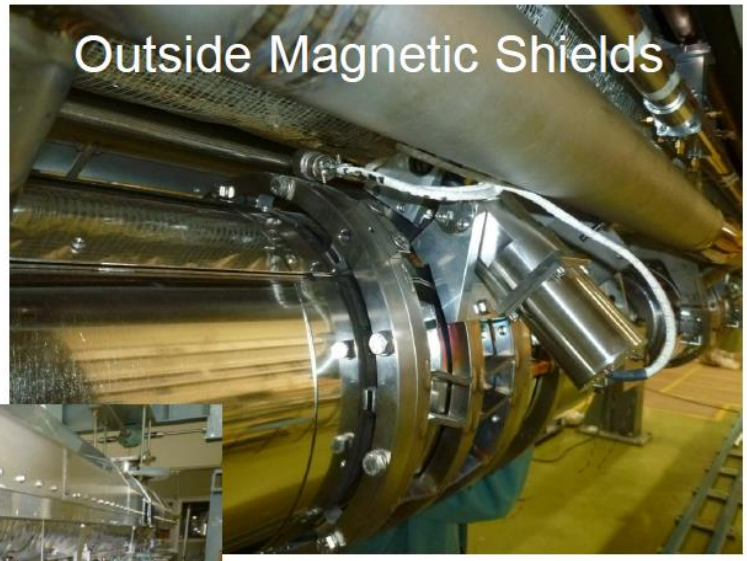
Optimizing Magnetic Shielding vs. Cryogenics

Configurations ILC (~16 000 cavités)

Installation of Magnetic Shields in S1-Global

DESY Cavities



FNAL Cavities

KEK Cavities

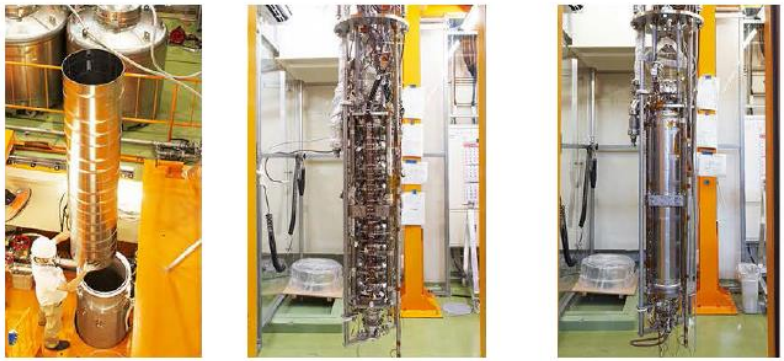
Magnetic Shields of DESY Cavities

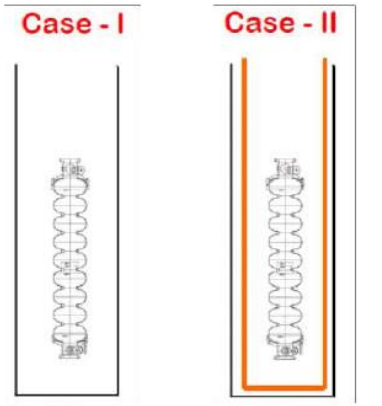
10 Components per 1 DESY Cavity

Magnetic Shields of KEK Cavities

4 Components per 1 KEK Cavity

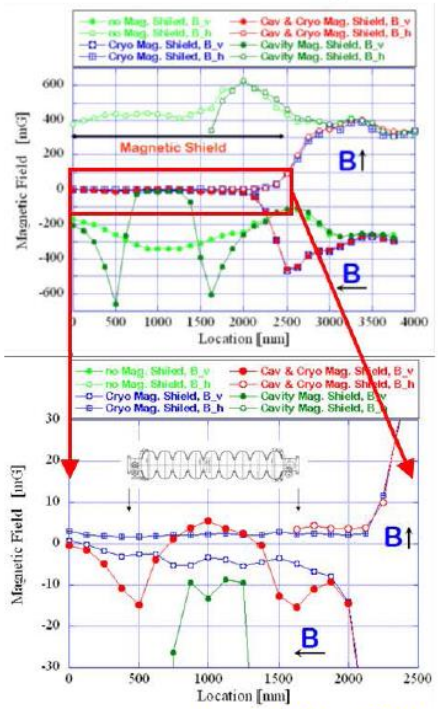
Tests of Magnetic Fields in KEK Cavity (1)





no mag. shield | Cryostat mag. shield | Cavity mag. shield | Cavity + Cryostat mag. shield

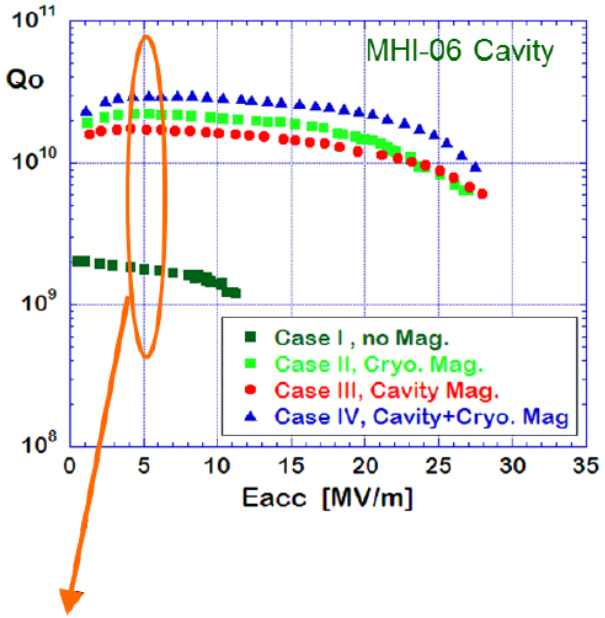
Residual magnetic field (B) inside the vertical cryostat



no mag. shield, B ~ 400 mG
with mag. shield, B < ~10 mG

cea

Tests of Magnetic Fields in KEK Cavity (2)



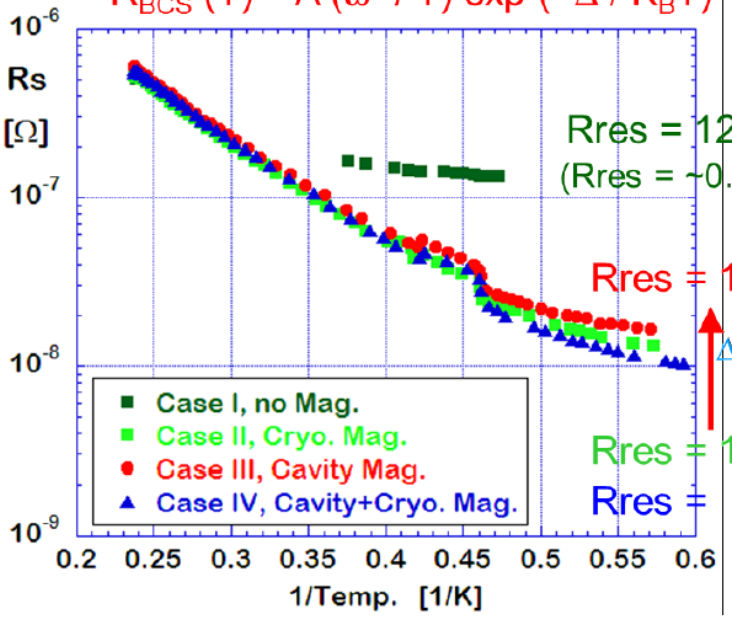
Qo at 5 MV/m (1.8 K)

Case I, Qo = 0.2 x 10^{10}
Case II, Qo = 2.2 x 10^{10}
Case III, Qo = 1.7 x 10^{10} , OK
Case IV, Qo = 3.0 x 10^{10}

Temperature Dependence of Surface Resistance (Rs)

$Rs(T) = R_{BCS}(T) + Rres$

$R_{BCS}(T) = A(\omega^2 / T) \exp(-\Delta / K_B T)$

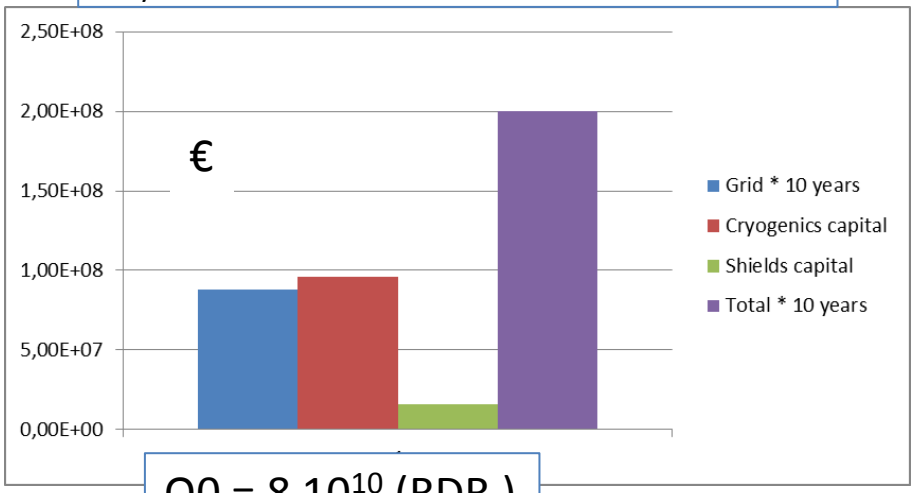


Cryonomics

If I am allowed to extrapolate the 75% increase of Q_0 shown by E. Kako with a double magnetic shielding, to ILC cavities with Eacc = 31.5 MV/m

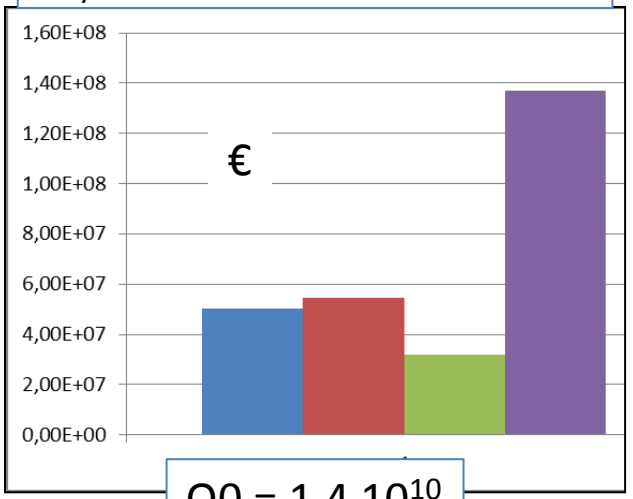
and with the assumptions: grid power = 0,15 € /kWh@300 K
CoP(2K) = 700 W/W
magnetic shield = 1000€ / cavity
cryogenics = 1 M€/100 W@2K

$P_{dyn.}$ = 9.6 kW@2K , 6.7 MW @ 300 K



Q0 = 8 10^{10} (RDR)

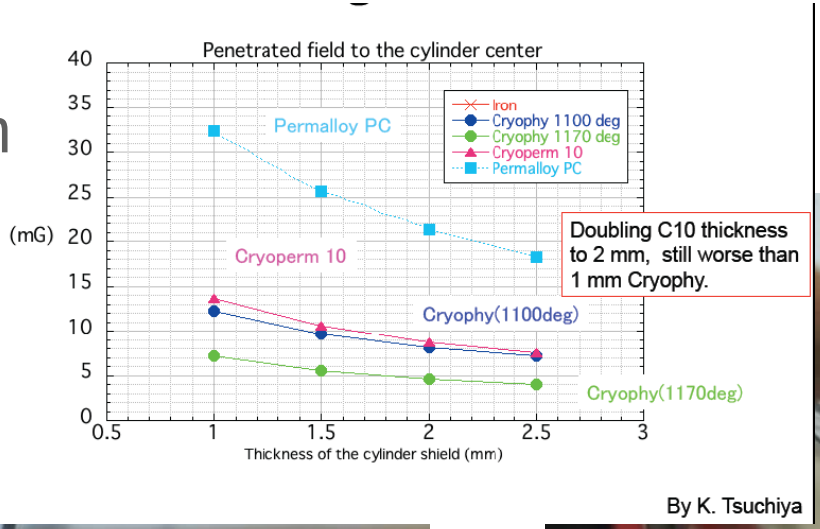
$P_{dyn.}$ = 5.5 kW@2K , 3.8 MW

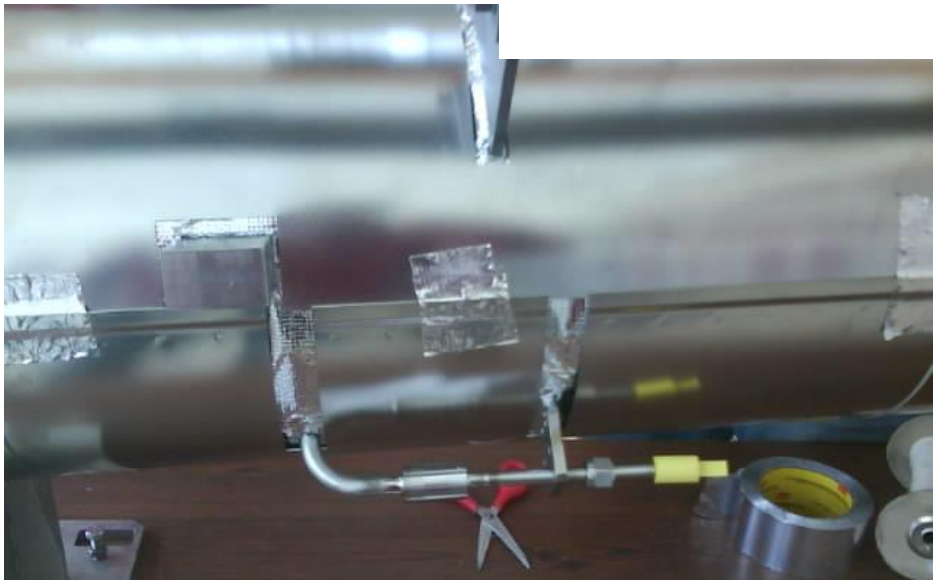


Q0 = 1.4 10^{10}

Magnetic Shielding

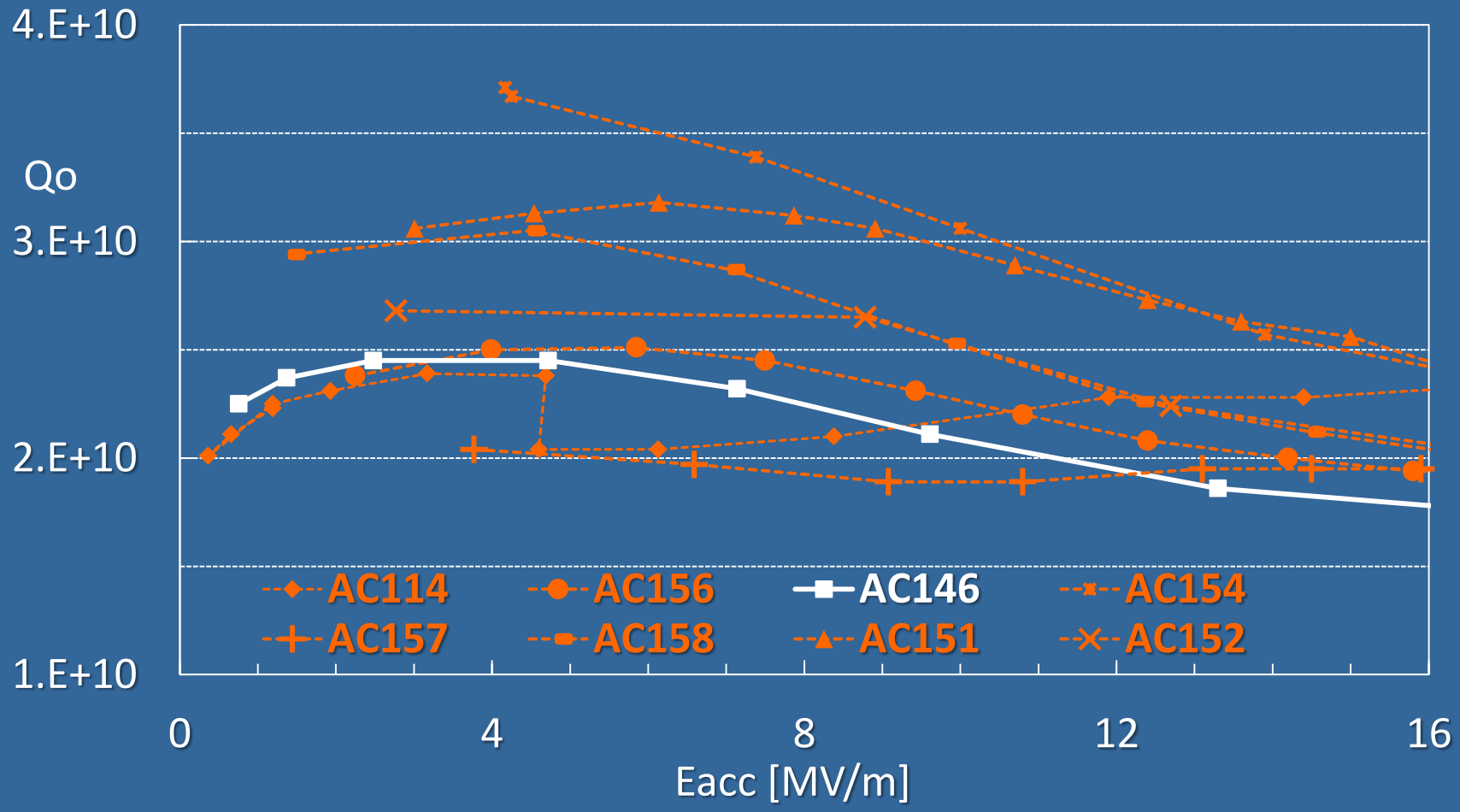
Produced by MecaMagnetic from Aperam/Cryophy 1mm sheets





Magnetic shields are qualified by the excellent dynamic cryogenic performance of XM-3

XM-3 cavities: vertical tests at 2K (7 Large Grain +1 Fine Grain cavity)



Measured dynamic heat load

Conclusion

Increasing Q0 of ILC cavities by whatever means, is GREEN

Better magnetic shielding is one possible cost efficient way.