I.FAST WP9 Kick-off Meeting

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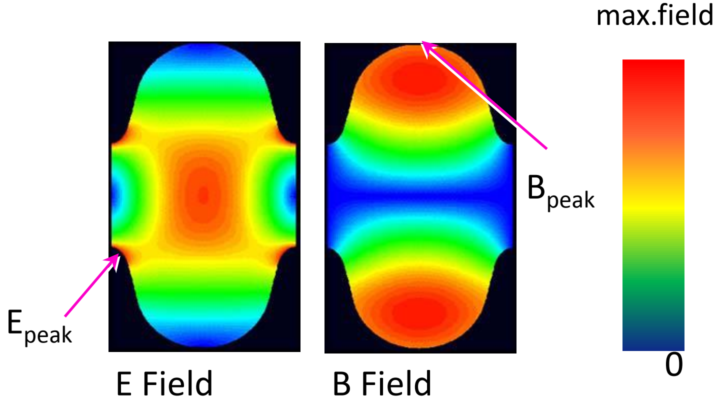
Introduction

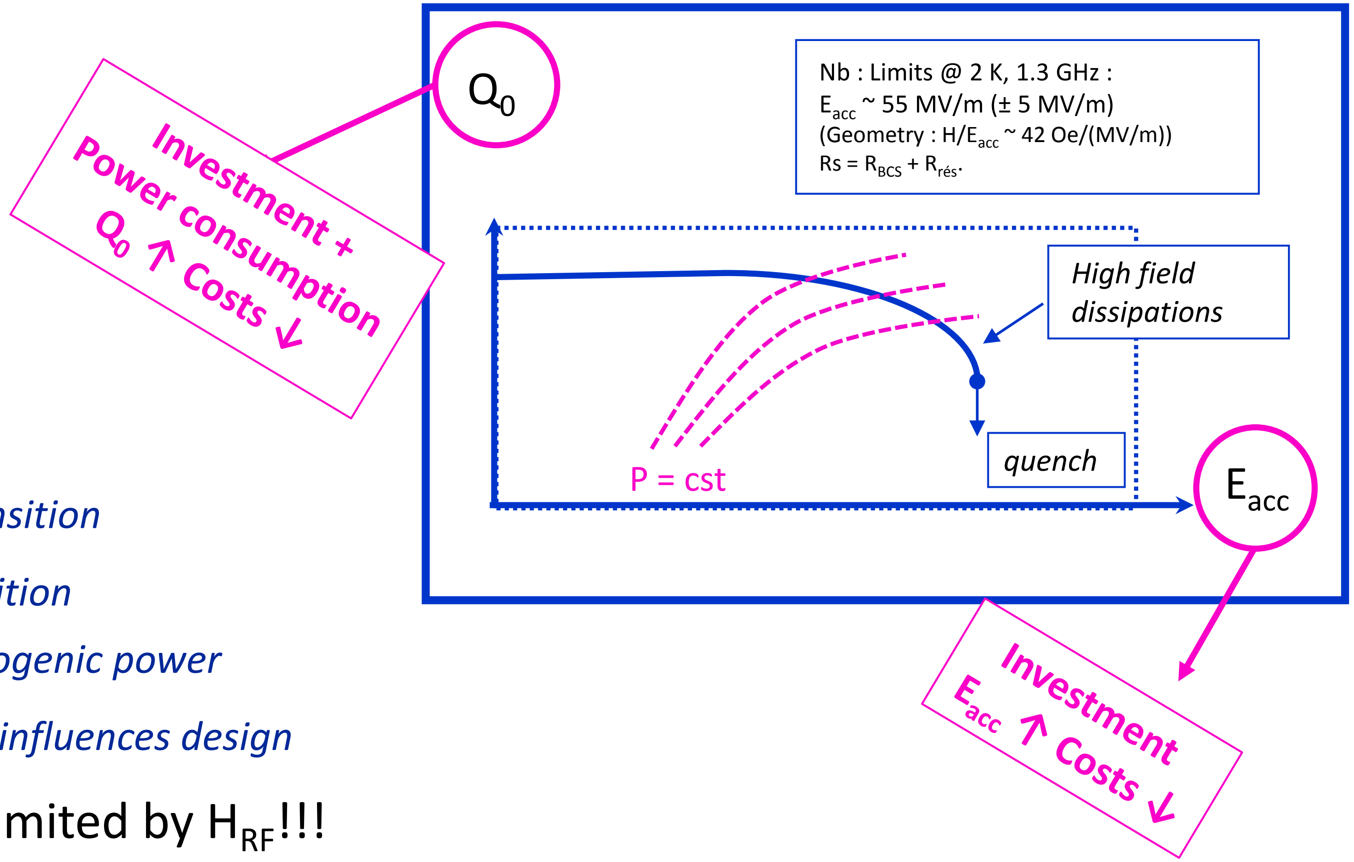
Short summary for new comers

Bulk Nb: monopoly in SRF since > 50 years

- Nb/Cu applications at low accelerating field only until recently (see TFSRF2021)

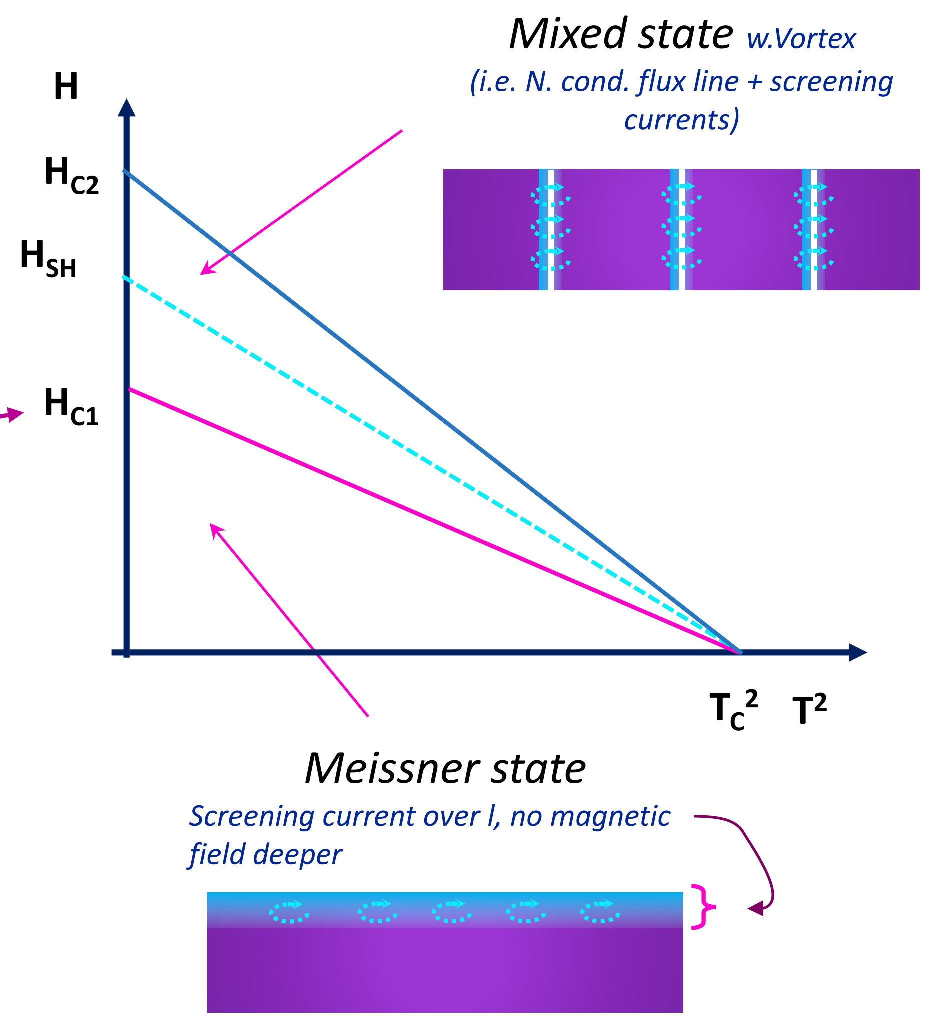


- Figures of merit:
  - E_{acc} : α *HRF limitation = magnetic transition*
  - Q_0 : α *1/RS limitation = thermal transition*
  - Duty cycle (=> 100%): *limitation = cryogenic power*
  - $\beta = \frac{v}{c}$ (particle speed /light speed): *influences design*
- At w < 3 GHz: cavities are mainly limited by H_{RF}!!!



Ultimate limits in SRF

- SC phase diagram
  - All SC applications except SRF: mixed state w. vortex
    - Vortices dissipate in RF !
  - SRF => Meissner state mandatory !
  - H_{C1} = limit Meissner/mixed state
  - Nb highest H_{C1} (180 mT)
  - "Superheating field" (H_{SH}) : Metastable state favored by H// to surface
    - Difficult to get in real life



Superconductors for SRF

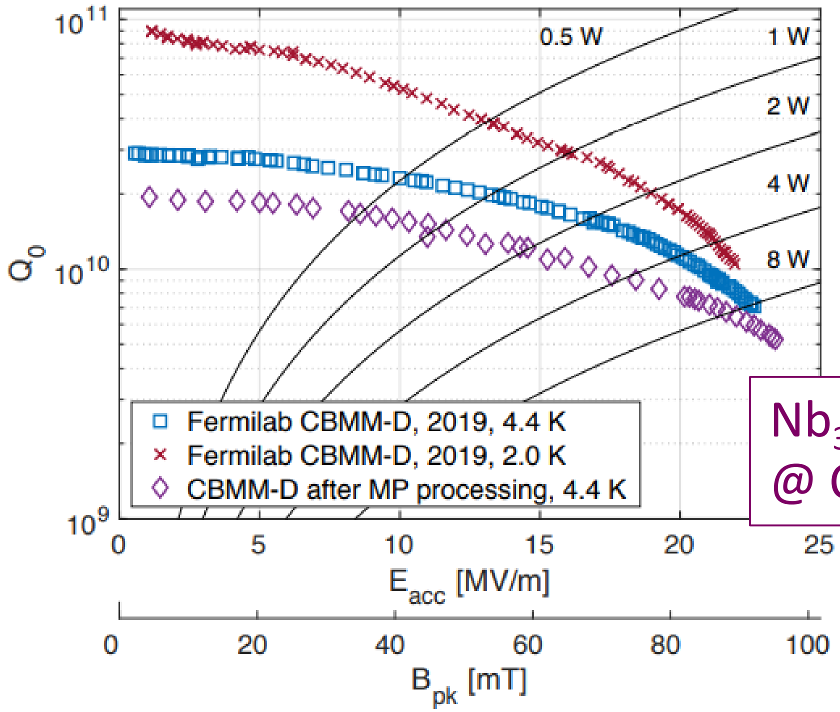
Material	T_C (K)	$\mu_0 H_{SH}$ (mT)@ 0 K
Pb	7,1	100
Nb	**9,2**	**219,0**
NbN	**17,1**	**214,0**
Nb_3Sn	**18,3**	**425,0**
MgB_2	**39,0**	**170,0**
Pnictides $Ba_{0.6}K_{0.4}Fe_2As_2$	**38,0**	**756,0**
~~**Cuprates YBaCuO**~~	**93,0**	**1050,0**

High H_{SH} => High E_{acc}… in theory

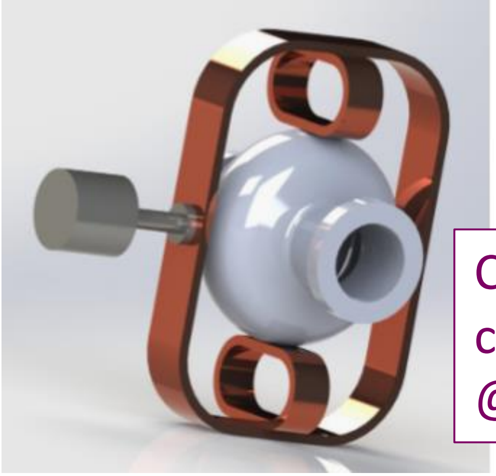
High T_C => High Q_0

Possible intermediate step: High Q_0, medium E_{acc}

- Many applications limited by cryogenic power
  - Medium E_{acc} fairly acceptable if high Q_0
    - e.g. high duty cycle applications
  - Same performance as Nb but 4.5 K instead of 2K
  - @ even higher operating temp => crycooler, different cooling scheme
- Exemple : Nb_3Sn, MgB_2 on Nb or Cu

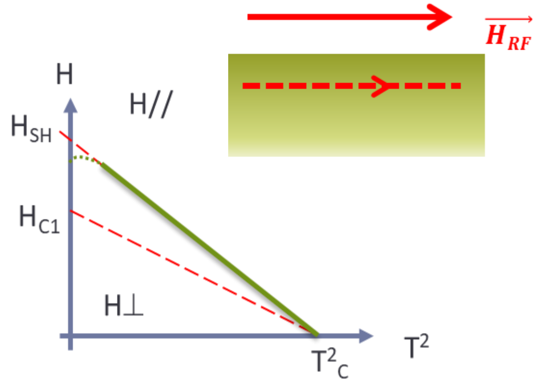


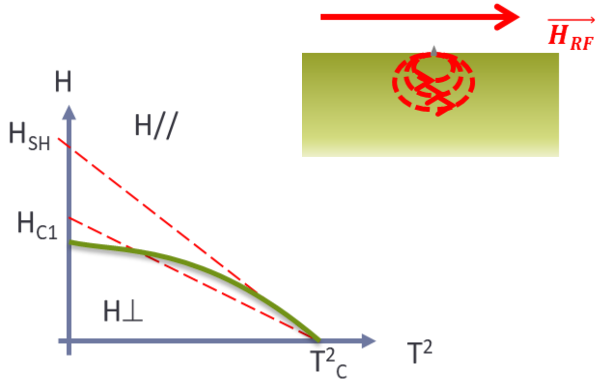
Nb_3Sn @ Cornell

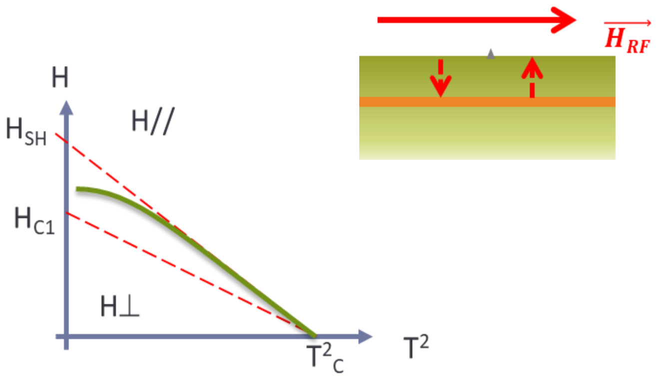


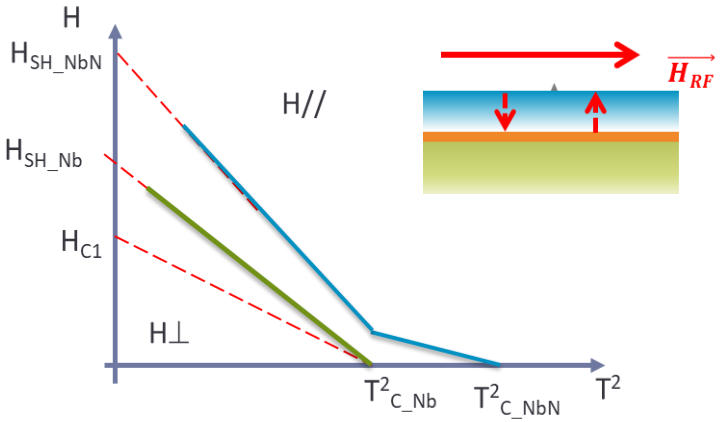
Cryogen free cooling scheme @ ANL

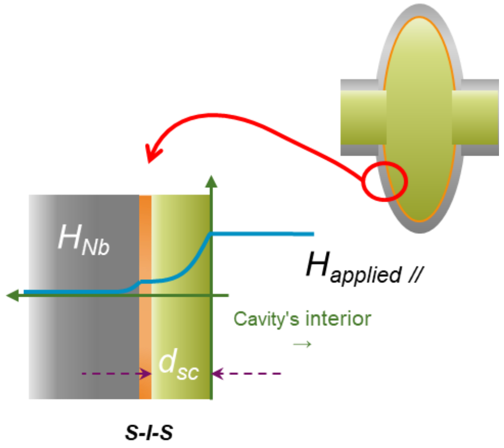
Multilayers concept
(or how to make theory face reality)

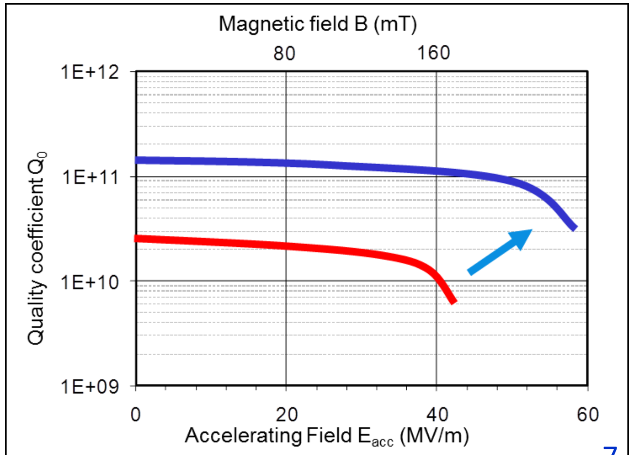












What past has taught us ?

- Huge parameter space has to be explored
  - Not achievable without cooperation and work sharing
  - Still relatively few actors and resources
- Paramount importance of substrate quality (pre/post treatments)
  - We knew it, but there is still room for improvement
- Thick and thin films very sensitive to crystalline defects, but not all defects are troublesome.
  - Need for characterization : structural, superconducting… RF wise.
  - For now still no overlapping w. techniques => predictions are difficult

IFAST WP9

Task 9.1

Coordination and strategy for innovative superconducting accelerating cavities

Objectives for WP9
Innovative superconducting cavities

- (Usual ☺) goal: Improve performance and reduce cost of acceleration systems
- We have built together a global strategy to be able to built Superconducting RF (SRF) cavities coated with a superconducting film.
- It includes pursuing the optimization and the industrialization:
  - Substrates preparation (Nb, and most of it Cu)
  - The production of seamless copper cavities
  - The deposition techniques.
  - Pre-and post treatment (laser)
- Produce and RF test prototypes of SRF cavities at 6, 3 GHz
  - Easier to handle, fabricate, dissect to provide fast feedback
- Produce accelerator type 1.3 GHz cavities. The only way to convince the accelerator community !!!

Task 9.1: Coordination and strategy for innovative superconducting accelerating cavities

Official task:

- Help the circulation of information, organize exchanges
  - *~ 8 WP meetings/ year*
  - *not only European wide : external collaborators, also see TTC TF group*
- Organize International thin film workshop
  - *It’s a mile stone: MS37(web site)*
- Edit a “Thin-Film SRF roadmap report” at the end of the project (**D9.1**).
  - *Summaries of the results obtained within the workpackage and prospectives inspired from WP advances as well as discussions at TF-SRF 2022.*

Task 9.1: What more ?

- Discuss how to adapt the strategy when progresses/setbacks
- *Help to find new funding possibilities/ organize new common proposals ?*
  - *looking for good will ☺*
- Discuss how to adapt the strategy when progresses/setbacks
- Have a big get-together once covid is off ☺ !

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Thank You

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