



# BAW-2

## Low Beam Power Undulator Source Relocation

Assumptions and questions needing  
work before BAW-2

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AD&I WebEx Meeting 15.09.10



## Low P Questions

- 1312 bunches with  $2 \times 10^{10}$  per bunch up to 500 GeV?
- Low energies use 5 + 5Hz mode or new undulator? The latter is new but has many benefits both technical and cost!
- Have parameters for all energies?? What about 5Hz and shorter period undulator? Or 1TeV with only 1312 bunches?
- Assume 2 X 3.2 km DR's in tunnel designed for 3 rings? Or is it 4? Need answer to whether a single E- ring can handle 2625 bunches and have 3ns kickers?
- Operation at all energies uses TF and multipart Q1?
- 1 Tev needs discussion and work! Separate upgrades in energy or luminosity or consider only one combined?
- Do we have a satisfactory E-DR design for 10Hz including modulated high power RF system which could share a tunnel with 2 E+ rings?



# Low P Questions

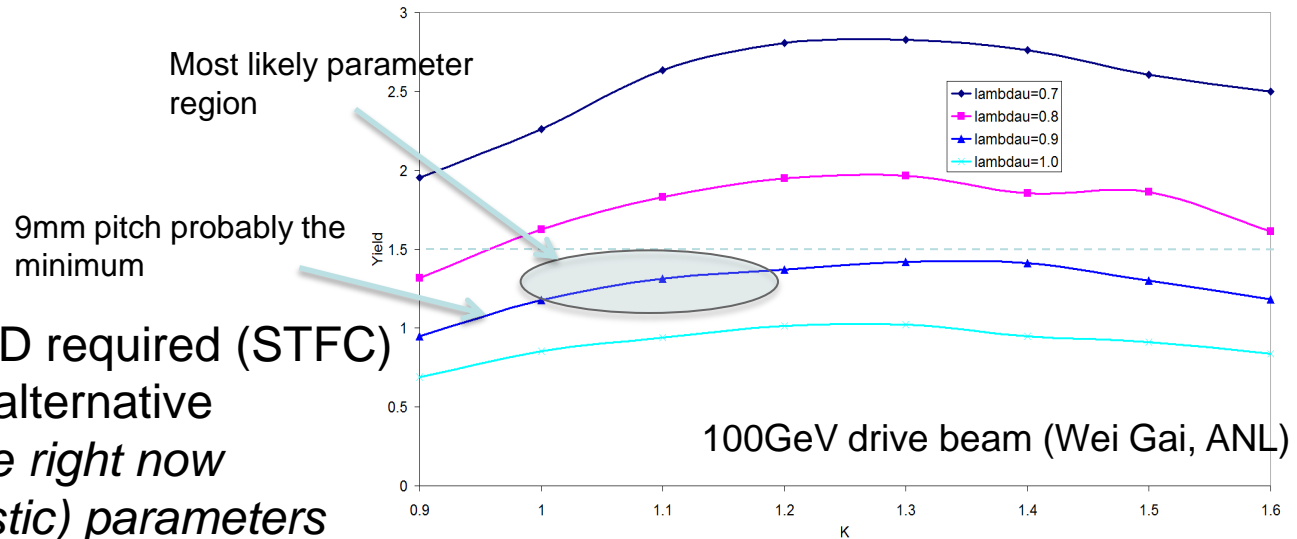
## 1312 bunches with $2 \times 10^{10}$ per bunch up to 500 GeV?

- Our focus is now on the agreed Ecm values of
  - 200 GeV
  - 230 GeV – recently requested (to be added to tables)
  - 250 GeV
  - 350 GeV
  - 500 GeV
- Our goal (Working Assumption) is to provide a constant (positron) bunch charge across this region
  - unlike 2009 December proposal
- This is still assuming the e+ source to be located at the end of the electron Main Linac
  - as part of the central campus integration / consolidation
- For the 200, 230 and 250 GeV parameter sets, this will require adoption of
  - 10Hz alternate pulsing scheme
  - Adjustment (optimisation) of undulator parameters
  - Possible high field / short wavelength undulator (Nb<sub>3</sub>Sn technology → R&D)
- Incremental cost estimation requires review before January BAW
  - currently 1.9% RDR TPC (mostly DR)



# Low P Questions

- **Low energies use 5 + 5Hz mode or new undulator? The latter is knew but has many benefits both technical and cost!**
  - Already briefly mentioned in previous slide.
  - Goal is to produce undulator capable of producing a yield of 1.5 at 100 GeV beam energy (200 GeV CM).
  - No need for 10Hz operation to produce positrons BUT
  - 10Hz concept could be used to effectively double the luminosity at low Ecm (no 50% DR duty cycle problem) *interesting concept! But still needs short damping T*



Proof of principle R&D required (STFC)  
Possible (attractive) alternative  
*but too immature right now*  
Need possible (realistic) parameters

*(not the only example in machine of solutions still requiring R&D)*



# Low P Questions

- **Have parameters for all energies??**
- **What about 5Hz and shorter period undulator?**
  - To first order will impact energy spread and possible reduce bunch charge (tbc)
  - We can produce alternative parameter sets (across range) when undulator parameters are settled.
  - But given risk in very novel technology, should we propose this as our TDR baseline?
- **Or 1TeV with only 1312 bunches?**
  - 1312 bunches would be a conservative approach, if we assume the reduction in L
  - Parameter set with TF has already been requested; linked to the question above?
    - if we believe it works for the current 500 GeV parameters, why will it not work for 1TeV?
  - Current TeV parameter set assumed beam power upgrade, either already before upgrade, or as part of the TeV upgrade (see later question)
  - TeV parameter set is “far reaching”. We can be aggressively optimistic and accept a high-risk at this time
    - We will understand the performance and limitations of our machine much better when we finally begin to plan the energy upgrade
  - **To do: produce additional parameter sets**
    - note possible combinations will generate several new sets
      - and possible confusion and much work!
- **After first round of discussion, publish guidelines defining limited subset of parameters to be studied for BAW-2**



# Low P Questions

- **Parameter sets accounting:**
  - 6 centre-of-mass energies (incl. 1TeV upgrade)
  - With or without Travelling Focus (x2=12!)
  - With or without beam-power ‘upgrade’ (x2=24!!)
  - Various other ‘scenarios’ (x2=48!!!)  
(e.g. positron source, say two options)
- **Clearly some “management” required here!**



# Low P Questions

- **Assume 2 X 3.2 km DR's in tunnel designed for 3 rings? Or is it 4? Need answer to whether a single E- ring can handle 2625 bunches and have 3ns kickers?**
  - Working assumption is design for 3 rings in a single 3.2km tunnel and initially install 2
  - Space for third ring can be consider as (a) risk mitigation if design luminosity is not achieved, (b) possible lumi upgrade path, if original goal performance is achieved.
  - we assume that doubling the current in the e- ring is acceptable (needs study of collective effects – on-going), and that the DR kicker is available by that time,
  - and that a doubling of the e+ current is constrained due to e-cloud (risk mitigation)



# Low P Questions

- **Operation at all energies uses TF and multipart Q1?**
  - Partly covered in previous answers
  - If we believe these options to be feasible, then there is no reason to assume they cannot be applied across the board
  - Acknowledged risk in TF is why we have produced parameter sets without using it (lower luminosity); these should be considered as more conservative options.
  - **Risk in new Q1 configuration still requires qualification**
    - note this solution is specific to Low Ecm running





# Low P Questions

- **1 TeV needs discussion and work! Separate upgrades in energy or luminosity or consider only one combined?**
  - A focused study of the energy upgrade is still to do and is planned for 2011
    - leading to white paper (input to TDR)
  - The parameter sets can be aggressive but should be treated cautiously
    - Upgrade will be after several years of operation and experience
  - Upgrading the beam power (lumi) can be treated separately
    - (see later)
  - However, *when* it happens is an open question. Current TeV parameter set assumes it happens, but says nothing about when
    - at the latest as part of the energy upgrade
  - Note we have already proposed to generate a TeV parameter set(s) based on the reduce bunch number
    - i.e. no beam-power upgrade



# Low P Questions

- **Do we have a satisfactory E-DR design for 10Hz including modulated high power RF system which could share a tunnel with 2 E+ standard rings?**
  - Not at this time
  - Requires study and ideas on how best to approach this problem
  - Producing one (or more) cost-effective schemes for the RF should be a priority goal for this year (and before the January BAW)

Action item for Geneva Workshop!



# Beam Power Upgrade

- **AAP/PAC – allow path back to 2600 bunches as**
  - risk mitigation or
  - possible lumi upgrade
- **Need to understand the scope of this statement (for costing)**
  - Already WA is to leave room for second e+ DR
  - CFS support for additional RF power?
    - different scope for KCS, DRFS, RDR HLRF Tech.
- **Needs some guidelines for this discussion**
  - e.g. include additional CFS upfront



# Other Issues (Studies)

- **Travelling Focus requires more study (AAP)**
  - simulation work
  - Understanding better the tolerances / stability
    - requirements for feedbacks etc.
  - Particle tracking (not just Guinea Pig)
  - Understanding how to tune-up the TF by adjusting the crab cavities
    - relationship / dependence on other FF tuning
- **Consolidation of parameter tables**
  - cross-check numbers (add GUINEAPIG simulations)
  - Fill in existing gaps (missing numbers)
  - Add additional parameter sets (identified in this talk)
  - Begin to add machine sub-system detailed parameter tables
    - consisted with IP parameters
- **Feasibility of Final Doublet concept?**
  - R&D plan?

Resources!



# Summary of Action Items

- **Consolidation of formal Ecm parameter sets (NW, JMP, AS + P&D)**
  - clearly not all permutations!
  - will define scope of studies
  - Add GP numbers to tables
- **RF Solution(s) for 50% duty cycle in e+ DR (S. Guiducci et al)**
- **Further simulation studies of Travelling Focus operation and performance (K. Kubo et al)**
- **Parameter sets (ranges) for undulator source (J. Clarke et al)**
  - particular for 'gray zone' (200-300 GeV) operation
  - include FC (as well as QWT)
  - Initial estimates of Nb<sub>3</sub>Sn-based solution
- **Consolidate HLRF parameters / requirements for reduced nb solutions**
  - this must include an assessment of supporting the proposed gradient spread from BAW-1
- **Refinement of cost increments (PMs and PHG)**
  - Re-analysis of cost of supporting 10Hz operation
  - DR RF configuration (update) and incl. of 50% duty cycle solution
  - Consolidate cost impact for reduced HLRF solutions (KCS, DRFS, RDR HLRF Tech.)



# Straw-man Schedule (TBC)

| What            | When        | Topics   |
|-----------------|-------------|--|
| AD&I webex      | 13.10.10    | Formal parameters consolidation (scope)  |
| Geneva Workshop | 19-22.10.10 | DR RF solution; Undulator parameters; ML HLRF parameters; DR e-cloud recommendation; cost increment review |
| AD&I webex      | 10.11.10    | TF simulations; P&D studies status   |
| AD&I webex      | 08.12.10    | Discussion of upgrade/risk mitigation scenarios (including cost impact). CFS status.                       |
| AD&I webex      | 05.01.11    | Final review of parameters and cost. Preparation for BAW (programme, proposal drafts etc.)                 |
| BAW-II          | 18-21.01.11 | Too late!  |

Clearly subject to change as we move forward