Architecting Algorithms with Mathematica

Bryan M. Minor, Ph.D.

President, ScienceOps

13 Oct 2006

SCIENCEOPS

Outline

- Background on ScienceOps
- Project based Algorithm Development
- ScienceOps projects and Mathematica
- Algorithm Development in Mathematica
- Conclusions

ScienceOps Background

- Founded in December 2001
- First client - Blue Origin
  - Jeff Bezos space company
  - www.blueorigin.com
- Business model
  - Algorithm expertise applied across industries
    - Vertical technology applied horizontally across industries
  - Team of experienced Ph.D. scientists
  - Using the right tools (Mathematica)
  - Small and medium business
  - Client owns all Intellectual Property (IP) developed

Project based Algorithm Development

- Scoping study first
- Firm fixed price contract
- Heavy emphasis on documentation
  - Client must fully understand
- Using the right tools (Mathematica)
- NDA

# SciCode Process
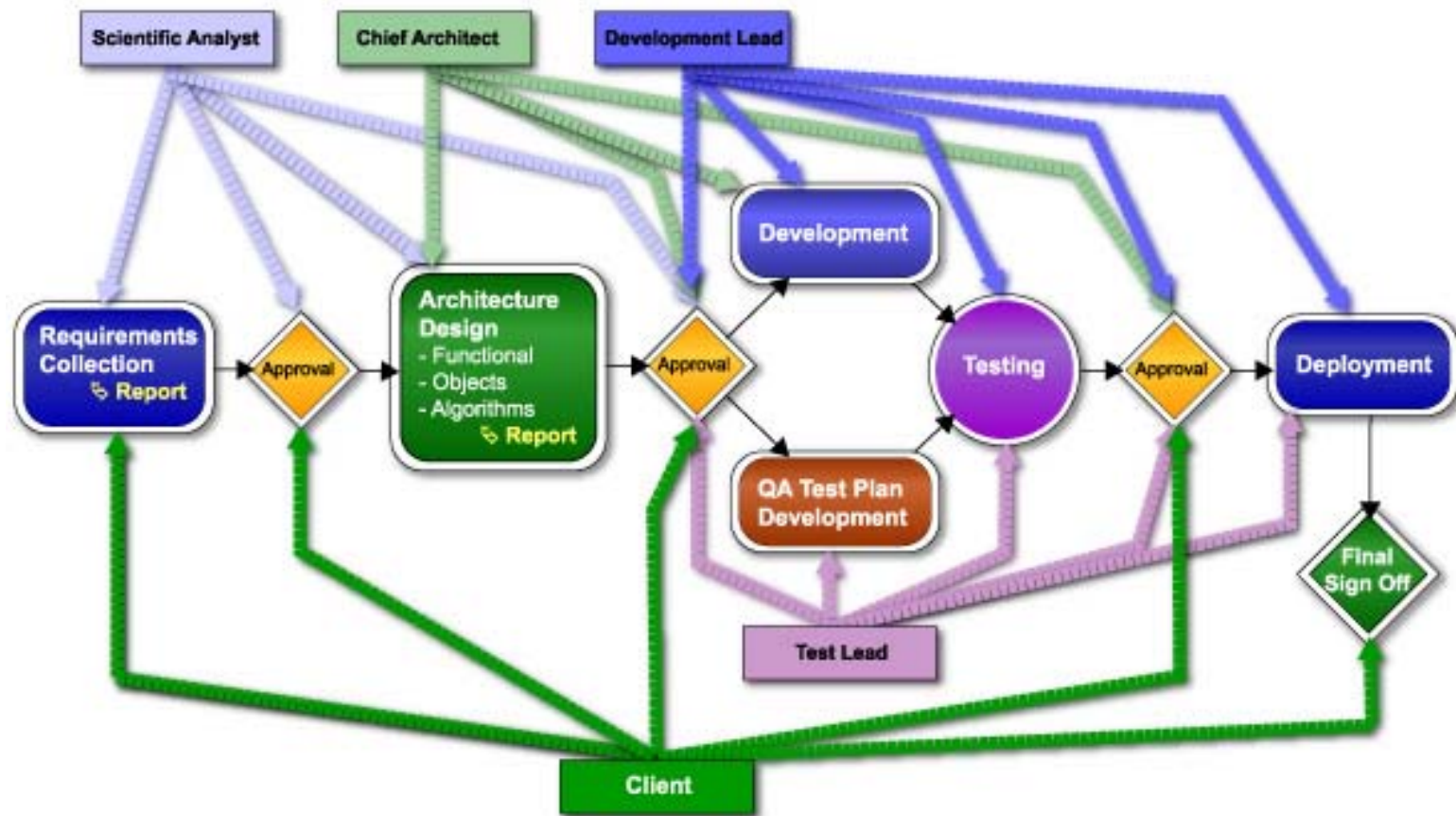
ScienceOps projects using Mathematica

- Blue Origin –Aerospace
- ***High Tech Comat – Lumber industry***
- ***BAE Systems – Aerospace***
- Phoenix Learning – Scheduling algorithm
- ***Warmly Yours – Industrial***
- IRRI REML – Agriculture in 3rd World
- Roche Molecular Systems – Cluster Analysis

ScienceOps projects using Mathematica (cont.)

- Follett HEG – Book store inventory prediction
- Right Media – Internet ads
- NIH – SBIR, Optical Mapping of DNA
- *DARPA – Space physics*
- NASA – Space Tether systems
- TideWorks Technology – Hazardous Material handling

High Tech Comat – Lumber industry

- Finding optimal center line of log
- Constrained spline developed in Mathematica
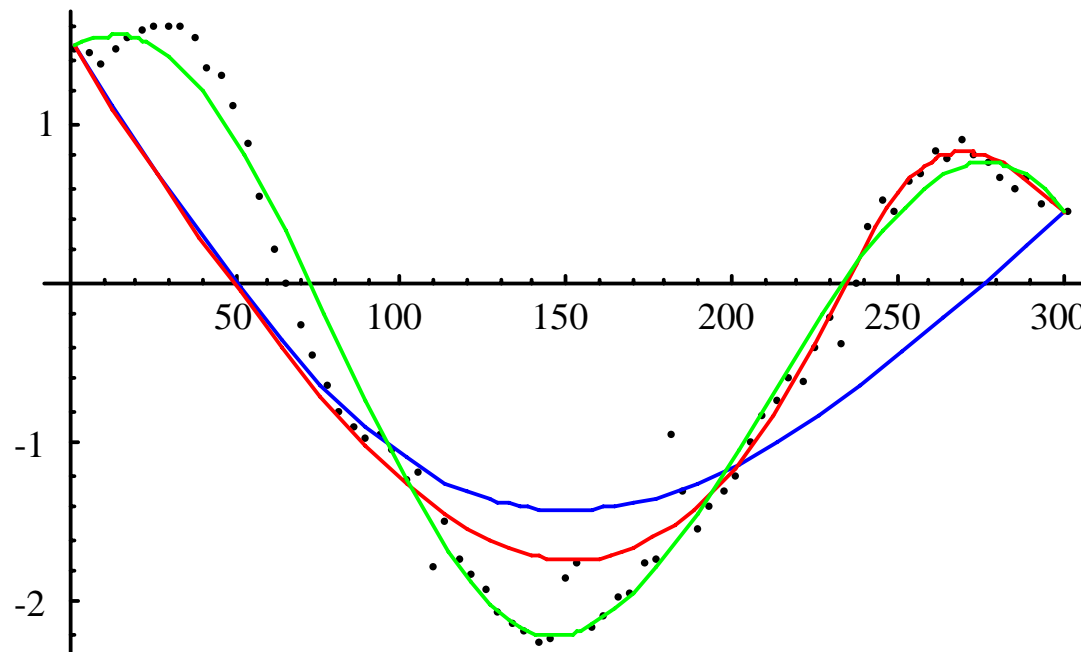
BAE Systems – Aerospace

- Validation of guidance algorithms for IR missile counter measures
- Examined all specifications
- Developed independent Mathematica models
- Developed webMathematica interface to allow for their QA

Warmly Yours – Industrial

- In floor electrical heating system
- www.WarmlyYours.com
- Given an arbitrary room with product connection constraints, how best to fit
- Mathematica designed algorithms
- Mathematica used to render XML solutions
- In production creating over half their designs
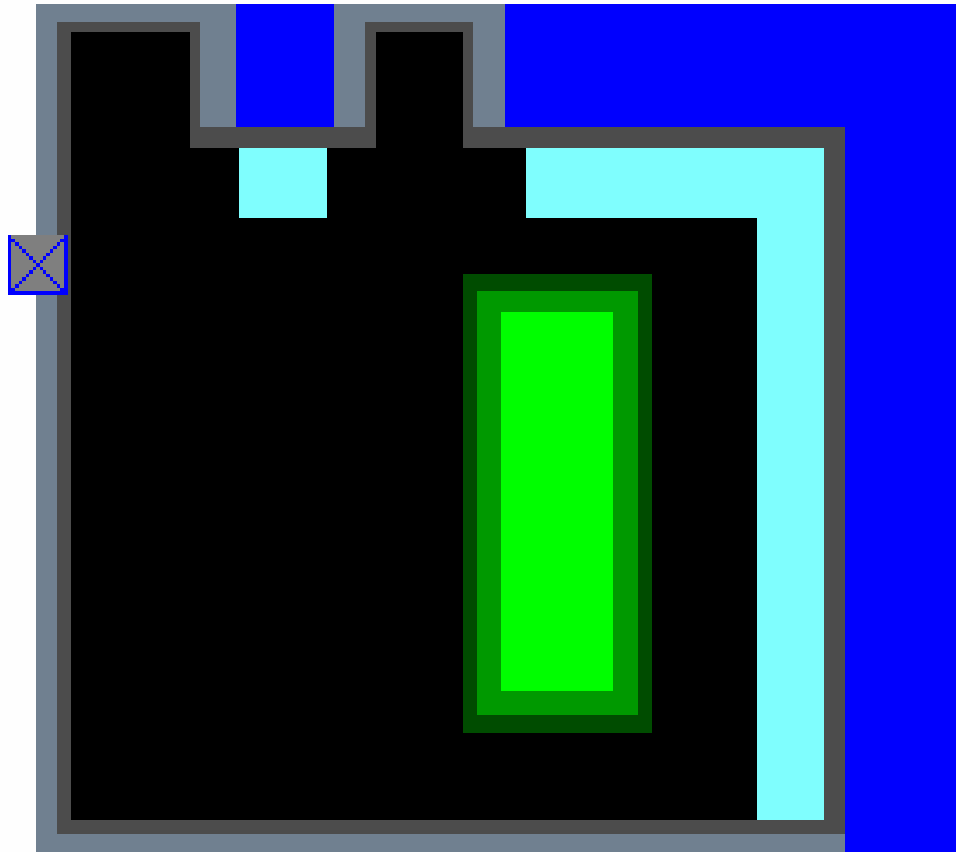- Final form of algorithm in C#
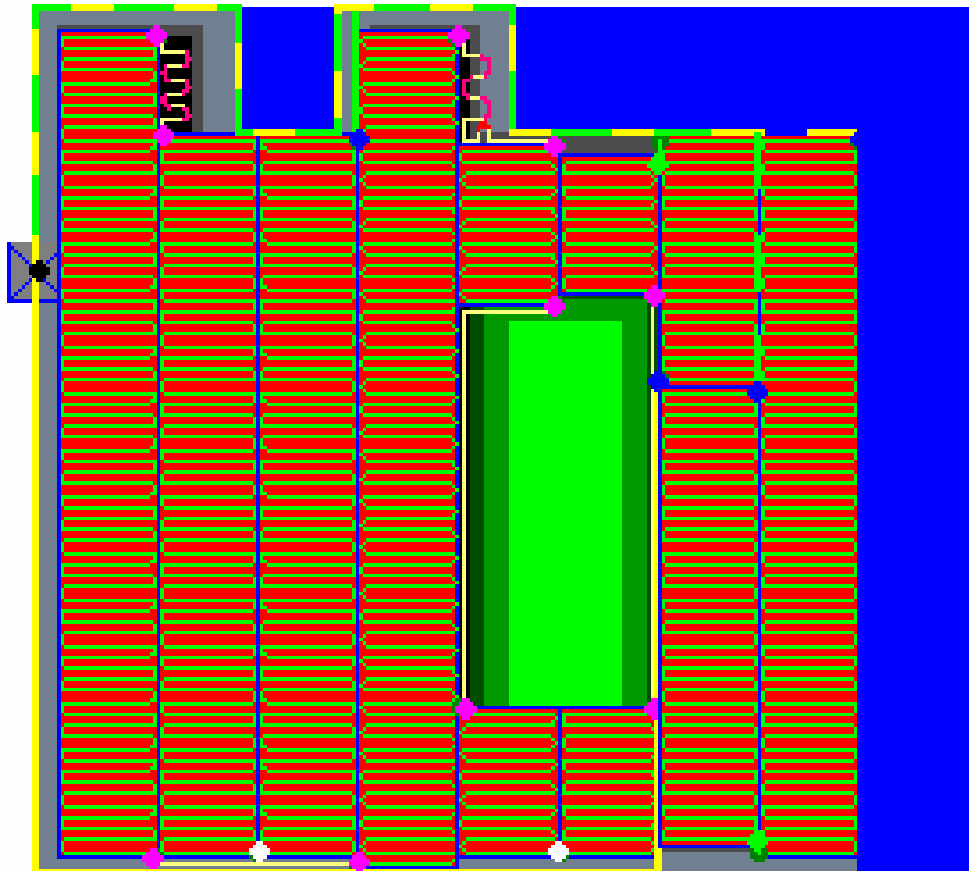
Warmly Yours – Room #1 Layout
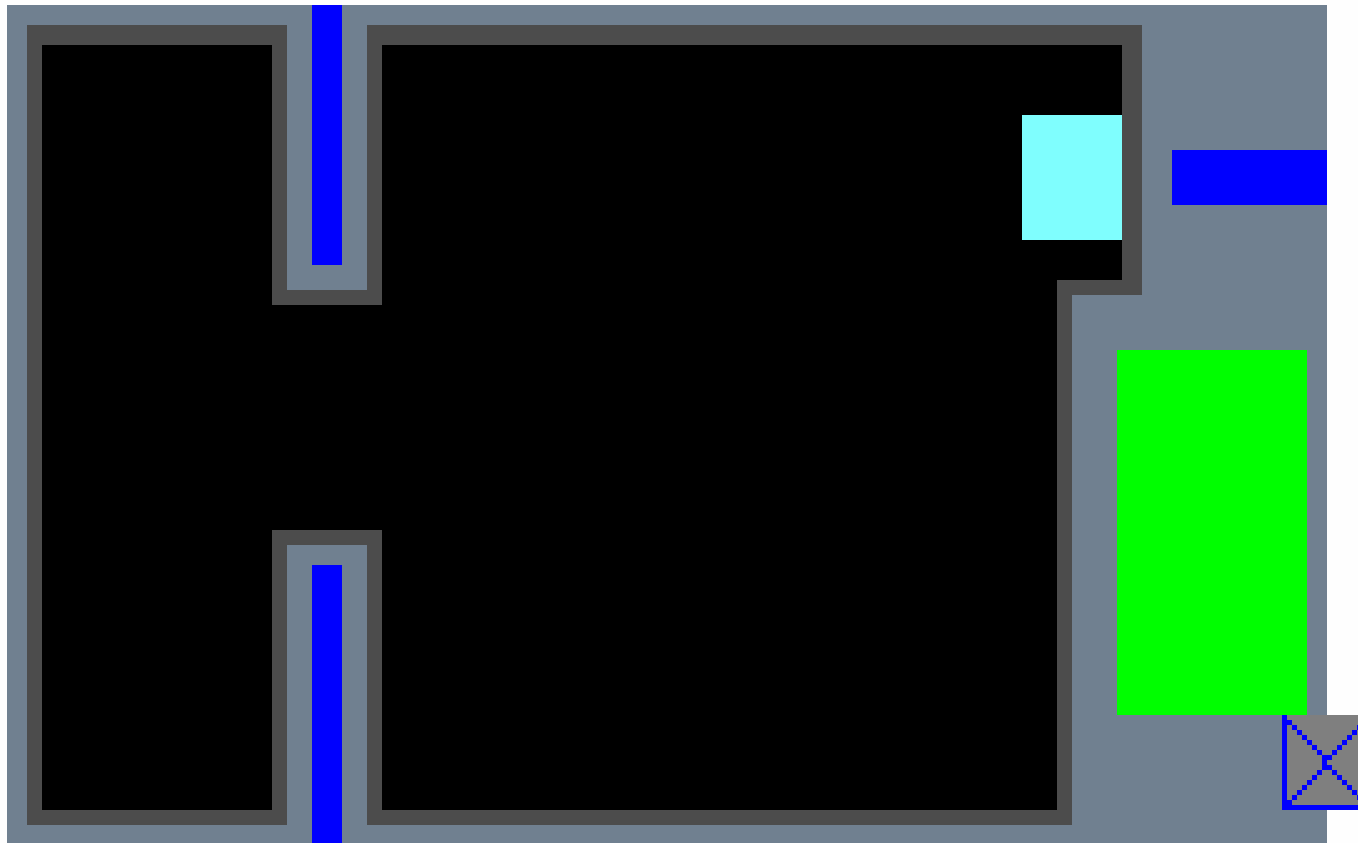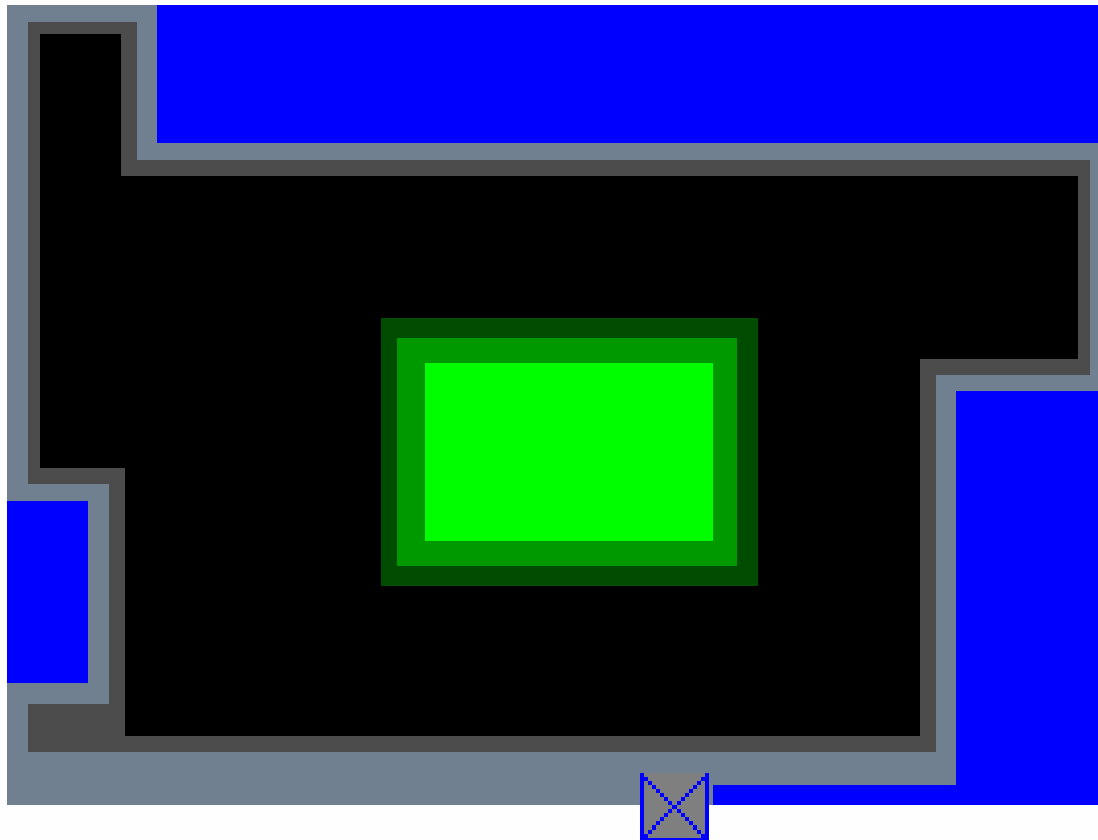
Warmly Yours – Room #1 Solution
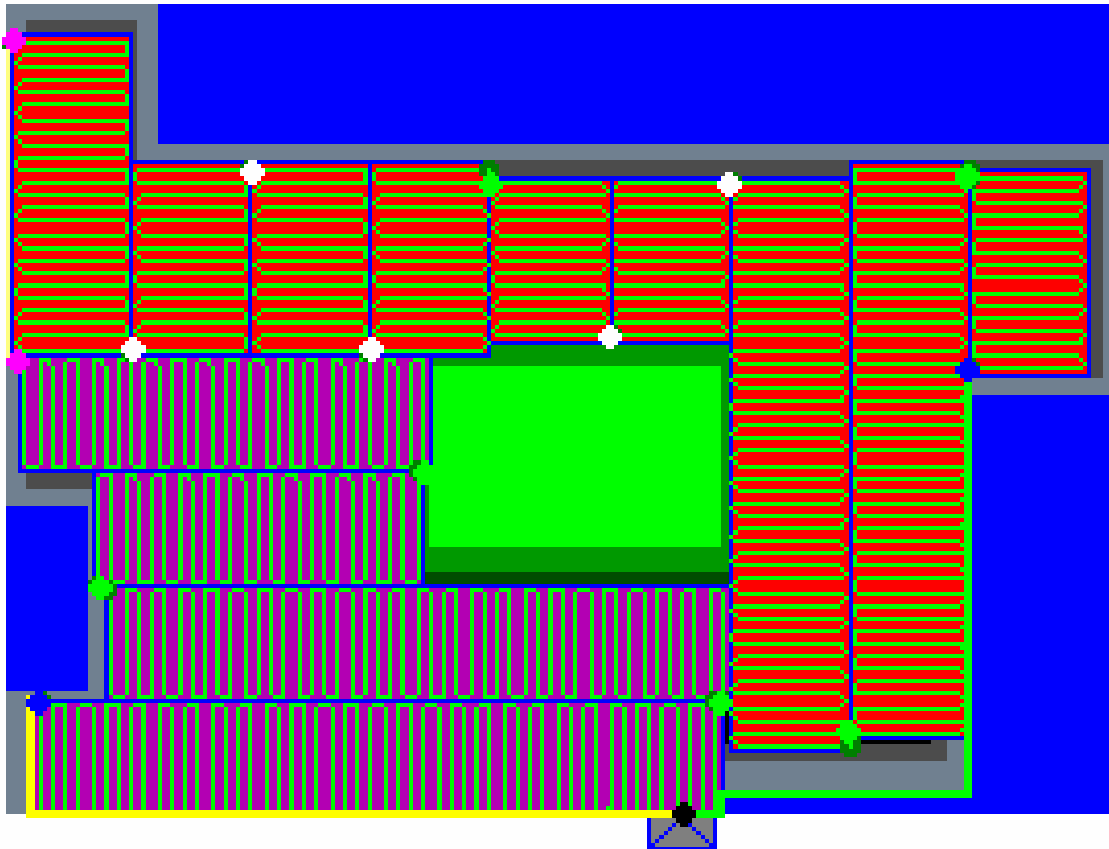
Warmly Yours – Room #2 Layout
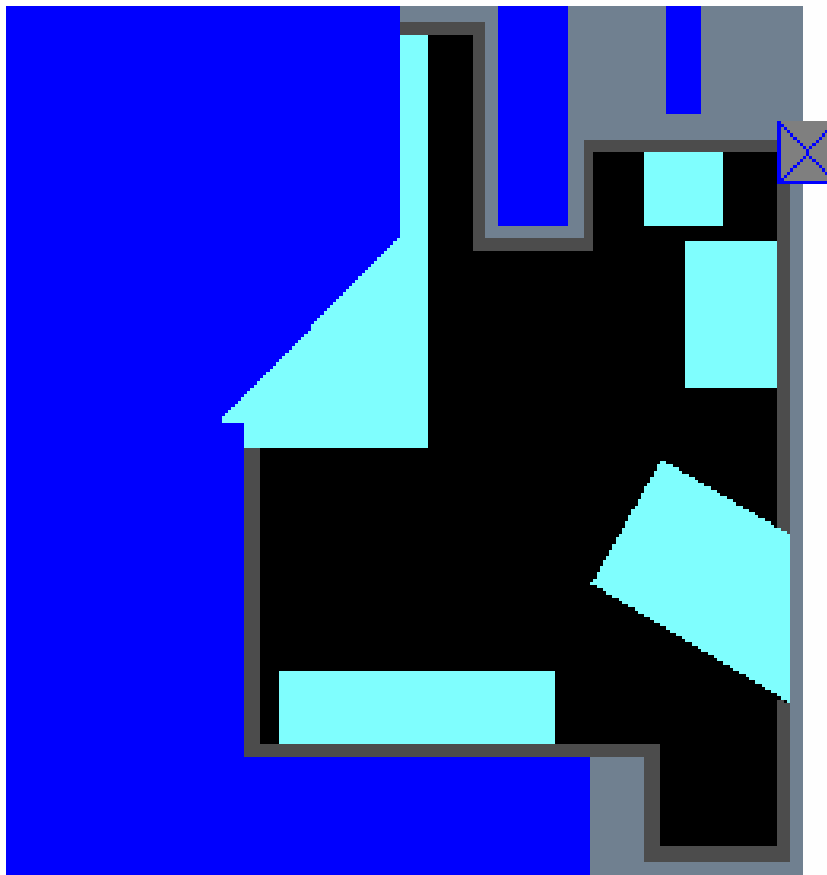
Warmly Yours – Room #2 Solution

Warmly Yours – Room #3 Layout

Warmly Yours – Room #3 Solution

Warmly Yours – Room #4 Layout

Warmly Yours – Room #4 Solution

DARPA – Space physics

- Remediation of Van Allen Belt with Electro-static space tether systems
- Seedling funded by DARPA
- Mathematica used for all modeling of system interactions with Van Allen Belt
  - Optimally designed system performance
- Nominated by SPO for DARPA technical achievement award at DARPA Tech 2004
- Article in Space.com
- Threat topic covered in Scientific American Jun 2004

HiVolts System
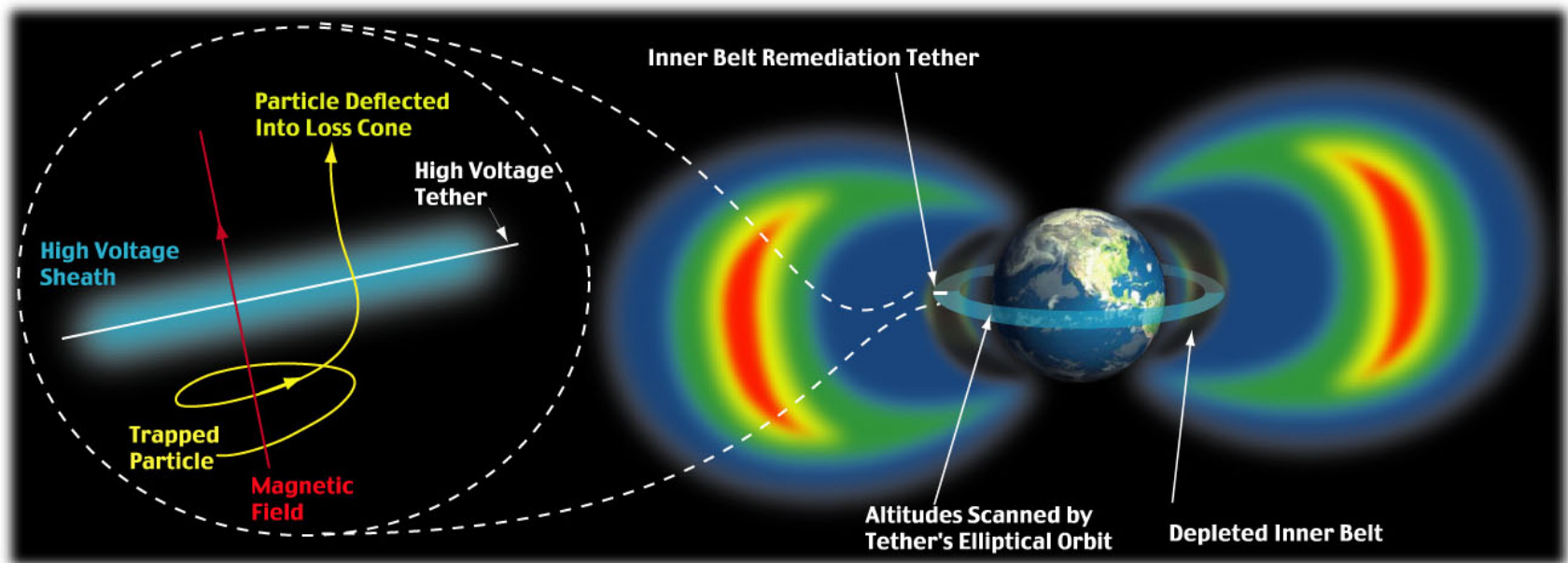
HiVolt Remediation
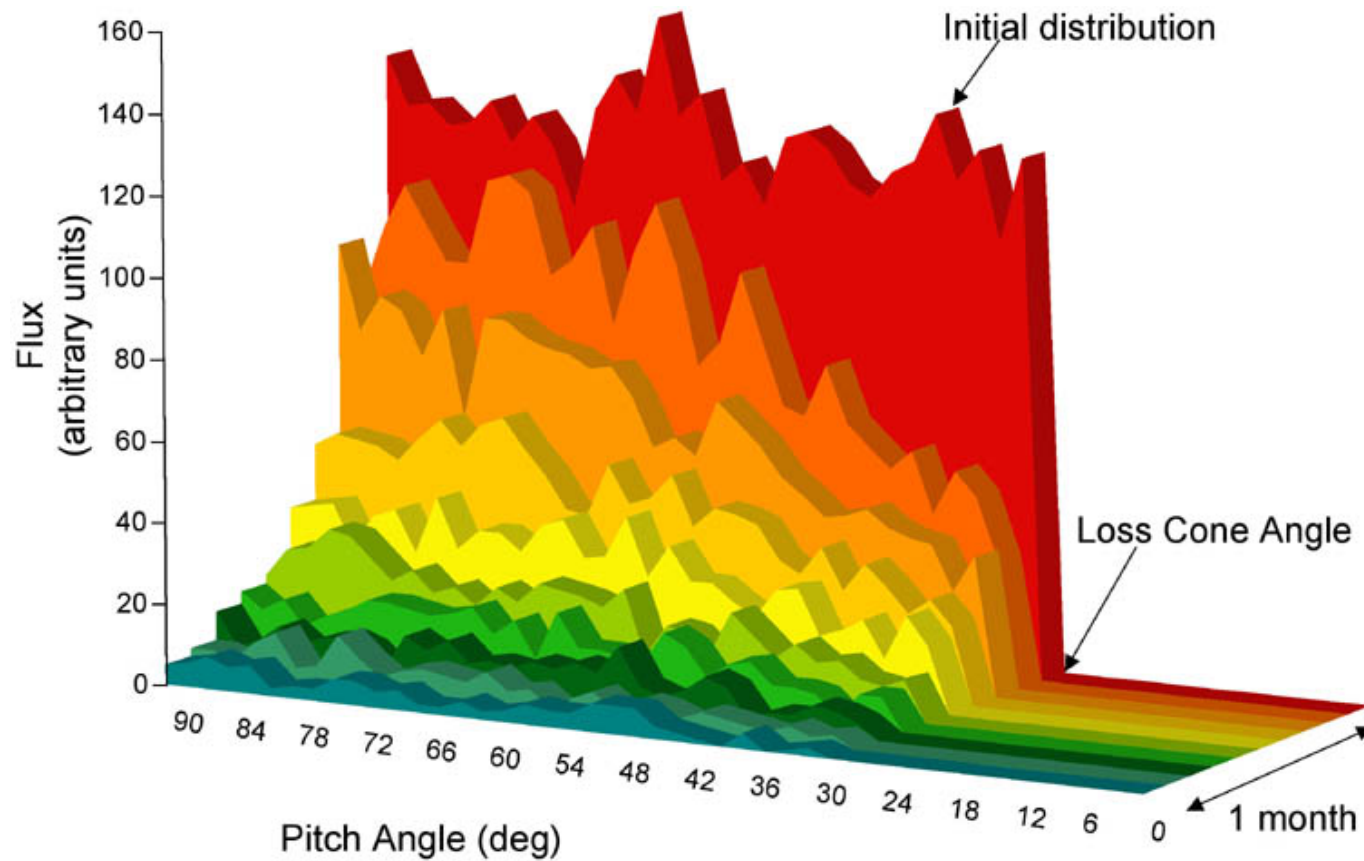
Approach to Algorithm Development

- Mathematica notebooks record of key analysis
- Test candidate algorithm analysis
- Structured approach
  - Module
  - Testing section
- Sharing results
  - OS independent
- Handling large projects
- Validation during QA

Conclusions

- Mathematica is key to ScienceOps success
  - Quickly finding the best algorithm for client
- Clients typically are not aware of Mathematica
  - Are impressed with results (time and quality)
- ScienceOps plans to use Mathematica as a computational engine
- Most of our clients have a real need for Mathematica based analysis and solutions (80%+)
- Enterprise market is hugely untapped for use of Mathematica