Positron WG Report for TCMB

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2018.5.29 ALCW2018, Fukuoka

History

- The WG started to write the report in mid March, the first compiled version appeared early April.
- After big discussion the final version (ver.7) was released on May 24. Uploaded to EDMS:
  - https://edmsdirect.desy.de/item/D000000001165115
  - login is not needed
- Will be in a public domain after agreement of TCMB

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Introduction Chapter

Summary of pros and cons
Principle only, not go to hardware detail
Intended for general readers

The advantages of the undulator scheme

(A) Positron polarization

(B) Thin target
- (B1) less total energy deposit on the target
- (B2) lower radiation level in the target region
- (B3) less demanding dynamic aperture of the damping ring

Disadvantages

(a) High energy electron beam needed

(b) No freedom in beam pulse structure

(c) Timing constraints

(d) Commissioning program can be complex

Introduction (continued)

- If you think of (A) and (B), the undulator scheme is no doubt overwhelming
- However, things have changed after many years R&D
- Because of (b), the required technology for undulator scheme is complex.
  - Rapidly rotating target (100m/s) needed
  - Long-flattop (~1ms) flux concentrator needed
- Improvement of DR dynamic aperture minimized the merit of (B3)
- Hence, it is not obvious the undulator scheme is overwhelming
- This is why the two schemes are still competitive
- (A) is now the major advantage of undulator scheme
  - (B2) is still an advantage

Caveats

- Introduction
  “This report is a snap shot of our studies as of spring 2018.. We tried to give consistent parameters as far as we could but it is inevitable that some of the parameters contain small inconsistencies.”

Summary Chapter

- As the summary I introduced a table showing the technology status (next page)
- Finally, I stated

  “As the table shows, the technology for neither scheme is ready now. Among the two the e-driven scheme seems to be closer to realization, judging from the present status of prototype development. On the otherhand, the baseline scheme, i.e., the undulator scheme, if feasible, has an advantage of the positron polarization. Therefore, the primary question for the choice of the scheme is

  - Is the undulator scheme feasible?
  - If so, can the feasibility be firmly verified by the time of design finalization?

Table 6.1: Summary of the technology status of the two schemes

	Undulator Scheme		e-Driven Scheme	
Target	Further consideration on wheel design, cooling calculation, mechanical performance (magnetic bearing), and Ti-Cu contact needed. Prototype shoud be built.	C	Further test of vacuum seal needed. W-Cu contact must be studied.	B
Matching device	FC has the problems of time-dependent field and PEDD.	D	Improvement from superKEKB and BINP. Design of cooling needed.	B
	QWT: yield marginal. Hardware design still required.	B		
Capture cavity	TDR design almost sufficient	A	Further consideration on thermal deformation and cavity cooling design needed	B
Beam dump	Photon dump still requires detailed design.	C	Beam dump is not an issue but radiation shielding must be studied instead.	B

Issues of Controversy

- Positron yield calculation
  - Undulator scheme
    In an early draft I wrote
    "The obtained yield e+/e- was 1.36.
    TDR adopted the design yield 1.5 including the margin. The above value is a little lower than this. If everything works as calculated, 1.0 is sufficient, of course. If the above value 1.36 is judged not to be enough, the length of the undulators must be increased by ~10%, which also means an increase of the heat load on the target. "
    This was criticized saying consistent parameters must be given.
    I added some more words for target load increase by 10%
  - e-Driven case
    Gives the yield 2.1. Criticized that other calculation showed 1.57. Some caveats added.

Issues of Controversy (2)

- Transient beam-loading in e-driven scheme
  - Beam current is much higher than in undulator scheme (O(A) compared with O(10mA))
  - Loading compensation in the travelling wave part using amplitude modulation seems to be reasonable, though some more fine calculation needed)
  - Standing-wave part (first few capture cavities) is controversy
  - Some caveats for further estimation were added
- Temperature variation in the first capture cavity
  - Frequency change due to temperature variation
- All these issues suggest lower `ranking' "B"→"C"

Issues of Controversy (3)

- “ranking table” in the summary
- Lots of voices in the level of change “B” ←→ “C”
- After a debate, it was needed to add
  “Note, however, this table does not mean that every member agrees on the status evaluation of individual items. Some of them suggest to assign severer scores for some items. Re-evaluation of the table is inevitable in the near future by the time to downselect the scheme. But it is more important to make a complete "ToDoList" for each item as stated above.”

Issues of Controversy (4)

- Finally, I stated in the summary
  "As the table shows, the technology for neither scheme is ready now. Among the two the e-driven scheme seems to be closer to reality. However, the undulator scheme, if feasible, is obviously better owing to the positron polarization. Therefore, the primary question for the choice of the scheme is
  - Is the undulator scheme feasible?
  - If so, can the feasibility be verified by the time of design finalization?
- I received critics from both sides.
- "is obviously better owing to the positron polarization. "
  → "has an advantage of the positron polarization.
- "firmly" verified
- "closer to reality, judging from the present status of prototype development."

Next Step

- Final choice will be a couple of years away
- By that time lots of things to be done
  - If “green light” this year, expect some R&D budget for the next couple of years
  - Need to make a complete ToDoList.
  - In parallel with the R&D, what is needed is CFS/engineering considerations more or less common to both schemes, such as shielding, target replacement, etc. The feasibility of each scheme is not an issue in this repect.