1MP7-20

Coated superconducting tape model based on distribution of currents between the tape layers. Computing implementation

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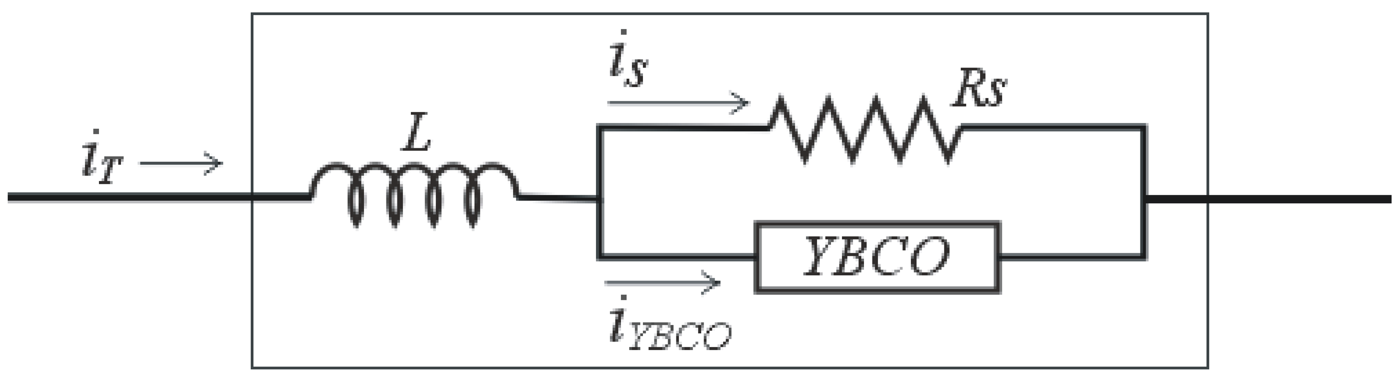
PROPOSED MODEL

Characterization based on parameters that adjust the non-linearity of the tape under two hypothesis:

a) The electrical current is distributed between the superconducting path, up to the critical current, and the resistive paths when it is exceeded.

b) The hysteresis in the superconductor can be modelled from an effective resistance in the stabilizer layer.

EQUIVALENT CIRCUIT



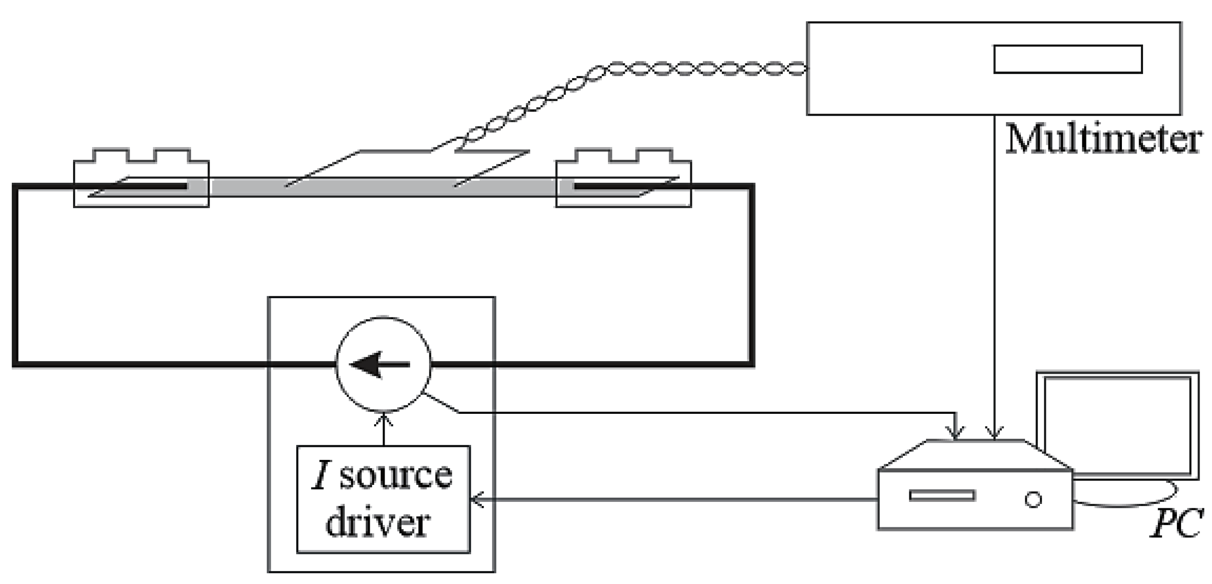
EQUATIONS OF THE MODEL

$$v_T = i_S R_S + L\frac{di_T}{dt}$$
$$i_T = i_{YBCO} + i_S \qquad (1)$$
$$i_S R_S = v_{YBCO}\left(i_{YBCO}\right)$$

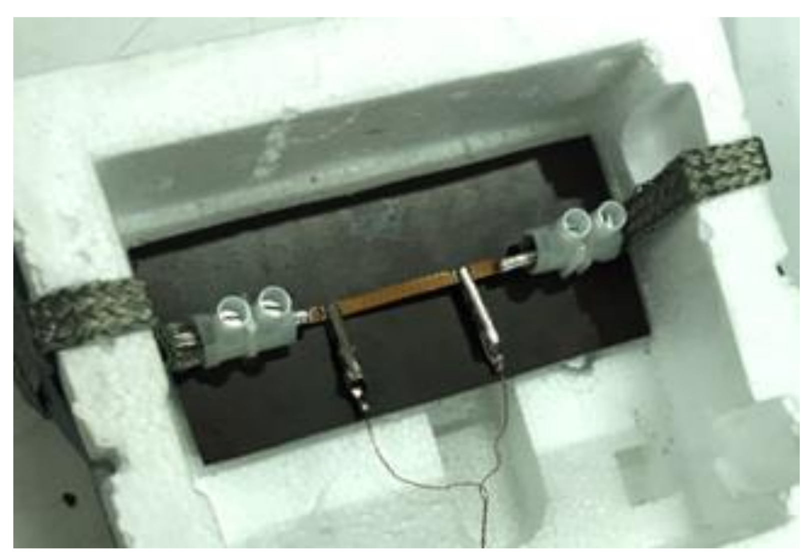
TAPE CHARACTERISTICS

Concept		Concept	
Manufacturer	SuperPower Inc.	*Critical current*	100 A @ 77 K
Type	SCS4050i-AP	*Width*	4 mm
Superconductor	YBCO	*Thickness*	208 µm
Stavilizer	Copper	*Sample length*	4 cm

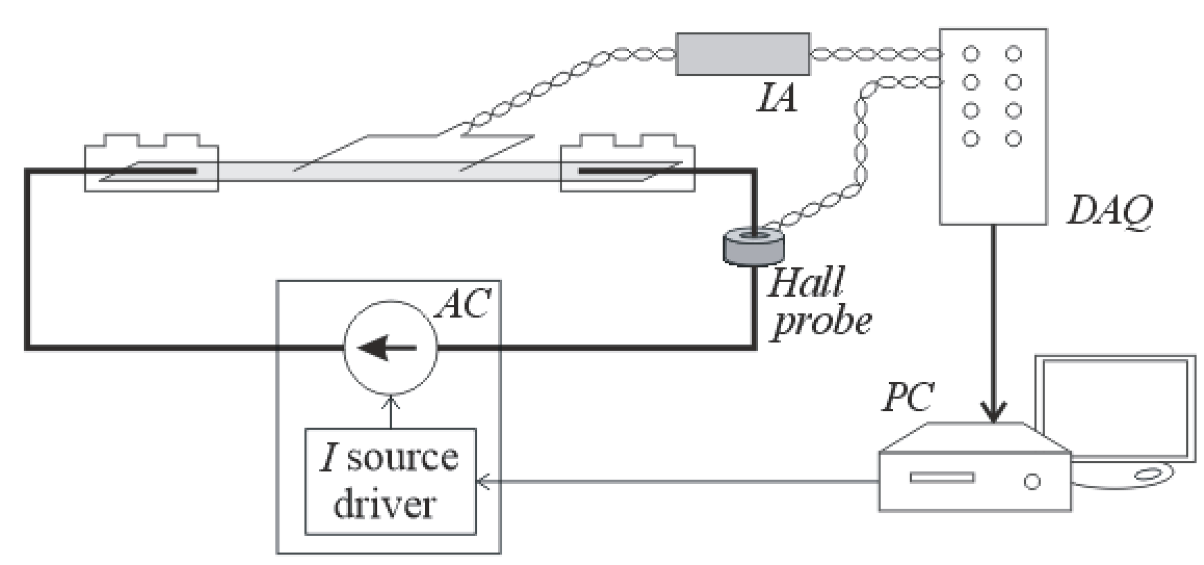
DC TEST



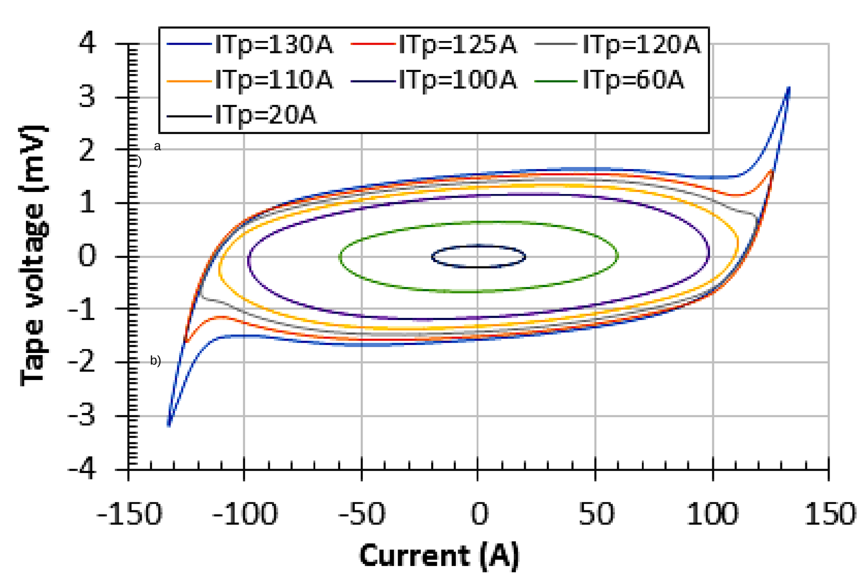
COMMON ARRANGEMENTS

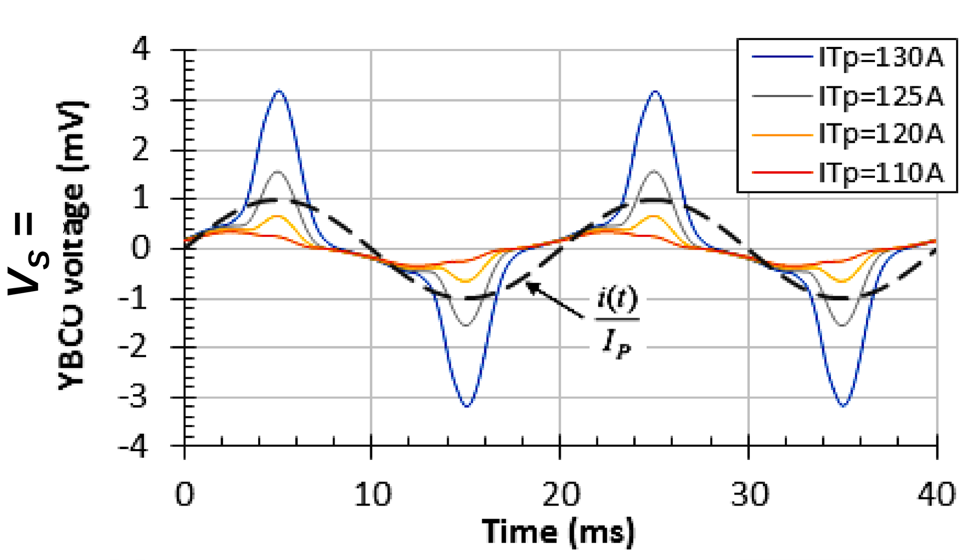


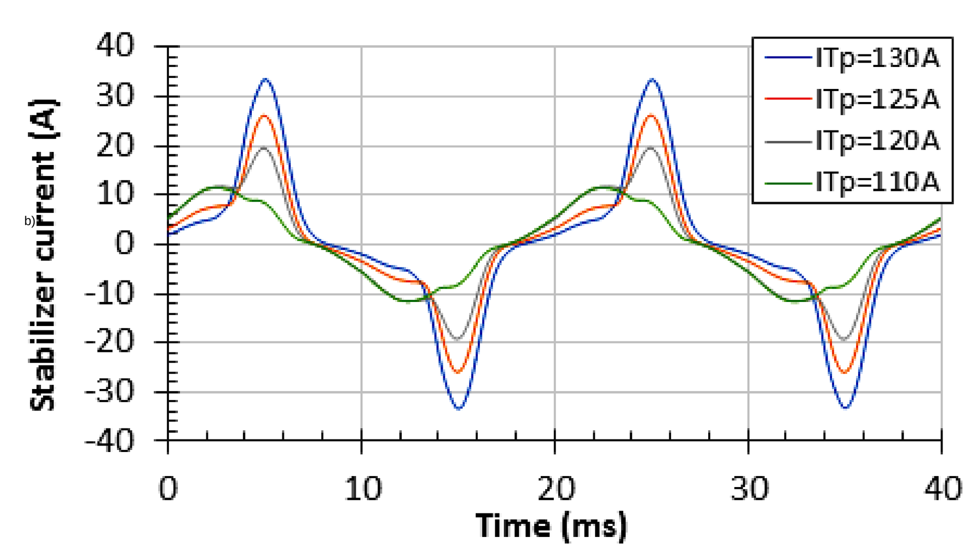
AC TEST

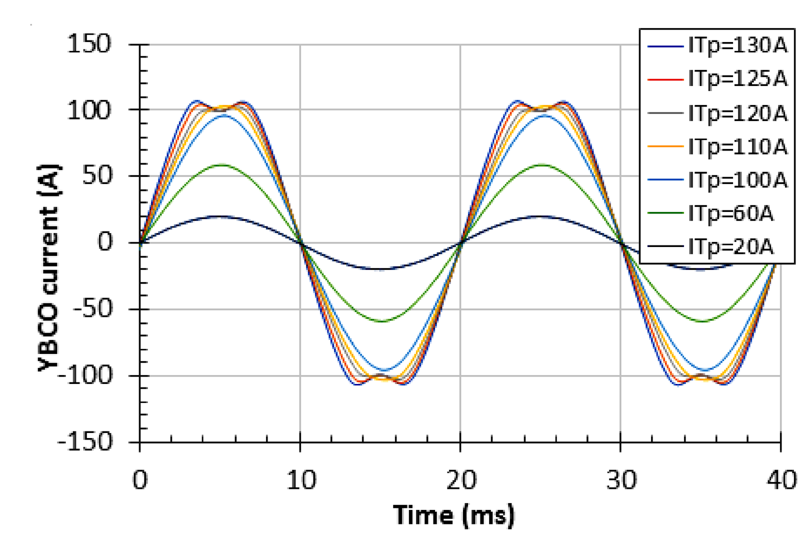


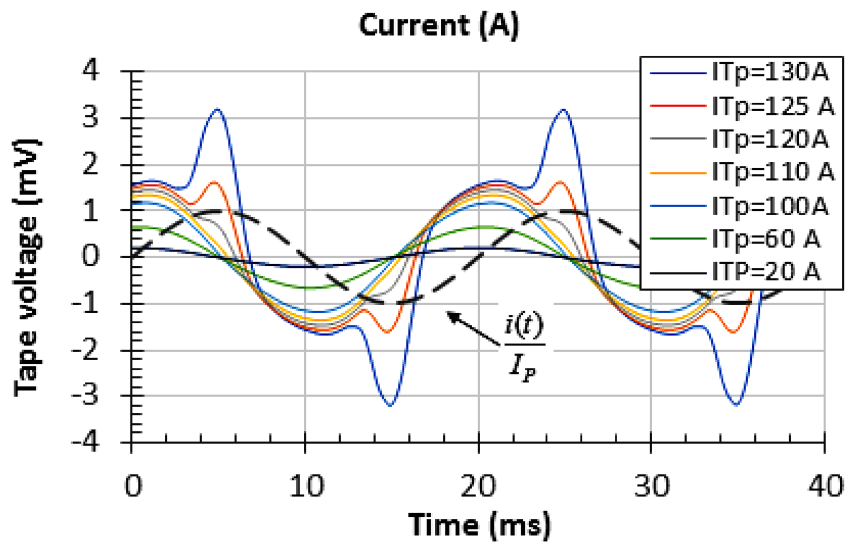
RESULTS AND DISCUSSION

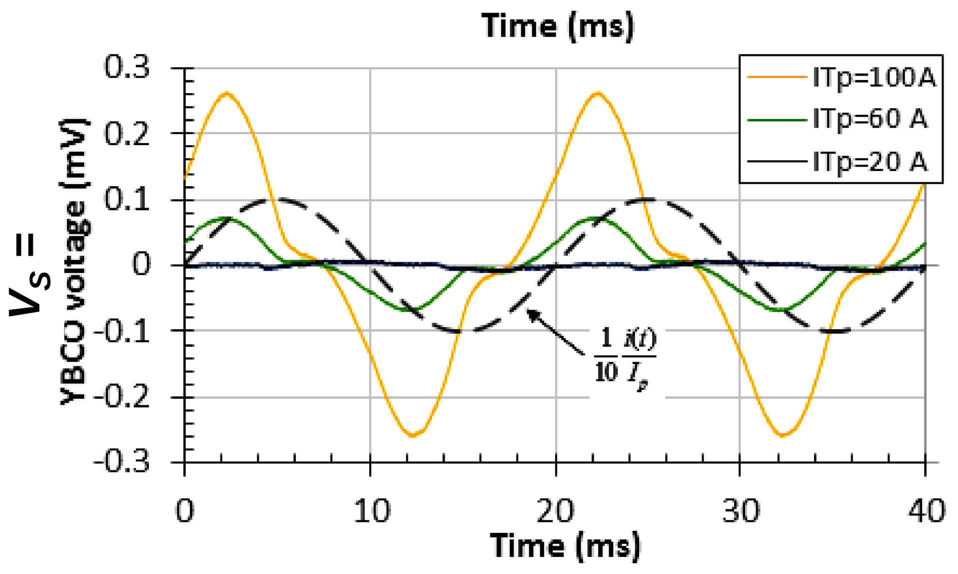


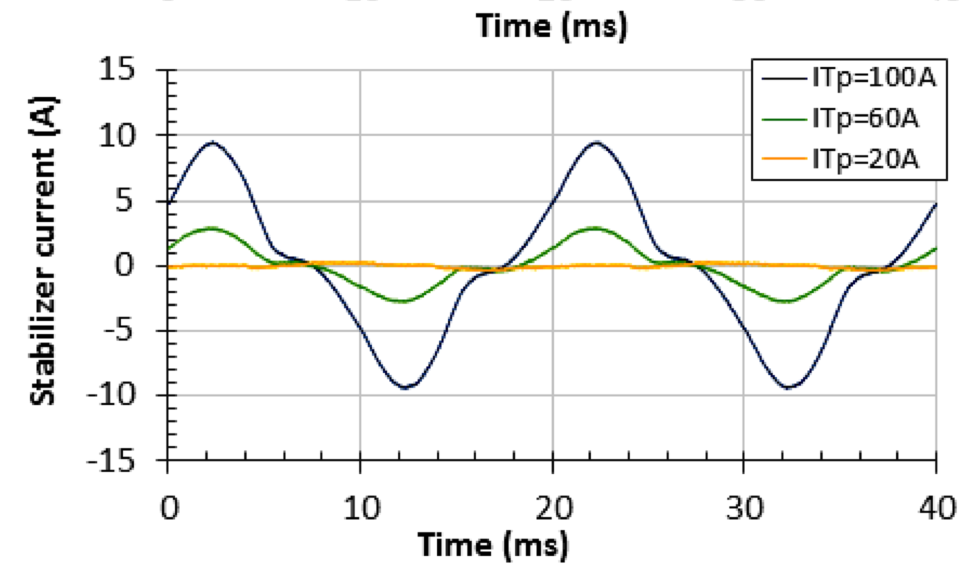












In the YBCO layer, the sinusoidal current in the tape is somehow limited at the critical current value.

The rest of the tape current goes through stabilizer

An inductive drop voltage is subtracted from the tape voltage to get the voltage in the resistive layer and YBCO layer.

$$L = \frac{1}{2\pi f}\frac{V_{Tp}}{I_{Tp}} \quad \text{for } I_{Tp} << I_c$$

The resulting voltage waveform is equal to the current waveform in the stabilizer, so, this only appears significantly when

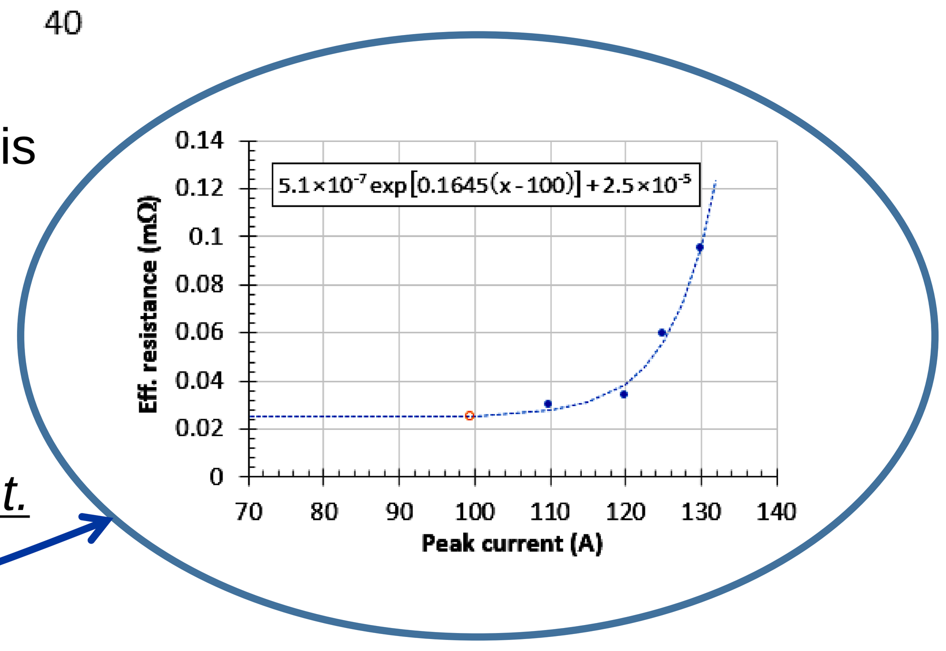
$$i_T > I_c\ .$$

Otherwise, V_{YBCO} only depends on the superconductor and I_S appears just to balance the voltages.

The effective stabilizer resistance is evaluated as:

$$R_S = \frac{V_S}{I_{Tp} - I_c}\ ,$$

and it *depends on the tape current.*



BASIC COMPUTING IMPLEMENTATION (First approaching to the model)