The MAST Upgrade Plasma Control System

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New features of MAST-U include:

Many new PF coils for divertor control studies

Different combinations of the same coils used to control different plasma shape parameters
– complex to manage

Many new gas injection locations for flexible multi-purpose applications

Multiple source gases, up to 6 gas species in simultaneous use. Any injection location can be used for any of several simultaneous gas control tasks
New features of MAST-U include:

- Different combinations of the same coils used to control different plasma shape parameters – complex to manage
- Multiple source gases, up to 6 gas species in simultaneous use. Any injection location can be used for any of several simultaneous gas control tasks
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**Common Concern:**
Many actuators need to be used simultaneously in multiple control tasks.
PCS based on General Atomics:

- Categories are placeholders for execution of interchangeable functions
- Each category has its own time segments (phases)

<table>
<thead>
<tr>
<th>Category</th>
<th>Pulse Duration</th>
<th>(Single immutable function and global data)</th>
</tr>
</thead>
<tbody>
<tr>
<td>System</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PF control</td>
<td>pre-magnetise</td>
<td>breakdown</td>
</tr>
<tr>
<td></td>
<td></td>
<td>ramp-up</td>
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<tr>
<td></td>
<td></td>
<td>flat-top</td>
</tr>
<tr>
<td>Gas control</td>
<td>inactive</td>
<td>prefill</td>
</tr>
<tr>
<td></td>
<td></td>
<td>density control</td>
</tr>
<tr>
<td></td>
<td></td>
<td>density + XYZ</td>
</tr>
<tr>
<td>Category X</td>
<td>inactive</td>
<td>function A</td>
</tr>
<tr>
<td></td>
<td></td>
<td>function B</td>
</tr>
<tr>
<td></td>
<td></td>
<td>function A</td>
</tr>
</tbody>
</table>

- Care needed when exchanging data between categories
- Data has global scope – ensure only one category writes to any item
Architecture decisions for MAST-U PCS:

For each of PF coils and gas:

- Define a functional chain of categories to break down complexity

Multiple control categories running in parallel…

Virtual to physical actuator mapping

Physical actuator change requests

Actuator collective controller

Plant voltage demands

Separate single actuator manager category that owns the plant

Separate category defines virtual actuators and maps to physical

…driving virtual actuators.

Define a functional chain of categories to break down complexity

Control aspect 1

Control aspect 2

Control aspect 3

Control aspect 4