Summary slides: FCC-hh and HFM

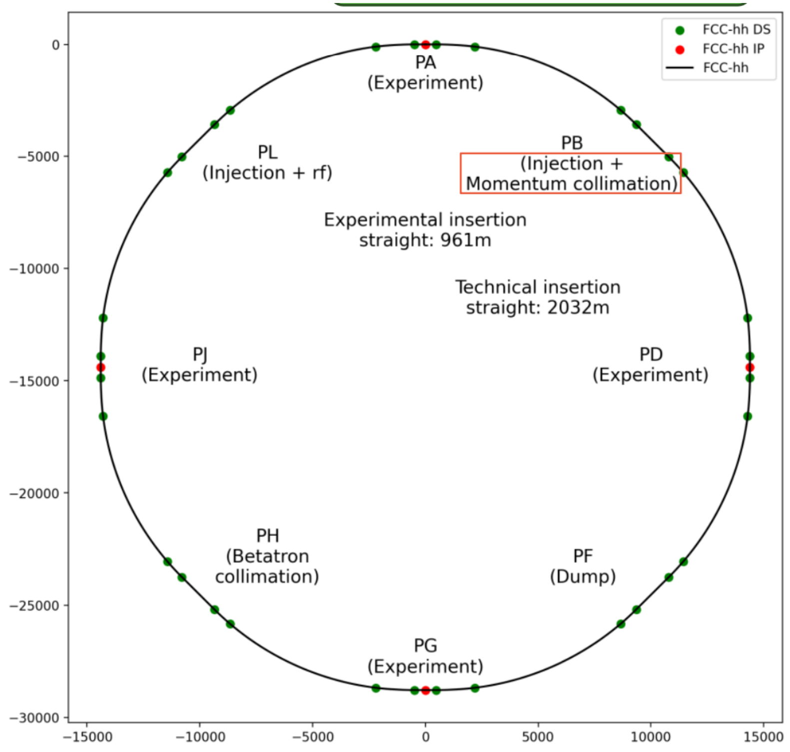
Soren Prestemon

Lawrence Berkeley National Laboratory

Review of FCC-hh general parameter ranges

Modifications improve:

- Injection layout
- Magnet fill factor



Parameter	Value
Collision energy cms [TeV]	84.6 – 120.8
Dipole field [T]	14(Nb_3Sn) - 20(HTS/Hybrid)
Circumference [km]	90.657

Gustavo Pérez Segurana

parameter	FCC-hh	HL-LHC	LHC
collision energy cms [TeV]	84 - 120	14	
dipole field [T]	14 - 20	8.33	
circumference [km]	90.7	26.7	
arc length [km]	76.9	22.5	
beam current [A]	0.5	1.1	0.58
bunch intensity [10^{11}]	1	2.2	1.15
bunch spacing [ns]	25	25	
synchr. rad. power / ring [kW]	1100 - 4570	7.3	3.6
SR power / length [W/m/ap.]	14 - 58	0.33	0.17
long. emit. damping time [h]	0.77 – 0.26	12.9	
peak luminosity [10^{34} $cm^{-2}s^{-1}$]	~30	5 (lev.)	1
events/bunch crossing	~1000	132	27
stored energy/beam [GJ]	6.3 – 9.2	0.7	0.36
Integrated luminosity/main IP [fb^{-1}]	20000	3000	300

Infrastructure

High voltage source and transmission system does appear to be compatible with FCC-hh (focus has been on FCCee)

Tunnel size and layout

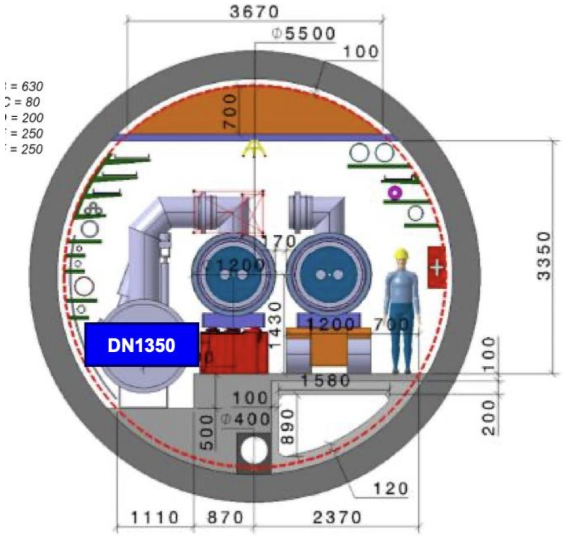
- Critical decision that needs to accommodate both ee and hh
- Interfacing with magnets and cryogenics critical

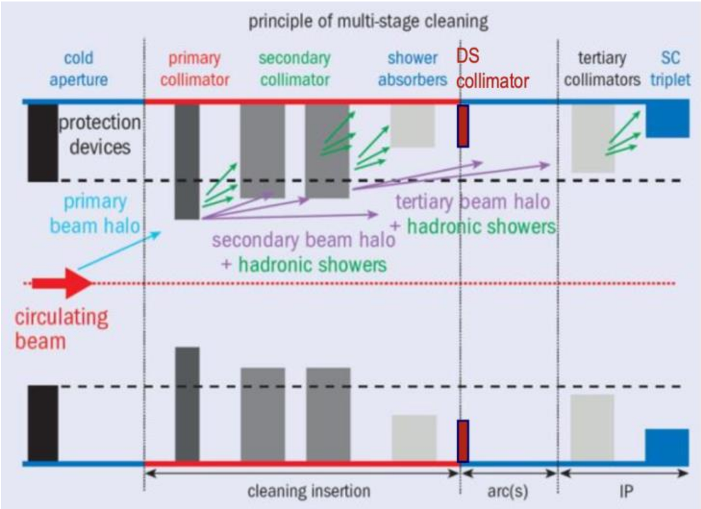
Collimation critical – "***FCC-hh beams are highly destructive***"

Mario PAROD

Laurent Delprat

Roderik Bruce

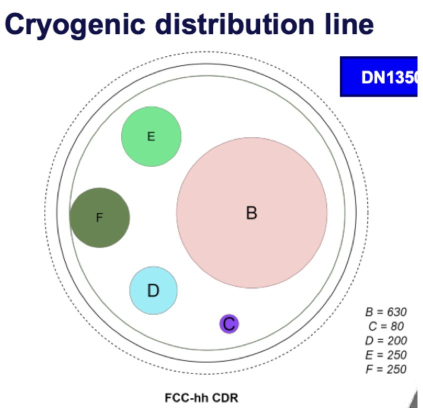


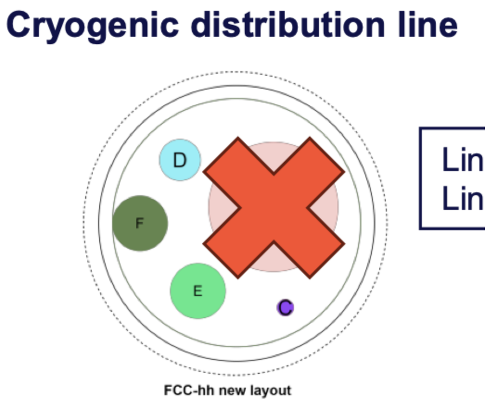


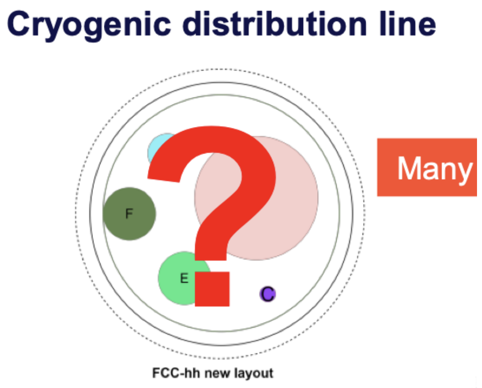
Cryogenics for FCC-hh

Fairly understood at 1.9K
Heat loads slightly less clear at 4.5K
Lots of unknowns at 20K

Conclusions:
- In 1.9 K & 4.5 K configurations distribution system (vs FCC-ee tunnel) compatible
- At 20K, lots of unknowns, ”seems compatible”







Laurent Delprat

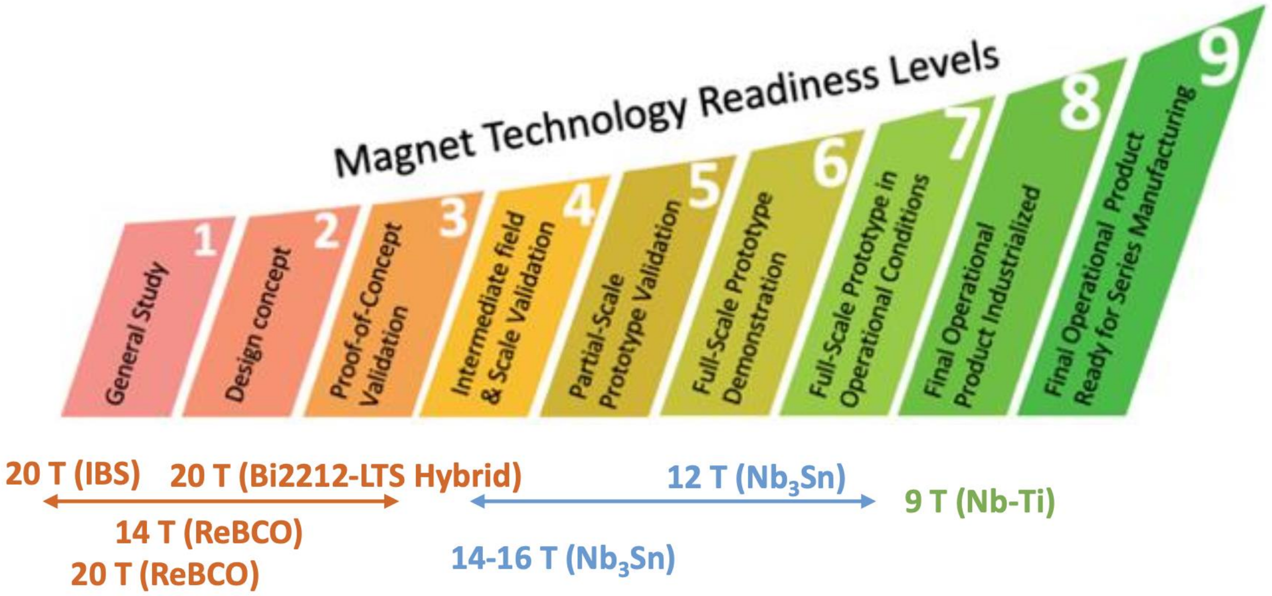
Magnet development

Message: For Nb3Sn magnets, ***14+ T***

- Magnet prototypes therefore need to prove themselves at ~15-15.5T to demonstrate adequate margin for reliable operation

Structure of European HFM is now more clearly focused

  - An effective timeline for Nb3Sn magnet development laid out

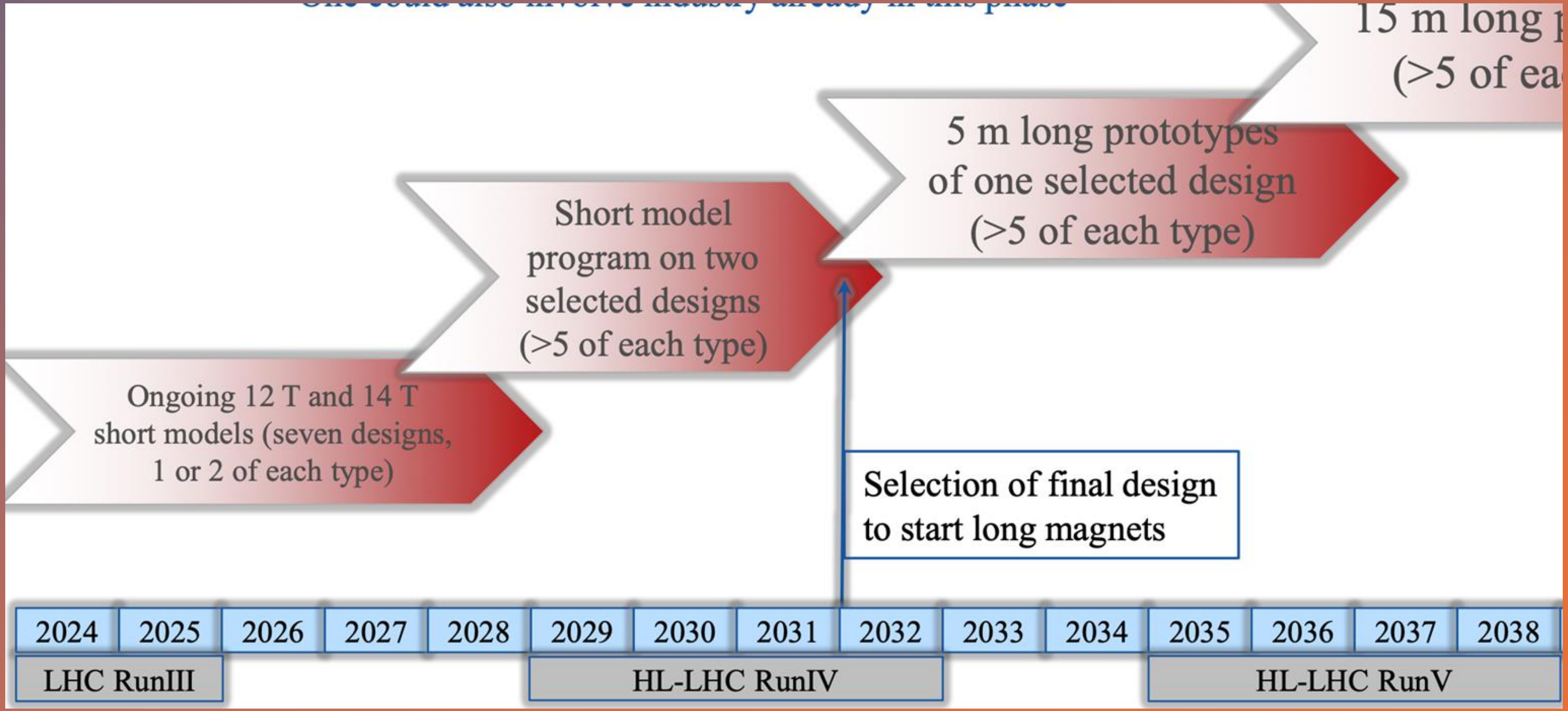


Ezio Todesco

Bernhard Auchmann

HFM
High Field Magnets Programme

Roadmap focused on dev. / downselect / scaleup



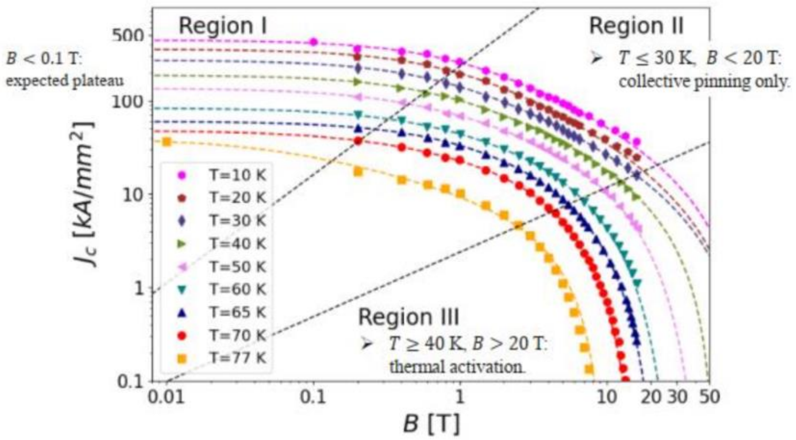
Opportunities for HTS solutions

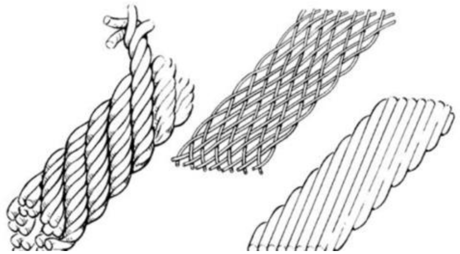
Bernhard Auchmann

HFM focus is on REBCO
- Primarily on design concepts leveraging conductor anisotropy

Roadmap is challenging:
- Significant R&D needed to "catch up"

$$I_c(B,T=T^*,\theta=\theta^*) = I^*_{c,0}\cdot\left(1+\frac{B}{B^*_0}\right)^{-\alpha^*}\cdot\left(1-\frac{B}{B^*_{irr}}\right)^{q^*}$$





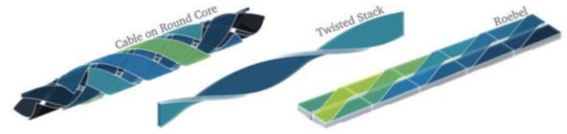
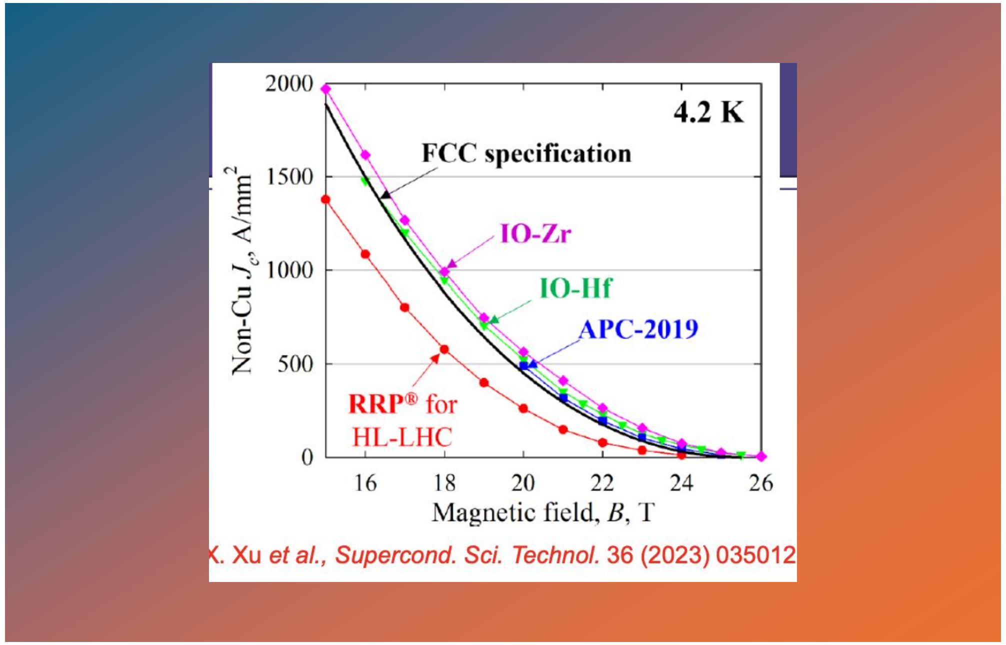
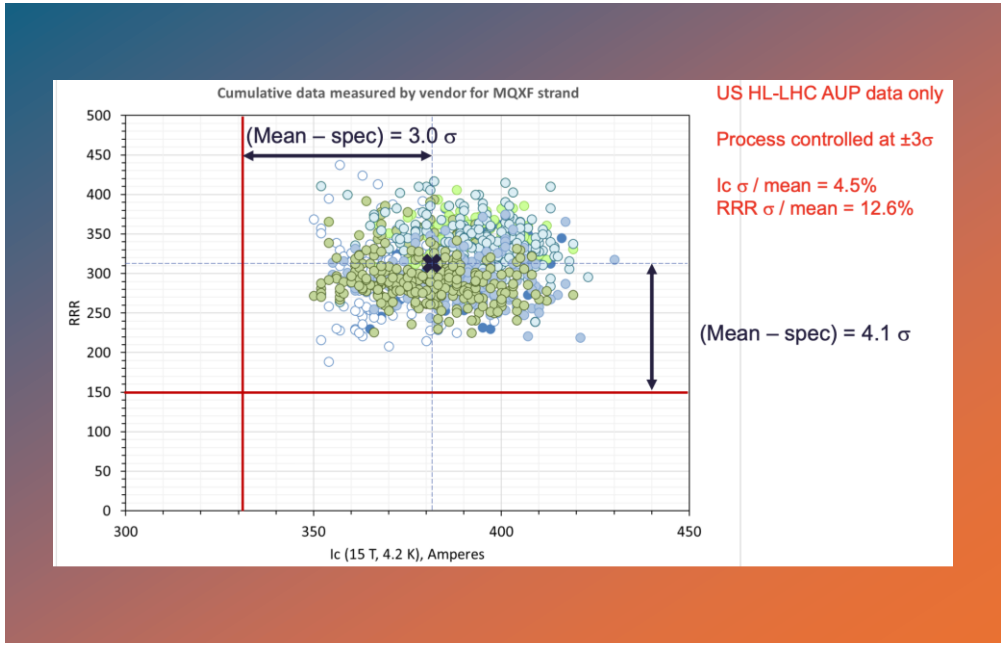


Figure 1.10. *Three different geometries for assembling a cable with ReBCO coated conductor. Also refer to Table 1.2.*

Lance Cooley

Conductor developments and considerations





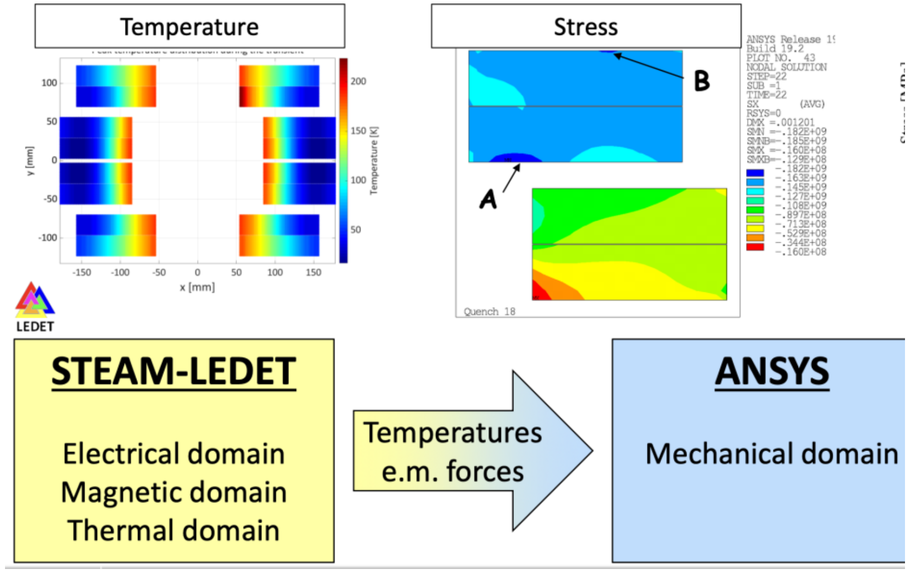
- Challenges:
  - Superconductivity applications are a tiny fraction of the Nb market space
  - Superconductivity needs pure Nb
- For HTS, many challenges and opportunities
  - Bi2212 led primarily by HEP
  - REBCO driven primarily by Fusion now

Magnet protection

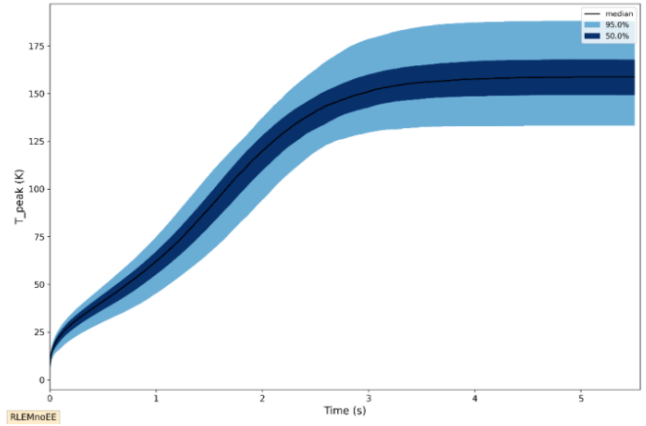
Evolution of the LHC powering and protection strategy

Emanuele Ravaioli

- Margins for protection get tighter at higher field
- CLIC provides significant flexibility, but has some drawbacks when scaled to FCChh;
  - alternative concepts are under development that may address those issues
- Modeling has advanced significantly, enabling coupled physics simulations of powering circuit and thermo-mechanical response of magnets during quench

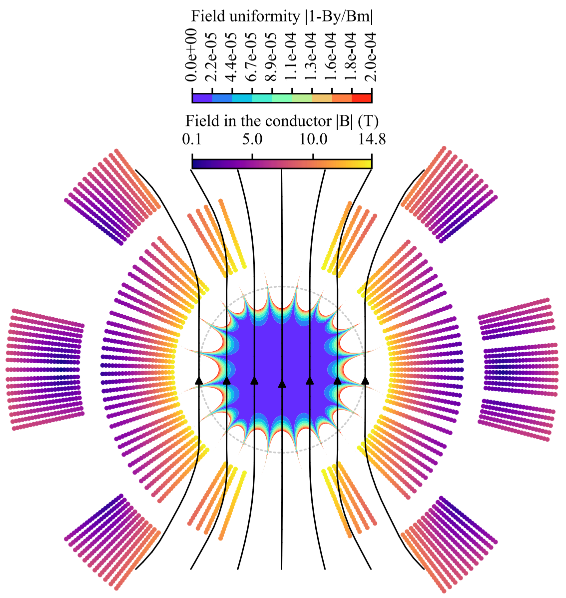


Impact or uncertainty on quench protection results



US MDP and collaboration with HFM

- MDP focused on “general” high field magnet development
  - “Stress-management” concepts
  - “Hybrid” LTS/HTS magnets
  - REBCO and Bi2212 HTS magnet technology



Complementarity of approaches mitigates risk factors:

- Bi-2212 as well as CORC/Star ReBCO wires in US-MDP,
- ReBCO anisotropic cables and IBS in HFM,
- High-risk high-reward topics (no-protection, hydrogen) covered in US-MDP.


Thanks for coming to San Francisco!