Proposals for Collaboration between KEK and Jlab for ILC

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Cost Savings

- Material costs
  - High Ta contents niobium
  - Ingot (“large grain”) niobium
- Gradient improvement
  - LL cavity shape
  - Contamination control
- Fabrication
  - Nb bellows
  - SC joint
  - Simpler coupler designs

LL Cavity Shape

Proposal#1: Proposal for collaboration between KEK and Jlab to develop A high gradient cavity for ILC with new shape

Nov. 12, 200

Several new cavity shapes with improved features have been calculated by Sekutowicz [ILC workshop, Japan] following a proposal by K. Saito [Tech Note]. In order to have a potential impact on the final cavity design for the ILC, these shapes have to be prototyped and investigated in a very timely manner. It is proposed to divide up the task of doing this between KEK and Jlab and to share the resources and results of this investigation.

Jlab has RRR niobium on hand, which could be used to immediately start to fabricate a 5-cell niobium model, possibly a 7-cell model at a frequency of 1300 MHz. Including the design and fabrication of deep drawing dies, we estimate that within 3-4 months such a cavity (without endgroups) could be completed. Afterwards the cavity could be electropolished at KEK and either tested at KEK or send back to Jlab for testing. It is conceivable that initial test results would be available late in spring of 2005, if the work would start immediately.The objectives of this effort would be to demonstrate that gradients in excess of 40 MV/m are achievable in a structure with favorable H_p / E_{acc} ratio. There is no effort made for this proposal to demonstrate appropriate damping of the HOM's.

LL Cavity(2):Status

- Electromagnetic design complete

  J. Sekutowicz (DESY), K.Ko et al (SLAC),

- Mechanical design checked out

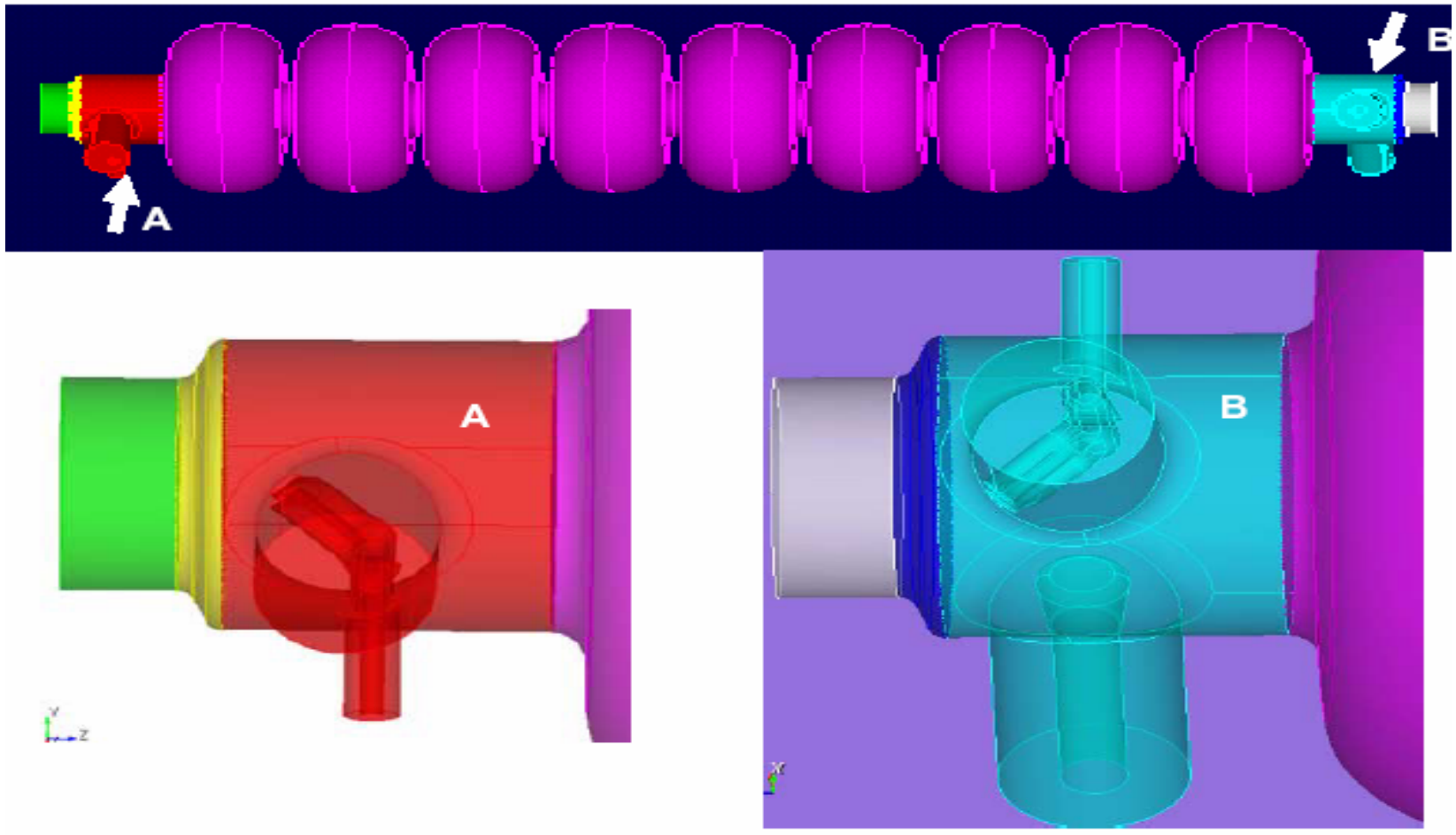
  N.Solyak et al (FNAL)

- Multipacting initial calculations done

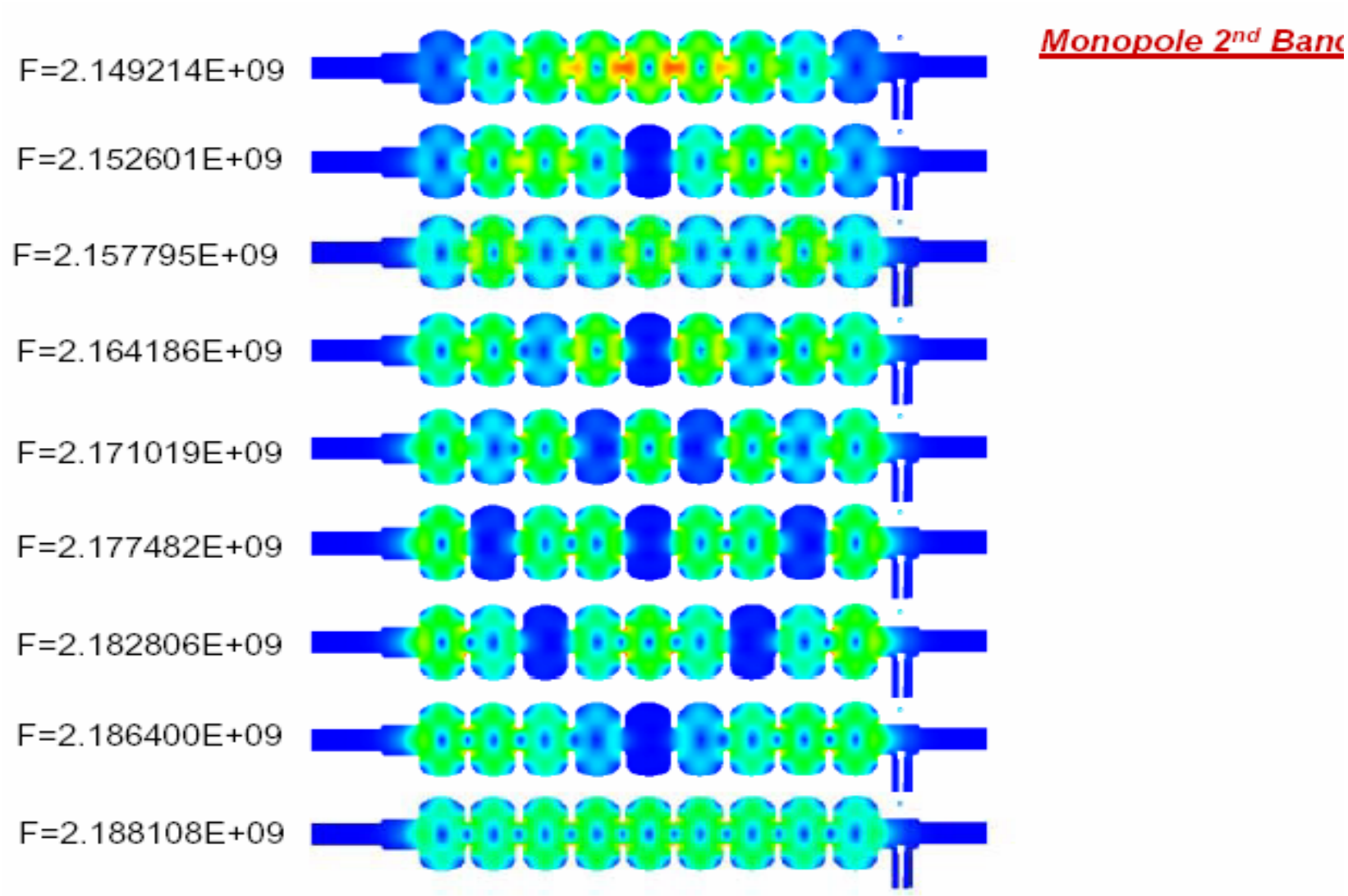
  K.Ko, N. Solyak

- Prototpye single cell fabricated at KEK
- Four 9-cell cavities to be fabricated at KEK by autumn

LL Shape(3)[K.Ko et al, SLAC]



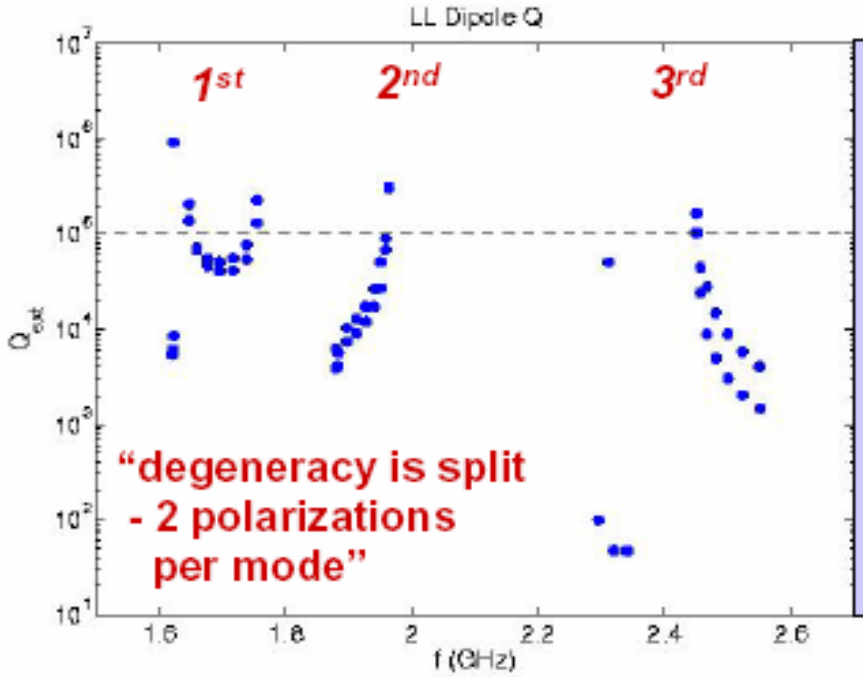
LL Shape(4)


Monopole 2nd Band
F=2.149214E+09
F=2.152601E+09
F=2.157795E+09
F=2.164186E+09
F=2.171019E+09
F=2.177482E+09
F=2.182806E+09
F=2.186400E+09
F=2.188108E+09

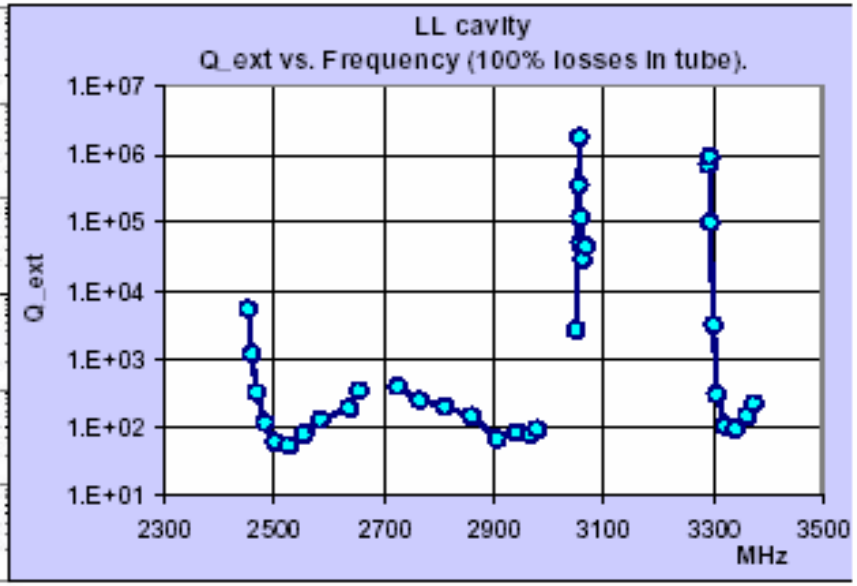
LL Shape (5)

Dipole Modes - Qe

Full 3D Model (SLAC)



2D Model (FNAL)



In Full 3D Model, terminations of power/HOM couplers and beampipes are OPEN and MATCHED

Superconducting Joint/Nb Bellows

- **Proposal 2: Development of a superconducting joint and beamline niobium bellows**
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- There are real cost savings possible in a linear collider design, in which the distance between cavities is shortened from the present TESLA design (~ 3/2 λ) by e.g. 1/2 λ . In that case it might be necessary to incorporate a superconducting joint between both neighboring cavities and in addition to replace part of the beam pipe of each cavity with a niobium bellows.
- It is proposed to develop these components in the following way:
- we have at Jlab a TM010 S – band cavity with beam pipes, which is split in two halves at the center of the cavity. This cavity has been used long time ago at the Forschungszentrum Karlsruhe for research on superconducting joints for application in the separator cavities. However the approach taken at that time was not very successful. It might be a better approach to replace the joint flanges on this cavity with conflat flanges made from NbTi and to use a RRR, heat treated Nb gasket for the joint. This is the proposed approach.
- By measuring Q vs E and R(T) one should be able to evaluate the quality of the sc connection. In addition, one can mount thermometers at the joint to detect any heating.
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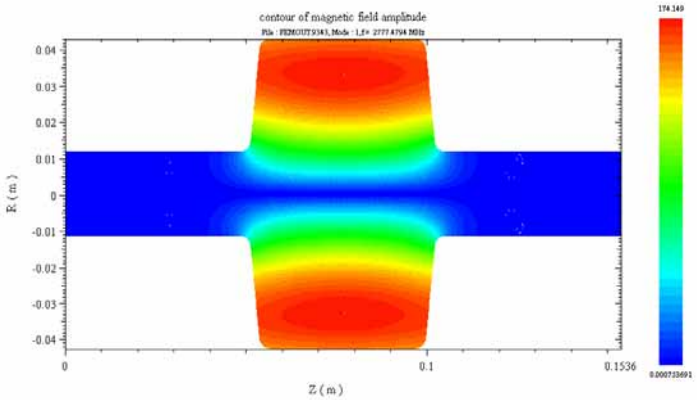
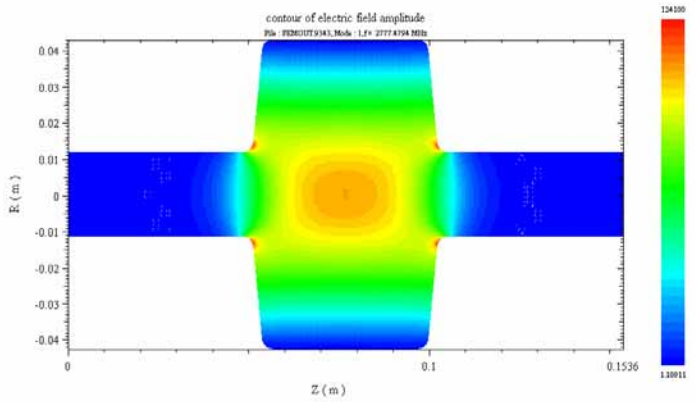
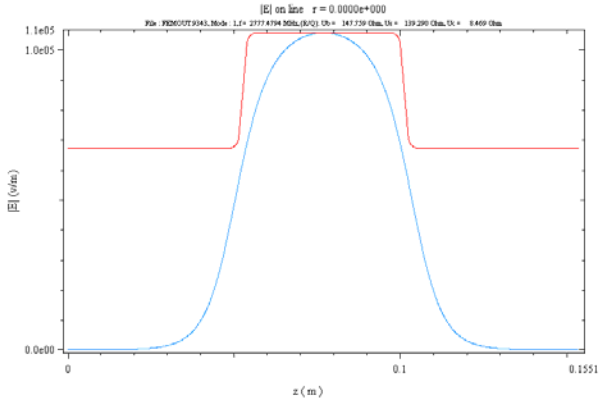
- We have in the past developed a two convolution niobium beam line bellows from thin wall electron beam welded niobium tubing. It is proposed to fabricate a die for 1 or 2 more convolutions and to use seamless niobium tubing (can be fabricated in collaboration with DESY – W. Singer)

Superconducting Joint/Nb Bellows[2]







Superconducting Joint/Nb Bellows[2]:Field calculations [J.Sekutowicz]

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 RESONANT MODE NUMBER =    1  BETA=1.0000
-------------------------------------------------------
: FREQUENCY                    :     2777.479376 : (MHZ) :
: QUALITY FACTOR QO            :       19288.934 : ****  :
: STORED ENERGY                :     0.39478E-05 :  (J)  :
: WALL LOSSES                  :     0.35718E+01 :  (W)  :
: GEOMETRIC FACTOR             :         265.221 : (OHM) :
: WAVE VECTOR                  :        58.21167 : (1/M) :
:                              :                 :       :
: -INTEGRAL(E(Z)DZ)      = U   :    -0.54863E+04 :  (V)  :
: -INTEGRAL(E(Z)SIN(K*Z))= US  :     0.30978E+04 :  (V)  :
: -INTEGRAL(E(Z)COS(K*Z))= UC  :     0.76384E+03 :  (V)  :
: SQRT(UC**2+US**2)      = UB  :     0.31906E+04 :  (V)  :
: RF.   SHUNT IMPEDANCE FOR U  :     0.42135E+07 : (OHM) :
: LINAC SHUNT IMPEDANCE FOR UB :     0.28501E+07 : (OHM) :
: LINAC SHUNT IMPEDANCE FOR US :     0.26868E+07 : (OHM) :
: LINAC SHUNT IMPEDANCE FOR UC :     0.16335E+06 : (OHM) :
: LINAC CONVEN. (R/Q) FOR UB   :         147.759 : (OHM) :
: LINAC CONVEN. (R/Q) FOR US   :         139.290 : (OHM) :
: LINAC CONVEN. (R/Q) FOR UC   :           8.469 : (OHM) :
: LOSS FACTOR FOR INPUT DOMAIN :     0.64465E+00 : (V/PC):
: LOSS FACTOR ASSUM.LEFT ASYM. :     0.60770E+00 : (V/PC):
: LOSS FACTOR ASSUM.LEFT SYMM. :     0.36948E-01 : (V/PC):
:                              :                 :       :
: EMAX = ABS( E PEAK ON METAL) :     0.12443E+06 : (V/M) :
:    R OF THE POINT WITH EMAX  :     0.13696E-01 :  (M)  :
:    Z OF THE POINT WITH EMAX  :     0.51161E-01 :  (M)  :
:                              :                 :       :
: HMAX = ABS( H PEAK ON METAL) :     0.16679E+03 : (A/M) :
:    R OF THE POINT WITH HMAX  :     0.34314E-01 :  (M)  :
:    Z OF THE POINT WITH HMAX  :     0.10035E+00 :  (M)  :
:                              :                 :       :
: AXIAL LENGTH OF THE DOMAIN   :         0.15360 :  (M)  :
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Investigation of HPR

Proposal 3: Investigation of High Pressure Rinsing Efficiency

- High Pressure Water Rinsing is presently the final preparation step in the surface preparation of high performance niobium cavities. Even though the process is successful, it is not very well understood. Especially it has not been systematically investigated, how the cleanliness of a surface/ cavity depends on the particulars of the rinsing system such as nozzle configuration, water flow, water pressure at the surface of the cavity, number of rinsing cycles etc.
- It is proposed to systematically measure many of these parameters (flow, pressure..) for different orifices and distances from a surface, then use defined contaminated surfaces and evaluate the cleaning efficiency by measuring the remaining particle contents on the surface.

Beamline Couplers

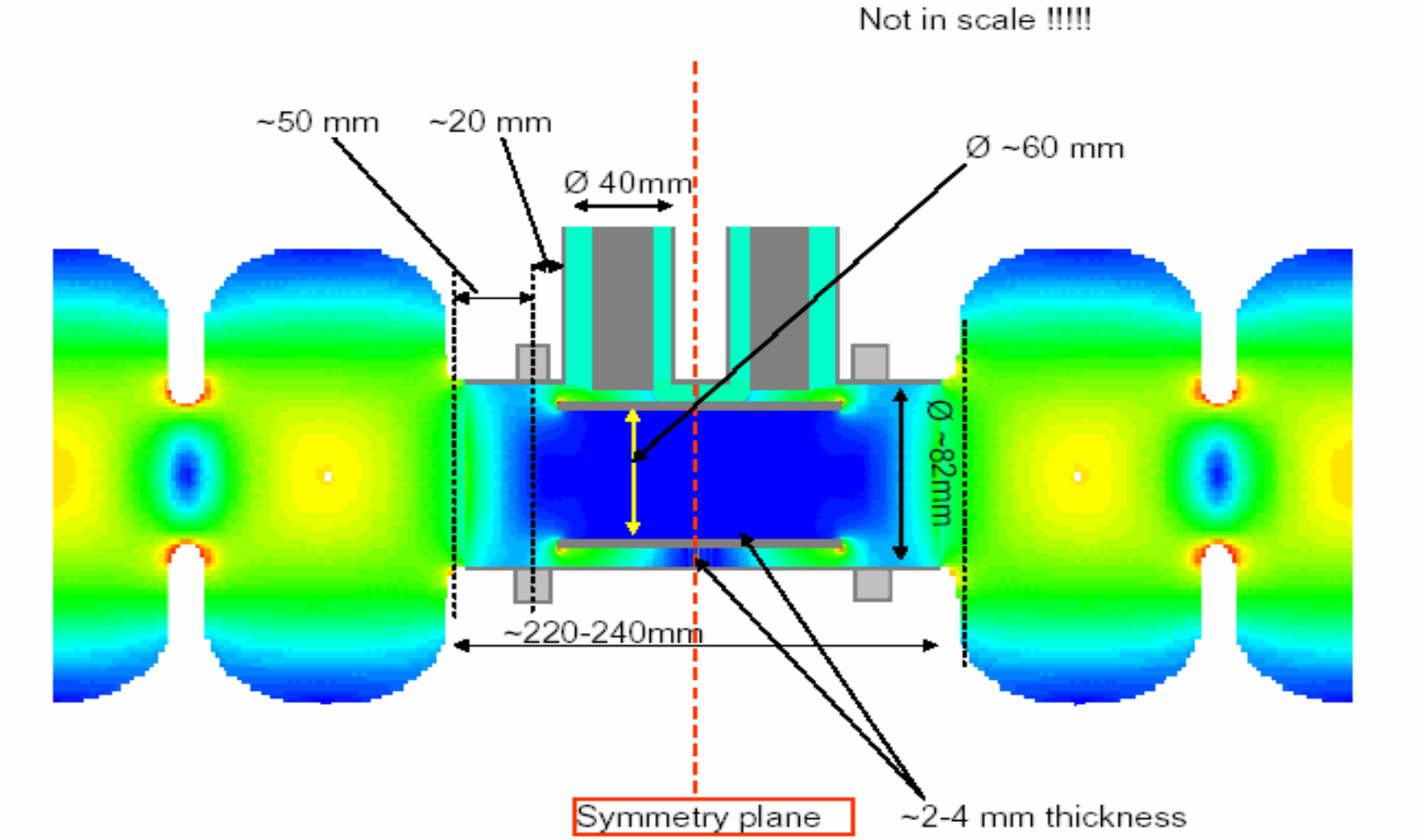
Proposal 4:Development of a cylindrical symmetric HOM coupler for ILC cavities

Presently the HOM damping of modes in the TESLA cavities is accomplished by the use of one coaxial coupler at each end of the beam pipe. This coupler has a complex shape and its fabrication is expensive, raising the overall costs of a TESLA cavity.

Work has started (J. Sekutowicz) to develop a HOM damping scheme with cylindrical symmetry (beam pipe coupling), which would significantly reduce the manufacturing costs.

It is proposed to fabricate and test such HOM couplers on a multi-cell cavity.

Beam line Couplers(2)



Beam line Couplers(3):Status

- Simulations have been done at SLAC (K.Ko et al)
- Copper model has been fabricated and tested at DESY
- The design looks promising both for Fundamental mode coupling (Qext can be varied over several orders of magnitude) and for HOM damping (J. Sekutowicz)