LINEAR COLLIDER COLLABORATION

Designing the world's next great particle accelerator

Report from POSIPOL 2014

113 ILC@DESY project meeting

19th September 2014

Sabine Riemann

Mission of the POSIPOL workshops

- POSIPOL workshop since 2006
- to discuss issues of polarized positron sources, high intensity positron sources, X-ray/Gamma-ray sources, and their applications.
  - **positron sources for the proposed future linear colliders, ILC and CLIC**
  - **positron sources for other colliders such as B-factories are also discussed**

Topics 2014:

- e- polarization
- e+ production
  - **Polarized sources**
    - Undulator based
    - Compton based
    - Pol Bremsstrahlung from pol electrons
  - **Conventional source**
- Target stress
- Target prototyping
- positron capture
- positron (pre)acceleration
- R&D plans for the ILC e+ source
- Details see http://kds.kek.jp/conferenceOtherViews.py?view=standard&confId=15241

POSIPOL 2014 28th AUGUST
@ICHINOSEKI IWATE JAPAN

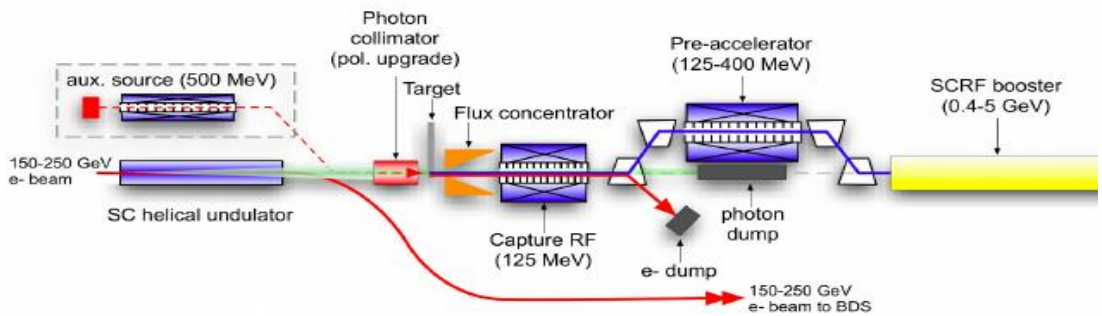
ILC e+ source at POSIPOL 2014 workshop

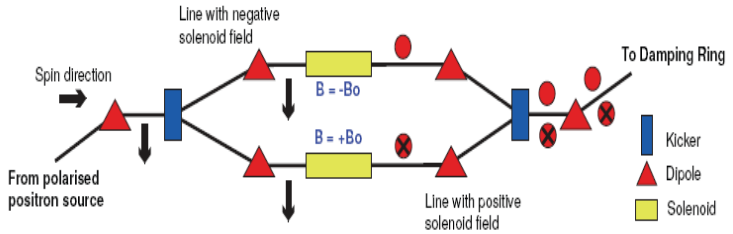
- e+ source is the only area of ILC where real R&D work is still remaining
- ILC Management asked for a proposal of R&D plan
  - **To be discussed and decided by ILC technical Board**
  - **To be presented at LCWS 2014, Belgrade**
  - **Budget request**

➔Besides status of work for polarized beams,

an action plan was discussed

ILC Positron Source (TDR)





Positron source is located at end of main linac, uses e- beam

- Superconducting helical undulator
  - **K=0.92, λ=1.15cm, (B=0.86T on the axis), aperture 5.85mm**
  - **Max 231m active length**
- e+ Production Target
  - **400m downstream the undulator**
  - **0.4 X0 Ti alloy**
- Positron Capture: Pulsed flux concentrator + capture RF
  - Alternative: quarter wave transformer + capture RF
- Normal-conducting pre-acceleration up to 400MeV
- e+ polarization
  - **Default: ~30% ; with photon collimator and longer undulator up to 60%**
  - **Polarization sign is determined by undulator winding → Spin Flipper**

Helical undulator (Y. Ivanyushenko, POSIPOL13)

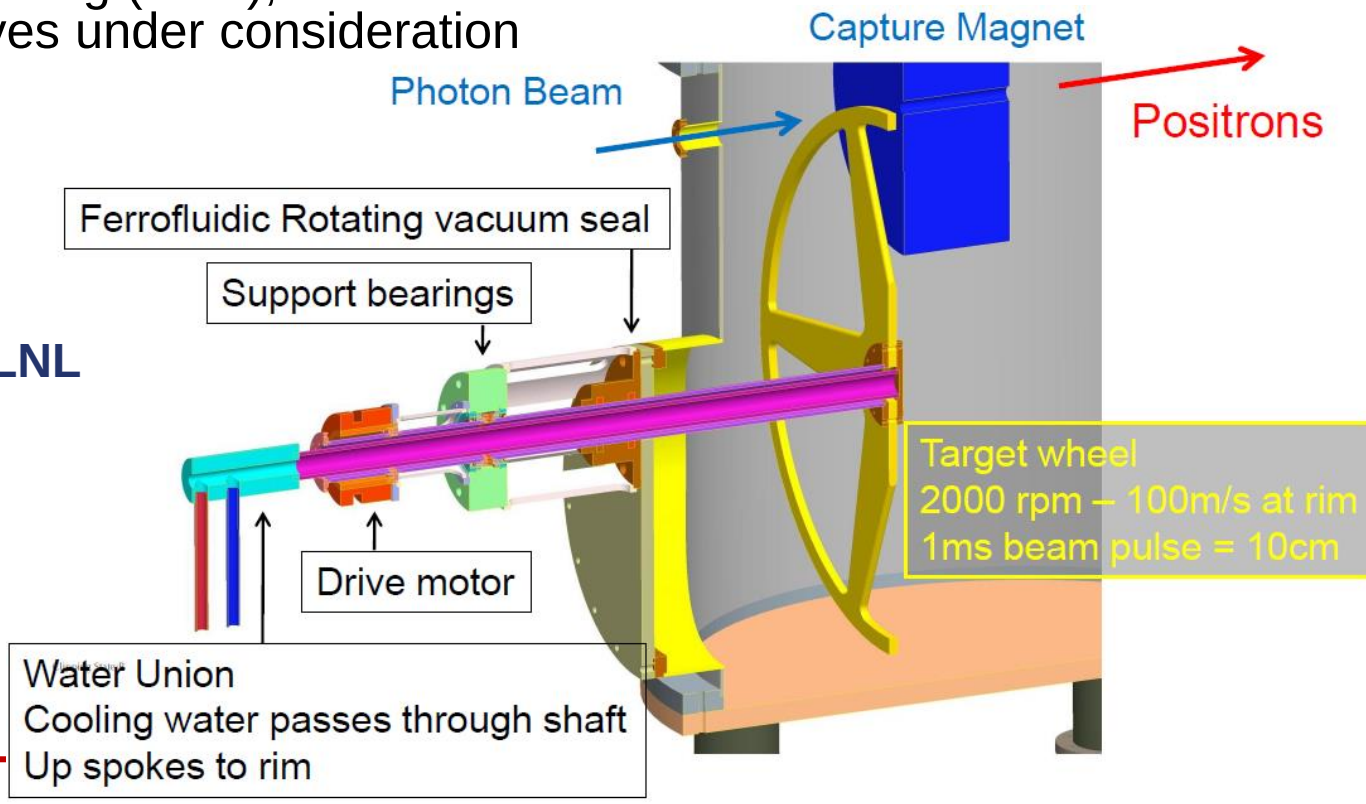
- A 4m helical undulator prototype has been built by RAL team for the ILC positron source project
- This project demonstrated a feasibility of building ILC helical undulator
- The first planar superconducting undulator has been built at the APS, and is currently in user operation.This project demonstrates that an SCU can successfully operate in a storage ring.
- The experience gained in those projects, could be now used for building undulators for Linear Colliders

Influence on energy spread and emittance growth are acceptable (see talk of Wei Gai)

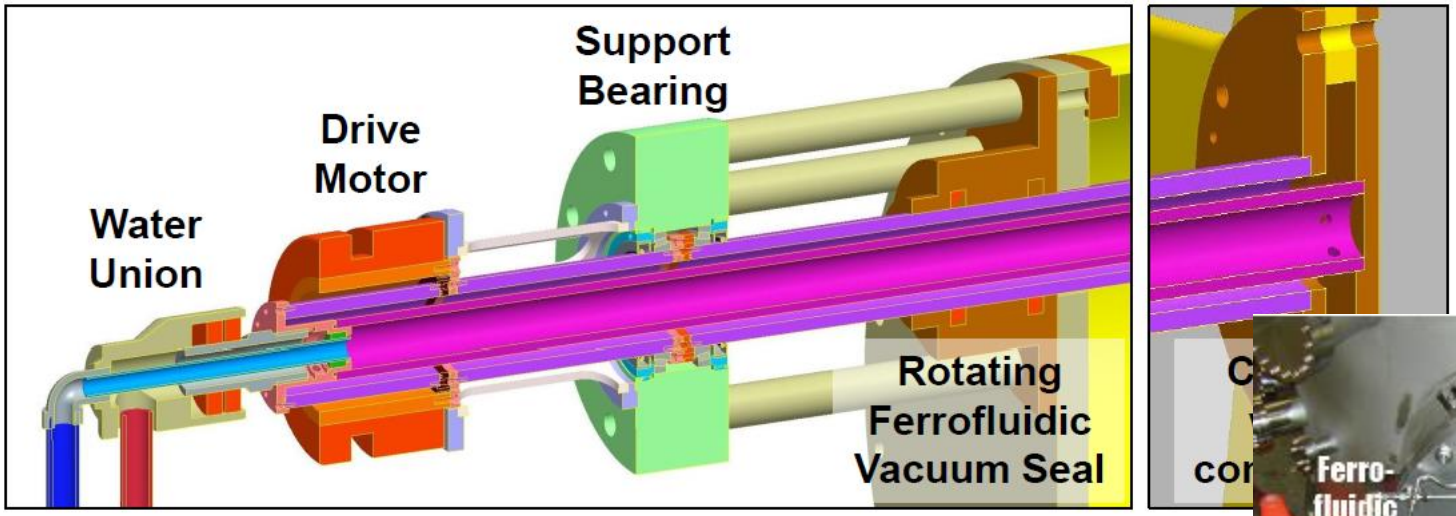
ILC undulator based source

- Biggest concern is the target
  - **Target wheel, Ti4Al6V; 1.4cm thick (0.4 X0**
    - Ø 1m, spinning with 2000rpm (100m/s)
    - Vacuum environment
    - Power deposition 2-7kW
    - Water cooling (TDR); alternatives under consideration

prototype @LLNL



ILC e+ target: Test of vacuum seals at LLNL



Built a full scale prototype shaft

- **Water cooling in the shaft (⇔ balancing)**
- **Ferrofluidic seals**
- **Same weight as Ti wheel but lower moment of inertia**

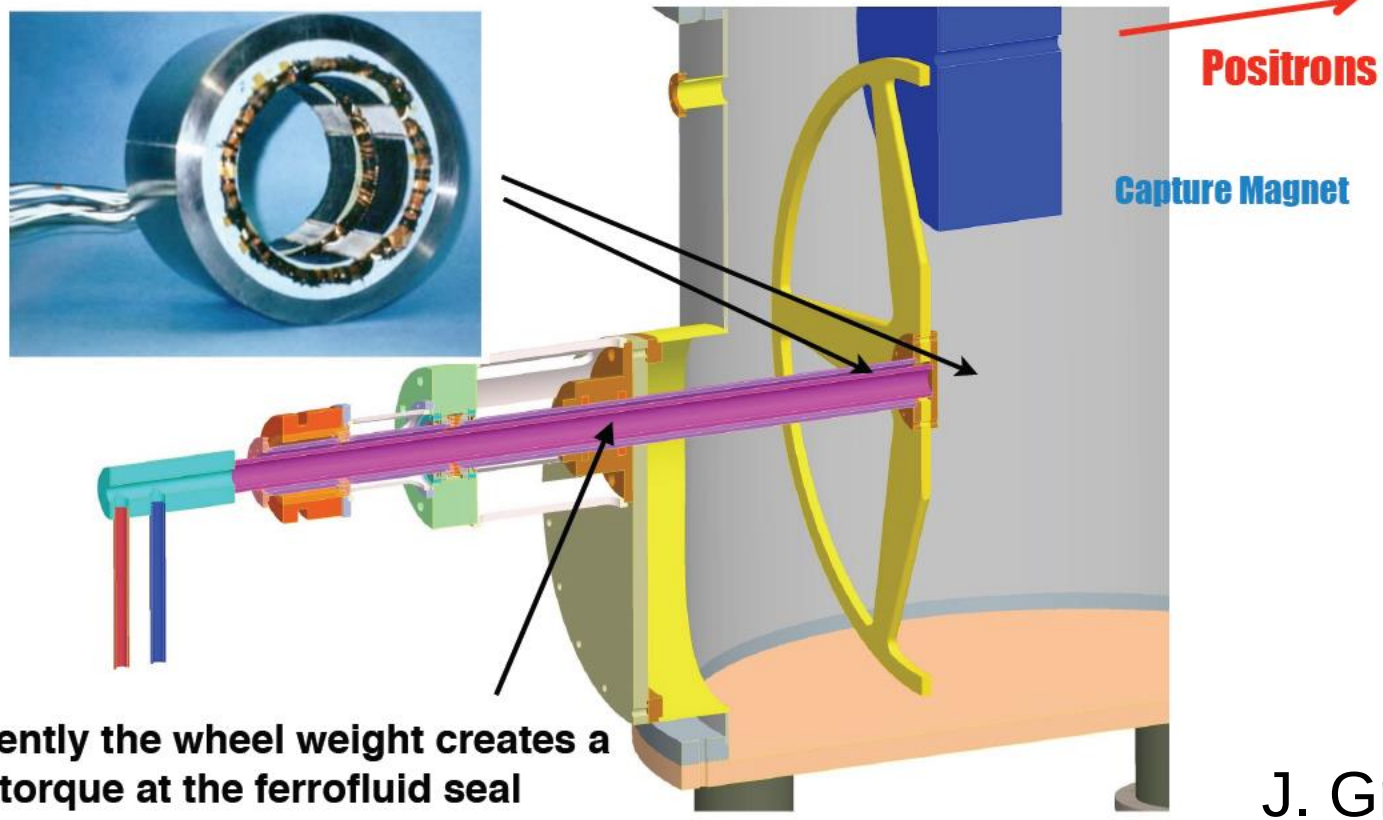
Prototyping results @ LLNL

- The ferrofluid seal didn't fail but:
  - **Outgassing spikes**
    - ➔ **differential pumping in region near the seal would help**
  - **Excessive vibrations in ferrofluid seal**
  - **significant heat dissipation due to rotation speed**
    - ➔ **need special design and improved cooling system**
    - ➔ **magnetic bearings at the wheel to achieve more robust system**

Currently lack of resources to continue with prototyping

required (estimate): ~1.2M USD (inc. labour); 1-2 years

Magnetic levitation bearings could work in vacuum without friction and stiffen the shaft against beam and magnet induced impulses



J. Gronberg

Lawrence Livermore National Laboratory

Option:UCRL#

Option:Additional Information

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Cooling of target rim

- Power deposited in Ti target 2-7kW
- TDR: water cooling
  - **so far, not yet tested for spinning wheel in vacuum**
- Alternative solutions:
  - **cooling by radiation**
    - Need radiative surface of >1m^2
    - looks promising (see talks of Andriy Ushakov, Peter Sievers)
    - Studies are ongoing → design (DESY, Uni H, P. Sievers,…) (+protoyping)
  - **Friction cooling (contact cooling)**
    - new idea, to be considered at ANL

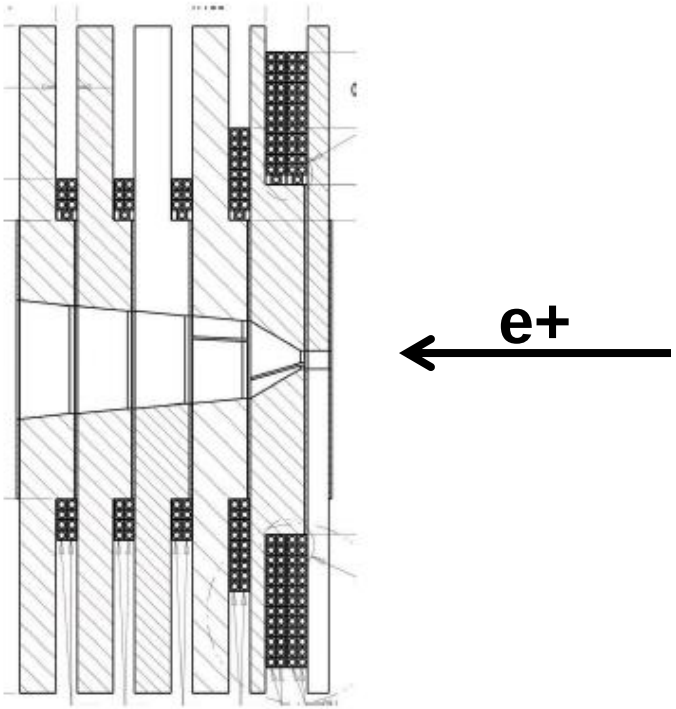
Recommendations @ POSIPOL

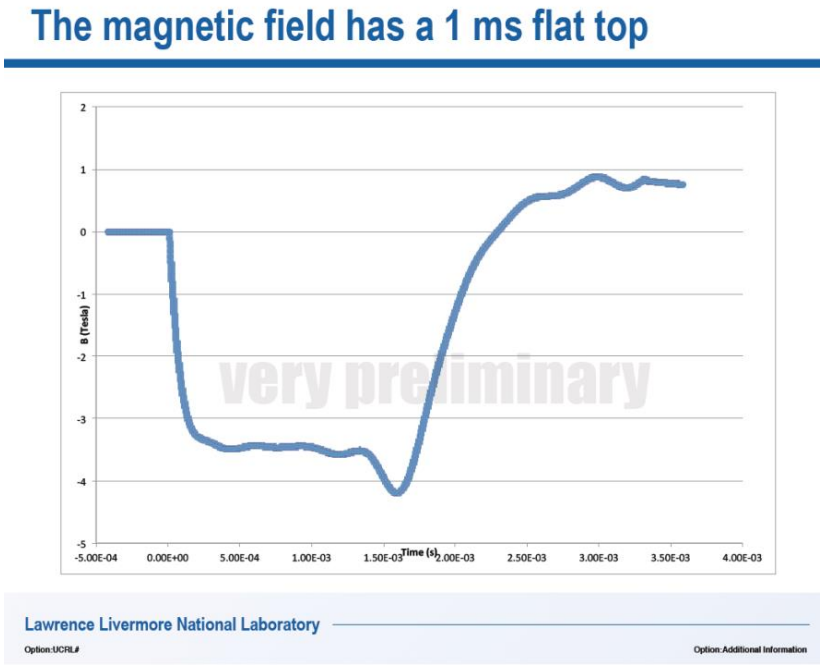
1. Ferrofluid seal + water cooling target
   - **Continue with modified target prototype tests at LLNL (1M USD, 2014-2015)**
   - **If this is successful; construction of target equivalent to real machine (3M USD, 2015-2017)**
   - **Endurance test of target (2017)**
2. Non water-cooled options
   - **Investigate and establish conceptual design (2014-2015)**
   - **Basic tests, if possible with limited amount of money, in 2014-2015**
   - **Mock-up construction which is compatible to test radiation cooling and contact cooling**
     - 3.1M Euro +5.5 man years; needs ~2 years

Flux concentrator

J. Gronberg

- Sandwich structure of energizing coils and concentrator plates
- Promising prototyping at LLNL (1ms flat top)





- But FC is less urgent since a quarter wave transformer could be used instead

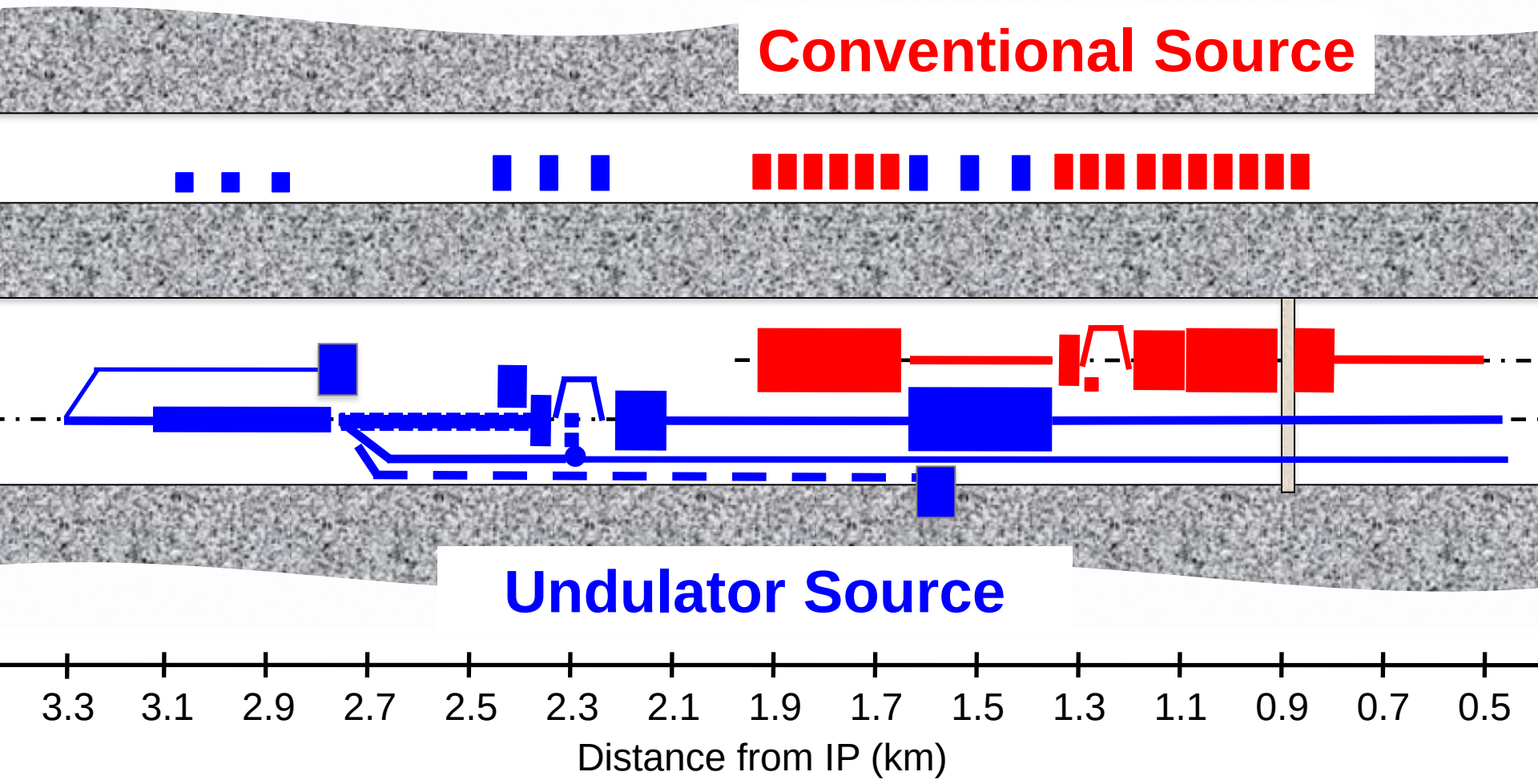
→ lower e+ yield ⇔ longer undulator (>231m)?

Alternative: e- driven 'conventional' scheme

- Idea: use e- beam of 6GeV, stretch the pulse to 63ms
  - Use rotating (~5m/s) rotating W target
  - Inspired by SLC target → so-called 300Hz scheme
  - Average energy deposition in target: 35kW
- **At conceptual level, the scheme seems to work well**
- **System implementation, e.g.**
  - footprint compatibility,
  - staging approach,..

  is ongoing
- **Start to figure out the technical design**
  - Collaboration of ANL, IHEP, CERN, DESY, KEK, Hiroshima U, Hamburg U

Both Sources in Central Region Tunnel



Footprint Compatibility
Both Sources in TDR Tunnel

T. Omori

Recommendation, e- driven 300Hz scheme

1. Continue and finish target prototyping and endurance test (2014-16)
2. Complete TDR level design (2015)
   - **Fix lattice, components with cost estimation**
3. Establish engineering design (2016-2017)

Summary

- POSIPOL 2014 was a successful, interesting workshops with intense discussions
- We all agree that there is no showstopper to get enough (polarized) positrons but a R&D work remains
- People are motivated but lack of resources (money, manpower)
- Action plan for most urgent topic: target
  - **Prototyping of photon target**
    - Vacuum seals
    - Target cooling options
    - Endurance tests
  - **Prototyping of e- driven scheme (300Hz)**
- TDR level for source design in 2015, engineering design in 2017
- Collaboration of groups incl. DESY + Uni H

- Next discussion in Belgrade

backup

Contact Cooling

- Each components are well established, but we have to evaluate feasibility from the system point of view.
- Cooling pads; pads design, lubricant for wheel friction reduction, quantify the material lost and dilution.
- Estimate vacuum pressure by measuring outgassing rate of the components.
- Temperature feedback for cooling adjustment.