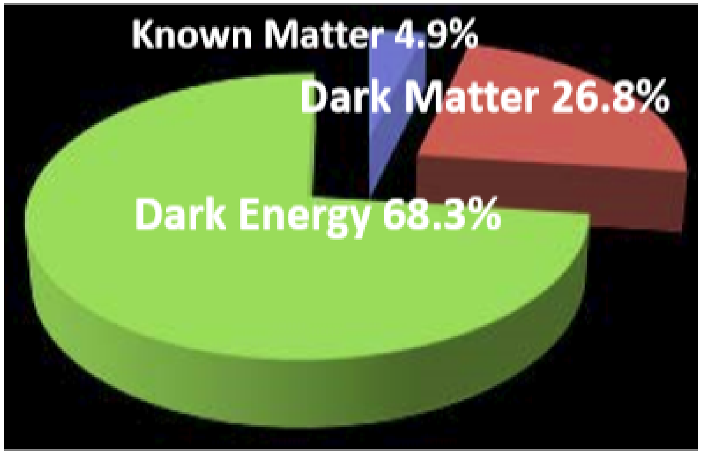
The Future High Energy Collider (FCC)

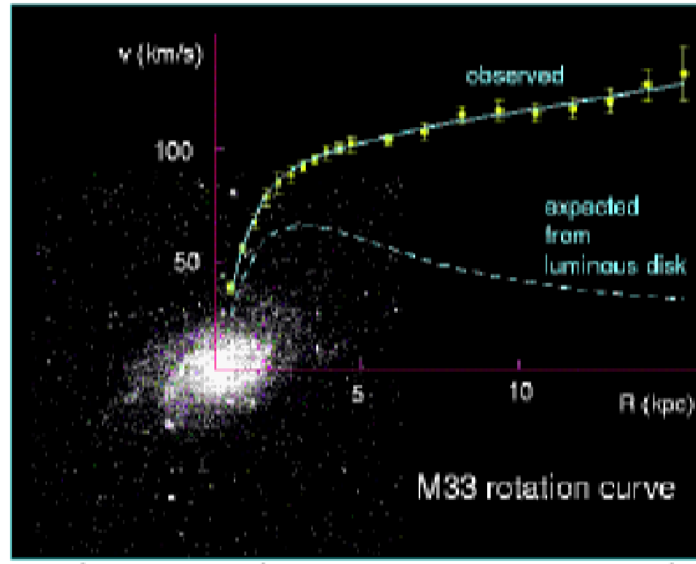
Planning after HiLumi LHC

(from a talk of Michael Benedikt, CERN)

Many open questions remaining

- Standard model describes known matter, i.e. 5% of the universe!





galaxy rotation curves, 1933 - Zwicky

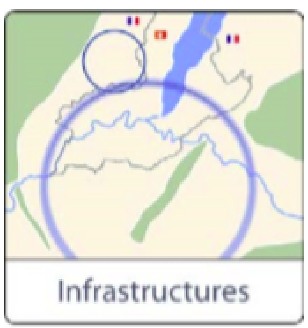
- what is dark matter?
- what is dark energy?
- why is there more matter than antimatter?
- why do the masses differ by more than 13 orders of magnitude?
- do fundamental forces unify in single field theory?
- what about gravity?
- Is there a “world equation – theory of everything”? ...

K. Borras

FCC Scope: Accelerator and Infrastructure

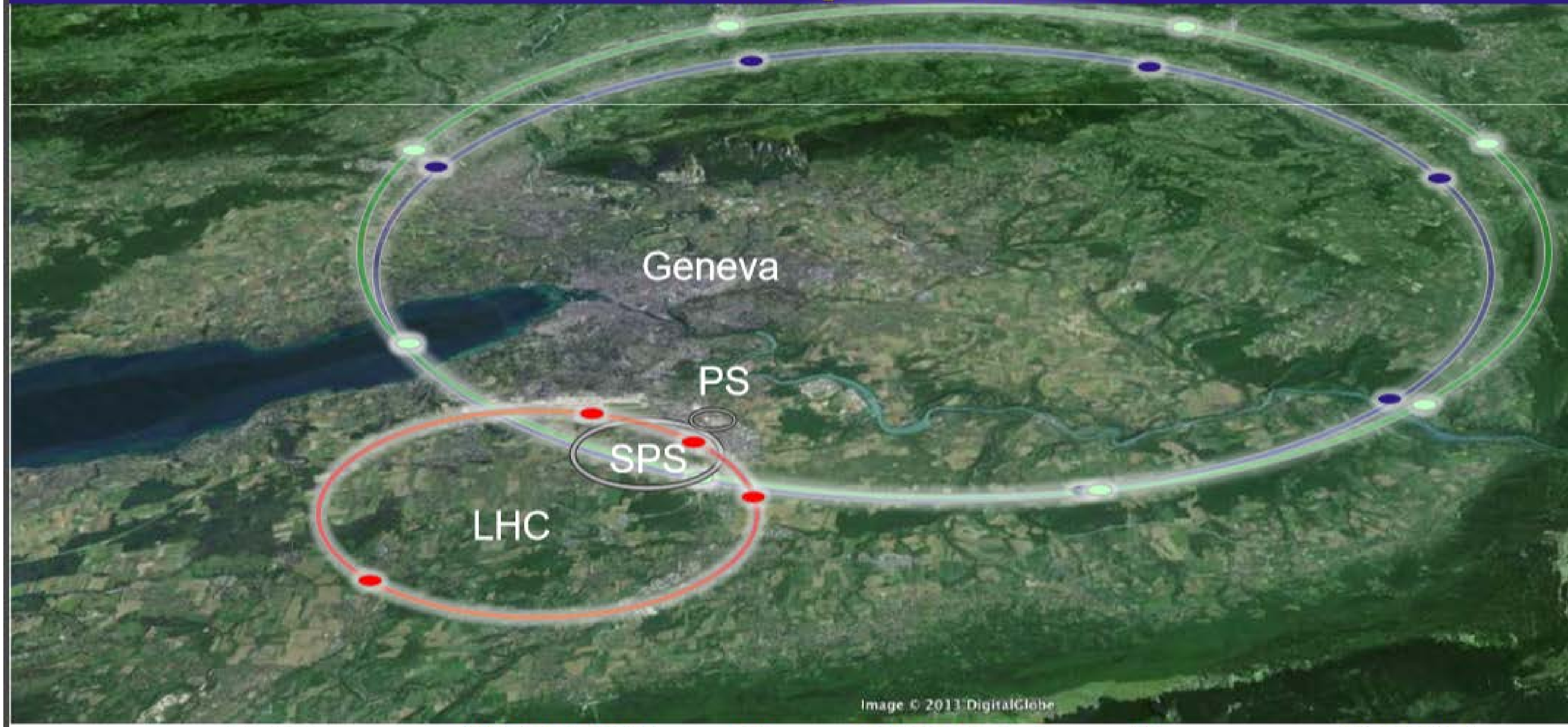
FCC-hh: **100 TeV pp collider as long-term goal**
→ defines infrastructure needs
FCC-ee: **e^+e^- collider**, potential intermediate step
HE-LHC: **based on FCC-hh technology**

Launch R&D on key enabling technologies
in dedicated R&D programmes, e.g.
16 Tesla magnet program, cryogenics, SRF technologies and RF power sources



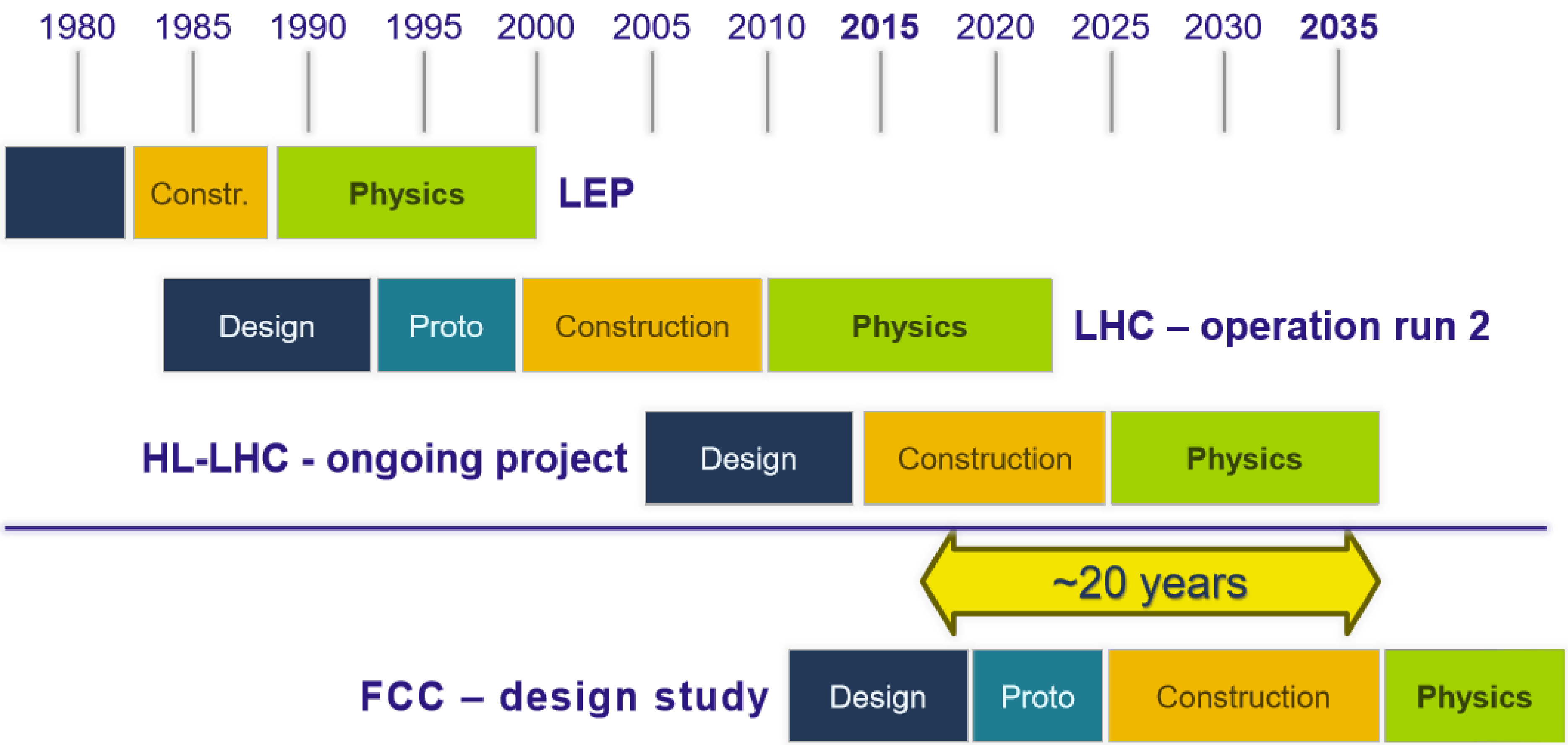
Tunnel infrastructure in Geneva area, linked to CERN accelerator complex;
site-specific, as requested by European strategy

FCC SC main magnet options and requirements



LHC	HE-LHC baseline	FCC-hh baseline	FCC-hh
27 km, 8.33 T	**27 km, 16 T**	**100 km, 16 T**	80 km, **20 T**
14 TeV (c.o.m.)	26 TeV (c.o.m.)	100 TeV (c.o.m.)	100 TeV (c.o.m.)
1300 tons NbTi	**2500 tons Nb_3Sn**	**10000 tons Nb_3Sn**	2000 tons HTS 8000 tons LTS

CERN Circular Colliders & FCC



Must advance fast now to be ready for the period 2035 – 2040

Goal of phase 1: CDR by end 2018 for next update of European Strategy

Main SC Magnet system FCC (16 T) vs LHC (8.3 T)

FCC

Bore diameter: 50 mm

Dipoles: $4578\ units, 14.3\ m\ long, 16\ T \Leftrightarrow \int Bdl{\sim}1\ MTm$

Stored energy ~ 200 GJ (GigaJoule) ~44 MJ/unit

Quads: $762\ magnets,\ \ 6.6\ m\ long, 375\ T/m$

LHC

Bore diameter: 56 mm

Dipoles: $1232\ units, 14.3\ m\ long, 8.3\ T \Leftrightarrow \int Bdl{\sim}0.15\ MTm$

Stored energy ~ 9 GJ (GigaJoule) ~7 MJ/unit

Quads: $392\ units,\ \ 3.15\ m\ long, 233\ T/m$

HTS coating for beam screen

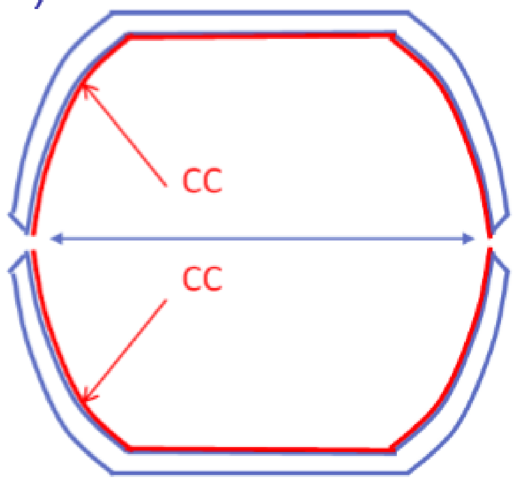
Goals: lower FCC-hh beam impedance for stability, while allowing higher beam-screen temperature for efficency

Candidate materials:

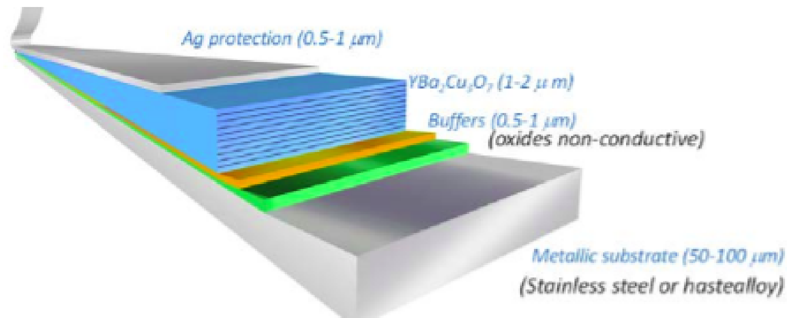
Tl-1223 (promising performance, opens up >100 K temperature window, scalable coating, R&D with CNR-SPIN and TU-Vienna)

YBCO (proven performance, requires forming technology, R&D with ICMAB-ALBA-IFAE)

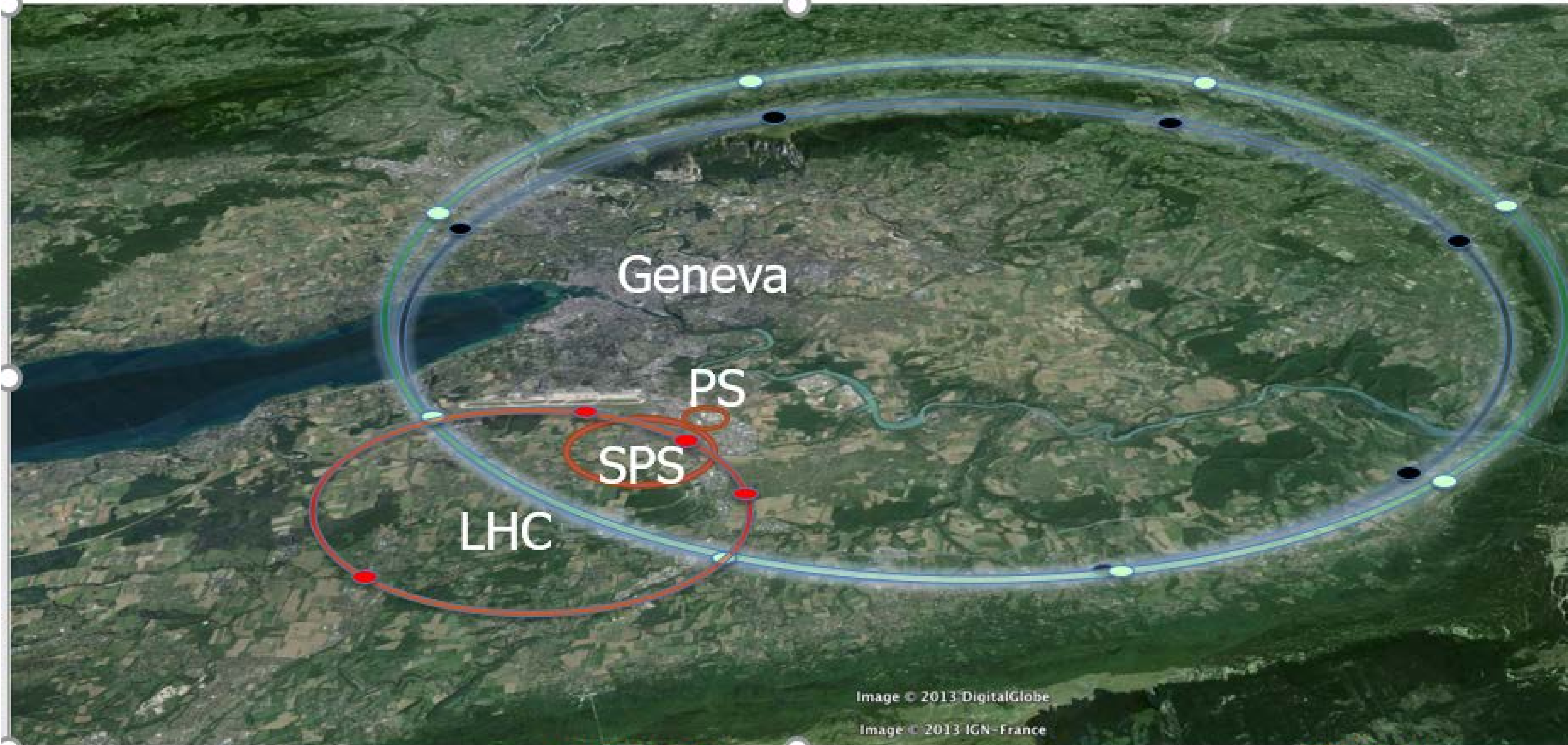
HTS can have surface resistance lower than Cu at T< 77 K and f < 10 GHz



CC: coated conductor



Beyond the LHC: the FCC's



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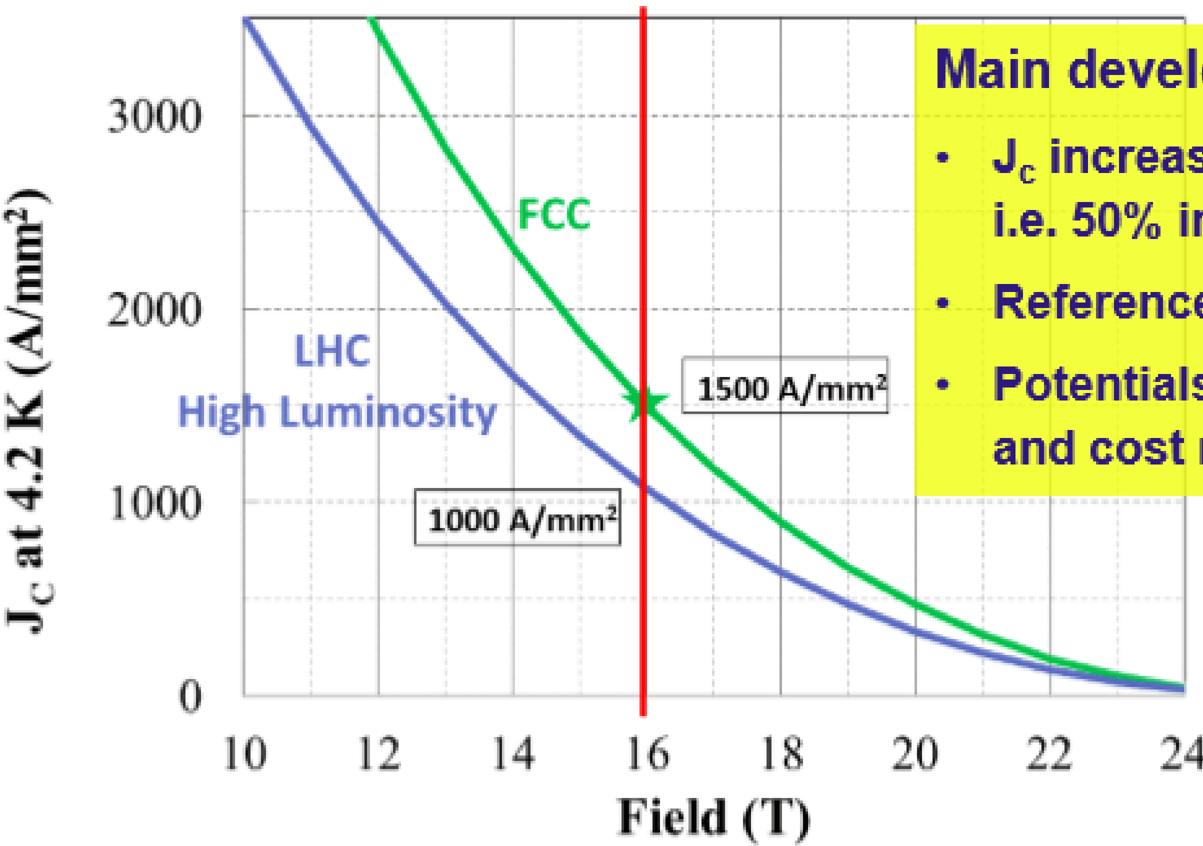
1300 tons NbTi	3000 tons LTS	9000 tons LTS	6000 tons Nb_3Sn
0.2 tons HTS	700 tons HTS	2000 tons HTS	3000 tons Nb-Ti

Nb_3Sn conductor program

Nb_3Sn is one of the major cost & performance factors for FCC-hh and must be given highest attention



Main development goals until 2020:

- J_c increase (16T, 4.2K) > 1500 A/mm^2 i.e. 50% increase wrt HL-LHC wire
- Reference wire diameter 1 mm
- Potentials for large scale production and cost reduction