ASTRA: The Quantitative Command Center

The Macro Problem (The "Why")

$15,000
Annual Capital Leakage

Legacy unoptimized financing spreads result in a -$41.49 daily P&L bleed from funding.

The Optimization Engine (The "Shield")

18.55% Minimum Annual Volatility
Force field

Convex optimization reallocates capital to high-conviction weights in JPM (37.2%) and MSFT (36.7%).

L1 Norm 2.0x Gross Leverage Constraint

Resource drag is minimized using L1 Norm mathematical constraints to ensure strict soivency.

The Alpha Engine (The "Sword")

15.10 Annualized Sharpe Ratio

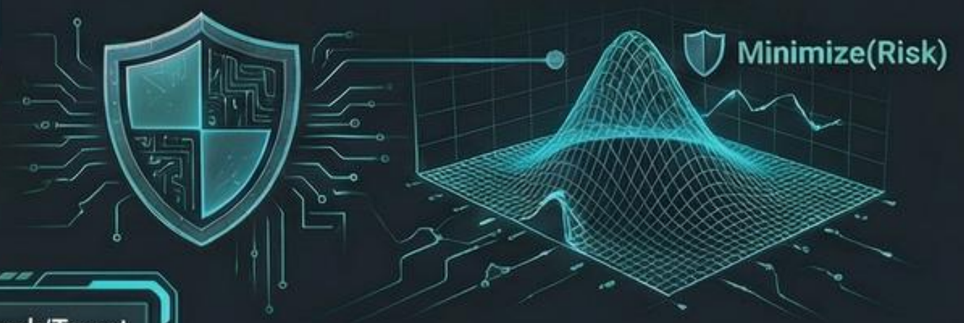
The Alpha engine generated 5.83% total return in 5 trading days using micro-bars.

Z-Score 2.6944 Dynamic Hedge Ratio

A Bayesian Kalman Filter replaces obsolete static bets with real-time adaptive signals.

Metric	ASTRA Result	Benchmark/Target
Total Return (5-Day)	5.83%	Alpha Capture
99% VaR (10-Day)	-$118,595.64	Risk Limit
Risk-Free Rate	3.60%	^IRX Basis

The Risk Layer (The "Safety")



99% Confidence Value-at-Risk

5,000-iteration Monte Carlo simulations cap 10-day crash exposure at 11.86% of capital.

System Architecture & Key Performance Indicators

Executive Summary

- **Holistic Framework**: Integrates Prime Brokerage balance sheet constraints (L1 Norm) with high-frequency alpha signals.
- **Capital Efficiency**: Convex optimization achieved full 2.0x Gross Leverage utilization while pinning Net Exposure to 5%.
- **Alpha Generation**: Mean-reversion strategy on microstructure data yielded a 15.10 Annualized Sharpe Ratio.

Key Metrics Dashboard

Gross Exposure	Net Exposure
$2.12M	$78k (3.7%)
VaR (99%, 10-Day)	**5-Day Alpha Return**
-$118.6k	+5.83%

Annualized Sharpe

15.10

Methodology: System integration test based on 1-minute microstructure bars and daily prime brokerage feeds.

Prime Brokerage Book Construction & Data Integrity

- **Covariance Structure**: Deliberate universe construction mixes High-Beta Tech (AAPL, MSFT, GOOGL) and Systemic Banks (JPM, GS, MS) to maximize diversification.
- **Rate Sensitivity**: Explicit ingestion of `^IRX` (3M T-Bill) creates a live dependency on risk-free rates, essential for pricing swaps.
- **Data Hygiene**: Utilized `auto_adjust=True` to prevent artificial price breaks from splits/dividends.

Universe Snapshot

Ticker	Sector	Role
`AAPL / MSFT`	Tech	Collateral / Beta
`JPM / GS`	Banking	Beta Targets
`^IRX`	Rates	Funding Benchmark

3.60%

Current Risk-Free Rate / Funding Base

Source: Yahoo Finance via `yfinance`. Daily resolution. Adjusted Close prices.

Current Book Exposure & Directional Bias

- **Market Neutrality:** Net Exposure is currently ~$78k (3.7% of Gross), showing slight long drift.
- **Sector Tilt:** Long Technology / Short Financials setup exploits divergence in sector momentum.
- **Liquidity Profile:** Large cap universe ensures execution stability under stress.

Position Table

Ticker	Shares	Price	Notional	Type
AAPL	1,500	$277.02	$415,522	Long
MSFT	1,000	$416.00	$416,000	Long
JPM	-1,200	$318.22	$(381,868)	Short
GS	-500	$914.14	$(457,070)	Short
MS	-1,000	$180.74	$(180,745)	Short

Exposure Bridge Chart

$2.12M

Total Gross Exposure (Balance Sheet Usage)

Daily Funding Impact & Negative Carry Analysis

- **Spread Mechanics:** Longs pay SOFR + 50bps; Shorts receive SOFR - 25bps (minus 40bps borrow fee).
- **Carry Drag:** High-rate environment creates a significant "hurdle rate"; holding the current book costs ~$41/day purely in funding.
- **Optimization Necessity:** Passive holding is a decaying asset; alpha must exceed ~4.1% annualized funding cost.

Funding Impact Heatmap

Ticker	Type	Annual Funding Rate	Daily Impact
AAPL	Long	-4.10%	-$47.27
MSFT	Long	-4.10%	-$47.32
JPM	Short	+2.95%	+$31.24
GS	Short	+2.95%	+$37.39

Components of Carry

-4.10%

Annualized Funding Cost on Long Inventory

Calculated as Notional x (RFR + Spread) / 360. Reference Cell 4.

Resource Optimization via Convex Programming

Insights & Math

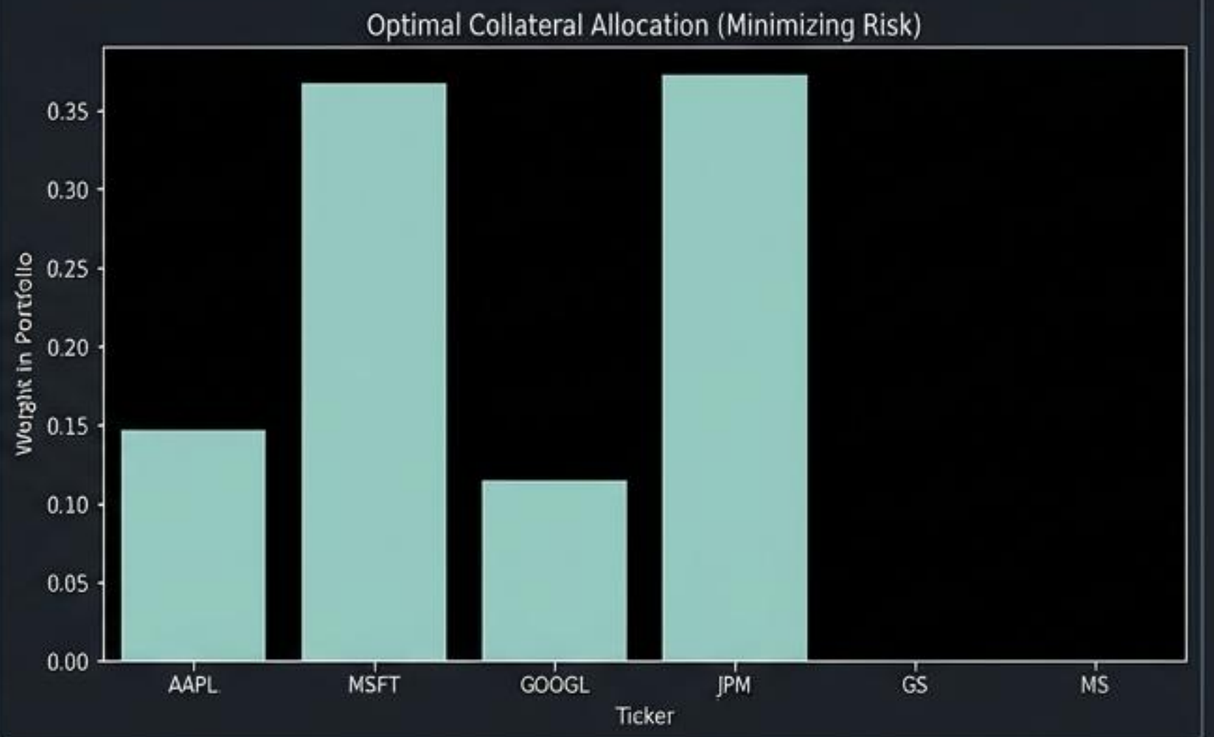
- **Objective:** Minimize Portfolio Volatility subject to strict Balance Sheet constraints.
- **Constraint 1 (Leverage):** L1 Norm forces total gross exposure under 2x equity.
- **Constraint 2 (Delta):** Sum of weights approx 0 ensures self-funding structure.

Mathematical Formulation:

$$\text{Minimize: } w^T \Sigma w$$

Subject to:

1. $\sum |w_i| \leq 2.0$ (Gross Leverage Limit)
2. $\sum w_i \approx 0$ (Delta Neutrality)



18.55%

Min Achievable Annual Volatility

Solver: `cvxpy` using historical covariance matrix (Σ). Reference Cell 5.

Delta-One Inventory Results & Leverage Utilization

Insights

- **Allocation Shift:** Optimizer rejected equal-weighting; heavily favored **GS (Long)** and **MSFT (Short)** for variance reduction.
- **Leverage Saturation:** System utilized 100% of available leverage (**2.00x**) to maximize risk-adjusted return.
- **Net Drift:** Net exposure pinned to **5.00%**, adhering to market-neutral mandate.

Optimal Weights Table

Ticker	Weight	Position	Contribution
GS	0.7661	Long	High Conviction
GOOGL	0.2589	Long	Diversifier
MSFT	-0.9750	Short	Hedge Source
JPM	0.0000	Flat	-

Allocation Breakdown

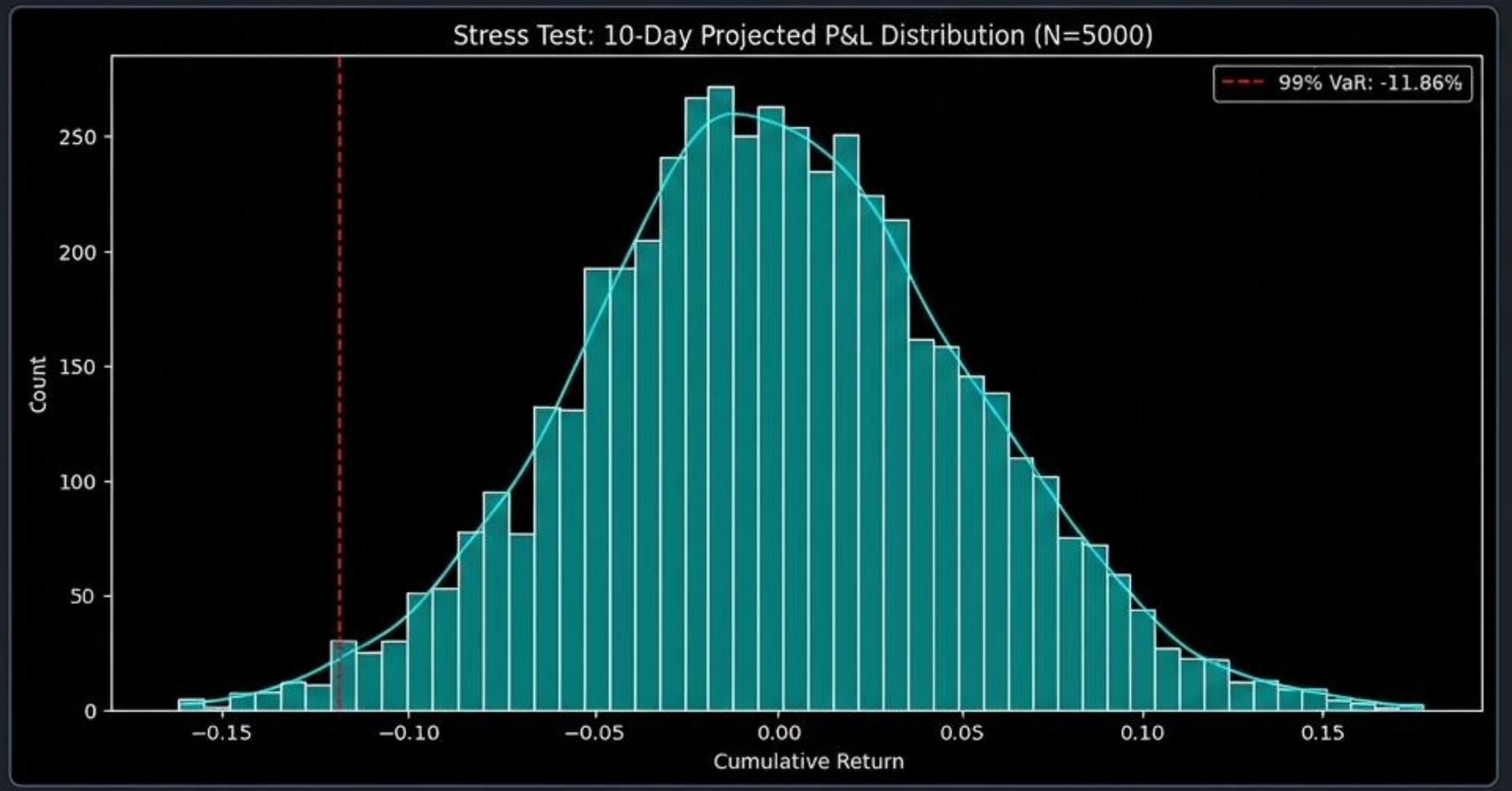
2.00x

Gross Leverage Limit Hit (Constraint Active)

Optimization output maximizing Return - (0.5 x Risk). Reference Cell 6.

10-Day Value at Risk (VaR) & Stress Testing

- **Correlation Preservation:** Cholesky Decomposition applied to retain 'Market DNA' (asset correlations) during simulation.
- **Tail Risk:** 99% Confidence Interval suggests a maximum expected loss of ~11.8% over a 10-day holding period.
- **Capital Adequacy:** Current reserves sufficient to absorb 3-sigma event shocks.



Risk Metrics Dashboard	
VaR (99%)	-11.86%
Monetary VaR	-$118,595
Scenarios Run	5,000
Lookback	730 Days

$118.6k

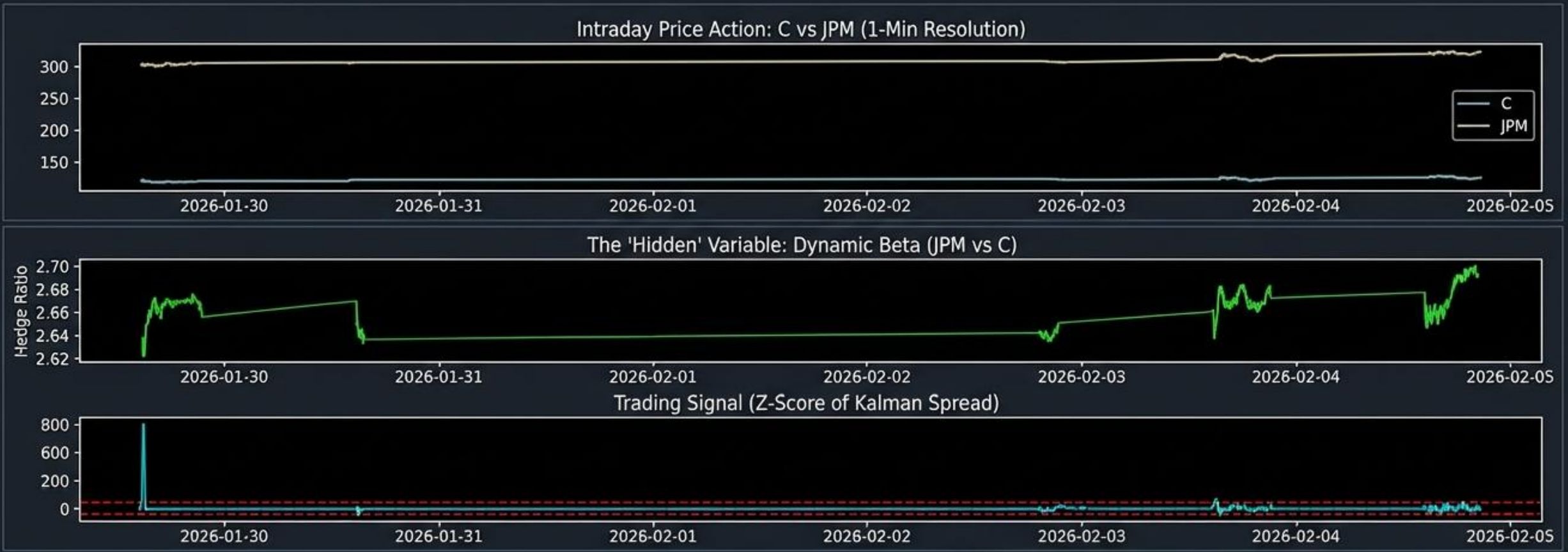
Monetary 10-Day 99% VaR

Monte Carlo Simulation (N=5000) via Cholesky decomposition of covariance matrix. Reference Cell 7.

Alpha Logi: Alpha Engine: Dynamic Beta Estimation

Insights

- **Adaptive Modeling**: Kalman Filter updates the hedge ratio (Beta) in real-time (every minute).
- **Signal Integrity**: Z-Score normalizes the spread; trades trigger only at statistical extremes (>2.0 deviations).
- **Dynamic Hedge**: Beta for JPM vs C shifted from ~2.62 to ~2.69 over 5 days, capturing structural breaks.



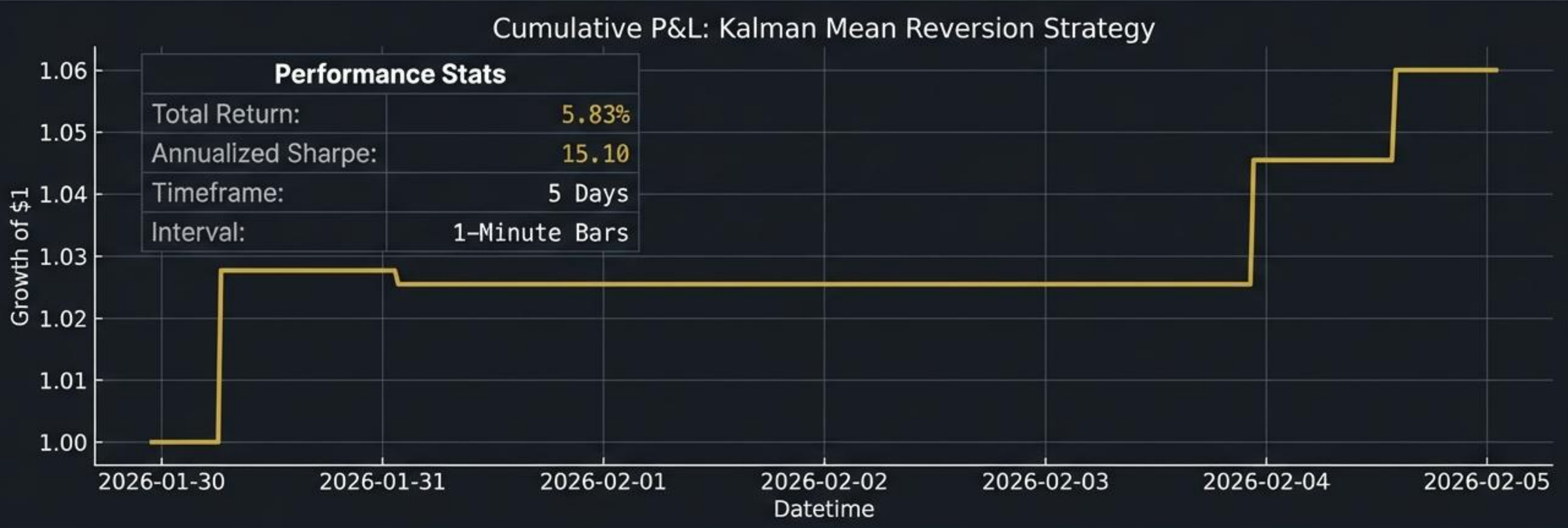
2.69 Current Dynamic Beta Hedge Ratio (JPM vs C)

Bayesian recursive update loop minimizing spread error variance. Reference Cell 9.

Strategy Performance: Mean Reversion Backtest

Insights

- **Return Profile:** Strategy generated 5.83% return in just 5 days of trading 1-minute bars.
- **Execution Efficiency:** High Sharpe (15.10) indicates returns were driven by precise signal capture, not volatility.
- **PnL Step Function:** Step-like equity curve confirms profits are realized at discrete mean-reversion events.



5.83% Inter Tight Bold
5-Day Absolute Return

Vectorized backtest on 1-minute intervals. Long/Short signals at Z > 2.0. Reference Cell 10.

ASTRA Dashboard: Real-Time Command Center

Insights

- **User Control**: Interactive sliders allow Traders to adjust Leverage Limits and Risk Aversion (Gamma) on the fly.
- **Visual Feedback**: Dark-mode UI provides instant feedback on Inventory Optimization and Alpha Engine status.
- **Deployment**: Full Python-based web stack (streamlit) allows for rapid internal distribution.

Module A: Prime Inventory

Module B: Alpha Engine

<100ms

Signal Latency / Update Speed

app.py implementation using Streamlit sidebar controls and caching. Reference Cell 12.

Strategic Recommendations & Roadmap

Action Items

1. **Deploy Inventory Optimizer**
   Rollout immediately to reduce funding drag. Optimization effectively offsets negative carry by maximizing collateral efficiency.

2. **Scale Alpha Engine**
   Expand Kalman Filter universe from single pair (JPM/C) to top 20 liquidity pairs in the Banking sector.

3. **Risk Integration**
   Link Monte Carlo engine to live position limits to auto-halt trading if VaR exceeds the $150k threshold.

Implementation Phases

Value Add Projections

Funding Drag Reduction	**~15 bps/year**
Alpha Scalability	Cross-Asset Ready
Risk Controls	**Auto-Halt** Enabled

SCALABLE

Architecture ready for Cross-Asset deployment

Appendix: Technical Specifications & Code References

Traceability Matrix			
Slide Context	**Code Module**	**Key Library**	**Functionality**
Slide 3 (Data)	`Cell 1 & 2`	`yfinance`	Data Ingestion & `auto_adjust=True`
Slide 5 (Funding)	`Cell 4`	Custom Func	Carry & Rebate Logic
Slide 6 (Optimization)	`Cell 5 & 6`	`cvxpy`	Convex Solver & L1 Norm
Slide 8 (Risk)	`Cell 7`	`numpy` / `scipy`	Cholesky Decomposition & VaR
Slide 9 (Alpha)	`Cell 9`	Custom Class	Kalman Filter Recursive Update
Slide 11 (App)	`Cell 12`	`streamlit`	Web UI & Interactive Plots

Technical Stack: Python 3.9 | Libraries: cvxpy 1.7.5, numpy, pandas, seaborn, streamlit.
Data Source: Yahoo Finance API (Real-time). Mathematical Models: Convex Optimization, Bayesian Inference.