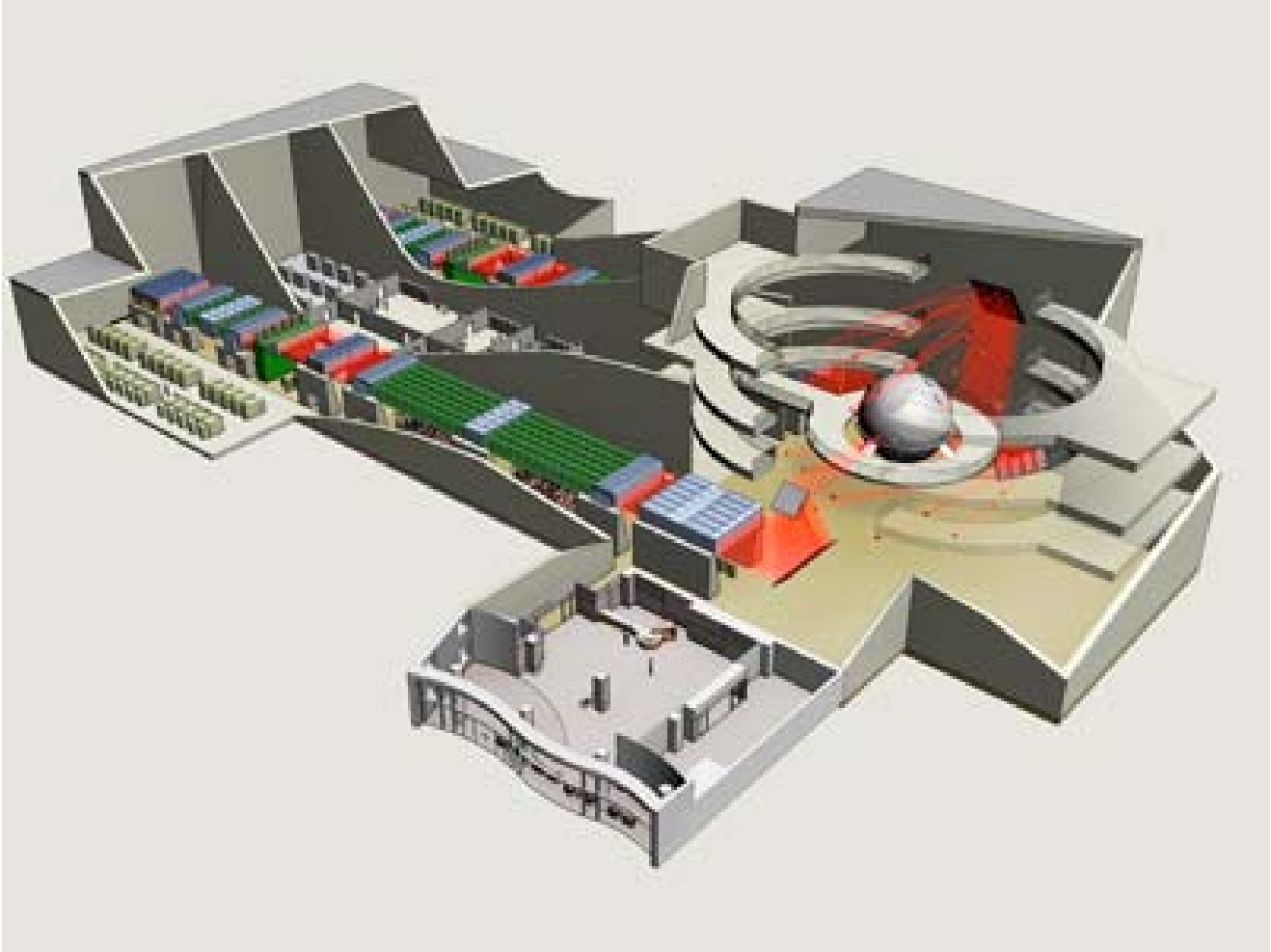
Conceptual design

1. **Implosion energy:**
   200 kJ in 5ns
   10 m chamber

2. **PW beamlines:**
   >70kJ in 10ps
   2ω

3. **Parallel development of IFE building blocks**
   - **Target manufacture**
   - **High rep-rate laser**
   - **Reactor designs**



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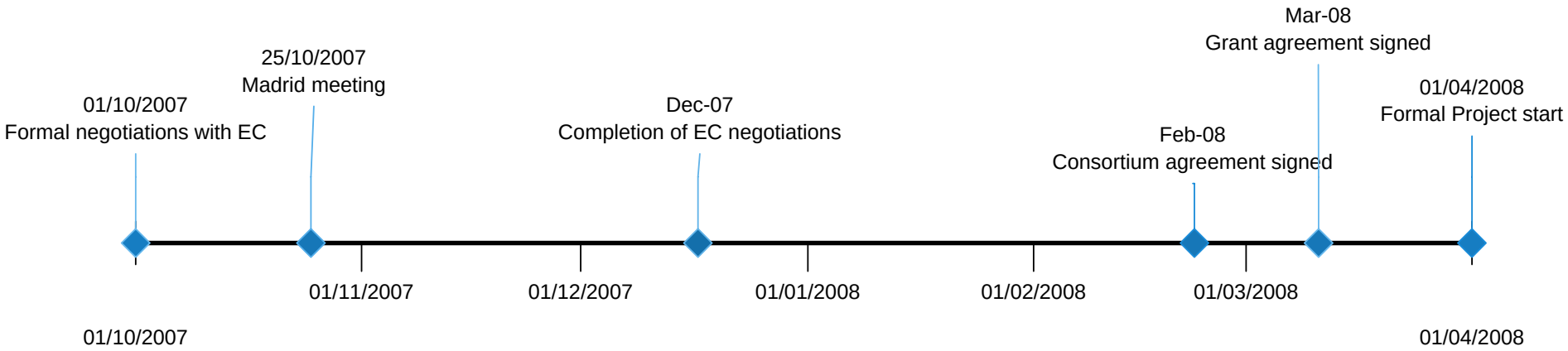
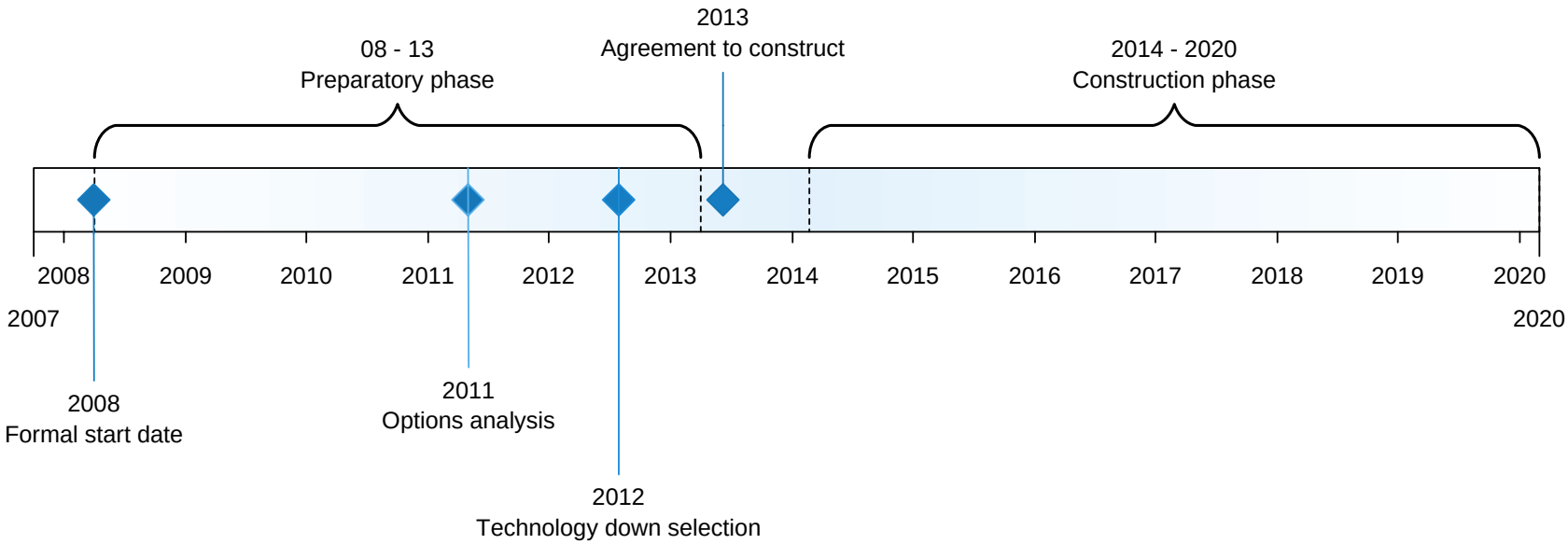
Project Timeline





Purpose of this “Round Table”

1. To provide advice on the priorities for work in the HiPER project
   - Target fabrication capability
   - Laser technology
2. To identify specific new opportunities for collaborative work within the HiPER project

In particular, to identify possible tasks within Russia that could link into the HiPER project

Required technical developments

- **Laser design**
  - **2ω CPA solution, OPCPA (for high power beam)**
  - **Flexibility for a range of ignition options**
  - **High repetition rate, high efficiency drivers**
- **Improved understanding of the target performance**
  - **Needs coordinated research programs on international laser facilities**
  - **Point design assessment, and key physics issues**
- **Micro-fabrication & delivery of fuel pellets (and future bulk manufacture methods)**
- **Integrated reactor designs**

International cooperation in these areas is essential

Specific areas of work (laser technology)

- **Baseline facility design**
- **System analysis to optimise LMJ design**
- **Beam coupling (phase locking CPA beams)**
- **Harmonic Conversion**
- **OPCPA development**
- **DPSSL high repetition rate development**
- **Sourcing of critical laser components (glass, crystals, large area parabola, etc)**

Target Fabrication – planned work (1 / 2)

Self-consistent target design

- **Iterate design to produce a practical, robust target:**
  - manufacture & fielding constraints
  - plasma modelling specifications
  - overall facility design constraints
- **Technical analysis of key target production issues:**
  - Cone/capsule seal at cryo temperatures
  - Thermal and structural analysis of target assembly
  - Layering for wicked foam and high density shell targets with cone
  - Baseline cryo insertion for direct drive fast ignition target
  - Experimental validation plan for the proposed design

To produce : Conceptual Design for FI target assembly and fielding

: Assessment of European capability in this area

: Future plans for required target production

Target Fabrication – planned work (2 / 2)

Target production for experimental validation

- For experiments on PETAL (and other international facilities)

Investigate mass production techniques and capability

- Determine credible, large scale target production route
  - for target manufacture, assembly, and preferred filling method
  - propose experimental validation plans where required
- Cost study for high repetition production
- Assess high rep-rate injection and tracking techniques
- Assess cryogenic infrastructure requirements & costs
- Analyse Tritium handling procedures

Top-level deliverables (draft)

WP 11 - Fusion Target Delivery	7	Input realistic targetry constraints to the HiPER point design model (WP9)	Month 6, 12, 24
	8	High rep-rate target production, injection and tracking techniques – requirements analysis [month 12], and proposed solutions (including initial prototyping) [month 30]	Months 12, 30
	9	Roadmap for development of cryogenic DT capability and infrastructure, based on detailed analysis of solutions for single-shot, and outline solutions for high rep-rate.	Month 28

Questions

1) What are the major technical challenges that the HiPER project needs to address?

2) How to demonstrate high rep rate capability (including realistic timescales)?

3) Logistics of shifting from DD to DT (including timescales)?

4) Lead tasks have been identified in the project plan. Does this need updating?

5) Are the deliverables realistic and appropriate?

6) How to ensure that enough suitably skilled staff are available on time?

Planned involvement (so far)

CEA SBT (cryogenics group) (France)

GA General Atomics (USA)

LPI Lebedev Physical Institute (Russia)

RAL STFC Rutherford Appleton Laboratory (UK)

TUD Technische Universität Darmstadt (Germany)

UPM Universidad Politécnica de Madrid (Spain)

Are there any others which should be included?

Academic European institutions

1) Lead, specify and co-ordinate HiPER target fabrication activities.
2) Analysis of European infrastructure requirements to enable all necessary aspects of HiPER target fabrication.
3) Examine new materials, especially for improving yield of IFE targets.
4) Study foam layering of shells.
5) Provide input into tritium handling procedures.
6) Computational modelling of cone-shell target layering including target and thermal (shroud) environment.
7) Propose methods for high repetition rate target production, handling, characterisation and injection

Draft tasks (2/3)

CEA laboratories

1) Design system to field single shot HiPER cryogenic targets based on modifying existing technology using both fill tube and permeation.

2) Cryogenic infrastructure: design of cryostats, DT fill apparatus, target positioner, thermal shroud and shroud remover; mK control of target fill and layering.

3) DT handling procedures

4) Specify permeation facility and technologies for transport of cryogenic targets.

5) Produce cost estimates for HiPER single shot cryogenic capability.

6) Provide outline design for high repetition rate cryogenic solution

Draft tasks (2/3)

US laboratories

1) Propose plausible methods for mass production of cone-shell targets including mass-production of; capsules and foam shells, capsule hole cutting, assembly and layering. Perform laboratory-scale demonstration of key techniques.

2) Analyse high repetition rate injection and tracking techniques including target placement accuracy.

3) Cost analysis for continuous high repetition rate (cryogenic) IFE target production and insertion including; optimised solution(s) and infrastructure (such as a target manufacturing plant).

4) Examine new materials, especially for improving yield of IFE targets.

Questions

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Prof Mike Dunne