Workshop on e+ e- in the 1-2 GeV: Physics and accelerator Prospects

Working group on Accelerators

Summary on the Technological Issues

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Multi-Bunch Feedback and High-Current Factories

Operational Experience, Theoretical Limits and Technology Options for future upgrades

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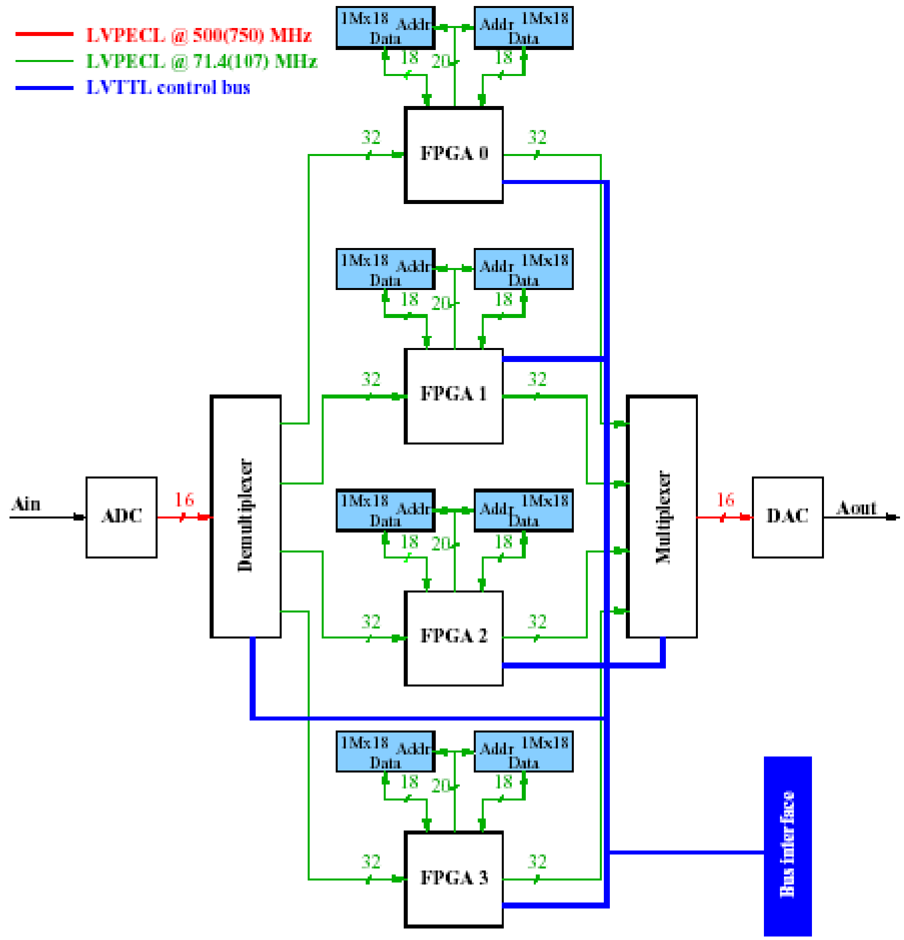
Alghero

GBoard 1.5 GS/sec. processing channel

- Next-generation instability control technology
- SLAC, KEK, LNF-INFN collaboration - useful at PEP-II, KEKB, DAFNE and several light sources.
- Transverse instability control
- Longitudinal instability control
- High-speed beam diagnostics (1.5 GS/sec. sampling/ throughput rate)
- Builds on existing program in instability control and beam diagnostics.
- Significant advance in the processing speed and density previously achieved.



- Experience from DAFNE/PEP-II/KEK-B/CESR is important and useful.
- Feedback systems have limits to performance, and the proposed configurations for both the energy upgrade and luminosity upgrade need to be fairly examined, and the required performance and system margins need to be estimated. There are technology options to consider in the design of non-downsampled processing channels useful for both transverse and longitudinal feedback. Active collaborative R&D is underway on this project.
- There are also R&D opportunities to consider in kicker structures for quadrupole longitudinal, as the existing control technique, using a common processing channel for dipole and quadrupole modes, may have limitations if the bunch length is decreased.

Summary

The three factories (DAFNE, KEK-B and PEP-II) all have significant experience running these multi-bunch instability control systems. Each set of system designers has achieved success for the existing operating currents

The instabilities themselves are proportional to current, and proportional to the driving impedances. Running these facilities at higher currents requires some analysis to understand the practical limits of these instability control systems.

The technology of these systems may evolve, but the fundamental limits to the performance of these systems, e.g. the saturation effects from noise limiting the gain, and the limits on gain and phase from loop stability of the feedback loop, are the central limits we must never ignore.

PEP-II is pushing the group delay limits in the control of the low in-cavity longitudinal modes, and has some operational history with power dissipation and thermal management of the kicker structures.

The diagnostics possible with the programmable DSP based systems are very useful in validating dynamics and understanding the performance of the instability control. They also provide many very unique accelerator diagnostics (such as measurement of complex HOM impedances). The flexibility of these systems has been an opportunity to address several control needs as the accelerators were modified (such as the addition of harmonic cavities to the ALS, requiring novel IIR control filters, or the quadrupole mode control at DAFNE)

The new technology in development (e.g. the Gboard effort) offers faster, more complex options.

Storage ring RF and longitudinal dynamics and feedback

Dmitry Teytelman

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Alghero, Italy

DAΦNE with strong RF focusing

As an example we will consider the effect of proposed RF configuration on longitudinal feedback

The proposed design has a much higher gap voltage which results in significantly shorter bunches at the IP and higher synchrotron frequency.

Parameter	Current	Proposed
RF frequency (f_{rf})	368.25 MHz	500 MHz
Momentum compaction (α_c)	0.029	-0.171
Circumference (L)	97.69 m	105 m
Revolution frequency (f_{rev})	3.069 MHz	2.857 MHz
Harmonic number	120	175
RF voltage (V_{rf})	120 kV	10.677 MV
Synchrotron frequency (f_s)	30 kHz	1.31 MHz
Revolutions per synchrotron period	~102	2.18
Bunch length (σ_z)	19 - 38 mm	2.6 - 20.4 mm

Conclusions

There are many interactions between the RF system and the coupled-bunch instability feedback

Experience from operating LBL/LNF/SLAC designed feedback systems at 5 different machines allowed us to carefully characterize these interactions.

Information on the RF parameters together with the impedance data can be used to predict with high degree of confidence the feasibility of the proposed configuration.

Analysis of the proposed strong RF focusing for DAΦNE shows feasibility of the design with respect to longitudinal coupled-bunch feedback with several possible problems:

- Excitation of the beam by the RF noise
- Reduced effective loop gain
- Lower kicker gain for quadrupole control
- High-frequency impedances sampled by a shorter bunch

More analysis needs to be done at the later stages of the design process.

Most importantly, from our experience with the LFB at multiple installations two things stand out

- In operating the machine you almost always find instability surprises not predicted in the design.
- Flexibility of the feedback architecture is critical to effectively control these "surprises".

CESR-c IR region magnetic survey

Alexander Temnykh
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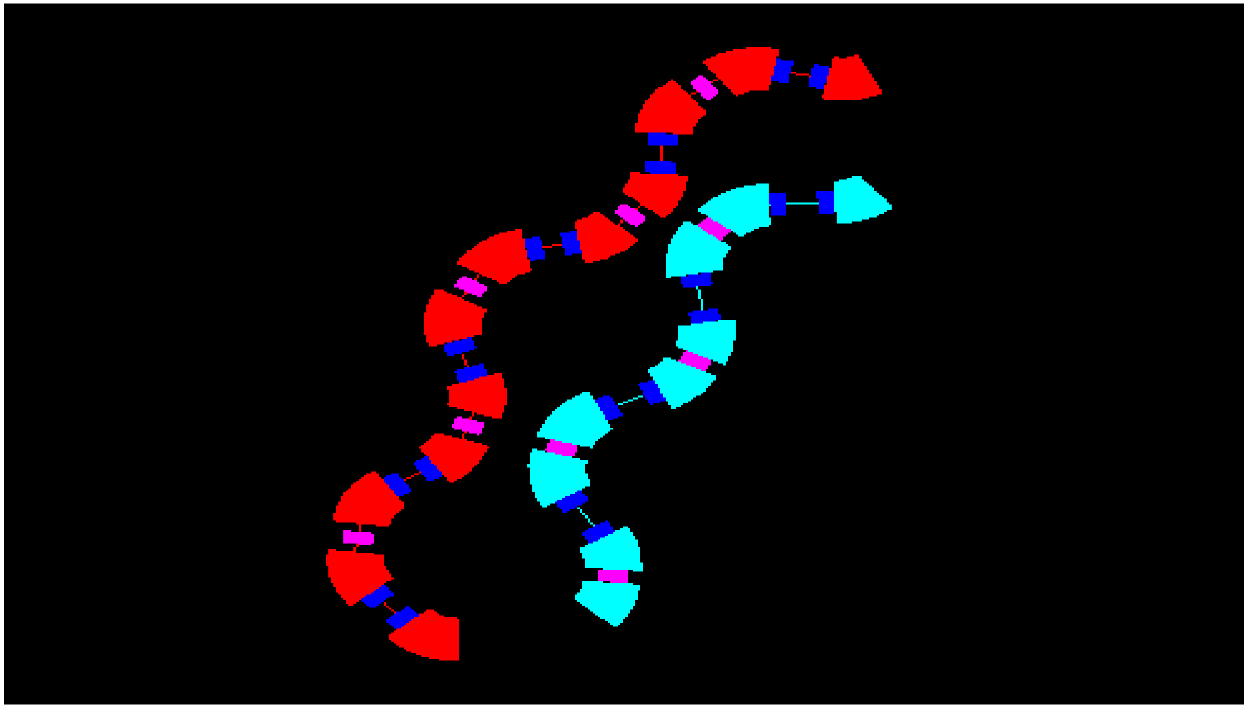
1. Introduction (VW theory)
2. Setup
3. Permanent quads survey (Q0E, Q0W)
4. SC quads survey (Q2E, Q1E, Q1W, Q2W)
5. Summary and orbit distortion analysis

- The issues of magnetic measurements of interaction region magnets was discussed, a technique from CESR was presented based on a vibrating wire, and a frequency decomposition of the modes of the wire. This technique has the interesting feature of being useful on the final assembly installed in place, though it required clear through access to string the wire.

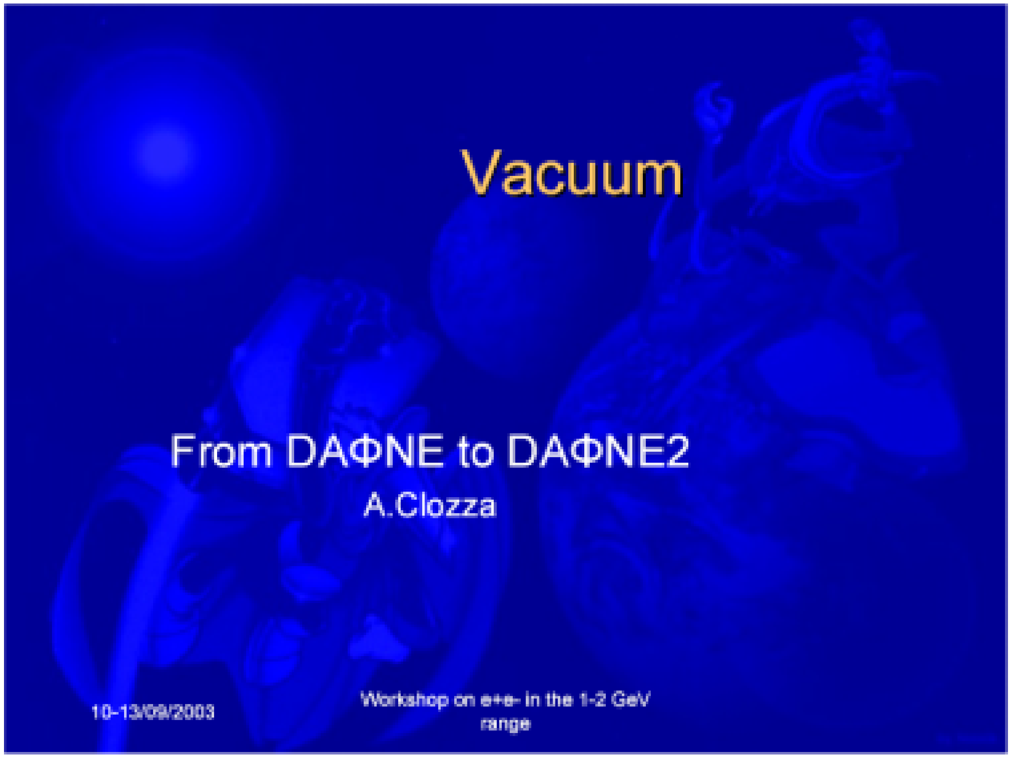
SuperDAFNE Dipoles first evaluation

Ruggero Ricci - INFN-LNF

Sector of SuperDAFNE rings



- Dipole magnets for the high luminosity option
- The talk presents estimates of the magnetic field uniformity, and estimates of a possible dipole design.
- Basic design issues, material choices, and cost estimates provide a feasibility proof and a starting point for a future detailed design if this path is selected.



A. Clozza has analyzed the vacuum system for the high luminosity and the high energy option.

- The gas loading for the existing aluminum chamber was estimated, and existing pumping speed and pressure requirements in the new operating schemes were estimated. The initial estimates suggest that only in the high energy option the existing vacuum system is adequate, while in the high luminosity option a completely new vacuum system is required.
- A design of the chamber, with pumping slots and structures, needs to be examined for possible HOM or heating effects if the bunch lengths are significantly decreased.
- New surface treatments and new material need to be investigate in order to reduce the e-cloud phenomena.

Conclusions

- Both are feasible
- High Luminosity ➡ A new machine
  - More demanding on costs and man power
- High Energy ➡ DAΦNE upgrade
  - Less demanding on costs and man power

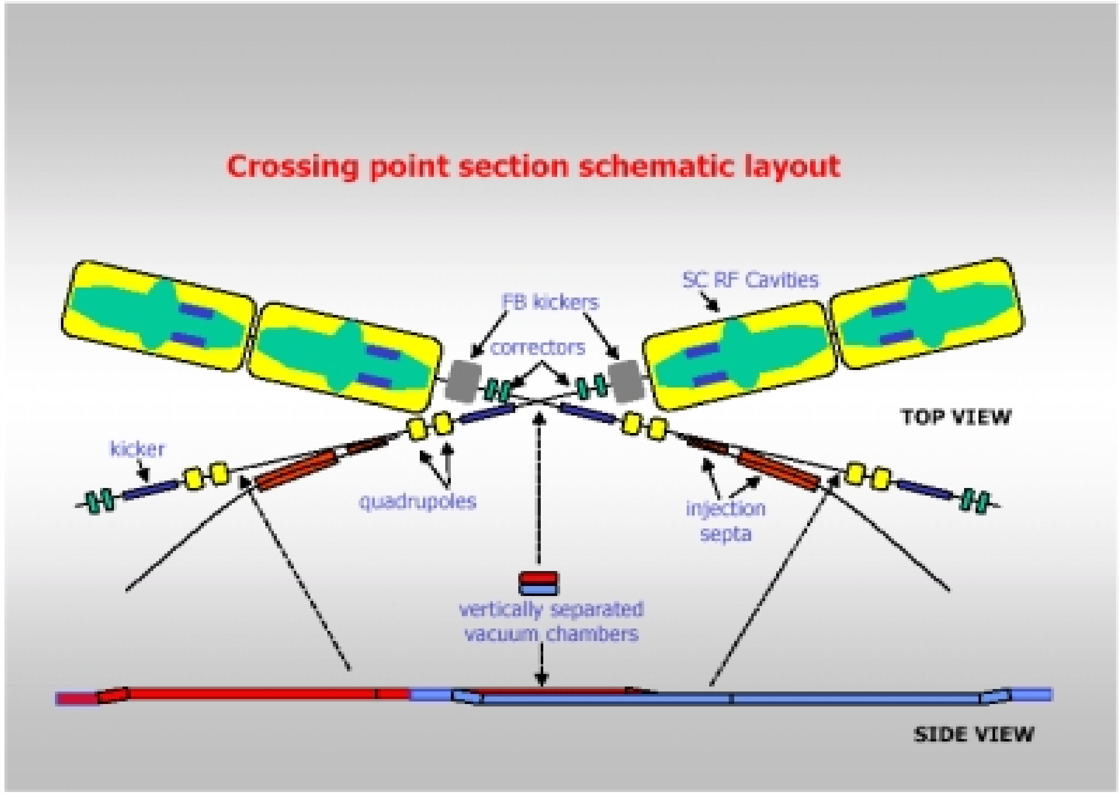
DAFNE Injection Upgrade
by Andrea Ghigo

- Andrea Ghigo presented several issues related to injector upgrades for the high luminosity options. The upgrades are based on the existing 511 MeV damping/accumulator ring. Because of concerns about injection efficiency, and the estimated short lifetime due to Touschek scattering, he proposes to add a dedicated transfer line from the accumulator so that electron and positron injection would use dedicated lines, eliminating the need to switch the polarity and setup of several magnetic elements which takes several minutes as implemented with the single shared transfer line. He presented a possible layout, suggesting there is room for the transfer lines, kickers, and RF cavities in the existing space.

Layout for separate transfer lines:

- The proposed transfer lines pass in existing controlled area

- Additional shielding needed in the area between the accumulator and DAFNE buildings



- The machine has one interaction point. In the opposite side the two beams cross each other, vertically separated by means of magnetic chicanes, passing into sep.vacuum chamber.
- The RF cavities must be located in a position with synchrotron phase advance difference μ/2, with respect to the interaction point.
- The bunch length is maximum in the RF section than the machine devices that contribute to the machine impedance should be located in this region to minimize the wakefield effects.
- The symmetries of the rings suggest long straight sections dedicated to the injection and the RF equipments.

Summary conclusion

- The high luminosity options need to be carefully studied in the dynamical behaviour: operating margin and system constraints need to be studied for RF and FB consistency.
- FB’s, dipoles , vacuum and injection are at early state of R&D, and need further studies.