RF for the e- Ring

From a basic Design to a Conceptual design

Some Issues Needing Study

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RF and beam parameters – T. Linnecar, 2008 Workshop

Energy = 70 GeV (50 GeV)

- Energy loss / turn @ 70 (50) GeV= 707 (184) MeV
- Beam current Ib= 74 mA
- Beam Power Pb= 54 (14) MW
- Total RF voltage Vrf= 900 (250) MV

  (Overvoltage for QL, + Some Reserve ....)
- Frf= 1002 GHz, h = 89100
- Fs = 1406 (1124) Hz, Qs = ~0.125 (0.1)

RF System – Basic Design – T. Linnecar, 2008 Workshop

Energy = 70 GeV (50 GeV)

- Assume 500 kW cw coupler - LHC has >350kW kW => feasible
  Leads to 100 (28) SC Cavities
- Cavity Diameter 50 cm …
- Conservative gradient – 6 MV/m => Ltot = 150 (42) m
- Few cavities/klystron 1 => 100 (28) with 500 kW Klystrons
  2 => 50 (14) @ 1 MW Klystrons
- Klystron Powering : LEP Style PC for 1 cav/klystron (4MW) on surface (?)
- Upgrade or doubling for 2 cavs/klystron
- HV bunkers, LLRF & Controls – Space needed underground..

Study Topics - 1

Exact RF Voltage Requirements.

- Vtot for Quantum Lifetime > 20hrs (as LEP)
- Margin for feedback systems (Need RF Power and Voltage)
- Margin for cavity/klystron trips (2 klystron margin ?)
- Beam Loading considerations – optimum coupling ?

  (LEP < 8mA, cavities matched for 12 mA)

Easy to Estimate …

Basic Design to a Conceptual Design

Study Topics - 2

Cavity and Cryomodule

- Define a cavity geometry, number of cells
- Helium: Is 2K needed, 4.5 K may be adequate at this gradient.
  - LHC cw 400MHz sputtered cavities can easily run at 8 MV/m (Pushed to 11MV/m)
  - Needs Study & Cost Estimation
- Cryomodule – Need schematic design, with dimensions, decide number of cavities per cryomodule.
- Overall heat load estimations, static & dynamic.

Cryo System

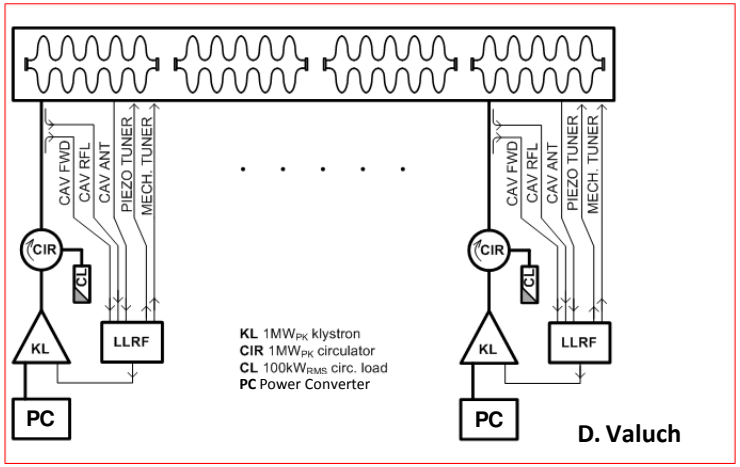
- Total cooling power needed - from above
- He supply system - Connection to existing system – new separate system?
- Location & footprints of additional cryo plant elements on surface and underground

Basic Design to a Conceptual Design

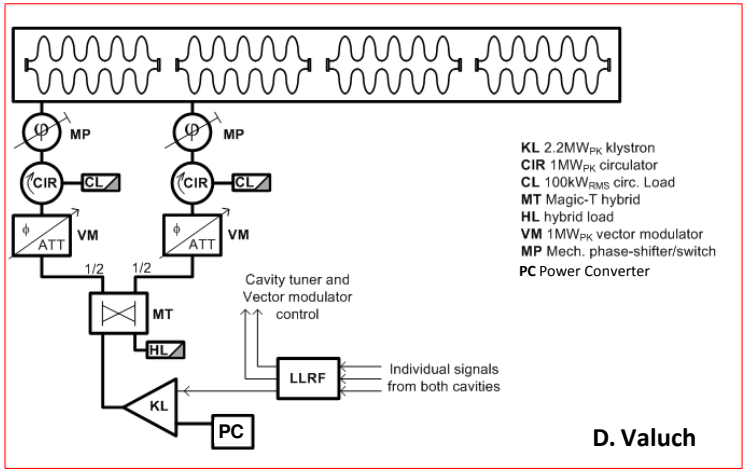
Study Topics - 3

RF Power System

- Suitable klystrons, number of klystrons
- Power coupler design
- Arrangement for feeding multiple (2) cavities/klystron, layout – space requirements
- Waveguide components – Circulators, Vector Modulators etc.
- Stability studies & LLRF conceptual design – Important in view of high intensity and beam loading.



One Cavity per Klystron



Two Cavities per Klystron

Basic Design to a Conceptual Design

Study Topics - 4

Some other Important Issues:

- Cavity effects - Ponderomotive effects, Microphonics, He oscillations,
- Beam transmitted instabilities

  ! LEP Experience - many such problems, even with low current, but 8 cavities per klystron made it difficult….

- HOMs and HOM coupler design. (synchrotron)
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Conclusions

Many issues needing further study:

- RF Parameters, voltage & power requirements - in more detail
- Cavity Design
- Cryomodule design
- Optimum RF Power Scheme and component design
- Layout and Integration
- Study of cavity effects, beam effects, HOMs

However:

- Synergy with other projects & studies

  SNS, SPL, XFEL, CLIC drive beam, etc.

  LEP Experience…