Plan for Engineering Study of ARIES-CS

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Background

- **Assessment of Compact Stellarator option as a power plant to help:**
  - **Advance physics and technology of compact stellarator concept and address concept attractiveness issues in the context of power plant studies**
  - **Identify optimum compact stellerator configuration for power plant**
    - **NCSX and QSX plasma/coil configurations as starting point**
    - **But optimum plasma/coil configuration for a power plant may be different**

ARIES-CS Program is a Three-Year Study

FY03: Development of Plasma/coil Configuration Optimization Tool

1. Develop physics requirements and modules (power balance, stability, , confinement, divertor, *etc.)*
2. Develop engineering requirements and constraints.
3. Explore attractive coil topologies.

FY04: Exploration of Configuration Design Space

1. Physics: , aspect ratio, number of periods, rotational transform, sheer, *etc.*
2. Engineering: configurationally optimization, management of space between plasma and coils.
3. Choose one configuration for detailed design.

FY05: Detailed system design and optimization

Year 1: Develop Engineering Requirements and Constraints

Design Process : Optimize design configuration and machine parameters to minimize COE while accommodating design requirements

Design Configuration (Engineering)

- Component Configurations:
  - Blanket
  - Shield
  - Vacuum Vessel
  - Divertor
  - Coils
- Maintenance Scheme

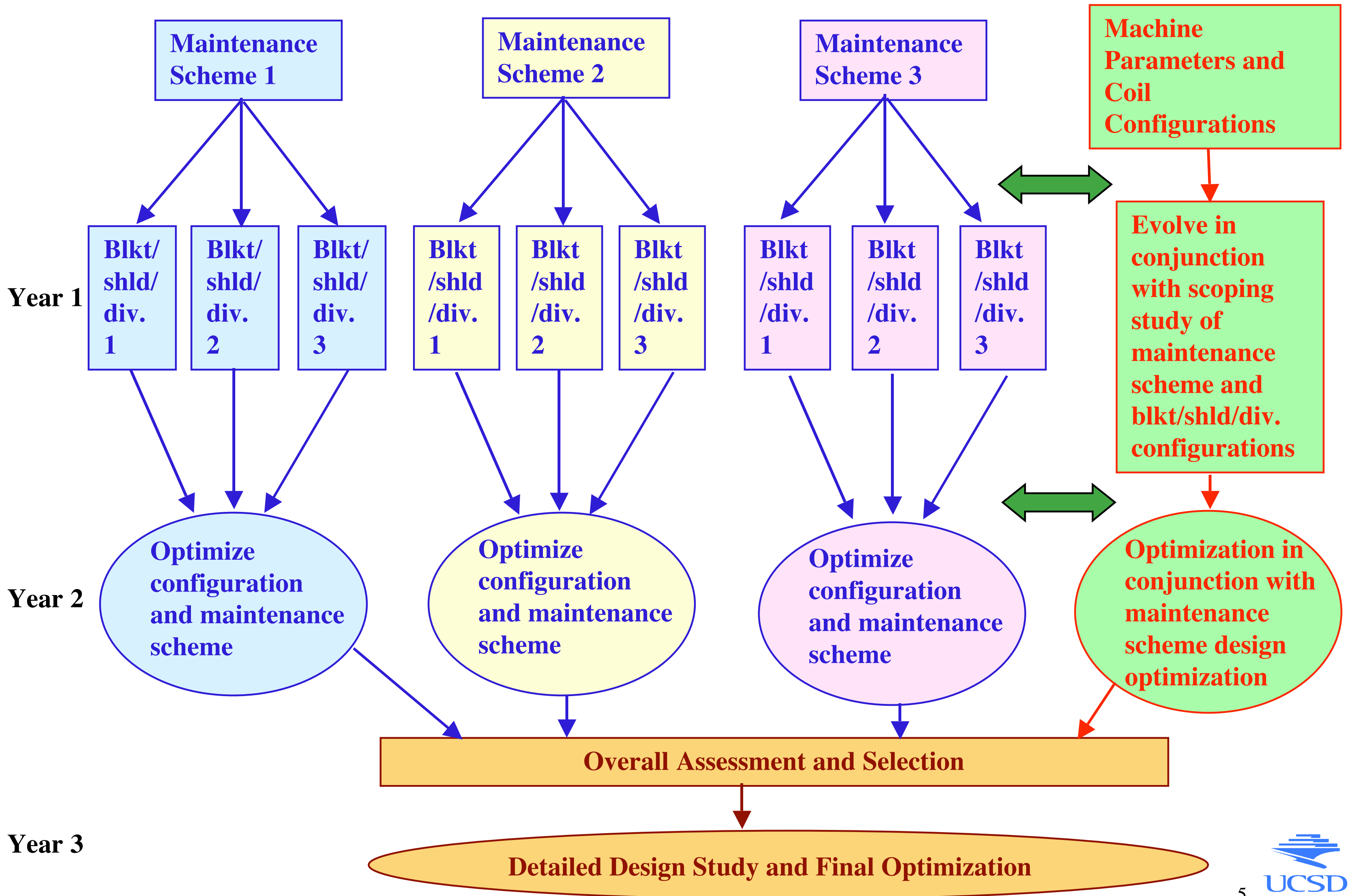
Machine Parameters (Physics, Coil System)

- Space between coils
- Minimum plasma edge to coil distance
- Size (major radius)
- Fusion power

Design Requirements and Performance Parameters

- Tritium breeding
- Shielding requirements
  - Magnet configuration and heating limits
  - Reweldability
- Thermal efficiency
- Maintenance requirements
  - Size and weight of blanket unit
  - Access
- Safety requirements

Proposed Plan for Engineering Activities



Engineering Activities: Year 1

- **Perform Scoping Assessment of Different Maintenance Schemes and Design Configurations**

  - **Three Possible Maintenance Schemes: (UCSD, PPPL, S. Malang, L. Waganer)**

    1. **Sector replacement including disassembly of modular coil system**
    2. **Replacement of blanket modules through maintenance ports arranged between all modular coils**
    3. **Replacement of blanket modules through small number of designated maintenance ports (using articulated boom)**

  - **Each maintenance scheme imposes specific requirements on machine and coil geometry**

Engineering Activities: Year 1

- **Scoping analysis of possible blanket/shield/divertor configurations compatible with maintenance scheme and machine geometry, including the following three main classes: (UCSD, UW, INEEL, Georgia Tech.,S. Malang)**
  1. Self-cooled liquid metal blanket(LiPb) (might need He-cooled divertor depending on heat flux)
     a) with SiC_f/SiC
     b) with insulated ferritic steel and He-cooled structure
  2. He-cooled liquid breeder blanket (or solid breeder) with ferritic steel and He-cooled divertor
  3. Flibe-cooled ferritic steel blanket (might need He-cooled divertor depending on heat flux)

- **Evolve coil configuration(s) (PPPL, MIT)**
  - Material and thicknesses
  - Radius of curvature, shape
  - Space and shielding requirements

Proposed Analysis Procedure

- **Start with coil and plasma shape from NCSX**
  - Need alternate concepts from physics (coils) to study better extrapolation to power plant

- **Perform scoping maintenance scheme/configuration analysis by scaling (?):**
  - Size of machine
    - Distance from plasma to coil
    - Distance between coils
  - Wall load (peak, average, at minimum distance between coil and plasma)

- **Need divertor guidelines (heat load, geometry)**

UCSD

Engineering Activities

Year 2: Configuration Optimization Including Plasma/Coil Space Management

- Assess and select best maintenance scheme/configuration pairings
- Optimize each selection including integration of machine/coil parameters and geometry
- Select most attractive integrated pairing(s) for detailed design study

Year 3: Perform Detailed Design Study and Optimization for ARIES-CS Power plant