Overview of Magnet Technology at STI Optronics

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May 18, 2005

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Magnetic Technology Areas

- Complete, end-to-end analysis, design, fab, assemble, tune
- Wigglers and undulators
  - 25 yrs experience
  - 60 insertion devices (18mm-200mm periods)
  - Some turn-key control systems
  - Both REPM and Hybrid technologies
- Permanent Magnet (PM) Beamline Optics
  - Main focus is quads
  - Also dipoles
- Other PM units
  - Linear Dispersion Mass Spectrometer – collaboration with UW
  - 20 kHz Laser Projector Scanner – Telecom startup that didn't
  - 45 deg sector dipole – JTO prototype
  - Lightweight NMR magnet for JPL
  - Zeeman spectrometer magnet for AFRL

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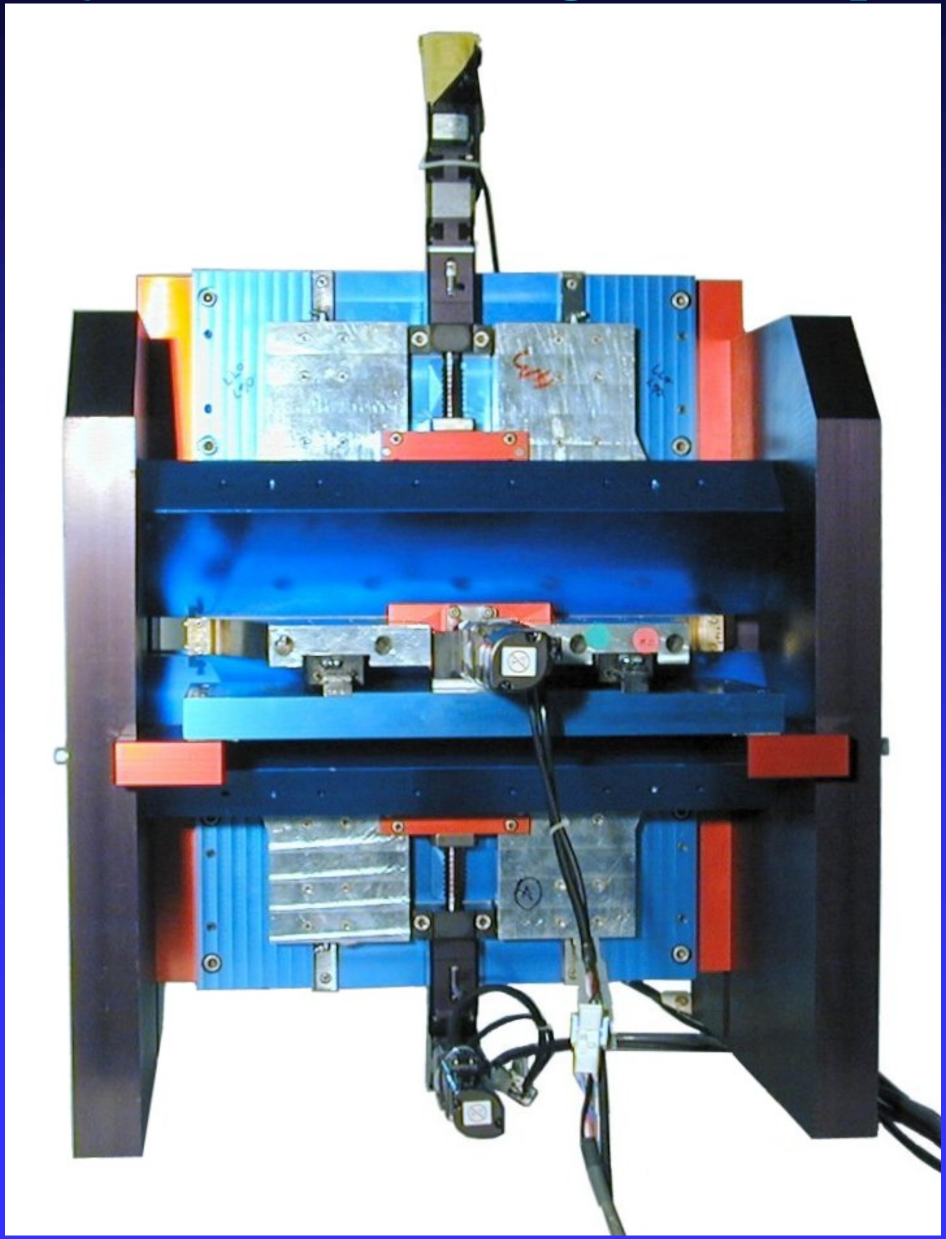
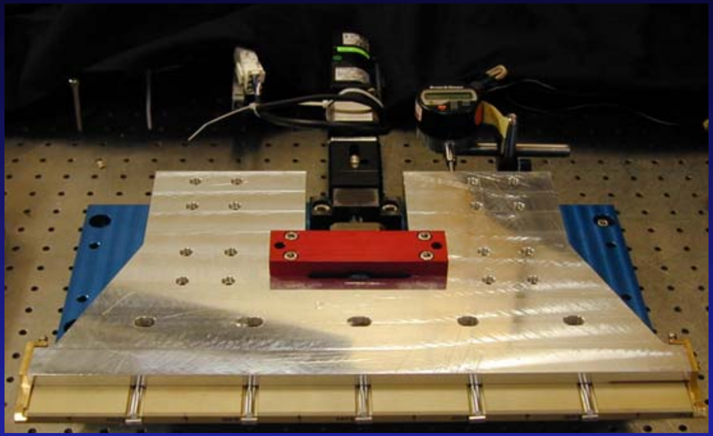
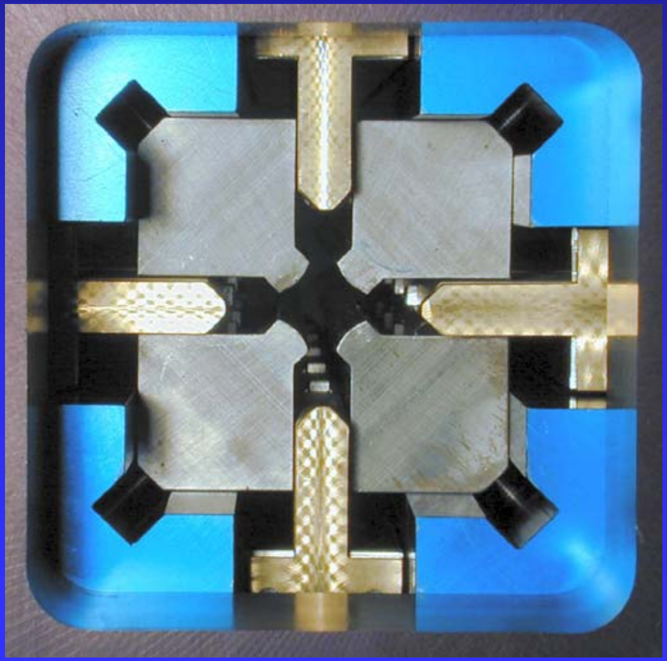
Adjustable Strength PM quad- motorized







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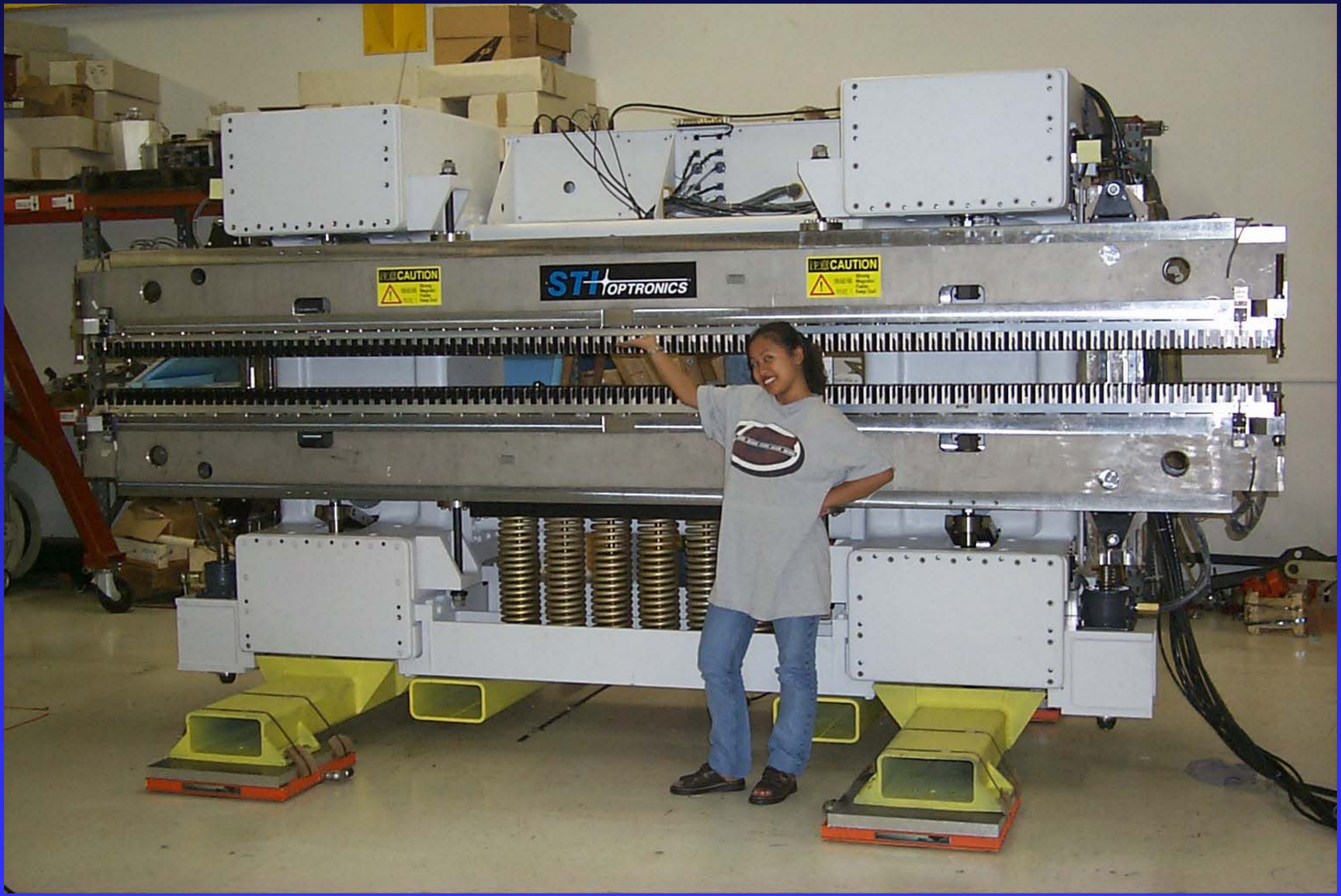
Adjustable Strength PM Quad – Manual Model

Examples of Wigglers and Undulators



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Examples of Wigglers and Undulators

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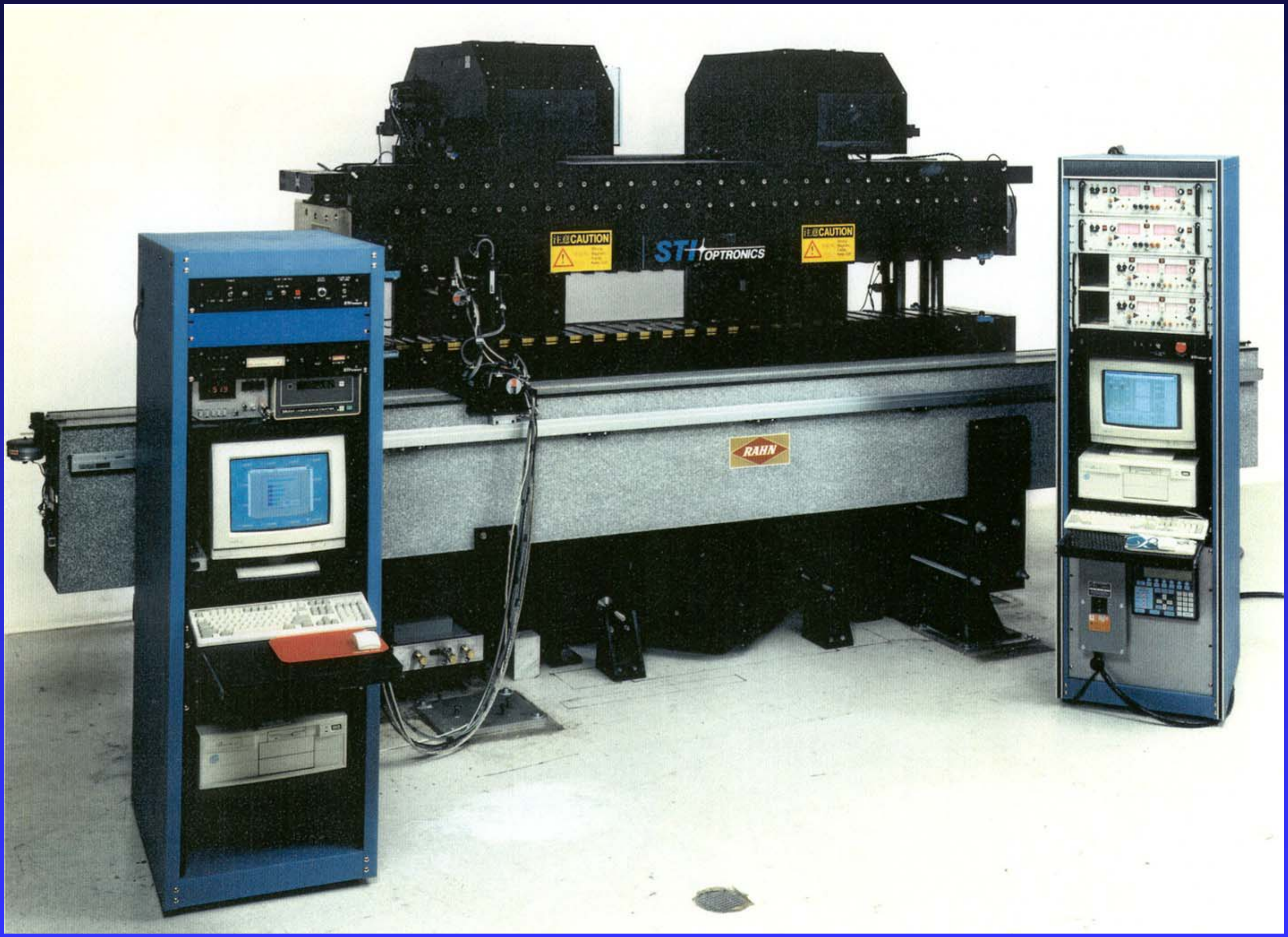

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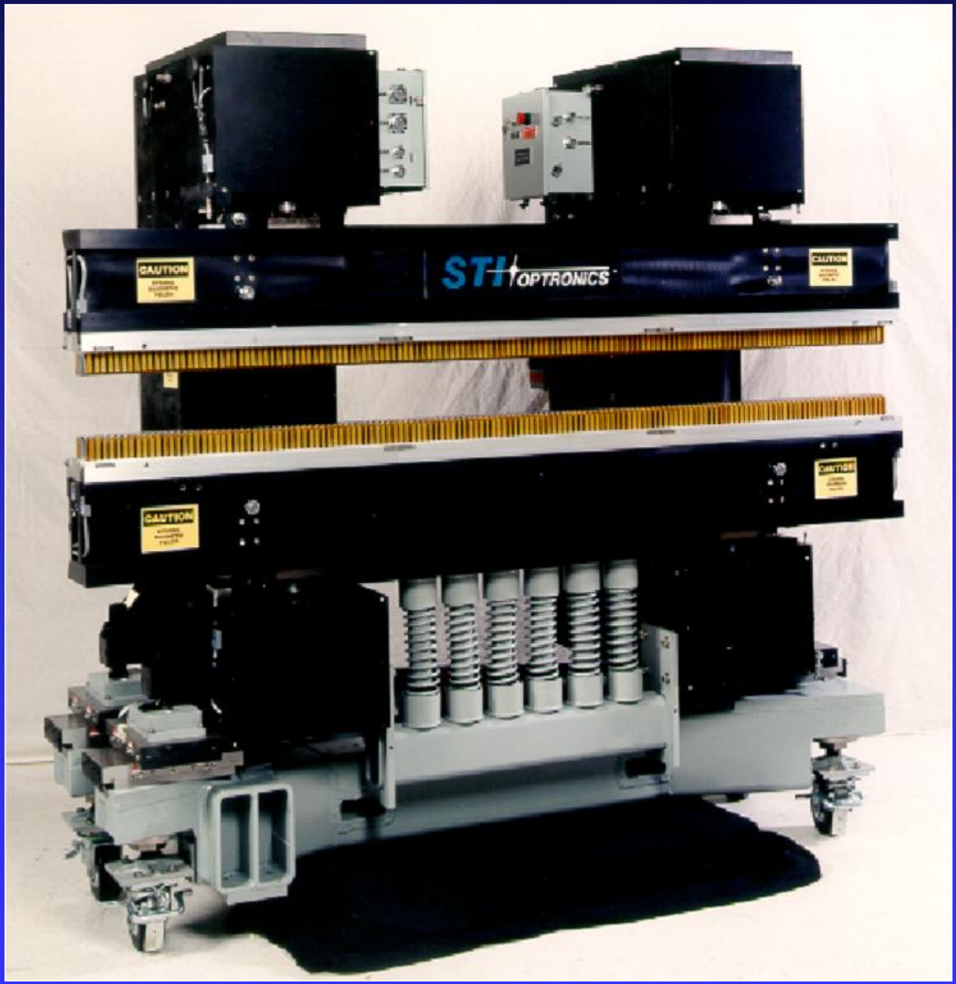

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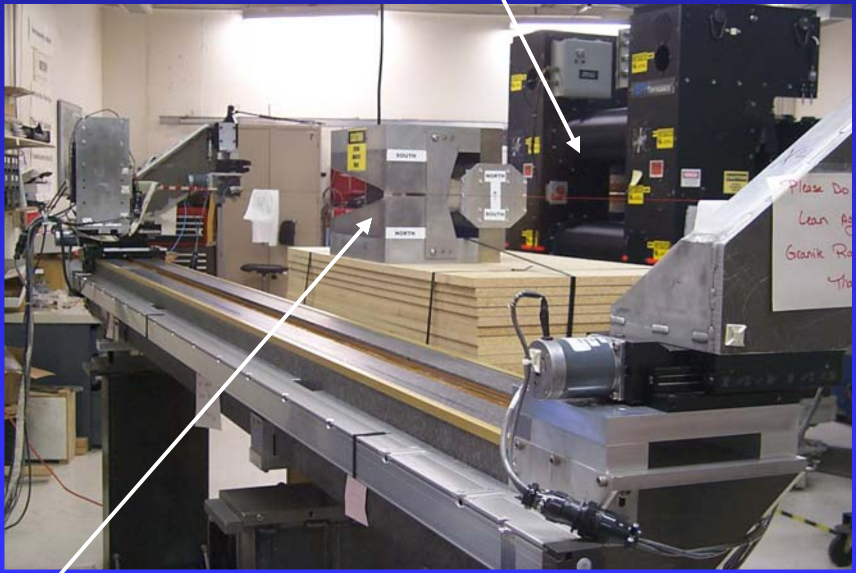
Linear Dispersion Mass Spectrometer (LDMS)*

Assembly tooling

Insertion device on scanner #2



Magnet on scanner #1

- Standard Spectrometer
    - Focal position scales as $M^{1/2}$
- LDMS
    - Focal Position scales as M
    - Complex pole shape
    - 3D optimization

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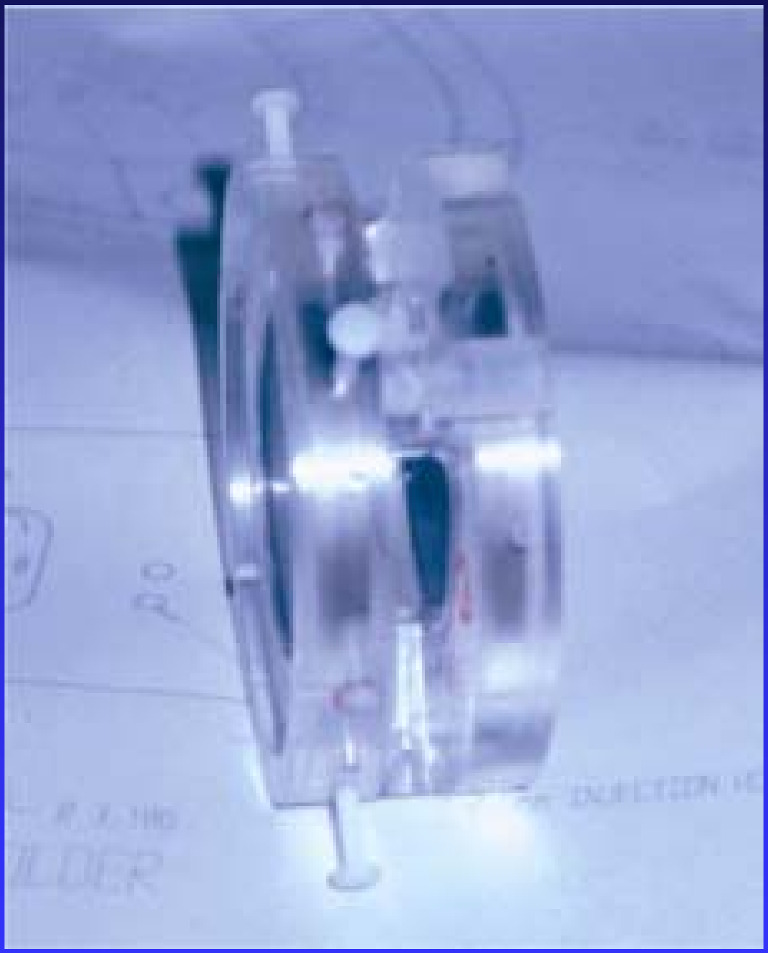
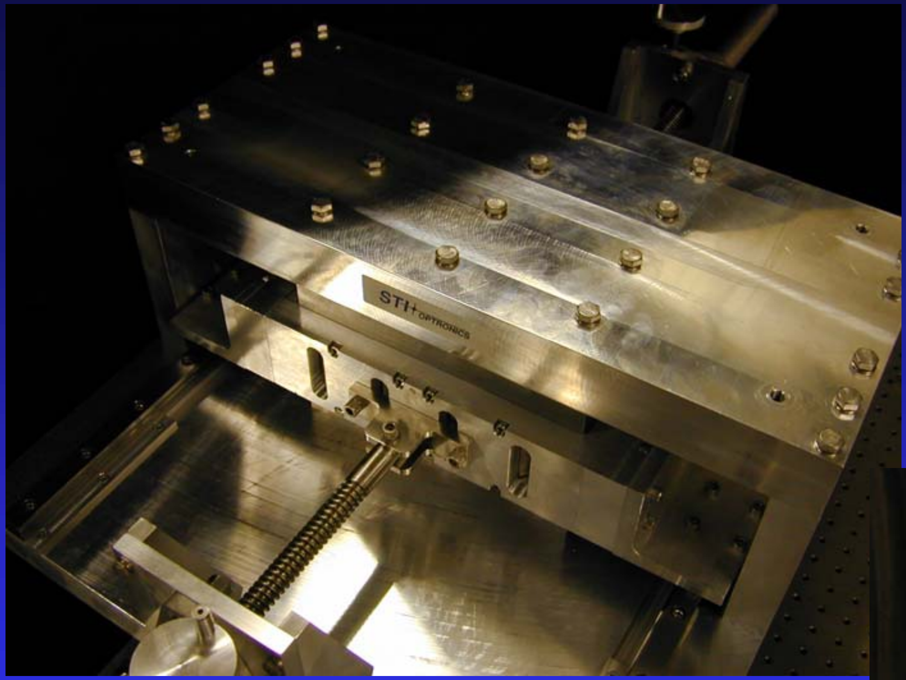
*** - US patent 6,182,831 B1**

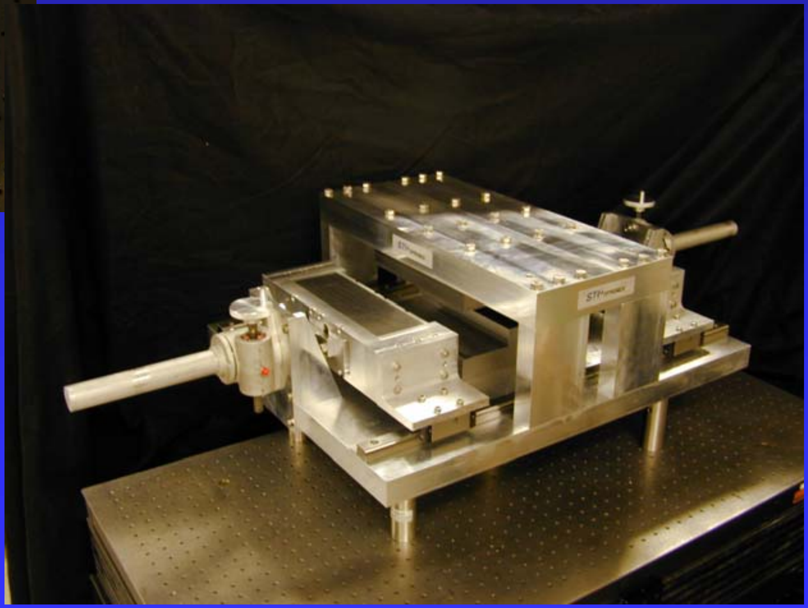
NMR/EPR magnet for JPL



- Very light weight (150 grams)
- Very high uniformity
    - 50ppm in huge volume
        - 80% of gap
        - 70% pole size
- Used stepped poles
- Learned importance of simulating symmetry breaking fabrication errors

Zeeman Spectroscopy Magnet for AFRL





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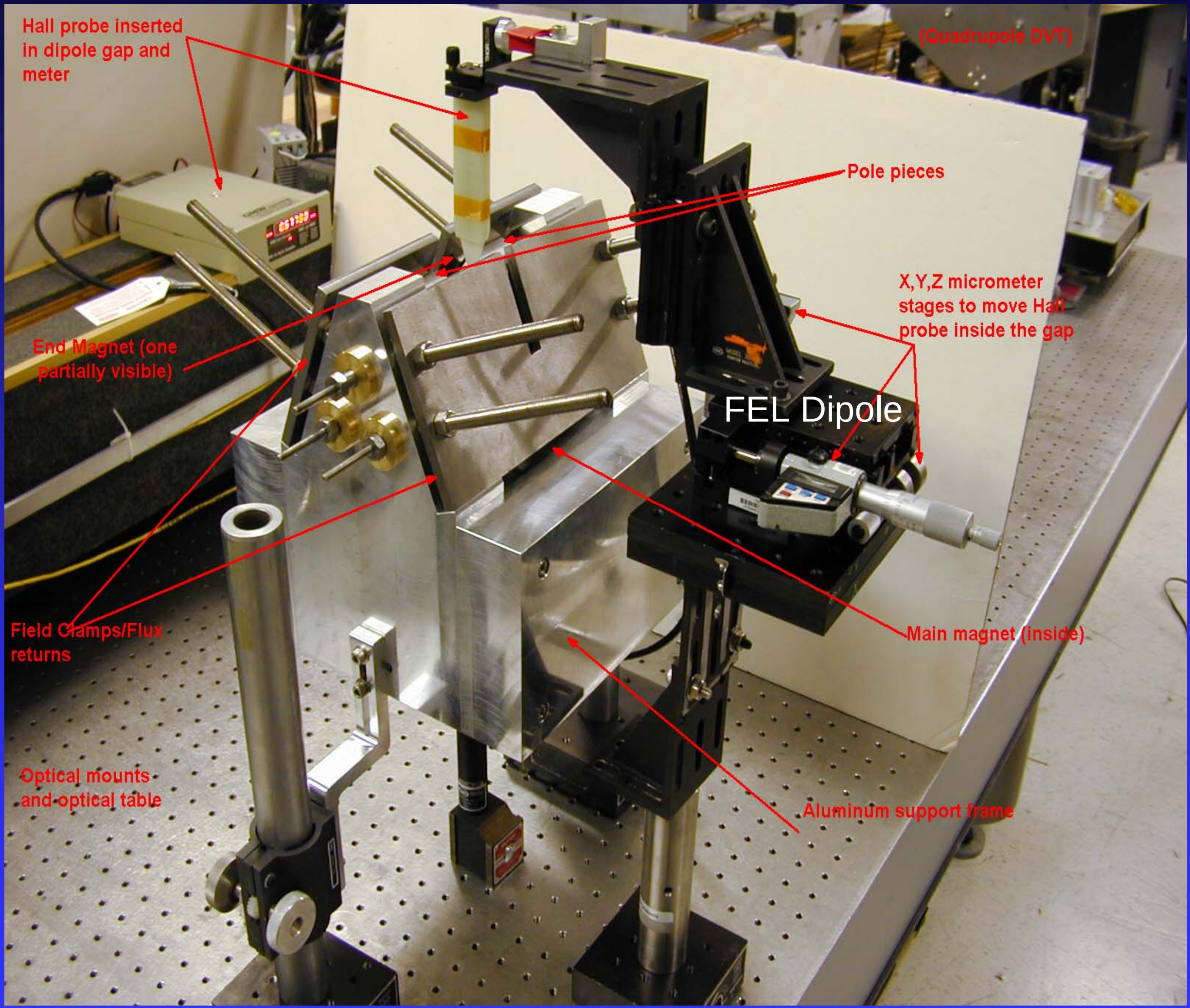
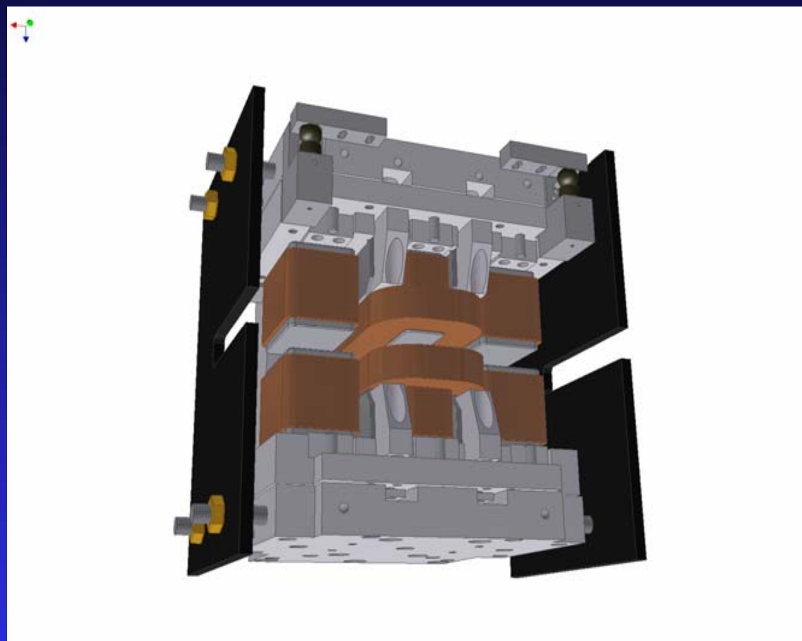
45 degree sector dipole for 25MeV Compact PM Bend



- •3D FEA uniformity agreed with measurements to 10ppm
- •Fringe fields agreed with FEA to 0.01%

Other Magnets



STELLA EM+PM Chicane

(In use at BNL)

STELLA EM Buncher

(too weak, replaced by short undulator)

Dispersive section, PM supplies most of L_D then EM trims it

A34 steel field clamps OK if use proper normalization. Hysteresis is < few G-cm

Magnet Design Approach

- Specifications
- Perform parametric magnetic analysis
  - Scope problem, identify issues
  - Specify critical components
  - Analyze
  - Send 3D model to engineering
- Perform engineering analysis
  - Make initial engineering design
  - Perform NASTRAN analysis
- Interactively iterate magnetic and engineering analyses
  - Always need forces and tolerances
- 'Complete' engineering design
  - Send 3D CAD model (SAT file) to magnetic group for final analysis
- Iterate one more time
- Finalize drawings
- Release to production
- Start on tooling design
- Start on detailed sensitivity analysis and tuning analysis

Electromagnetic Analysis Tools

- MagNet from Infolytica Corp
  - 2D/3D
    - Solid modeling
    - Static
    - Transient with motion
    - Harmonic
  - Parametric modeling
    - Extremely powerful
    - PM quad model has 92 parameters
  - Scripting
    - Over 1000 API's
    - Excel, VB, MatLab, Simulink, Excel, LabView, etc can control
- OpiNet
  - Global optimizer based on evolutionary strategy
  - Discussed more later

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Other analysis and design tools

- Inventor 3D CAD for solid modeling
- FEMAP mesher
- MSC NASTRAN for mechanical FEA
  - Aerospace and Defense Industry standard
  - Extremely well benchmarked
- Analyses
  - Fortran95 –Lahey
  - Fortran.NET – Lahey
  - IDL
  - VB
  - MathCAD, C
  - TecPlot, Mathematica

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The End