ITER_D_2NQFLK

Atomic & Molecular Data Needs for ITER

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ITER Organization

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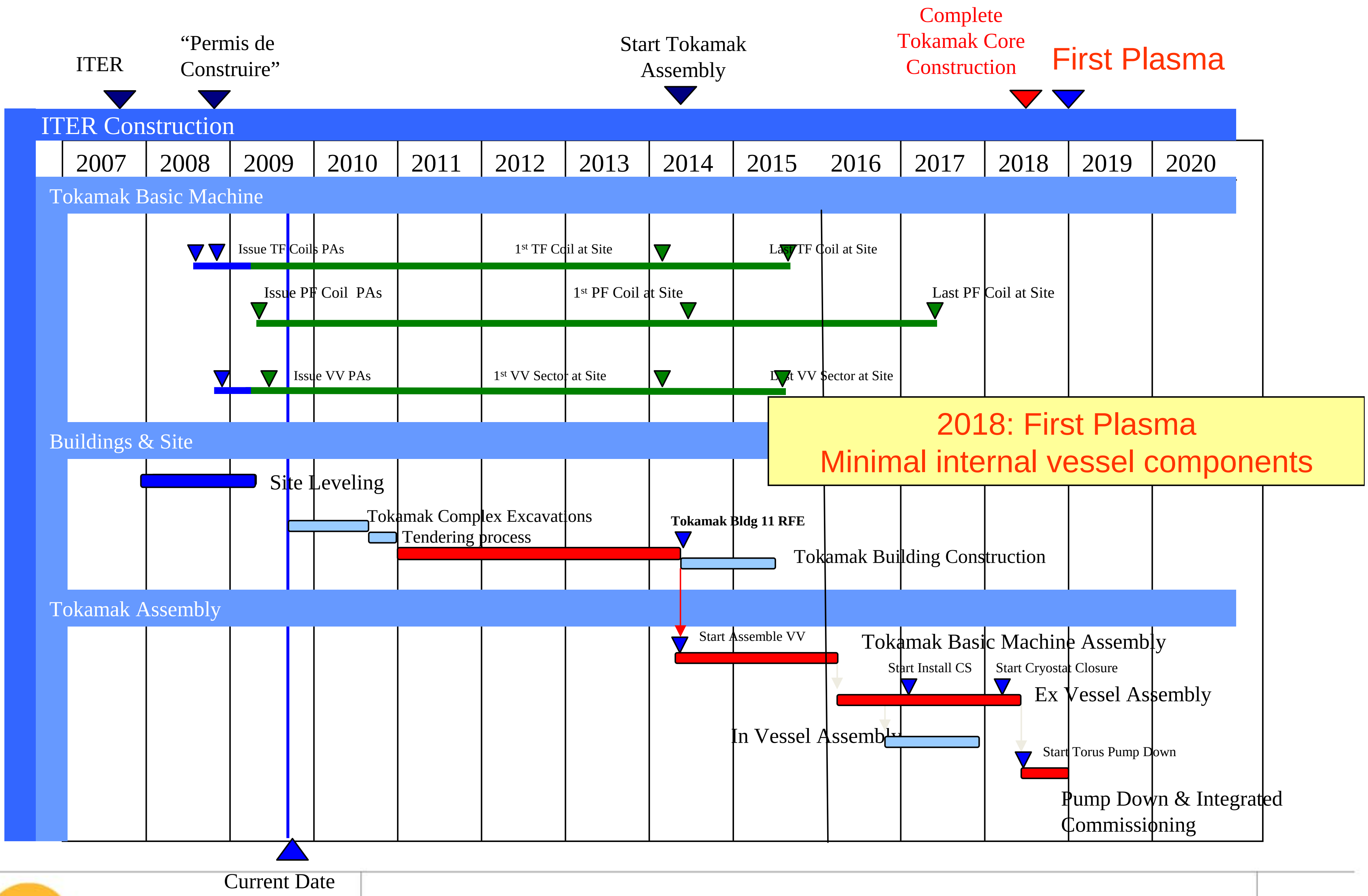
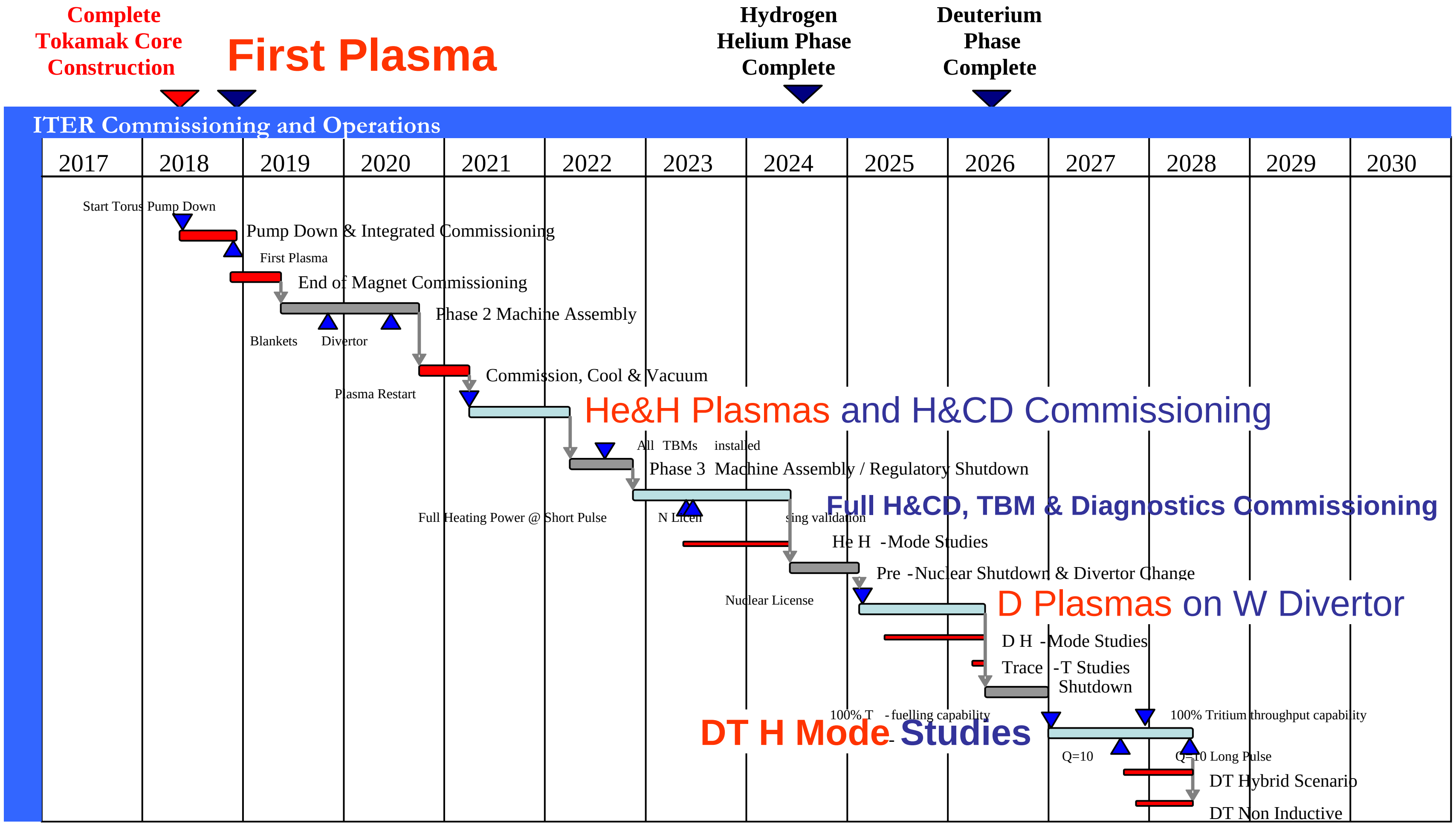
Present ITER Construction Site

Updated Schedule



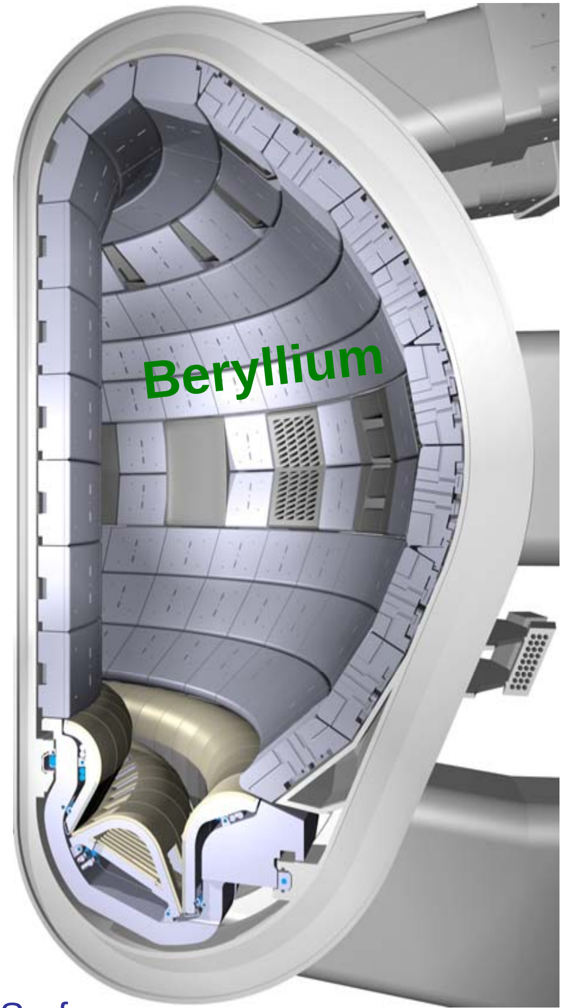
Approach to DT Operation

- First D-T Plasma foreseen at the end of 2026 or beginning of 2027



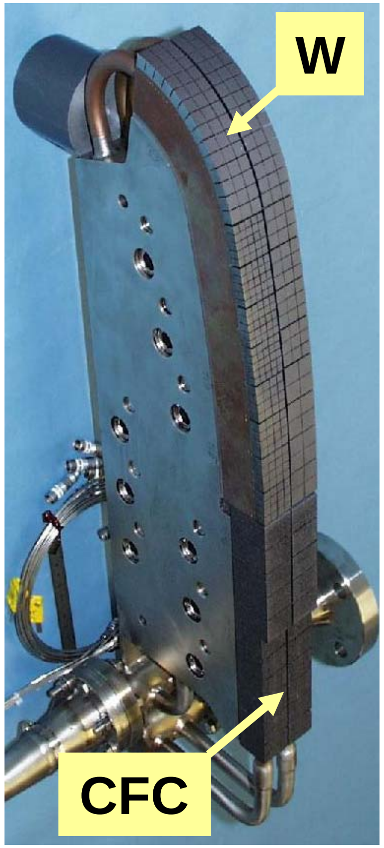
➔ The timescale for modeling development

ITER materials choices



Surface areas:
Be: 700 m^2, W: 100 m^2
CFC: 50m^2

- Be for the first wall
  - Low T-retention
  - Low Z
  - Good oxygen getter



- For H and part of D phase: C for the targets
  - Low Z
  - Does not melt
  - Excellent radiator
- W for the dome/baffles
  - High Y_{phys} threshold

Driven by the need for operational flexibility

- For D and DT phases:
  - Be wall, all-W divertor*

To avoid problem of T-retention

*The possibility of CFC target during the initial DT phase is not precluded

Main species in ITER: H, D, T, He, Be, C, W, O, N, Ne, Ar, Kr

ITER Modeling

Core plasma inside the separatrix (ASTRA):

1D transport, averaged over the flux surfaces

mostly coronal approximation for impurity radiation

Edge plasma outside the separatrix (SOLPS):

"dirty" plasma (neutrals, impurities, wall interactions); essentially 2D

multi-fluid model for ions & electrons

→ a separate fluid for each charge state

Monte-Carlo model for neutrals

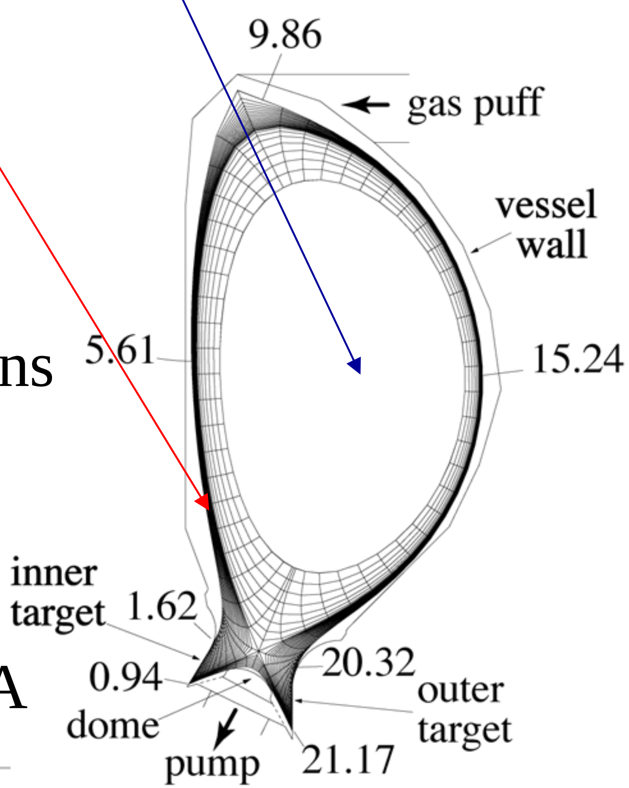
→ geometry detail (3D), full set of reactions

→ neutral-neutral collisions included

→ radiation transport can be included

Integration: parameterisation of SOLPS results

→ boundary conditions for ASTRA



Current Modeling

- Most of effort on modeling the energy and particle transport
  - Analysis of divertor design
  - Data on ionisation, recombination, and total emissivity
- Burning plasma conditions with C targets (the decision on W targets for D-T phase was made rather recently)
  - → Data for H isotopes, He, Be, and C;
    $T_e \in [0.01 \div 1000]$ eV, $n_e \in [10^{18} \div 10^{21}]$ m^{-3}
    - generally, existing; refinement desirable
    - Vibrational excitations for D_2 molecules important for neutral transport
      - → Data for DT? For T_2?
- Turning to the pre-DT phase (especially, He plasmas) with C targets
  - → He data more important, in particular, 3-body recombination and radiation emissivity – refinement desirable

Next step

- Turning to the DT phase with W targets
  - – Rather urgent: the second set of divertor cassettes to be designed before start of ITER operation
  - → Impurity seeding
  - → W, Ne, Ar, N, (Kr, Xe) data;

    $T_e \in [10^2 \div 10^4]$ eV, $n_e \in [10^{19} \div 10^{20}]$ m^{-3} core

    $T_e \in [10^{-2} \div 10^3]$ eV, $n_e \in [10^{18} \div 10^{21}]$ m^{-3} edge
  - High-Z → bundling the charge states desirable
    - Transport-dependent → convenient tools needed
  - N_2 molecules: vibrational excitations?

Further plans

- Diagnostics assessment: test bench for diagnostics developers
  - Emissivity of separate lines
    - for spectroscopy
    - disturbing e.g. Thomson scattering measurements

    → identification of proper lines
- Abnormal event detection (water leak, loss of tiles, …)
  - H_2O, O, O_2, Fe, Cu data
- Parasitic plasma under the dome
  - Photo-ionisation & photo-dissociation data
- Wall interaction data
  - Excitation of reflected/desorbed particles?

Summary

- Usual non-specific request: more data, better evaluated
- W data seem to be critical for near future
  - Continued validation of tungsten atomic data important
  - Tools for bundling charge states are needed
- Importance of line radiation data
  - Selection of proper lines: input from diagnostics community needed
- Molecule excitations
  - Isotope effect?
  - Gaseous impurities?