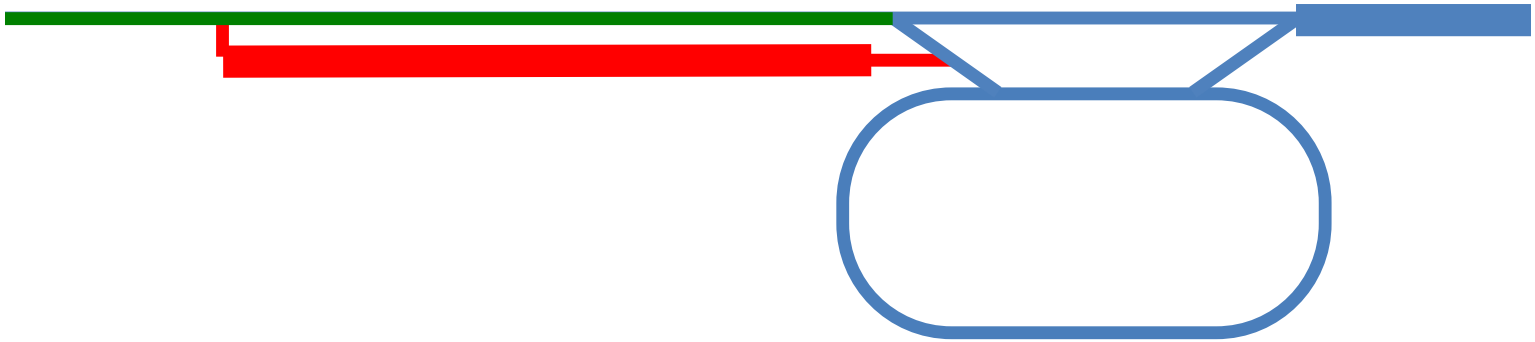
ILC tunnel lengths & Commissioning with E-driven e+ source and, a Proposal of the separate tunnel for the e+ source



T. Omori, 23-Oct-2018

LCWS 2018, Oct 22nd - 26th, 2018
University of Texas at Arlington, USA

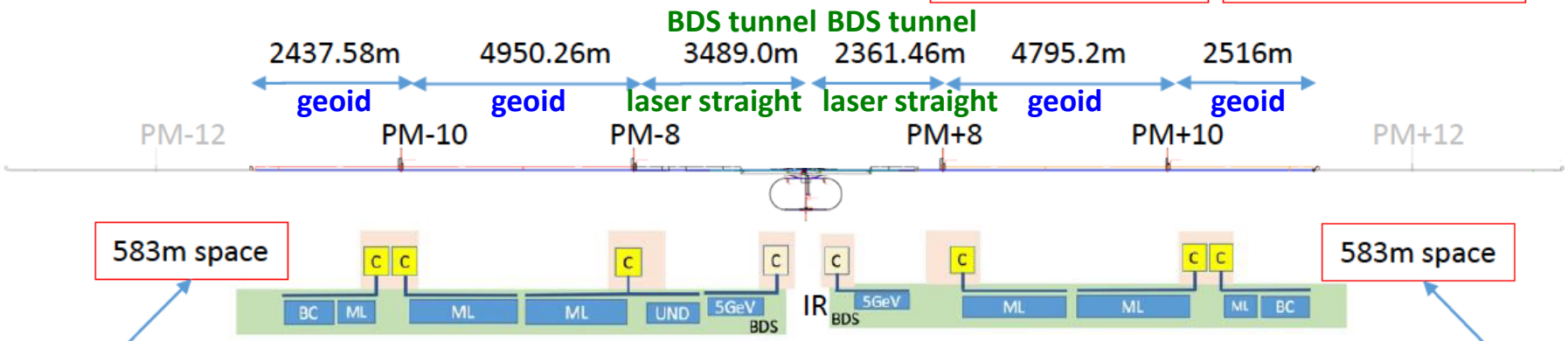
ILC tunnel lengths

E-driven e+ source

Option A

Note:
This was called "Option C" by the end of the last year

ECM=250GeV **SRF 31.5MV/m**



Ecm=250GeV

	BC				e+inj		e-inj				BC	
module space margin for option C, 31.5MV/m	51	90	189	189	24	module space	24	180	189	90	51	module space margin for option C, 31.5MV/m
	51	45	189	189	24	cryomodules	24	180	189	45	51	
	17	10	42	42	8	RF unit	8	40	42	10	17	
e^- 134.8GeV =	10.0	12.8	53.5	53.5	5.0	E gain (GeV)	5.0	51.0	53.5	12.8	10.0	= e^+ 132.3GeV +5.8%margin

Total tunnel length = 20549.5m
(20.5km)

with
E-driven e+ source

Option A

Note:
This was called "Option C" by the end of the last year

with E-driven e+ source
2361m

ECM=250GeV

SRF 31.5MV/m

BDS tunnel BDS tunnel

2437.58m 4950.26m 3489.0m 2361.46m 4795.2m 2516m

geoid geoid laser straight laser straight geoid geoid

PM-12 PM-10 PM-8 PM+8 PM+10 PM+12

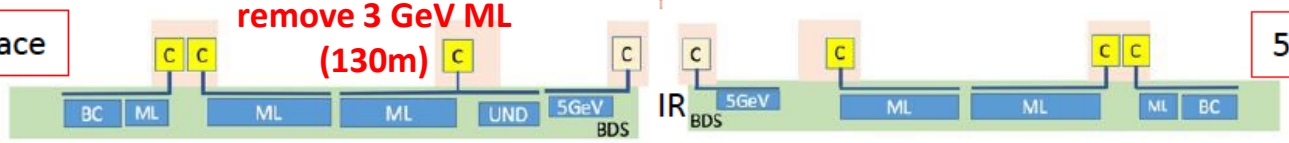
with E-driven e+ source 150 m

583m space

with E-driven e+
remove 3 GeV ML
(130m)

with E-driven e+ source 150 m

583m space



module space margin
for option C, 31.5MV/m

module space margin
for option C, 31.5MV/m

	BC				e+inj	Ecm=250GeV	e-inj				BC	
	51	90	189	189	24	module space	24	180	189	90	51	
	51	45	189	189	24	cryomodules	24	180	189	45	51	
	17	10	42	42	8	RF unit	8	40	42	10	17	
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+5.8%margin

With E-driven e+ source, length of electron-BDS becomes significantly shorter (3489m -> 2361 m).

Total tunnel length = 20549.5m

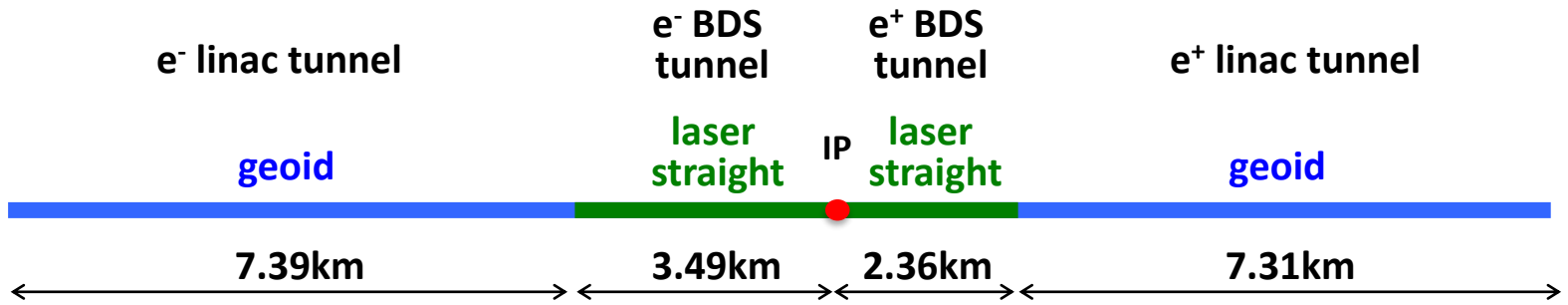
(20.5km)

with E-driven e+ source
Total tunnel length 18.5 km

Tunnel Length Comparison

Option A 31.5 MV/m

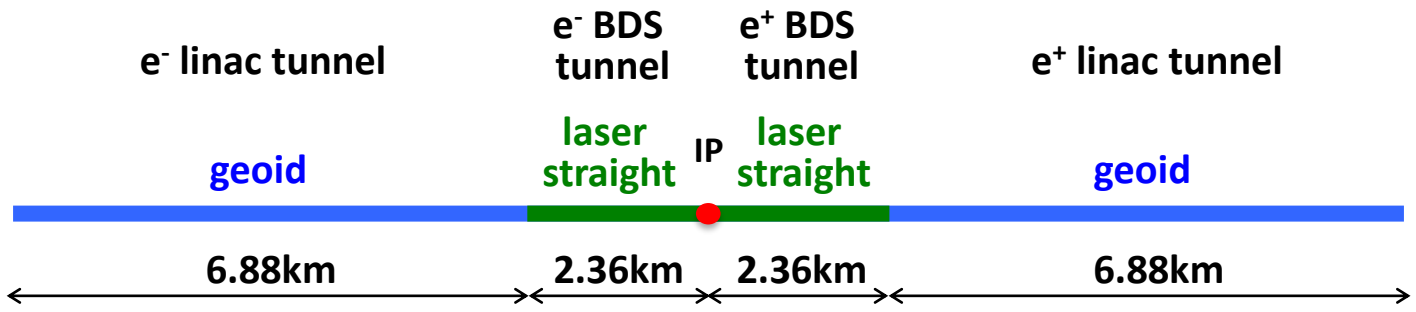
ILC with undulator positron source



total : 20.55 km

Option A 31.5 MV/m

ILC with E-driven positron source



total : 18.48 km

Access Tunnels

Site-specific design of Access tunnels

Option A

Note:
This was called "Option C" by the end of the last year

Total Accelerator tunnel length = 20,549.5m (20.5km)

access tunnels	5	Detector shaft	1
total length	4876m	ϕ18m	depth 75m
Drain tunnel	1	Utility shaft	1
total length	4335m	ϕ10m	depth 75m

Access Tunnels

Site-specific design of Access tunnels

with E-driven e+ source

Option A

Note:
This was called "Option C" by the end of the last year

AT-10: 1503m

with E-driven e+ source 1500 m

PM-10

electron linac

with E-driven e+ source 2361m

PM-8

AT-8: 691m

with E-driven e+ source 490m

3489m

AT・DR (access point to DR): 763m

AT・DH (branch to detector hall): 693m

Interaction Region

damping ring

2361m

drain tunnel (0.13%gradient): 4335m

AT+8: 283m

PM+8

positron linac

AT+10: 943m

PM+10

Total Accelerator tunnel length = 20,549.5m (20.5km)

with E-driven e+ source

Total Accelerator tunnel length 18.5 km

access tunnels	5	Detector shaft	1
total length	4876m	ϕ18m	depth 75m
Drain tunnel	1	Utility shaft	1
total length	4335m	ϕ10m	depth 75m

With E-driven e+ source, length of electron-BDS becomes significantly shorter (3489m -> 2361 m).
Access tunnel to the electron-BDS becomes shorter too (690m -> 490 m).

Summary of Tunnel Length

(1) With E-driven e+ source, length of several tunnels can be shorter.

(2) Total footprint length becomes shorter, 20.5 km -> 18.5 km.

(3) Especially length of electron-BDS (where e+ source is located) becomes significantly shorter (3489m -> 2361 m).

(4) The access tunnel to the electron-BDS becomes shorter too (690m -> 490 m).

(5) Both (3) and (4) mean tunnel construction period of electron-BDS can be shorter than that of the baseline design.
-> possibility of early commissioning of the central part (source and DR).
See next page.

Commissioning strategy

with E-driven e+ source

Commissioning Strategy

My Proposal

(1) E-driven e+ source is independent of the e- main linac.

(2) Make use of the short construction period of e-BDS tunnel and the independence, maybe we can start the commissioning of the e+ source earlier than that of main linacs.

(3) We would like to make an integrated commissioning strategy of ILC with an integrated tunnel construction plan, in order to start physic run as early as possible.

Construction and Commissioning of e+/e- sources and DR

Optimistic plan or materials to trigger discussions

year	1	2	3	4	5	6	7	8	9	10

e+ Source Construction

Making Parts
Acc. tubues, Magnets
Klystrons, Modulators
Target, FC, etc.

preparation 1.5ys → production 5ys

Tunnel construction
tunneling, access holes,
finishing, water, electricity

preparation 1.5ys → construction 5ys

Installation 1y

Central Part Commissioning
sources and DRs
1.5y

ML construction
MLs and ML tunnels
9ys (ML tunnel const. + ML const.)

Global Commissioning
with ML
1y

year	1	2	3	4	5	6	7	8	9	10

reference: Construction and Commissioning in TDR

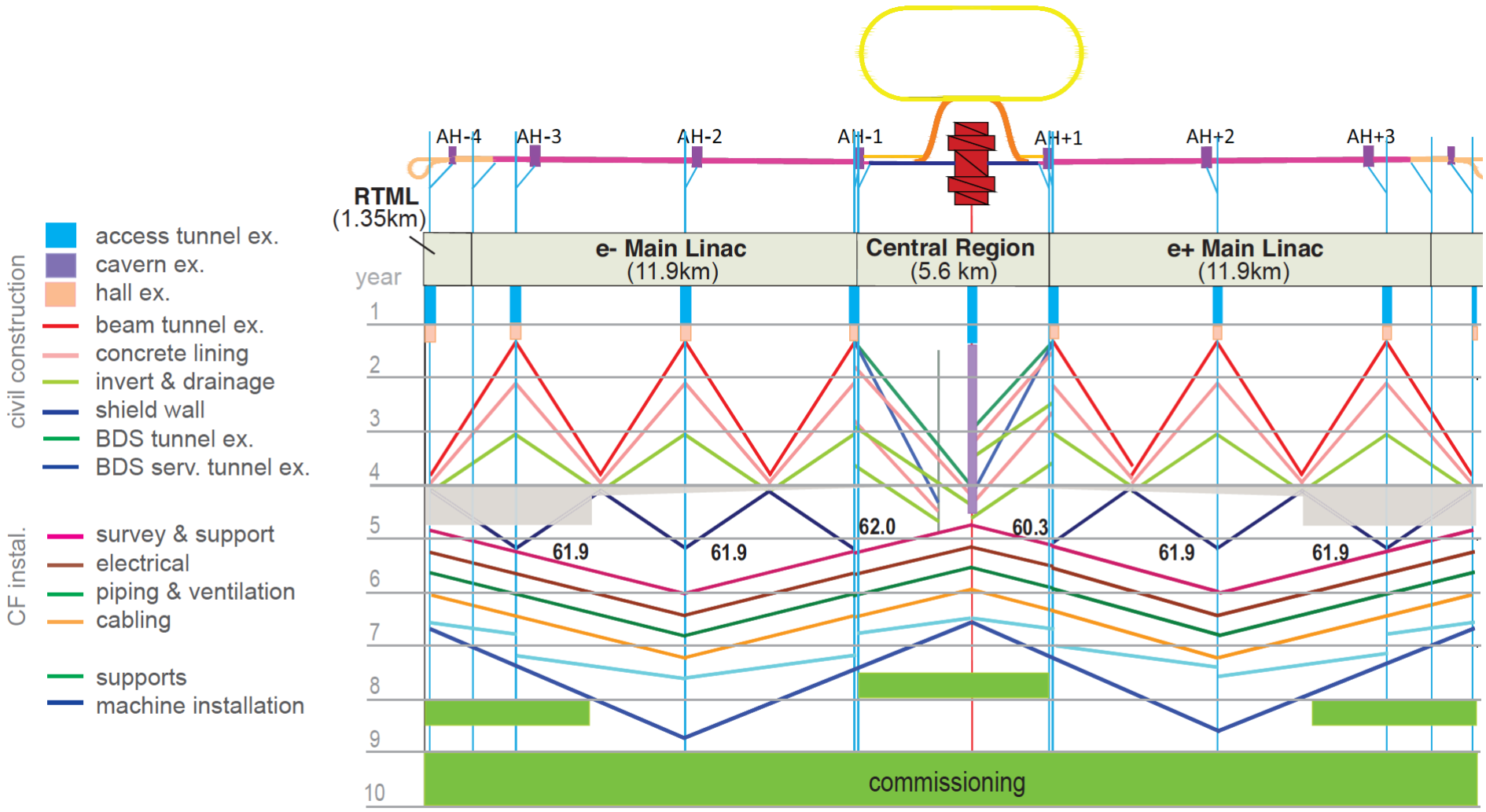


Figure 14.3. The construction and commissioning schedule for the mountain topography design variant. See Fig. 14.2 caption for details.

Summary of Commissioning Strategy

My Proposal

(1) What I showed today is just to trigger discussions.

(2) We would like to make an integrated commissioning strategy of ILC with an integrated tunnel construction plan, in order to start physic run as early as possible.

E-driven e+ source in a Separate tunnel

Thanks to Hayano-san and Miyahara-san

Access Tunnels

Site-specific design of Access tunnels

with E-driven e+ source

Option A

Note:
This was called "Option C" by the end of the last year

AT-10: 1503m

with E-driven e+ source 1500 m

PM-10

electron linac

with E-driven e+ source 2361m

PM-8

AT-8: 691m

with E-driven e+ source 490m

3489m

AT・DR (access point to DR): 763m

AT・DH (branch to detector hall): 693m

Interaction Region

damping ring

2361m

drain tunnel (0.13%gradient): 4335m

AT+8: 283m

PM+8

positron linac

AT+10: 943m

PM+10

Total Accelerator tunnel length = 20,549.5m (20.5km)

with E-driven e+ source

Total Accelerator tunnel length 18.5 km

access tunnels	5	Detector shaft	1
total length	4876m	ϕ18m	depth 75m
Drain tunnel	1	Utility shaft	1
total length	4335m	ϕ10m	depth 75m

With E-driven e+ source, length of electron-BDS becomes significantly shorter (3489m -> 2361 m).
Access tunnel to the electron-BDS becomes shorter too (690m -> 490 m).

Access Tunnels

Site-specific design of Access tunnels

with E-driven e+ source

Option A

Note:
This was called "Option C" by the end of the last year

AT-10: 1503m

with E-driven e+ source 1500 m

PM-10

electron linac

PM-8

AT-8: 691m

with E-driven e+ source 490m

AT▪DR (access point to DR): 763m

AT▪DH (branch to detector hall): 693m

drain tunnel (0.13%gradient): 4335m

3489m

with E-driven e+ source 2361m

Interaction Region

damping ring

2361m

AT+8: 283m

PM+8

Close up -> next page

positron linac

AT+10: 943m

PM+10

Total Accelerator tunnel length = 20,549.5m (20.5km)

with E-driven e+ source Total Accelerator tunnel length 18.5 km

access tunnels	5	Detector shaft	1
total length	4876m	ϕ18m	depth 75m
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With E-driven e+ source, length of electron-BDS becomes significantly shorter (3489m -> 2361 m).
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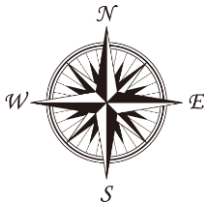
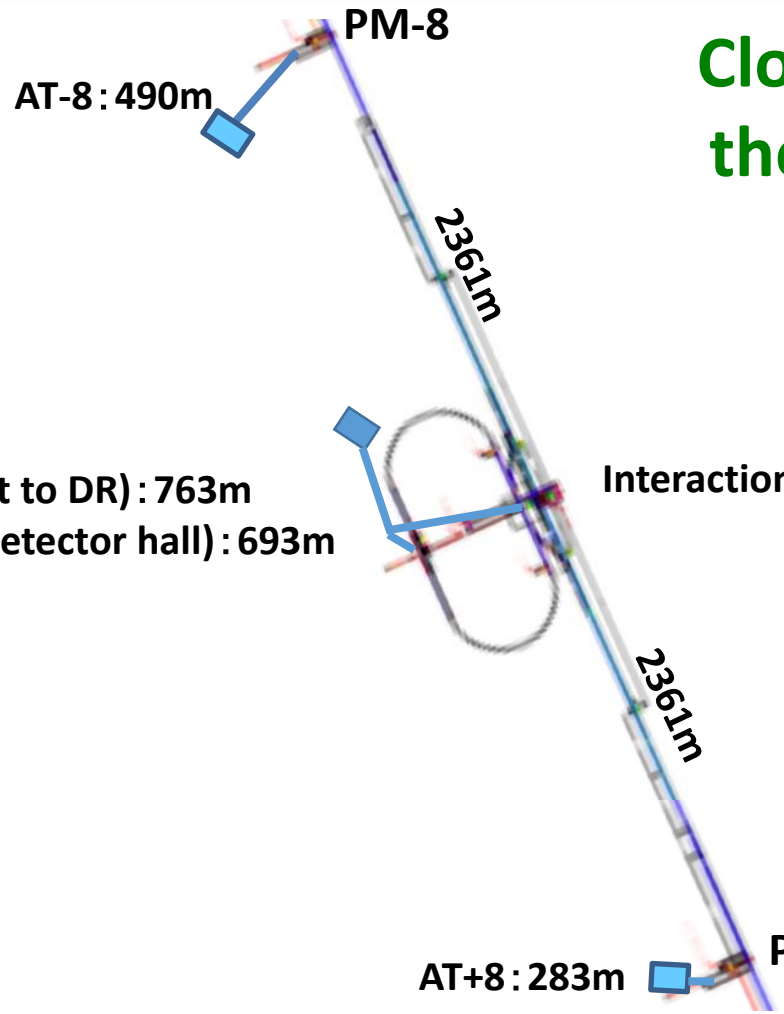
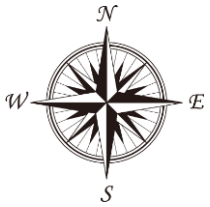
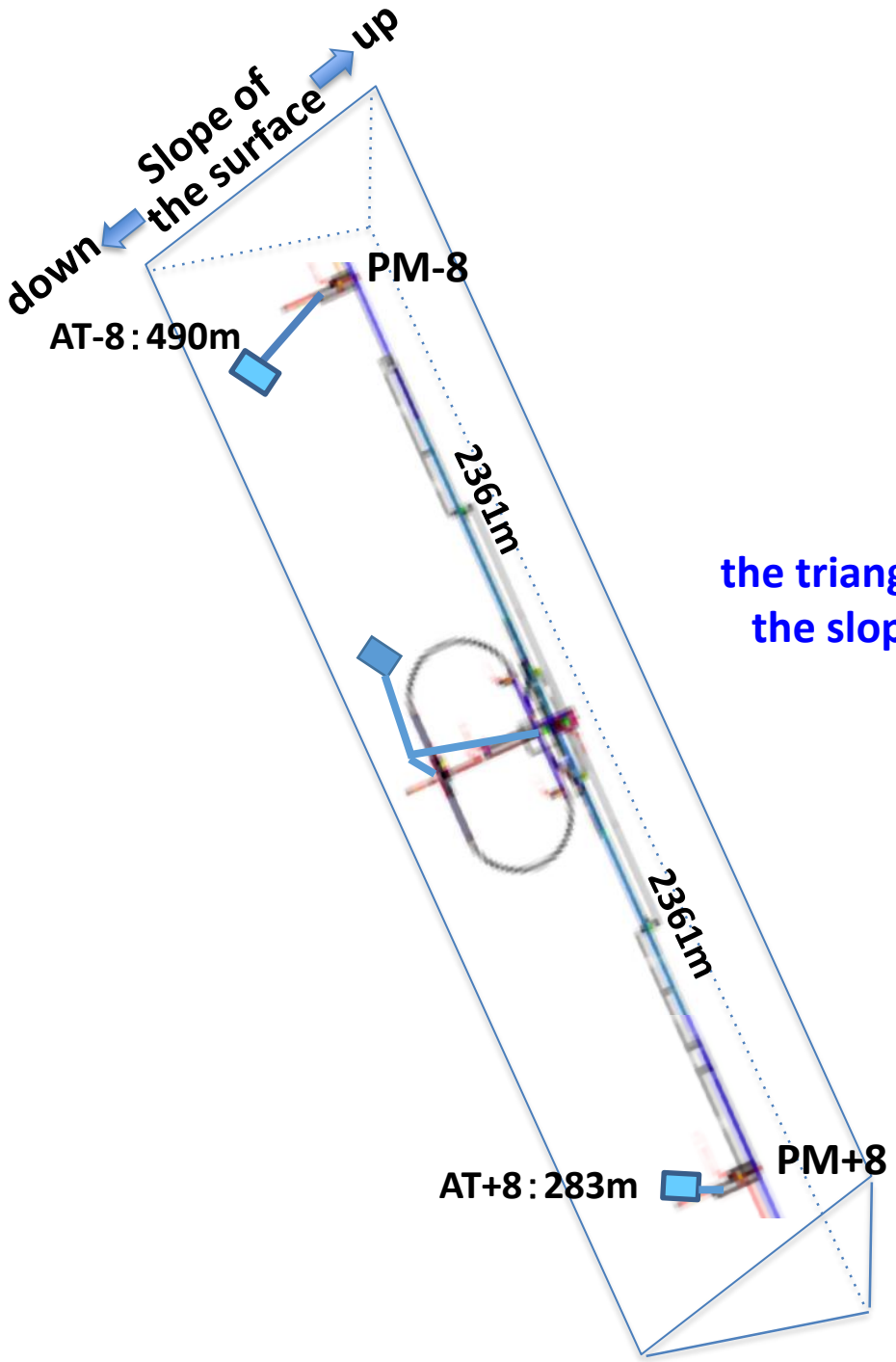


Close up view of the central part

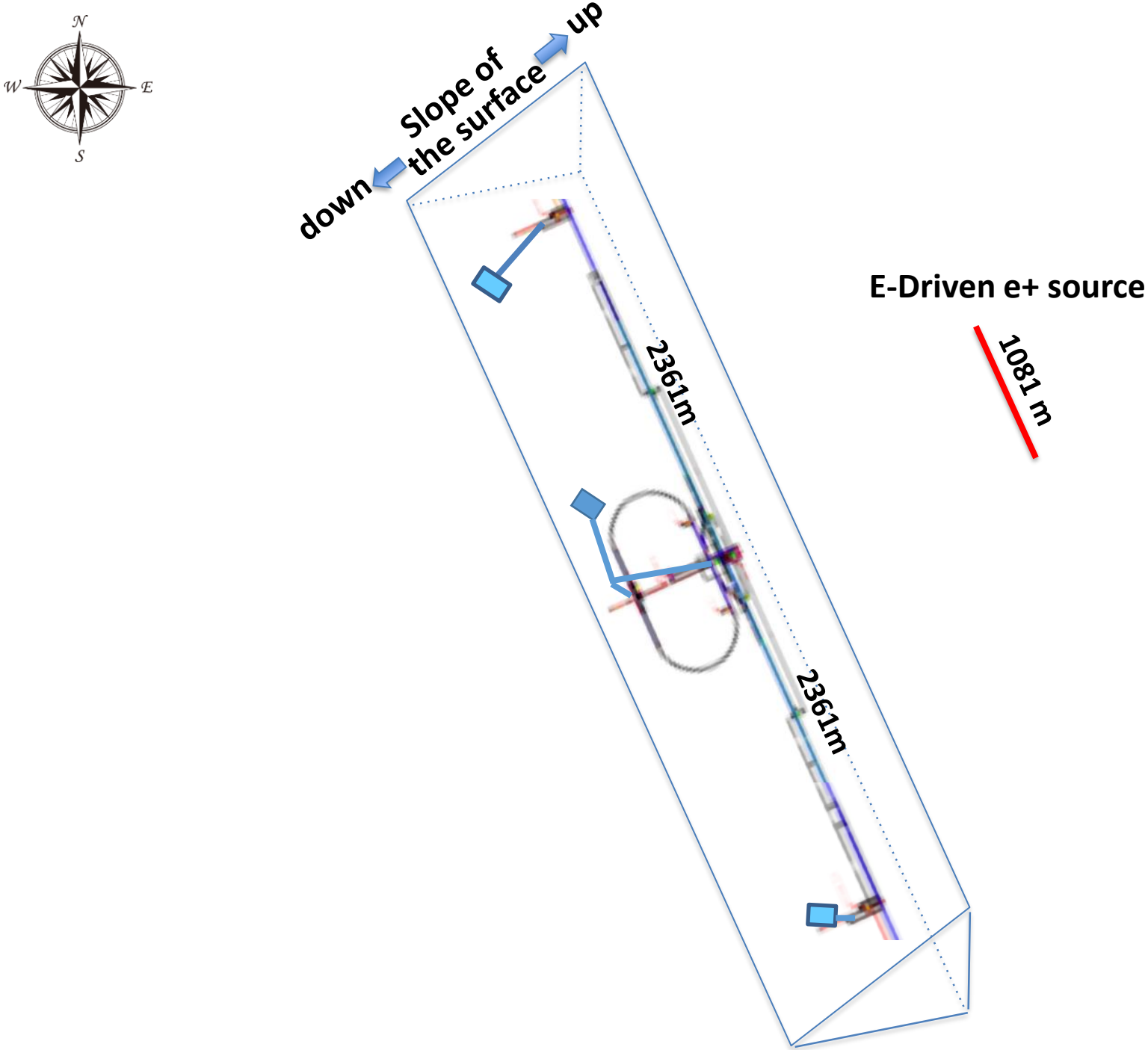


AT・DR (access point to DR) : 763m
AT・DH (branch to detector hall) : 693m

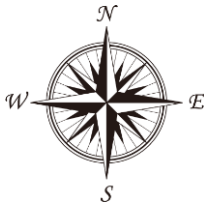


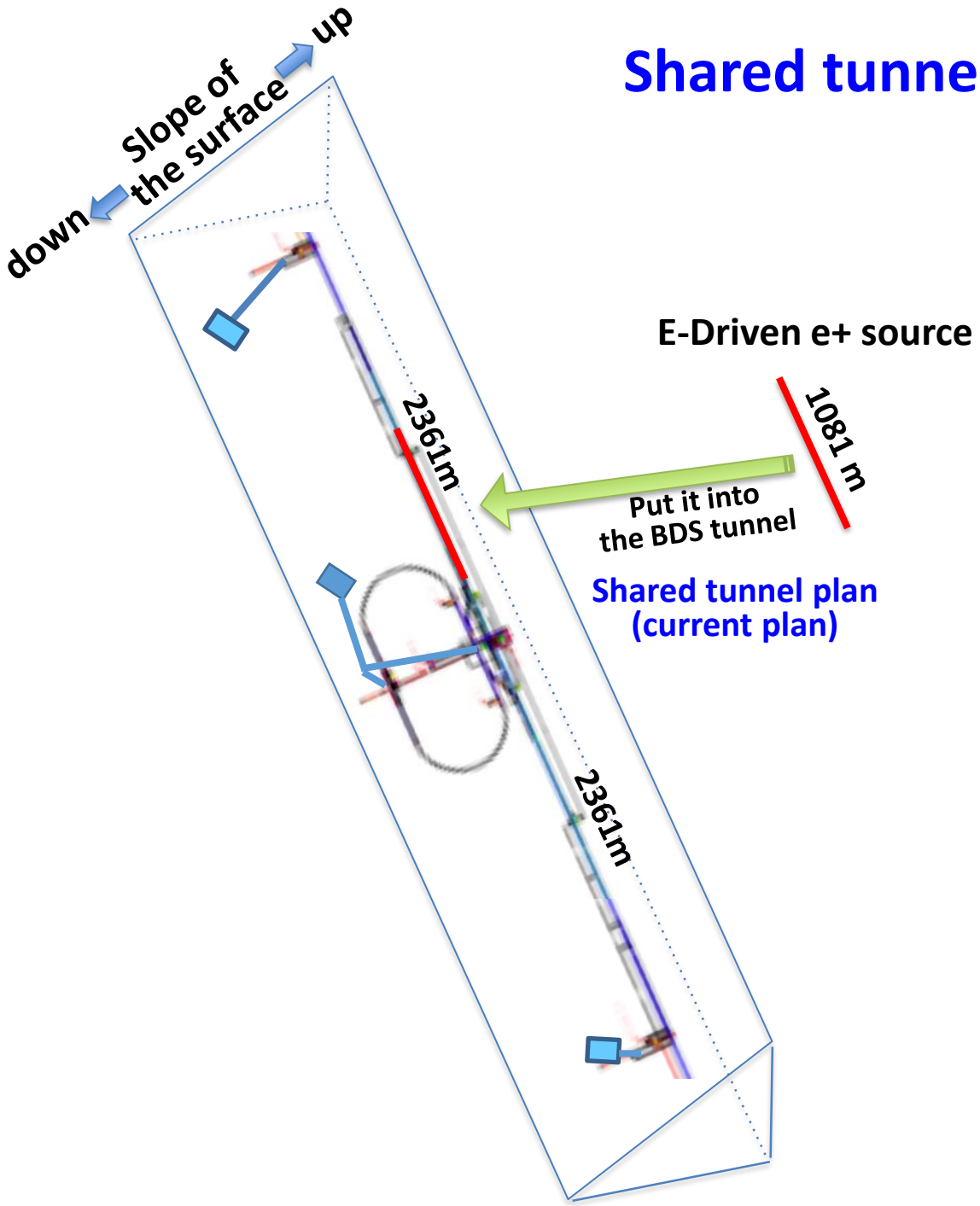


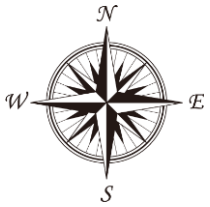
the triangular prism shows the slope of the surface


N
W
E
S
Slope of
the surface
up
down
2361m
2361m
E-Driven e+ source
1081 m

Shared tunnel plan



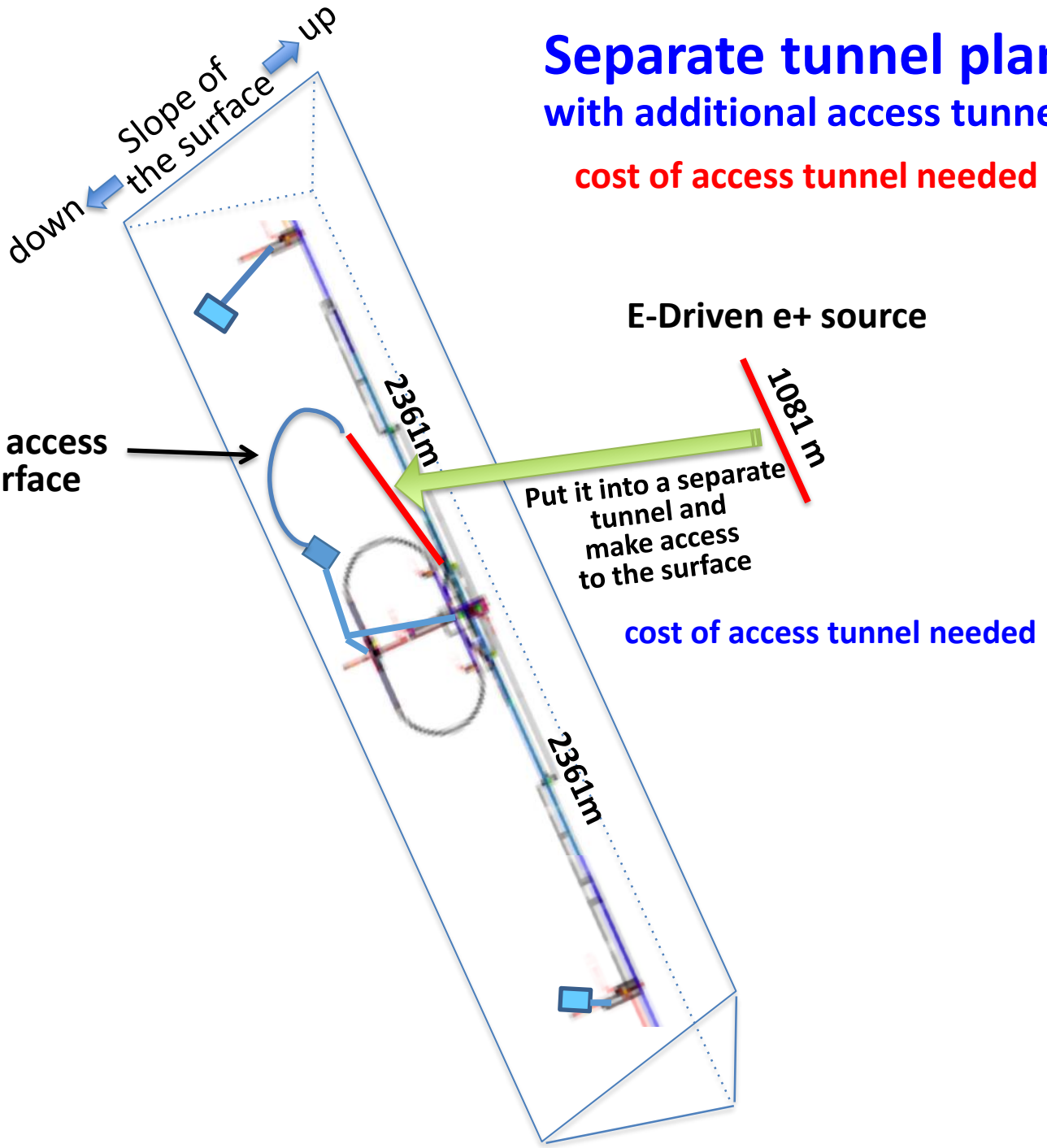


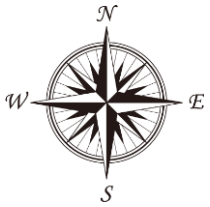


Separate tunnel plan

with additional access tunnel

cost of access tunnel needed

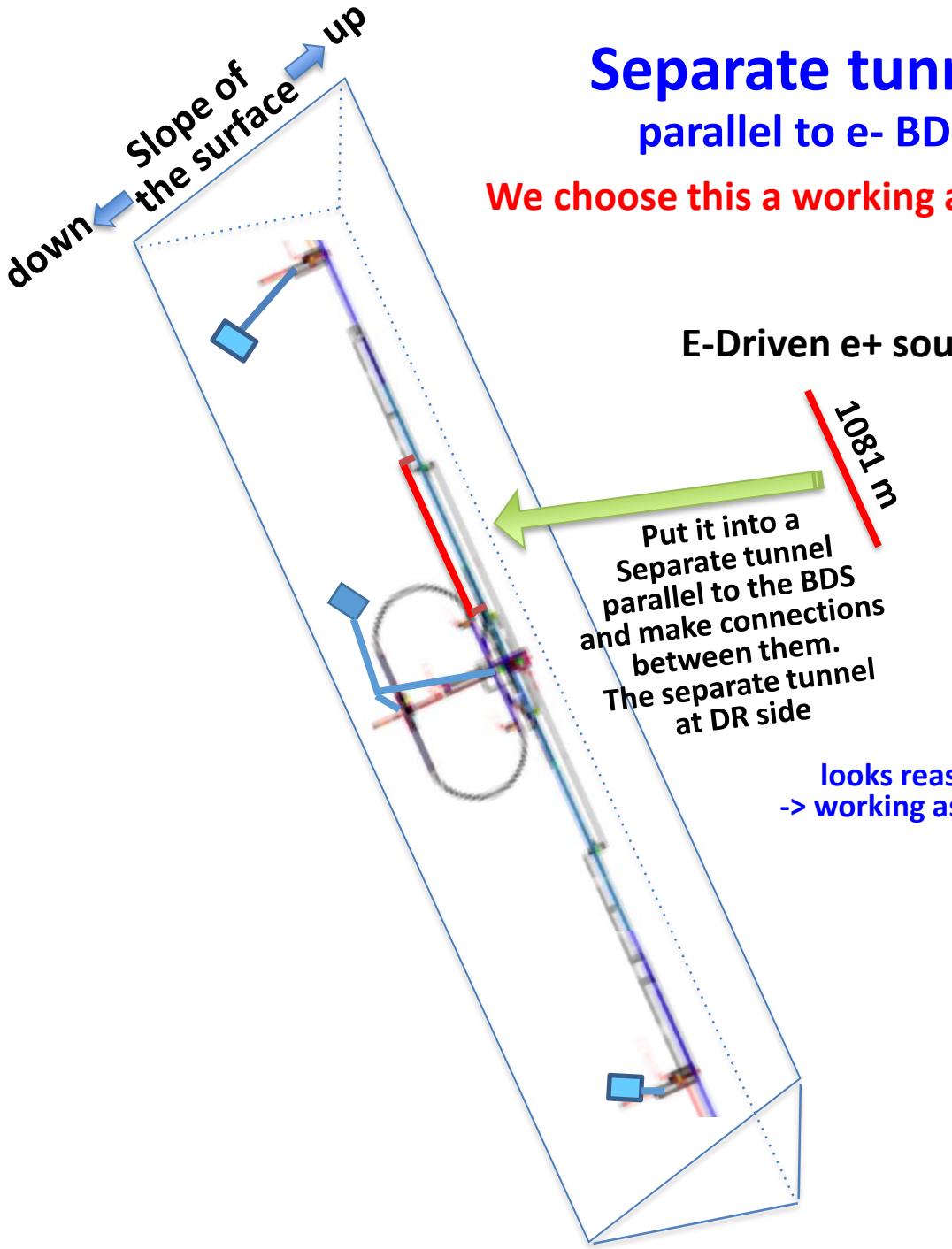




Separate tunnel plan

parallel to e- BDS tunnel

We choose this a working assumption today.



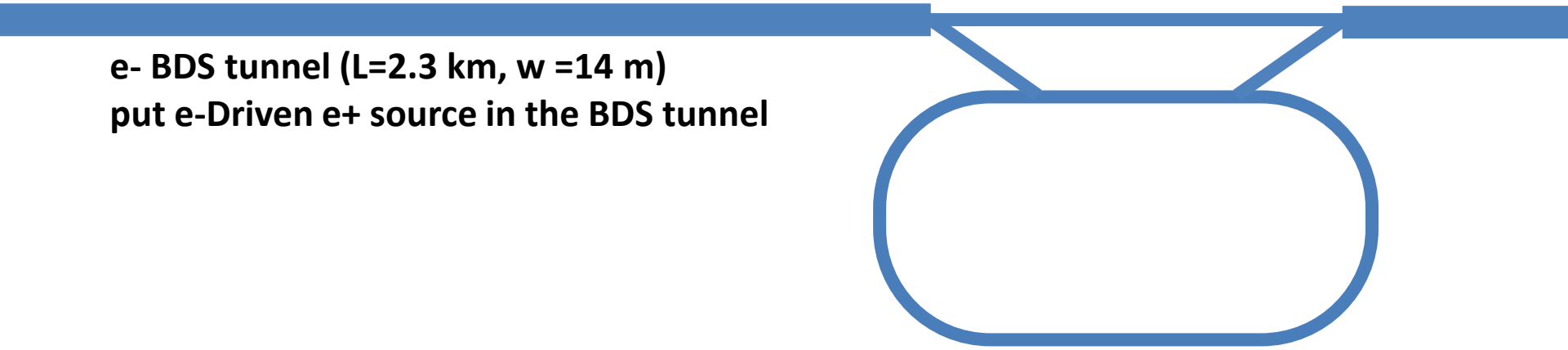
looks reasonable
-> working assumption

Shared tunnel plan and Separate tunnel plan

- **Shared tunnel plan**

e- BDS tunnel (L=2.3 km, w =14 m)

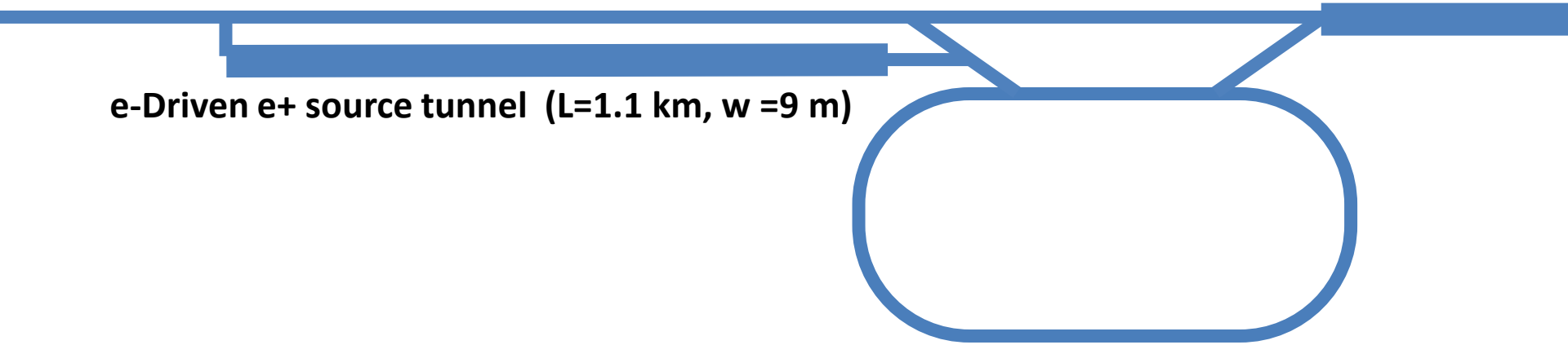
put e-Driven e+ source in the BDS tunnel



- **Separate tunnel plan**

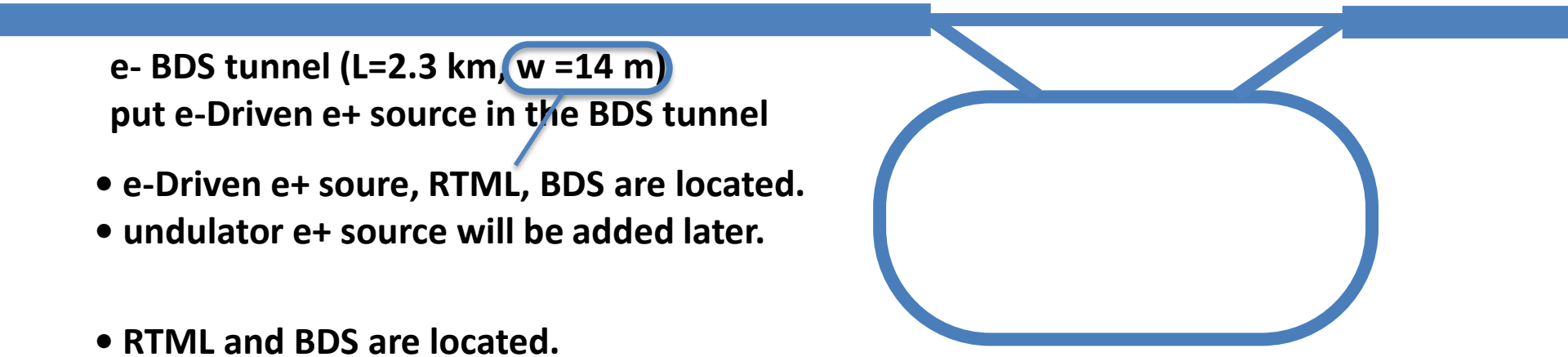
e- BDS tunnel (L=2.3 km, w =7.5 m)

e-Driven e+ source tunnel (L=1.1 km, w =9 m)



Shared tunnel plan and Separate tunnel plan

- **Shared tunnel plan**



e- BDS tunnel (L=2.3 km, w =14 m)

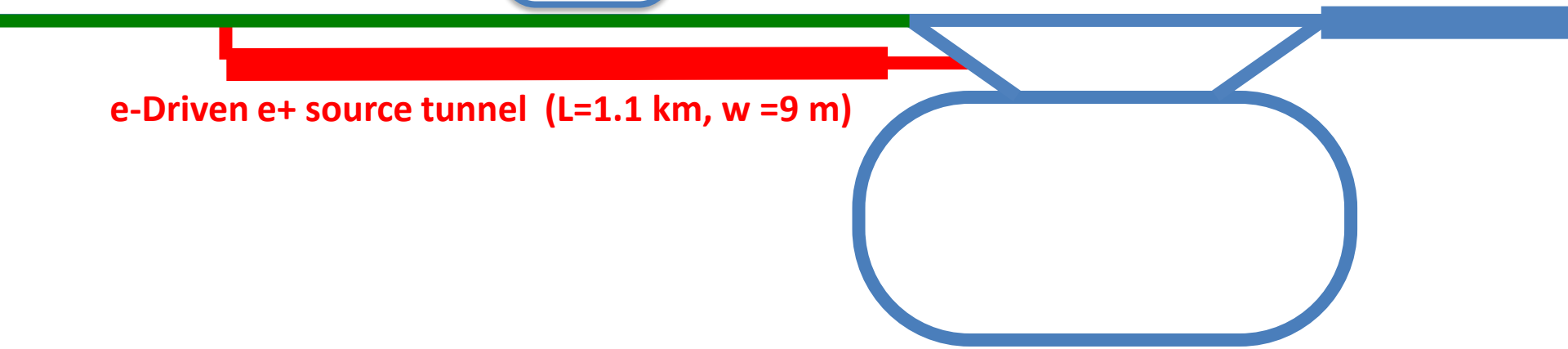
put e-Driven e+ source in the BDS tunnel

- **e-Driven e+ soure, RTML, BDS are located.**
- **undulator e+ source will be added later.**

- **RTML and BDS are located.**
- **later, tunnel will be widen and undulator e+ source will be added**

- **Separate tunnel plan**

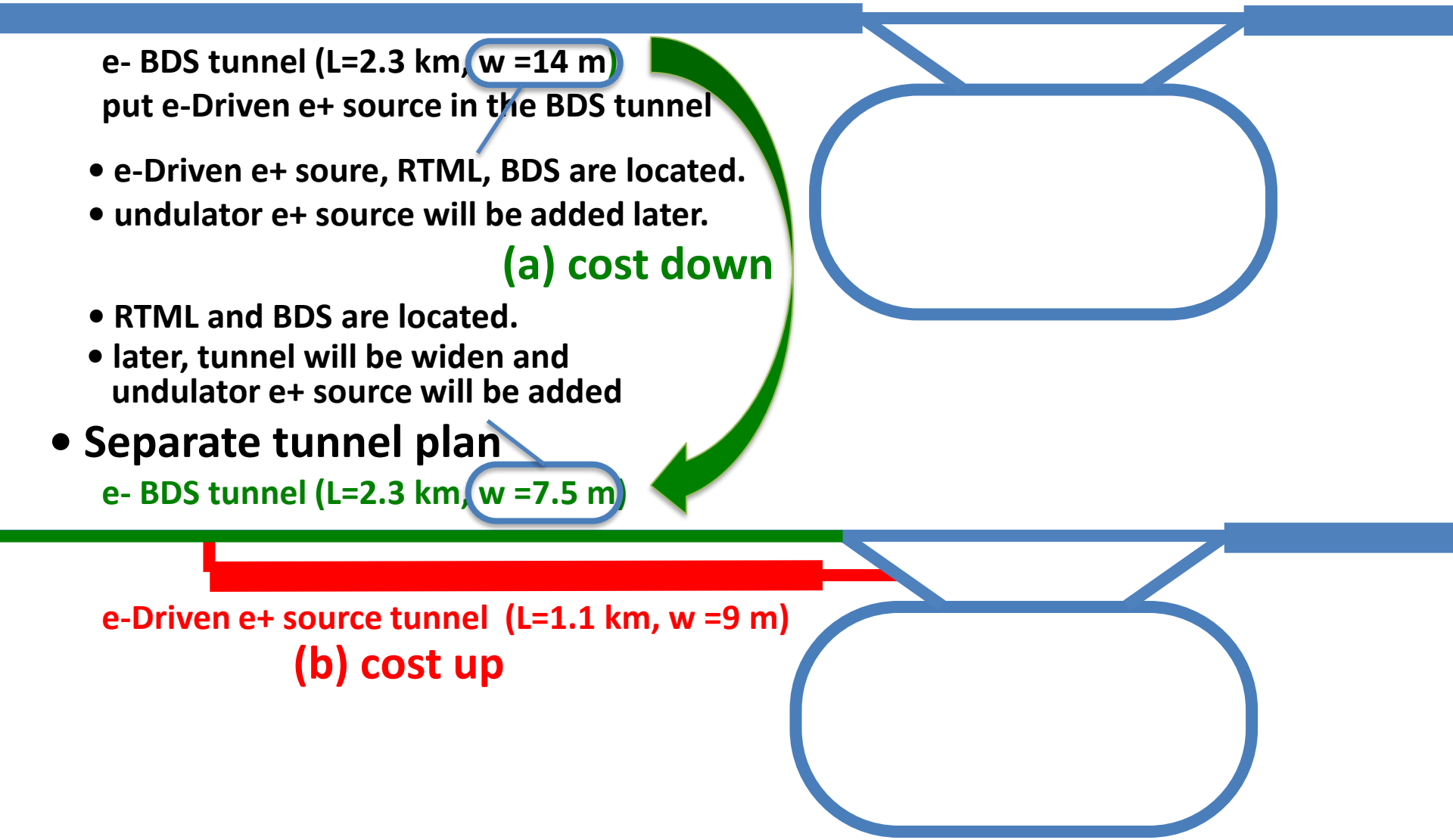
e- BDS tunnel (L=2.3 km, w =7.5 m)



e-Driven e+ source tunnel (L=1.1 km, w =9 m)

Shared tunnel plan and Separate tunnel plan

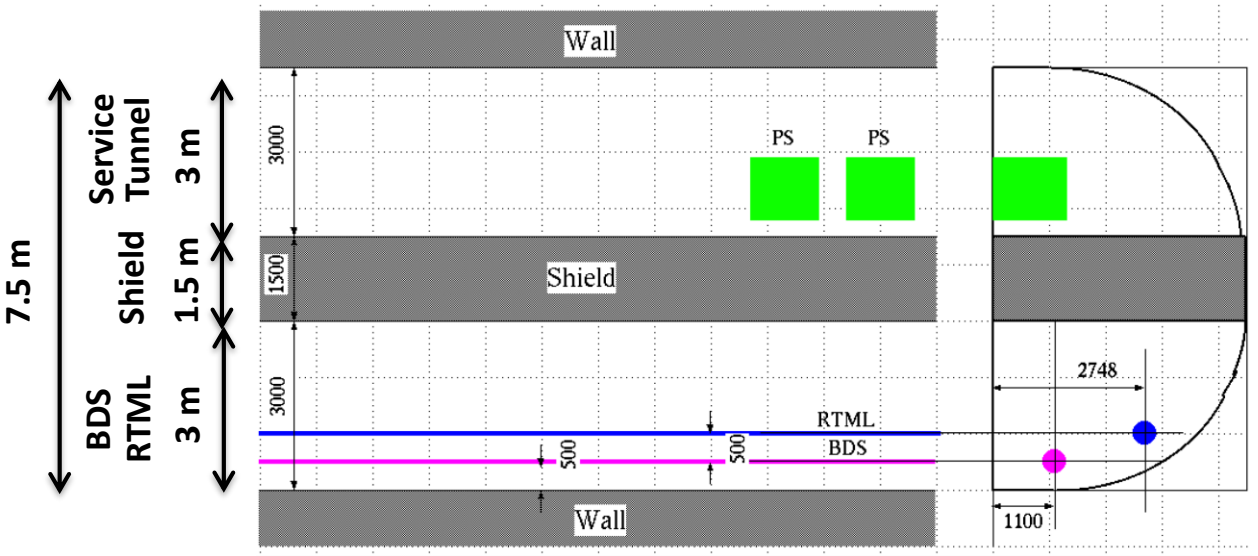
- **Shared tunnel plan**



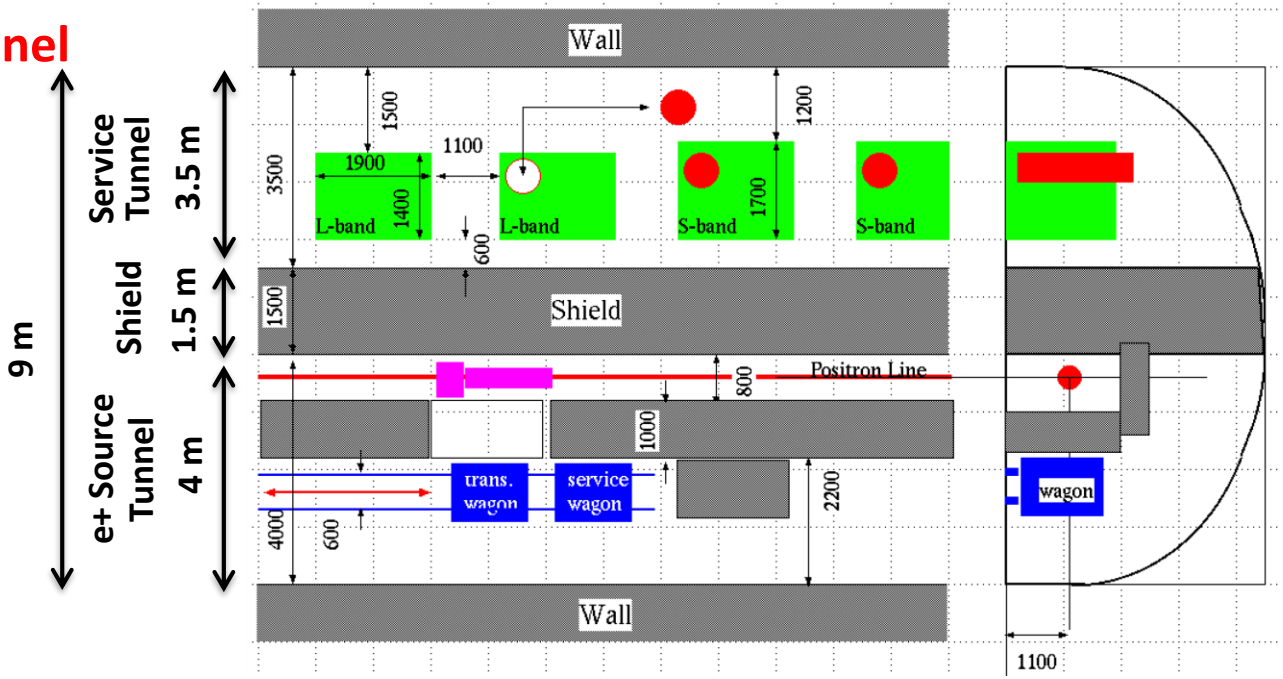
very rough estimation: (a) + (b) ~ 0

Separate tunnel plan

e- BDS tunnel
(L=2.3 km, w =7.5 m)



e-Driven e+ source tunnel
(L=1.1 km, w =9 m)



Summary of Separate tunnel

My Proposal

(1) What I showed today is just to trigger discussions.

(2) Separate tunnel for e-Driven e+ source has potential to make early commissioning easier.

(3) We can make BDS tunnel (L=2.3 km) narrower (w= 14 m -> 7.5m). The cost down by the narrow BDS tunnel probably compensate the cost up by making a separate tunnel (L=1.1 km, w=9 m) for the e+ source. (we need detailed study)

Polarization Upgrade

If we start with the E-driven e+ source, we need an upgrade path to the undulator source.

The question is "Can we have it?"
Especially, can we have it when we start with shorten BDS tunnel?

Polarization Upgrade

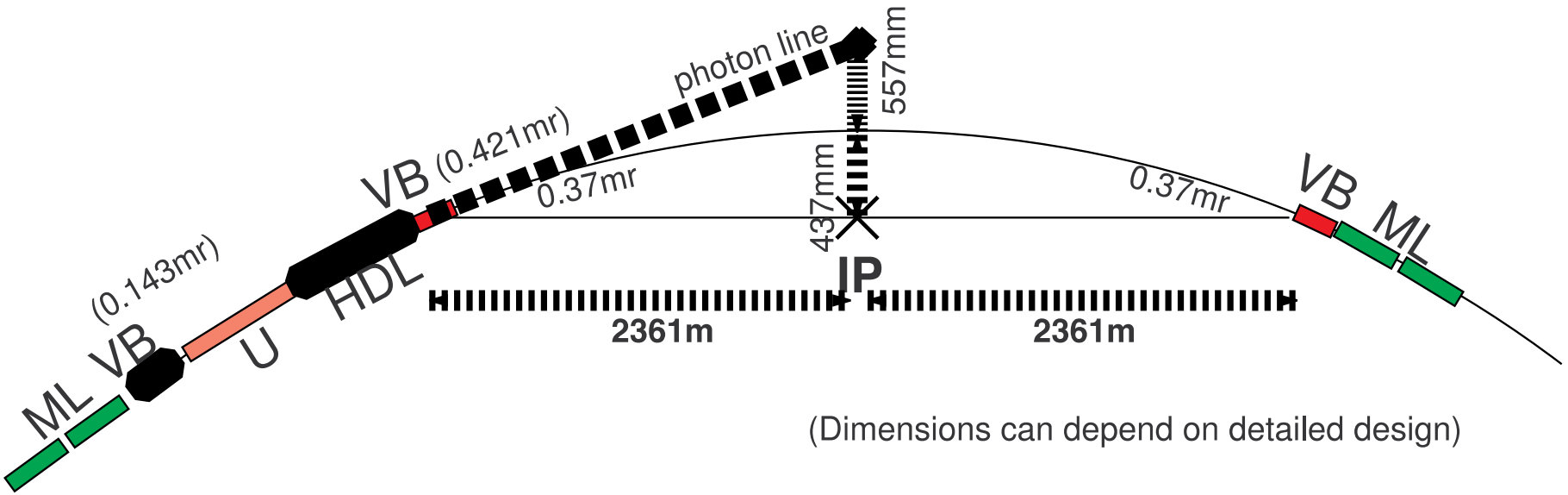
If we start with the E-driven e+ source, we need an upgrade path to the undulator source.

The question is "Can we have it?"
Especially, can we have it when we start with shorten BDS tunnel?

Yes we can. We can put undulator and photon drift in the geoid tunnel. --> Yokoya-san's symmetric laser straight scheme

Polarization Upgrade

Yokoya-san's symmetric laser straight scheme



(Dimensions can depend on detailed design)

- **Only BDS tunnels are laser straight.**
- **Straight part is symmetric wrt the IP**
- **Undulator and photon drift (and, of course ML) are in the geoid tunnel.**

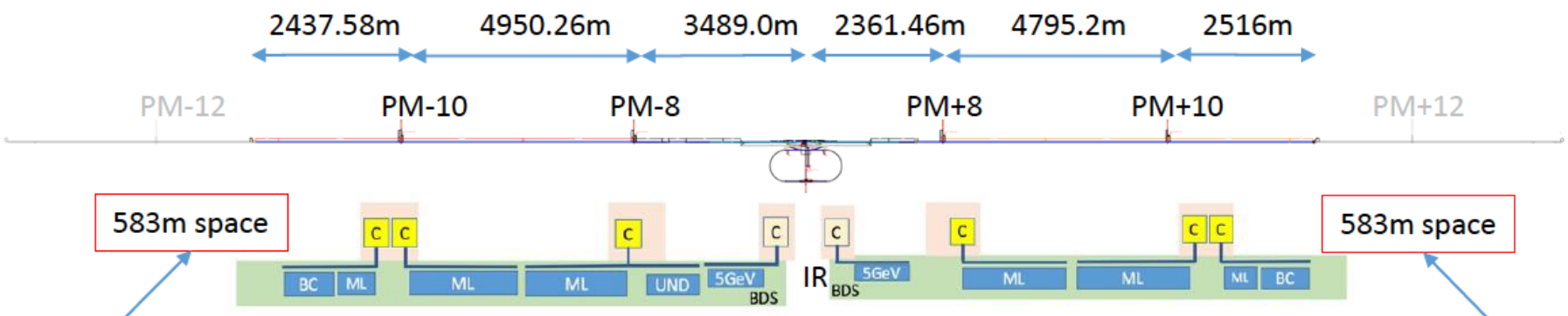
The END

Thank you for your attention.

Option A

Note:
This was called "Option C" by the end of the last year

ECM=250GeV **SRF 31.5MV/m**



module space margin for option C, 31.5MV/m

module space margin for option C, 31.5MV/m

	BC				e+inj	Ecm=250GeV	e-inj				BC	
	51	90	189	189	24	module space	24	180	189	90	51	
	51	45	189	189	24	cryomodules	24	180	189	45	51	
	17	10	42	42	8	RF unit	8	40	42	10	17	
e^- 134.8GeV =	10.0	12.8	53.5	53.5	5.0	E gain (GeV)	5.0	51.0	53.5	12.8	10.0	= e^+ 132.3GeV

+5.8%margin

Total tunnel length = 20549.5m

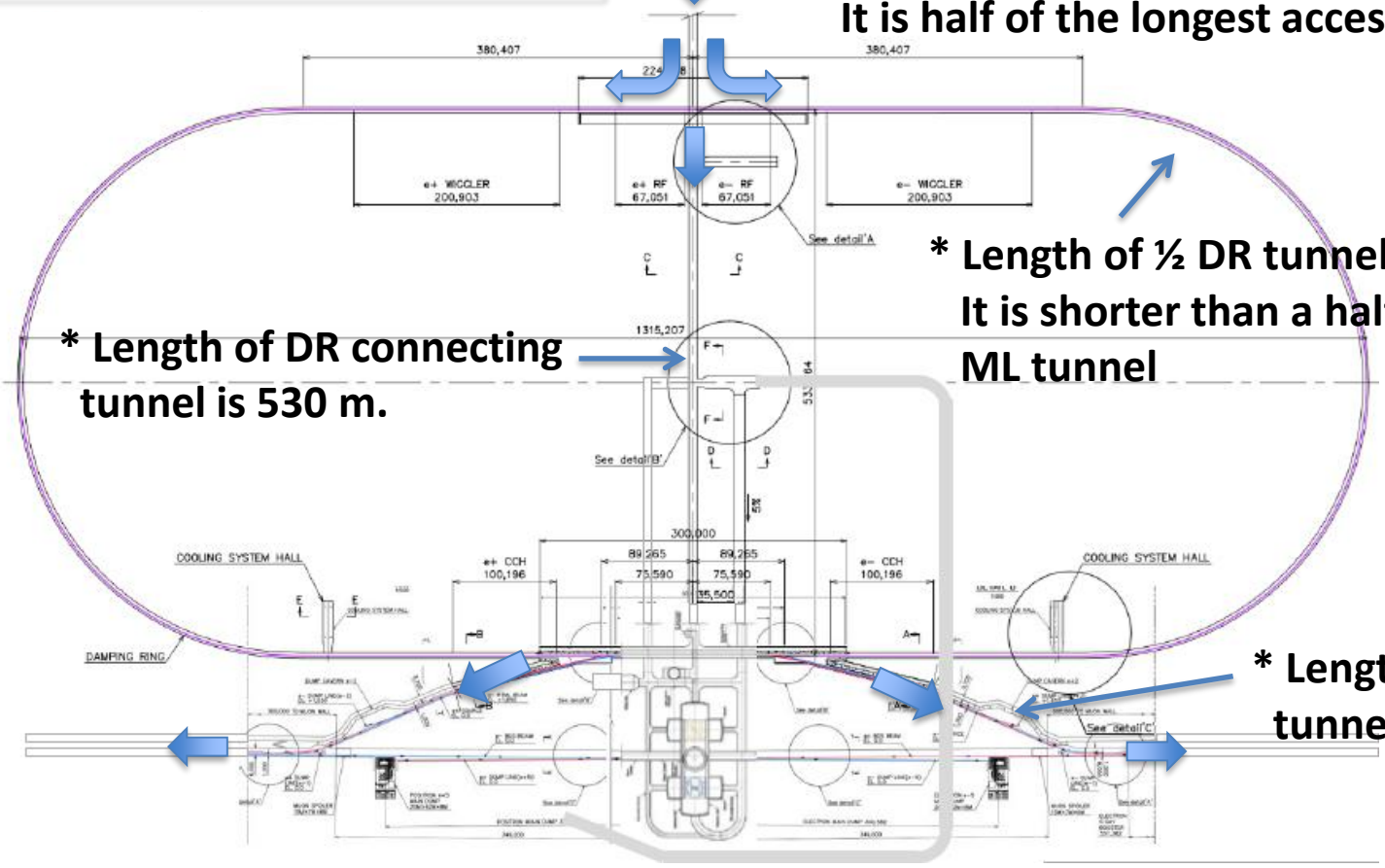
(20.5km)

My Proposal and Assumption with E-driven e+ source

Make use of the shorter tunnel length and make effort to optimize tunnel construction schedule of near DR (*), we may try to make it possible to start commissioning of e+/e- sources and DR earlier than global commissioning.

direction of tunnel construction

*** Length of DR access tunnel is 763 m. It is half of the longest access tunnel at ML.**



*** Length of ½ DR tunnel is 1500 m. It is shorter than a half section of ML tunnel**

*** Length of DR connecting tunnel is 530 m.**

*** Length of RTML tunnel is 250 m.**

Commissioning Scenario

Assumptions

- Tunnel excavation of the entire site will be completed almost simultaneously, though TDR says (v3 part2 p.244)

What TDR says

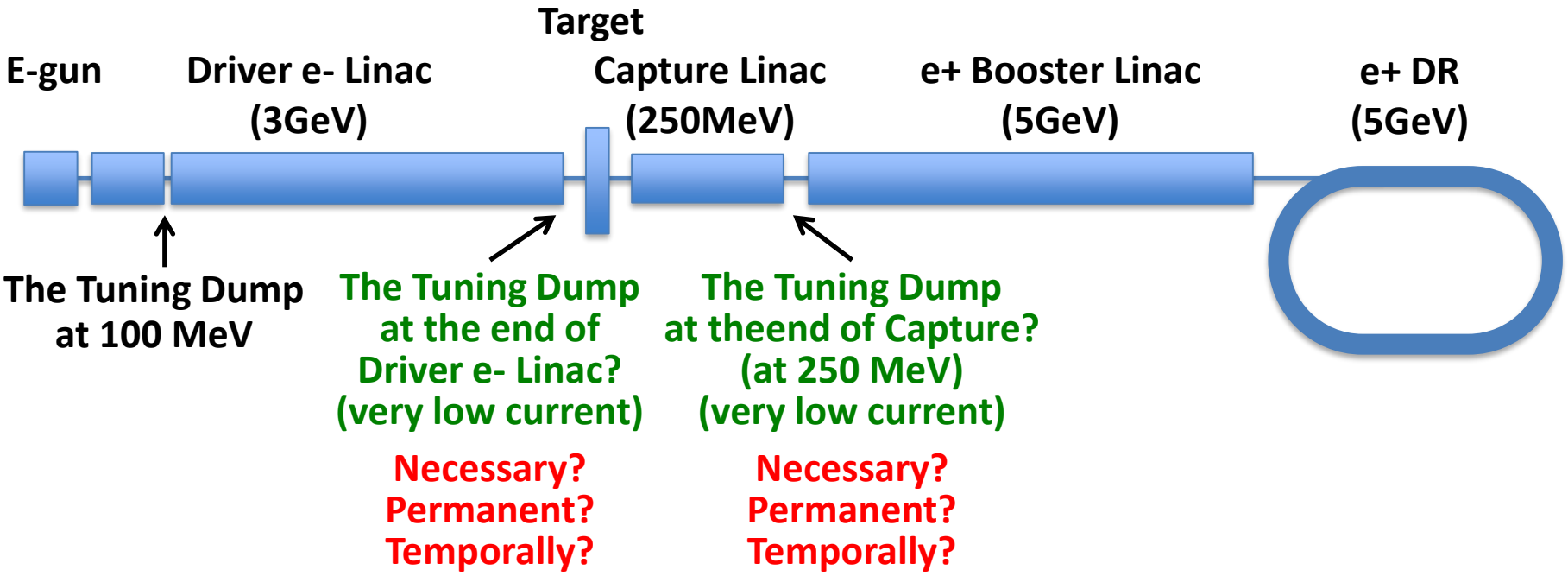
- Excavation of access tunnel starts at year 1.0
- DR commissioning can start at year 7.5
- ML commissioning can start at year 9.0

This does not seem to be realistic.

- Commissioning starts after installation of all the big components

- **In TDR, it is assumed that central region tunnels is finished 1.5 years earlier than main linac tunnels. Then it is assumed that central region commissioning starts 1.5 years earlier than global commissioning.**
- **Today, people say that earlier start of central region commissioning is NOT realistic.**

Commissioning of the e+ injector system



- Basic strategy: Commissioning of the entire e+ injector system will be done through e+ source and the e+ DR at once (一つの放射線申請).
- No partial commissioning will be performed in the injector system. If we make the commissioning step-by-step for each part (個々別々の申請), it will rather take long time.
- However the tuning of very low radiation operation at some part may be useful. Tuning at 100MeV point of the driver e- linac will be useful. How about at the end of the Driver e- Linac? Maybe NOT necessary? How about at the end of the Capture? Maybe NOT necessary?