How did we build the schedule

• Divide the plan in phases:
  – Conceptual study
  – Engineering, demonstration, models
  – Full size prototypes
  – Pre-series
  – Series
  – Test
  – Installations

• Estimate quantities, time and parallel lines based on previous experience (LHC, HL-LHC)

• CAVEAT: this is not a formal, self-consistent, nor complete schedule
We have a plan

<table>
<thead>
<tr>
<th>Complex</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
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</tr>
</tbody>
</table>

### Target and Capture (HTS)
- R&D and demonstrators
- Models
- Prototypes
- Construction
- Test
- Installation

#### 6D cooling
- Specification and concept development
- R&D and demonstrators
- Solenoids for Cooling Cell Test Area
- Construction
- Integration
- Test
- Installation

#### Final cooling
- Specification and concept development
- R&D and demonstrators
- Ni UHF conceptual design and engineering, mechanical and protection tests
- Models
- Prototypes
- Construction
- Integration
- Test
- Installation

### Accelerators
- R&D and concepts (NO)
- Models (NO)
- Series (NO)
- Acceptance tests (NO)
- Installation (NO)
- R&D and concepts (NC power)

#### Accelerators and concept development (SC)
- R&D and demonstrators (SC)
- Models
- Prototypes
- Pre-series
- Series (RC52 and RC53)
- Series (RC54)
- Test
- Installation

### Collider (3 TeV)
- R&D and demonstrators
- Models
- Prototypes
- Pre-series
- Series
- Test
- Installation

### Collider (10 TeV)
- Specifications and concept development
- R&D and demonstrators
- Models
- Prototypes
- Pre-series
- Series
- Test
- Installation

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**Muon beam production**

**Muon beam acceleration**

**Collider options**
Muon beam production – 1/3

<table>
<thead>
<tr>
<th>Complex</th>
<th>Target and capture (HTS)</th>
<th>Year</th>
</tr>
</thead>
<tbody>
<tr>
<td>R&amp;D and demonstrators</td>
<td>1</td>
<td>2015</td>
</tr>
<tr>
<td>Models</td>
<td>2</td>
<td>2016</td>
</tr>
<tr>
<td>Prototypes</td>
<td>3</td>
<td>2017</td>
</tr>
<tr>
<td>Construction</td>
<td>4</td>
<td>2018</td>
</tr>
<tr>
<td>Test</td>
<td>5</td>
<td>2019</td>
</tr>
<tr>
<td>Installation</td>
<td>6</td>
<td>2020</td>
</tr>
<tr>
<td>Cable and winding development</td>
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<tr>
<td>20T/20K single coil test</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>Prototype coil (spare)</td>
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<td></td>
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<tr>
<td>Target, decay and capture magnets completed</td>
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<tr>
<td>Final cooling solenoids completed</td>
<td>11</td>
<td></td>
</tr>
<tr>
<td>Final cooling cells completed</td>
<td>12</td>
<td></td>
</tr>
<tr>
<td>Final cooling cells completed</td>
<td>13</td>
<td></td>
</tr>
</tbody>
</table>

Target, decay and capture

- Seems feasible, no criticality identified with the schedule
- Technology is rather evolved (from fusion) and resorts on “standard” fabrication techniques (TRL=5)
- Muon target, decay and capture channel could be built by Y15
Muon beam production – 2/3

6D cooling

- Seems feasible, but the number of components is large and will require parallel manufacturing lines
- Technology is not yet ready for the high field end (e.g. from stage B5 downwards) (TRL=3)
- Integration is a considerable effort

- 2864 single coils, 1652 cells of 12 types (based on US-MAP)
- At least 2 firms for coil production
- At least 4 teams for cooling cell integration
- The 6D cooling cells could be built by Y17
Muon beam production – 2/3

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<td>Prototype coil (spare)</td>
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<tr>
<td>Target, decay and capture magnets completed</td>
<td>8</td>
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</table>

**Final cooling**

- Seems feasible, no criticalities identified in the schedule
- Technology is not yet ready (TRL=2...3)
- Performance is the main focus, cost may be less of an issue (small percentage of total cost)
- The final cooling cells could be built by Y19
Muon beam acceleration

Pulsed (NC) system
- NC magnet construction requires optimization and demonstration, but does not appear to be critical, technology known (TRL=7...8)
- Power converter schedule is critical because of the large number of units
- Energy storage and power conversion will require development, engineering and demonstration (string test), but relatively known technology (TRL 6...7)
- Pulsed (NC) system could be built by Y13 (up to RCS3) and Y17 (RCS4)
Muon beam acceleration

Steady (SC) system
- SC magnet construction depends on technology choice, but likely to be HTS (beam losses and field reach)
- Schedule is tight w/r to the pulsed system
- Technology requires development, engineering and demonstration (TRL=3)
- Steady (SC) system could be built by Y18 (up to RCS3) and Y22 (RCS4)
LTS collider magnets (\(\text{Nb}_3\text{Sn}\)) – 3 TeV

- Schedule has been estimated based on LHC and HL-LHC experience
- Technology still requires development, but relies on HFM and US-MDP advances (TRL=5...6)
- LTS collider magnets could be built by Y17
Muon beam acceleration

**HTS collider magnets (REBCO) – 10 TeV**

- Schedule accommodates relatively long study and demonstration phase
- Technology is not yet ready (TRL=2...3)
- HTS collider magnets could be built by Y26
A plan is a living entity, it is made to be changed

A plan is a tool to facilitate our work

A plan is a powerful instrument to set work objectives and priorities

To work well, a plan needs to be shared and integrated
Hic Svnt Dracones
We have a cost estimate

3 TeV
Share in percentage of total cost for the magnet and powering systems

10 TeV
Share in percentage of total cost for the magnet and powering systems

- The 6D cooling and accelerator (RCS) are the largest cost positions
- RCS4 is the largest single cost item in the 10 TeV collider option
- Target and capture (largest stored energy single magnet in the system) and final cooling (largest nominal field) only represent a few % of the total cost