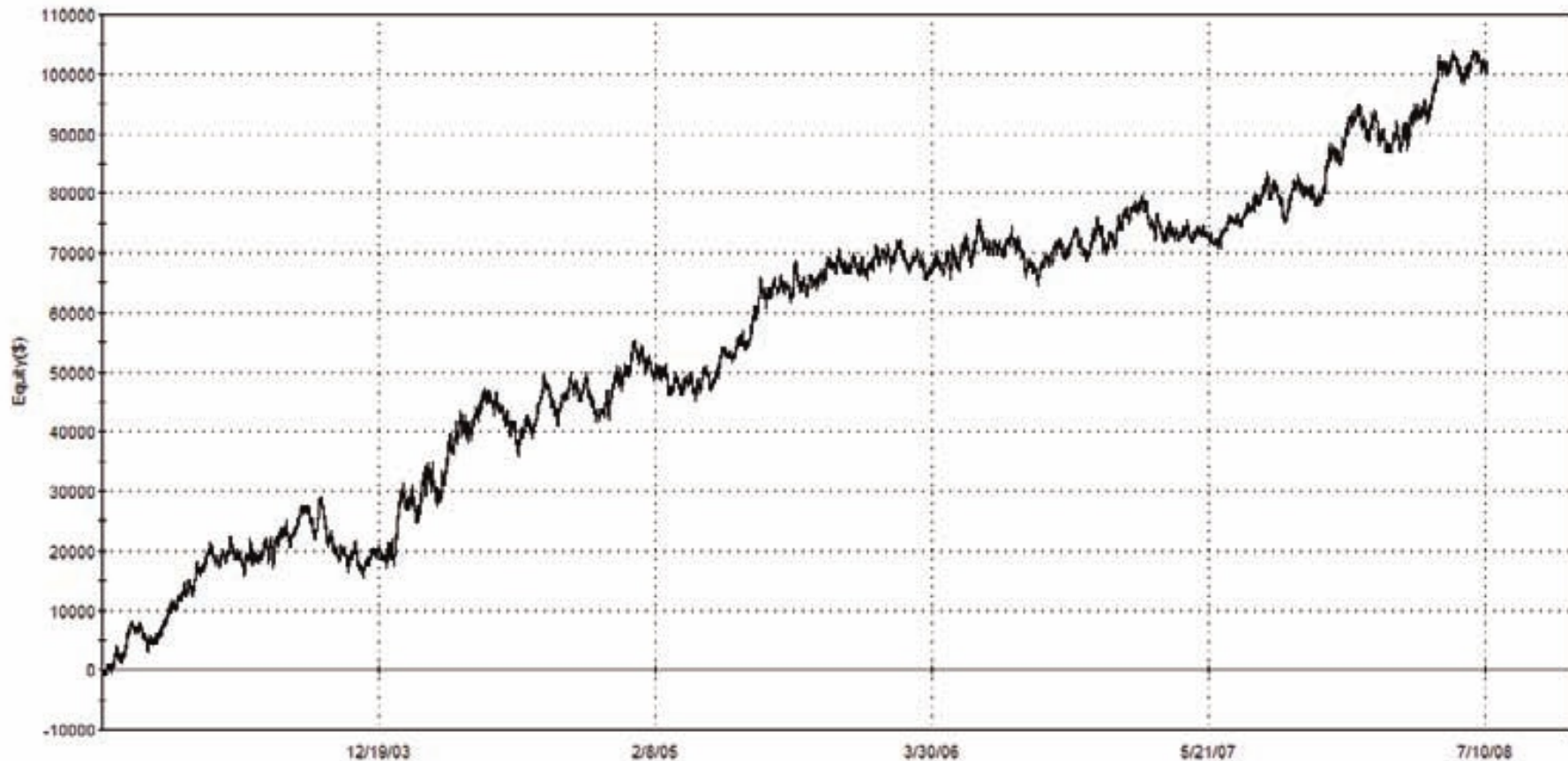
3 Parameter Optimization

Number total trades generated



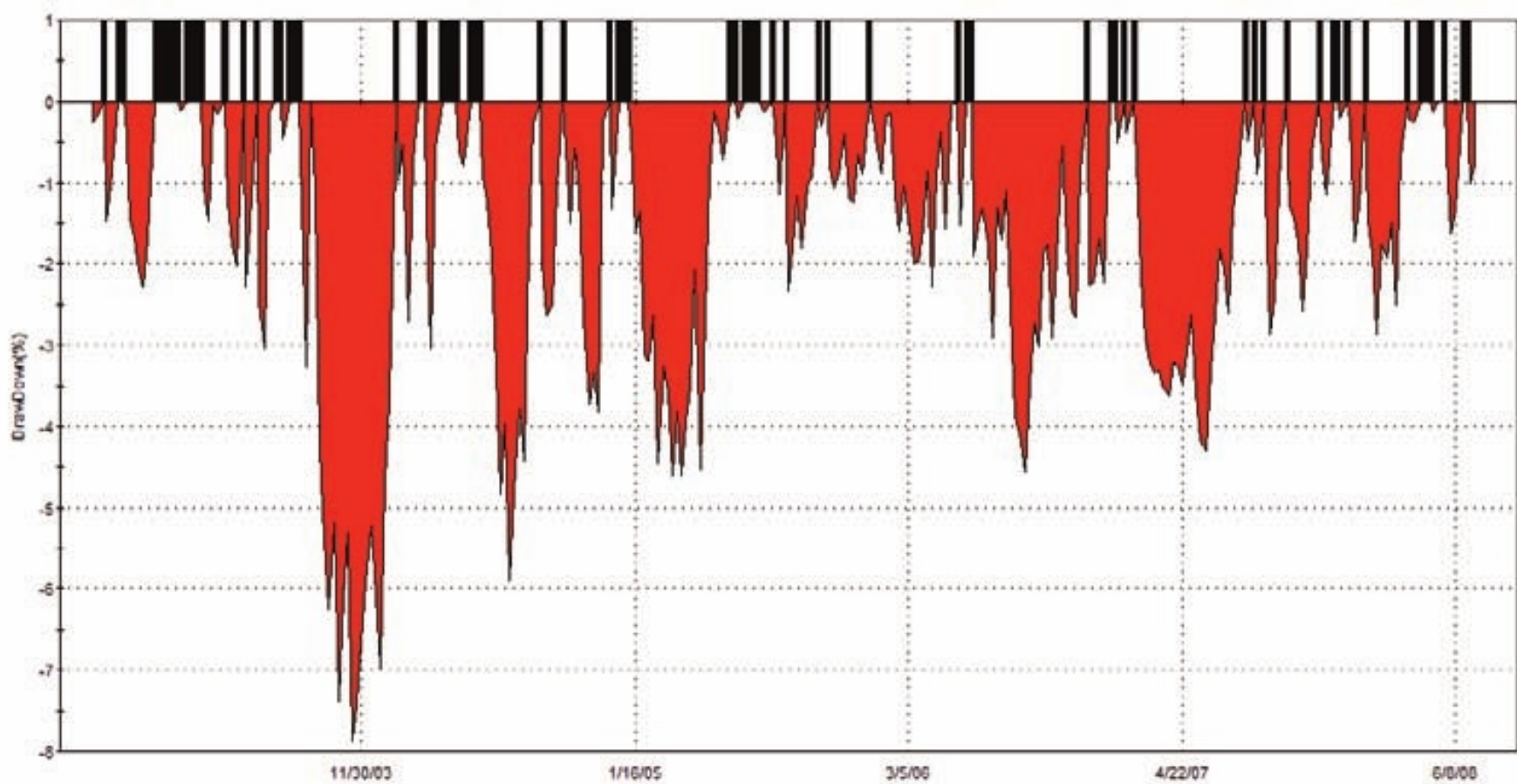
3 Parameter Optimization

Optimised input parameters in terms of net profit: SLOW=44, FAST=1. System without exits, always in the market, long or short. Back-test includes \$30 slippage and commission.



3 Parameter Optimization

- Weekly drawdown percent
- Reduced from 15% to 8% maximum



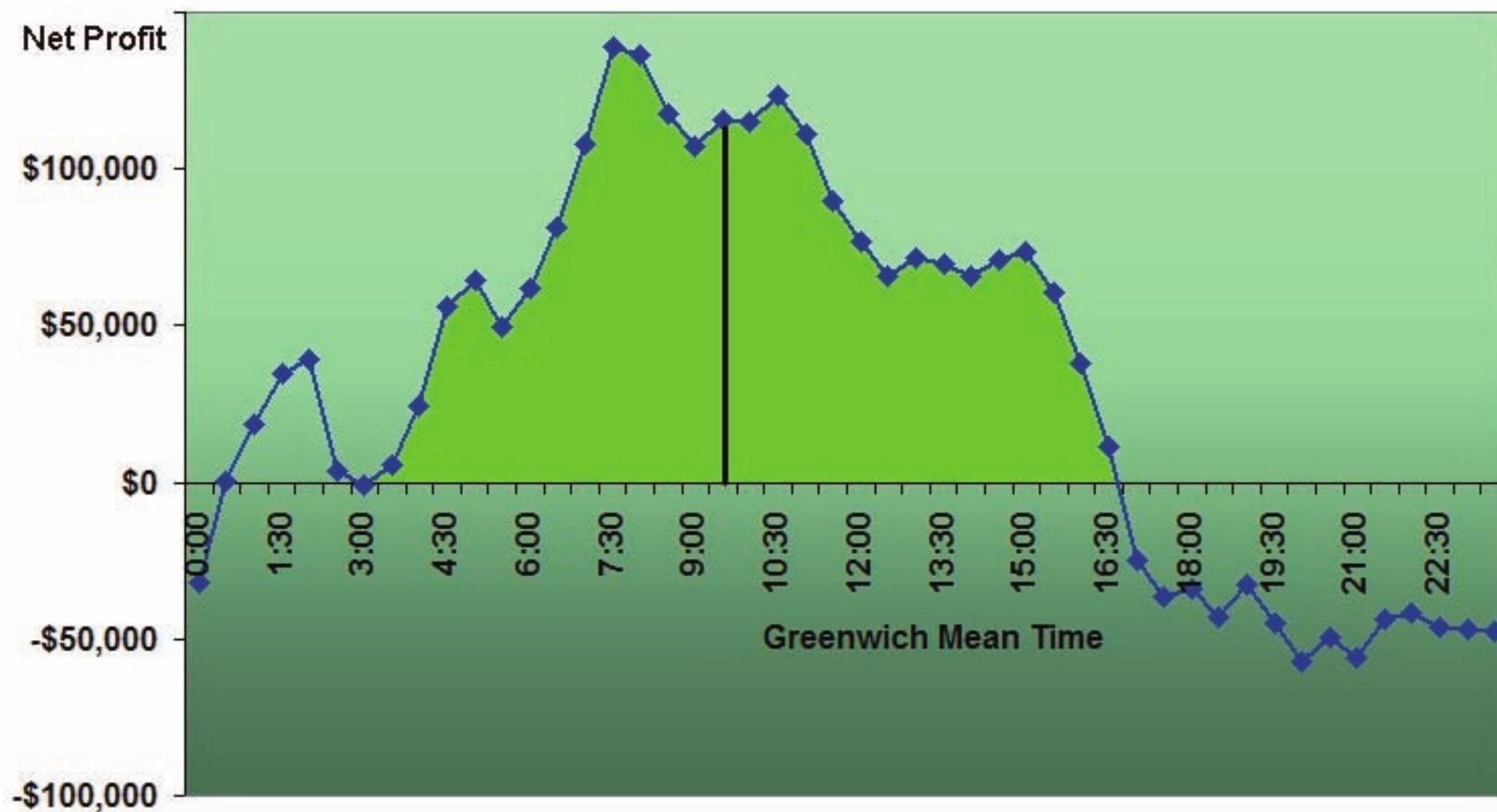
3 Parameter Optimization

Average trade net profit improved to \$33.60

	All Trades	Long Trades	Short Trades
Total Net Profit	\$100,125	\$73,888	\$26,237
Gross Profit	\$666,862	\$347,323	\$319,540
Gross Loss	(\$566,738)	(\$273,435)	(\$293,303)
Profit Factor	1.18	1.27	1.09
Total Number of Trades	2980	1490	1490
Percent Profitable	26.41 %	28.26%	24.56%
Winning Trades	787	421	366
Losing Trades	2193	1069	1124
Avg. Trade Net Profit	\$33.60	\$49.59	\$17.61
Avg. Winning Trade	\$847	\$825	\$873
Avg. Losing Trade	(\$258)	(\$256)	(\$261)
Ratio Avg. Win:Avg. Loss	3.28	3.23	3.35
Largest Winning Trade	\$5,428	\$5,428	\$4,418
Largest Losing Trade	(\$2,062)	(\$2,062)	(\$1,452)
Max. Consecutive Winning Trades	7	7	7
Max. Consecutive Losing Trades	24	18	21
Avg. Bars in Total Trades	24.69	25.61	23.77
Avg. Bars in Winning Trades	60.75	60.82	60.66
Avg. Bars in Losing Trades	11.75	11.75	11.76
Max. Drawdown (Intra-day Peak to Valley)	(\$13,440)	(\$7,594)	(\$19,284)
Date of Max. Drawdown	26-Nov-03		

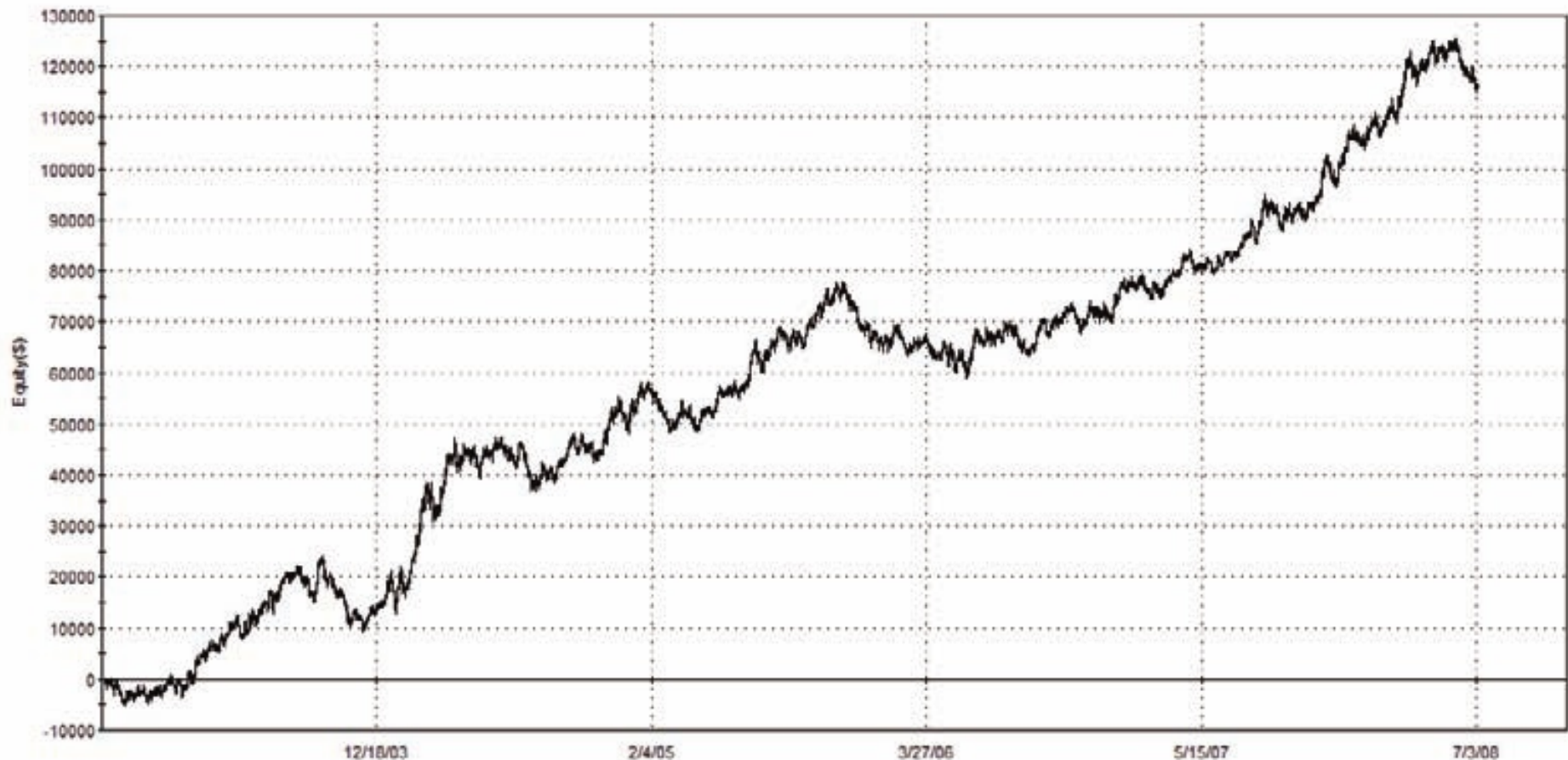
4 Intraday Time Filter

Total Net Profit as a function of the entry time of a 4-hour time window. LUXOR system, tested on British pound/US dollar (FOREX), 30 minute bars, 21/10/2002-/7/2008. SLOW=44, FAST=1. Calculation incl. \$30 S+C per RT. No exits are in place



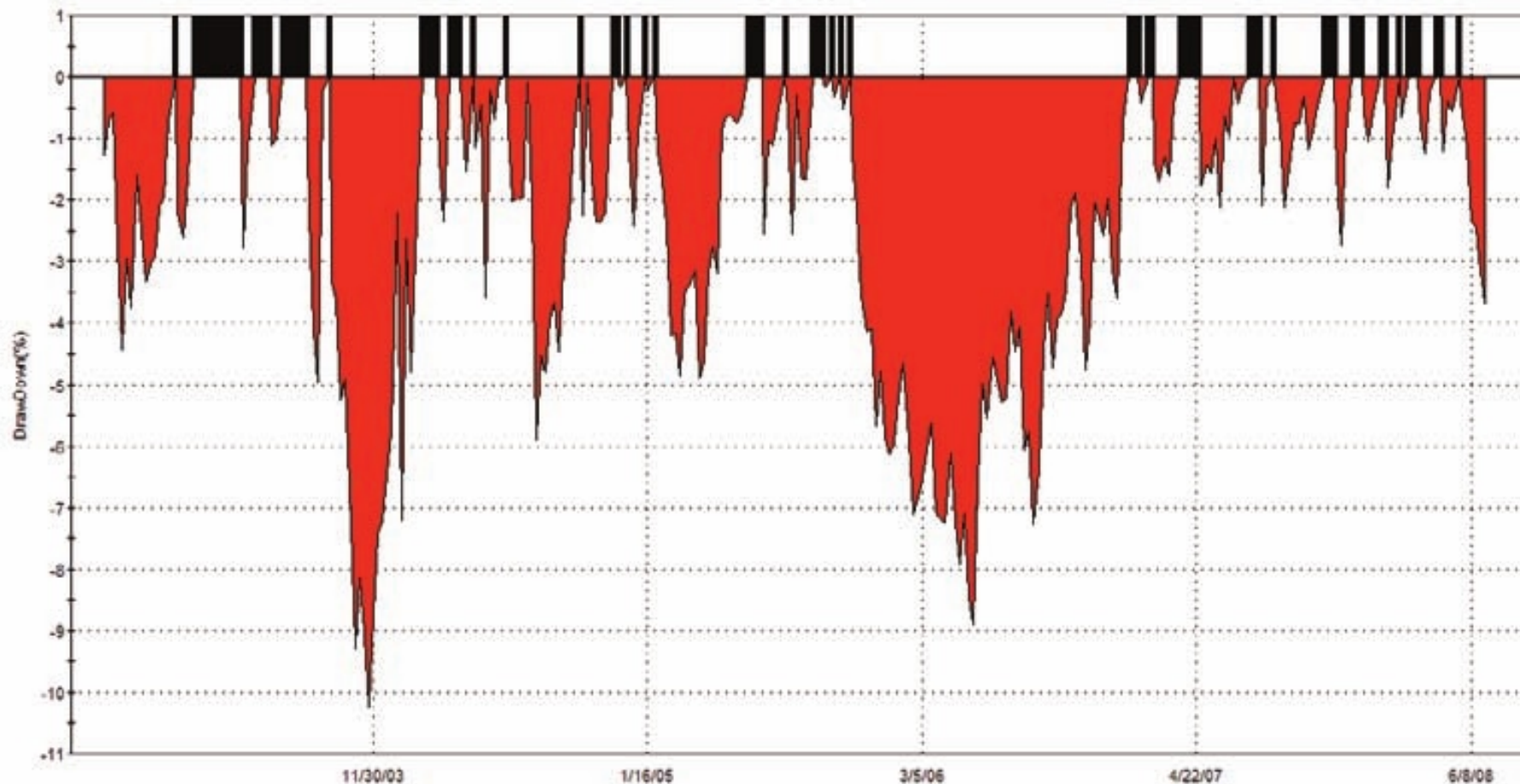
4 Intraday Time Filter

LUXOR system results with added time filter. Entries only allowed in the 4-hour time window from 9.30am–1.30pm GMT. A: detailed equity curve. B: weekly underwater equity curve. British pound/US dollar (FOREX), 30 minute bars, 21/10/2002–4/7/2008. Optimised input parameters in terms of net profit: SLOW=44, FAST=1. Test without exits. Back-test includes \$30 slippage and commission.



4 Intraday Time Filter

LUXOR system results with added time filter. Entries only allowed in the 4-hour time window from 9.30am–1.30pm GMT. A: detailed equity curve. B: weekly underwater equity curve. British pound/US dollar (FOREX), 30 minute bars, 21/10/2002-4/7/2008. Optimized input parameters in terms of net profit: SLOW=44, FAST=1. Test without exits. Back-test includes \$30 slippage and commission.



4 Intraday Time Filter

- Number trades 3000 to 902
- Net profit \$100,000 to \$115,000
- Average trade net profit \$33.00 to \$128

	All Trades	Long Trades	Short Trades
Total Net Profit	\$115,502	\$82,050	\$33,452
Gross Profit	\$428,864	\$226,323	\$202,541
Gross Loss	(\$313,362)	(\$144,273)	(\$169,089)
Profit Factor	1.37	1.57	1.2
Total Number of Trades	902	451	451
Percent Profitable	42.02%	44.79%	39.25%
Winning Trades	379	202	177
Losing Trades	523	249	274
Avg. Trade Net Profit	\$128	\$182	\$74
Avg. Winning Trade	\$1,132	\$1,120	\$1,144
Avg. Losing Trade	(\$599)	(\$579)	(\$617)
Ratio Avg. Win:Avg. Loss	1.89	1.93	1.85
Largest Winning Trade	\$6,748	\$6,748	\$5,728
Largest Losing Trade	(\$2,531)	(\$2,531)	(\$2,442)
Max. Consecutive Winning Trades	6	7	6
Max. Consecutive Losing Trades	13	8	11
Avg. Bars in Total Trades	78.82	78.44	79.2
Avg. Bars in Winning Trades	116.73	113.29	120.66
Avg. Bars in Losing Trades	51.34	50.16	52.41
Total Slippage	\$18,040	\$9,020	\$9,020
Total Commission	\$9,020	\$4,510	\$4,510
Percent of Time in the Market	99.92%		
Max. Drawdown (Intra-day Peak to Valley)	\$18,894	\$9,402	\$17,378
Date of Max. Drawdown	24-May-06		

5 Exits

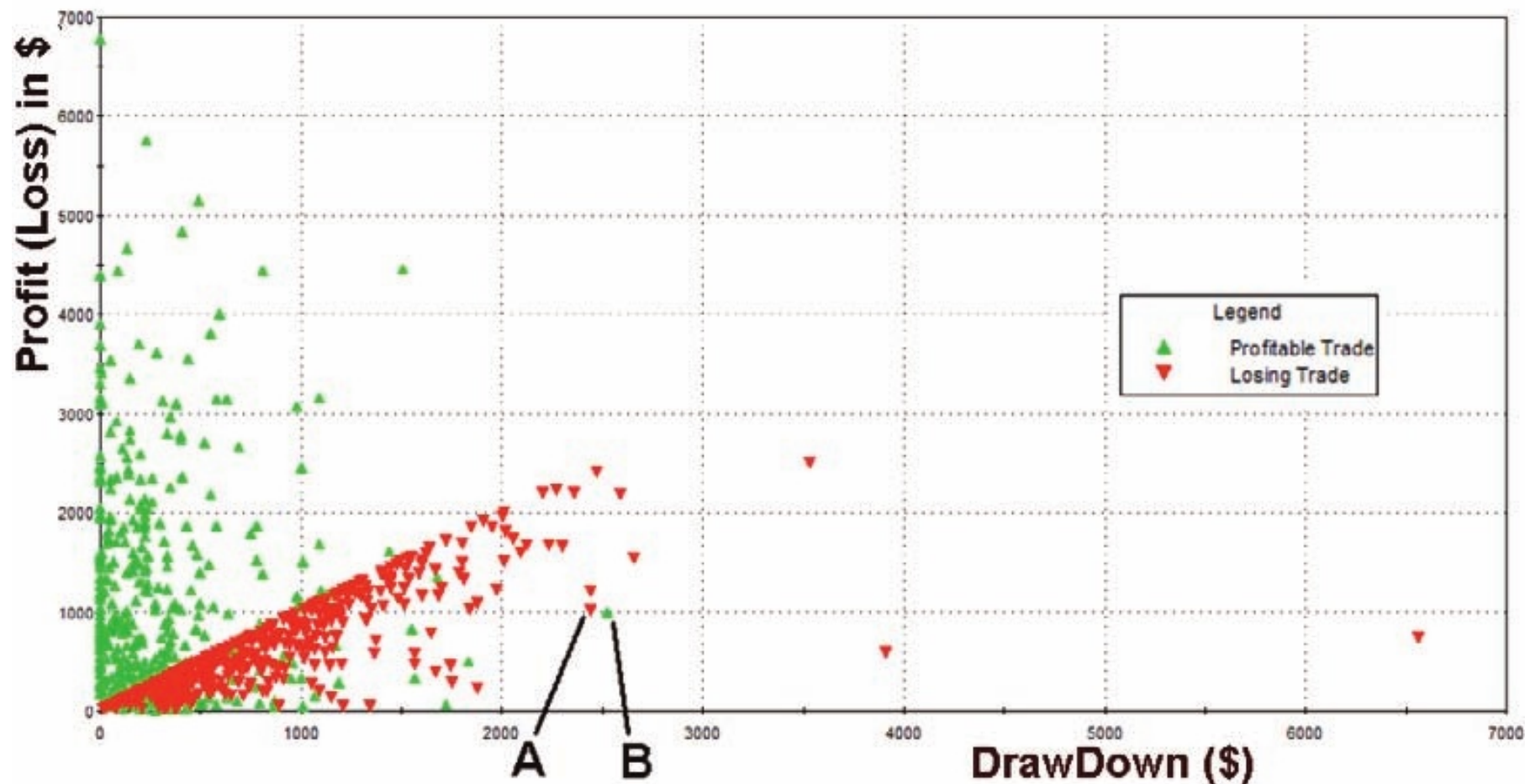
The Dynamic of Exits. In the phase of low volume and low volatility different exits are needed than in the phase of increasing volume with the short breakout. Chart example was taken from Light Crude Oil, 5 minute, NYMEX from 22 August 2008.



5 Exits – Dollar MAE

The MAE graph of LUXOR system. Green: winning trades, red: losing trades. System tested on British pound/US dollar (FOREX), 30 minute bars, 21/10/2002-4/7/2008, with entry time window 9.30am-1.30pm GMT. Input parameters SLOW=44, FAST=1. Without exits, always in the market, including \$30 S+C per RT.

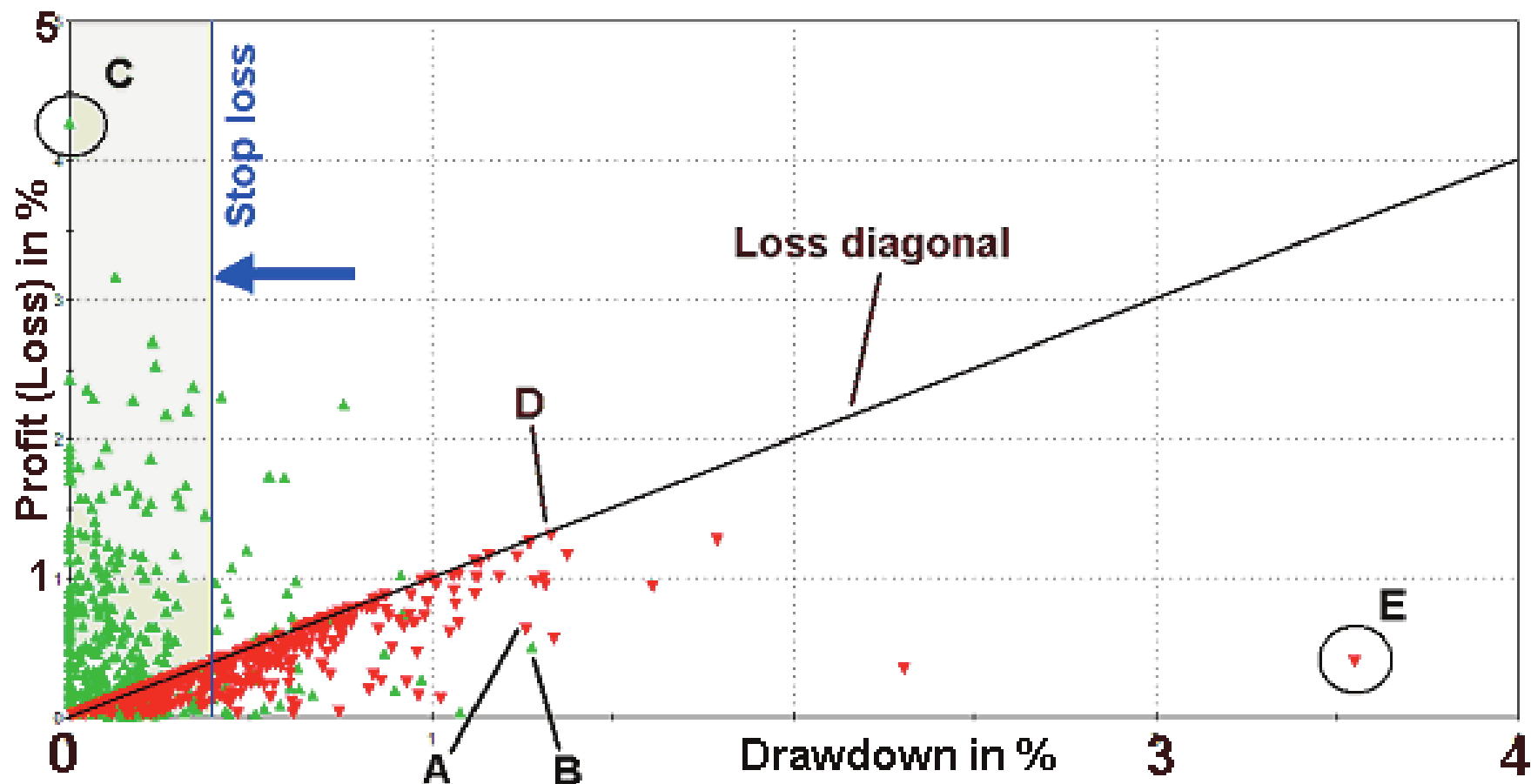
- A and B reached \$2400 draw down level at some point during trade
- B recovered to become profitable at \$1000
- A partially recovered and finished as a loss \$1000



5 Exits – Percent MAE

MAE graph in percentage terms. Green up arrows = winning trades, red down arrows = losing trades. Trend-following system British pound/US dollar (FOREX), 30 minute bars, 21/10/2002-4/7/2008, with entry time window 9.30am-1.30pm GMT. Input parameters SLOW=44, FAST=1. Without exits, always in the market, including \$30 S+C per RT.

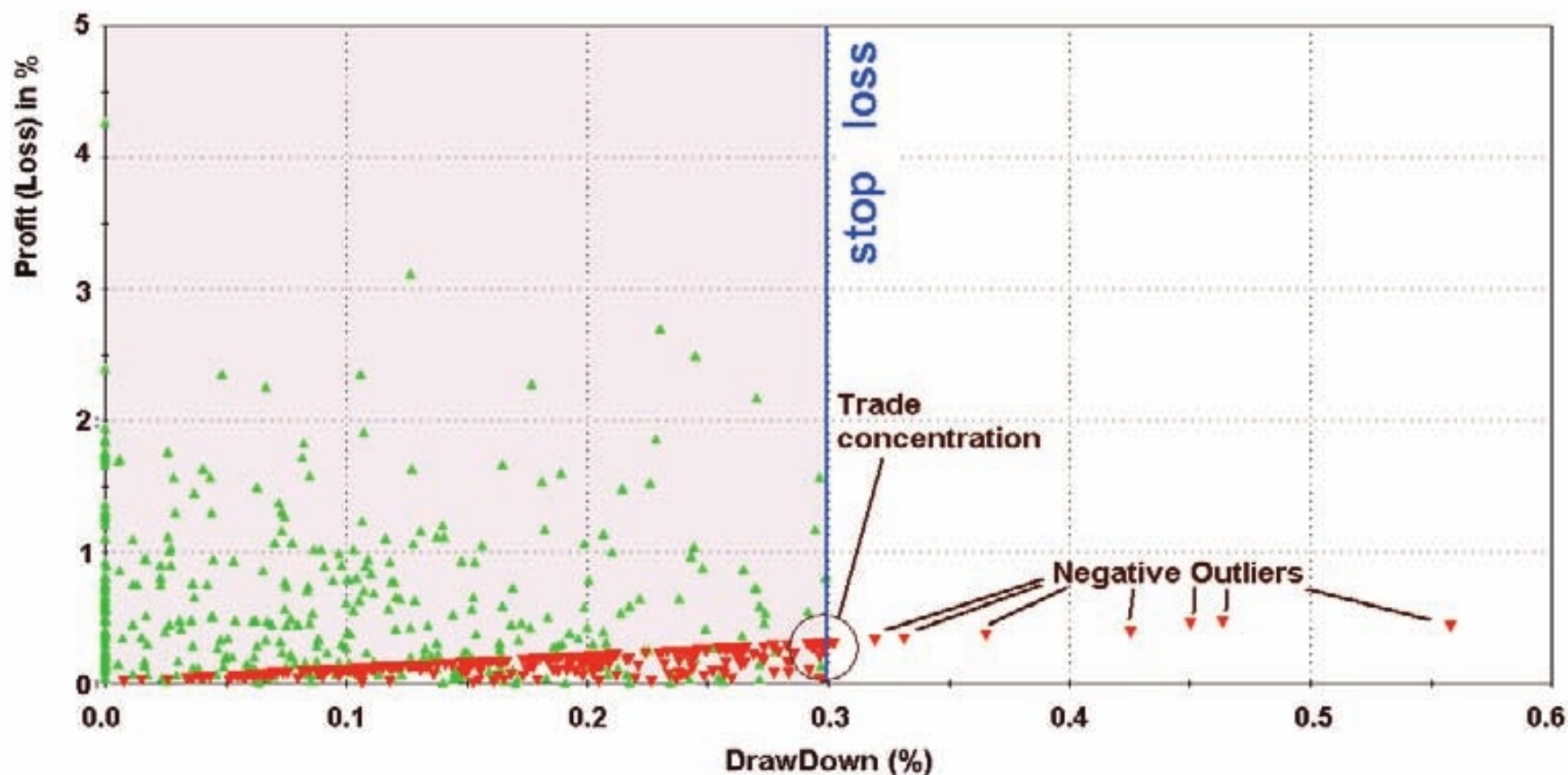
- A and B further apart as MAE occurred at different price levels
- C best type of trade – high profit with no draw down
- D final loss is equal to maximum draw down
- E large 3.5% draw down which recovered 0.5% loss



5 Exits – Choosing Stop Loss

Maximum Adverse Excursion graph in percentage terms after inserting a 0.3% stop loss into the system. LUXOR system tested on British pound/US dollar (FOREX), 30 minute bars, 21/10/2002-4/7/2008, with entry time window 9.30am-1.30pm GMT. Input parameters SLOW=44, FAST=1.

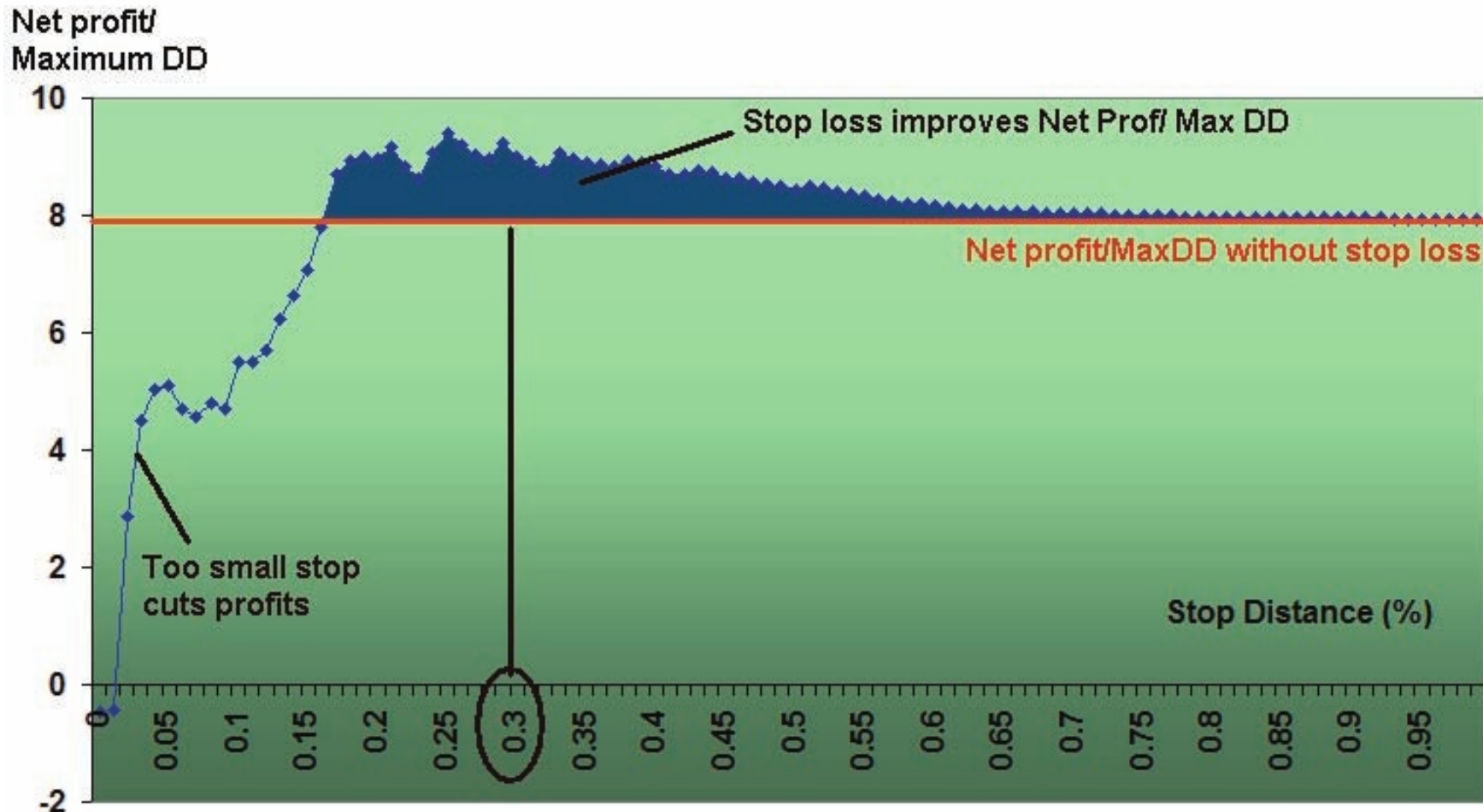
- 0.3% stop loss
 - All losses greater 0.3% move close to 0.3% losses
 - Profitable trades with greater than 0.3% MAE to become losses
- Slippage and gaps result in some loss outliers over 0.3%



6 Risk Stop Loss

Ratio of total net profit/maximum intraday drawdown as a function of the stop loss distance in per cent. LUXOR system tested on British pound/US dollar (FOREX), 30 minute bars, 21/10/2002-4/7/2008, with entry time window 9.30am-1.30pm GMT. SLOW=44, FAST=1. Including \$30 S+C per RT.

Validate choice of 0.3% stop loss with parameter optimization and choose more stable region if needed

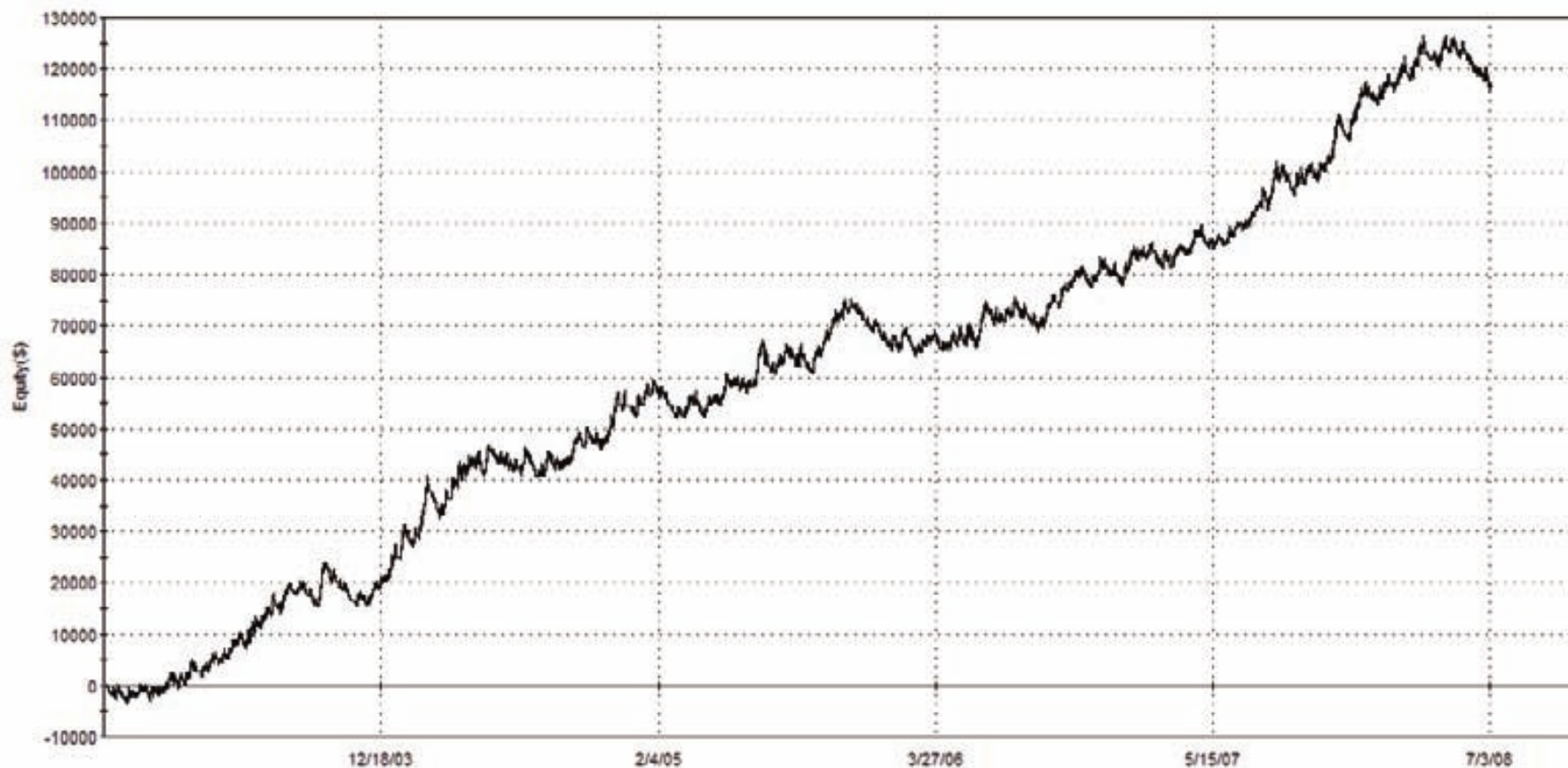


6 Risk Stop Loss

Detailed equity curve, B: underwater equity curve with 0.3% risk stop loss in place. LUXOR system tested on British pound/US dollar (FOREX), 30 minute bars, 21/10/2002-4/7/2008, with entry time window 9.30am-1.30pm GMT. SLOW=44, FAST=1. Including 30 \$S+C per RT.

Profitability approximately the same

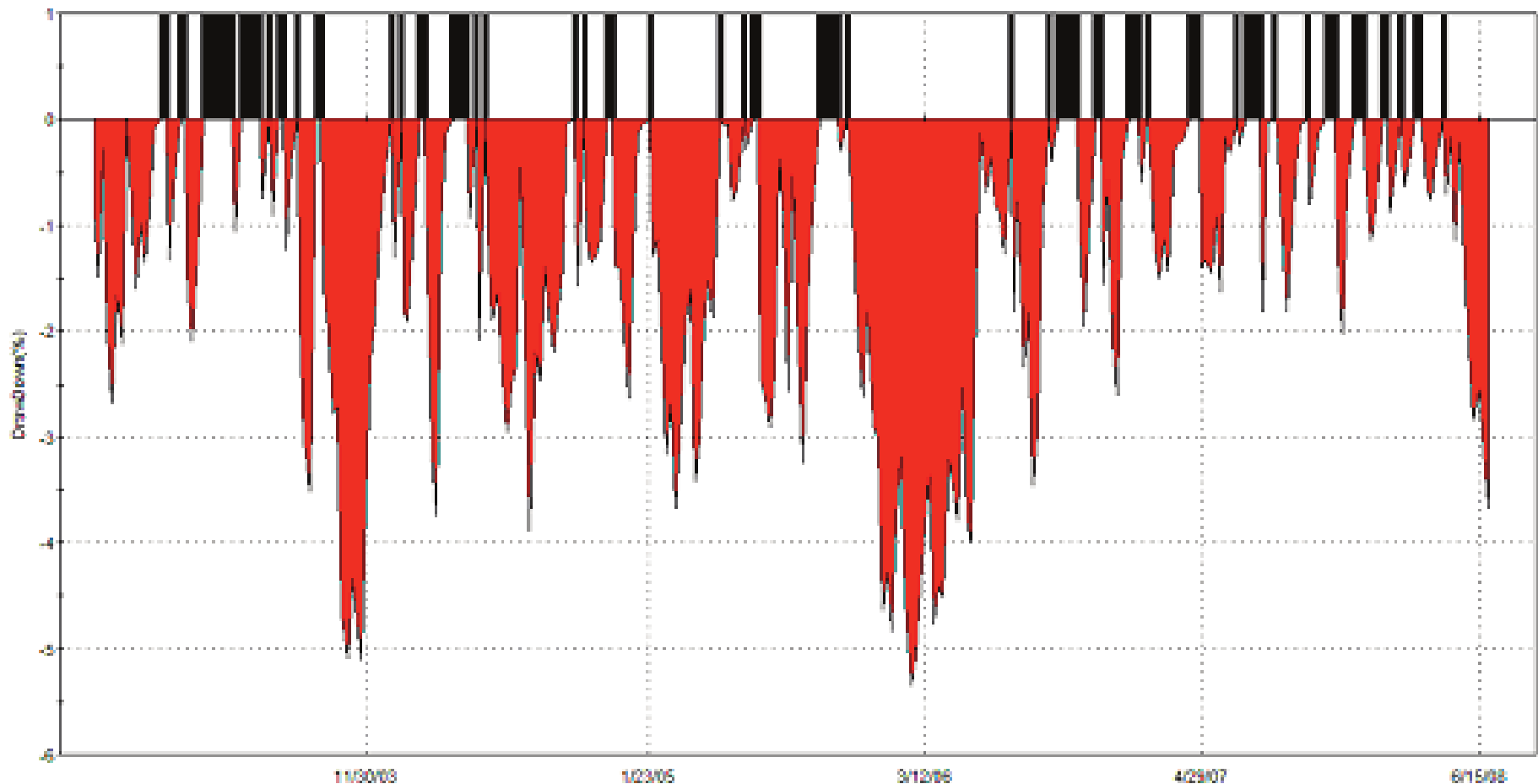
- Net profit \$115,000 to \$116,000
- Avg trade profit \$128 to \$113



6 Risk Stop Loss

System risk decreased

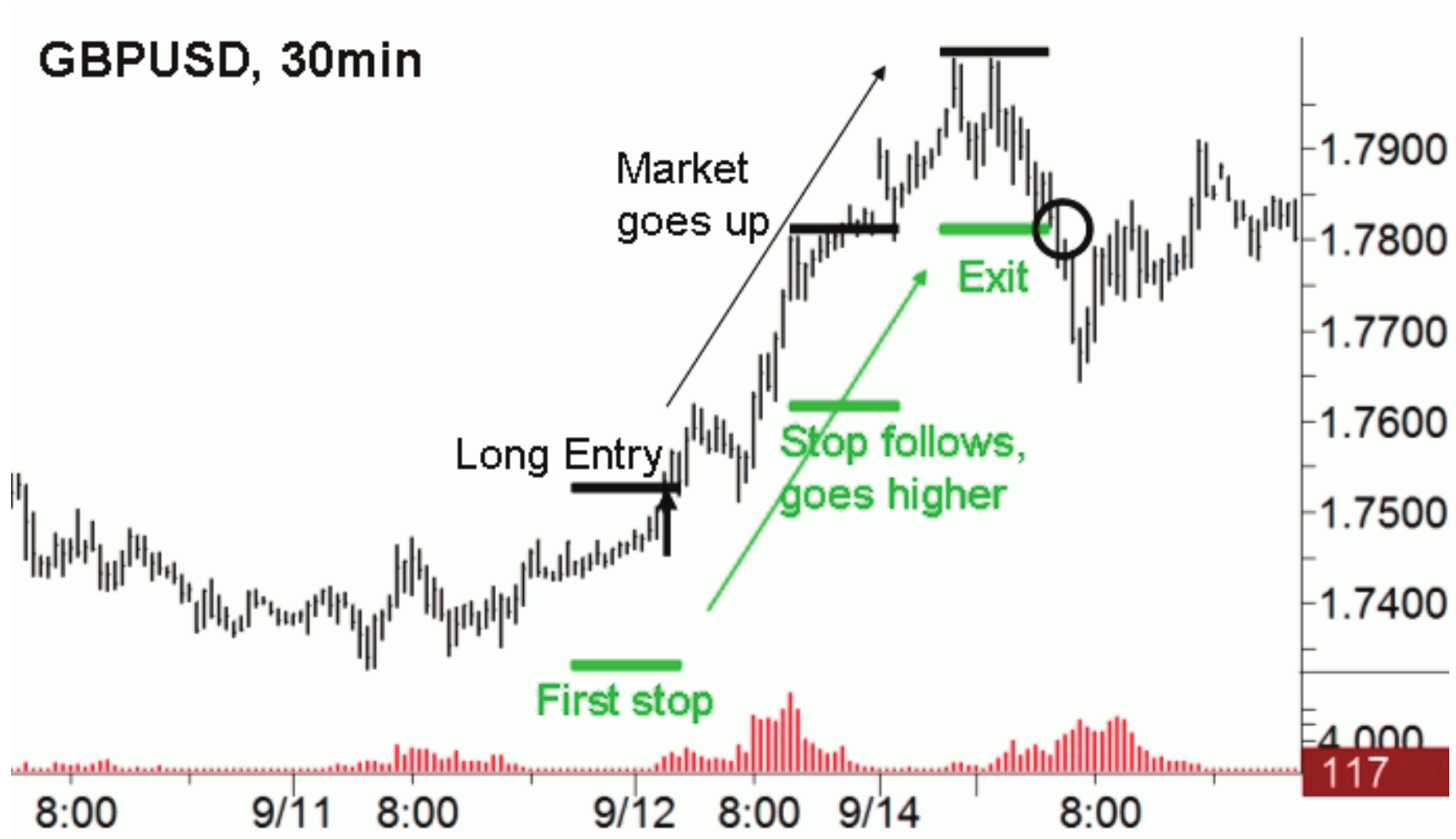
- Maximum draw down reduced from 10% (\$18,000) to 5% (\$11,000)
- Largest losing trading reduced from \$2500 to \$810



7 Trailing Stop

The principle of a trailing stop. Chart example from British pound/US dollar (FOREX), 30 minute bars, September 2008.

- Protects achieved profits
- Specify initial stop and trailing percent

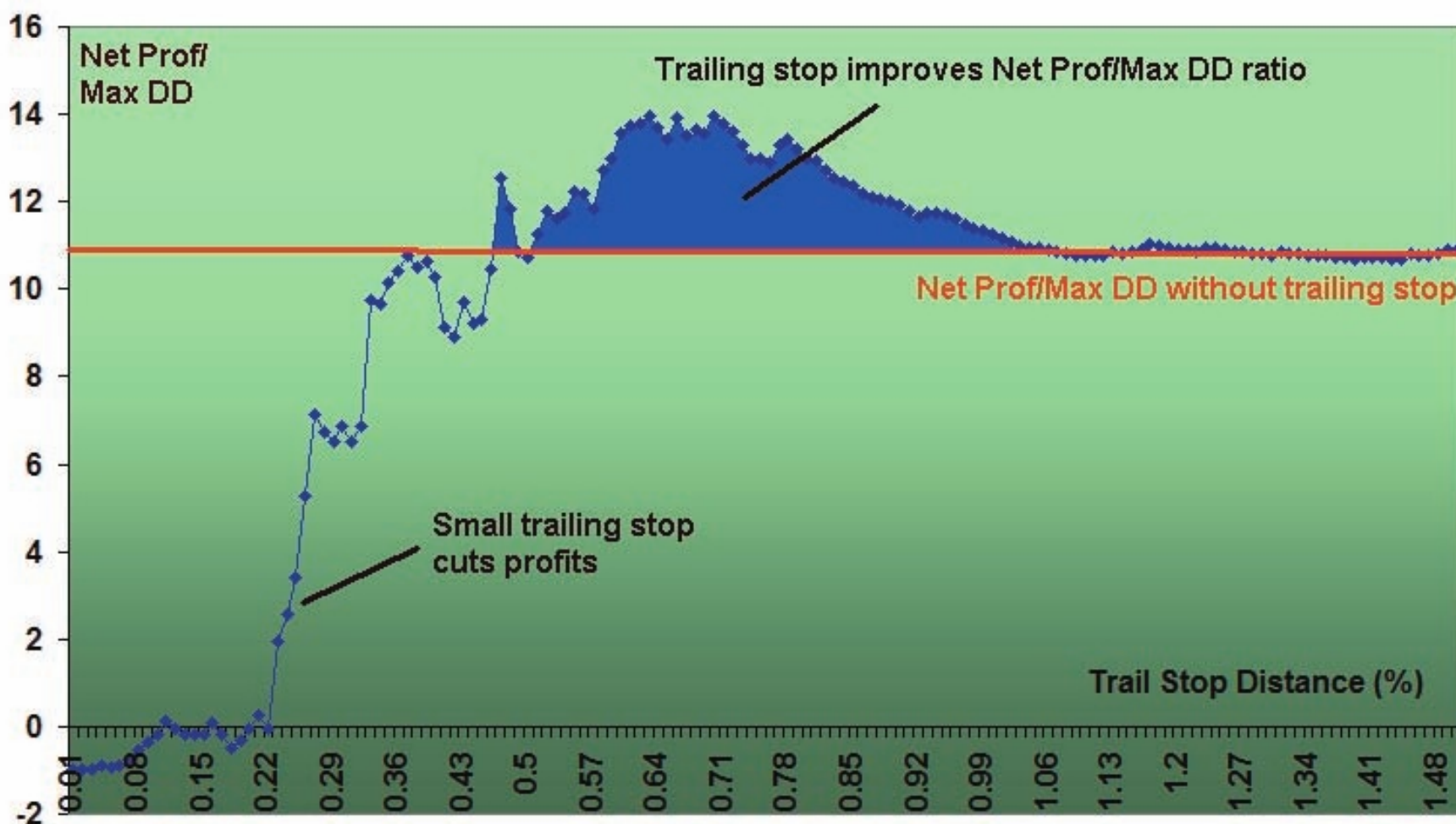


7 Trailing Stop

Ratio of total net profit/maximum intraday drawdown as a function of the distance of an added trailing stop. Risk stop loss of 0.3% kept in place. LUXOR system tested on British pound/US dollar (FOREX), 30 minute bars, 21/10/2002-4/7/2008, with entry time window 9.30am-1.30pm GMT. SLOW=44, FAST=1. Including \$30 S+C per RT.

Choose stop loss value using parameter optimization

- 0.8% selected on right of center to avoid drop off

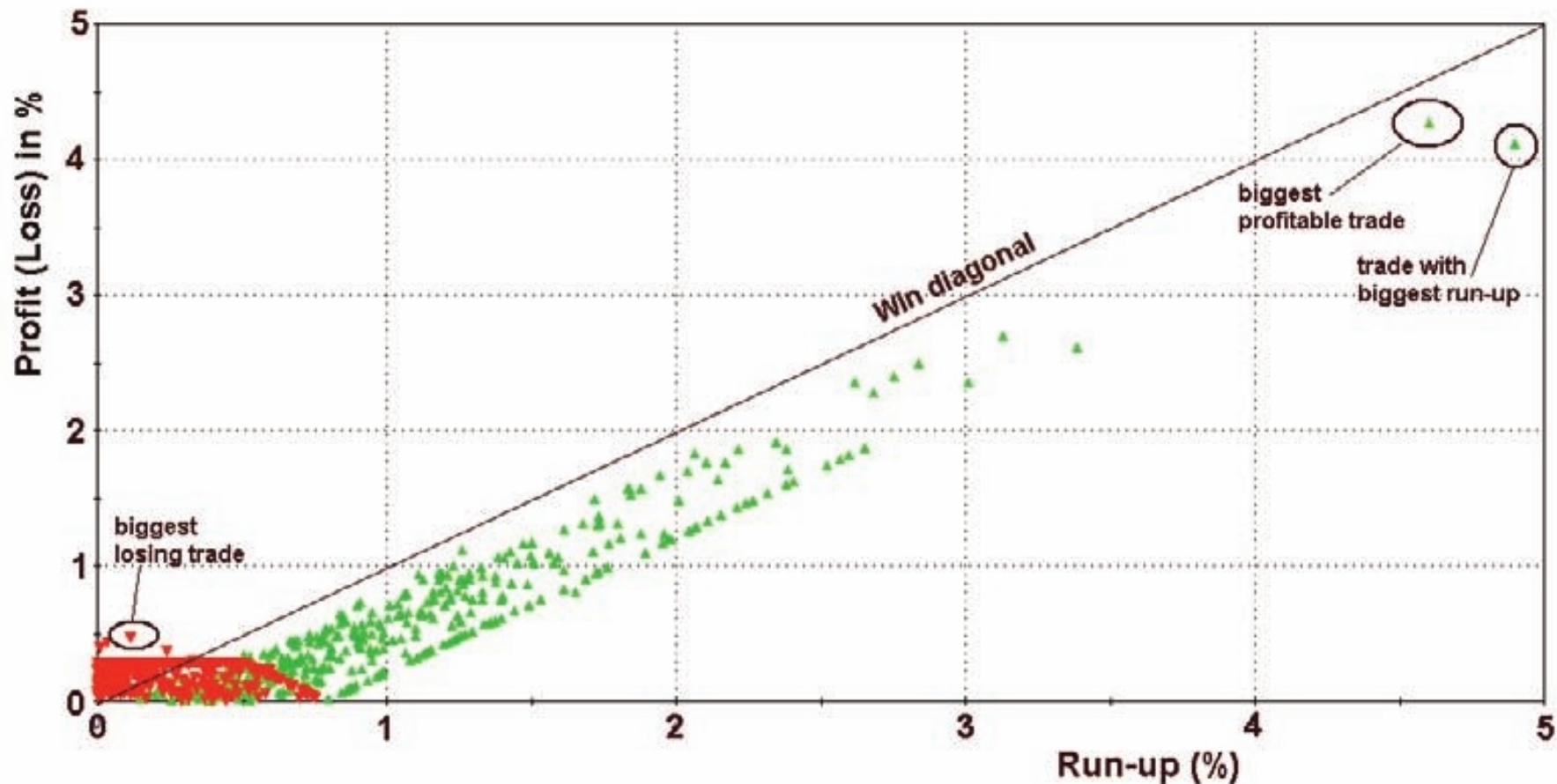


8 Profit Targets

The MFE graph shows the realised profit/loss vs. run-ups of all trades. Green: winning trades, red: losing trades. LUXOR system tested on British pound/US dollar (FOREX), 30 minute bars, 21/10/2002-4/7/2008, with 0.3% risk stop and 0.8% trailing stop. Input parameters SLOW=44, FAST=1, including \$30 S+C per RT.

Profit targets most likely not helpful

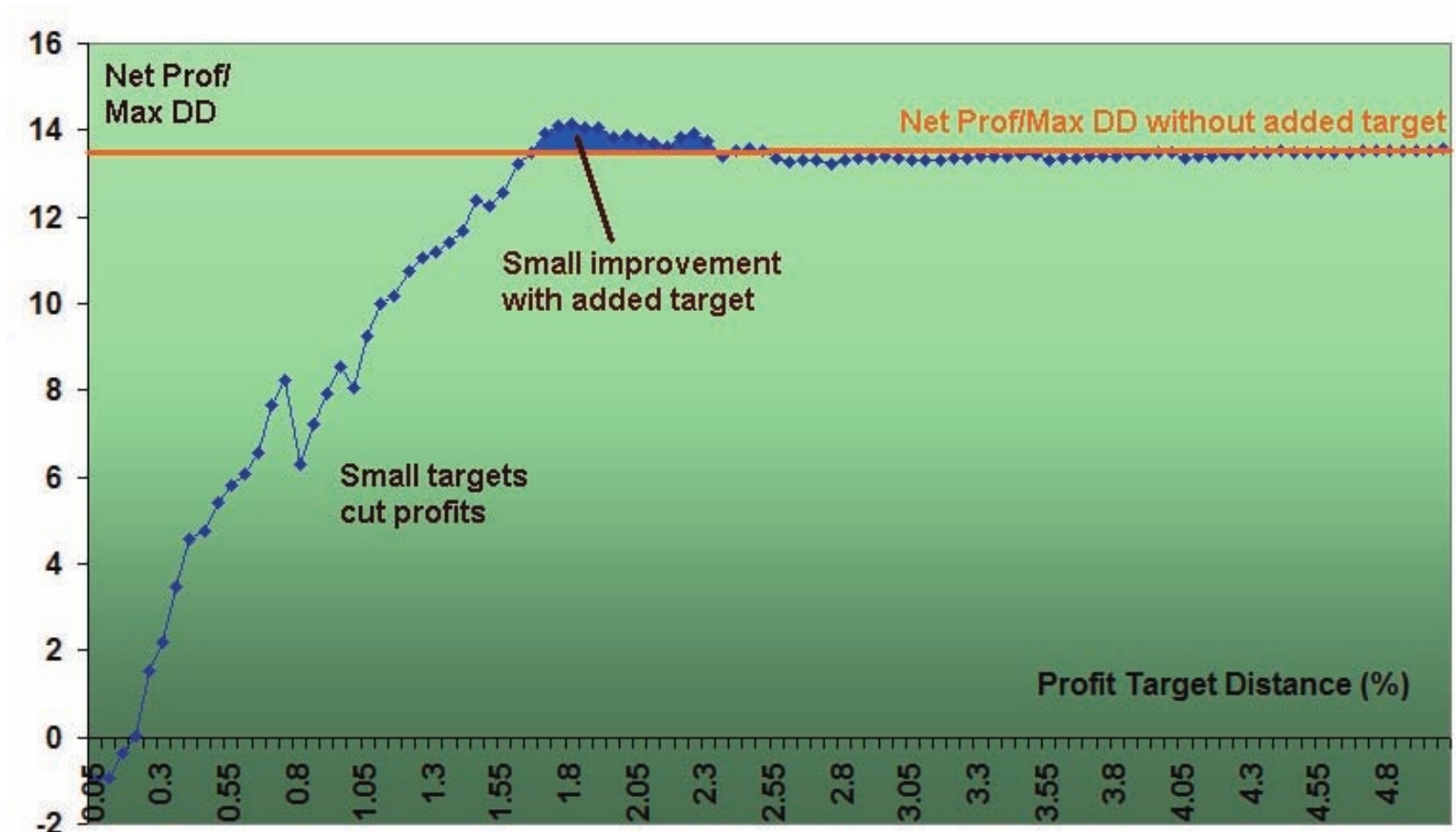
- Losing trades do not exhibit significant favorable excursion
- Winning trades do not slip far from their MFE



8 Profit Targets

Ratio of total net profit/maximum intraday drawdown as a function of the distance of an added profit target. Risk stop loss of 0.3% and trailing stop of 0.8% are kept in place during tests. LUXOR system tested on British pound/US dollar (FOREX), 30 minute bars, 21/10/2002-4/7/2008, with entry time window 9.30am-1.30pm GMT. SLOW=44, FAST=1. Including. \$30 S+C per RT.

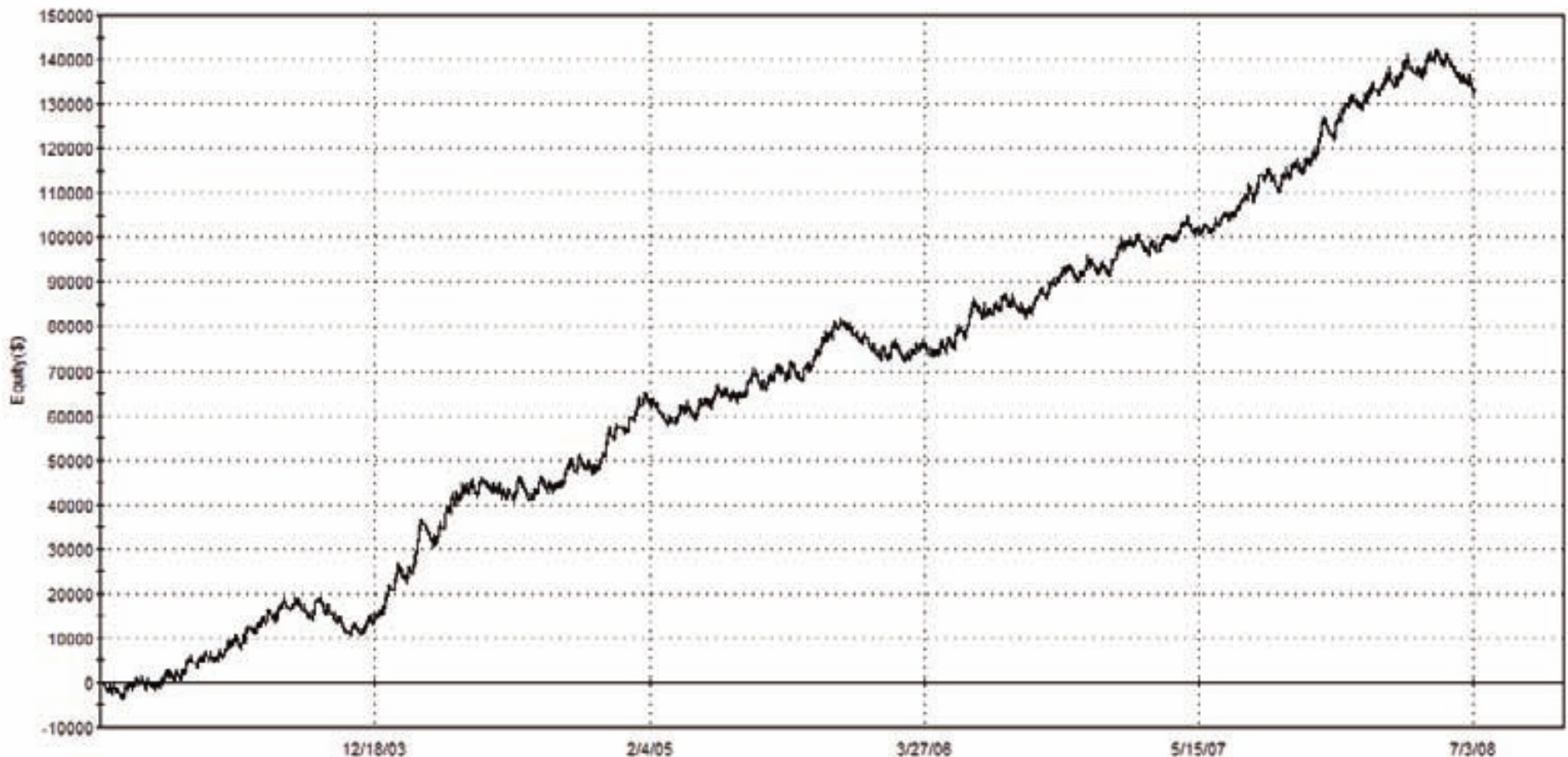
- Profit target less than 1.7% degrades base system performance
- Profit target larger than 1.7% does not result in significant gains



Results

LUXOR system with all three exits in place: 0.3% risk stop, 0.8% trailing stop and 1.9% profit target, tested on British pound/US dollar (FOREX), 30 minute bars, 21/10/2002-4/7/2008, with entry time window 9.30am-1.30pm GMT. SLOW=44, FAST=1. Including \$30 S+C per RT. A: detailed equity curve, B: end of month equity curve, C: average profit per month.

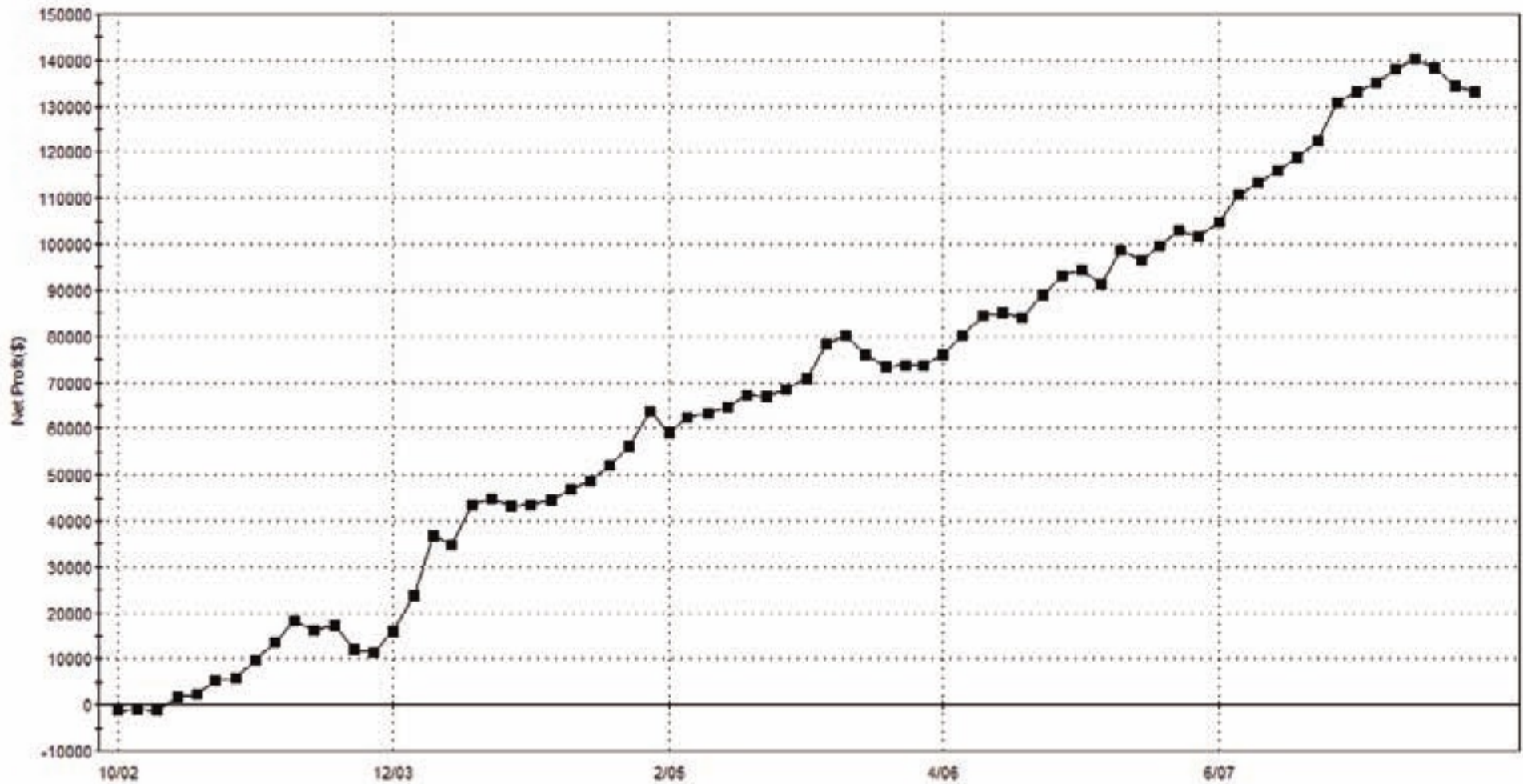
Final equity value approximately \$135,000



Results

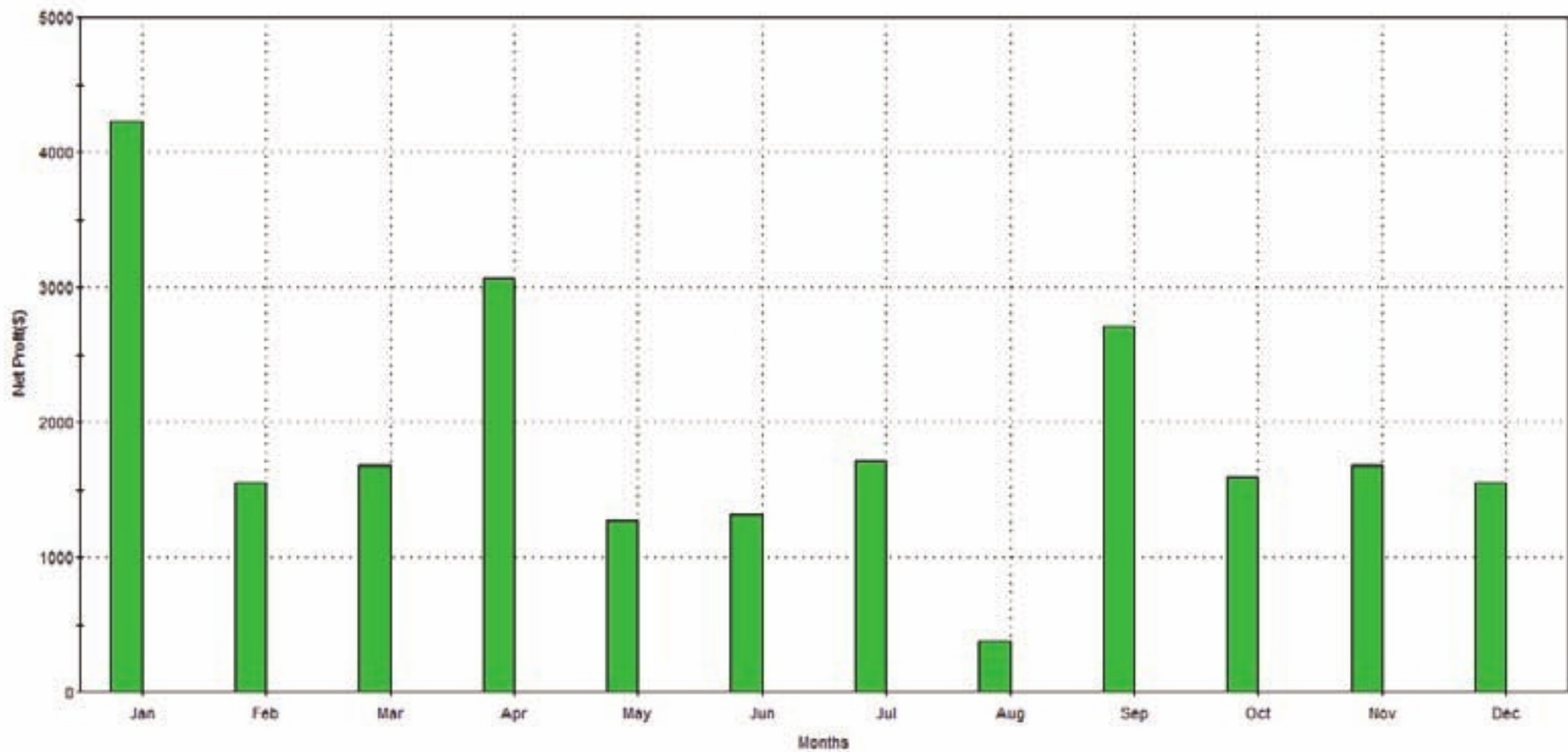
End of month results

- Consider the sequence



Results

Net profit by month



Results

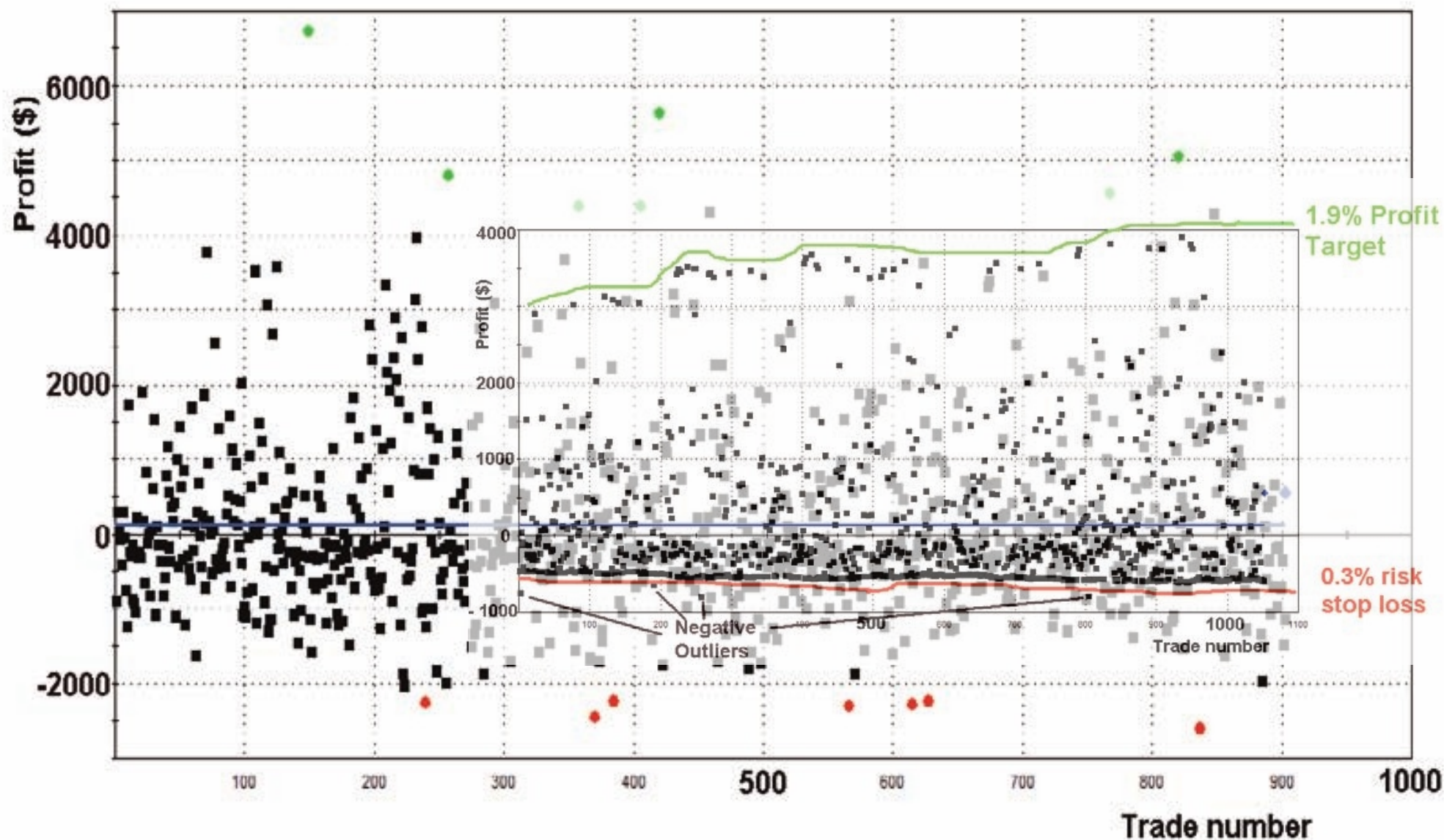
Impact of added features and optimization

	Without Exit	With Stop Loss 0.3%	With Stop loss 0.3% and Trail Stop 0.8%	With Stop loss 0.3% and Trail Stop 0.8% and Profit Target 1.9%
Total Net Profit	\$115,502	\$116,209	\$126,772	\$132,590
Gross Profit	\$428,864	\$399,440	\$405,347	\$414,533
Gross Loss	(\$313,362)	(\$283,232)	(\$278,576)	(\$281,944)
Profit Factor	1.37	1.41	1.46	1.47
Total Number of Trades	902	1025	1040	1051
Percent Profitable	42.02%	34.34%	35.38%	35.20%
Winning Trades	379	352	368	370
Losing Trades	523	673	672	681
Avg. Trade Net Profit	\$128	\$113	\$122	\$126
Avg. Winning Trade	\$1,132	\$1,135	\$1,101	\$1,120
Avg. Losing Trade	(\$599)	(\$421)	(\$415)	(\$414)
Ratio Avg. Win:Avg. Loss	1.89	2.7	2.66	2.71
Largest Winning Trade	\$6,748	\$6,748	\$7,510	\$3,900
Largest Losing Trade	(\$2,531)	(\$810)	(\$810)	(\$810)
Max. Consecutive Winning Trades	6	5	6	6
Max. Consecutive Losing Trades	13	12	12	12
Avg. Bars in Total Trades	78.82	52.81	49.47	46.79
Avg. Bars in Winning Trades	116.73	108.74	100.75	93.42
Avg. Bars in Losing Trades	51.34	23.56	21.39	21.45
Percent of Time in the Market	99.92%	73.56%	69.98%	66.70%
Max. Drawdown (Intraday Peak to Valley)	(\$18,894)	(\$11,266)	(\$10,292)	(\$10,292)
Date of Max. Drawdown	24-May-06	24-Feb-06	24-Feb-06	24-Feb-06
Total Slippage and Commission	\$27,060	\$30,750	\$31,200	\$31,530

Risk Management

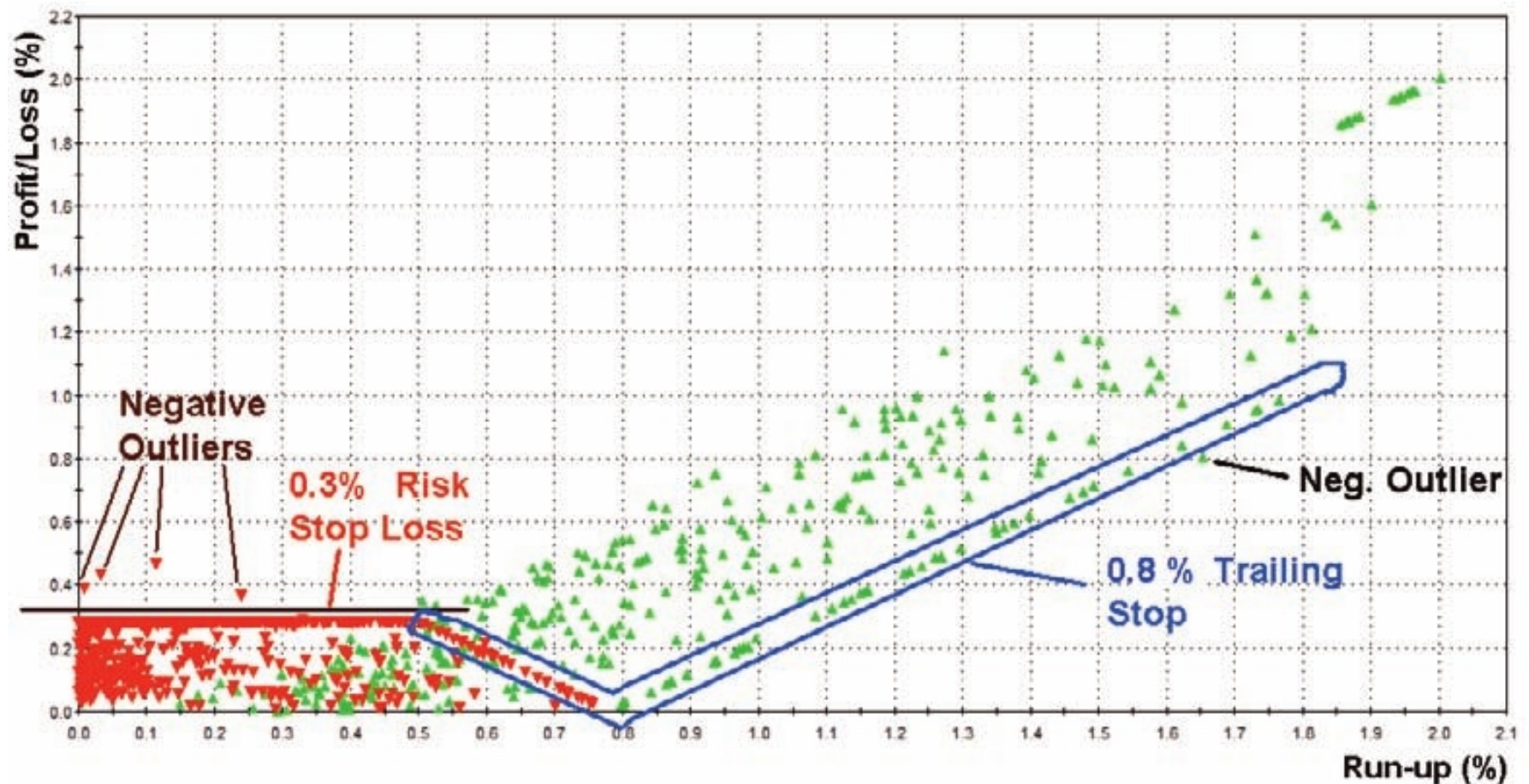
Range between largest winner and loser reduced

\$2000-\$6000 reduced to **\$500**-\$4000



Risk management

Effect of 0.8% trailing stop



Development Process

