Report of DESY BTR meeting

BTR(TBR) meeting at DESY (24-27/Oct/2011)

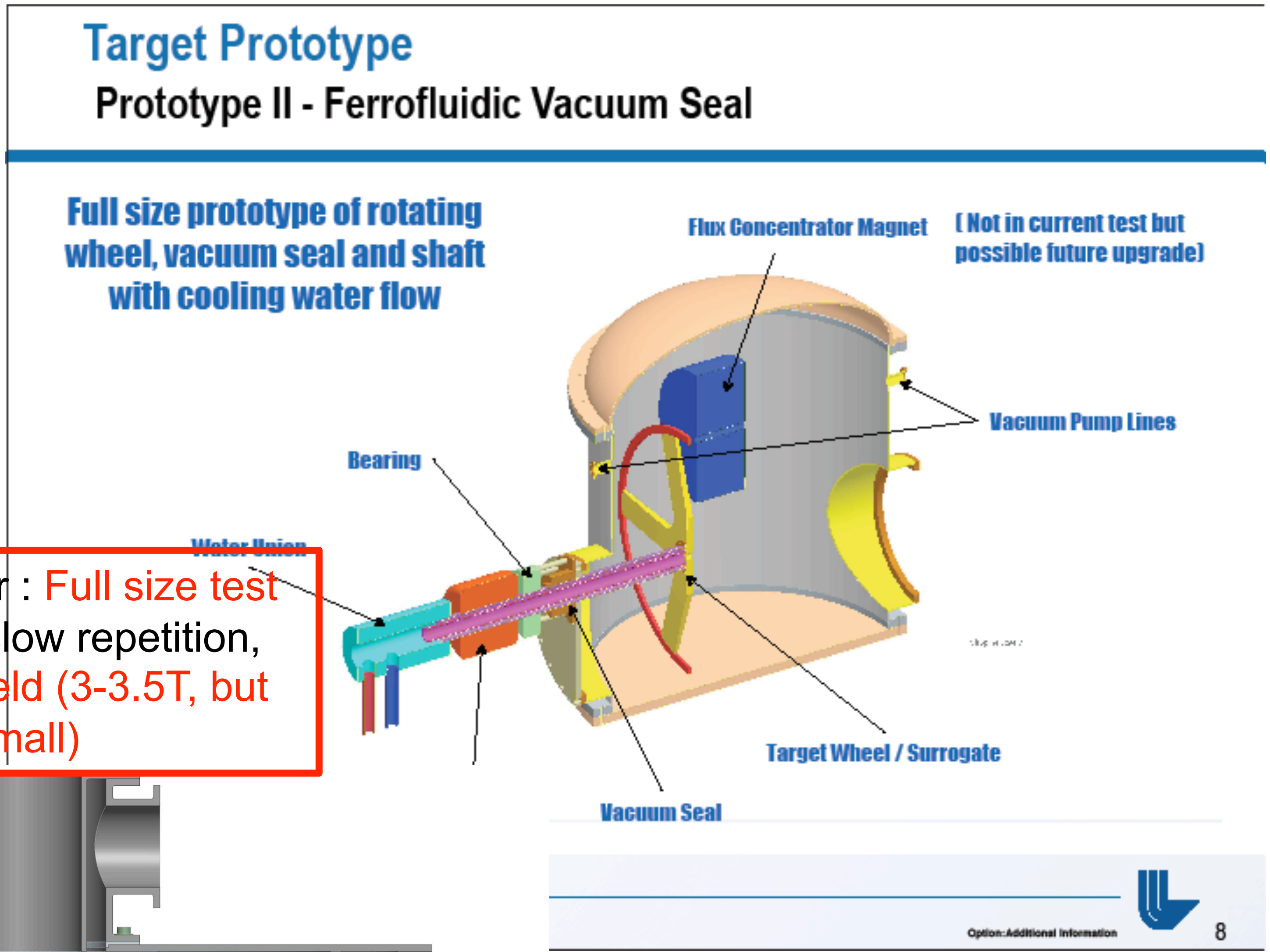
17-Nov-2011
ILC-CLIC e+ studies
T. Omori (KEK)

BTR Programme

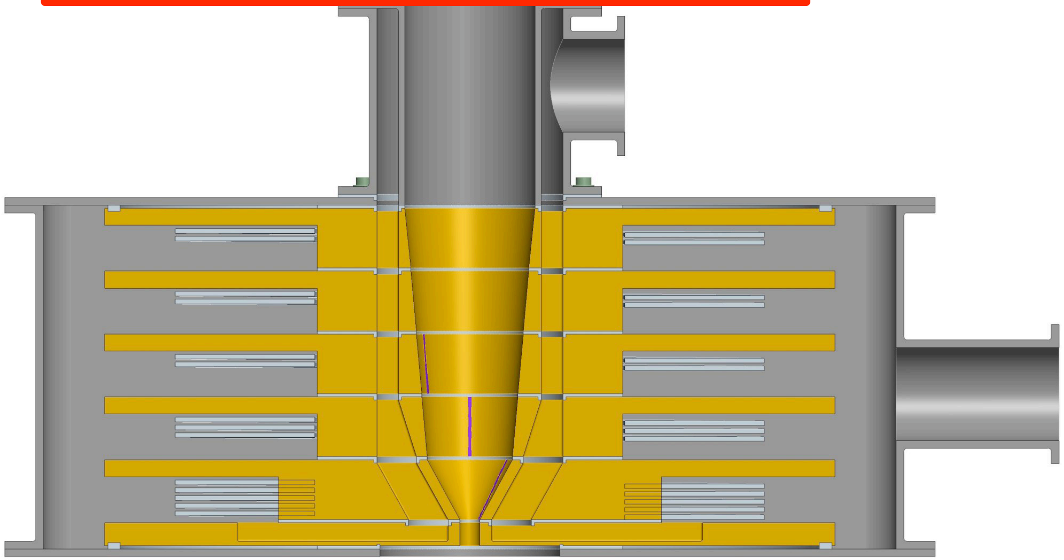
- Formal baseline design review for:
  - sources, RTML, BDS/MDI
- Basic format:
  - System parameters, design, layout, tech. systems
  - CFS requirements
  - Cost
  - AS specific issues
  - Phys. & detector input

Documentation for EDMS!

	Mon. 24.10	Tue. 25.10	Wed. 26.10	Thu. 27.10
AM	Intro & BDS/MDI	e+ source	e- source	RTML (general)
	BDS/MDI	e+ source	e- source	Central Region Integration
PM	BDS/MDI	e+ source	RTML (1 vs 2-stage BC)	TDR planning
	BDS/MDI	e+ source	RTML (1 vs 2-stage BC)	Close-out



Flux concentrator : Full size test at LLNL, test at slow repetition, Reduced peak field (3-3.5T, but effect on eff. is small)



Vacuum rotation target :
Full size test at LLNL
First step failed: cause under study

Lawrence Livermore National Laboratory

Vacuum Seal R&D

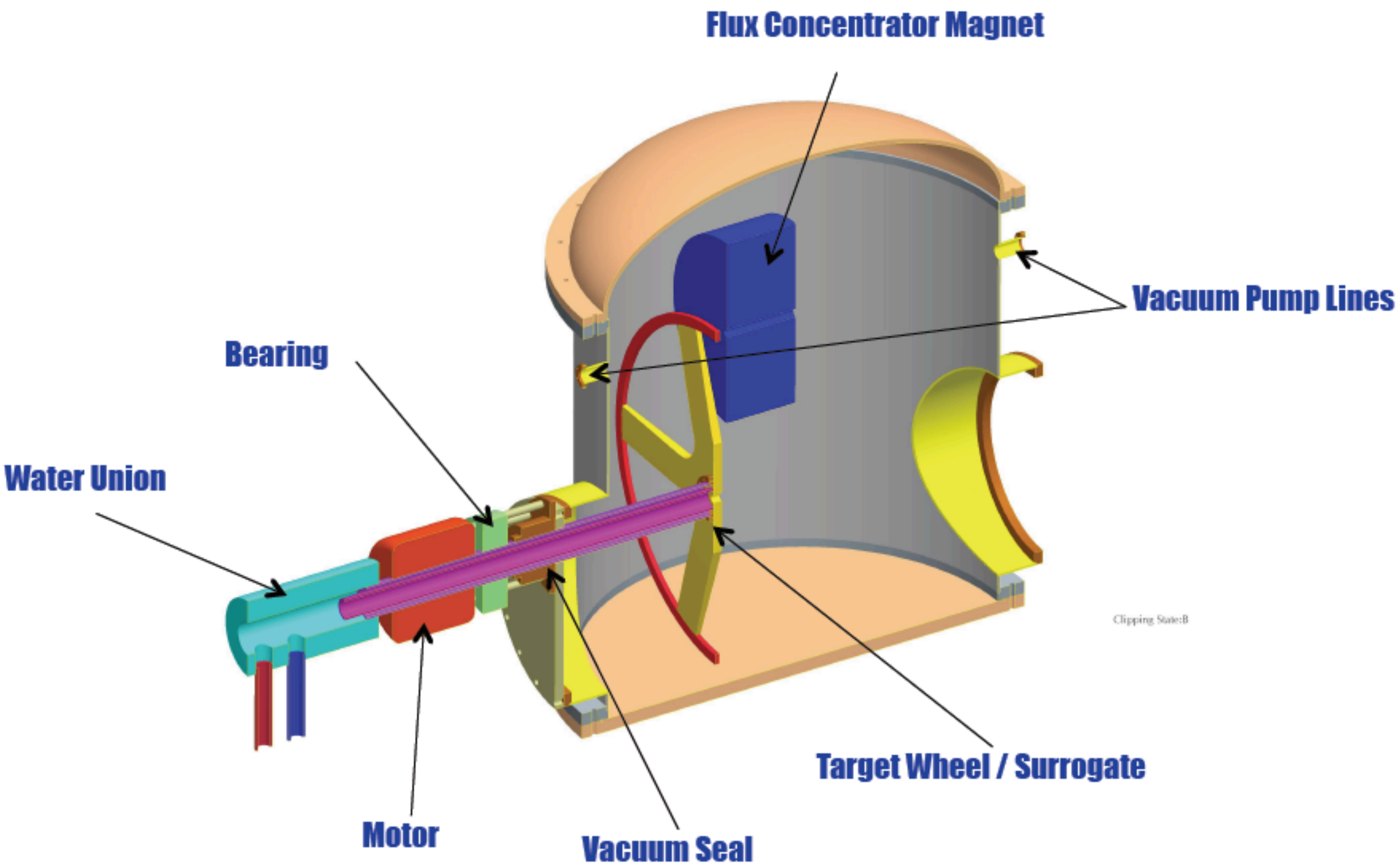
Tom Piggott, Jeff Gronberg, Craig Brooksby, Nick Killingworth

Lawrence Livermore National Laboratory, P. O. Box 808, Livermore, CA 94551

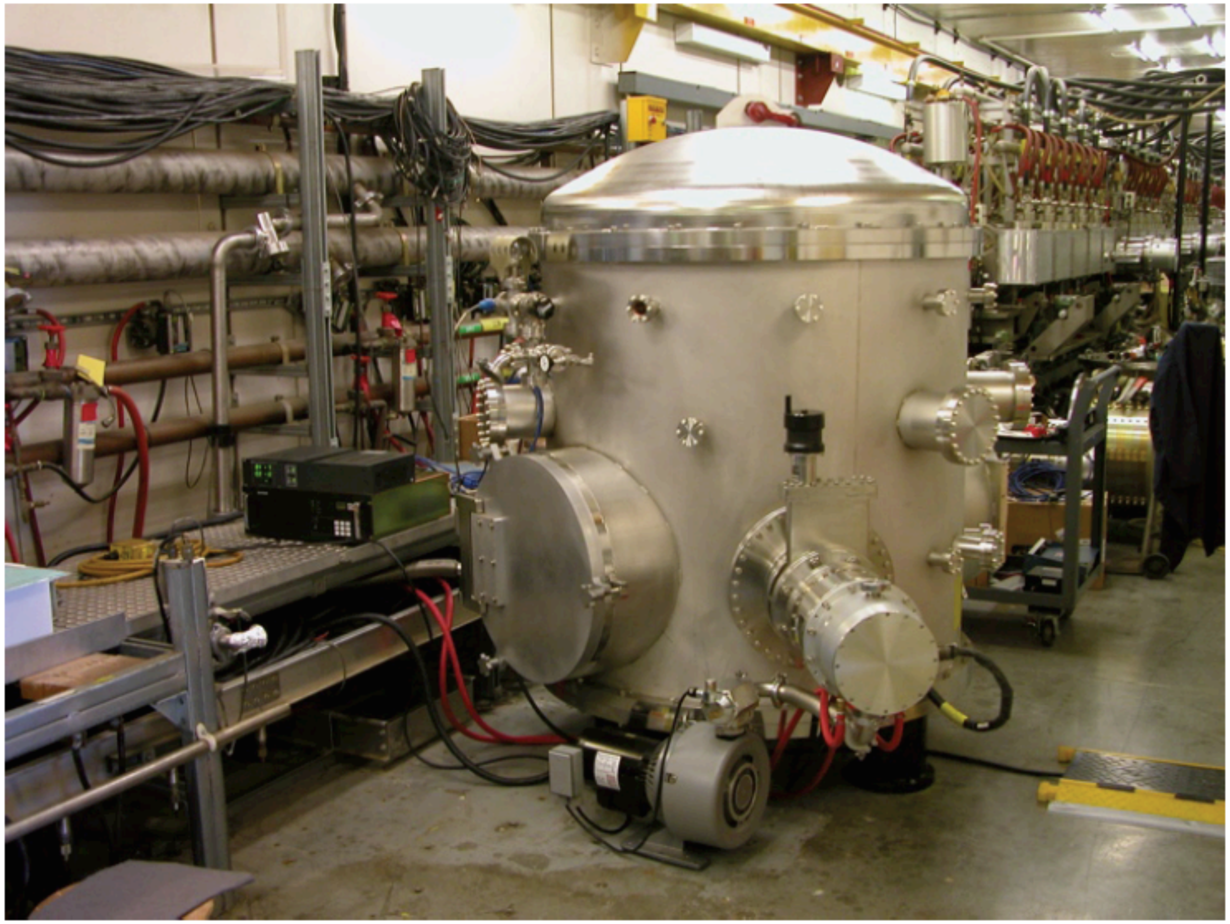
This work performed under the auspices of the U.S. Department of Energy by Lawrence Livermore National Laboratory under Contract DE-AC52-07NA27344

LLNL-PRES-495331

We are prototyping the rotating vacuum seal and the pulsed flux concentrating magnet

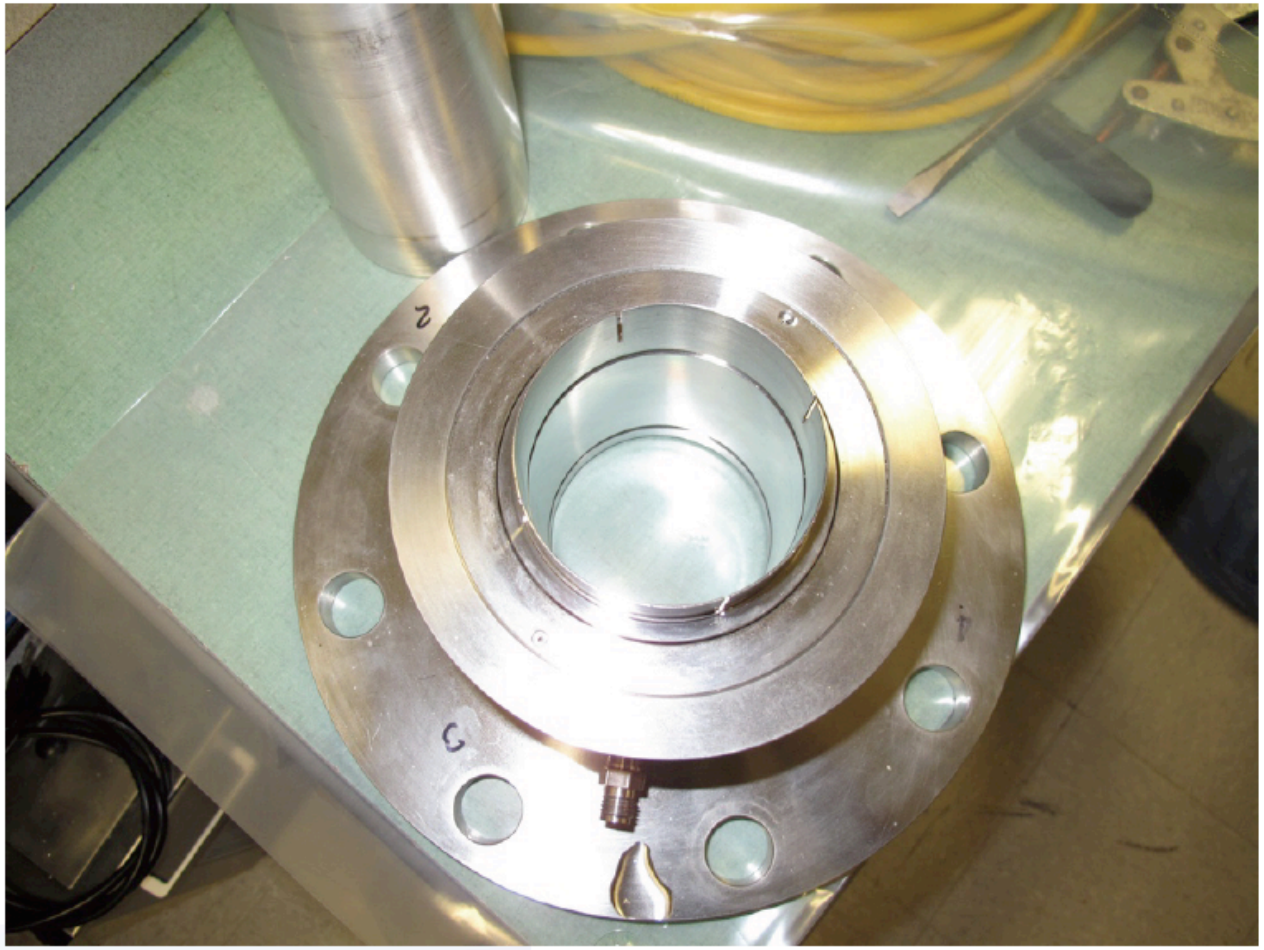


The vacuum tank is setup and under vacuum



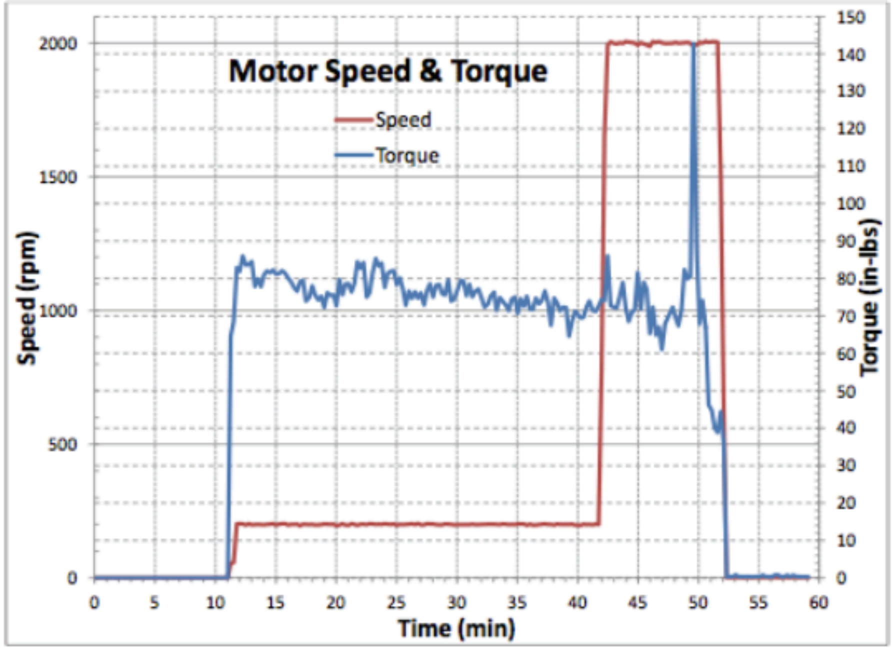
All parts are at LLNL except the Daresbury target wheel

We have begun initial vacuum testing of the Rigaku Ferrofluidic Seal in a separate test stand



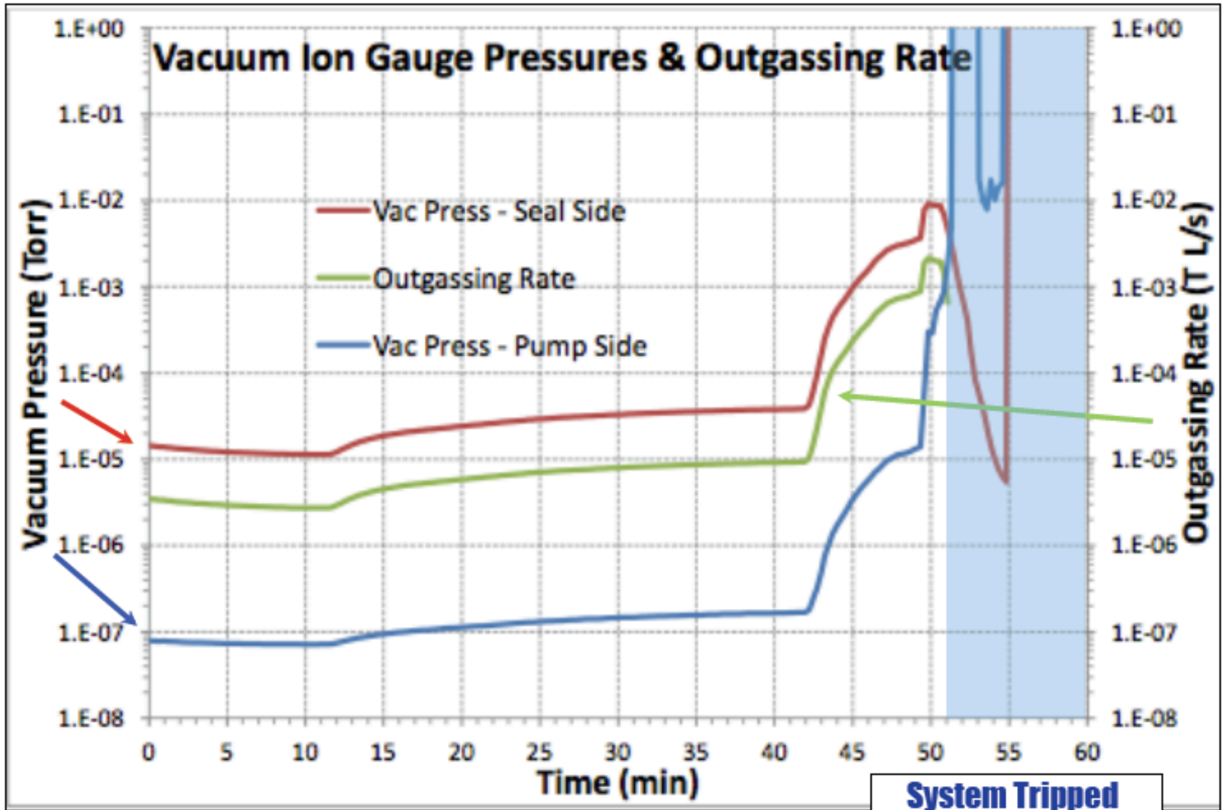
October 3rd we did our first full test of the Rigaku seal

Scan #	Time	Time	Speed	
	H:M:S	min	rpm	Comments
1	10:32	0	0	started data recording
17	10:35	3	0	took full RGA Scan
20	10:36	4	0	took full RGA Scan
40	10:41	9.2	0	took full RGA Scan
43	10:42	10.2	0	took full RGA Scan
47	10:43	11.2	200	
123	11:03	30.5	200	took full RGA Scan
162	11:13	40.5	200	took full RGA Scan
168	11:14	42	2000	
191	11:20	48	2000	took full RGA Scan
197	11:22	49.6	2000	Torque ramped up & vacuum leak occurred
208	11:24	52.3	0	Stopped motor
235	11:31	59.1	0	Ended data recording



... and we killed it.

Outgassing looked like it was stabilizing when the seal failed



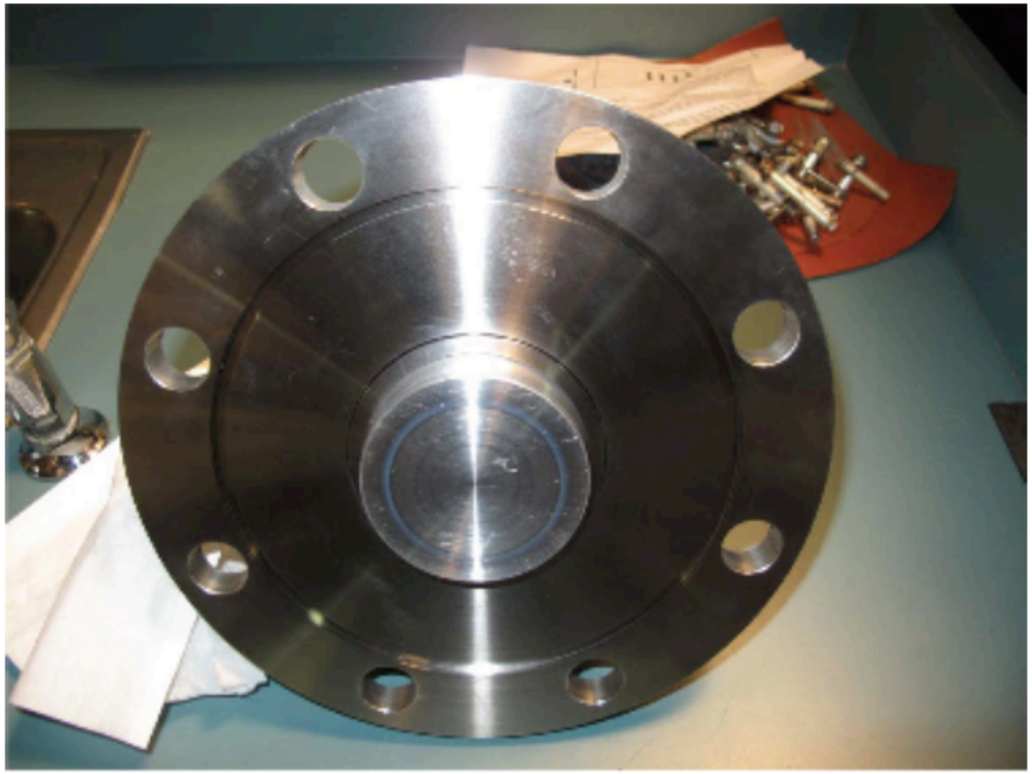
System Tripped

Gate Valves closed

Seal inspected after failure

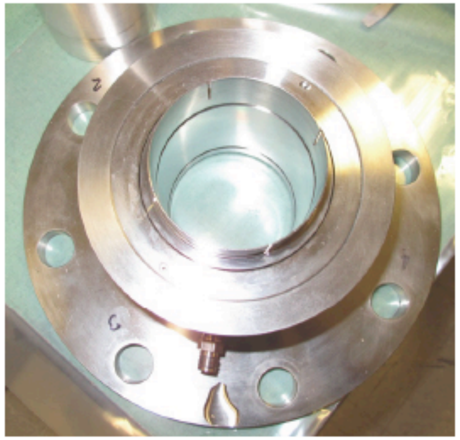
- No visual signs of failure or residue

- No signs of residue inside the chamber



Status

- Both Ferrotech and Rigaku assert that these seals should run at 2000 RPM as long as there is cooling water flow
- We are acquiring a plug compatible replacement from Ferrotech
- The Rigaku seal will be returned to Rigaku for post-mortem and repair
- We will continue with assembly of the prototype shaft
    - but we will wait to mount the new seal until after it runs successfully on the test stand



Truly Conventional e^+ Source for ILC

T. Omori (KEK)

25-Oct-2011
Baseline Technical Review at DESY

Truly Conventional Collaboration

ANL, IHEP, Hiroshima U, U of Tokyo, KEK, DESY, U of Hamburg

Wei Gai, Jie Gao, Shin-ichi Kawada, Wanming Liu, Natsuki Okuda, Tsunehiko Omori, Guoxi Pei, Sabine Riemann, Tohru Takahashi, Junji Urakawa, and Andriy Ushakov

paper; arXiv:1110.1450 --> going to submit to NIM A

Special Thanks to Takahashi-san:

About half of the slides are taken from Takahash-san's talk at ALCPG11&e+meeting@IHEP

Conventional e+ Source for ILC

Normal Conducting Drive and Booster Linacs in 300 Hz operation

e+ creation

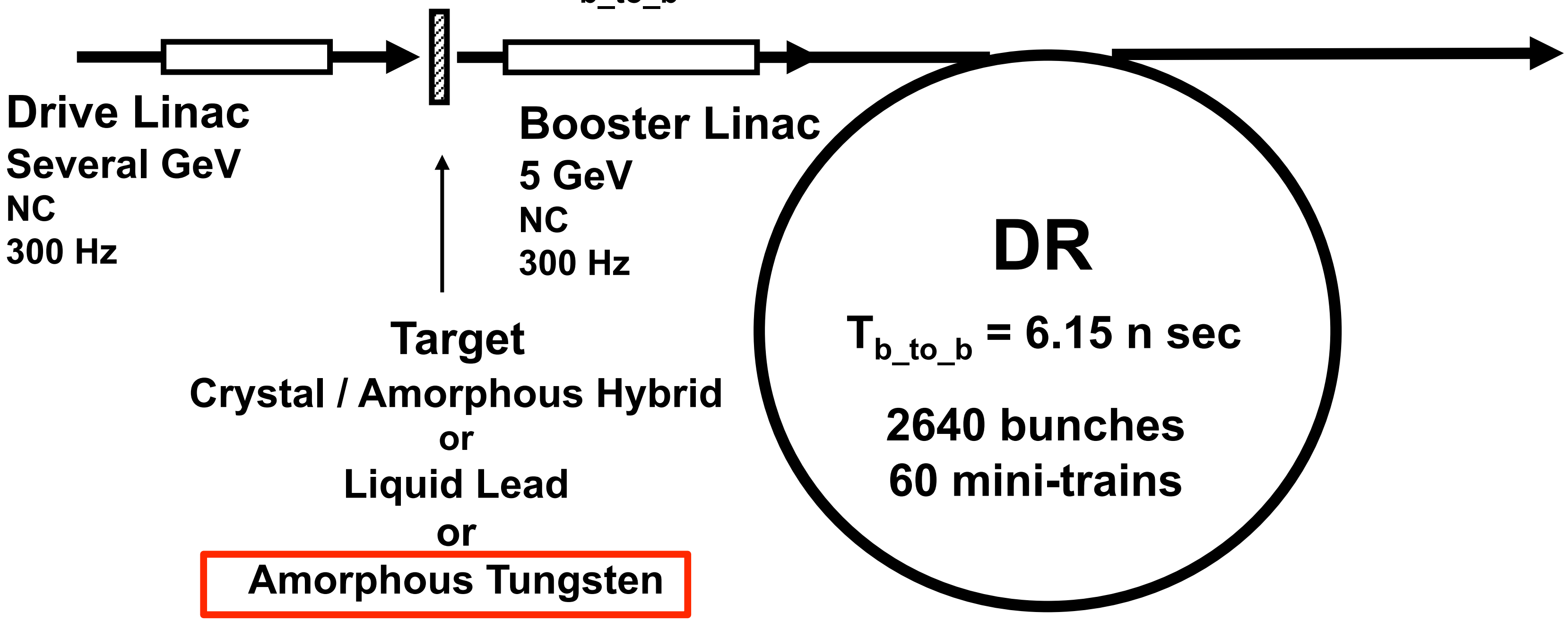
20 triplets, rep. = 300 Hz

- triplet = 3 mini-trains with gaps
- 44 bunches/mini-train, $T_{b\_to\_b}$ = 6.15 n sec

go to main linac

2640 bunches/train, rep. = 5 Hz

- $T_{b\_to\_b}$ = 369 n sec



Truly Conventional

Time remaining for damping = 137 m sec

We create 2640 bunches in 63 m sec

10 authors
IHEP, ANL、DESY, Hiroshima, U . Tokyo, U. Hamburg, KEK
Conventional e+ source is OK for ILC
make cost estimate and put into TDR vol. 1

Discussion for Keep Alive Source / Auxiliary Positron Source

KURIKI Masao
Hiroshima U. /KEK

Two Scenarios

- Start up e+ source is very important in MD phase.
- In the initial phase, $3X_0$ W-Re instead of $0.4X_0$ Ti alloy improves the e+ intensity.
- 500 MeV single bunch S-band accelerator (30m) can generate 20 % intensity e+ beam.
- The target can be replaced when undulator is ready for the commissioning. KAS becomes a small backup with a few % intensity.
- Could W-Re (or W) and Ti alloy be implemented in a same target ? (Hybrid).

Two Scenarios

- Start up e+ source is very important in MD phase.
- In the initial phase, $3X_0$ W-Re instead of $0.4X_0$ Ti alloy im

TARGET REPLACE

- 50 can generate 20 % intensity e+ beam.
- The target can be replaced when undulator is ready for the commissioning. KAS becomes a small backup with a few % intensity.
- Could in a same

MOSAIC TARGET

Positron polarization issues

Technical Baseline Review, 25 October 2011

Sabine Riemann, DESY Zeuthen

- Introduction
- Degree of e+ polarization
  - **Photon beam collimation**
- Spin rotation and helicity reversal
- Summary

Many thanks to the ILC Positron Source group, in particular:

V. Kovalenko, G. Moortgat-Pick, F. Staufenbiel, A. Ushakov

Left-Right Asymmetry A_{LR}

for equal luminosities

$$A_{LR} = \frac{A_{LR}^{meas}}{\langle P_{eff} \rangle} = \frac{\sigma_{LR} - \sigma_{RL}}{\sigma_{LR} + \sigma_{RL}} \cdot \frac{1}{\langle P_{eff} \rangle} = \frac{N_{LR} - N_{RL}}{N_{LR} + N_{RL}} \cdot \frac{1}{\langle P_{eff} \rangle}$$

- Essential for A_{LR} measurement:
  - luminosity and polarization have to be helicity-symmetric: $L_{LR} = L_{RL}$ and $P_L = -P_R$
  - Achieved by rapid helicity reversal (SLC: bunch-to-bunch)
  - small differences have to be known and corrected

$$A_{LR} = \frac{A_{LR}^{meas}}{\langle P_{eff} \rangle} + \frac{1}{\langle P_{eff} \rangle} \left[f_{bgr} \left(A_{LR}^{meas} - A_{bgr} \right) + A_{LR}^{meas^2} A_{Peff} + A_{L} + \ldots \right]$$

$A_{\mathcal{L}}$ = asymmetry in luminosity for LR and RL

A_{Peff} = asymmetry in L and R polarization

$A_{LR} < 1$ → $A_{\mathcal{L}}$ is more important than A_{Peff}

Remember SLC: $A_{\mathcal{L}}$, $\delta A_{\mathcal{L}} \sim 10^{-4}$ A_P, δA_P ~ few 10^{-3}

  - Small $A_{\mathcal{L}}$, $\delta A_{\mathcal{L}}$, A_{Peff}, δA_{Peff} required also for ILC

- helicity correlated effects can be reduced by additional slow reversal

ALR Systematic effects

ILC polarized positrons:

- after the damping ring, differences between LR and RL should stay within tolerance limits of ~10^{-2} for A_{Peff} and 10^{-3} for $A_{\mathcal{L}}$

- Fast helicity reversal
  - Kicker to parallel lines with opposite sign spin rotators (Moffeit et al., 2005, SLAC-TN-05-045)

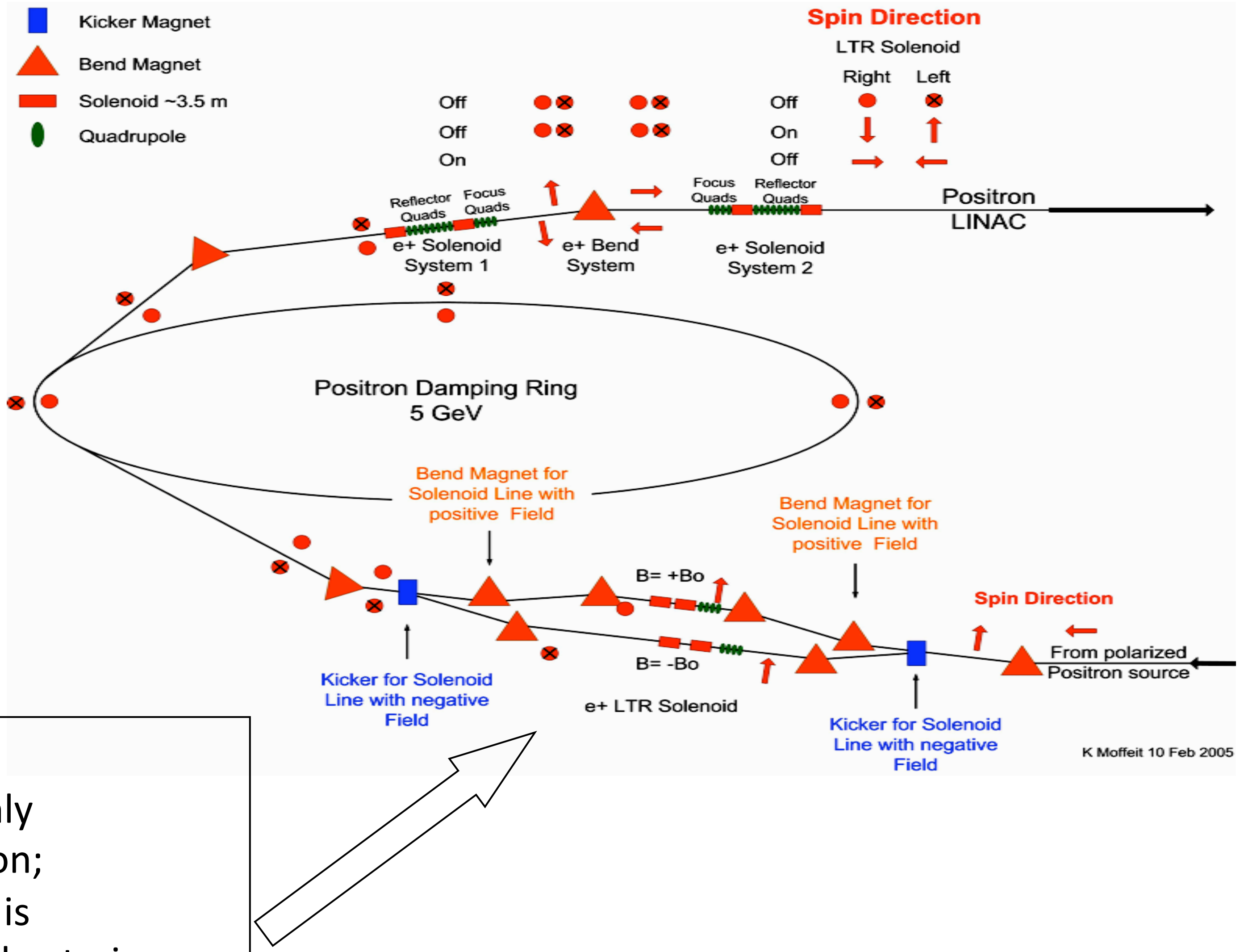
- Slow helicity reversal
  - Very precise monitoring of relative intensities polarizations for LR and RL states
  - Nevertheless, larger systematic uncertainties for most observables
  - (in worse case, it could be even larger than without e+ polarization)

What is ‘fast’ ?

- SLC: random, bunch-to-bunch
- ILC: train-to-train (5 Hz)
  - e+ helicity has to be reversed as fast as e- helicity
  - In case of stable experimental conditions, $f_{reverse} < 5Hz$ would be ok

e+ spin rotation and **helicity reversal** @ 5GeV

K. Moffeit et al.,
SLAC-TN-05-045



parallel spin rotation
beam lines for randomly
selecting e+ polarization;
pair of kicker magnets is
turned on between pulse-trains

Bunch compressor
1-stage or 2-stage ?

PMs's decision

- 2 stage bunch compressor is TDR Baseline
- (1 stage was baseline of SB2009)
- bunch length is still 300 micron

Consensus

- 2-stage BC has larger flexibility, better tolerance on phase

Discussions (NO decision)

- 2-stage BC has possiblirity to go to Modified Gao parameter (or variant).

- shorter bunch length: 150um - 220um
- smaller beta *
- smaller bunch charge : 1x10^{10}   (half of RDR)
- larger bunch number: 2600 (= RDR)
- better emittance preservation

give us same peak-1%-luminosity, but pair background ~ 1/3 per bunch

Impact of Bunch Length on Top-Level Parameters

K. Yokoya

2011.10.26 BTR DESY

RDR Parameter Sets

TABLE 2.1-2
Beam and IP Parameters for 500 GeV cms.

Parameter	Symbol/Units	Nominal	Low N	Large Y	Low P
Repetition rate	f_{rep} (Hz)	5	5	5	5
Number of particles per bunch	N (10^{10})	2	1	2	2
Number of bunches per pulse	n_b	2625	5120	2625	1320
Bunch interval in the Main Linac	t_b (ns)	369.2	189.2	369.2	480.0
in units of RF buckets		480	246	480	624
Average beam current in pulse	I_{ave} (mA)	9.0	9.0	9.0	6.8
Normalized emittance at IP	$\gamma\epsilon_x^*$ (mm·mrad)	10	10	10	10
Normalized emittance at IP	$\gamma\epsilon_y^*$ (mm·mrad)	0.04	0.03	0.08	0.036
Beta function at IP	β_x^* (mm)	20	11	11	11
Beta function at IP	β_y^* (mm)	0.4	0.2	0.6	0.2
R.m.s. beam size at IP	σ_x^* (nm)	639	474	474	474
R.m.s. beam size at IP	σ_y^* (nm)	5.7	3.5	9.9	3.8
R.m.s. bunch length	σ_z (μm)	300	200	500	200
Disruption parameter	D_x	0.17	0.11	0.52	0.21
Disruption parameter	D_y	19.4	14.6	24.9	26.1
Beamstrahlung parameter	Υ_{ave}	0.048	0.050	0.038	0.097
Energy loss by beamstrahlung	δ_{BS}	0.024	0.017	0.027	0.055
Number of beamstrahlung photons	n_γ	1.32	0.91	1.77	1.72
Luminosity enhancement factor	H_D	1.71	1.48	2.18	1.64
Geometric luminosity	$\mathcal{L}_{geo}$ $10^{34}/\mathrm{cm}^2/\mathrm{s}$	1.20	1.35	0.94	1.21
Luminosity	$\mathcal{L}$ $10^{34}/\mathrm{cm}^2/\mathrm{s}$	2	2	2	2

Gao's Parameter Set

- RDR included Low-Charge option
- Jie Gao (IHEP) proposed a parameter set similar to Low-Charge at BAW2 at SLAC, Jan. 2011
- N_b 1312 → 2625
  n 2×10^{10} → 1×10^{10} (same beam current)
- Luminosity loss by factor 2 is compensated for by smaller ε_y , β_y , β_x
- Smaller β_y requires shorter bunch

Merits of the Low-Charge set

- Smaller beamstrahlung
- Smaller vertical disruption Dy
- Smaller single bunch wake in DR by factor ~1/2
  (But doesn't help electron cloud)
- Smaller single bunch transverse wake in ML and BC by factor ~1/4 (smaller N, shorter σ_z)
  - Allow smaller emittance
- For comparison I relaxed Gao's parameter set a little bit
  - ε_y too small $1\mathrm{x}10^{-8} \rightarrow 2.5\mathrm{x}10^{-8}$ (cf. $3.5\mathrm{x}10^{-8}$ in SB2009)
  - Squeezed β_y , β_x , σ_z a little more

Basic Formulas ($\sigma_x >> \sigma_y$)

$$\mathcal{L} = \frac{f_{rep} n_b N^2}{4\pi\sigma_x\sigma_y} H_D, \qquad P_B = f_{rep} n_b N E$$

$$D_y = \frac{2Nr_e}{\gamma}\frac{\sigma_z}{\sigma_x\sigma_y} \qquad \Upsilon_{av} = \frac{5}{6}\frac{N r_e^2 \gamma}{\alpha\sigma_z\sigma_x}$$

$$n_\gamma = 2.16 \frac{\alpha N r_e}{\sigma_x\sqrt{1+\Upsilon^{2/3}}}$$

$$\delta_B = 0.836 \frac{N^2 r_e^3 \gamma}{\sigma_z \sigma_x^2 \left[1 + (1.5\Upsilon)^{2/3}\right]^2}$$

out coming angle of pairs

$$\theta_p \approx \sqrt{\frac{N}{E_p \sigma_z}} \times \text{(logarithmic factor)}$$

Model Parameter Sets

- Dy 38→16
- n_γ 1.7→1.1
- δ_B ~4%→2.8%
- L(top 1%) 60%→69%

		500GeV Reference		Gao	mod. Gao
		noTF	TF	BAW2	
Ecm	GeV	500	500	500	500
gamma		4.89E+05	4.89E+05	4.89E+05	4.89E+05
N	e10	2.0	2.0	1	1
frep	Hz	5.0	5.0	5	5
Nb		1312	1312	2625	2625
PB	MW	10.5	10.5	10.5	10.5
sigz	mm	0.3	0.3	0.166	0.15
enx	m	1.0E-05	1.0E-05	1.00E-05	1.00E-05
eny	m	3.5E-08	3.5E-08	1.00E-08	2.50E-08
betax	mm	11.0	11.0	8.0	7.0
betay	mm	0.48	0.20	0.166	0.15
sigx	nm	474.2	474.2	404.4	378.3
sigy	nm	5.86	3.78	1.84	2.77
theta_x	ur	43.1	43.1	50.5	54.0
theta_y	ur	12.2	18.9	11.1	18.5
Dx		0.30	0.30	0.12	0.12
Dy		24.6	38.2	25.6	16.4
Upsilon		0.062	0.062	0.066	0.078
Ngamma		1.7	1.7	1.0	1.1
deltaB		3.7%	3.7%	2.3%	2.7%
HDx		1.1	1.1	1.0	1.0
HDy		6.1	2.8	4.0	3.4
HDy		2.0	1.5	1.6	1.5
Lgeo		7.51E+33	1.16E+34	1.40E+34	9.97E+33
L (formula)		1.47E+34	1.75E+34	2.24E+34	1.50E+34
Simulation (noTF)		noTF	TF		mod.Gao
Ngamma		1.82			1.093
deltaB(%)		4.107			2.887
L		1.58E+34			1.48E+34
L(1%)		60.2			69.4
simulation (TF)					
Ngamma			1.87		1.09
deltaB(%)			4.26		2.853
L			2.09E+34		1.72E+34
L(1%)			60.2		69.3
L(TR)/L(no)					

- (modified) Gao's parameter can give
  - More stable collision
  - Less beamstrahlung
  - Comparable 1% top luminosity
  - More margin to control pair angle
- What else needed, in addition to double stage BC
  - 3nsec extraction kicker
  - Lower vertical emittance

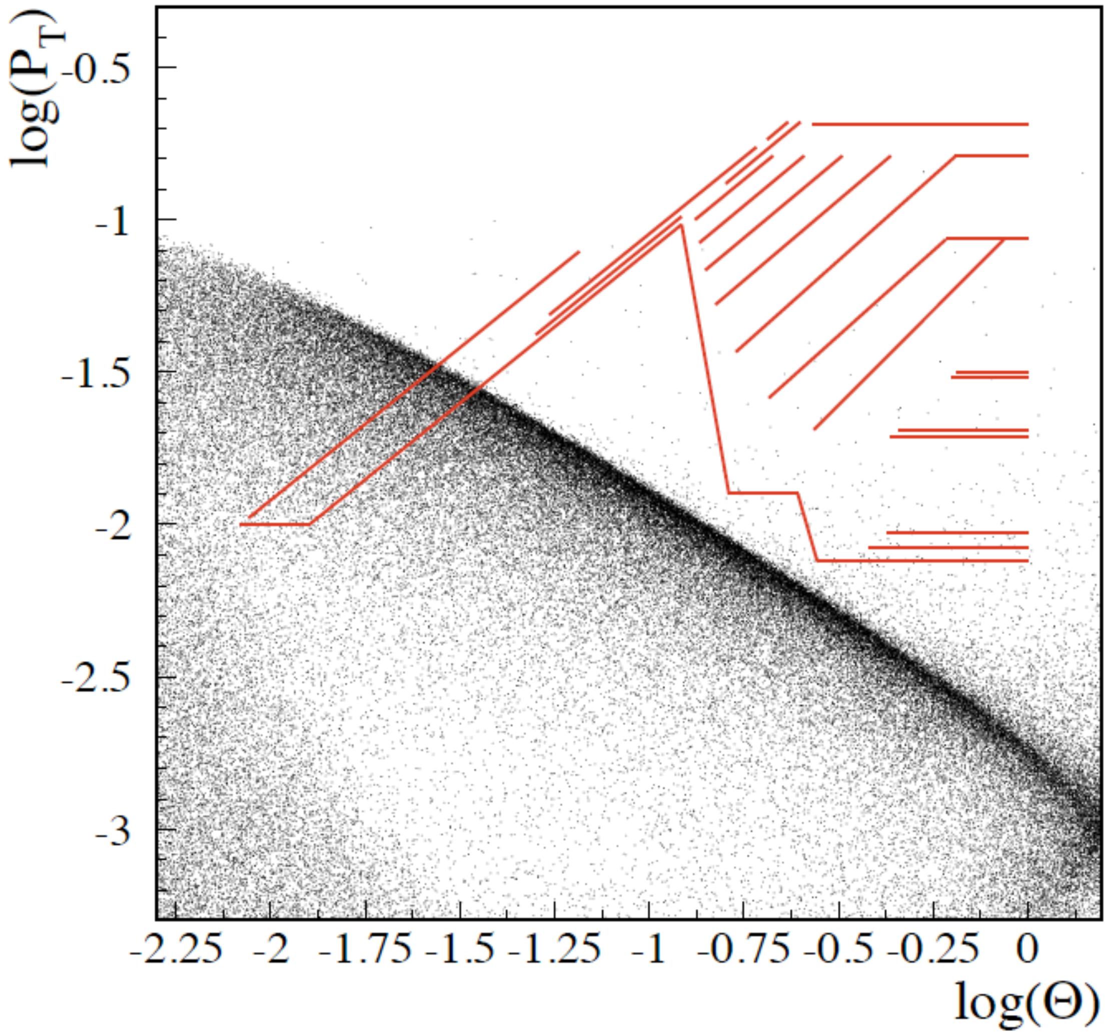
Bunch-compressor and Physics

Mikael Berggren[1]

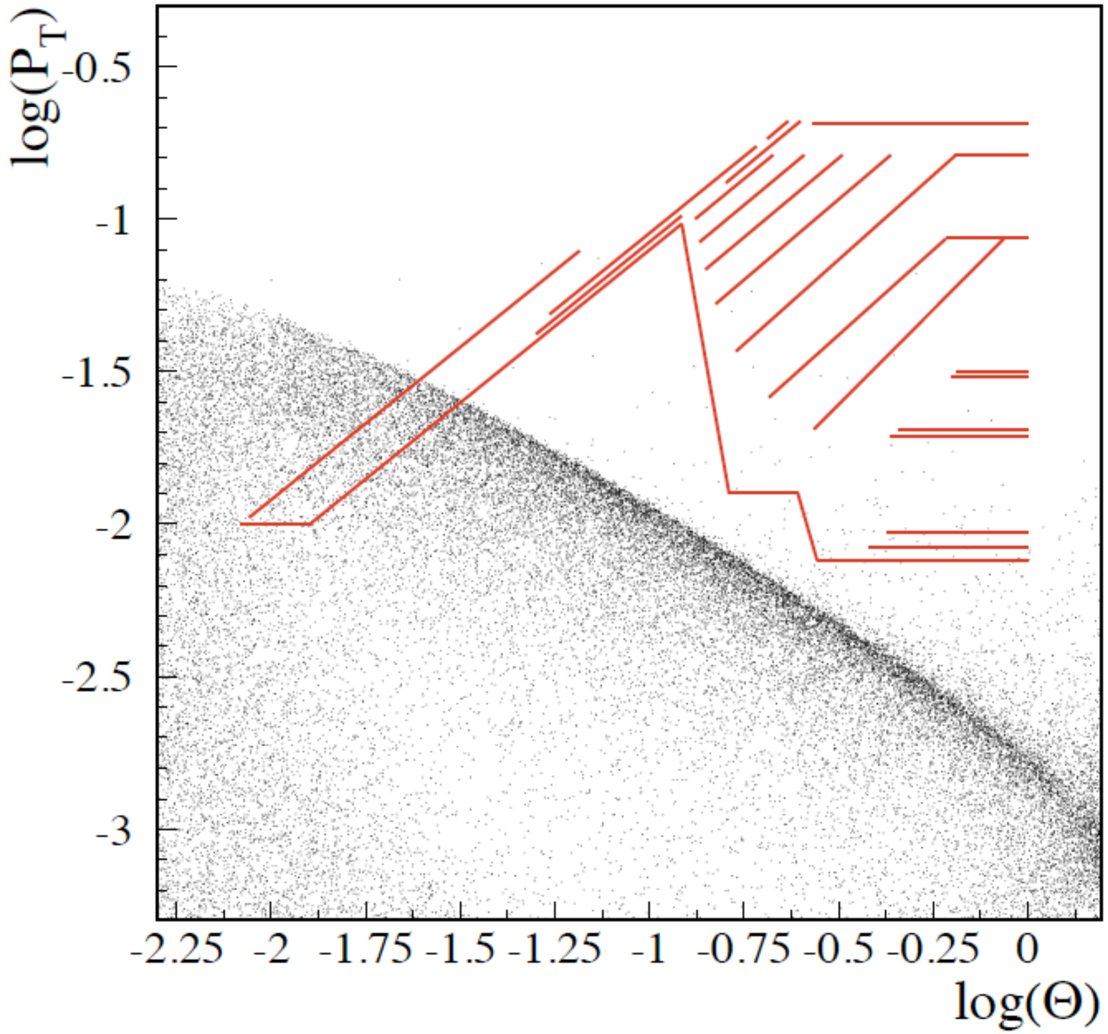
[1]DESY, Hamburg

TBR, DESY, Oct 2011

Pairs in tracker: NB with TF



Pairs in tracker: Modified Gao low charge.



Observations

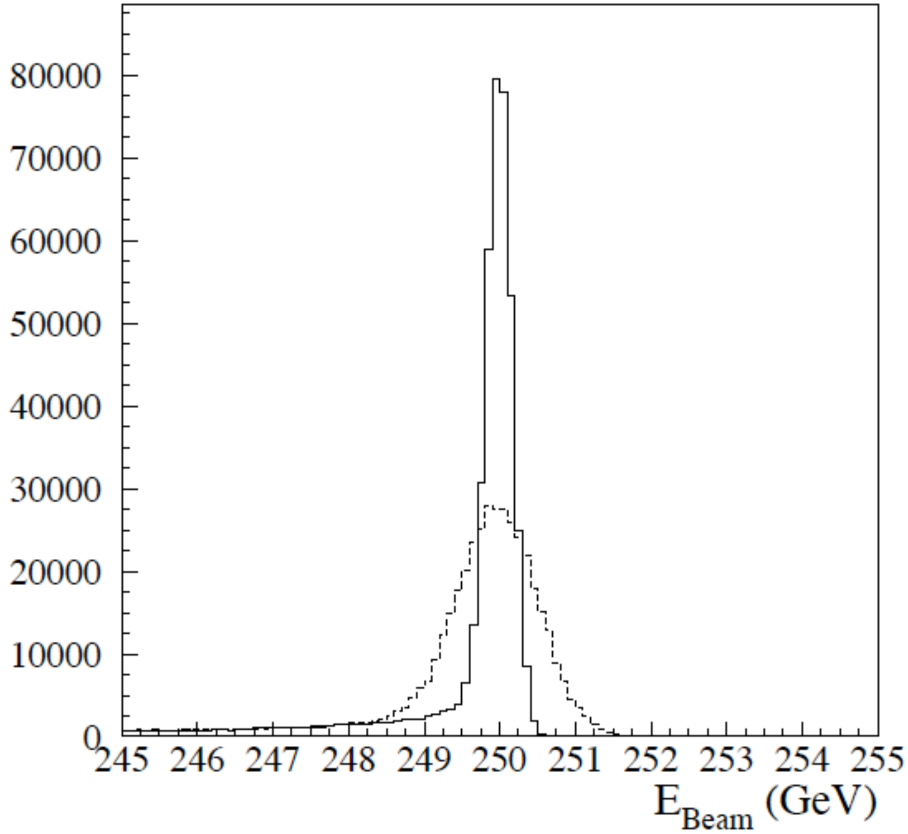
The Low-Charge option yields:

- Less pairs, by a factor 3
- Larger detector stay-clear

Beam-spectra

- Full beam-spectra for electrons (dash) and positrons (solid), for Low-Charge
- ... and the peak.
- Full E_{CMS} distribution for Low-Charge (solid) and NB w/ TF (dash)
- ... and the peak.
- CAVEAT: same *total* lumi. Nevertheless, increase within 2 σ is clear.

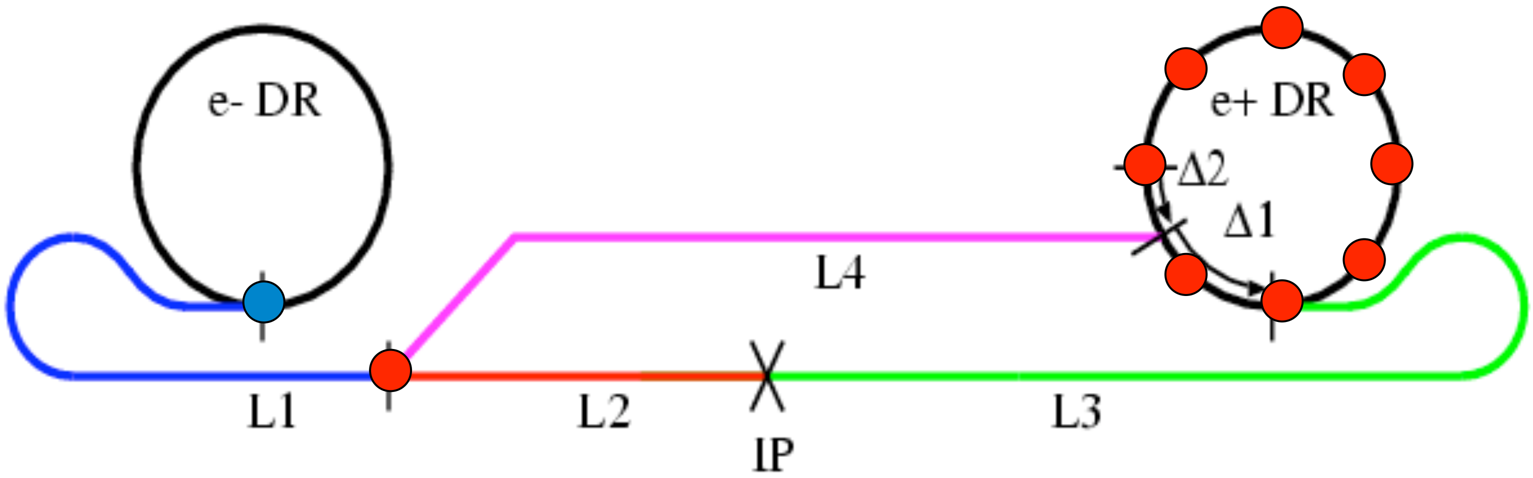
Omori's note:
Beam energy spreads of e- and e+ are largely different. It is caused by e+ generation by e- beam. It is not related to the Gao-parameter.



Positron Timing Considerations

KURIKI Masao
Hiroshima U. /KEK

Self Reproduction condition(5)



By vanishing L_1 and Δ_2 from the equations, we get

$$L_3 + L_4 - L_2 + \Delta_1 = nC_{DR}$$

When the path length condition (and collision condition) is satisfied, the generated positron is always accepted by DR. This condition is independent from DR fill pattern.

STATUS of E+/- GLOBAL TIMING

BTR, DESY

Oct 24-27 2011

JMP

STATUS

- Path Lengths

	Central Region	Close to final design This meeting?
	Linac	Decision Jan 2012?
	Turn-around	Needs final decision This meeting?

- Latest Estimate of needed correction

The latest data on path length difference (Benno List) shows E+ minus E- equals 9 x Circumference of DR + 350 meters

Therefore a simple shortening of the E+ linac side of the central region by 350/2 or 175 meters is required. (Between E- gun and end of linac)

A Proposed Global Timing Correction System

- **Get initial installed path lengths correct to 10 mm**
- **Design a 50 m long simple 4 magnet chicane whose central magnets can be moved horizontally by up to 1.5 meters from a straight line with two vacuum pipes and bellows to allow changes under vacuum. *Can this be done with RTML at final elevation?* NOT a motorized system.**
- **Install in RTML between BDS and end of E+ linac. RTML shares tunnel only with drift section of the high energy beam.**
- **During commissioning one can use DR path-length adjustment to measure motion required and manually move chicane system. Then during operation DR system is optimized for DR alone and +/- 1% variation in RTML chicane magnet strength can be used for frequent changes or feedback.**

PMs's decision: 1 - 5

I skipped 4 and 5

1. Source: Reduce the field of flux concentrator as baseline for TDR

2. Source: Auxiliary source with Kuriki's parameter

3. Two staged bunch compressor (resumed) instead of the single bunch compressor once proposed in SB2009,

4. Booster (up to 5 GeV) HLRF rating to include current overhead x 1.5 (for redundancy),

5. Booster HLRF would not to be with KCS. (DRFS or RDR would be encouraged, depending on the site and CFS condition).

END

No summary