THE FUSION REPORT

GLOSSARY

Fusion Energy 101: **Key Terms and Definitions**

- **Active Cooling**

  Systems designed to continuously remove heat from reactor components during operation.

- **Actuator Control Systems**

  Mechanisms used to adjust plasma parameters dynamically, such as magnetic fields, heating power, and fueling rates.

- **Additional Heating**

  Methods used to raise plasma temperature beyond what is achieved by Ohmic heating, such as neutral beam injection or radiofrequency heating.

- **ADITYA-U**

  An upgraded version of India's first indigenously designed and built tokamak, ADITYA, aimed at studying plasma confinement.

- **Advanced Fuels**

  Alternative fusion fuels, such as helium-3 or deuterium-deuterium, requiring higher temperatures but producing fewer neutrons.

- **Advanced Plasma Fuels**

  Fuels beyond deuterium-tritium, such as deuterium-helium-3 or proton-boron, requiring higher temperatures but offering cleaner energy output.

- **Advanced Reactor Materials**

  High-performance materials designed to withstand extreme heat, radiation, and mechanical stress in fusion reactors.

- **Advanced Tokamak**

  A tokamak design optimized for higher performance and improved confinement, often incorporating non-inductive current drive and advanced shaping.

- **Alcator C-Mod**

  A compact, high-magnetic-field tokamak operated by MIT for plasma physics research.

- **Alfvén Waves**

  Low-frequency oscillations in magnetized plasmas, important in energy and particle transport.

- **Alpha Channeling**

  A method to extract energy from alpha particles while improving plasma confinement.

- **Alpha Channeling Effect**

  A method to direct energy from alpha particles to plasma heating, enhancing overall reactor efficiency.

- **Alpha Heating**

  The process where alpha particles (helium nuclei) produced in fusion reactions transfer energy to the plasma, helping to sustain the fusion process.

- **Alpha Particle**

  A helium-4 nucleus released during fusion reactions, carrying a significant portion of the reaction energy.

- **Alpha Particle Containment**

  The ability of a reactor to confine helium nuclei produced in fusion reactions, contributing to sustained heating.

- **Alpha Particle Transport**

  The behavior of helium nuclei (alpha particles) produced in fusion, critical for plasma heating and stability.

- **Anisotropic Transport**

  Transport in plasma that varies depending on the direction, influenced by magnetic fields.

- **Anomalous Transport**

  Unexpected or enhanced movement of energy and particles in plasma, often caused by turbulence.

- **Antenna**

  Device used to transmit electromagnetic waves into the plasma for heating and current drive purposes.

- **Artificial Neural Networks (ANNs)**

  Machine learning algorithms used to analyze plasma behavior and optimize reactor operations in real-time.

- **ASDEX Upgrade**

  A German tokamak experiment focusing on plasma stability and confinement, contributing to ITER research.

- **Aspect Ratio (Plasma)**

  Ratio of the major radius to the minor radius of a tokamak's toroidal plasma, influencing stability and confinement.

- **Atomic Cross-Sections**

  The effective area for interaction between particles and nuclei, critical in fusion reaction modeling.

- **Atomic Emission Spectroscopy**

  A diagnostic method that measures the light emitted by plasma to determine composition and impurity levels.

- **Auxiliary Heating**

  External heating methods used to raise plasma temperature, such as radiofrequency or neutral beam injection.

- **Axial Symmetry**

  Symmetry around the central axis of a toroidal reactor, crucial for maintaining plasma stability.

- **B**

  The symbol used to denote the strength of the magnetic field, typically given in units of “Tesla”. The Earth's magnetic field is 0.00005 Tesla.

- **Ballooning Instabilities**

  Pressure-driven plasma instabilities that occur in regions with unfavorable magnetic curvature.

- **Beamlines**

  Pathways that direct high-energy particle beams into the plasma for heating or diagnostic purposes.

- **Beryllium Cladding**

  A layer of beryllium applied to plasma-facing components to protect against erosion and improve tritium breeding.

- **Beryllium Erosion**

  The wear and tear on beryllium plasma-facing components due to high-energy particle impacts.

- **Beryllium Tritide**

  A compound formed when beryllium absorbs tritium, relevant for tritium retention and recycling studies.

- **Bifurcation**

  A sudden change in plasma behavior, such as the transition from L-mode to H-mode confinement.

- **Bioshield**

  A protective barrier that absorbs radiation, ensuring safety for personnel and the environment.

- **Biot-Savart Law**

  A fundamental principle used to calculate magnetic fields produced by electric currents in fusion devices.

- **Blanket**

  In a fusion reactor, the layer surrounding the plasma that absorbs neutrons and converts their energy to heat. It is also a place to breed tritium fuel when the blanket modules contain lithium.

- **Blanket Cooling**

  Techniques used to manage heat generated in tritium breeding blankets.

- **Blanket Modules**

  Replaceable sections of the reactor blanket, used to breed tritium and manage neutron flux.

- **Bootstrap Current**

  A self-generated electric current in the plasma due to pressure gradients, reducing external power requirements.

- **Bootstrap Current Efficiency**

  The effectiveness of self-generated currents in reducing the need for external current drive.

- **Bootstrap Current Profile**

  The distribution of self-generated current within a plasma, which impacts stability and confinement.

- **Boronized Walls**

  Reactor walls coated with boron to reduce impurities and improve plasma performance.

- **Bounce Frequency**

  The rate at which particles oscillate along magnetic field lines in a toroidal plasma.

- **Boundary Layer Plasma**

  The outermost layer of the confined plasma, where interactions with reactor walls and divertors occur.

- **Breakdown Voltage**

  The voltage required to ionize gas and initiate plasma formation in a reactor.

- **Breakeven**

  The point at which a fusion reaction produces as much energy as is required to initiate and sustain it (Q=1).

- **Breeding Blanket**

  A blanket designed to generate tritium through reactions with neutrons, ensuring a sustainable fuel supply.

- **Breeding Technologies**

  Methods and materials used to produce tritium within a fusion reactor.

- **Bremsstrahlung Radiation**

  Electromagnetic radiation produced by the deceleration of charged particles in the plasma, causing energy losses.

- **Broader Approach**

  A collaborative program between Europe and Japan to accelerate fusion energy development.

- **Burn**

  A sustained fusion reaction where the plasma maintains its temperature through internal heating from fusion-produced alpha particles.

- **Burn Control**

  The methods used to regulate the rate of fusion reactions in a reactor.

- **Burn Dynamics**

  The behavior of fusion reactions as they sustain themselves in a burning plasma.

- **Burn Fraction**

  The percentage of fusion fuel that reacts before being replaced, influencing reactor efficiency.

- **Burning Plasma**

  A plasma in which the majority of heating comes from fusion reactions within the plasma itself.

- **Carbon Tiles**

  Plasma-facing materials made of carbon, known for their ability to withstand high temperatures but prone to erosion.

- **CEA**

  French Alternative Energies and Atomic Energy Commission, involved in fusion research and development.

- **Central Electron Heating**

  Methods to specifically raise the temperature of electrons in the plasma core, improving overall performance.

- **Central Solenoid**

  The primary electromagnet in a tokamak that drives plasma current and shapes the magnetic field.

- **Centralized Fueling**

  Delivering fuel directly to the core of the plasma to improve fusion efficiency.

- **Charge Exchange**

  A process where ions exchange electrons with neutral particles, used in diagnostics and affecting plasma behavior.

- **Charge Neutralization**

  The process of balancing ion and electron populations to maintain plasma stability.

- **Closed Magnetic Surfaces**

  Magnetic field configurations that trap plasma particles effectively, preventing energy and particle losses.

- **Cohesive Energy Density**

  A material property that indicates resistance to damage under extreme fusion reactor conditions.

- **Coil Inductance**

  The property of reactor coils to store energy in a magnetic field, crucial for controlling plasma.

- **Collective Scattering**

  A diagnostic technique that measures plasma density fluctuations by scattering electromagnetic waves.

- **Collisional Damping**

  The reduction of wave energy in the plasma due to particle collisions, affecting heating and stability.

- **Commissioning**

  The process of testing and validating systems and components of a fusion device before full operation.

- **Compact Fusion**

  Fusion reactor designs that aim to reduce size and cost while maintaining performance.

- **Compact Stellarator**

  A smaller, more efficient version of the stellarator, designed for easier construction and operation.

- **Compact Toroid**

  A plasma configuration with a closed magnetic field structure, offering potential advantages in reactor design.

- **Component Replacement Robotics**

  Advanced robotic systems designed to replace worn or damaged reactor components remotely.

- **Confinement**

  The process of containing and controlling the hot plasma required for fusion reactions. In stars, plasma confined by the gravitation of their immense mass, but on earth strong magnetic fields are currently the most successful method.

- **Confinement Hysteresis**

  The phenomenon where plasma remains in a high-confinement state even after the conditions initiating it are reduced.

- **Confinement Scaling Laws**

  Predictive equations describing how plasma confinement properties change with reactor size and magnetic field strength.

- **Confinement Time**

  The duration that energy or particles remain in the plasma before escaping, critical for achieving fusion conditions.

- **Cooldown**

  The process of lowering the temperature of reactor components, especially superconducting magnets, to operational levels.

- **Cooling Water System**

  Infrastructure that removes excess heat from reactor components to maintain safe operating temperatures.

- **Core Plasma**

  The central region of the plasma, where temperatures and densities are highest, driving fusion reactions.

- **Coronal Plasma**

  Plasma conditions similar to those found in stellar coronas, relevant in high-energy physics studies.

- **Correction Coils**

  Magnets used to adjust and fine-tune the magnetic field configuration, correcting asymmetries.

- **Critical Density**

  The maximum plasma density that allows efficient wave propagation for heating and stability.

- **Critical Gradient**

  The threshold of plasma parameter gradients beyond which instabilities develop.

- **Cross-Field Diffusion**

  The movement of particles and energy perpendicular to magnetic field lines, often caused by turbulence.

- **Cryogenic**

  Pertaining to extremely low temperatures, often used in the context of cooling superconducting magnets.

- **Cryogenic Coolant**

  Extremely cold fluids, such as liquid helium, used to cool superconducting magnets in fusion reactors.

- **Cryogenic Pellet Injection**

  A method of injecting frozen fuel pellets into the plasma to enhance fueling efficiency.

- **Cryogenic Refrigeration Systems**

  Systems that maintain ultra-low temperatures for superconducting magnets and other critical components.

- **Cryopellet Injector**

  A device that introduces frozen fuel pellets into the plasma, providing efficient refueling.

- **Cryoplant**

  Facility that produces and manages cryogenic fluids for cooling purposes in a fusion reactor.

- **Cryopump**

  A device that uses cold surfaces to condense and trap gases, creating a high-vacuum environment.

- **Cryostat**

  A large, insulated chamber that maintains low temperatures for components like superconducting magnets.

- **Current Density Profile**

  The distribution of electrical current within the plasma, affecting stability and confinement.

- **Current Drive**

  A means for producing the toroidal plasma current. Techniques used to generate and sustain electric current within the plasma, essential for maintaining confinement.

- **Cusp Confinement**

  A magnetic confinement concept using magnetic cusps to trap plasma.

- **Cyclotron Frequency**

  The natural oscillation frequency of charged particles in a magnetic field, important for heating mechanisms.

- **Cyclotron Resonance**

  The condition where particles absorb energy efficiently from electromagnetic waves at their natural oscillation frequency.

- **Cyclotron Wave Damping**

  The loss of wave energy as it transfers to particles moving at cyclotron resonance frequencies.

- **Decommissioning**

  The process of safely dismantling a fusion facility after its operational life ends.

- **DEMO**

  A proposed demonstration fusion power plant intended to bridge the gap between experimental reactors like ITER and commercial fusion energy.

- **Dense Plasma Focus (DPF)**

  A fusion concept using a high-density plasma to achieve conditions for fusion reactions.

- **Density Limit**

  The maximum plasma density a tokamak can achieve before disruptions occur.

- **Density Pedestal**

  The sharp increase in plasma density near the edge, characteristic of H-mode operation.

- **Deuterium**

  A naturally occurring isotope of hydrogen with one proton and one neutron in its nucleus, commonly used as fusion fuel. It is abundant and can be easily extracted from sea water.

- **Deuterium-Deuterium Fusion**

  A fusion reaction between two deuterium nuclei, producing tritium, helium, or neutrons.

- **Deuterium-Tritium Plasma**

  Plasma composed of deuterium and tritium ions, the most commonly studied fuel mix for fusion reactors.

- **Deuterium-Tritium Reactions**

  Fusion reactions between deuterium and tritium nuclei, producing helium and high-energy neutrons.

- **Diagnostic Mirrors**

  Reflective surfaces used to direct plasma emissions to diagnostic tools while resisting erosion and contamination.

- **Diagnostic Neutral Beam**

  A low-power beam used for plasma diagnostics, such as measuring ion temperature and rotation.

- **Diagnostics**

  Instruments and methods used to measure and analyze plasma properties and reactor conditions.

- **DIII-D**

  A tokamak operated by General Atomics in the USA, contributing to fusion research and ITER preparations.

- **Direct Conversion**

  A method of converting fusion energy into electricity without using a steam cycle.

- **Direct Drive**

  An inertial confinement fusion method where lasers or beams directly compress the fuel pellet.

- **Direct Energy Conversion**

  Techniques to convert the kinetic energy of fusion products into electricity without intermediary steps.

- **Disruption**

  A sudden loss of plasma confinement, leading to rapid cooling and potential damage to reactor components.

- **Disruption Avoidance**

  Techniques and technologies designed to predict and prevent plasma disruptions.

- **Disruption Mitigation**

  Techniques to prevent or lessen the impact of plasma disruptions, protecting the reactor.

- **Divertor**

  A component that removes waste particles and excess heat from the plasma, maintaining purity and stability.

- **Divertor Channel**

  The pathway through which particles and heat are directed from the plasma to the divertor.

- **Divertor Detachment**

  A condition where the plasma in the divertor region cools sufficiently to reduce heat and particle fluxes on reactor walls.

- **Domestic Agencies**

  National organizations responsible for managing contributions to international fusion projects like ITER.

- **Double Null Configuration**

  A plasma shape with two X-points, improving stability and divertor performance.

- **Double Pancake**

  A winding configuration for superconducting coils, enhancing magnetic field strength and stability.

- **Dust Particles**

  Microscopic particles generated within the reactor, often from erosion of plasma-facing materials.

- **Advanced Divertor Concepts**

  Designs aimed at improving the performance and longevity of divertor systems by reducing heat loads and enhancing particle exhaust.

- **Dynamic Positioning**

  Real-time adjustment of plasma and magnetic fields to maintain optimal confinement.

- **EAST**

  Experimental Advanced Superconducting Tokamak in China, focusing on steady-state plasma operation.

- **Edge Density Gradient**

  The steep change in plasma density near the edge, impacting transport and stability.

- **Edge Electron Temperature**

  The temperature of electrons at the plasma boundary, influencing interactions with reactor walls.

- **Edge Kinetic Effects**

  Plasma behaviors near the edge influenced by particle collisions and magnetic fields, critical for divertor performance.

- **Edge Plasma**

  The outermost layer of plasma, influencing interactions with the reactor walls and divertor.

- **Edge Turbulence Suppression**

  Methods to control or reduce turbulence at the plasma boundary, improving overall confinement.

- **Edge-Localized Modes (ELMs)**

  Plasma instabilities at the boundary that expel particles and energy, potentially damaging divertor components.

- **Elastic Scattering**

  A process where particles collide without energy loss, impacting plasma behavior and diagnostics.

- **Electric Field Shear**

  Variation in electric fields that can suppress turbulence and improve confinement.

- **Electron**

  A subatomic particle with a negative electrical charge.

- **Electron Beam**

  A stream of high-energy electrons used for heating plasma or in diagnostic equipment.

- **Electron Bernstein Waves (EBWs)**

  Plasma waves that transfer energy to electrons, used in advanced heating techniques.

- **Electron Collisionality**

  A measure of how often electrons collide with other particles, affecting energy transport.

- **Electron Cyclotron Resonance Heating**

  A method of heating plasma by resonantly transferring energy from microwaves to electrons.

- **Electron Drift**

  The movement of electrons relative to ions, influencing electric fields and instabilities.

- **Electron Energy Loss**

  Energy lost from the plasma due to electron collisions and radiation.

- **Electron Temperature**

  The average kinetic energy of electrons in the plasma, critical for achieving fusion.

- **Electrostatic Confinement**

  A fusion concept using electric fields to trap ions and promote collisions.

- **Electrostatic Probes**

  Diagnostic tools inserted into the plasma to measure properties like density and electric potential.

- **ELM (Edge Localized Mode)**

  Instabilities at the plasma edge that can cause periodic expulsions of energy and particles.

- **Energy Amplification**

  The process of increasing the energy output of a fusion reaction relative to the input.

- **Energy Breakeven**

  The condition where the energy produced by fusion reactions equals the energy input to sustain the plasma.

- **Energy Confinement Mode**

  Describes the operational state of the plasma, such as L-mode (low confinement) or H-mode (high confinement).

- **Energy Confinement Time**

  The average time that energy remains in the plasma before being lost, crucial for achieving net energy gain.

- **Energy Recovery Linacs (ERLs)**

  Linear accelerators designed to recover and reuse energy from particle beams, enhancing efficiency.

- **Energy Recovery Systems**

  Technologies that capture waste heat from reactor components and convert it into useful energy.

- **EPFL**

  École Polytechnique Fédérale de Lausanne, a Swiss institution involved in fusion research.

- **Equatorial Port**

  Openings located around the mid-plane of a tokamak, used for diagnostics, heating, and maintenance access.

- **Equilibrium Field**

  The magnetic field configuration that balances plasma pressure and confinement forces.

- **Ergodic Magnetic Fields**

  Magnetic configurations that cause field lines to become stochastic, improving impurity control but reducing confinement.

- **Erosion**

  The process by which plasma-facing materials degrade due to high-energy particle impacts.

- **EUROfusion**

  A consortium of European fusion research organizations coordinating efforts towards fusion energy development.

- **Exhaust Power Handling**

  The capacity of divertors and plasma-facing materials to manage the heat and particles expelled from the plasma.

- **External Magnetic Perturbations**

  Deliberate distortions in magnetic fields used to control instabilities and improve plasma performance.

- **Fast Alpha Particles**

  High-energy helium nuclei produced by fusion reactions, contributing to plasma heating.

- **Fast Ion Confinement**

  The ability to retain high-energy ions within the plasma for effective heating and sustained reactions.

- **Fast Ion Losses**

  The escape of high-energy ions from the plasma, reducing efficiency.

- **Field Line Mapping**

  A diagnostic technique to trace magnetic field lines and assess confinement.

- **Field Line Tracing**

  Computational methods to map magnetic field lines and understand plasma confinement.

- **Field-Reversed Configuration (FRC)**

  A magnetic confinement scheme using closed magnetic field loops for plasma stability.

- **First Wall**

  The inner lining of the reactor vessel that directly faces the plasma, subject to intense heat and particle flux.

- **Flux Compression**

  A technique to rapidly compress magnetic fields, used in some fusion concepts.

- **Flux Pinning**

  The phenomenon where magnetic flux lines are locked into place within superconducting materials.

- **Flux Surface**

  Magnetic field lines in the plasma that form nested surfaces, crucial for confinement.

- **Fuel Cycle System**

  The processes involved in supplying, managing, and recycling fusion fuel within a reactor.

- **Fuel Efficiency**

  The fraction of fuel converted into energy, a key metric for fusion reactor performance.

- **Fuel Injection Timing**

  The precise control of when and how fuel is added to the plasma, critical for maintaining stability and performance.

- **Fuel Isotope Ratio**

  The proportion of deuterium and tritium in the plasma, optimized for maximum fusion yield.

- **Fuel pellets**

  Small slugs of frozen deuterium and tritium fuel, typically 3-6 mm in diameter, fired frequently into the plasma to sustain sufficient fuel density.

- **Fuel Pellets**

  Small, solid pieces of frozen deuterium and tritium used to fuel the plasma through injection.

- **Fuel Recycling**

  The process of recovering and reusing hydrogen isotopes in a fusion reactor.

- **Fusion**

  The process of combining light atomic nuclei to form a heavier nucleus, releasing energy.

- **Fusion Machine**

  A device designed to harness energy from nuclear fusion reactions.

- **Fusion Industry Association**

  An Industry organization dedicated to advancing fusion energy policy and commercialization.

- **Fusion Neutron Activation**

  The process by which materials become radioactive due to exposure to fusion-generated neutrons.

- **Fusion Power Density**

  The amount of power generated per unit volume of the plasma.

- **Fusion Product**

  The particles or nuclei resulting from a fusion reaction.

- **Fusion Triple Product**

  The product of plasma density, confinement time, and temperature, used to evaluate fusion performance.

- **Gallium Cooling Systems**

  Experimental systems using liquid gallium as a coolant for advanced fusion reactor designs.

- **Gravitational Confinement**

  A theoretical fusion concept, analogous to the process occurring in stars, relying on gravitational forces.

- **Gyrokinetic Simulations**

  Advanced models that simulate plasma behavior, including particle orbits and turbulence effects.

- **Heat Shield Coatings**

  Protective layers on reactor components to handle extreme thermal loads and reduce erosion.

- **Helical Axis Stellarator**

  A stellarator design with a helical magnetic axis, providing improved confinement and stability.

- **Helium Ash**

  Helium nuclei produced as a byproduct of fusion reactions, which need to be removed from the plasma.

- **Helium-3 Fusion**

  A clean fusion reaction involving helium-3, producing protons and energy with minimal neutron output.

- **Helium-Cooled Lead Lithium (HCLL)**

  A tritium breeding blanket design using helium coolant and lead-lithium alloy.

- **Helium-Cooled Pebble Bed (HCPB)**

  A concept for a tritium breeding blanket using helium as a coolant and solid lithium-containing pebbles.

- **High Aspect Ratio**

  A tokamak design with a larger major radius relative to the minor radius, affecting stability and confinement.

- **High Energy Density Physics (HEDP)**

  The study of matter under extreme conditions of pressure, temperature, and density, relevant to fusion research.

- **High Temperature Superconductors (HTS)**

  Materials that can become superconducting at temperatures significantly above absolute zero.

- **High-Field Side (HFS)**

  The side of a tokamak closest to the magnetic axis, where magnetic field strength is highest.

- **High-Frequency Modes**

  Plasma oscillations occurring at high frequencies, often associated with turbulence and instabilities.

- **High-Gain Mode**

  Plasma conditions where energy confinement and fusion yield are significantly improved.

- **High-Performance Plasmas**

  Plasma configurations optimized for increased confinement and fusion power output.

- **High-Temperature Superconductors (HTS)**

  Materials that enable strong magnetic fields at higher operating temperatures, improving reactor efficiency.

- **High-Z Materials**

  Elements with high atomic numbers, used for certain plasma-facing components to handle extreme conditions.

- **Hot Spots**

  Localized areas of high temperature within the plasma, often associated with instabilities or diagnostics.

- **Hybrid Plasma Modes**

  Operational regimes combining characteristics of L-mode and H-mode confinement, offering stability and efficiency.

- **Hybrid Reactor**

  A fusion-fission hybrid concept where fusion neutrons drive a subcritical fission reaction.

- **Hydraulic Testing**

  Testing reactor components under simulated coolant flow and pressure conditions.

- **Hydrodynamic Instabilities**

  Fluid-like instabilities in plasma that can disrupt confinement and heating.

- **Hydrodynamic Instability Mitigation**

  Techniques to reduce turbulence and instabilities in inertial confinement fusion experiments.

- **Hydrogen Isotope Mixture**

  The specific ratio of hydrogen isotopes, such as deuterium and tritium, used in the fusion fuel.

- **ICRF Heating (Ion Cyclotron Range of Frequencies)**

  A plasma heating method using radiofrequency waves at ion cyclotron resonance frequencies.

- **Ignition**

  The state where a plasma sustains its temperature through internal fusion heating without external input.

- **Impurity Control Systems**

  Technologies and techniques to limit or remove heavy ions and other impurities from the plasma.

- **Impurity Radiation**

  Energy lost due to the presence of heavy elements in the plasma, which radiate energy as light.

- **Inboard Blanket**

  Tritium breeding blankets located on the inner side of the tokamak torus.

- **Inertial confinement fusion**

  A method of fusion that uses lasers or particle beams to compress and heat fusion fuel rapidly. The National Ignition Facility (NIF) and OMEGA are two of the largest U.S. ICF facilities.

- **Inertial Confinement Fusion (ICF)**

  A fusion approach using high-energy lasers or particle beams to compress and heat fuel pellets.

- **Inertial Electrostatic Confinement (IEC)**

  A fusion method that uses electrostatic fields to confine plasma.

- **Injection System**

  Equipment used to introduce fuel, impurities, or heating particles into the plasma.

- **Integrated First Wall**

  A multi-functional reactor component combining plasma-facing material, tritium breeding, and heat removal.

- **Integrated Modeling**

  Computational frameworks that combine multiple physics models to simulate and optimize reactor performance.

- **Interferometry**

  A diagnostic method that uses the interference of waves to measure plasma density.

- **International Thermonuclear Experimental Reactor (ITER)**

  The largest international fusion project, aimed at demonstrating the feasibility of fusion energy.

- **Ion**

  An atom or molecule with a net electric charge due to the loss or gain of electrons.

- **Ion Acoustic Turbulence**

  A type of turbulence driven by sound waves in the plasma, impacting transport properties.

- **Ion Acoustic Waves**

  Low-frequency oscillations in plasma caused by ion motion, important in energy transport.

- **Ion Beam Injection**

  A plasma heating technique using high-energy ion beams directed into the plasma.

- **Ion Cyclotron Emission (ICE)**

  Electromagnetic waves generated by fast ions in the plasma, used for diagnostics and stability monitoring.

- **Ion Cyclotron Resonance**

  A plasma heating process that energizes ions at their natural cyclotron frequency.

- **Ion Cyclotron Wave Heating**

  A method of plasma heating using radiofrequency waves at ion cyclotron resonance frequencies.

- **Ion Drift Waves**

  Plasma oscillations caused by density and electric field gradients, influencing transport.

- **Ion Gyromotion**

  The circular motion of ions around magnetic field lines, fundamental to plasma behavior.

- **Ion Temperature**

  The average kinetic energy of ions in the plasma, crucial for achieving fusion conditions.

- **Ion Temperature Gradient Modes**

  Instabilities driven by steep temperature gradients in the plasma, impacting confinement.

- **Ionization Potential**

  The energy required to remove an electron from an atom, critical for plasma formation.

- **Isotope**

  Atoms of the same element with different numbers of neutrons in their nuclei.

- **Isotope Enrichment**

  The process of increasing the concentration of specific isotopes, such as deuterium or helium-3, for fusion applications.

- **Isotope Separation**

  Techniques to enrich or separate deuterium and tritium for fusion fuel.

- **ITER**

  Defined as "the way" in Latin, ITER is a tokamak under construction in France, and the result of 33 countries coming together to build and then experiment with.

- **ITER Baseline Scenario**

  The primary operational plan for the ITER project, designed to achieve its performance goals.

- **JET (Joint European Torus)**

  Europe's flagship fusion experiment, contributing to ITER design and tritium handling research.

- **K-DEMO**

  A proposed Korean demonstration fusion power plant following the ITER experiment.

- **Keplerian Orbits**

  The elliptical motion of particles in magnetic fields, relevant in certain plasma behaviors.

- **Kinetic Energy**

  The energy of motion, critical in describing the high-speed particles in a plasma.

- **KSTAR (Korea Superconducting Tokamak Advanced Research)**

  A superconducting tokamak focusing on steady-state plasma operation.

- **Langmuir Probe**

  A diagnostic tool used to measure plasma density and temperature near the edge.

- **Larmor Motion**

  The spiral trajectory of charged particles in a magnetic field.

- **Larmor Radius**

  The radius of the circular motion of charged particles in a magnetic field, influencing confinement.

- **Laser Ablation Diagnostics**

  Techniques using lasers to vaporize material and analyze its composition for impurity studies.

- **Laser Fusion**

  A method of inertial confinement fusion using high-power lasers to compress and heat fuel pellets.

- **Lawson criterion**

  A set of requirements for achieving fusion in terms of plasma temperature, density, and confinement time.

- **L-H Transition**

  The transition from low-confinement (L-mode) to high-confinement (H-mode) in plasma, significantly improving performance.

- **Limiter**

  A component that defines the boundary of the plasma, protecting the reactor walls from direct exposure.

- **Limiter Configuration**

  A simpler alternative to divertors, where physical structures limit the plasma boundary.

- **Limiter Shadowing**

  The use of limiters to shield critical reactor components from direct plasma exposure.

- **Liquid Metal Divertors**

  Divertor designs using liquid metals like lithium or tin to handle extreme heat loads and reduce erosion.

- **Lithium**

  The lightest metal element. Tritium can be produced within a tokamak's lithium containing blanket when neutrons escaping the plasma interact with the lithium.

- **Lithium Blanket**

  A fusion reactor component containing lithium to breed tritium and absorb fusion neutrons.

- **Lithium Coating**

  The application of lithium to plasma-facing components to reduce impurities and enhance confinement.

- **Lithium Lead Blanket**

  A design using lithium-lead alloy for neutron absorption and tritium breeding.

- **Localized Heating Zones**

  Targeted areas within the plasma where heating methods like RF waves or neutral beams are focused.

- **Locking Modes**

  Plasma instabilities that can cause magnetic field perturbations, impacting performance.

- **Long-Pulse Operation**

  Sustained plasma discharge over extended periods, a key goal for steady-state fusion reactors.

- **Low Activation Materials**

  Materials chosen for their minimal long-term radioactivity when exposed to fusion neutrons.

- **Low Temperature Superconductors (LTS)**

  LTS is an older generation of superconductors that require cooling to extremely low temperatures, often using liquefied helium at 4 °K.

- **Low-Z Materials**

  Light elements like carbon or beryllium, used in plasma-facing components for reduced impurity generation.

- **Magnet Coil**

  An electromagnet in which a loop of electrical current produces a magnetic field.

- **Magnet Coil Winding**

  The process of constructing superconducting or normal magnets for fusion reactors.

- **Magnet Systems**

  The network of magnets used to generate and control the magnetic fields in a reactor.

- **Magnetic Axis**

  The central line around which the plasma is confined in toroidal reactors.

- **Magnetic Coil Cryostat**

  A structure that maintains low temperatures for superconducting coils.

- **Magnetic Compression**

  Techniques that compress magnetic fields to increase plasma pressure and temperature.

- **Magnetic Confinement**

  The use of magnetic fields to confine plasma in devices like tokamaks or stellarators.

- **Magnetic Flux Expansion**

  The spreading of magnetic field lines to distribute heat loads in the divertor.

- **Magnetic Flux Surfaces**

  Nested surfaces formed by magnetic field lines in a confined plasma, critical for maintaining stability.

- **Magnetic Island Healing**

  The process of mitigating or eliminating magnetic islands to improve plasma confinement.

- **Magnetic Islands**

  Regions of plasma where magnetic field lines form closed loops, potentially affecting confinement.

- **Magnetic mirror**

  A configuration of magnetic fields used to reflect charged particles in some fusion devices.

- **Magnetic Nozzle**

  A device that accelerates plasma using magnetic fields, often studied for propulsion applications.

- **Magnetic Resonance Heating**

  Heating methods that exploit resonances between magnetic fields and particle motion to transfer energy efficiently.

- **Magnetic Shear**

  The variation in magnetic field pitch angle, influencing plasma stability.

- **Magnetic Shear Optimization**

  Adjusting the variation of magnetic field pitch to improve plasma stability and reduce turbulence.

- **Magnetically Insulated Line Oscillators (MILOs)**

  Devices used in inertial confinement fusion to generate high-power electromagnetic pulses.

- **Magnetization Parameter**

  A measure of the plasma's response to magnetic fields, influencing confinement.

- **Magnetohydrodynamics (MHD)**

  A theory of plasma dynamics in which the plasma is treated as a fluid.

- **Major Radius**

  The distance from the center of the plasma torus to the magnetic axis in a tokamak.

- **Material Ablation**

  The process by which material is removed from reactor walls due to intense plasma interaction.

- **Material Fatigue**

  Degradation of reactor materials due to repeated exposure to high heat and radiation fluxes.

- **Megawatt (MW)**

  A unit of power describing how much electricity can be produced by a power plant. One MW is equal to one million watts.

- **Microinstabilities**

  Small-scale instabilities in the plasma that can lead to turbulence and energy losses.

- **Microwave Reflectometry**

  A technique to measure plasma density profiles by reflecting microwaves off plasma layers.

- **Minor Radius**

  The radius of the cross-sectional area of the plasma in a tokamak.

- **Mode Locking**

  A condition where plasma instabilities become fixed, leading to reduced confinement performance.

- **Molten Salt Blankets**

  Tritium breeding blankets using molten salts for heat transfer and neutron capture.

- **Momentum Transport**

  The movement of momentum within the plasma, influencing flow patterns and stability.

- **Monte Carlo Simulations**

  Computational techniques used to model plasma behavior and particle interactions in fusion reactors.

- **Multi-Mirror Configuration**

  A confinement concept using a series of magnetic mirrors to trap and stabilize plasma.

- **Multi-Scale Simulations**

  Computational models that integrate plasma behavior across different spatial and temporal scales.

- **Nanostructured Materials**

  Advanced materials engineered at the nanoscale to enhance performance under fusion conditions.

- **National Ignition Facility (NIF)**

  A massive laser-based inertial confinement fusion research device located at Lawrence Livermore National Laboratory in California, designed to achieve fusion ignition by using 192 high-powered laser beams to compress and heat a small fuel target to extreme temperatures and pressures.

- **Neoclassical Transport**

  Predictable transport of particles and energy in plasma due to collisional processes.

- **Neutral beam injection**

  A method of heating plasma by injecting high-energy neutral atoms into it.

- **Neutral Beam Injection (NBI)**

  A heating method that injects high-energy neutral particles into the plasma.

- **Neutral Gas Shielding**

  The use of neutral gas clouds to reduce the impact of high-energy particles on reactor walls.

- **Neutron**

  A subatomic particle with no electric charge, often produced in fusion reactions.

- **Neutron Activation**

  The process by which materials become radioactive after exposure to neutrons in the reactor.

- **Neutron Beam Collimation**

  The process of aligning neutron beams for precision material testing and diagnostics.

- **Neutron Blanket Lifetime**

  The operational lifespan of the blanket material before it requires replacement due to neutron exposure.

- **Neutron Collimation**

  Techniques to focus and direct neutron flux for diagnostics or material testing.

- **Neutron Flux**

  The intensity of neutron flow in a fusion reactor, critical for material testing and tritium breeding.

- **Neutron Flux Monitors**

  Devices that measure the intensity and distribution of neutron radiation in fusion reactors.

- **Neutron Reflectors**

  Materials used to bounce neutrons back into the reactor to improve efficiency.

- **Neutron Shielding Design**

  Engineering solutions to minimize the impact of neutron radiation on sensitive reactor components.

- **Neutron Wall Loading**

  The amount of neutron energy impacting the reactor's first wall per unit area.

- **Neutronics**

  The study of neutron behavior and interactions within a fusion reactor.

- **Next-Step Devices**

  Fusion experiments designed to bridge the gap between current research reactors and commercial power plants.

- **Non-Destructive Testing (NDT)**

  Inspection techniques that evaluate reactor components without causing damage.

- **Non-Inductive Current Drive**

  Methods of driving plasma current without relying on inductive fields, essential for steady-state operation.

- **Nonlinear Instability Growth**

  The amplification of small plasma disturbances into large-scale instabilities, critical for reactor stability.

- **Nonlinear Plasma Dynamics**

  The study of complex plasma behaviors, including turbulence and instabilities, that cannot be described by simple linear models.

- **Ohmic Current**

  The plasma current driven by inductive means, providing initial heating and confinement.

- **Ohmic Heating**

  Plasma heating caused by the resistance of plasma to an induced electric current.

- **Open Field Lines**

  Magnetic field lines that do not form closed loops, usually found near the plasma edge or in the divertor region.

- **Optical Diagnostics**

  Tools and techniques that use light (visible, infrared, or ultraviolet) to study plasma properties.

- **Optical Emission Spectroscopy**

  A diagnostic technique analyzing light emitted by plasma to determine elemental composition and temperatures.

- **Parallel Transport**

  The movement of particles and energy along magnetic field lines in a plasma.

- **Particle Confinement**

  The ability of a fusion reactor to keep plasma particles contained within the magnetic field.

- **Particle Drift Kinetics**

  The study of particle motion in plasma due to electric and magnetic fields, affecting transport and confinement.

- **Particle Pinch Effect**

  The inward transport of particles due to plasma gradients, helping to maintain fuel concentration in the core.

- **Pedestal Region**

  The high-pressure plasma layer at the edge of H-mode confinement, critical for performance.

- **Pedestal Stability**

  The stability of the high-pressure edge region in H-mode plasmas, crucial for maintaining confinement.

- **Pellet Injection**

  A method of delivering fuel into the plasma in the form of frozen deuterium-tritium pellets.

- **Plasma**

  An extremely hot (10,000+°C) ionized gas consisting of free electrons and positive ions, often referred to as the fourth state of matter.

- **Plasma Beta**

  The ratio of plasma pressure to magnetic pressure, indicating the efficiency of magnetic confinement.

- **Plasma Beta Limit**

  The maximum beta value a plasma can achieve before magnetic instabilities occur.

- **Plasma Beta Poloidal**

  The ratio of plasma pressure to poloidal magnetic pressure, influencing stability and performance.

- **Plasma Burnthrough**

  The phase when plasma breaks down residual gases during startup, transitioning to full ionization.

- **Plasma Contamination**

  The introduction of impurities that can radiate energy and reduce plasma performance.

- **Plasma Core**

  The innermost region of the plasma where fusion reactions are most intense.

- **Plasma Current**

  Large electrical currents in plasma which can create an embedded magnetic field and is a key element of tokamaks' magnetic confinement.

- **Plasma Current Density**

  A measure of the electric current per unit area in the plasma, influencing magnetic field structure.

- **Plasma Current Quench**

  The rapid decrease in plasma current during a disruption, often leading to runaway electrons.

- **Plasma Density**

  The number of particles per unit volume in a plasma, affecting the fusion reaction rate.

- **Plasma Drift**

  The motion of plasma particles perpendicular to magnetic field lines, influenced by electric and magnetic forces.

- **Plasma Edge Turbulence**

  Instabilities at the plasma boundary that can affect overall confinement.

- **Plasma Facing Components (PFCs)**

  Reactor components that are directly exposed to the plasma, such as the first wall and divertor.

- **Plasma Flow Shear**

  The variation in plasma flow velocities that can stabilize turbulence.

- **Plasma Heating**

  Methods used to increase the temperature of plasma to fusion conditions, such as ohmic heating, neutral beam injection, or radio-frequency heating.

- **Plasma Impurity Control**

  Techniques to manage unwanted elements in the plasma that can radiate energy and reduce efficiency.

- **Plasma Instabilities**

  Disturbances in the plasma that can lead to energy losses or disruptions.

- **Plasma Operating Space**

  The range of plasma parameters, such as temperature, density, and pressure, where a reactor can operate safely and efficiently.

- **Plasma Polarization**

  The alignment of plasma particles under electromagnetic fields, affecting wave propagation and heating.

- **Plasma Pressure Gradient**

  The rate of change of pressure across the plasma, influencing stability and turbulence.

- **Plasma Reconnection Events**

  Phenomena where magnetic field lines break and reconnect, releasing energy and affecting plasma confinement.

- **Plasma Refueling**

  Methods to replenish fuel in a fusion reactor without disrupting confinement.

- **Plasma Shaping**

  The process of controlling the plasma's geometry to optimize confinement and stability.

- **Plasma Shaping Coils**

  Magnetic coils used to modify the plasma's geometry for improved stability and performance.

- **Plasma Startup**

  The initial phase of a fusion experiment, where the plasma is created and heated to fusion conditions.

- **Plasma Startup Scenario**

  Predefined sequences of operations to initiate and sustain plasma conditions.

- **Plasma Transport**

  The movement of particles, energy, and momentum within the plasma, often due to turbulence.

- **Plasma Turbulence**

  Chaotic fluctuations in the plasma that can lead to energy and particle losses.

- **Plasma Wall Interactions (PWI)**

  The interactions between the plasma and the reactor walls, influencing erosion, impurity generation, and tritium retention.

- **Polarimetry**

  A diagnostic method that measures the polarization of light to infer magnetic fields in a plasma.

- **Poloidal Field**

  The magnetic field component running around the short axis of a toroidal plasma.

- **Poloidal Flow Shear**

  Variations in plasma flow along the poloidal direction, which can stabilize turbulence.

- **Poloidal Plasma Flow**

  The motion of plasma along the short axis of the torus, impacting turbulence and transport.

- **Power Exhaust**

  The process of removing excess heat and energy from the plasma through the divertor or other components.

- **Power Flux**

  The rate of power transfer to the reactor components, particularly at the divertor and first wall.

- **Power Plant Studies**

  Research and design work focused on developing commercial fusion power plants.

- **Proton-Boron Fusion**

  A fusion reaction using hydrogen and boron, producing clean energy without neutrons.

- **Puff-and-Pump Technique**

  A method of removing impurities by injecting gas and simultaneously pumping it out.

- **Pulsed Operation**

  Fusion reactor operation in short bursts, as opposed to continuous steady-state operation.

- **Q Factor**

  The ratio of fusion power produced to the power required to maintain the reaction, with $Q > 1$ indicating net energy gain.

- **Quantum Electrodynamics (QED) Effects**

  High-energy interactions in plasma were quantum effects influence particle behavior, relevant in extreme fusion conditions.

- **Quasi-Stationary Operation**

  A near-steady-state condition where plasma parameters remain stable over extended periods.

- **Quasi-Stationary Plasma**

  Plasma that appears stable over time but may exhibit slow changes in certain parameters.

- **Radiation Shielding**

  Materials and structures that protect personnel and equipment from radiation produced in fusion reactors.

- **Radiation Shielding Blanket**

  Layers of material designed to absorb neutron and gamma radiation, protecting reactor systems.

- **Radiative Cooling**

  The loss of plasma energy through radiation, primarily from impurities.

- **Radiative Cooling Blanket**

  A reactor component designed to absorb excess plasma energy via radiation, reducing heat loads.

- **Radiative Cooling Zones**

  Regions in the plasma or divertor where energy is lost via radiation, used to manage heat loads.

- **Radiative Divertor**

  A divertor designed to dissipate heat through radiation before it reaches plasma-facing components.

- **Radio Frequency (RF) Heating**

  Plasma heating using electromagnetic waves in the radio frequency range.

- **Radiofrequency Antenna**

  A device used to transmit RF waves into the plasma for heating and current drive.

- **Ramp-up time**

  The amount of time needed to initiate plasma and heat it up to burn temperatures.

- **Rare Earth Elements**

  Critical materials used in certain components of fusion reactors, such as magnets.

- **Reactive Ion Recycling**

  Techniques that utilize ions from the plasma boundary to fuel or stabilize the core plasma.

- **Reactive Power**

  Power required to maintain magnetic and electric fields in a fusion device, not directly converted to heat or electricity.

- **Reactor Assembly Automation**

  The use of robotics and automated systems for the precise construction of complex fusion reactors.

- **Reactor Chamber**

  The central vessel in which the plasma is confined, and fusion reactions occur.

- **Reactor Maintenance**

  Procedures to inspect, repair, or replace fusion reactor components.

- **Reactor Vessel**

  The structure housing the fusion plasma and its containment systems.

- **Real-Time Feedback Control**

  Systems that monitor plasma behavior and dynamically adjust reactor parameters to maintain stability.

- **Recycling Coefficient**

  The ratio of particles re-entering the plasma to the total number of particles lost, affecting plasma sustainability.

- **Reflectometry**

  A diagnostic technique that uses reflected electromagnetic waves to measure plasma density profiles.

- **Remote Handling**

  Robotic systems used to maintain or repair reactor components in radioactive environments.

- **Residual Gas Analyzer (RGA)**

  A diagnostic tool used to measure and monitor gas composition in the reactor.

- **Resistive Ballooning Modes**

  A type of plasma instability related to pressure gradients and magnetic field line curvature.

- **Resistive Instabilities**

  Plasma instabilities caused by resistive dissipation of currents, influencing confinement.

- **Resonant Ion Heating**

  A method of heating plasma ions using electromagnetic waves tuned to their natural frequencies.

- **Resonant Magnetic Perturbations (RMPs)**

  Deliberate distortions in magnetic fields to control edge-localized modes (ELMs) and improve stability.

- **Reverse Shear**

  A plasma configuration where the magnetic shear changes sign, often improving stability and confinement.

- **Ripple Effects**

  Variations in magnetic field strength that can lead to energy losses in the plasma.

- **Runaway Electron Avalanche**

  The exponential growth of high-energy electrons during disruptions, posing risks to reactor components.

- **Runaway Electron Suppression**

  Techniques to manage or mitigate high-energy electrons generated during disruptions.

- **Runaway Electrons**

  High-energy electrons accelerated during disruptions, capable of damaging reactor components.

- **Safety Factor (q)**

  A parameter describing the stability of magnetic field lines in a plasma, crucial for confinement.

- **Sawtooth Oscillations**

  Periodic temperature and density fluctuations in the plasma core, often associated with energy redistribution.

- **Scaling Laws**

  Mathematical relationships that describe how plasma behavior changes with reactor size or operating conditions.

- **Scrape-Off Layer (SOL)**

  The outermost region of the plasma where particles and energy are lost to the divertor.

- **Scrape-Off Layer Plasma**

  The layer of plasma outside the confined core, interacting with reactor walls and divertor systems.

- **Seed Plasma**

  Initial plasma created during the startup phase of a reactor to enable further heating and confinement.

- **Self-Heating**

  Heating of the plasma by the energy released from fusion reactions, reducing external heating requirements.

- **Self-Sustained Fusion Burn**

  A condition where the plasma's energy comes predominantly from fusion reactions, without external heating.

- **Self-Sustaining Fusion**

  A state where fusion reactions produce enough energy to maintain plasma conditions without external input.

- **Separatrix**

  The boundary between confined plasma and open magnetic field lines in a tokamak.

- **Shadowing**

  A technique where certain reactor components are positioned to shield others from direct plasma or radiation exposure.

- **Shattered Pellet Injection**

  A disruption mitigation technique that introduces fragmented pellets into the plasma to rapidly cool and stabilize it.

- **Shield Blanket**

  A component that protects reactor systems from radiation and absorbs neutrons for tritium breeding.

- **Shielding Blanket**

  A reactor component that absorbs neutrons and radiation to protect outer systems.

- **Shielding Material Degradation**

  The wear and weakening of neutron shielding materials over time due to radiation exposure.

- **Shutdown**

  The process of safely turning off a fusion reactor and its associated systems.

- **Side Port**

  Access points in the reactor chamber for diagnostics, heating, or maintenance.

- **Smart Materials**

  Advanced materials capable of self-healing or adapting to changing conditions in fusion reactors.

- **Snowflake Configuration**

  A divertor design with additional X-points to spread heat loads and enhance particle exhaust.

- **Snowflake Divertor**

  A novel divertor design with multiple X-points to spread heat loads more evenly.

- **Soft X-Rays**

  Low-energy X-rays emitted by the plasma, often used for diagnostics.

- **Solenoid**

  A coil of wire that produces a magnetic field when electric current flows through it, used in tokamaks for plasma initiation.

- **Spectroscopic Diagnostics**

  Tools that analyze light emitted by the plasma to determine temperature, density, and composition.

- **Spherical Tokamak**

  A compact fusion device with a spherical shape, offering potential advantages in efficiency and cost.

- **Spitzer Resistivity**

  The resistivity of plasma due to collisions, described by the Spitzer formula.

- **Spontaneous Rotation**

  Plasma rotation that occurs without external torque, often enhancing confinement.

- **Sputtering**

  The ejection of atoms from a surface due to high-energy particle impacts, contributing to material erosion.

- **Stable Plasma**

  A plasma configuration that remains confined without significant instabilities or disruptions.

- **Startup Mode**

  The operational phase during which the plasma is initiated and heated to fusion conditions.

- **Steady-State Fusion Operation**

  A condition where the reactor operates continuously without requiring periodic resets, essential for commercial viability.

- **Steady-State Operation**

  Continuous operation of a fusion reactor, a goal for commercial power plants.

- **Steady-State Plasma**

  Plasma that maintains stable conditions over extended periods without significant fluctuations.

- **Stellarator**

  A type of magnetic confinement device with a twisted, non-axisymmetric shape, eliminating the need for plasma current.

- **Stochastic Magnetic Field**

  A disordered magnetic field configuration, often caused by instabilities, affecting confinement.

- **Superconducting Cable**

  Conductors made from superconducting materials, used in high-field magnets for fusion reactors.

- **Superconducting Joint**

  Connections between superconducting coils, essential for maintaining current flow in cryogenic conditions.

- **Superconducting Magnet Cooling**

  Systems to maintain the low temperatures required for superconducting magnets in fusion devices.

- **Superconducting Magnets**

  Magnets made from superconducting materials, enabling high magnetic fields with low power consumption.

- **Superconductor**

  A type of material that can conduct electricity with zero resistance.

- **Superconductor Quench Protection**

  Systems that prevent damage to superconducting magnets when transitioning to a normal conducting state.

- **Supersonic Molecular Beam Injection (SMBI)**

  A method of fueling plasmas using high-speed molecular beams.

- **Super-X Divertor**

  An advanced divertor design aimed at reducing heat loads on plasma-facing components.

- **Sustainability**

  The ability of a fusion reactor to operate efficiently over long periods with minimal environmental impact.

- **Synchrotron Radiation**

  Electromagnetic radiation emitted by charged particles moving at high speeds in magnetic fields, a source of energy loss in plasmas.

- **Synthetic Aperture Diagnostics**

  Techniques that combine data from multiple diagnostic tools to create detailed plasma images.

- **Tandem Mirror**

  A linear magnetic confinement concept using magnetic mirrors to confine plasma at each end.

- **Tangential Injection**

  A fueling or heating method where particles or energy are injected at an angle relative to the plasma surface.

- **Tearing Mode Suppression**

  Techniques to control instabilities that break magnetic field lines in the plasma.

- **Tearing Modes**

  Plasma instabilities that can disrupt magnetic field lines, potentially degrading confinement.

- **Teller-Ulam Design**

  A theoretical approach to enhancing energy yield in inertial confinement fusion.

- **Temperature Gradient**

  The rate of temperature change across the plasma, influencing energy transport.

- **Tertiary Neutrons**

  Neutrons produced from reactions involving fusion-produced neutrons, often used in diagnostics.

- **Test Blanket Module (TBM)**

  Experimental modules in a fusion reactor used to test tritium breeding concepts.

- **Thermal Barrier**

  A region in advanced plasma configurations where temperature gradients reduce energy loss.

- **Thermal Conduction**

  The transfer of heat within the plasma due to particle collisions.

- **Thermal Desorption**

  The release of trapped gases from materials under heat, studied for tritium recycling and impurity control.

- **Thermal Hydraulic Analysis**

  The study of heat and fluid flow in reactor systems to optimize cooling and performance.

- **Thermal Load**

  The amount of heat a reactor component must handle, especially plasma-facing materials.

- **Thermal Neutrons**

  Neutrons slowed down to thermal energies, important in tritium breeding reactions.

- **Thermal Quench**

  A rapid loss of plasma temperature, often associated with disruptions or instabilities.

- **Thermonuclear Fusion**

  Fusion reactions driven by the extremely high temperatures and pressures in the plasma.

- **Thomson Scattering**

  A diagnostic method using scattered laser light to measure plasma temperature and density.

- **Tokamak**

  A toroidal magnetic confinement device that uses strong magnetic fields to confine plasma.

- **Tokamak Core Density**

  The plasma density at the central region of a tokamak, influencing fusion reaction rates.

- **Tokamak Divertor**

  A specialized region of the tokamak designed to handle plasma exhaust and remove impurities.

- **Tokamak Energy**

  A private company developing high-field, compact spherical tokamaks for commercial fusion power.

- **Tokamak Equilibrium Code**

  Computational tools used to calculate and optimize the magnetic and plasma configuration in a tokamak.

- **Toroidal Alfvén Eigenmodes (TAEs)**

  Plasma instabilities driven by fast ions, influencing energy and particle confinement.

- **Toroidal Field**

  The magnetic field running around the toroidal (donut-shaped) axis of a tokamak.

- **Toroidal Field Ripple**

  Variations in magnetic field strength along the toroidal axis, which can cause particle losses.

- **Toroidal Plasma**

  Plasma confined in a donut-shaped configuration, typical in tokamaks and stellarators.

- **Toroidal Rotation**

  Plasma rotation along the toroidal axis, influencing stability and confinement.

- **Toroidal Rotation Shear**

  Variation in plasma rotation speed along the toroidal direction, influencing turbulence.

- **Transmutation Effects**

  Changes in material properties due to neutron interactions, critical for long-term reactor operation.

- **Transport Barriers**

  Regions in the plasma with reduced turbulence, improving energy and particle confinement.

- **Tri-Alpha Particles**

  Helium-4 nuclei produced in certain fusion reactions, particularly in advanced fuels like helium-3.

- **Tritium**

  A radioactive isotope of hydrogen with one proton and two neutrons in its nucleus, used as fusion fuel.

- **Tritium Breeding Ratio (TBR)**

  The ratio of tritium produced in a reactor to the amount consumed, critical for fuel sustainability.

- **Tritium Handling Systems**

  Infrastructure and processes to safely manage, store, and recycle tritium fuel.

- **Turbulence**

  Irregular plasma motion that leads to energy and particle transport, often reducing confinement efficiency.

- **Turbulent Eddy Structures**

  Swirling plasma motions that contribute to energy and particle transport losses.

- **Vacuum Chamber**

  The main containment vessel in a fusion reactor, maintaining the low-pressure environment for plasma.

- **Vacuum Integrity**

  The ability of a reactor's vacuum chamber to maintain the required low-pressure conditions.

- **Vacuum Plasma Interaction**

  The interaction between the plasma and residual gases in the vacuum chamber, affecting purity.

- **Vacuum Pump**

  Equipment that removes air and impurities to create a high-vacuum environment in the reactor.

- **Vacuum System Integrity**

  The ability of a reactor's vacuum chamber to maintain a low-pressure environment essential for plasma stability.

- **Vacuum Vessel**

  The structure that contains the plasma and provides the high-vacuum environment for fusion reactions.

- **Vertical Displacement Event (VDE)**

  A plasma instability where the plasma moves vertically, potentially causing damage.

- **Vertical Displacement Instabilities**

  Uncontrolled vertical movement of the plasma column, requiring active feedback systems.

- **Vertical Instabilities**

  Displacements of the plasma column along the vertical axis, requiring active control systems.

- **Vertical Stability Control**

  Systems used to prevent vertical plasma displacement and maintain confinement.

- **Viscous Drag**

  The resistance experienced by particles moving through the plasma, affecting confinement.

- **Viscous Heating**

  Heating caused by friction between moving layers of plasma, contributing to overall energy balance.

- **Volumetric Heating**

  Heating distributed throughout the plasma volume, typically from fusion reactions.

- **Wall Conditioning**

  Techniques to prepare plasma-facing surfaces for optimal operation by reducing impurities and improving performance.

- **Wall Erosion Mitigation**

  Strategies to reduce wear and extend the lifespan of plasma-facing materials.

- **Wave Absorption**

  The process by which plasma absorbs energy from electromagnetic waves, used in heating and diagnostics.

- **Wave Coupling Efficiency**

  The effectiveness with which electromagnetic waves transfer energy to the plasma.

- **Wave Launch Geometry**

  The positioning and orientation of wave-generating devices to maximize energy transfer to the plasma.

- **Wave Propagation**

  The movement of electromagnetic or plasma waves through the reactor, critical for heating and diagnostics.

- **Waveguide**

  Structures that direct electromagnetic waves into the plasma for heating or diagnostics.

- **Wave-Particle Interaction**

  The exchange of energy between plasma waves and particles, critical for heating and stability.

- **Weakly Ionized Plasma**

  Plasma where only a small fraction of particles are ionized, often used in specialized applications.

- **Wendelstein 7-X**

  A stellarator in Germany designed to explore steady-state plasma confinement.

- **Wetting Layer**

  A thin liquid layer on plasma-facing components designed to absorb heat and reduce erosion.

- **Winding Pack**

  The tightly coiled section of a magnet where the magnetic field is generated.

- **X-Divertor**

  An advanced divertor design aiming to improve heat and particle exhaust in tokamaks.

- **X-Point**

  The point in a tokamak where magnetic field lines converge, critical for divertor operation.

- **X-Point Targeting**

  Precise control of magnetic configurations to position the plasma's X-point for optimal divertor performance.

- **X-Ray Crystal Spectroscopy**

  A diagnostic method using crystals to analyze X-rays emitted by plasma, providing temperature and density information.

- **X-Ray Diagnostics**

  Tools using X-rays to measure plasma properties like temperature and density.

- **X-Ray Emission**

  High-energy photons emitted by the plasma, used for diagnostics or indicating energy losses.

- **Yield Amplification**

  Techniques aimed at increasing the energy output of fusion reactions relative to input energy.

- **Yield Scaling Laws**

  Mathematical models that predict how fusion power output scales with reactor size and plasma parameters.

- **Zeeman Effect**

  The splitting of spectral lines in a magnetic field, used in plasma diagnostics.

- **Zeff (Effective Charge)**

  A measure of the average charge state of ions in the plasma, impacting energy losses and stability.

- **Zero Dimensional Model**

  A simplified plasma model that treats the entire system as a single point to analyze global behavior.

- **Zero Dimensional Reactor Models**

  Simplified models that approximate reactor behavior using averaged plasma parameters, useful for initial design studies.

- **Zeta Pinch**

  An early magnetic confinement approach where plasma is compressed along the axis of a cylinder.

- **Zirconium Alloys**

  Materials used in reactor components for their high resistance to heat and radiation.

- **Zonal Flow Damping**

  The reduction of large-scale plasma flows due to collisional or turbulent effects, impacting confinement.

- **Zonal Flows**

  Large-scale plasma flows that can reduce turbulence and improve confinement.

- **Zonal Mode Formation**

  The development of large-scale flows in the plasma, reducing turbulence and enhancing confinement.

- **Zone of Interaction**

  The region in the plasma where fusion reactions predominantly occur.

- **Z-pinch**

  A type of fusion device that uses an electrical current to create a magnetic field that compresses and heats the plasma.

- **Z-Pinch Stabilization**

  Techniques to enhance stability in Z-pinch configurations by controlling current and magnetic fields

THE FUSION REPORT