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ILC e^- and e^+ sources overview

Jim Clarke

STFC Daresbury Laboratory, UK

On behalf of ILC Positron Sources Group

ILC Electron Source

- Extract from R&D Plan (Aug 2010)
  - Primary on-going R&D for the electron source is the construction and demonstration of a prototype polarised electron source to ILC specifications. In particular, such a facility would enable polarised cathode charge limit investigations in this regime to be quantified.
- R&D Milestones:
  - mid 2010 Procurement of a coherent V18 laser
  - end 2010 Inverted DC gun prototype 2 at 120kV
  - end 2011 Inverted DC gun prototype 3 at 200kV
  - end 2011 Final laser demonstration
  - end 2011 ILC beam demonstration (time structure) using 100kV SLAC SLC gun and cathodes
  - mid 2012 Installation of final ILC test facility (gun and laser) at JLab
  - end 2012 Final beam tests

See detailed talk by John Sheppard

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ILC Positron Source

- Extract from R&D Plan (Aug 2010)
  - **The positron source R&D programme can be separated into two categories:**
  - **R&D on critical components for the baseline source (undulator-driven).**
  - **R&D on alternative source technology (or for the auxiliary source).**

- *Alternative / Auxiliary source R&D*
  - end 2011 Boron-nitride window beam tests at KEK
  - end 2011 Liquid lead target beam tests at KEK

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ILC Positron Source

- *Baseline R&D (Undulator-driven source)*
  - end 2010 Completion of rotating target magnetic eddy-current tests
  - end 2010 Conceptual design study (feasibility) for magnetic flux concentrator
  - end 2010 Conceptual design study (feasibility) for liquid lithium lens
  - end 2010 Source parameters based on possible Nb_3Sn undulator design
  - mid 2011 Demonstration of target rotating vacuum seal using 'surrogate target'
  - mid 2011 Horizontal cold-tests of 4m undulator prototype
  - mid 2011 Conceptual design study (feasibility) for magnetic flux concentrator
  - end 2011 Analyse (simulation) of target shock-wave survivability
  - end 2011 Target radiation damage estimates (lifetime modelling)
  - end 2011 Radiation tests of ferrofluid (rotating seal)
  - end 2012 Prototype module of Flux Concentrator (funding permitting)
  - end 2013 Feasibility of Nb_3Sn undulator

ILC Positron Source Integration

- Model now well developed in CAD
- Accurately reflects lattice decks but there are *no decks in some parts* so have had to make assumptions about layout
- All of the relevant beamlines are included in the model, not just the positron source ones
- The tunnels accurately reflect the current ILC design

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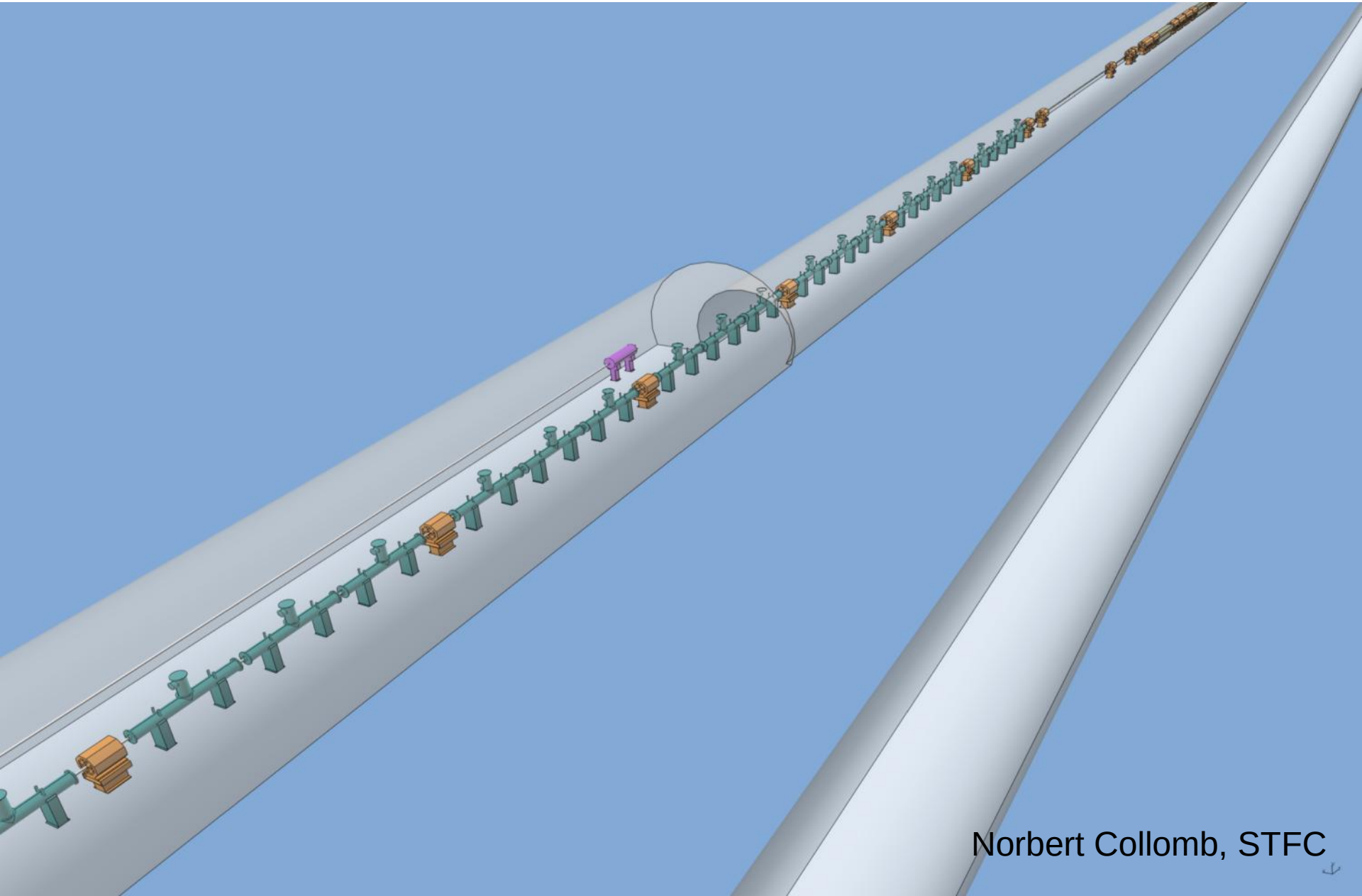
Undulator & Fast Abort Dump



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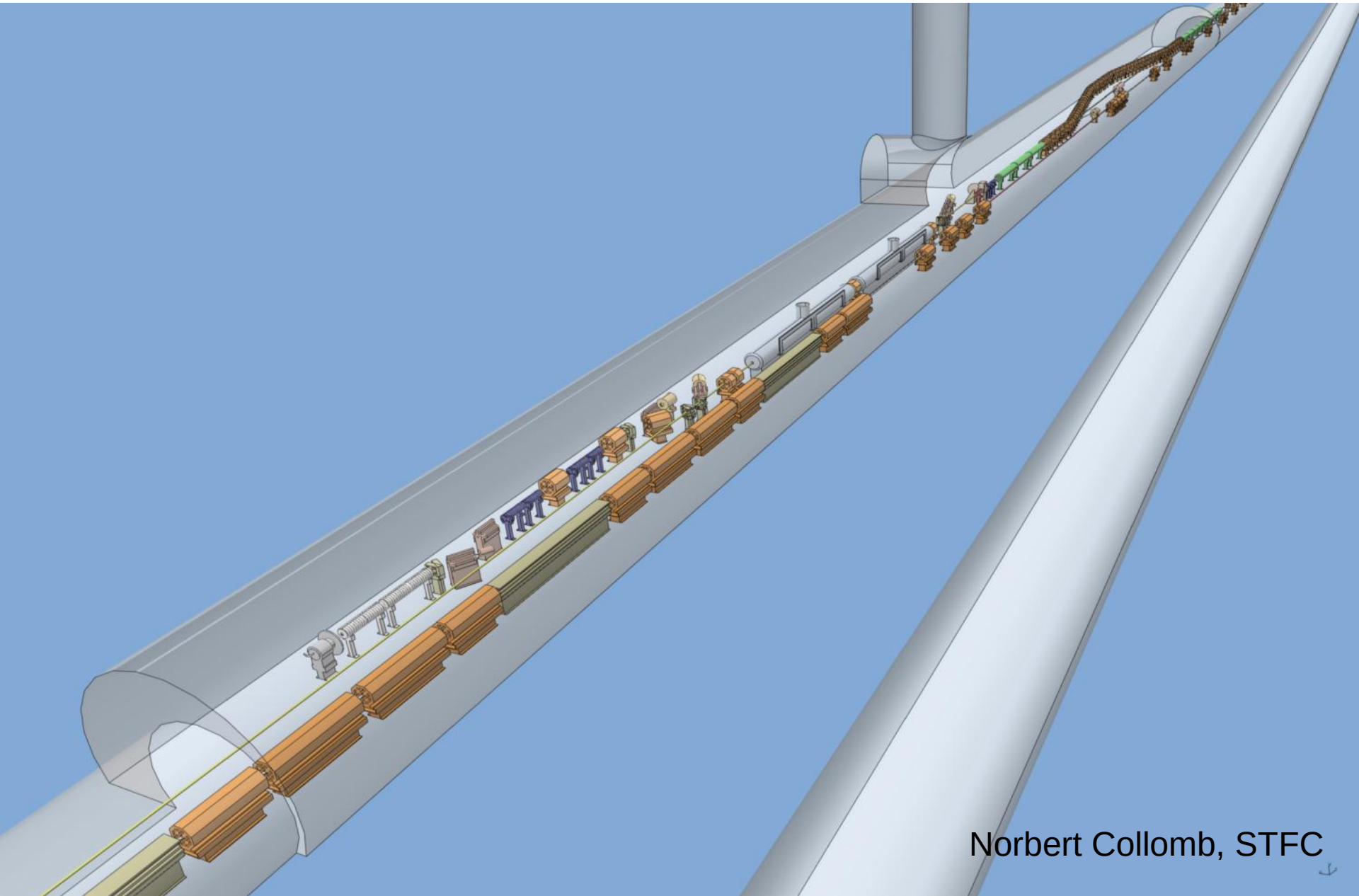
Photon Line, BDS Dog-leg, Auxiliary Source



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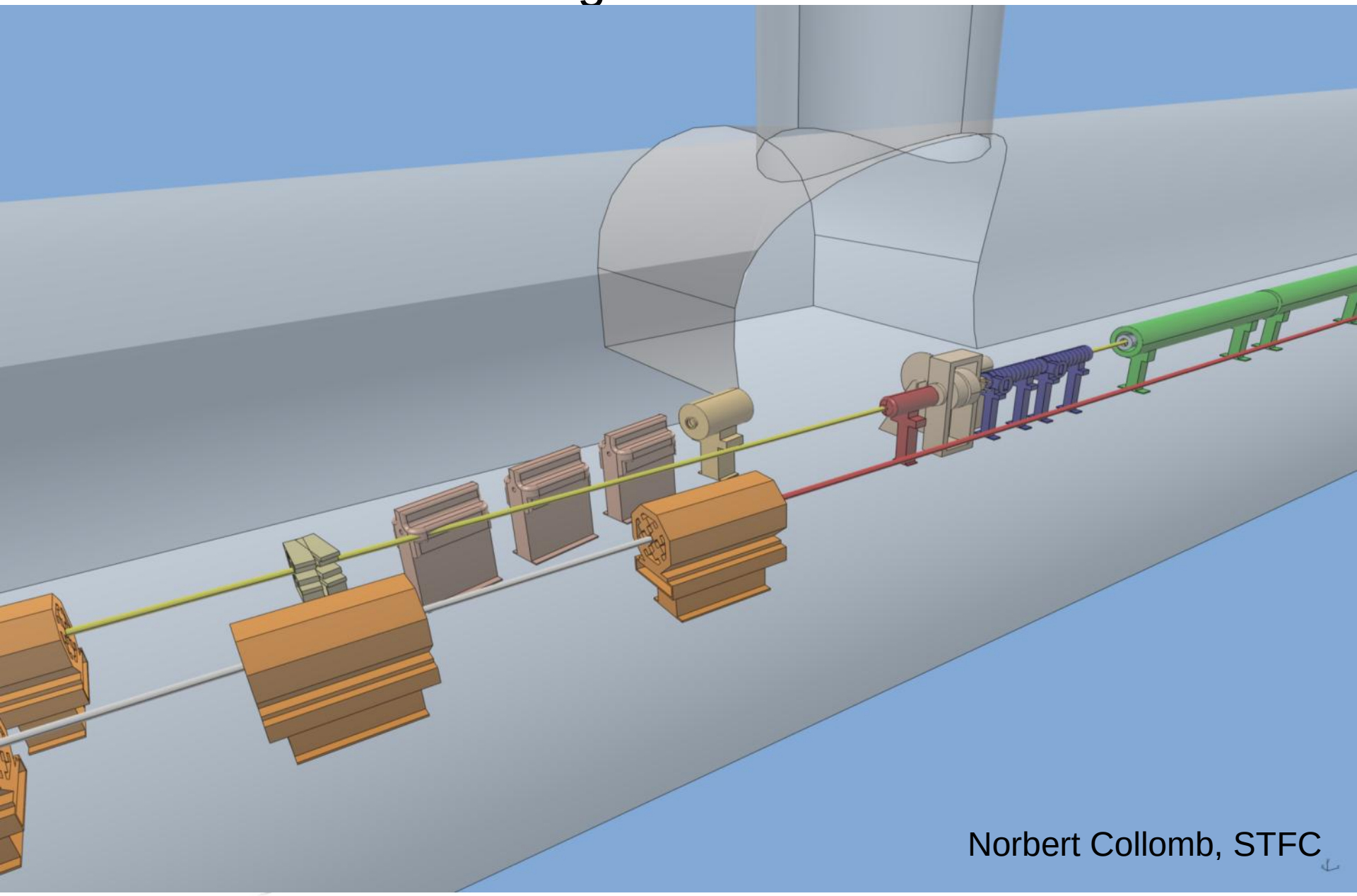
Photon Target, BDS, Auxiliary Source Diagnostic Line



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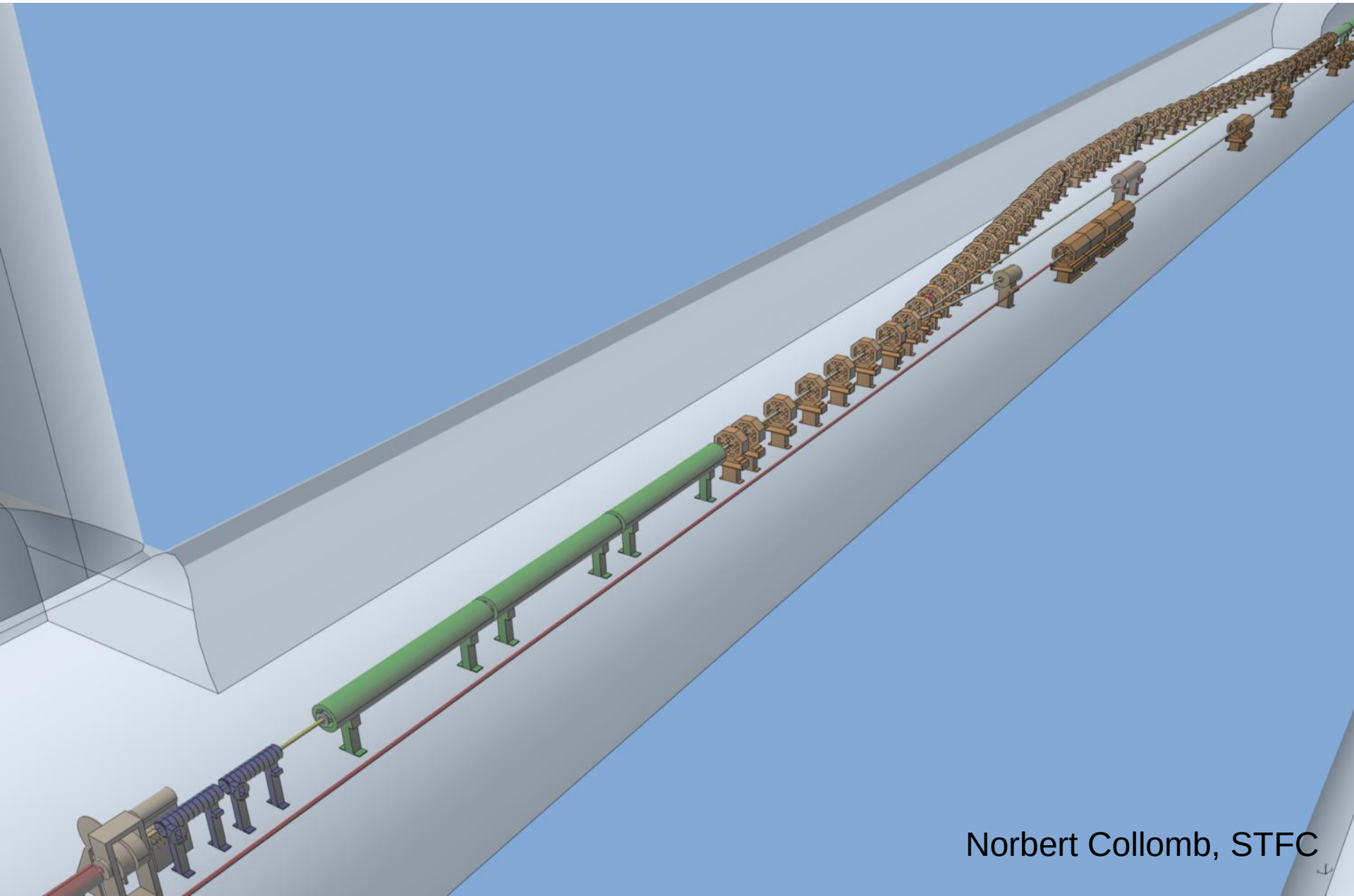
Pre-Accelerator, BDS, Photon Dump



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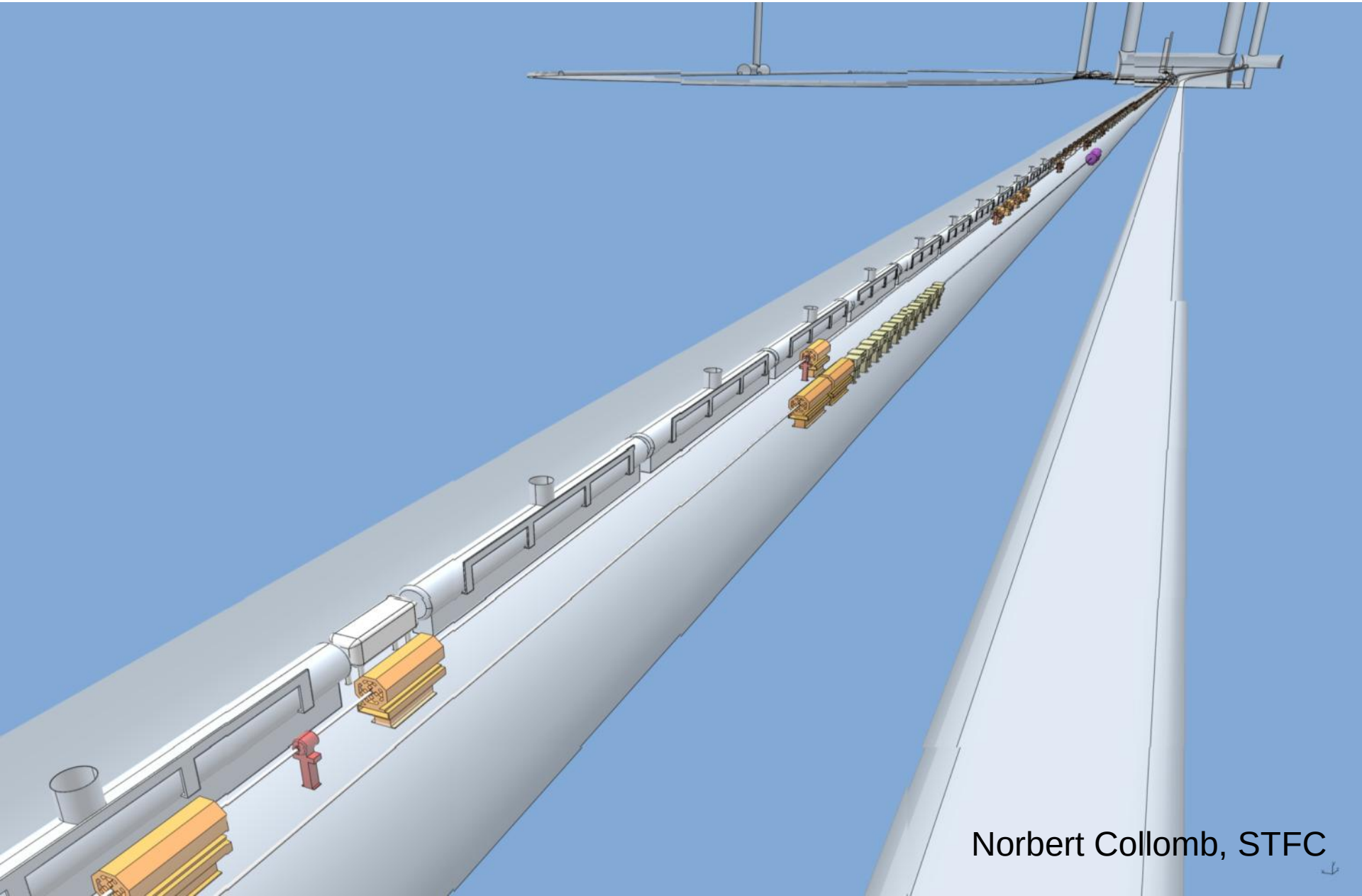
5GeV Booster, BDS, BDS Diagnostic Line and Dump



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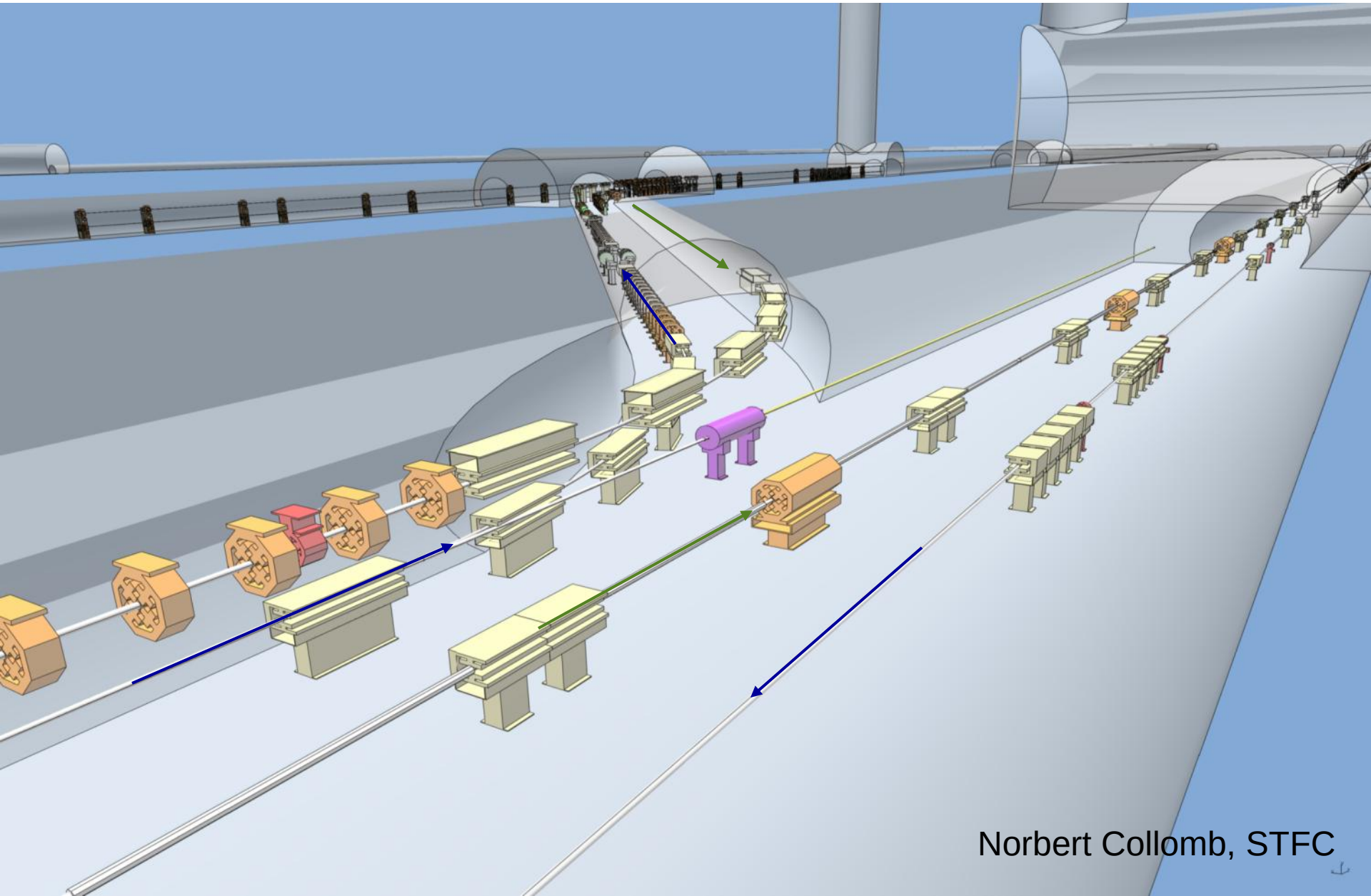
e^+ to DR, e^- RTML, BDS, e^+ line to main dump



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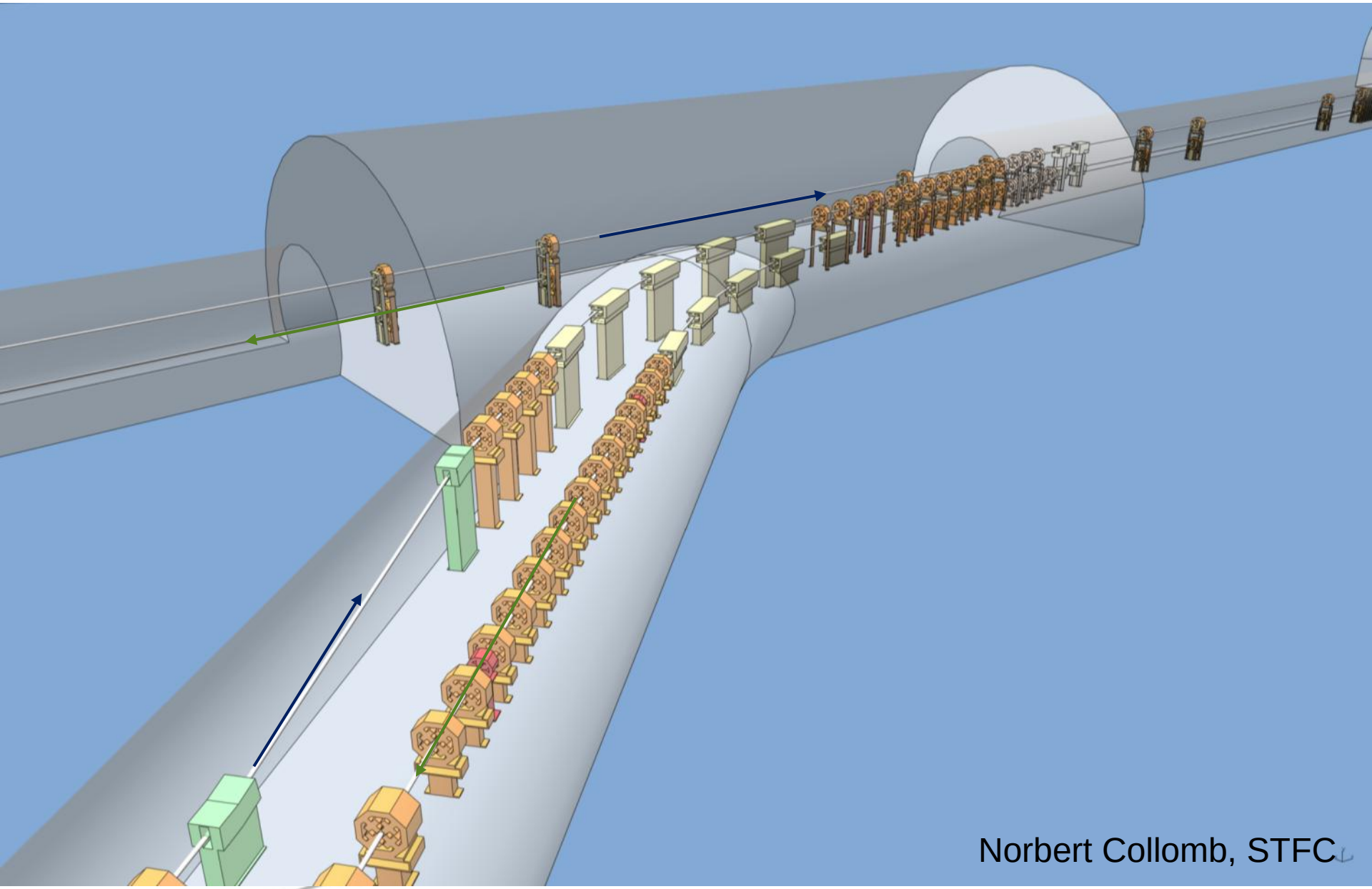
e^+ to DR, e^- RTML, DR



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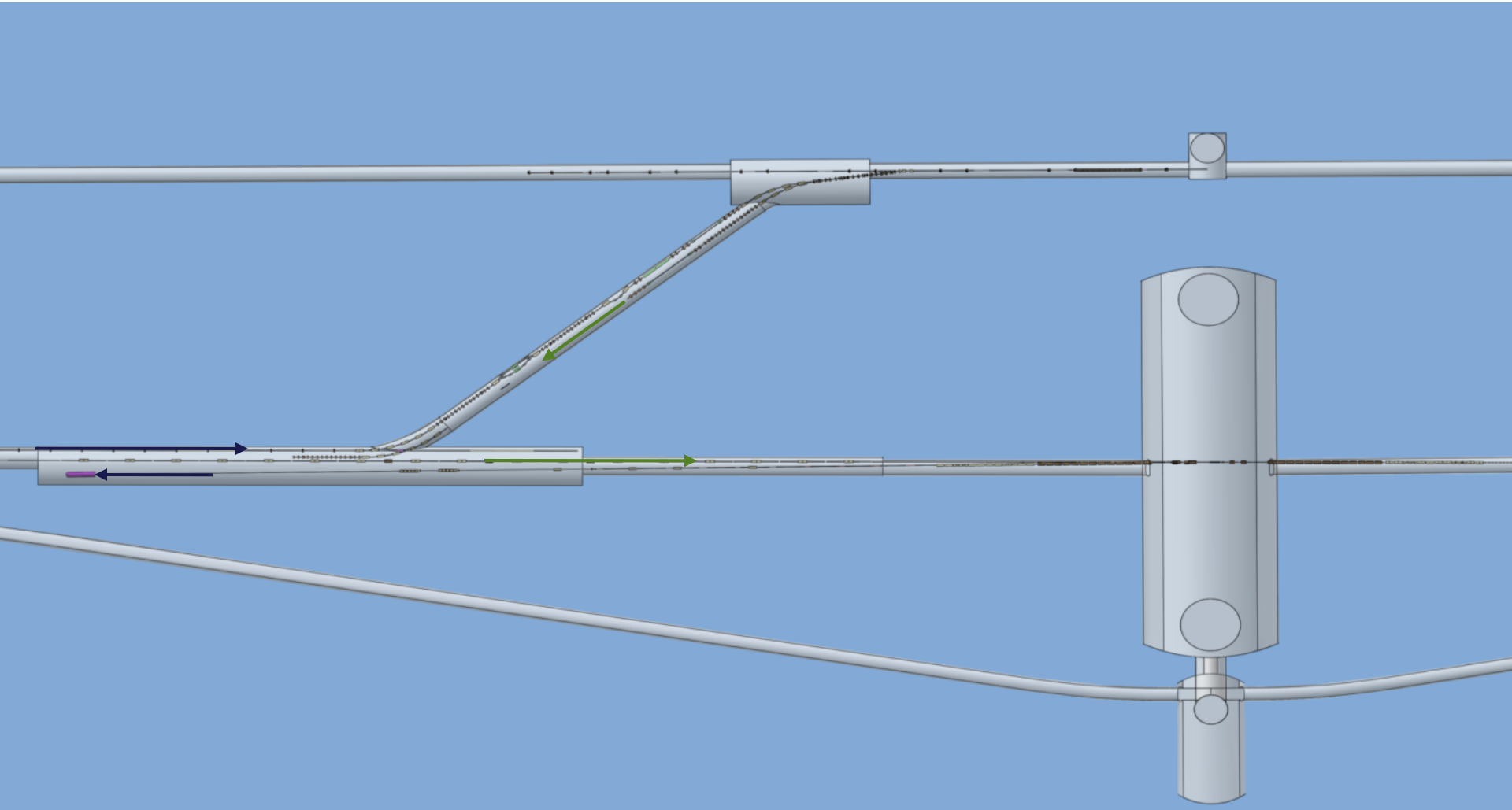
Overall IP Region Layout



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Undulator

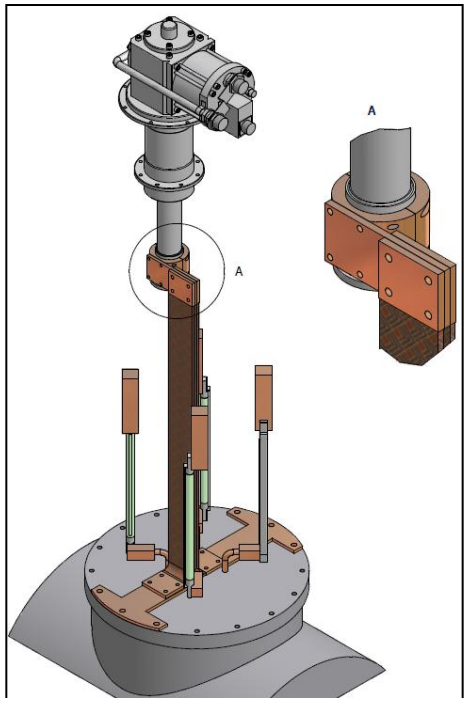
- 2 x 1.75m undulators successfully tested vertically at RAL
- Specification of 0.86T exceeded
  - 1.15T quench limit
- 4m cryomodule assembled but heat load was too high
  - prevented powering of magnets

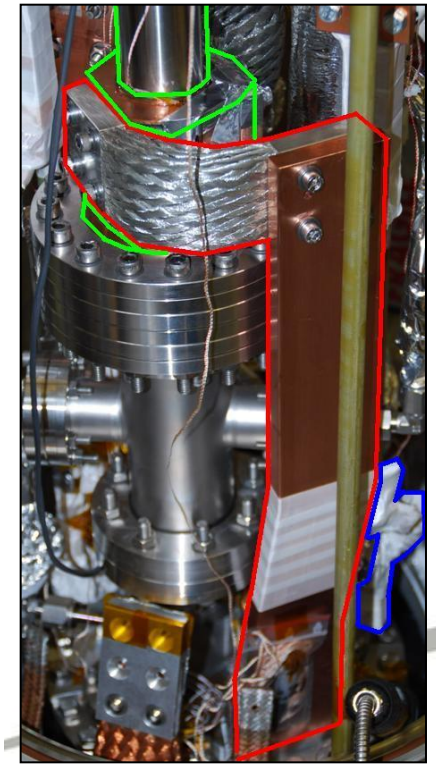
Undulator Cryomodule

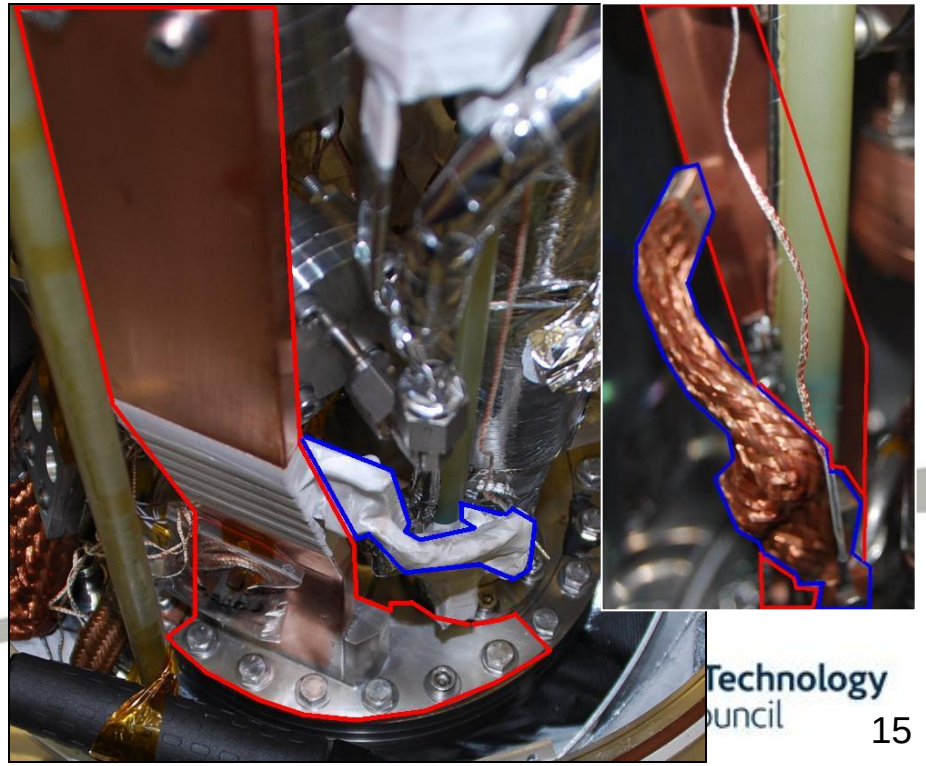
July 2010 – Top plate cooled by cryocooler

It was seen that it did not take much heat input to change temperature of top plate and HTS/LTS join.

Large copper bars have been inserted to cool top plate and HTS/LTS join directly from the 2nd stage of the cryocooler.

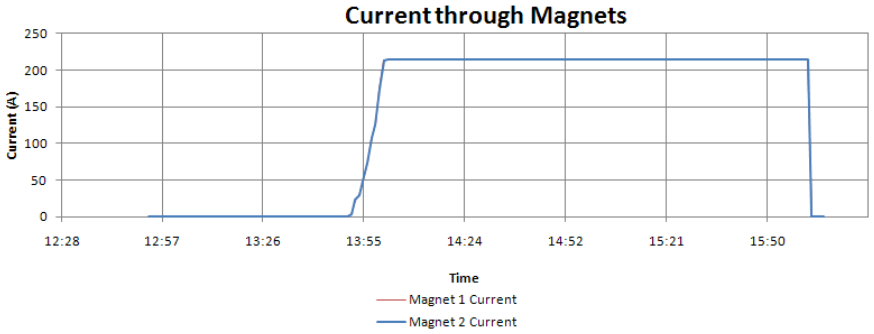


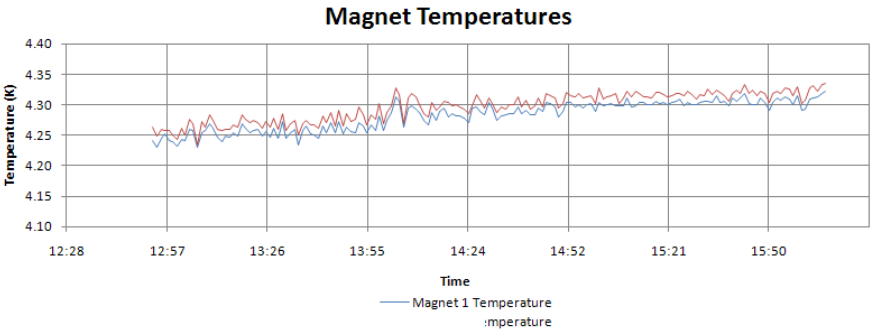




Undulator Cryomodule

- **Both undulators now powered individually and together at 215 A (0.86T) – stable for 2 hours**
- Both also powered at 252A for > 1hour but then **lead quenched above top plate**
  - Not enough margin on top plate temperature at high current?
  - **No magnet quenches so far**





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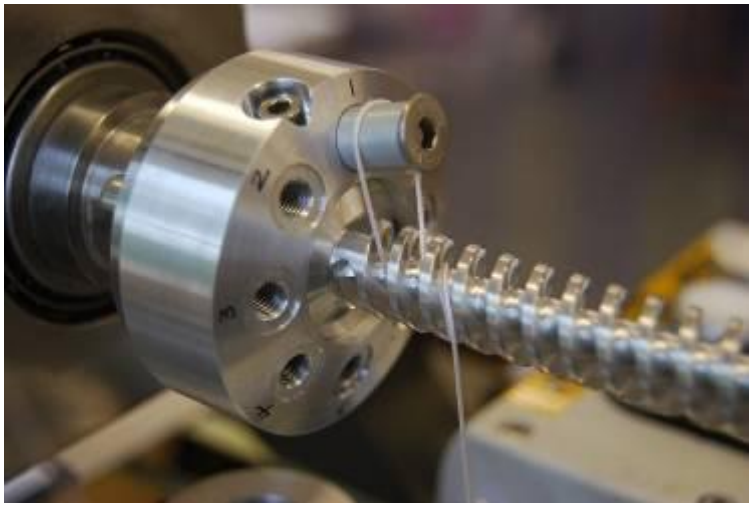
Application of Nb_3Sn

- To generate higher fields or to be able to reduce the period we need to use Nb_3Sn
- Goal would be to reduce period to ~9 mm
- **Concerns**
  - Packing factor reduced as insulation is thicker
  - Performance of wire at <5T
  - Insulation of former
  - Can no longer wind with ribbon
  - More difficult material to work with (heat treatment)
- Need Nb_3Sn wire to have small diameter for similar filling factor
- Have purchased 1 km of Ø0.5 mm (Ø0.63 mm with glass braid) wire from OST.

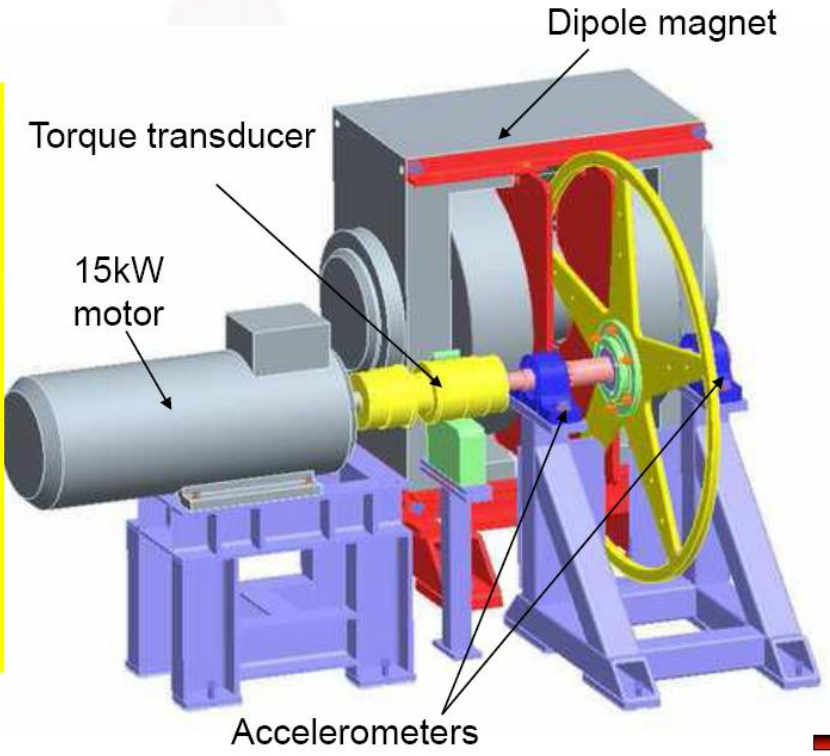
Trial Winding Started



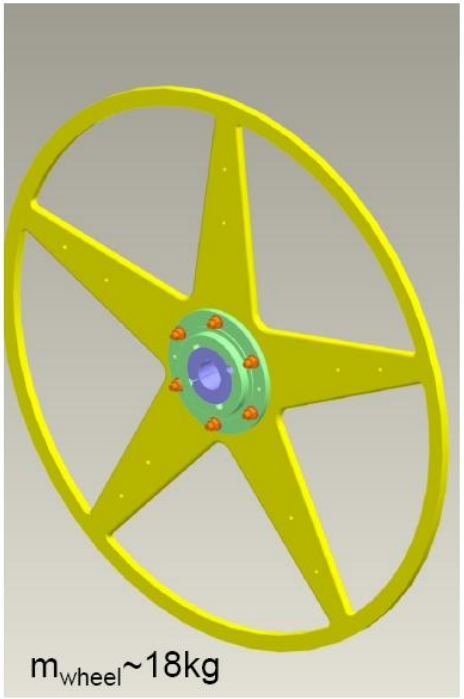
Target

Target Prototype Design

Prototype I - eddy current and mechanical stability



Ken Davies - Daresbury Laboratory



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Target

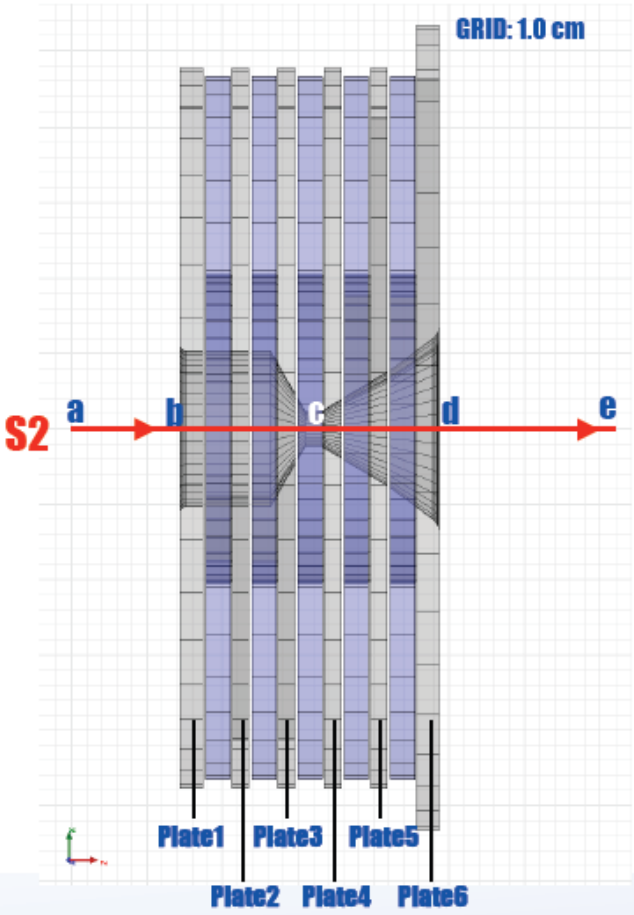
- Prototype
  - Data-taking began Nov 08 and is mostly complete.
  - All measurements taken for speeds <1800rpm
  - Higher speeds vibration and noise (in air)
  - Extrapolating to 2000rpm shows that wheel will be able to operate in immersed fields ~1T without problems.
  - Detailed studies of torque Fourier spectra, etc ongoing
- Eddy current models
  - CARMEN consistent with earlier (rim only) ELECTRA model
  - CARMEN in agreement with new LLNL simulation at 10% level
  - Prediction of large effect from spokes not seen in data!
  - Carrying out conductivity material tests at Lancaster and further magnetic field measurements at DL to try to resolve this

Flux Concentrator

- Design work ongoing at LLNL

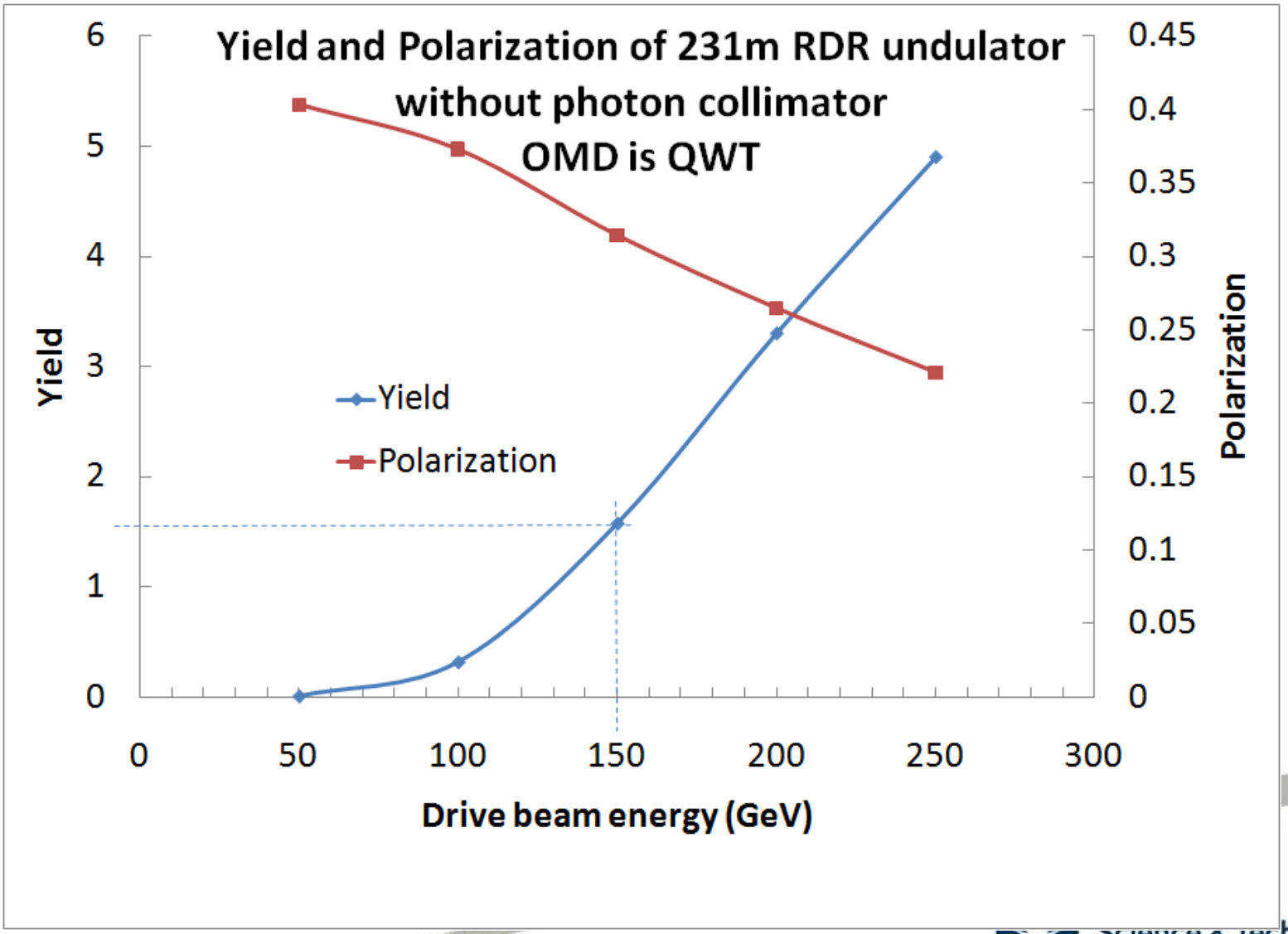
Coils with magnetic shaping plates (Brechna's Configuration)

- Each plate has a 0.2 cm slit that is out of phase by 60° from the neighboring plates



See detailed talk by Tom Piggott

Positron Yield



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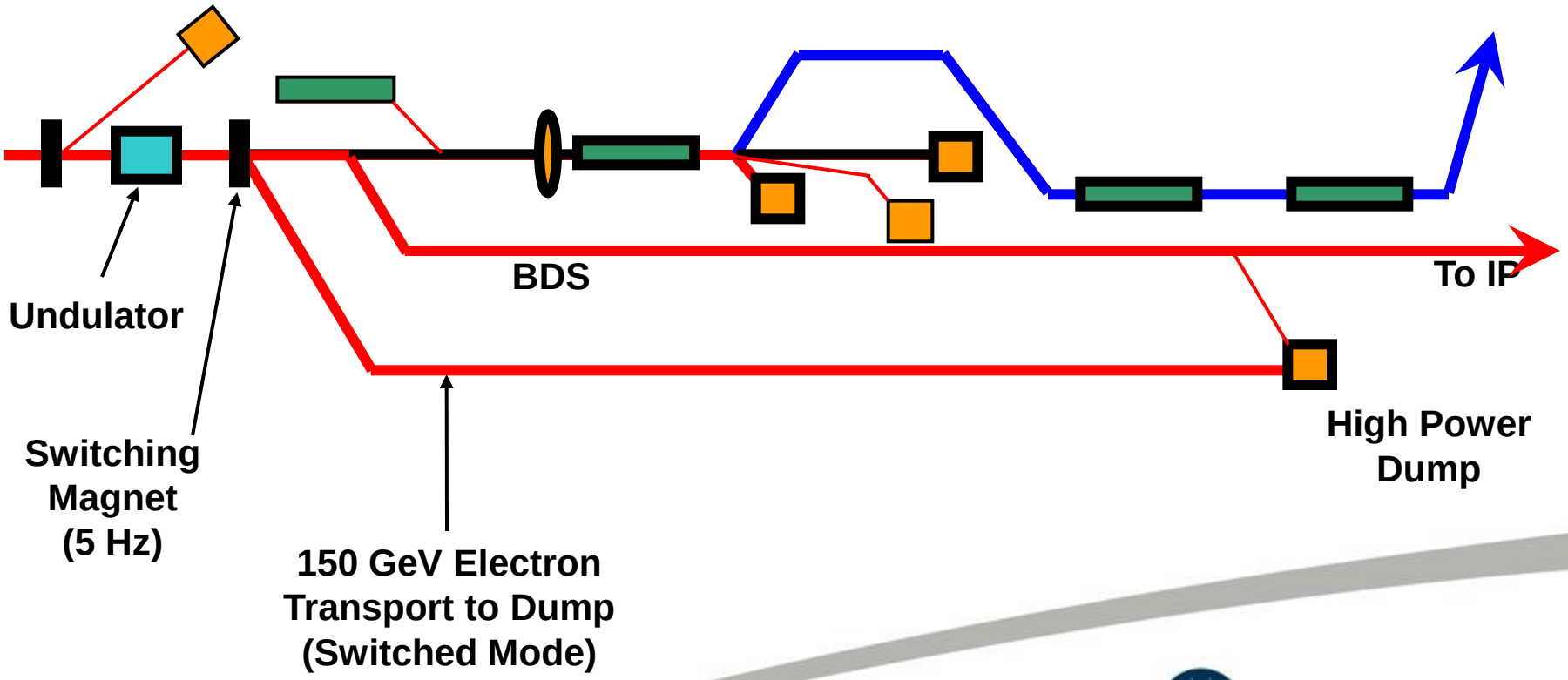
Wei Gai, ANL

Switched Mode Option for Low Energy Running (10Hz Operation)



See talk by Andrei Seryi on Tuesday for latest parameters

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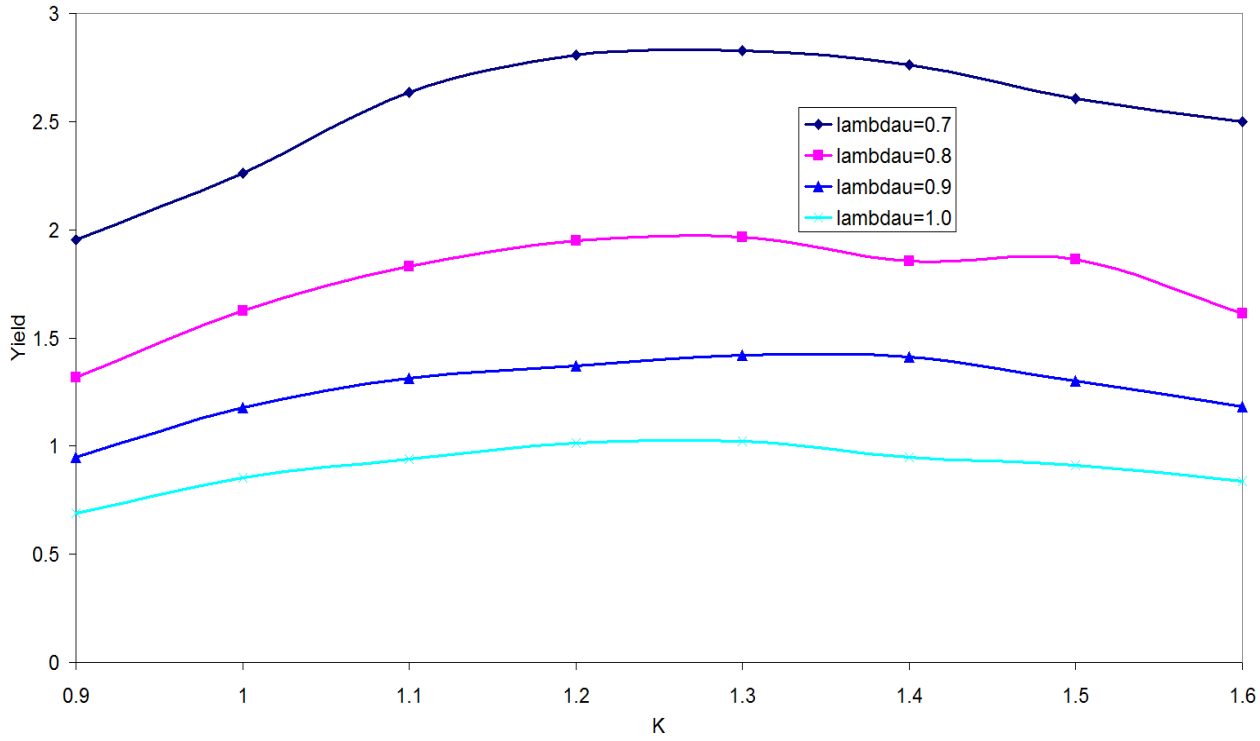
Use Different Undulator Parameters

- Assumptions
  - 231 m long undulator
  - 100 GeV drive beam energy
  - Flux Concentrator

Potential alternative to 10Hz running?



Baseline Assessment Workshop # 2 Proposal

(SLAC)

- January 18 2011: Reduced RF, focusing on parameters, running scenarios and development plans
- January 19: Reduced RF focusing on cost and performance projections and potential upgrade paths and summary/recommendation,
- January 20: Positron Source Location, focusing on running scenarios and technical issues
- January 21: Positron Source Location, focusing on cost and performance projections and summary/recommendation.

Discussion expected at SLAC - BAW

1. Reduced RF
- Global Parameters
- Pulse length, n_b, power and cryogenic consumption
- AS impact – sources, damping rings and BDS
- Upgrade paths
- R & D strategies
- Cost impact – key cost items
- Performance impact – luminosity performance and impact on physics

2. Positron Source Location
- Running Scenarios – key aspects and luminosity as a function of energy
- Technical parameters – operational issues as a function of energy
- Variable repetition rate issues – power and cryogenic consumption; sources and damping ring performance
- Cost impact – key cost items
- Performance impact – luminosity performance and impact on physics

Summary

- SB2009 concept of undulator at end of linac now fully integrated
- R&D progress continues on key areas
  - Undulator
  - Target
  - Flux Concentrator
- Operation at energies <150 GeV affects positron yield
  - Options exist to restore the yield
- BAW2 in Jan 2011 will discuss this in detail and make recommendations