ARIES CS
Magnet definition

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Costing

- Issue that I was investigating:
  - Cost of complexity
- No one at MIT had a handle on this issue
  - Stellarator magnets not previously costed
- Weldenstein did not respond (Bosch)
  - But even if they had responded, it would have been not relevant, as they have tried to address design issues during construction
- Will try to get information from the Japanese group in early December

Conventional design

- Nb_3Sn, as in the baseline case
- Cost ~ 1 $/KA m
- Wind and react

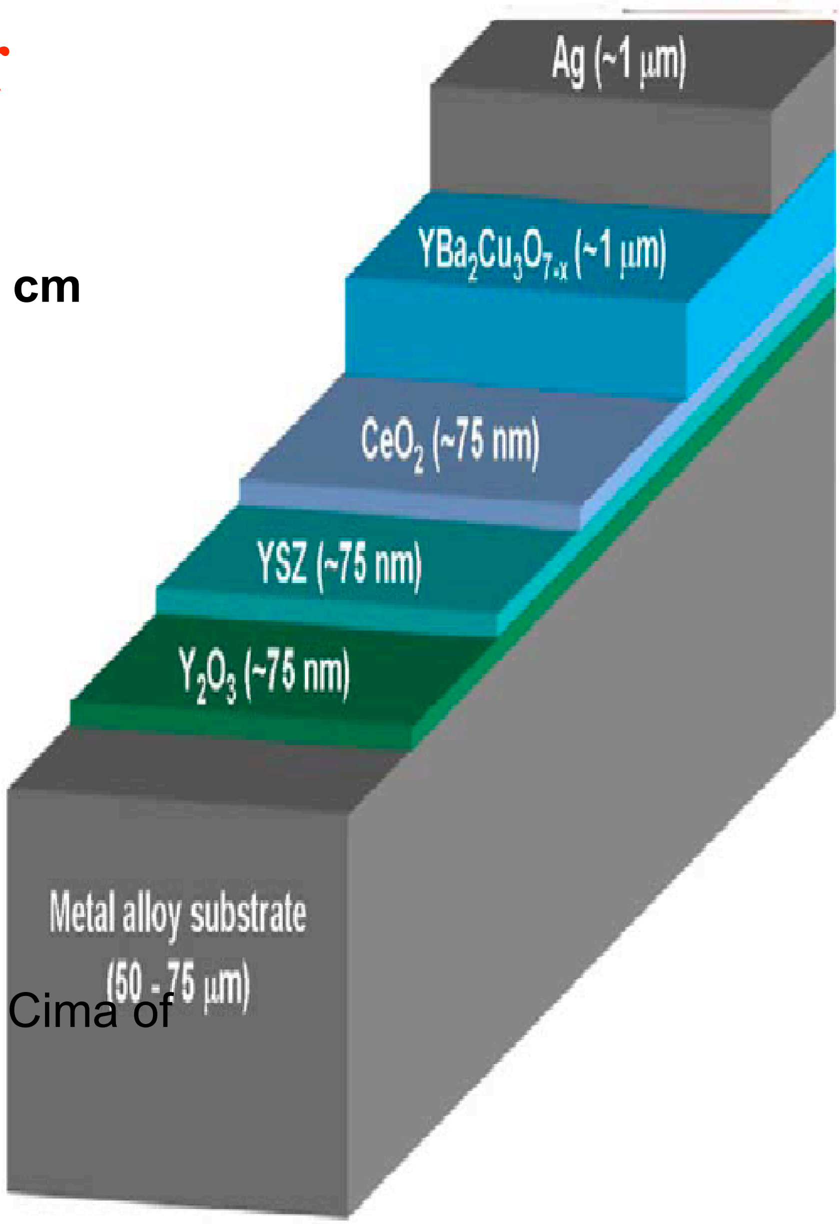
- MgB_2 could also be used, and may be cheaper
- Both materials are sensitive to strain

However…

- First generation HTS wires were BSCO 2223 based, difficult to grow, within a silver matrix
  - Costly (probably not less than about 10 $/kA m, even at high capacity)
  - For comparison,
    - NbTi today ~ < $1 /kA m
    - Nb_3Sn ~ $5-10/kA m today, DoE goal ~ $1/kA m

AMSC 344 conductor

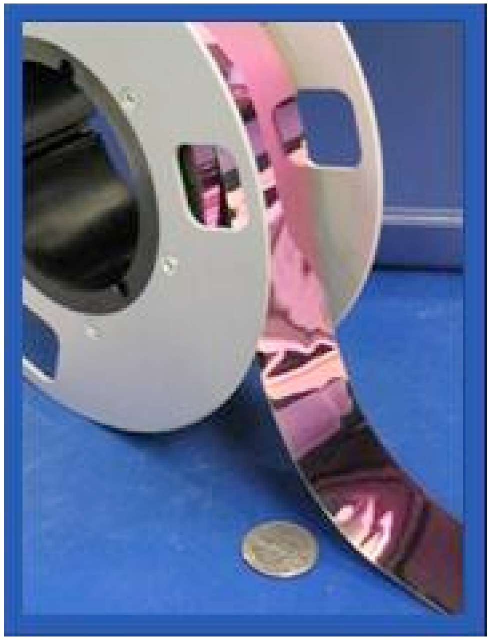
- **Width Evolution: 1 cm -> 4 cm -> 10 cm**
- **Substrate: Ni-5%W alloy•**
  - Deformation texturing-
- **Buffer stack: Y2O3/YSZ/CeO2**
  - High rate reactive sputtering
- **YBCO**
  - Metal Organic Deposition of TFA•
  - *ex-situ* process
- **Ag**
  - DC sputtering



Developed in collaboration with MIT Prof. M. Cima of Department of Material Sciences

344 tape

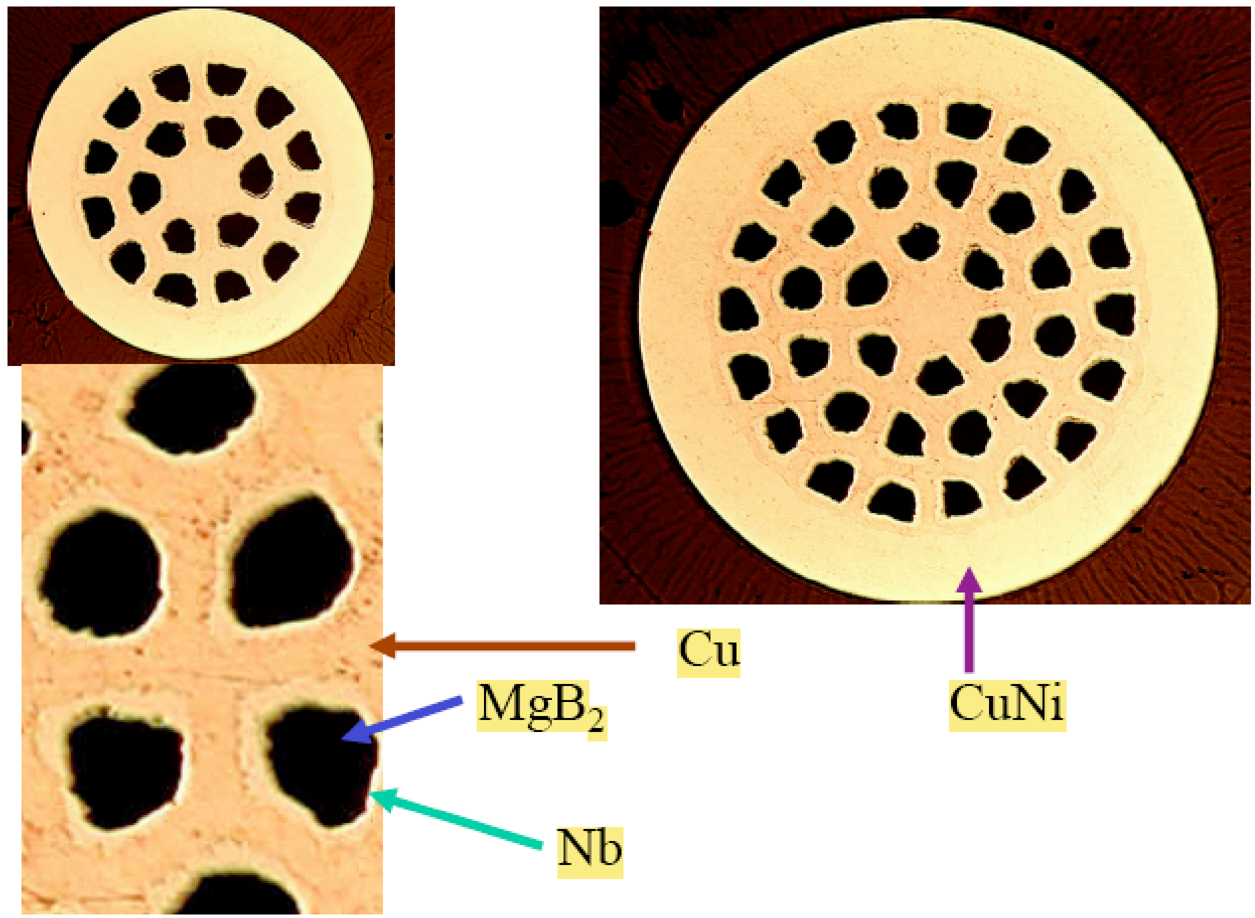
- Highly strain resistant
- 1% strain tolerant, compared with 0.2% for other low temperature conductors
  - Cheaper materials that do not have to match the coefficient of thermal expansion (CTE) for the superconductor
    - I.e., conventional steels, instead of Incoloy 908
    - Thus higher stresses in the superconductor material than in the structure
  - Note: 1% of a structure that is 10m is about 10 cm!
  - Deformations need to be included in the design
- Simplified the design of the coil, as material is determined more from strain than from stresses
- Substantial savings in structural materials



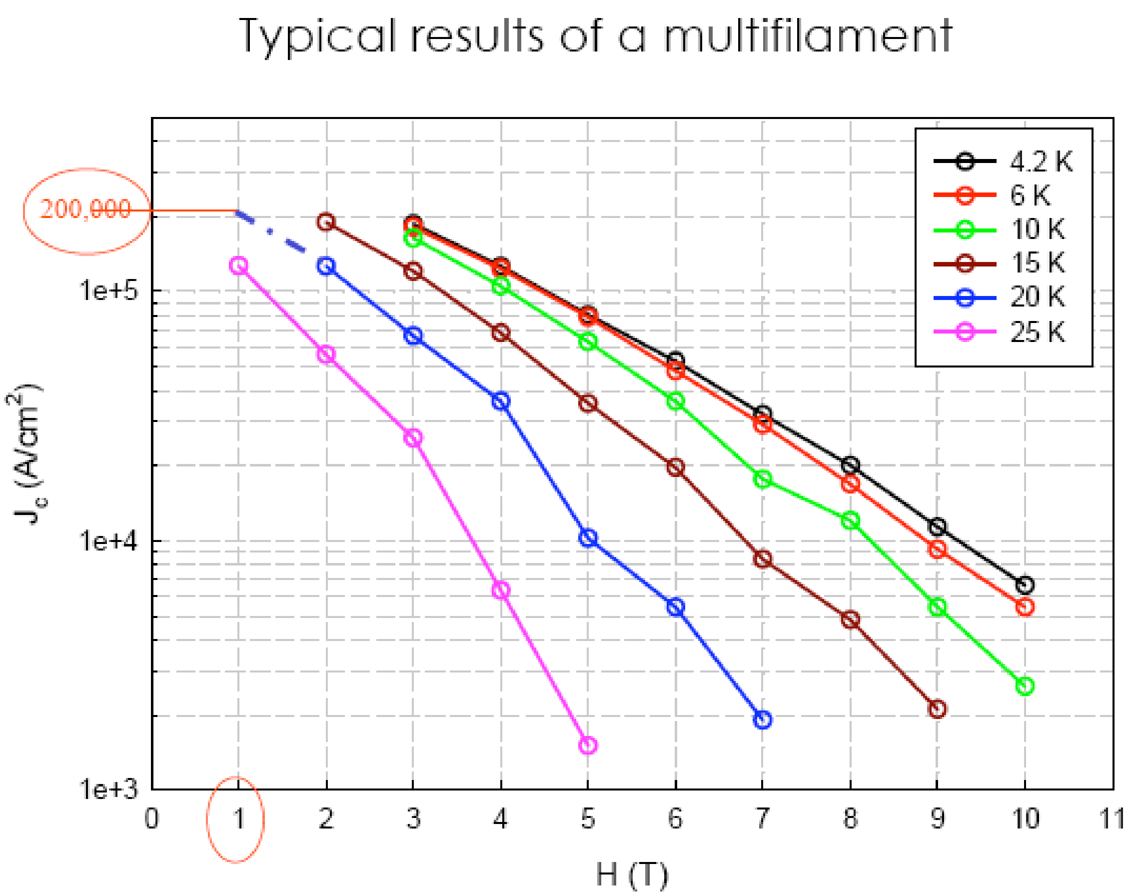
Quench protection

- For Nb3Sn (conventional design)
  - Quench protection by using large number of parallel coil circuits
  - High current operation
  - Discharge time ~ $E_{magnet}/N_{coil\ circuits}\ I\ V_{max}$
  - Requires large number of dump systems, feedthroughs
- For ARIES-AT, we proposed the possibility of stabilization by paralleling coils
  - Concept not considered, used instead assumptions that quench will not occur because of design of conductor and large energy margins.

Hyper tech MgB_2



MgB2 restacked 19 filaments conductor



DoE SBIR

- MgB_2
  - Possibility of collaborating with Hyper Tech in development of a test for fusion
    - Can we consider one of the highly deformed winding, scaled down?
- 2nd generation wires
  - Using multiple tapes for winding small coil
  - Use ARIES-CS type of quench protection for low/intermediate temperature operation
    - Considered for ARIES-AT but not included in final design.