



# New Light Source Project

## **Status of the NLS Source Design**

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# New Light Source Project

- **Overall concept is that the Stage 1 baseline specification should be buildable “now” based essentially on proven technology with some further development to optimise performance, reduce costs and risk, but no “critical R&D”.**



# New Light Source Project

- **Initial work in 2008 (up to Nov. 19<sup>th</sup>) considered generic normal conducting (NC) and superconducting (SC) linac based machines. Some initial consideration was also given to a recirculating scheme.**
- **Initial costs were estimated for 1, 2 and 3 GeV machines.**
- **Since the decision, primarily for rep. rate reasons, to adopt cw SC technology, we have concentrated only on this option, in both single-pass and recirculating configurations.**



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- **A Science Coordinators meeting on Dec. 12<sup>th</sup> defined the energy ranges for the initial suite of FELs:**  
**FEL1: 50 - 300 eV    FEL2: 250 - 850 eV    FEL3: 430 - 1000 eV**  
with variable polarization. This enabled the first more precise assessment of machine energy.
- **Based on a 8 mm magnet gap, and APPLE-II undulators, the required tuning ranges can be met with a common energy of 2.25 GeV, assuming minimum  $K_{rms} = 0.7$**   
(with the slight compromise that 430 eV in FEL3 can be reached with horizontal and vertical polarization, but not vertical)
- **For historical reasons machine design is currently based on 2.2 GeV – final energy will be fine-tuned later, after taking into account undulator type, gap, vacuum vessel thickness, and operating margins etc.**

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- **Optimisation of the single-pass linac has been performed, and is underway for the recirculating linac. Start-to-end simulations (i.e. gun to FEL output) confirm good SASE output at 1 keV for the single-pass linac (not yet for the recirculating linac)**  
**(R. Bartolini/P. Williams)**
- **Current view is that the FELs will be seeded with laser HHG up to at least 333 eV (200 eV), with 3<sup>rd</sup> (5<sup>th</sup>) FEL harmonic scheme to reach 1 keV. Nominal pulse length 20 fs FWHM.**
  - has the advantage of a common electron beam for all 3 FELs (otherwise, can't generate 20 fs pulses in all FELs if one is seeded and another SASE using the same electron bunch parameters).**FEL simulations show this is feasible using a “real” electron bunch, from the single-pass linac.**  
**(J. Tisch – seed source, N. Thompson – FEL calcs.)**



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- **Conventional laser sources will cover the region from 0.06 eV (20  $\mu\text{m}$ ) – 5 eV and using HHG to 50 eV. (C. Froud)**
- **In a 2<sup>nd</sup> stage a low energy FEL is foreseen: 5-50 eV**  
- electron energy under discussion, affects layout **(N. Thompson)**
- **Synchronised THz/IR (20  $\mu\text{m}$  – 500  $\mu\text{m}$ ) to be provided by Coherent Undulator Radiation (à la FLASH), or alternative CDR/CTR or laser source. Must be synchronised, FEL pulse envelope to IR phase. (N. Thompson)**
- **Capacity for up to 6 FELs with 2 experimental stations per FEL being taken into consideration in the layout. (M. Roper)**



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- **Stage 1 gun will be normal-conducting L-band, 1 kHz, based on a modified PITZ/XFEL gun. Output from the simulation of this gun is being used in the start-to-end simulations. (J-H. Han)**
- **Stage 2 gun: normal-conducting VHF or superconducting, up to 1 MHz (B. Militsyn)**



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## Lots to Do ..

- **Decision on single-pass/recirculating ... default: single-pass**
  - evaluate cost saving vs. compromise in performance
- **Decision on undulator and vacuum vessel**
  - APPLE-II/Delta, in- or ex-vacuum .. **(J. Clarke)**
- **Complete the machine optimisation and define main parameters**
- **Assess tolerances and effect on electron beam quality and FEL output .. and margins:**
  - undulator length ?
  - machine energy ?
  - seed power ?
  - or, lower charge operation ?



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- **Define nominal and minimum output performance (to feedback to science working groups)**
- **Assess sensitivity to jitter (RF voltages, phase, seed laser, power supplies etc.), set realistic tolerances, define output stability**
- **Define overall layout**
  - beam merger/spreader for the recirculating scheme
  - beam switchyard (to allow independent operation of 3-6 FELs)**(D.Angal-Kalinin)**
- **Component specification and design choices**
  - RF, diagnostics, timing, vacuum, controls etc. etc.
- **Outline building design**
  - up-date earlier work
- **Detailed cost breakdown**



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## Timescales

- **Present 1<sup>st</sup> outline facility design at Community Meeting, April 24<sup>th</sup>**
- **Present basis of Outline Design Report to TAC, June 4<sup>th</sup>-5<sup>th</sup>**
- **Present Outline Design Report to PALS and for international review mid-July**
- **Produce Conceptual Design Report and Project Costs ready for Large Facilities Capital Fund submission end 2009.**