WAMSDO presentation

"NbTi and Nb_3Sn PIT strands for accelerators"

Manfred Thoener

European Advanced Superconductors GmbH & Co. KG

 # Fine and very fine NbTi filament conductors

 # PIT Nb_3Sn conductors

 # Keystone cables and cabling

NbTi – fine filaments

about 30000 km of inner dipole strands with 7µm (double stack technique) have been produced in the last 10 years

more than 2000 keystone cables (460m each) have been produced for the inner dipole magnets of LHC

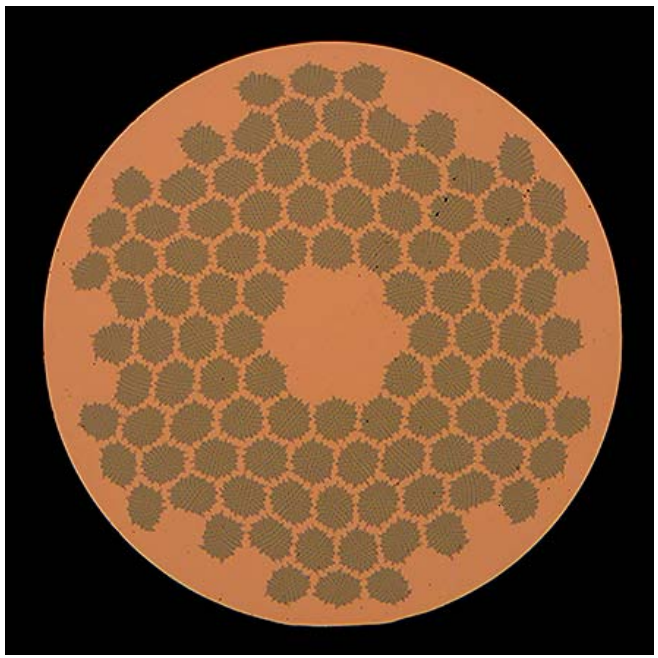
about 13000 km of matching quadrupole strand with 6µm (single stack technique) have been produced in the last 7 years

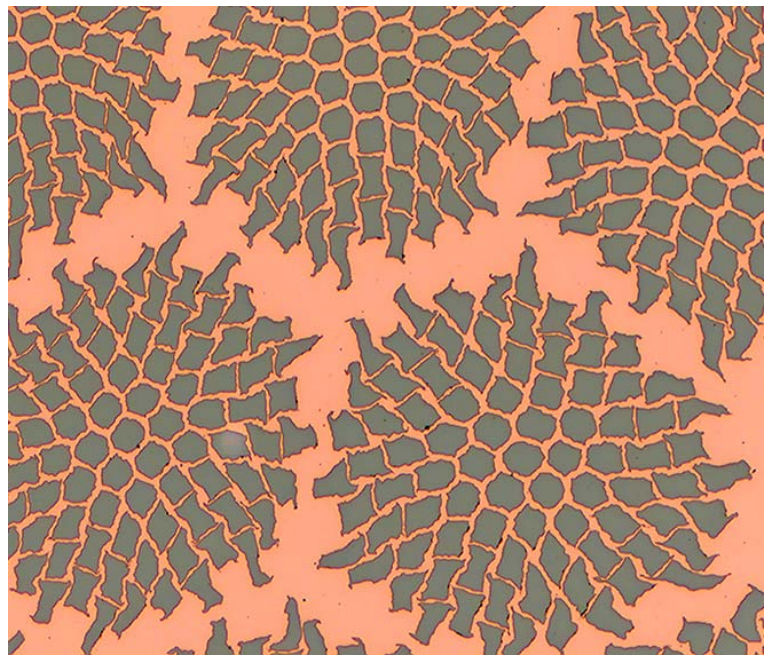
about 600 keystone cables (530m - 760m each) have been produced for the matching quadrupole magnets of LHC

NbTi – LHC

7 µm filaments conductor for the inner dipoles of LHC

- cross-section and filament array -

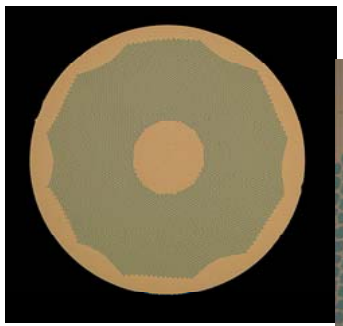


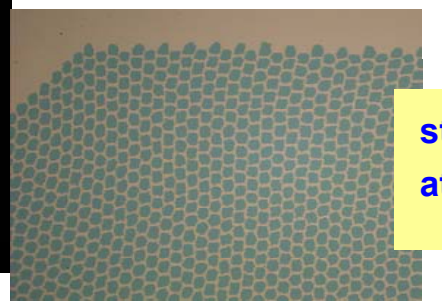


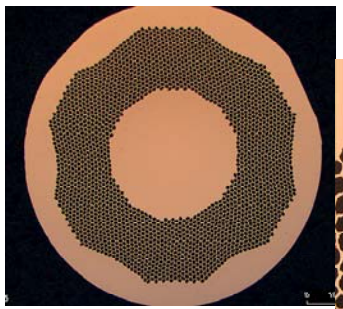
Strand with 102 x 85 (8670) filaments of 7µm each

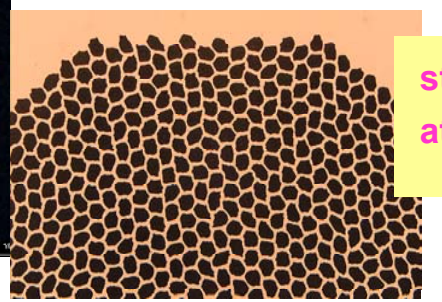
NbTi - LHC

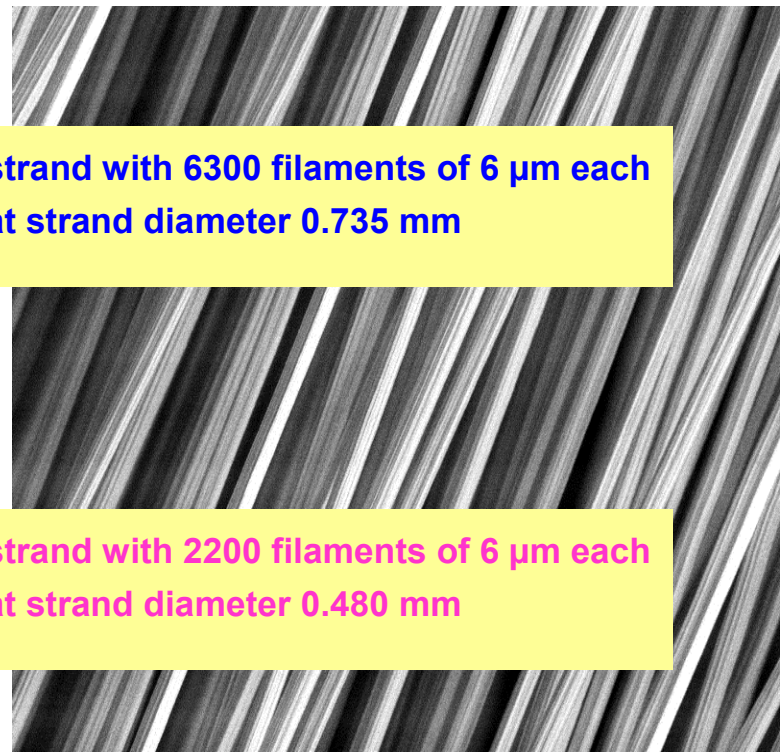
6 µm filaments conductor for the matching quadrupoles of LHC
- cross-section, filament array, filament quality -











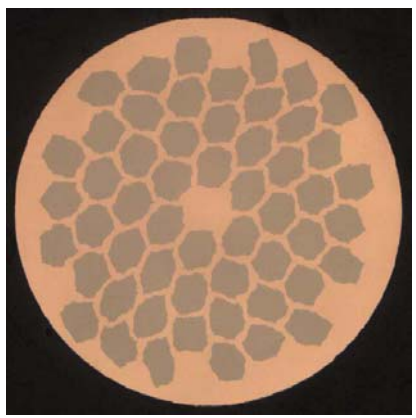
strand with 6300 filaments of 6 µm each
at strand diameter 0.735 mm

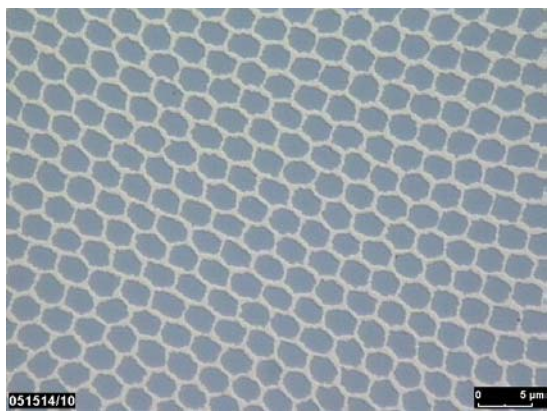
strand with 2200 filaments of 6 µm each
at strand diameter 0.480 mm

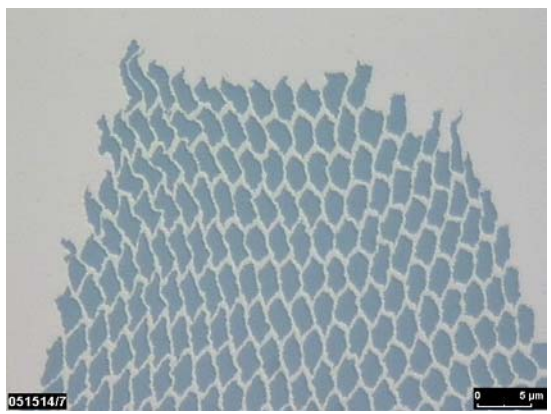
NbTi – very fine filaments

several conductors with 2.5µm filaments in CuMn matrix with 2300 A/mm^2 (5T- 4.2K) have been produced 1990 - 1992 for HEB (SSC) e.g.

42174 filaments (54 x 781) of 2.1µm each
Ø 0.685mm, Cu/CuMn:NbTi = 1.5, Twist 4.7mm



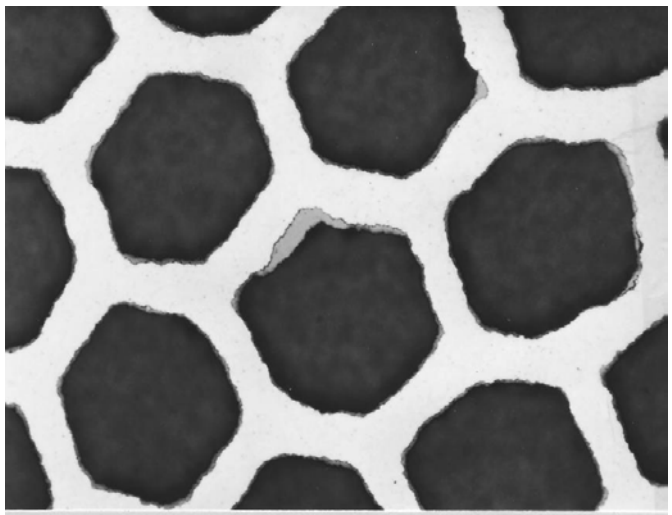


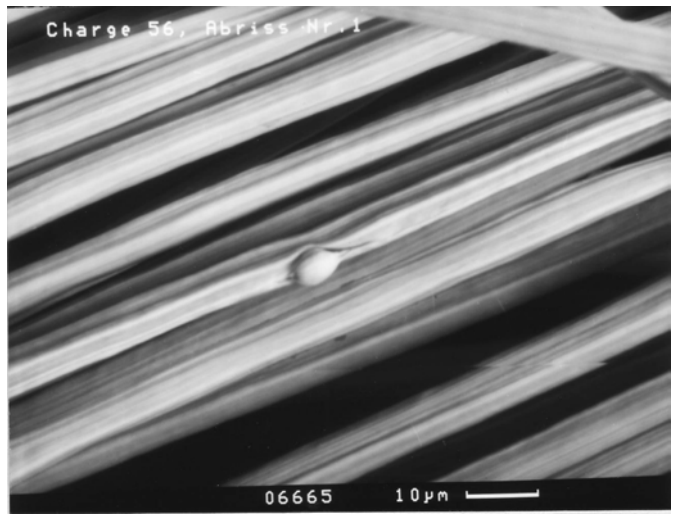


NbTi – very fine filaments

42174 filaments (54 x 781) of 2.1µm each
Ø 0.685mm, Cu/CuMn:NbTi = 1.5, Twist 4.7mm

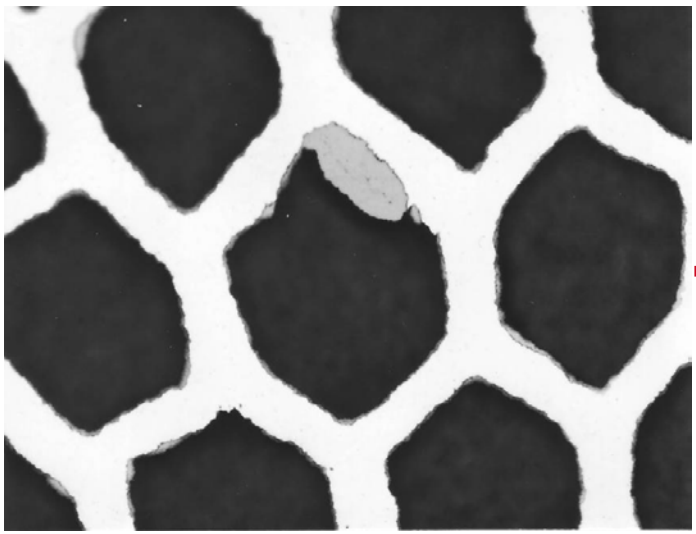
many wire breakages have occurred due to unsuited Nb barrier technique at that time e.g.



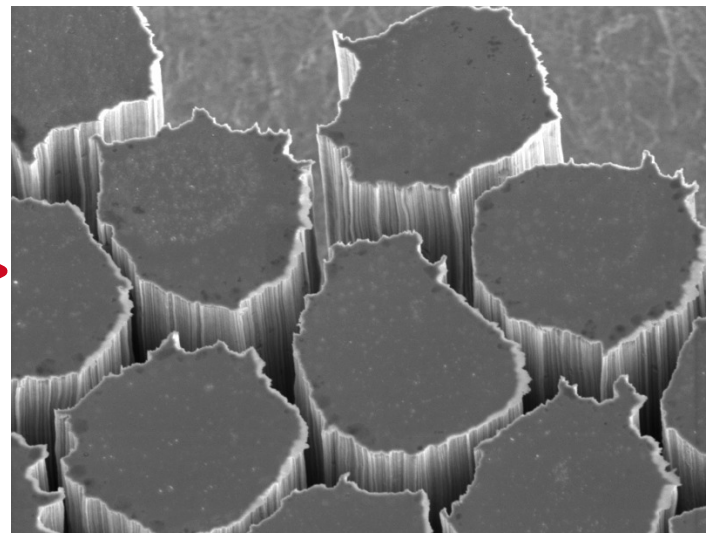


NbTi – very fine filaments

optimized Nb barrier techniques have been established within the LHC project e.g.



local Nb barrier defect
leading to wire breakages

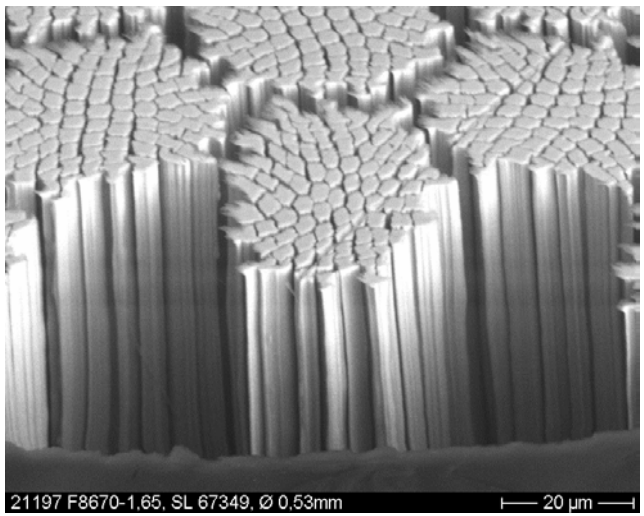


defect free Nb barriers
leading to long length production

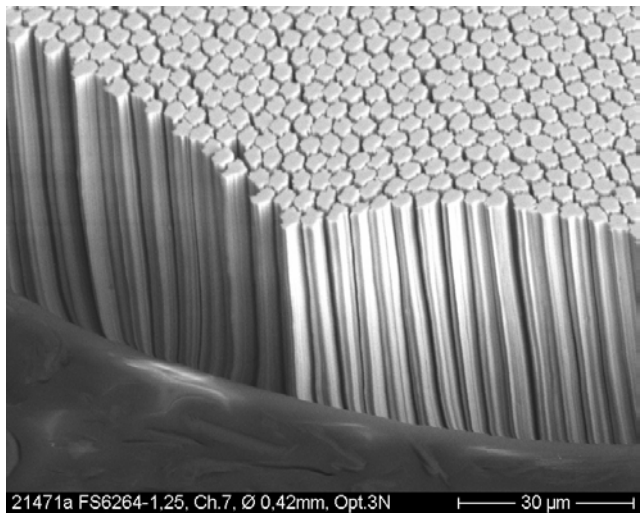
NbTi – very fine filaments

different conductor samples with 3.5µm filaments in Cu matrix with 2800 A/mm^2 (5T- 4.2K) have been produced 2003 - 2005 for FAIR (GSI) e.g.

double stack



single stack



numerous measurements and calculations have been performed

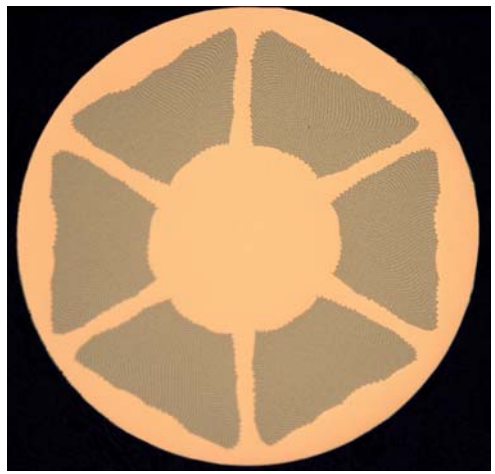
NbTi – very fine filaments

different conductor lengths with 4.3-4.5µm filaments in Cu matrix with 2700-2800 A/mm^2 (5T- 4.2K) have been produced in 2005 and delivered to GSI for SIS 100 and SIS 300 e.g.

SIS 100

Ø 0.5mm – Øfil ≈ 4.3µm
14km with Cu:NbTi ≈ 1.25
30km with Cu:NbTi ≈ 1.40

SIS 300



Ø 0.825mm – Øfil ≈ 4.5µm
SnAg5 coated (0.5µm)
19km with Cu:NbTi ≈ 1.85µm

NbTi – very fine filaments

no funding for development of conductors with < 2.5µm filaments in CuMn matrix has been available since 1992

conductor design optimization with 2.0µm filaments in CuMn matrix have been performed 2007 for the DISCORAP INFN experiment

billet production needed to verify and to proof the conductor design on industrial scale

Nb_3Sn – PIT status

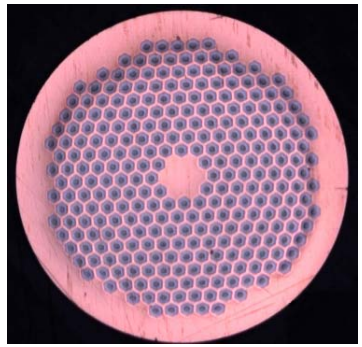
upscaled powder production has been installed in Hanau

industrial powder production in Hanau has started

PIT billets with these powders are under production

dedicated drawing bench installed and put into operation

Nb_3Sn – PIT status



NED /Care PIT design:

  Ø 1.25mm with 288 filaments of ≈50µm each

samples of billet B207 and B215 have been delivered in the last years

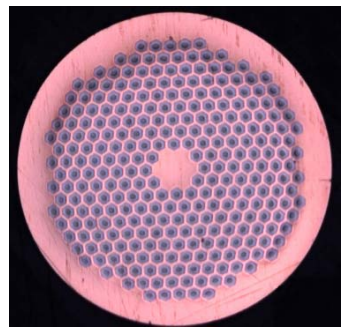
B215 has been cabled last year at LBNL

1000m of billet B228 has been delivered in April, 2008

120kg are under production at the moment

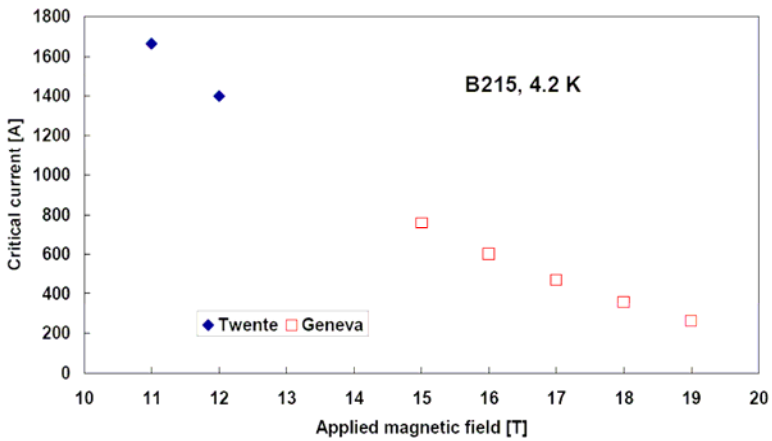
Nb_3Sn – PIT status

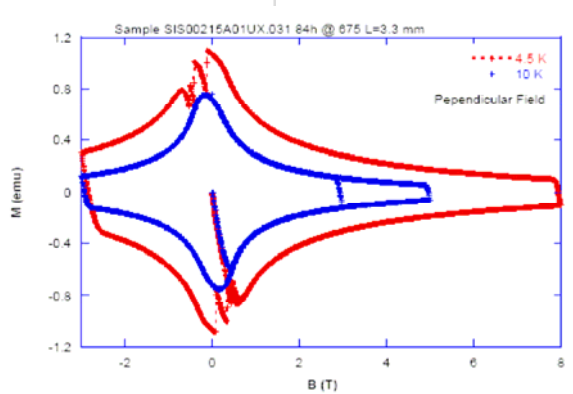
NED /Care PIT - many measurements and investigations have been published on B207 and B215 already e.g. EUCAS 2007



Nb_3Sn conductor development and characterization for NED+

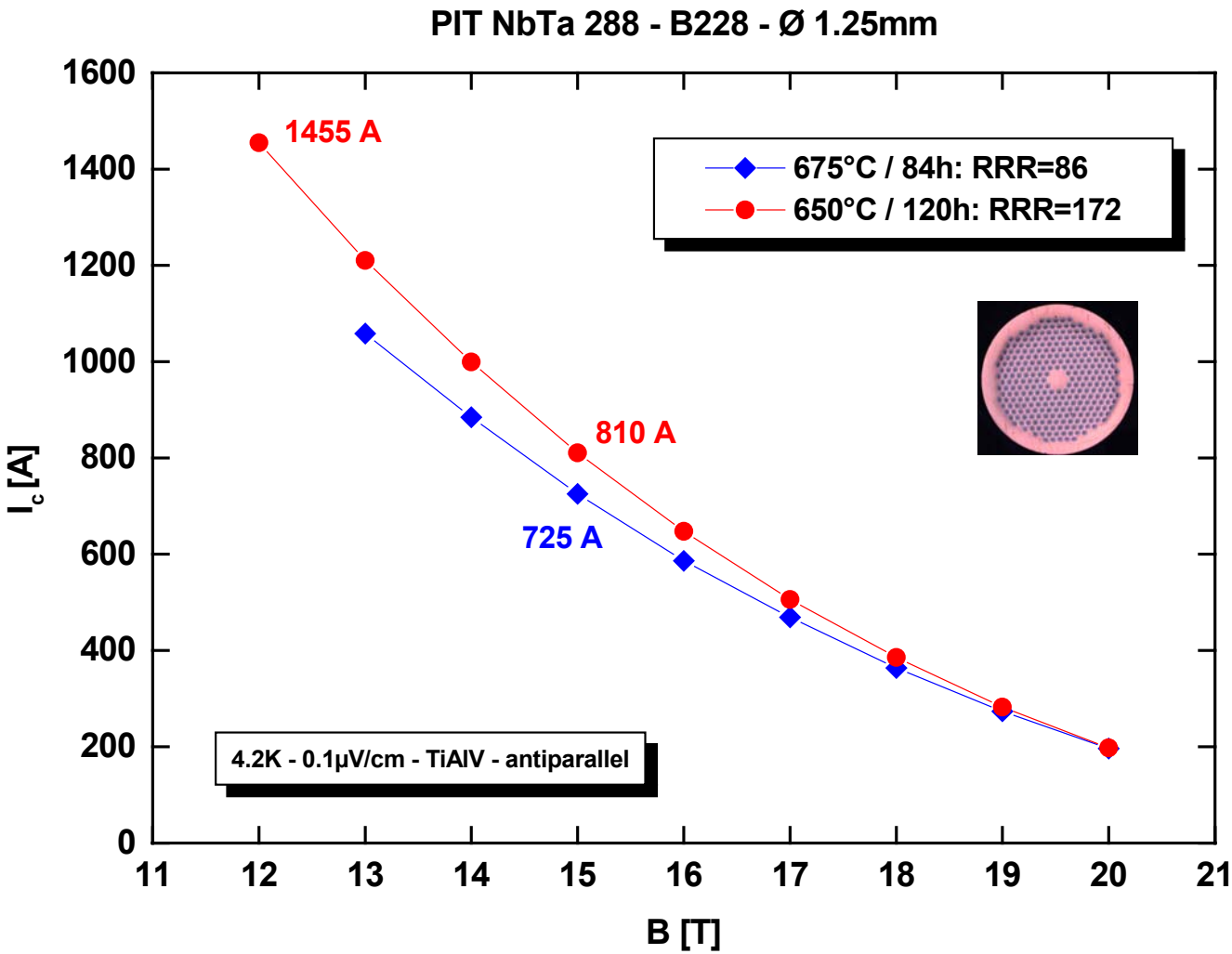
T Boutboul[1], A den Ouden[2], A Devred[1,3], P Fabbricatore[4], M Greco[4], D Leroy[1], L Oberli[1], D Pedrini[5] and G Volpini[5]





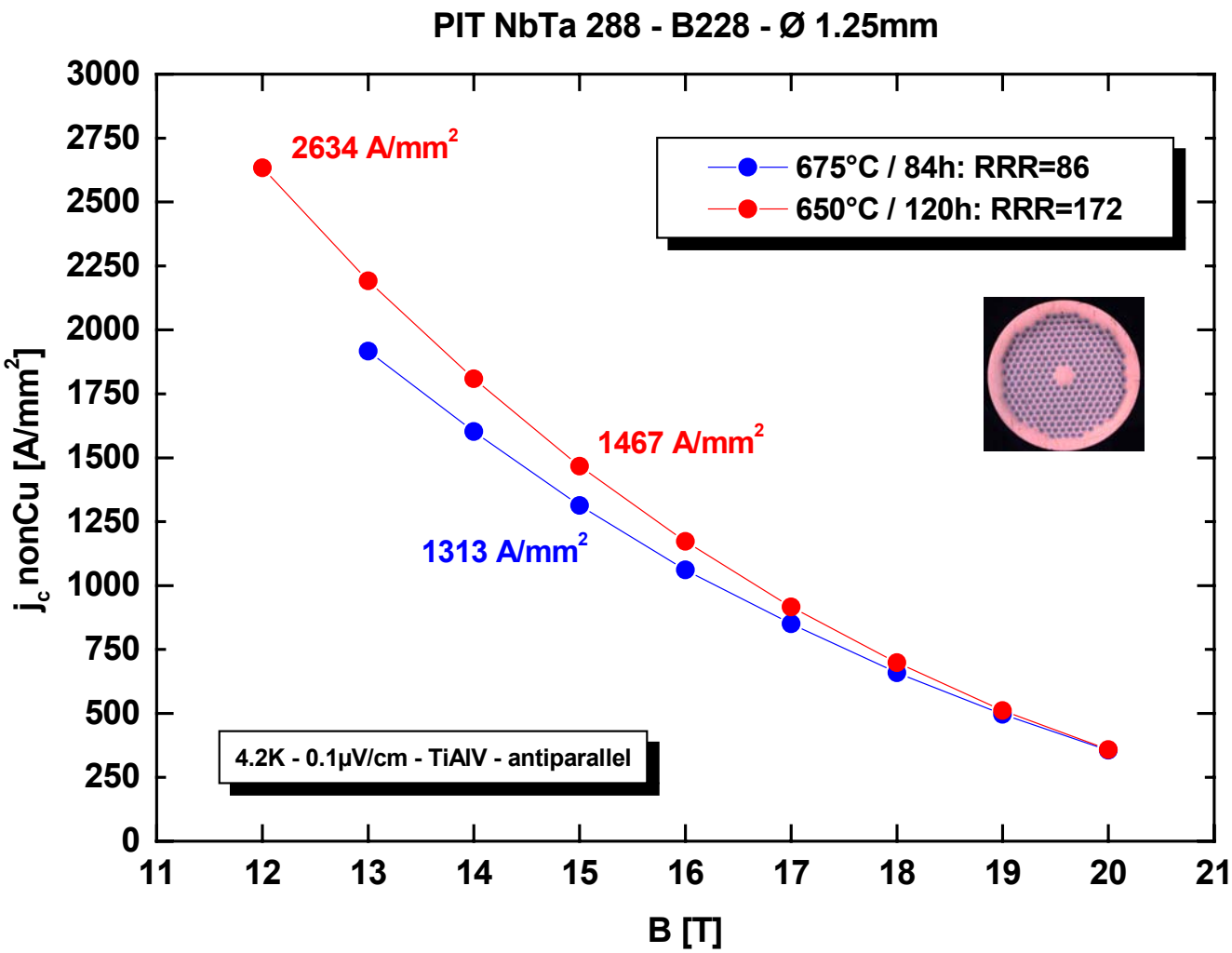
Wire	Wire dia. [mm]	SE dia. [µm]	Cu/non-Cu	RRR	I_c, 4.2 K, 12 T[A]	I_c, 4.2 K, 15 T[A]	$J_c^{non\text{-}Cu}$, 4.2 K, 12 T [A/mm^2]
B207	1.255	53	0.96	250	1315	708	2084
B215	1.257	50	1.22	84	1397	756	2499

Nb_3Sn – PIT I_c



15.05.2008
M. Thoener

Nb_3Sn – PIT j_{cnonCu}



15.05.2008
M. Thoener

Keystone cables and cabling

- # cabling of keystone cables without core is an established process and has been proven within the LHC project on several cabling machines on industrial scale
- # cabling of keystone cables with core has to be proven and optimized for industrial production (e.g. the shape stability of the cable after retwisting for flushing the mineral oil)
- # fine tuning of the cabling tools and cabling parameters has to be performed with original superconducting strand material
- # several billets will be needed to optimize these parameters
- # EAS is in discussion with several potential partners for cabling

Acknowledgement

"I like to thank you for your kind attention"

Manfred Thoener