Summary report of the first meeting on Accelerator Design & Integration 28-29th May, DESY

17th June, 2009

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Contents

Attendance

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Axel	Brachmann	SLAC	John	Osborne	CERN
Karsten	Buesser*	DESY	Ewan	Paterson	SLAC
Phil	Burrows*	JAI/OXU	Marc	Ross	FNAL
John	Carwardine	ANL	Tetsuo	Shidara	KEK
Norbert	Collomb	CI	Nikolay	Solyak	FNAL
Eckhard	Elsen	DESY	Junji	Urakawa	KEK
Atsushi	Enomoto	KEK	Nicholas	Walker	DESY
Shigeki	Fukuda	KEK	Barbara	Warmbein	DESY
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Susanna	Guiducci	INFN	Akira	Yamamoto	KEK
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WebEx:					
Rongli	Geng	JLab	Tom	Lackowski	FNAL
Camille	Ginsburg	FNAL			

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Agenda & Presentation Material

The agenda and presentation material can be found on ILCAgenda here.

Purpose of Meeting

- Review the proposed Straw-man Baseline 2009 (SB2009) modifications to the RDR baseline
- Systematically work through each sub-system and identify questions and issues pertaining to the SB2009 choices
- Understand the pros and cons of each proposed modification
- Agree on as many choices as possible
- Agree on a set of Action Items to be completed by ALCPG
- Discuss and agree the mechanism and process for information exchange with the CFS group
- (Begin) updating RDR Risk Register for both RDR and SB2009 configurations

General discussion and comments

Cavity Gradient Yield

As part of the TDP-1 re-baselining activities, it is intended to re-evaluate the choice of the average accelerating gradient. Discussions at this meeting were in preparation of that re-evaluation, expected at the end of this year or early next year (if possible). Of paramount importance is the collation and consolidation of world-wide cavity results into a single database, which would allow consistent analysis of all the cavity data. Although significant progress has been made in the last years, the problem of yield definition and interpretation of the results was highlighted both during the presentations and the resulting discussions. In particular, it was noted that:

- The original scope of the S0 assumed multiple treatments of the same cavity as a way of separating out mechanical (i.e. fabrication) errors from surface treatment effects. The original goal was to count 'surface treatments' and corresponding vertical tests (so-called 'process yield'). This has now changed, and the focus is now on single-preparation "first vertical test" results, which is more inline with the definition of a 'production' yield.
- There is insufficient statistics for the gradient yield evaluation; the current estimates can be easily scattered (35 MV/m at 15-50% yield) depending on the 'cut' or 'filtering' the results.
- Yield needs to be clearly and unambiguously defined to support a consistent and relevant analysis across all the world-wide cavity data available. Specifically, well-defined 'acceptance criteria' for cavities to be included in the yield statistics need to be made and universally applied. The basis for the acceptance criteria should be justifiable in terms of any future mass-production process (i.e. "why we can ignore this cavity").

Definition of yield criteria will be a focus of the Cavity Preparation TAG (lead by Rongli Geng, JLab) over the next months. The consolidation of the cavity data into a single uniform database will be lead by Camille Ginsburg (Fermilab). To assist her, the following contact people for the labs (other than Jlab and Fermilab) have been identified: Sebastian Aderhold (DESY), Zac Conway (Cornell, TBC), Yasuchika Yamamoto (KEK). A critical part of this database is the inclusion of historical data for each cavity, including multiple EP or HPR cycles and test results for instance, and the inclusion of all cavities, even those immediately rejected. The draft spreadsheet is included in the meeting indico site, and comments for changes should be sent directly to Camille at ginsburg@fnal.gov.

The goal of the R&D is to feed into the evaluation of the choice of the baseline gradient for the machine. This choice must be ultimately linked to the cost model used for the project. The discussions highlighted the difference between the yield definitions currently being used for R&D purposes ("process yield" and "production yield" above) and the yield model that was used for the RDR cost estimate. The RDR assumed that 80% of manufactured cavities (first vertical test) would achieve ≥35 MV/m. The cost-model assumed an over-production by 125% of the required cavities, of which the rejected cavities (≤35 MV/m) where simply 'discarded'. This was considered to be a simplistic and conservative model for the purposes of estimating the total cavity cost. In reality, the 'rejected' cavities would almost certainly be re-processed. R. Geng suggested plotting the yield curves for both first and second cycle and as an evaluation tool.

It was note that the RDR concept of driving all cavities at the same gradient (31.5MV/m) also has an impact on the acceptable yield definition. Future cost-models should include the effect of average gradient operation over some acceptable gradient spread by using a variable tap-off PDS.

During the re-evaluation at the end of TDP-1, it is important to attempt to extrapolate to expected performance in 2012 when the TDR is to be published. When discussing the choice of mass-production yield, models for acceptance criteria and 'risk mitigation' will need to be considered. How this is to be achieved, and on what criteria the decision will be based still remains a subject for discussion. However, the original RDR definition still remains a relatively conservative approach from the aspect of cost estimation.

Finally, it was noted that the RDR assumption of a 100% cryomodule yield seems too optimistic and should be re-assessed for the TDR cost estimate.

Single Tunnel: DRFS and Klystron Cluster HLRF configurations

Fundamental to the SB2009 cost reduction is the adoption of a single underground tunnel for the RTML and Main Linac. Removal of the RDR service tunnel requires a review of the original arguments for a double-tunnel solution, which essentially were based on arguments of availability (access to klystrons, modulators, electronics and other hardware during beam operation) and safety. Historical scaled estimates of potential cost savings (based on the RDR design and costs) put the saving at the 100 MILCU level. This includes additional costs to increase availability of a single tunnel solution.

SB2009 will re-evaluate both the cost savings and attempt to review and quantify the availability issues.

Safety issues were not discussed at this meeting. The Working Assumption is that an acceptable safety scheme for a single tunnel can be found for all regions (although not necessarily the same in all regions). Investigation into safety requirements and schemes is on-going.

Pros and Cons of the DRFS concept with respect to the RDR were presented. Tentative cost estimate for the HLRF components of DRFS is 25% higher (than RDR), but the total cost including CFS (single tunnel configuration and other changes) is still to be determined. KEK is planning to manufacture one DRFS unit in order to show its feasibility at the S1-global test.

Two important differences to the historical RDR single-tunnel models are the two proposed novel HLRF solutions, both of which will be supported in SB2009:

- DRFS: ~8000 × 800kW Modulated Anode Klystrons (MAK), modulators and power supplies installed in the (single) tunnel. Each MAK drives two cavities (RDR nominal power spec.)
- Klystron Cluster: Power from ~35 × 10MW MBKs located in a surface building is combined and transported via a single over-moded waveguide into the underground tunnel, where power is 'tapped-off' to drive the cavities. These "clusters" would be located approximately every 2km.

Both proposals are predicted to give significant cost savings with respect to the RDR – primarily via adoption of a single-tunnel solution.

Both of these solutions have associated risks which differ conceptually:

- The Klystron Cluster is a novel concept requiring 'proof of principle' R&D to demonstrate the long-pulse power handling of the waveguide components. Further work on understanding the RF and beam energy control of a system which has an effective RF unit ~1 km long is also required. Many operational aspects of this system require careful consideration. A full 'systems test' is certainly cost and schedule prohibited, however component power handling tests are planned.
- Plans to test a DRFS 'unit' at KEK are well underway but this is not expected to be an issue given the scale (single klystron driving two or four cavities). In comparison to the Klystron Cluster, the main challenge is seen in the Design for Manufacture that is required to make the concept cost effective. Questions were also raised on the single-tunnel installation layout, which currently assume the RDR standard 4.5m diameter tunnel. Specifically
    - It was noted that the current 3D models do not yet include other hardware that needs to be installed in the tunnel (power supplies, shielded electronics etc.)
    - The current proposed solution has the cryomodules hanging from the roof of the tunnel, similar to the XFEL solution. It was noted that this concept was rejected during the Snowmass 2005 deliberations due to vibration and stability issues (notably on beam dynamics, given the 100 times smaller vertical emittance than XFEL). Temperature stability of the tunnel was also cited as stability issue.

Both schemes propose to be 'better' solutions over the RDR in terms of availability. The Klystron Cluster scheme has all RF power components accessible on the surface, and in principle it is easy (cost effective) to add additional klystrons as operational 'over-head'. The DRFS scheme assumes the lower-power MAK will achieve a longer MTTF than the MBK, and the smaller more compact units will be easier to exchange (for which access is required).

It was also noted that an option of the standard RDR RF unit housed in a single tunnel should also be considered, as this may be more cost effective than the DRFS.

Extrapolation of the XFEL solution to the ILC should also be studied, since ~2 km of this solution is currently being detailed engineered with a view to construction, and will provide the most accurate cost estimate of all the options.

Difficulties in supporting both of these configurations as part of SB2009 still exist. Specifically it was noted that there is a strong desire to maximise the common design elements between these two design (as far as possible).

CFS Issues – costing methodology and process

CFS is considered a primary cost driver. Reduction of CFS requirements – particularly underground volume and CF requirements – is a primary motivator for the choices outlined in SB2009.

Initial investigation of the impact of the SB2009 changes are an important step to assessing the 'worth' of the proposed baseline. Specifically, it is important to make a first-pass estimate of the cost savings by the Albuquerque meeting.

As a model for future work, the 2008 analysis made by the Americas team for the Klystron Cluster concept was presented. The scope and depth of the analysis is effectively defined by the level of detail in the RDR, on which the cost estimates (differentials) are based. Specifically

- An initial investigation on the differences of the klystron cluster proposal with respect to the RDR baseline was made
    - What was removed
    - What was added
    - What was modified
- A detailed itemised list of the results was generated in a WBS-like fashion
- Where applicable, unit costs from the RDR – suitable scaled – were used to estimate the cost impact
- Where necessary, new cost estimates were made for new components not in the original RDR WBS (e.g. over-moded waveguide). These estimates were de-escalated back to ILCU (2007).
- Level of detail of the study varied from adjustments to existing RDR schematics to 'best guess' scaling based on experience.
- All work is well documented and traceable, with associated annotation and justification.

It was agreed that a similar process must now be applied to the remaining elements of the SB2009 proposal. To facilitate this, the CFS team re-enforced the need to re-establish "points-of-contact" to the relevant Technical Area Groups. Specifically:

- Issues relating to choice of gradient
    - Jim Kerby, Vic Kuchler
- Electron Source
    - Axel Brachmann & John Sheppard - Tom Lackowski (supported by M+W Zander)
- Positron Source
    - Jim Clarke - John Osborne
- Damping Ring
    - Susanna Guiducci - Tom Lackowski
- Ring to Main Linac
    - Nikolay Solyak - Vic Kuchler (supported by M+W Zander)
- Main Linac
    - Chris Adolphsen (Klystron Cluster) - Tom Lackowski
    - Shigeki Fukuda (DRFS) - Atsushi Enomoto
- Beam Delivery System
    - Andrei Seryi - John Osborne

From the point of view of complexity, the CFS team views those SB2009 elements which impact more than one area system to be the most problematic; i.e. areas requiring a high-degree of integration.

Two specific areas – the low-power option and the central region integration – where specifically noted as needing additional attention.

The relevant technical group leaders will be expected to supply the necessary data in a concise format (spreadsheets), including component counts, changes in tunnel lengths, water cooling requirements etc. For the initial immediate studies, these are not intended to be detailed or precise, but can be scaled estimates from the RDR. A series of WebEx meetings have been scheduled to walk through the requirements modifications. It was noted that:

- Area System Presentations at this meeting provided some valuable Insight into the complexity and progress on Criteria Development;
- Preliminary discussions between CFS and some of the Area Systems Points of Contact have been already completed
- Some initial CFS prioritizations are in place:
    - Review of the Damping Ring, Electron Source, Positron Source and RTM will be the focus of initial CFS Efforts, as these are considered as relatively straightforward.
    - If a range for possible gradient change could be identified, the impact of this can also be addressed (also considered relatively straightforward).

The following schedule for WebEx meetings with the CFS teams was agreed:

- June 2 - CFS Internal Review of AD&I Meeting
- June 9 - CFS and Damping Ring w/S. Guiducci
- June 30 - CFS and Electron Source w/ A. Brachmann
- July 7 - CFS and Positron Source w/J. Clarke and N. Collomb
- July 14 - CFS and RTML w/N. Solyak

Special meetings to address the more complex issues (central region integration) will be scheduled in the near future.

CFS Issues – surface sites and tunnel configuration studies

Presentation was made (Lackowski) on the on-going studies of several main linac tunnel configurations, including near surface tunnel and cut-and-cover solutions. The studies at Fermilab are attempting to make a comparative of several possible options of layout. The RDR solution is used as the basis for the requirements. Special modifications will be made to accommodate the proposed SB2009 single-tunnel configurations.

During the course of the discussions, several questions were raised concerning the central region configuration, and in particular whether or not this will also use a single tunnel solution. A question was also raised on whether – given the SB2009 focus on a single-tunnel – studies of the double-tunnel options should be continued (PM action item).

As part of the comprehensive studies, safety issues (US) as well as new cost estimates for civil (were needed) are being addressed.

CFS Issues – HLRF

A comprehensive review was given of the CFS solutions for the three HLRF solutions under discussion – RDR, DRFS and Klystron Cluster.

It was noted that the Klystron Cluster scheme requires four more additional surface buildings and shafts (cf RDR), and that this may be constrained by geographical and topological constraints of a given site. Specifically, implementation of the klystron cluster at the Asian sample site, which is characteristic of a mountainous region with near horizontal access tunnels (instead of shafts) would either require larger, less frequent surface clusters, serving longer sections of linac, or underground cluster units. Both options look less attractive. As an alternative, DRFS may offer cost benefits for a single tunnel solution in such a topology. Safety issues were also briefly compared across the options.

It was agreed that the impact of both the DRFS and Klystron Cluster single tunnel configurations on *all three RDR sample sites* should be considered to an equal and adequate level of detail.

Central Region Integration

Several key questions remain for the central region configuration, especially concerning CFS. The two top-level questions concern the overall layout and the need for a service tunnel:

- Overall beamline layout geometry (across IR): The e+ side does not require the photon target doglegged bypass which is a saving in tunnel length. However, this introduces an asymmetry between e+ and e- BDS layouts. An acceptable solution still needs to be proposed.
- While it is a WA that all the beamline components can be made to fit in the same tunnel, there remains the question as to where all the support components will be housed (power supplies, klystrons, etc.) This is most critical in the areas of high-component density (around e+ target and capture, parallel to 5GeV booster linacs etc.) An initial working assumption is to assume a contiguous service tunnel in the central region. As a second iteration, the service tunnel will be replaced by alternative solutions (shafts, underground vaults or alcoves) if this is deemed more cost effective. Alternative solutions for power supply layout, including availability issues is also an important aspect of this optimization.
- The need to pay attention to installation requirements was noted. The planned 3D CAD integration models will help evaluate these issues.
- For the e- source, it was noted that a separate a separate independent housing should also be kept as an option, as it that would allow early commissioning of the e- DR (and potentially the e+ DR with electrons). It was also noted that the geometry of the sources is additionally constrained by the requirements of spin rotation going into the damping ring, and this needs to be taken into account by any integrated geometry considered.

Positron Source

The proposed SB2009 remains the undulator-driven RDR source with the following differences:

- The complete system is moved to the end of the main electron linac to facilitate better (cheaper) central region integration.
- A quarter-wave transformer should be assumed for the optical matching device.

The first point has ramifications on the luminosity for E_{cm}<500 GeV running. A set of scenarios will be simulated and presented at ALCPG. The choice of production margin (captured e+ per initial e-) is a critical parameter. Suggested scenarios are to study values of 2 at E_{cm} = 500 GeV, and 1.5 at E_{cm}=300 GeV (the RDR values).

It is also intended to include an auxiliary 'conventional' source which would be housed in the same central region beam tunnel, and use the same photon target. The source should be capable of producing a positron current of a several % of the nominal. This source is to replace the original RDR 'keep alive' source proposed in the RDR.

Much of the discussion was focused on the perceived risks associated with the concept, in particular

- Emittance preservation of the high-energy electron beam in the undulator.
- Engineering solution / feasibility of the high-velocity rotating target in vacuum.
- Survivability of the target – primarily due to the induced shock-waves. (It was noted that the reduction in capture efficiency by the adoption of the QWT (~40% effect) would need to be compensated the equivalent higher incident photon power on the target.
    - Two alternative capture devices (flux concentrator and lithium lens) are currently being conceptually studied, and the results will be available for evaluation towards the end of the year.

An alternative independent electron driven source based on a 300 Hz s-band linac with either a liquid lead or a so-called "hybrid" target is also being considered. A complete integrated solution for this source is still required (and is strongly encouraged, although it is noted that lack of resources may make this difficult). R&D on some of the key components such as liquid lead target and the Boron Nitride windows will be made at KEK (although not at full spec.) Much of this R&D has potential benefits for either source.

Although support for polarised positrons was on briefly discussed, It was noted by the MDI representatives that a polarised source would likely find more support in the detector and physics community than a non-polarised source.

Damping Rings

The proposal and options to reduce the circumference of the DR were discussed. It was noted that the DR design work and R&D goals have been set by the most aggressive of the RDR 'parameter plane' requirements, which the SB2009 proposed parameters do not exceed. A lattice for a 3.2km race-track ring exists, and as such the evaluation of SB2009 cost differentials is relatively straightforward.

A primary limiting risk remains the collective effects in both rings, and specifically the e-cloud in the positron ring. The SB2009 parameters effectively do not change the risk for e-cloud (current remains the same as the RDR nominal value).

A discussion on the 'upgrade' potential from the SB2009 proposed 1312 bunches back to the current RDR nominal value of 2623 immediately identified bottlenecks. While the kicker speed is considered to be achievable for a doubling of the bunches (already the R&D goal), the effective doubling of the current is certainly critical with respect to e-cloud.

It was noted that a reduction of the ring circumference by another factor of 2 (~1.6km) was conceivable for the SB2009 bunch parameters. While this would also increase the beam current by a factor of two, the smaller ring would not require damping wigglers, which are the primary source of e-cloud effects.

The Working Assumption is to continue with the 3.2km option, but attempt to quantify the current limits due to e-cloud (on-going R&D). The smaller ring – which would almost be identical to the proposed B-factories – is attractive and will be further considered in parallel.

Ring to Main Linac

Adoption of SB2009 single-stage compressor appears straightforward. Performance (emittance preservation) is comparable to two-stage RDR design (few nm of vertical emittance growth after tuning). Dominant cost-reduction due mostly to CFS (~200m reduced tunnel length, shaft and alcove reduction etc.)

Coupler kicks and wakes remain an issue and may require adjustable tilts on the cryomodules (micro-movers).

Design work on new emergency and tune-up extraction line and dump on-going and proceeding well.

Noted that single-stage compressor reduces flexibility of bunch length tuning, and does not support compression rations much above a factor of 20.

During discussions, it was noted that no reference was made to the phase and amplitude stability requirements for the bunch compressor RF, which should be re-evaluated for the single stage system.

There was a brief discussion on sensitivity of the long return line to time-varying stray fields. A programme of measurements is on-going in accelerator housing at Fermilab. Some concerns were raised about single-tunnel issues, particularly for concepts where the RF power sources are in the tunnel.

Component counts and modified CFS requirements for cost differential estimate should be straightforward.

BDS/MDI

An update on the lattice design work for SB2009 was presented. The work is currently focused on shortening where possible the BDS lattice (maintaining 1 TeV compatible geometry, but allowing more synchrotron radiation emittance growth at that top energy), and design of a low-emittance dogleg system for the positron target (strictly speaking part of the source system). Work is progressing well and the lattice presented is a good Working Assumption to allow the central region integration work (CAD 3D visualization) to proceed.

Several questions remain concerning location and geometry of the emergency extraction line (upstream of positron source undulator) and the design of the positron BDS system (symmetry arguments already covered in the Central Region Integration above). Working Assumption on these issues should be defined over the next weeks as part of the integration effort.

It was noted that the current reduction in length of the FFS allowing for higher emittance growth at 1 TeV is only of the order of ~100m. Further optimization of the lattice is expected over the remainder of the year.

No detailed solution for the travelling focus implementation currently exists. The current idea is to use an additional crab-cavity in conjunction with the sextupoles in the final doublet to produce the waist shift along the bunch. The parameters for the crab cavity appear less challenging than the required crossing-angle crab cavity requirements. It was not that it is only necessary to allow suitable space in the lattice for the cavities for the integration activities.

Comparisons of solutions for the positron source target chicane were presented. The shortest system presented had an offset of 1.5m for the target clearance at a location in the lattice where there is ~50m drift to avoid interference. This lattice will be assumed for the initial integration studies.

It was noted that the MDI groups need the IP beam parameters for the travelling focus case to evaluate the impact on beam-beam backgrounds on the performance of the detectors. The travelling focus scheme itself still requires further (simulation) study.

Estimating Cost Increments

Cost comparison tables will be produced by the AS Groups, Main Linac Technology Groups and the CFS Groups. These will be translated to ILCU by the TDP Cost Engineers (Tetsuo Shidara, Wilhelm Bialowons and Peter Garbincius) and returned to the Project Managers for review.

The translation process was discussed and agreed upon at the meeting. In general, (there may be exceptions), the technical Groups will provide component count differences and new component estimates, in present-year currency and labour basis, to the cost engineers. The cost engineers will apply local de-escalation and use the international currency exchange rates established during the development of the RDR Value estimate.

Development of the new costing-tool (ICET) is almost complete, and it will first be used to consolidate the RDR cost basis. The tool will support the estimate of the cost differential estimates during the SB2009 studies.

It was noted the tool would allow the original RDR cost estimate (for the RDR baseline) to be updated during the TD Phase.

Wilhelm Bialowons reported on the basis of the RDR cost estimate for the SCRF cryomodule. A simplistic model for the yield was assumed for the cavity production cost estimation: 125% cavity over-production, of which 20% is assumed to fail the acceptance test of ≥35 MV/m (first test) –

effectively a production yield of 80%. Bialowons noted that this was a conservative model for the purposes of the cost estimate.

Bialowons also emphasised that the RDR cryomodule cost was based substantially on the TESLA industrial studies by Babcock Noell and ZANON. The model used was a “single-vendor” model, where a single firm was requested to construct all cavities and cryomodules. Bialowons noted that assuming more than one vendor (potentially several, if we accept one or more vendor per region) could incur a significant cost increase over the single-vendor model, citing general learning curves as a rough basis for scaled estimates.

Other (Concluding) Remarks and Discussions

Risk Register

A stated deliverable for the DESY meeting was an update of the Risk Register, both for the RDR (review) and SB2009. It was soon apparent that this process must be driven top-down by the Project Management, in order to establish a rationalisation of ‘risk’ across the entire design which is consistent. It was noted during the discussions that the original RDR register contained mostly low risk entries. The Risk Register was consistent with the findings and prioritisations of the RDR R&D Board, which independently accessed the risks of the design.

With this in mind, the Project Management will make a re-evaluation of the risk register, taking into account the input received at the meeting. The updated register will then be released for feedback and comment. A final agreed-upon register should be a goal for ALCPG.

Availability Studies (task force)

It was acknowledged in the meeting that issues pertaining to operations and availability are central to the support for a single tunnel solution for the RTML and Main Linac. However, there was no discussion of the issues beyond this at the meeting itself, which focused on technical details of the mechanical layout and parameters. The PMs will form an Availability Task Force to begin the job of assessing and quantifying the availability issues for SB2009. It is expected to attempt to quantify availability using the AvailSim tool. A general approach will be to:

- Prepare to assess/quantify the availability for both the proposed single-tunnel HLRF solutions. This will require setting up the component counts and estimating the required input parameters for the operational model in both cases.
- Review the input numbers (MTBF) and operational model (maintenance model etc.)
- Identify parametric studies of key parameters in the model
- Evaluate possibilities of independent checks on the results

Comments on RDR and TDR

A discussion on the relevance of the RDR in TD Phase 2 was had, and in particular the role of the RDR design in the TDR documentation that is intended for submission for approval. The design configurations and associated cost estimates (stated TDR deliverables) are expected to be an evolution of the current RDR baseline. SB2009 is a set of proposals for modifications to that RDR baseline which – if approved early 2010 – will form the basis and focus of all the technical work in the next years leading up to the TDR. As noted before above (Estimating Cost Increments), we do intend to maintain and update the RDR cost base during the technical work on the TDR configurations, but no further technical (i.e. CFS) design work on that baseline is expected.

Summary of Action Items (now until ALCPG meeting)

Area	item	Action Item	Lead responsibility	Comments
General	0	Prepare spreadsheets (WBS-like) with approximate modified components counts and CFS requirements for cost evaluation (see #3 and #4)	All TAG leaders	
Cavity Yield	1	Consolidate global legacy test data into a single database	Ginsburg	
	2	Clearly define 'acceptance criteria' and 'yield' to be applied to the data in #1	Geng	
CFS	3	Schedule WebEx meetings with responsible area contacts	Kuchler	done
	4	Prepare feedback questions for TAG group meetings (requirements)	Kuchler	
	5	Evaluate SB2009 requirements and generate cost differentials	Kucher, Garbincius	2008 Klystron cluster used as model
	6	Evaluate impact of both HLRF solutions on all three sample sites	Kuchler, Osborne, Enomoto	
	7	Compile/review safety solutions for single-tunnel	Kuchler, Osborne, Enomoto	
HLRF/CFS	8	Update DRFS single tunnel integration models to include utilities, services and other (non-RF) hardware	Enomoto, Fukuda	
	9	Consider possible DRFS tunnel solution with cryomodules supported from the floor	Enomoto, Fukuda	
	10	Identify/maximise common design features between both HLRF solutions	CFS + Fukuda, Adolphsen	
E source	11	Evaluate integration in central region tunnel (incl. spin rotation issue)	Brachmann, Paterson	
	12	Consider options for independent source housing / DR integration	Brachmann, Paterson	

P source	13	Explore parameter options for end-of-linac operation (as a function of energy) for the following scenarios: yield of 2 at 250GeV; yield of 1.5 at 150 GeV; QWT and Flux Concentrator and/or Li lens options.	Clarke	
	14	Produce comprehensive target shielding curves (rate vs concrete shielding thickness) for above schemes	Clarke	
	15	Supply envelope dimensions ("box") for target and capture station	Clarke	
	16	Compile review of existing beam dynamics simulations (emittance preservation)	Clarke	
	17	Compile available documentation on target engineering solution	Clarke	
	18	300 Hz source - prepare exact comparison charts for planned R&D tests	Omori, Urakawa	Planned R&D at ATF
	19	300 Hz source - Identify scope and resources required for integrated design work	Clarke, Omori	Begin planning for a more integrated source design.
DR	20	For 3.2km ring, what are the estimated limits on bunch charge and number?	Guiducci	Best estimate based on current understanding of e-cloud limits and thresholds.
RTML	21	Review and re-evaluate stray-field tolerances in long return line	Solyak	
	22	Review and re-evaluate phase and amplitude stability requirements for single stage compressor	Solyak	
BDS/MDI	23	Supply presented lattice with TME dogleg to Walker for CAD3D integration (see slide 6 in BDS/MDI presentation)	Angal-Kalinin	
	24	Attempt to quantify scaling for L* on FF length, impact on collimation etc.	Seryi	Is L* an FF cost driver?
CRI	25	Proposal for overall lattice geometry solution including IR asymmetry	Paterson, Walker	cut and paste existing lattices and look for first-order solution

Management	26	Form availability task force and define plans/studies	PMs	
	27	Top-down re-evaluation and update of RDR risk register	PMs, Paterson	Will require iteration with TAG leaders and review of definition of risk quantification (including cost impact)

SB2009 Proposal (Working Assumptions for ALCPG)

General parameters

parameters not explicitly quoted are assumed the same as in the RDR)

		RDR	SB2009		comment
Beam and RF Parameters					
No. of bunches		2625	1312		low-power option
Bunch spacing	ns	370	740		
beam current	mA	9.0	4.5		
Avg. beam power (250 GeV)	MW	10.8	5.4		
Accelerating gradient	MV/m	31.5	31.5		
P_{fwd} / cavity (matched)	kW	294	147		
Q_{ext} (matched)		3×10^6	6×10^6		
t_{fill}	ms	0.62	1.13		
RF pulse length	ms	1.6	2.0		
RF to beam efficiency	%	61	44		
IP Parameters					
Norm. horizontal emittance	μm.μr	10	10		
Norm. vertical emittance	μm.μr	0.040	0.035		
bunch length	mm	0.3	0.3		
horizontal β*	mm	20	11		
horizontal beam size	nm	640	470		
			no trav. focus	*with trav. focus*	
vertical β*	mm	0.40	0.48	0.2	
vertical beam size	nm	5.7	5.8	3.8	

D_y		19	25	21	
$\delta E_{BS}/E$	%	2	4	3.6	
Avg. P_{BS}	kW	260	200	194	
Luminosity	$cm^{-2}s^{-1}$	2×10^{34}	1.5×10^{34}	2×10^{34}	

General Layout Assumptions

Approximate values

	RDR	SB2009		comments
RTML / Main Linac housing	service + beam tunnel	single (beam) tunnel		
HLRF		*Configuration A*	*Configuration B*	
Layout	10MW MBK driving 26 cavities	Surface Klystron Cluster	DRFS	
Num. of klystrons (both linacs)	560 × 10MW MBK	~280 × 10MW MBK	~3600 × 800kW MAK	
Location	Service tunnel	Surface buildings (every ~2km)	Beam tunnel	
PDS	distribution system connecting three cryomodules (26 cavities) via penetrations between service and beam tunnel.	• 18x10MW MBK cluster • 180 MW transport via over-moded WG into tunnel • Drives ~1000 cavities	800kW MAK directly drives 4 adjacent cavities locally.	
Modulators	560 Bouncer-type modulator in service tunnel	~230 Marx-type modulator located in surface cluster buildings	~3600 MA modulators distributed in tunnel.	
RTML/ML power supplies, electronics	located in service tunnel	located in tunnel	located in tunnel	
Damping Ring	2x 6.7 km circumference ring	2x 3.2 km race-track ring		
Damping Ring bunch length	9 mm	6 mm		
Bunch Compressor	two-stage, compression x40 (max)	single-stage, compression x20		
Positron source	undulator @ 150 GeV point	undulator at exit of ML (250 GeV)		
Positron source yield (e+/e-)	1.5	~2 at 250 GeV (TBC)		
Positron capture device	pulsed flux concentrator	QWT		
Length of undulator	~200m	TBD		

Aux. positron source	Independent 10% charge “keep alive” source	few % auxiliary source integrated into beam tunnel, using same target and capture sections.	
General central region integration			
• Undulator source now integrated between ML exit and start of BDS • Integrated auxiliary source (few %) using primary photon target and capture/acceleration • electron source integrated in upstream positron BDS tunnel • optimised (minimum) use of shafts, etc.			