What is the total RF requirement for FCC Higgs Factory?
How many 400 MHz and 800 MHz cells will be required?
What are the development challenges?
What is the cost impact of Nb/Cu film technology for FCC?

GARD-SRF Roadmap Workshop

9-10 February 2017, FNAL

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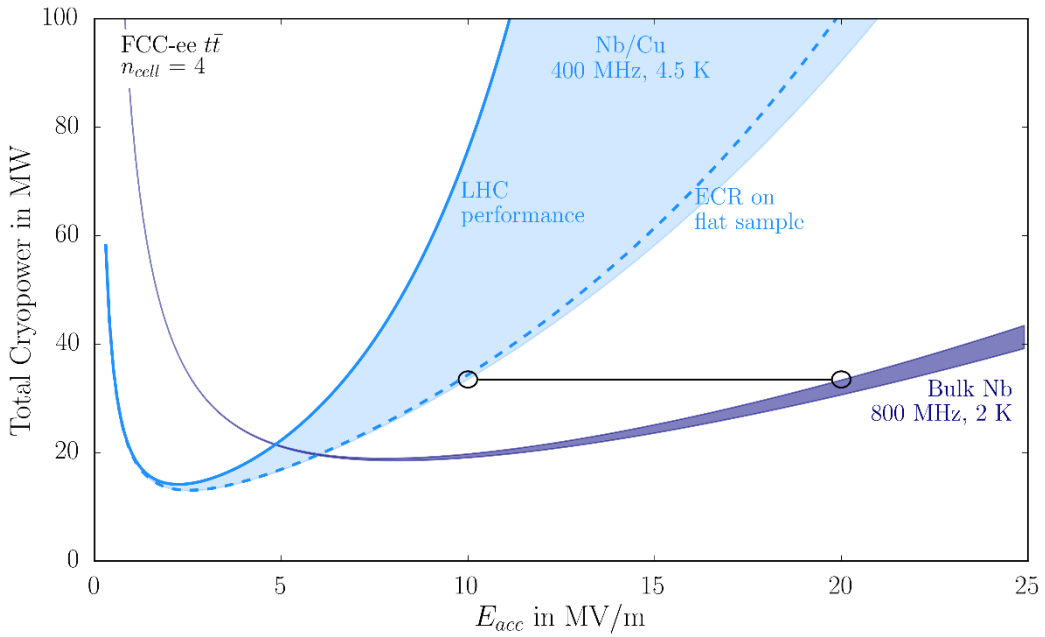
RF requirement for FCC-ee Higgs (and top)

	H	$t\bar{t}$
Beam energy in GeV	120	175
Beam current in mA	30	6.6
RF voltage in GV	3	10
Beam lines	2	1



	OPTION 1	OPTION 2
Frequency in MHz	400	800
Technology	Nb/Cu	Bulk Nb
E_{acc} in MV/m	10	20
Temperature in K	4.5	2.0
# of cells/cavity	3 – 5	
# of cavities FCC H	160 – 270	
# of cavities FCC t	530 – 890	
# of CM for FCC H	100	
# of CM for FCC t	170	

Two competing options for the (S)RF system for FCC-ee H/t

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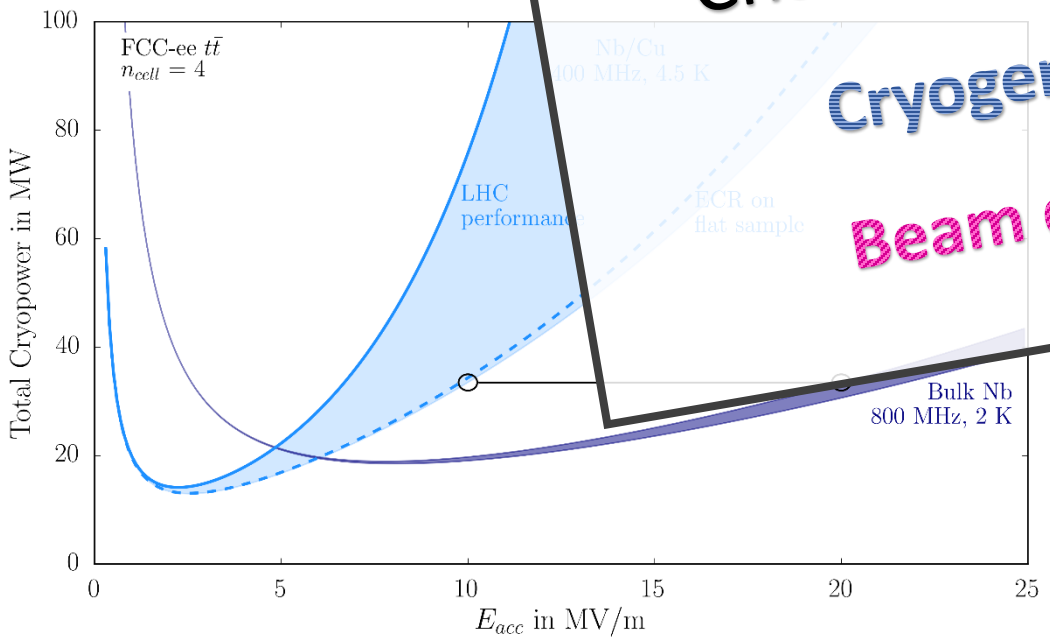
Challenges for FCC-ee H/t

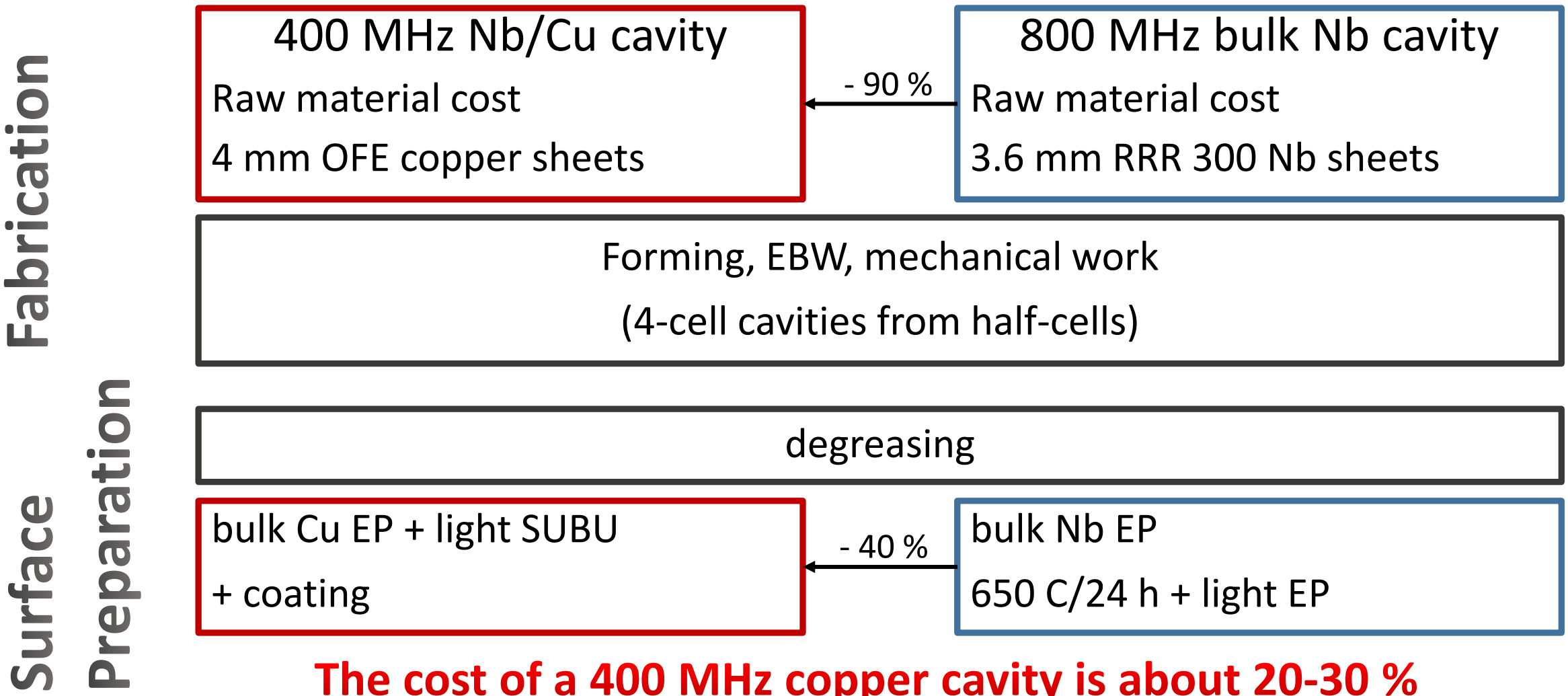
Cryogenic consumption

Beam dynamics issues



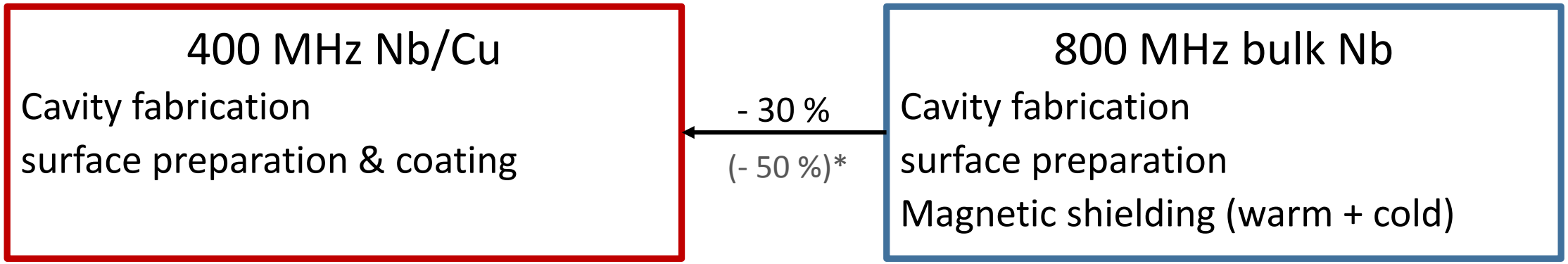
Two competing options for the (S)RF system for FCC-ee H/t

Cavity Cost



The cost of a 400 MHz copper cavity is about 20-30 %
less than for a 800 MHz bulk Nb

Cryomodule Cost



* For seamless cavities and forming cost reduced by 50 %

4 cavities, 4 He tanks,

4 FPC, 8 HOM coupler, 4 tuner

1 cryostat, 2 cryo valves

The cost for a CM with 400 MHz Nb/Cu cavities is 25-40 %
less than for a CM with 800 MHz bulk Nb cavities

Cryogenic Plant:

Tooling

Chemical Hazards

4.5 K vs 2.0 K

Raw material availability

Clean room requirements for 10 MV/m @ 400 MHz vs 20 MV/m @ 800 MHz

Industrialization

Seamless cavities

Helium distribution:

4.5 K vs 2.0 K

Micro-phonics

New forming techniques

Coating

Cost for R&D

What's missing

Beam dynamics

cost

Underground space for a 400 MHz vs a 800 MHz system

RF Power Sources: 400 MHz vs 800 MHz

Summary: FCC RF Parameters

RF Parameters - summary table (6/2/2017)

	FCC_hh	Z		W		H		t	
Ibeam [mA]		1450.0		152.0		30.0		6.6	
Nb bunches		91500	30180	5162		770		78	
RF voltage [GV]	0.03	0.20	0.40	0.80		3.00		10.00	
Energy loss/turn [GeV]		0.03	0.03	0.33		1.67		7.50	
Bunch Length (mm)		3.00	1.60	3.00		3.00		3.00	
frequency [MHz]	400	400	400	400	400	400	800	400	800
cavity technology	Nb/Cu	Nb/Cu	Nb/Cu	Nb/Cu	Nb/Cu	Nb/Cu	Nb	Nb/Cu	Nb
operating temp	4.5	4.5	4.5	4.5	4.5	4.5	2.0	4.5	2.0
accelerating gradient [MV/m]	10	10	10	10	10	10	20	10	20
Nb cavities	32/beam	54/beam	107/beam	214/beam	107/beam	200/beam	200/beam	667	667
Nb cell / cav	1	1	1	1	2	4	4	4	4
coupler type	movable	fixed		fixed		fixed		fixed	
power per cavity [kW]	500	924	462	235	470	251	251	75	75
Q_{ext} matched	2E4 - 9E4	1.7E+05	3.5E+05	6.9E+05	7.0E+05	2.6E+06	2.6E+06	8.9E+06	8.9E+06
RF system length [m]	41	68	136	272	176	480	330	1600	1100
Pcryo tot [MW] @ RT	0.6	1.6	4.1	2.9	2.9	9.8	9.3	32.5	30.0