

Tunnel Length Issue

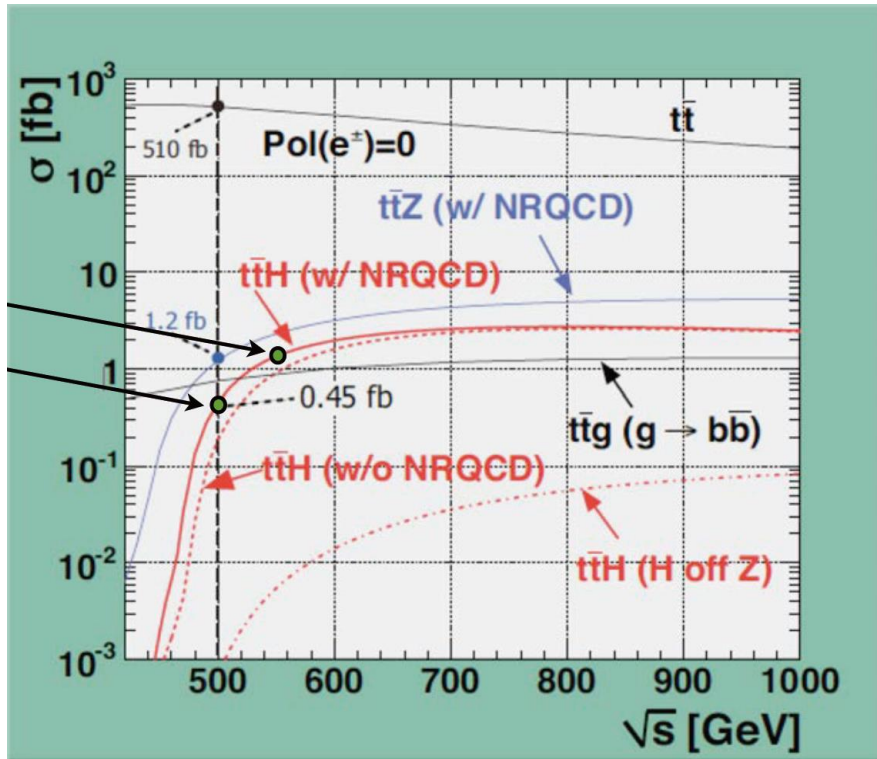
K.Yokoya

2014-1211 ADI

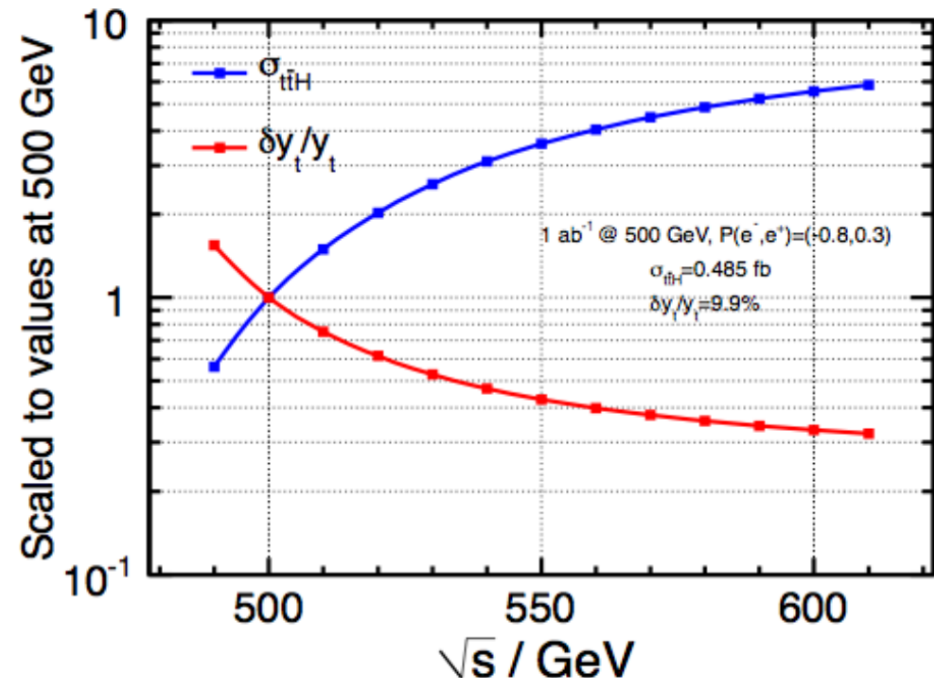
ADI/CFS Informal mtg at KEK on Dec.4

Physics Issue

- TDR Design : Maximum energy $E_{CM}=500\text{GeV}$
 - ✓ Decided before the discovery of Higgs at $\sim 125\text{GeV}$
- 500GeV is close to the threshold of $e^+ e^- \rightarrow t \bar{t} H$ at $E_{CM}=475\text{GeV}$
- $E_{CM} \sim 550\text{GeV}$ is preferable for measuring top-Yukawa coupling
 - The crosssection at 550GeV is factor ~ 4 larger than at 500GeV



2014/12/4 ADI-CFS Yokoya



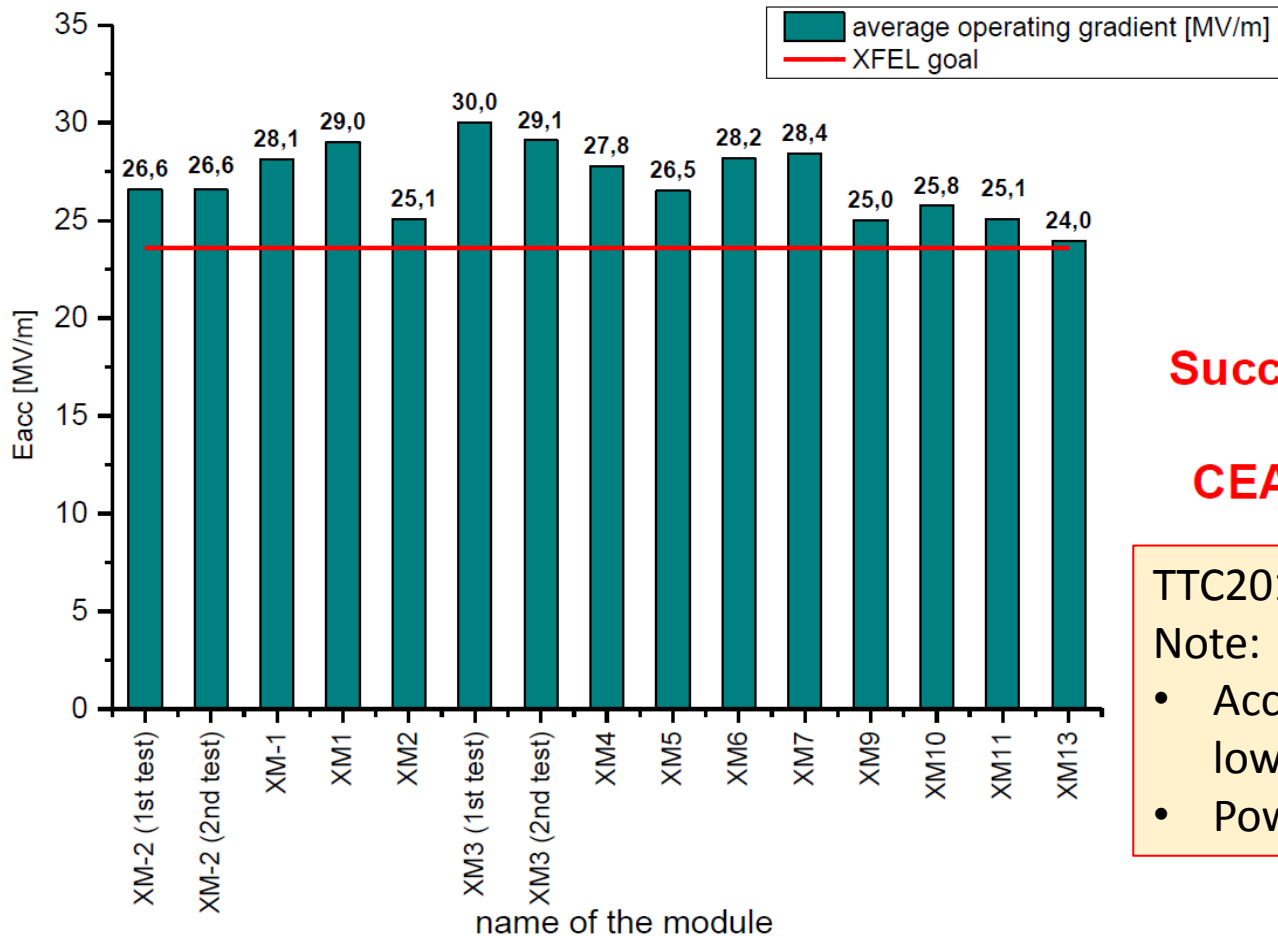
Parameter Group report (Oct.2014)

Accelerator Issue

- The average operation gradient defined as $G=31.5\text{MV/m}$ in TDR
- → linac length $\sim 11\text{km}^*2$ for 500GeV
- Can we guarantee 31.5MV/m?
 - Vertical test for XFEL so far shows values somewhat lower than ILC spec 35MV/m
 - Moreover, gradient reduction in cryomodule
 - Average reduction of first 11 module = $\sim 14\%$ (but only 10 of full production)
- If the actual gradient is lower, e.g., by 5%, ttH will be completely missed

Module Test Results II

- Average Operational gradients of modules with individual rf distribution
- All modules can be operated above 23.6 MV/m !!



Successful technology transfer to CEA Saclay + Alsyom

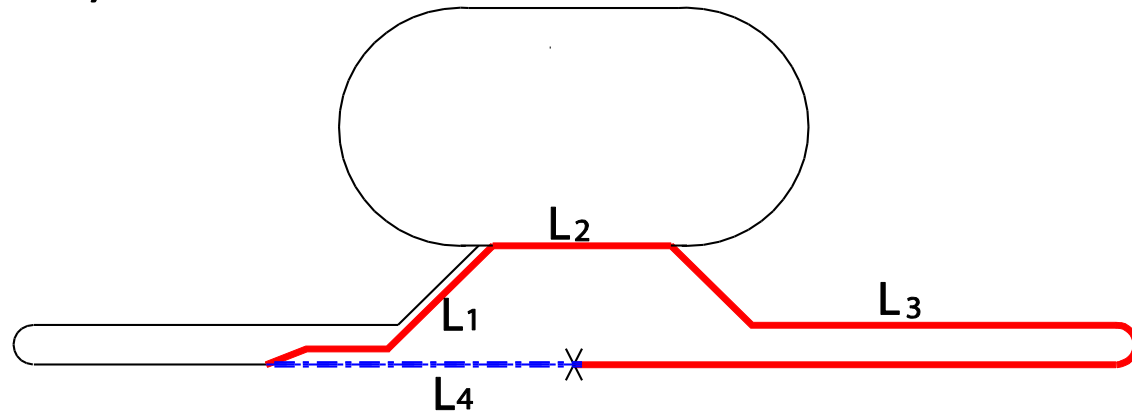
TTC2014@KEK D. Reschke

Note:

- Acceptance criterion at lower gradient
- Power-limit 31MV/m

Timing Issue

- $(L_1 + L_2 + L_3) - L_4 = n \times C_{DR}$



- TDR values give
 $(L_1 + L_2 + L_3) - L_4 = 9 \times C_{DR} + 294\text{m}$
- It is possible to adjust the value either by
 - Shortening the BDS by $\sim 150\text{m}$or by
 - Expanding the DR circumference by $\sim 30\text{m}$
- This will nearly keep the TDR layout
- But no margin for 500GeV, no way to reach 550GeV

What if longer linac is needed?

- Perhaps, ~10% (sum of physics and accelerator demands) is a reasonable extension
- 10% fully equipped linac is probably out of concern
 - Too expensive O(500M\$)
- But at least we can prepare additional empty tunnel
- With TDR C_{DR} , $(L_1 + L_2 + L_3) - L_4 = 10 \times C_{DR}$
tells the positron tunnel must be lengthened by
 $\Delta L_{Linac} = C_{DR} / 2 - 294m/2 = 1473m = \mathbf{14\%}$ of TDR linac tunnel
- This is enough for the timing issue, but the electron tunnel should also be lengthened for E_{CM} issue
 - ✓ Nearly 3km increase in total

Another Solution

- Keep $n=9$ and adopt longer C_{DR}
- $\Delta L_{e+Linac} = 9 \times \Delta C_{DR} / 2 - 294m/2$
- For example, $C_{DR} = 3508m$ gives $\Delta L_{e+Linac} = 1064m = \sim 10\%$
($\Delta L_{total} \sim 2.1km$)
- This requires 8.3% larger DR
 - ✓ Slight modification of wiggler length and RF is needed

h	Circumference (m)	n	N*circumference (m)	Mismatch (m)
7022	3238.7	9	29148.1	-293.6
7906	3646.4	8	29171.2	-270.6
8005	3692.1	8	29536.5	94.7
7126	3286.6	9	29579.8	138.1
8102	3736.8	8	29894.4	452.6
8108	3739.6	8	29916.5	474.8
8126	3747.9	8	29982.9	541.2
7240	3339.2	9	30053.0	611.3
8148	3758.0	8	30064.1	622.3
8172	3769.1	8	30152.7	710.9
8182	3773.7	8	30189.6	747.8
8191	3777.8	8	30222.8	781.0
8237	3799.1	8	30392.5	950.7
7372	3400.1	9	30601.0	1159.2
7382	3404.7	9	30642.5	1200.7
8308	3831.8	8	30654.5	1212.7
8378	3864.1	8	30912.8	1471.0
7498	3458.2	9	31124.0	1682.2
7606	3508.0	9	31572.3	2130.5
7736	3568.0	9	32111.9	2670.2
7022	3238.7	10	32386.8	2945.0

How to proceed?

- Consensus to increase tunnel length
- Some more detail of the design
 - Modification of DR if needed
 - Where to insert the empty section?
 - Cryogenics system
 - CFS issues : study started
 - Cost estimation
 - ✓ Empty tunnel ~25M\$/km
 - ✓ Beam line (high energy beam, RTML)
 - ✓ Δ cost of DR
- Time line
 - ✓ Change request early next year
 - ✓ Final decision by ALCW at KEK in Apr.2015

Which is better?

A) $\Delta L_{\text{total}} = 3\text{km}$

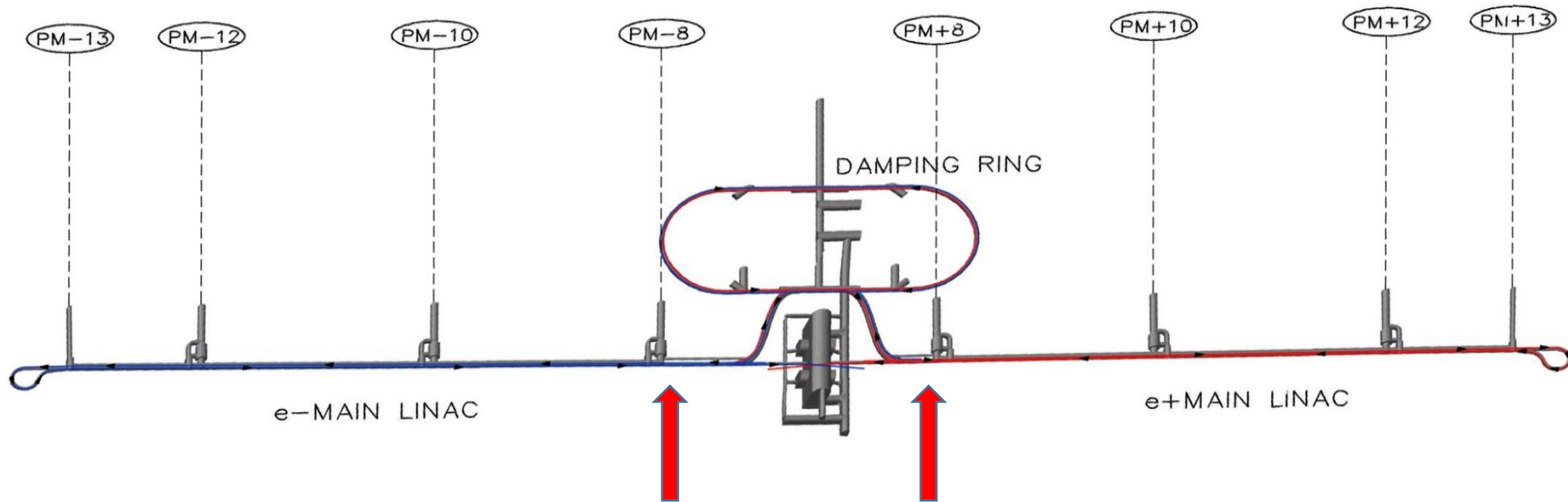
- gives larger gradient margin (14%)

B) $\Delta L_{\text{total}} = 2.1\text{km}$ with $\Delta C_{\text{DR}} = 269\text{m}$ (8.3%)

- Requires less increase of tunnel length
- But 8.3% increase of C_{DR} (plus 8% wiggler length and RF power/voltage) may even be more expensive than 1km of linac tunnel
- Redesign of DR needed \rightarrow manpower ?

Where should the extra linac tunnel be inserted?

- High energy ends of linacs
 - ✓ Cryogenics station at PM+8 can be reinforced later
 - ✓ Additional access tunnel not needed



SCRF Experts Discussion at KEK after TTC (Dec.5)

- Improvement of gradient reduction in cryomodule might be improved
 - One of the important topics of TTC
- Should wait 1-2 more years for the final decision