Moscow aviation institute
(national research university)
Department of electrical machines and power electronics

Modeling and experimental research of machine with annular HTS winding

K Kovalev
N Ivanov
V Podguzov
S Zanegin

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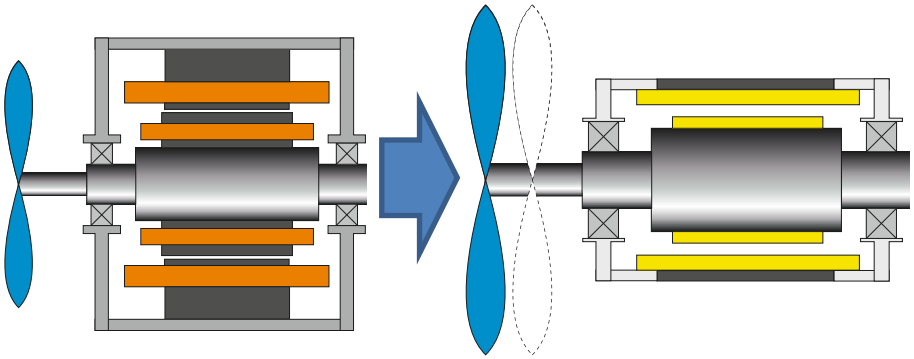
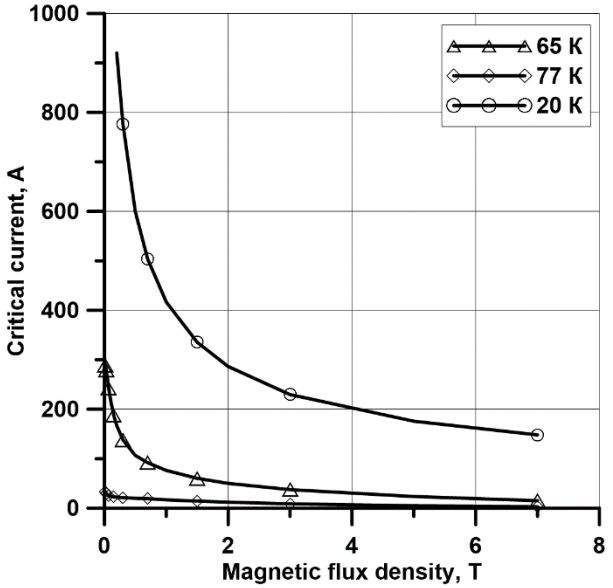
Experience in the field of HTS machines

Increasing of specific and volume power is possible with application of HTS field and armature windings in electrical machines.



Conventional machine Fully HTS machine

Field dependency of critical current does not allow to obtain high magnetic fields for 77 K. Decreasing of the temperature could solve this problem. The most perspective way is to go to 20 K.

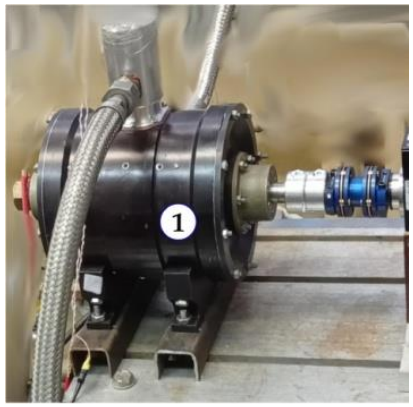


Field dependency of critical current for SuperOx tape

Recent developed machines

We have already developed several experimental devices in recent years. It gave us opportunity to clarify our analytical techniques which could be used for further calculations. Today we are ready to go to the high power.

Fully HTS machine



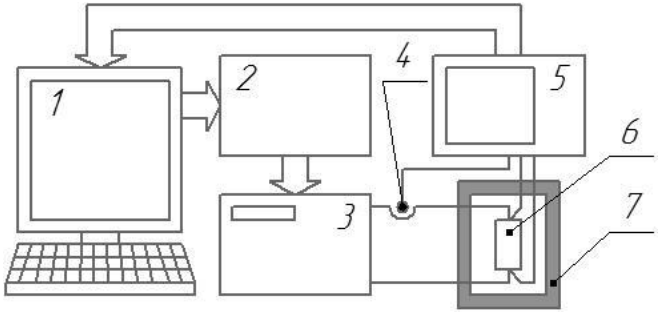
Machine with PM and HTS winding

Parameters of 10 kW prototype	
Parameter	**Value**
Nominal output power, kW	10
Rotational speed	2500
Field winding current, A	40
Armature winding current, A	20
Armature winding type	Teeth-coils
Operating temperature, K	77
Electrical frequency, Hz	125

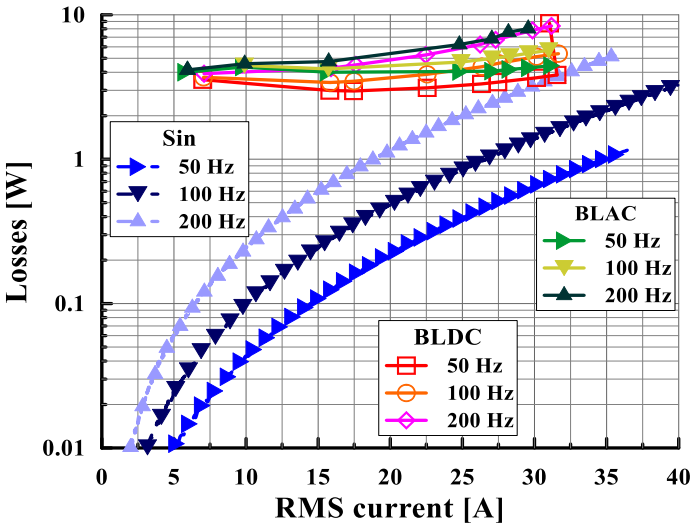
Parameters of 10 kW prototype	
Parameter	**Value**
Nominal output power, kW	10
Rotational speed	2500
Field winding current, A	40
Armature winding current, A	20
Armature winding type	Annular
Operating temperature, K	77
Electrical frequency, Hz	125

AC losses studies

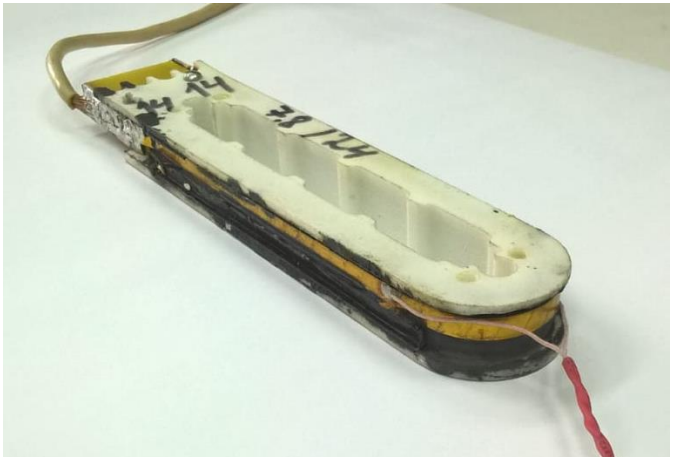
Experimental ant theoretical investigation on AC losses were done during projects. These include data about losses for supply currents with different amplitudes, frequencies and waveforms.



1 – PC, 2 – extension socket, 3 – Current source, 4 – current sensor, 5- scopecorder YOKOGAWA, 6 – coil, 7 – cryostat.
Test bench for experimental research of HTS coils



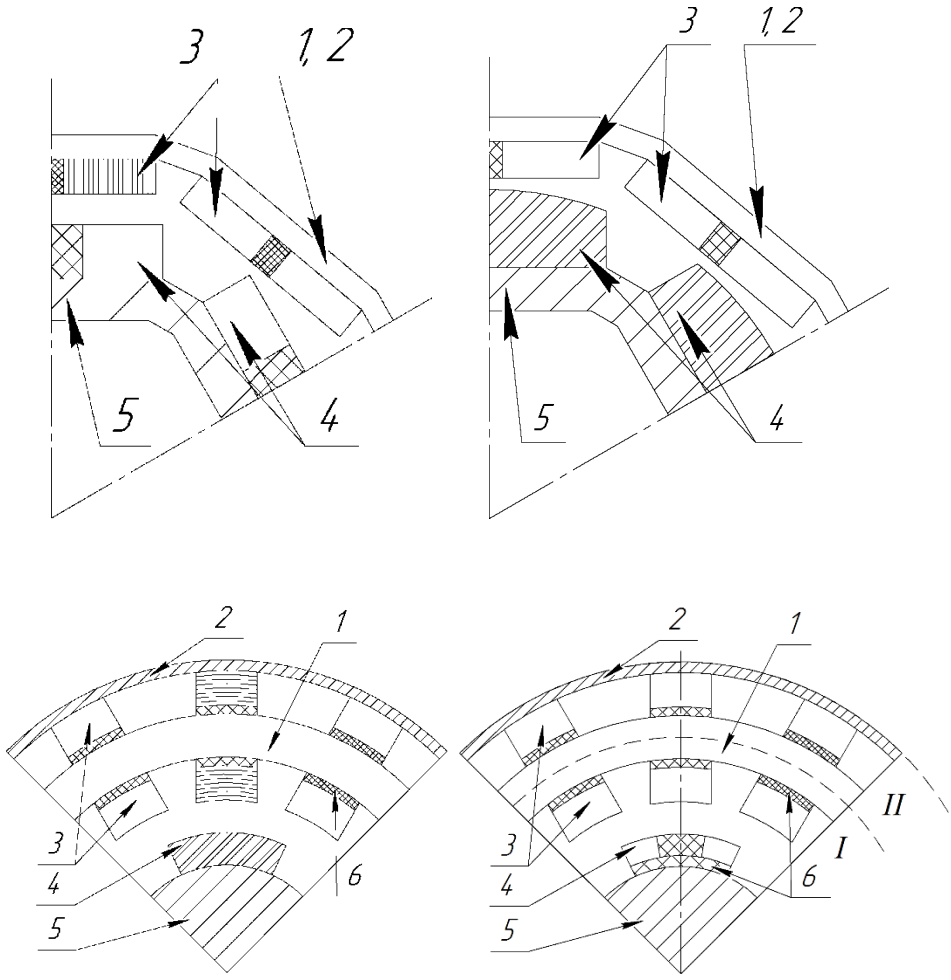
AC losses dependencies



Small-scale experimental prototype of the HTS coil

Possible schemes of machines

№	Excitation	Armature	Magnetic circuit	Magnetic shield
1	PM	Teeth	core-less	Ferromagnetic
2	PM	Teeth	core-less	Electromagnetic
3	PM	Teeth	2 magnetic cores	No
4	PM	Teeth	Full	No
5	PM	Annular	2 magnetic cores	Ferromagnetic
6	PM	Annular	2 magnetic cores	Electromagnetic
7	PM	Annular	2 magnetic cores and teeth	Ferromagnetic
8	PM	Annular	2 magnetic cores and teeth	Electromagnetic
9	Field winding	Teeth	core-less	Ferromagnetic
10	Field winding	Teeth	core-less	Electromagnetic
11	Field winding	Teeth	2 magnetic cores	No
12	Field winding	Teeth	Full	No
13	Field winding	Annular	2 magnetic cores	Ferromagnetic
14	Field winding	Annular	2 magnetic cores	Electromagnetic



1 – stator magnetic core, 2 – magnetic shield, 3 – AC HTS winding, 4 – DC HTS winding, 5 – rotor magnetic core, 6 - support

Thank you for attention

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n.s.ivanov88@gmail.com – N. Ivanov