Road map of the workshop

V.Parma, Introductory talk

- Machine availability:
  - "work-horse" in the injection chain
  - 100% availability not viable,.What is achievable? And at which cost?
- Reliability of built-in components and operational risks (degraded performance without intervention)
  - Typical faults expected on:
    - Cavities
    - Couplers
    - Tuners
    - ..
- Operation with degraded performance and mitigating measures:
  - Degraded performance of cavity/ies → reduced energy
  - Degraded optics (quads, steerers) → reduced beam quality
  - Operating with leaks
  - ...
- Built-in redundancy (e.g. need for installed spare cryo-modules)
- Maintainability:
  - Radioactive cool-down time
  - Warm-up/cool-down .Time and reliability. Need for partial or complete warm-up of strings to replace built-in components or even one cryo-module
  - Accessability of components for regular maintenance or repair
- Design complexity of compared solutions
- Operational complexity (e.g.cryogenics with 1.7% slope)
- Installation and commissioning
- Coping with incidents (MCI). Loss of beam and/or insulation vacuum :
  - helium leaks
  - Air leaks
- Cost differences between options
- - …

Goals

V.Parma, Introductory talk

- Primary goals:
  - Identify the main operational and intervention scenarios for the cryogenics and vacuum systems of the SPL
  - Elaborate an exhaustive technical and economical comparison between *single "continuous" cryostat* and *"segmented" cryostat with cryo distribution line*
  - Possibly reccomend a choice between the two options
  - Define a "baseline" cryogenic distributions scheme and vacuum sectorisation
  - Elaborate, if necessary, a list of further developments for making a choice
- Other goals:
  - Identify advantages for alternative sectorisation schemes (intermediate solutions)
  - Technical comparison between layouts with warm and cold magnets
  - Identify other machine architectures to be explored for an improved sectorisation (e.g. alternative optic schemes)

Preliminary conclusions

(V.Parma, S.Calatroni)

- More doors opened than closed! …but
- Lots of precious information made avaialble: thank you to the speakers!
- SPL availability. Needs to be "as high as possible", so down-time should be minimised.
- Replacement of a cryomodule is a matter of several weeks in a continuous machine and could be a matter of a couple of weeks with a full segmentation (to be properly assessed!)
- Which components are most likely to fail (or have degraded operation):
  - Cavities. Degraded performance after installation experienced at FLASH, but no degradation from operation. Within certain limits can be compensated by better performing cavities or by in-situ reconditioning (e.g.LEP)→ But built-in cavity redundancy is probably needed.
  - Tuner motor and piezos remain sensitive components. KEK moved motor outside cryostat.
  - Power coupler. For HP SPL 1 ceramic window, risk of leak. Risk of leak on coupler window to be explored. Interlocked gate valves would be very useful
  - Cold feed-throughs (better avoid, FNAL, JLAB)
  - Cold seals sensitive (Indium, JLAB)
  - Gate Valves (operational accident. e.g. LEP)
  - Leaks due to thermal cycles

- Quad reliability and alignment. Magnets do not need to be warm. (But warm zones may complicate the beam vacuum (bake-out)).
- Warm quads. SPL Low beta zone with warm magnets gets long as compared to Isolde extraction needs (energy) but this is not considered today as a constraint.
- A fully segmented with warm magnets solution would not have margin for 5 GeV, with 25 MV/m. Continuous solutions gives some margin for ~20% (?) redundant cavities.
- SPL operational scenario
  - No components needing regular servicing
  - Maintenance only during yearly shut-downs (3 months for LHC).

Preliminary conclusions (cont.d)

- Segmentation in other machines.
  - Long (>1 km) machines tend to reduce segmentation for cost reasons (ILC study, XFEL project)
  - Shorter machines normally have segmentation (SNS, Cebaf)
- SPL: "to segment or not to segment?"
  - Advantages of Seperate distribution line are clear. Mainly: maintenance flexibility, installation and commisionning. Magnets can be warm→ simpler cryomodules, more reliable/maintainable...but:
  - Drawbacks: too long machine to house redundant cavities (cryomodules)?

Cryogenics cooling schemes:

- Many options (7) for cooling schemes presented.
- Cool-down/warm-up through "parallel" capillary circuit (XFEL concept) seems to work but not preferred by CERN (Udo). To be further discussed with XFEL people. (Bernd).
- "Roman fountains" operation (possibly with capillary levelling from bottom of cavities) could work but testing is highly recommended (no existing experience).
- Other concepts could also be explored (e.g. Horizontal bi-phase tube).
- Possiible lenght of cooling loop to be further investigated
- Warm-up and cool-down time in case of XFEL is limited by "banana effect" due to the GRP. (~1 week). On short segments it could be much faster and becomes a matter of capacity (~) ...
- Choice of cooling scheme needs further work.

Preliminary conclusions (cont.d)

Vacuum.

- Machine availability
  - Define ability to live at reduced performance, with degraded components, or some non operating component
    - Leaks on insulation vacuum
    - Vacuum issues in beam - cavities
    - (Magnets)
  - Redundancy
- Beam vacuum segmentation. Interlocked gatevalves can limit contamination of leaks or accidental venting. XFEL is planning to install cold gatevalves (specifically developed).
- XFEL experiment. Air venting in beam tube has quite slow propagation (~4 s per module), so "slow" gate valves can manage it.
- Insulation vacuum. No major point. Introduce vacuum barriers to have reasonably short cryostat segments (ease commisioning, leak localisation...)

Design, installation, commissioning, operation and repair criteria all discussed (Paul):

- Increased segmentation:
  - Installation and operation flexibility, maintainability in case of major faults, safety due to gate valves
  - Increased number of components, reduced reliability
- Reduced (no) segmentation:
  - Maximization of real estate, simplification of components and built-in redundancy
  - Limited in-situ intervention in case of failures, and larger affected zones

Preliminary conclusions (cont.d)

- Lots of analysis of presented information still to be done...Give us some time!
- Final report will be produced in the coming weeks with a thorough comparison between continuous and segmented versions.

Thank you for your participation !