Better Living through Controls: Two examples

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High-Level Controls

• Anything above the hardware & p/s level
• Applications that provide physics parameters: Optics, Mass, Charge, Rigidity....
• Automation [Amthor?]  

Spreadsheets, Calculators, LISE,...

Two Examples:
• (i) Gas Cell Degrader Scan
• (ii) Predictive Dipole Matching
Gas Cell Degrader Angle = Rigidity Scan
Gas Cell Degrader Angle = Rigidity Scan

N4 AC Line Controls

N4 Drive Labels...

3.0000 Tm

0.0000m

AC206-Angle 10.3 deg

AC206

AC233-Angle -1000.0 deg

AC233

Camera

B_set

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>AC209TA</td>
<td>9.566 kg</td>
</tr>
<tr>
<td>AC211TB</td>
<td>12.274 kg</td>
</tr>
<tr>
<td>AC213TC</td>
<td>5.292 kg</td>
</tr>
<tr>
<td>AC219DS</td>
<td>8.293 kg</td>
</tr>
<tr>
<td>AC227TA</td>
<td>0.434 kg</td>
</tr>
<tr>
<td>AC229TB</td>
<td>1.785 kg</td>
</tr>
<tr>
<td>AC231TC</td>
<td>-0.131 kg</td>
</tr>
</tbody>
</table>
## Rigidity Scan with LISE

### [Python code interfacing with LISE API]

### LISE Parameters

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>34</td>
</tr>
<tr>
<td>Z</td>
<td>17</td>
</tr>
<tr>
<td>q</td>
<td>17</td>
</tr>
<tr>
<td>m</td>
<td>33.973762</td>
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</tbody>
</table>

### Set Point

- **AC206ANG-R**: 10.8715 Deg
- **Set Point**: 11.0000 Deg

### Inclination

**Inclination**: 11.00 degree

### Effective Thickness

- **Effective Thickness**: 125.302 mg/cm²
- **Energy Loss**: 96.966 MeV/μ
- **Brho7 [LISE]**: 2.906081 Tm

### B_set

<table>
<thead>
<tr>
<th>Magnet</th>
<th>Value</th>
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<tbody>
<tr>
<td>AC209TA</td>
<td>9.566 kG</td>
</tr>
<tr>
<td>AC211TB</td>
<td>12.274 kG</td>
</tr>
<tr>
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<td>5.292 kG</td>
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</table>

**N4 AC Line Controls**

- **Enabled**: Disabled

**If "Enabled," changing BRhoScan will set magnets.**

**If "Disabled," magnets cannot be set from this page.**
Rigidity Scan with LISE

Chandana Sumithrarachchi
Thursday 09:00
Predictive Dipole Matching

A1900 Dipoles are large, superconducting, & slow.

Equipped with NMR probes

Hysteresis effects are important: Approach field from above.

Simple tool:
Push-button matching.

Takes a long time, takes attention away from other tasks.
A1900 Dipoles take long time to ramp \textit{and} a long time to settle.

\textbf{B [Tesla] vs. time [seconds]}

\textbf{B - Bfinal [uT] vs. time [seconds]}

\textbf{Rigidity: 1.5 Tm}
Simple Tool: Push-button Matching

B [Tesla] vs. time [seconds]
Automatic Matching

First attempt (2012):
Based on time & partial correction. Not successful.

Issue: No time for development.
N4 vault reconfiguration – AC219DS.
New Idea: Analyze B(t).
A1900 Equipment Upgrade.
B(t) Analysis – Predictive Matching

Pragmatic Approach: Get close, automatically.
Analyze evolution of B(n) – B(n+1) step by step.
Use spare NMR controller & speed up readout.

Assume $B(t) \sim B_0 + B(\text{rem})\exp(-t/\tau)$.
Found $\tau$ varies from $\sim 30$ to $80$ sec depending on field strength & history.

Big help: Excel with introduced noise.
Recipe: Take NMR readings when current has reached final value.
Ignore first minute.
Match after three minutes.
First two A1900 dipoles. “Typical Spectrum”
B(t) Analysis – Predictive Matching
Tuning secondary beams is hugely expensive in terms of manpower. Saving even minutes is worthwhile.

There is much that can be done to improve the operation of our separators. Both in the big picture, and in the automation of tedious tasks.

TALK TO YOUR CONTROLS PEOPLE. Or become one yourself.

Mathias Steiner
Michigan State University
Extra Slides
Pragmatic Approach

Set & Read Currents

Field
Simple Tool: Push-button Matching

Difficult to get the timing right. Automation would be nice...