2nd Sound as tool for quench detection in superconducting cavities

- Superconducting cavities
- Detection of 2nd Sound
- Setup of measurement
- Evaluation program
- >Summary





Superconducting cavities



- > Accelerate electrons, used at FLASH (European XFEL, ILC)
- Made out of Niobium, operate at 2 K

Main Linac

TIMITICA CONTRACTOR

- Length of ~1.3 meters
- Radio frequency (1.3 GHz)



Main Linac

31 km



Standing wave (through power coupler)

> Quality Factor:

$$Q_0 = \frac{\omega U}{P_{diss}} = \frac{\omega}{\Delta \omega} \approx 10^{10}$$

 > Quench: Cavity becomes normal conducting at one spot (due to critical field)
→generates heat pulse



Happens at defect (detection could improve cavity)

Detection of 2nd Sound

- Helium below ~2 K can be described as mixture of normal (Helium I) and superfluid (Helium II, no viscosity!) liquid
- Heat transfer by wave like motion beginning at quench (velocity \sim 19.9 m/s)
- detectors: consists of plate and gold coated membrane (Helium 2 inside)
- When wave arrives: oscillation due to density difference

lipp Horn

glue

120V



Setup of measurement



- Reflected wave from power coupler provides quench time
- > Detectors give arrival time of wave
- They need direct line of sight to quench
- > Before: 8 detectors, now: 16





Old Evaluation program





New evaluation Program





Quench spot calculation





Name of file and cavity	CAV00518_79_20130625T170434.txt - Notepad						×
Quench times	Quench time(RF-Signal1) [s]: 5.2853 Quench time(RF-Signal2) [s]: 5.2246						
Quench position	Position of Quench: Rho: 102.9628 Theta: 327.3896 Z: 917.8883						
Used Detectors + positions, Running time, Intensity	Det. 6 7 13 16	Rho 109 101 98 109	Phi 315 38 38 315	Z 695 810 580 930	Running [s] 0.0091182 0.0065182 0.025075 0.0038747	Intensity -0.23211 -0.47005 -0.063587 -1.4127	-
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- Calculate quench spot with program
- Recorded by up to 16 detectors
- >Heat wave (2nd sound) is radiated
- These defects cause quenches (become normal conductive)
- Improving superconducting cavities by location of defects on surface

