Asian Tunnel Configuration

Atsushi Enomoto

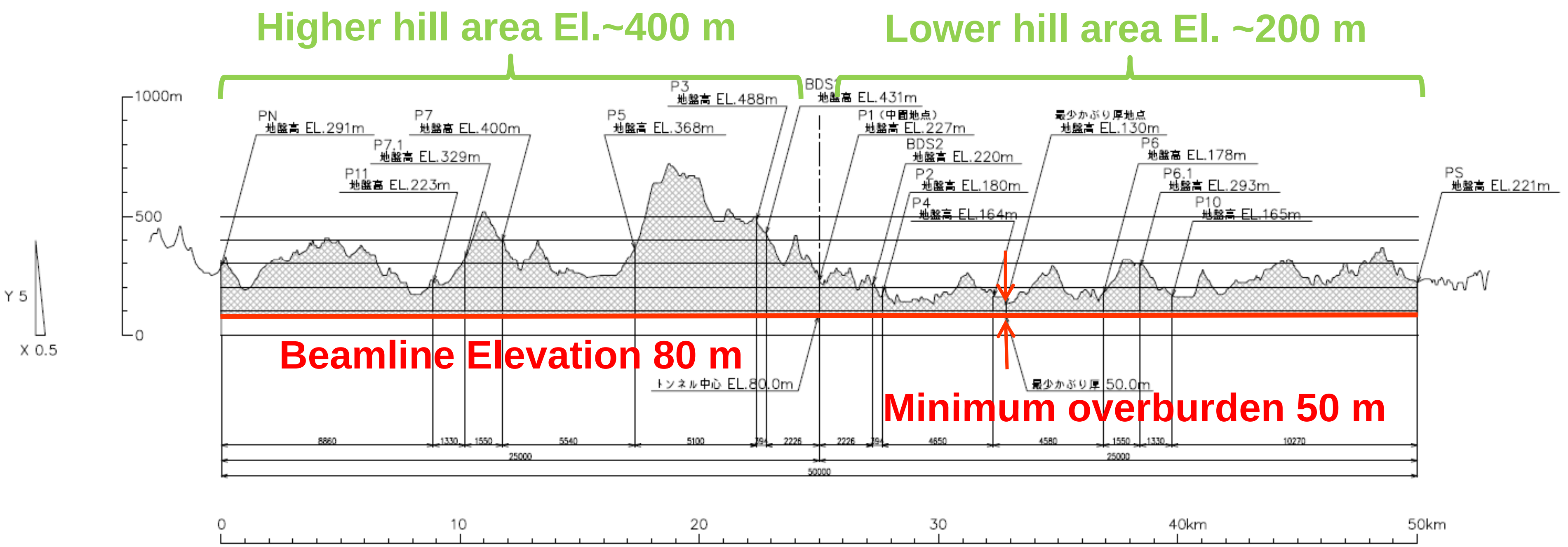
KEK

Contents of this talk

- Specific feature of Asian Sample Site
- Ways of access from ground to underground
- Sections of caverns
- KCS and DRFS configurations

Specific feature of Asian Sample Site

Elevation



Higher hill area El.~400 m
Lower hill area El. ~200 m
1000m
500
0
Y 5
X 0.5
PN 地盤高 EL.291m
P7 地盤高 EL.400m
P7.1 地盤高 EL.329m
P11 地盤高 EL.223m
P5 地盤高 EL.368m
P3 地盤高 EL.488m
BDS1 地盤高 EL.431m
P1（中間地点） 地盤高 EL.227m
BDS2 地盤高 EL.220m
P2 地盤高 EL.180m
P4 地盤高 EL.164m
最少かぶり厚地点 地盤高 EL.130m
P6 地盤高 EL.178m
P6.1 地盤高 EL.293m
P10 地盤高 EL.165m
PS 地盤高 EL.221m
Beamline Elevation 80 m
トンネル中心 EL.80.0m
最少かぶり厚 50.0m
Minimum overburden 50 m
8860
1330
1550
5540
5100
794
2226
2226
794
4650
4580
1550
1330
10270
25000
25000
50000
0
10
20
30
40km
50km

Ways of access from ground to underground

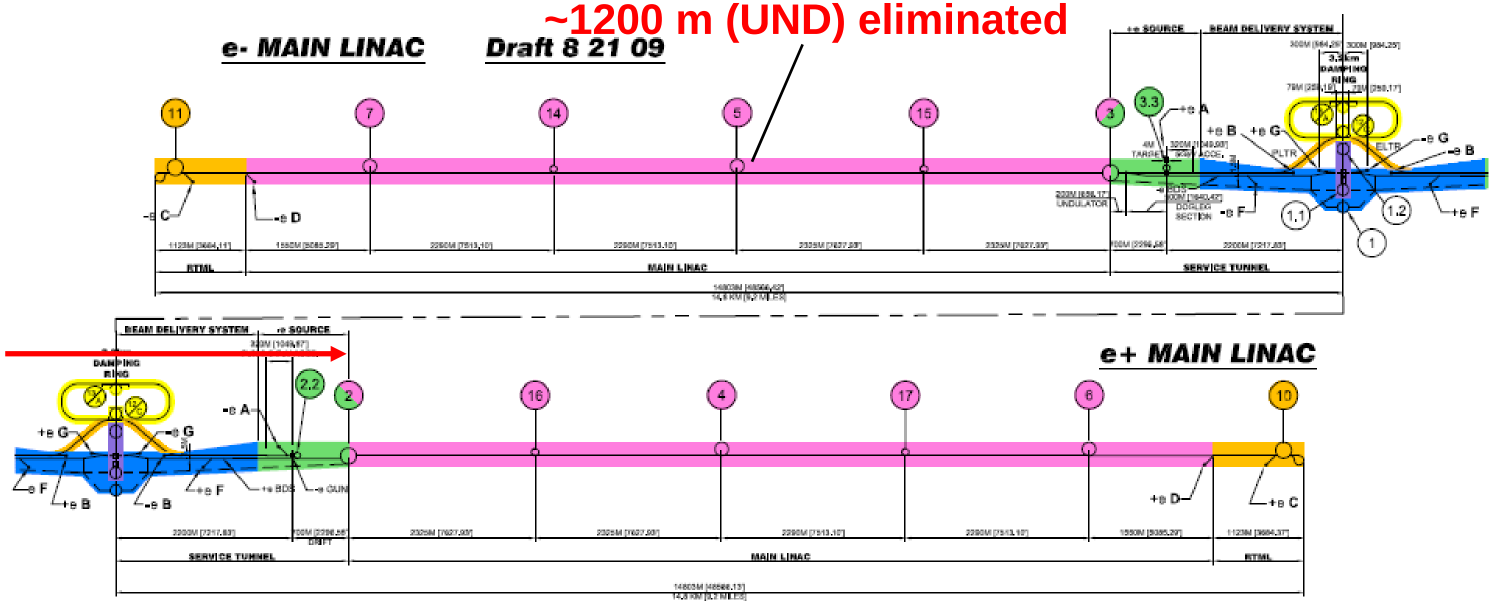
Global Design Effort - CFS

~6600 m (Sep 25 ver.)

What changes in SB2009 ?

5800 m (5200 m inRDR)

~1200 m (UND) eliminated



SITE / TUNNEL LENGTHS (M)

e- SIDE ML + RTML	e+ SIDE ML + RTML	B.D.S./SOURCES SERVICE/FTRL/PTRL	DAMPING RING	TOTAL
13233	13233	5800 + 5800 + 800	3238	41904

TUNNELS

AREA SYSTEM	e- INJECT. & BDS/SERVICE	D.R.	R.T.M.L. BEAM	MAIN LINAC BEAM	e+ INJECT. & BDS/SERVICE
width M	9,5 + 5,2	5.2	5.2	5,2	9,5 + 5,2

SHAFT BASE CAVERNS

POINT	2, 3,	4, 5, 6, 7,	10, 11	14, 15, 16, 17
(L x W x H)m	52 x 10 x 5.3			3 x 3 x SHAFT

SHAFTS

POINT	1,0	1.1	1.2	2	2.2	3	3,3	4	5	6	7	10	11	12/C	13/A	14	15	16	17
Ø M	9	16	16	14	4	14	4	14	14	9	9	14	14	9	9	3	3	3	3

DETECTORS HALL

POINT	1,1, 1,2	1.0
(L x W x H)m	120 x 25 x 39	40 x 15 x 15

MUON WALL WIDENINGS

POINT	BDS -eG & +eG
(L x W x H)m	25 x 7 x 6 +15 x 7 x 6

LEGEND

- RTML
- ML
- SOURCES
- DR
- BDS
- DETECTOR AREA

SOURCES CAVERNS

POINT	e+ SOURCE
(L x W x H)m	40 x 40 x 8

DAMPING RING

POINT	12/C	13/A
(L x W x H)m	10 x 10 x 5	74 x 10 x 5

BEAM ABORT CAVERNS ( )

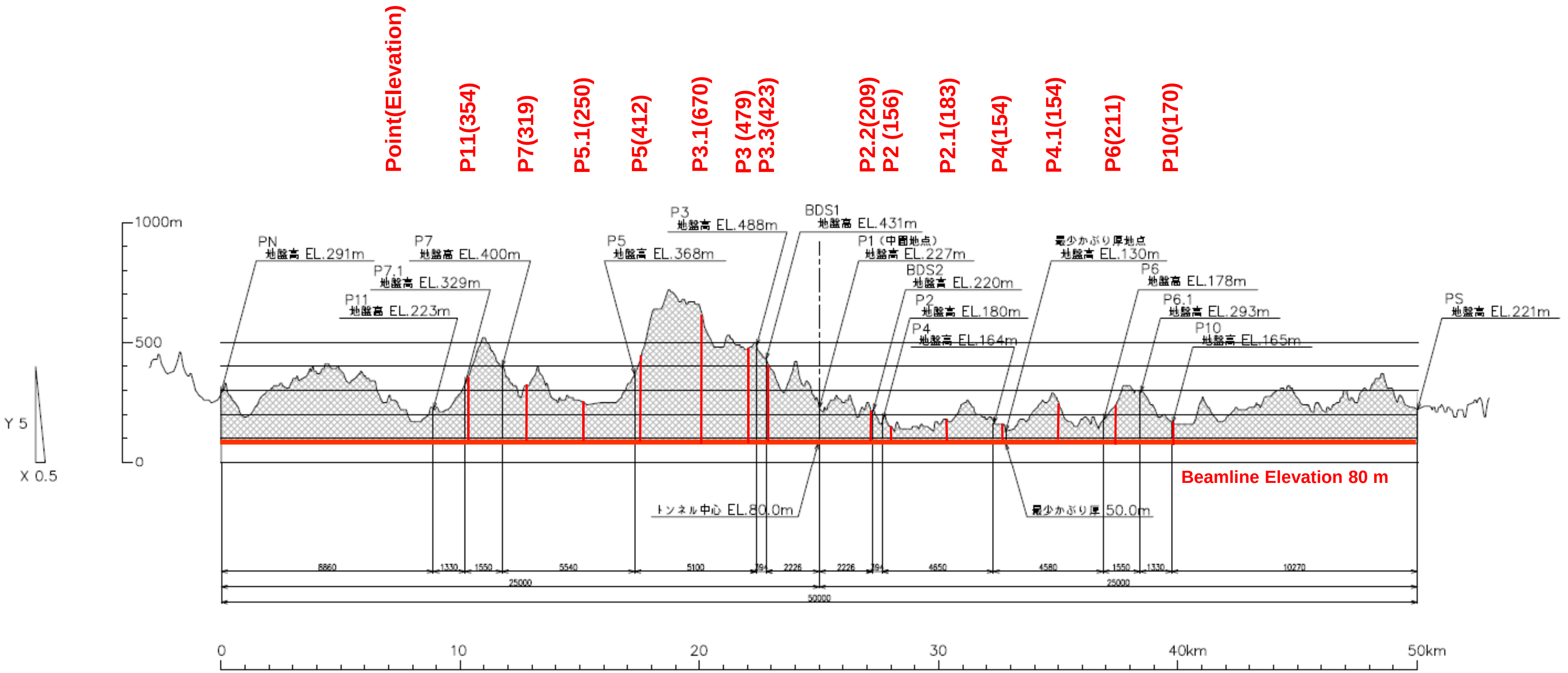
POINT	SOURCES -eA & +eA	RTML -eC, -eD, +eC & +eD	BDS -eB, -eF, -eG, +eB, +eF & +eG
(L x W x H)m	5 x 4 x 4		20 x 9 x 15 +1 STORY

BEAM ABORT SERVICE HALLS ( )

POINT	BDS -eB, -eG, +eB & +eG
(L x W x H)m	30 x 20 x 10

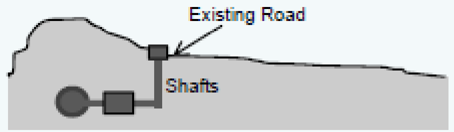
Our presentation at Albuquerque based on SB2009 CFS Key Plan 8 21 Version

Access Points (SB2009)



What we did up to this meeting

Possibilities of reducing distance from surface to underground tunnel
----- though it may cost higher

Case	Access way	Schematic Layout
RDR	Sloped Tunnel	
Case B	Shaft	
Case C	Shaft + Horizontal Tunnel (surface hall)	
Case D	Shaft + Horizontal Tunnel (underground hall)	

Global Design Effort - CFS

Access Point Data in Asain Sample Site

Point ID	Elevation (m)	L (km)	dL (km)	Tunnel EL (m)	Entrance	Type	Elevetion (m)	Hor.Distance (m)	Depth (m)	Slope (%)	Cost	Remarks
P11	354	14.703	2.573	80		Shaft	354	0	274	—		
						Shaft+Tunnel	350	350	270	—		
						Sloped Tunnel	210	1570	130	8.3		
P7	319	12.130	2.290	80		Shaft	319	0	239	—		
						Shaft+Tunnel	240	440	160	—		west side
						Shaft+Tunnel	320	345	240	—		east side
						Sloped Tunnel	215	1350	135	10.0		
P14	250	9.840	2.290	80		Shaft	250	0	170	—		
						Shaft+Tunnel	225	700	145	—		west side
						Shaft+Tunnel	250	195	170	—		east side
						Sloped Tunnel	205	1420	125	8.8		
P5	412	7.550	2.325	80		Shaft	412	0	332	—		
						Shaft+Tunnel	290	700	210	—		east side
						Shaft+Tunnel	410	505	330	—		west side
						Sloped Tunnel	230	1580	150	9.5		
P15	670	5.225	2.325	80		Shaft	670	0	590	—		
						Shaft+Tunnel	570	780	490	—		west side
						[illegible]	[illegible]	[illegible]	[illegible]	[illegible]		[illegible]
P16	183	−5.225	2.325	80		Shaft+Tunnel	155	150	75	—		west side
						Sloped Tunnel	145	870	65	7.5		
P4	154	−7.550	2.325	80		Shaft	154	0	74	—		
						Shaft+Tunnel	160	265	80	—		west side
						Shaft+Tunnel	125	295	45	—		east side
						Sloped Tunnel	125	450	45	10.0		
P17	154	−9.840	2.290	80		Shaft	154	0	74	—		
						Shaft+Tunnel	220	360	140	—		west side
						Sloped Tunnel	150	1060	70	6.6		
P6	210.5	−12.130	2.290	80		Shaft	210	0	130	—		
						Shaft+Tunnel	200	140	120	—		west side
						Sloped Tunnel	155	860	75	8.7		
P10	170	−14.703	2.573	80		Shaft	170	0	90	—		
						Shaft+Tunnel	150	235	70	—		west side
						Sloped Tunnel	145	790	65	8.2		
P12C	252			80		Shaft	252	0	172	—		
						Shaft+Tunnel	250	90	170	—		west side
						Sloped Tunnel	210	1470	130	8.8		
P13A	268			80		Shaft	268	0	188	—		
						Shaft+Tunnel	260	90	180	—		west side
						Sloped Tunnel	230	1950	150	7.7		
P1	230			80		Shaft	230	0	150	—		
P1.1	220			80		Shaft	220	0	140	—		
P1.2	235			80		Shaft	235	0	155	—		

We have figured out some sloped tunnels can/should be replaced by shafts/(shafts+ horizontal tunnel) taking account of not only access length but also the construction costs.

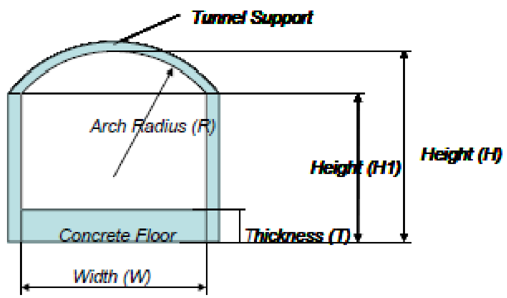
Sections of caverns

Tunnel Cross Section assumed in RDR

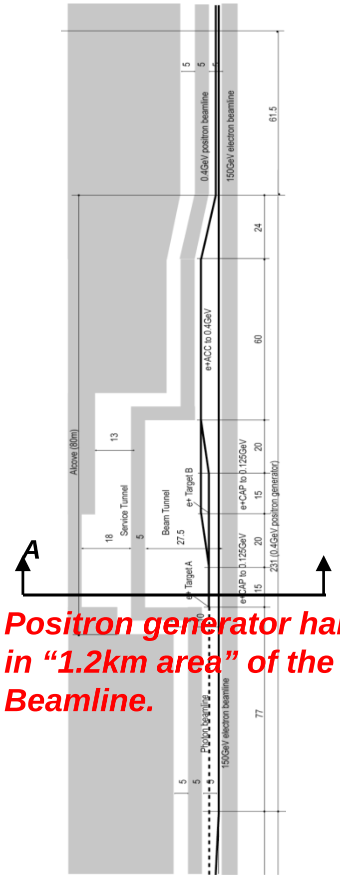
CE UNIT COST

Access Shafts		
16m diameter	16m diameter shaft, "step-by step" Double-lining of 1.1m thick	
14m diameter	14m diameter shaft, "step-by step" Double-lining of 1.1m thick	
9m diameter	9m diameter shaft, "step-by step" Double-lining of 1.1m thick	
4m diameter (place holder)	4m diameter shaft, "step-by step" Double-lining of 1.1m thick	
3m diameter (place holder)	3m diameter shaft, "raise borer"	
1.50m diameter	1.5m diameter shaft, "raise borer" Steel pipe.	
Access (Sloped) Tunnel by NATM (Blast & Drill)	Horseshoe W(m) X H(m), R(m), T(m)	A(m2)
Soil deep to ~5m, D-class rock down to ^20m	W(7.5)H(6.5)R(3.75)T(0.5x5m,0.695x2.5m) (near surface -200m-)	42.7
B-class hard rock deeper than ~20m	W(7.5)H(6.5)R(3.75)T(0.5x5m,0.695x2.5m) (hard rock)	42.7
Soil deep to ~5m, D-class rock down to ^20m	Horseshoe shape tunnel of 3.5m wide, 3.5m high (near surface -200m-)	10.936
B-class hard rock deeper than ~20m	Horseshoe shape tunnel of 3.5m wide, 3.5m high (hard rock)	
Beam/Service Tunnel & Alcove by NATM	Horseshoe W(m) X H(m), R(m), T(m)	A(m2)
4.5m Beam/Service Tunnel	W(4.5)H(4.5)R(2.25)T(1.145)	18.1
TBM start point	W(7.5)H7)R(3.75)T(1.895)	46.5
BDS IR2 (Chunk at tunnel branch)	W(4.5)H(4.5)R(2.25)T(1.895) expded from 4.5mϕ TBM	18.1
BDS IR2	W(7.5)H(5)R(4.06)T(1.895)	32.3
5GeV Injector Beam Tunnel	W(7.5)H(5)R(4.06)T(1.145)	32.3
5GeV Injector Beam/Service Tunnel	W(19)H(9.25)R(12.74)T(1.145)	150.9
5GeV Injector Beam/Service Tunnel	W(16.2)H(9)R(10.2)T(1.145)	126.2
UND beam tunnel alcove	W(27.5)H(11)R(17)T(1.145)	244.7
UND beam tunnel alcove	W(10)H(6.5)R(6.25)T(1.145)	57.5
UND beam tunnel alcove	W(7.5)H(6.5)R(4.06)T(1.145)	43.5
KAS beam cavern	W(28.75)H(11)R(18.26)T(1.895)	255.3
KAS beam cavern	W(11.25)H(8.875)R(5.625)T(1.895)	86.3
Laser Room	W(12.4)H(8)R(7.91)T(1.145)	87.9
UND bservice tunnel alcove	W(16)H(8)R(10)T(1.145)	108.7
UND bservice tunnel alcove	W(5)H(5)R(2.5)T(1.145) expded from 5mϕ TBM	22.3
KAS service tunnel	W(5)H(6.5)R(2.5)T(1.895)	29.8
KAS service tunnel	W(15)H(7.5)R(9.79)T(1.145)	96.5
KAS service tunnel	W(12)H(7)R(7.5)T(1.895)	73.2
KAS service tunnel	W(12.5)H(7)R(8.01)T(1.895)	76.1
Beam Dump Hall	W(20)H(10)R(12.5)T(1.895)	169.9
Tunnel by TBM		
4.5m Beam/Service Tunnel (short)	D=4.5m, TBM (short run), 1.145m high concrete floor	15.9
4.5m Beam/Service Tunnel (long)	D=4.5m, TBM (long run), 1.145m high concrete floor	15.9
5m Beam Tunnel (long)	D=5m, TBM	19.6
Housing		
Platform for the shaft-base caverns (16m wide)		

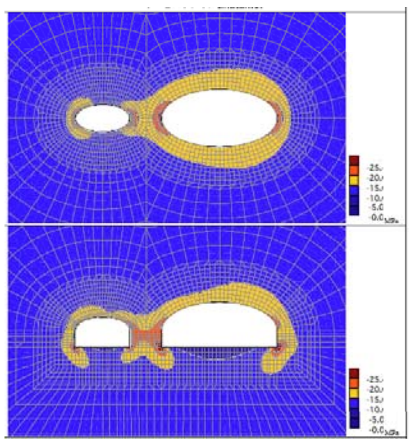
Unit costs

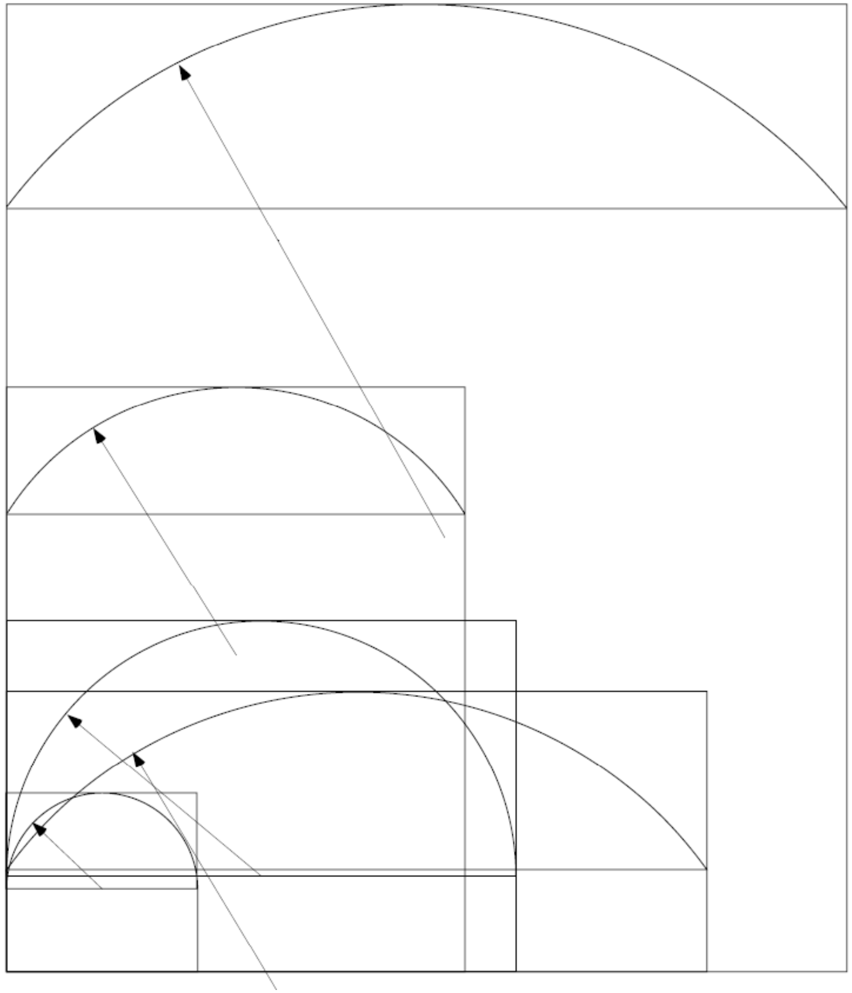


Tunnel Cross Section assumed in RDR



Positron generator hall in "1.2km area" of the e-Beamline.





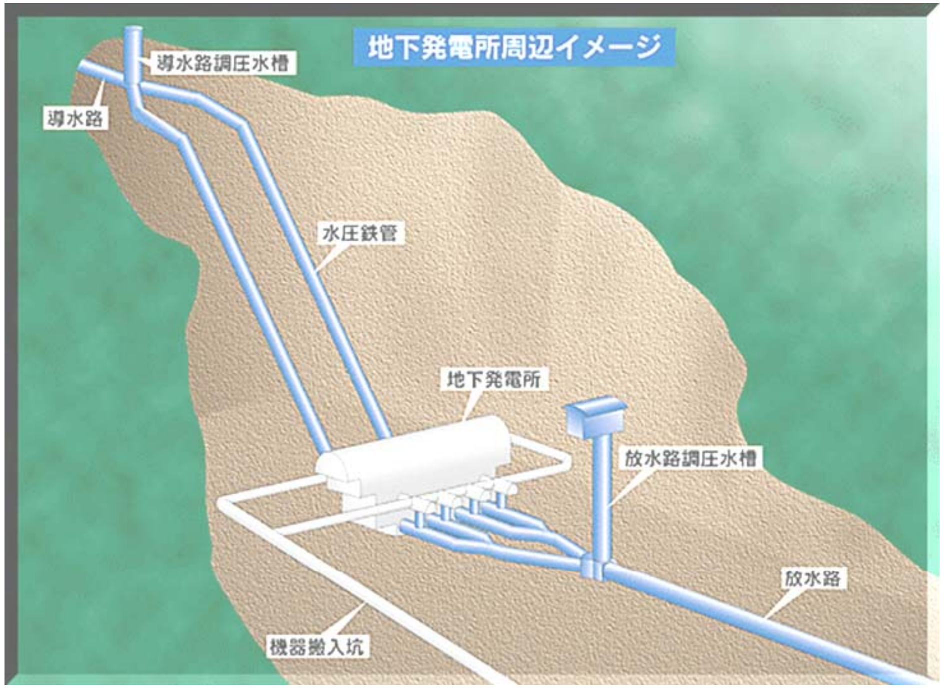
Granite (compressive strength~100MPa)

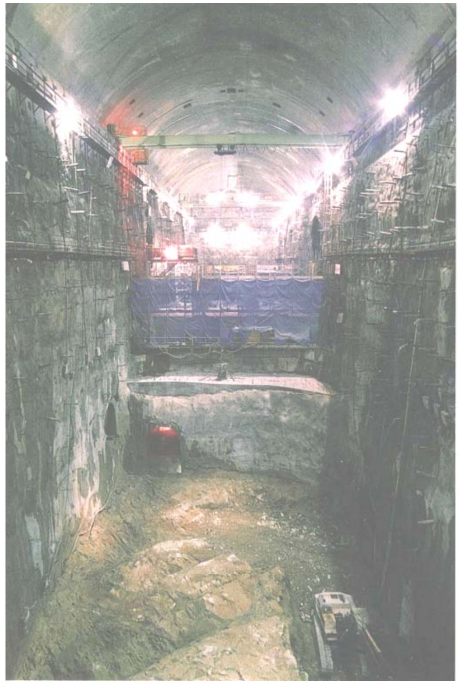
- *Underground structure without concrete lining.*
- *Basically finished with "Shotcrete"(sprayed concrete).*
- *Drainage boring and Grouting as supplementary work.*

An example of underground facilities constructed in granite geology: Tenryugawa-Sakuma underground dam plant without lining worked more than 50 years without any troubles.

Construction Experiences in Japan

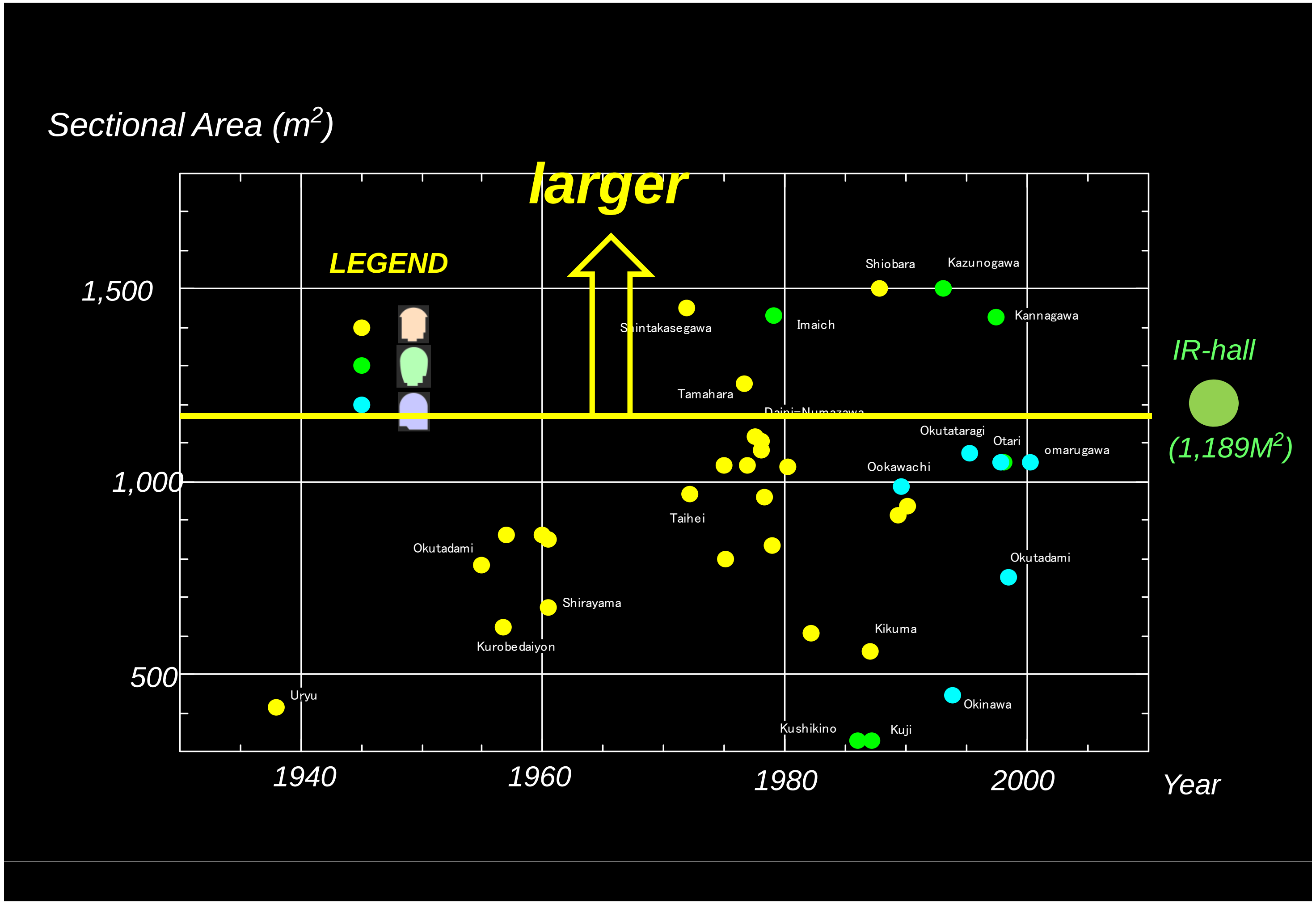
- *By S.Shikama (Kumagaigumi Co.Ltd. JAPAN) at Asian KOM, Sep. 2007 (following 5 slides).*



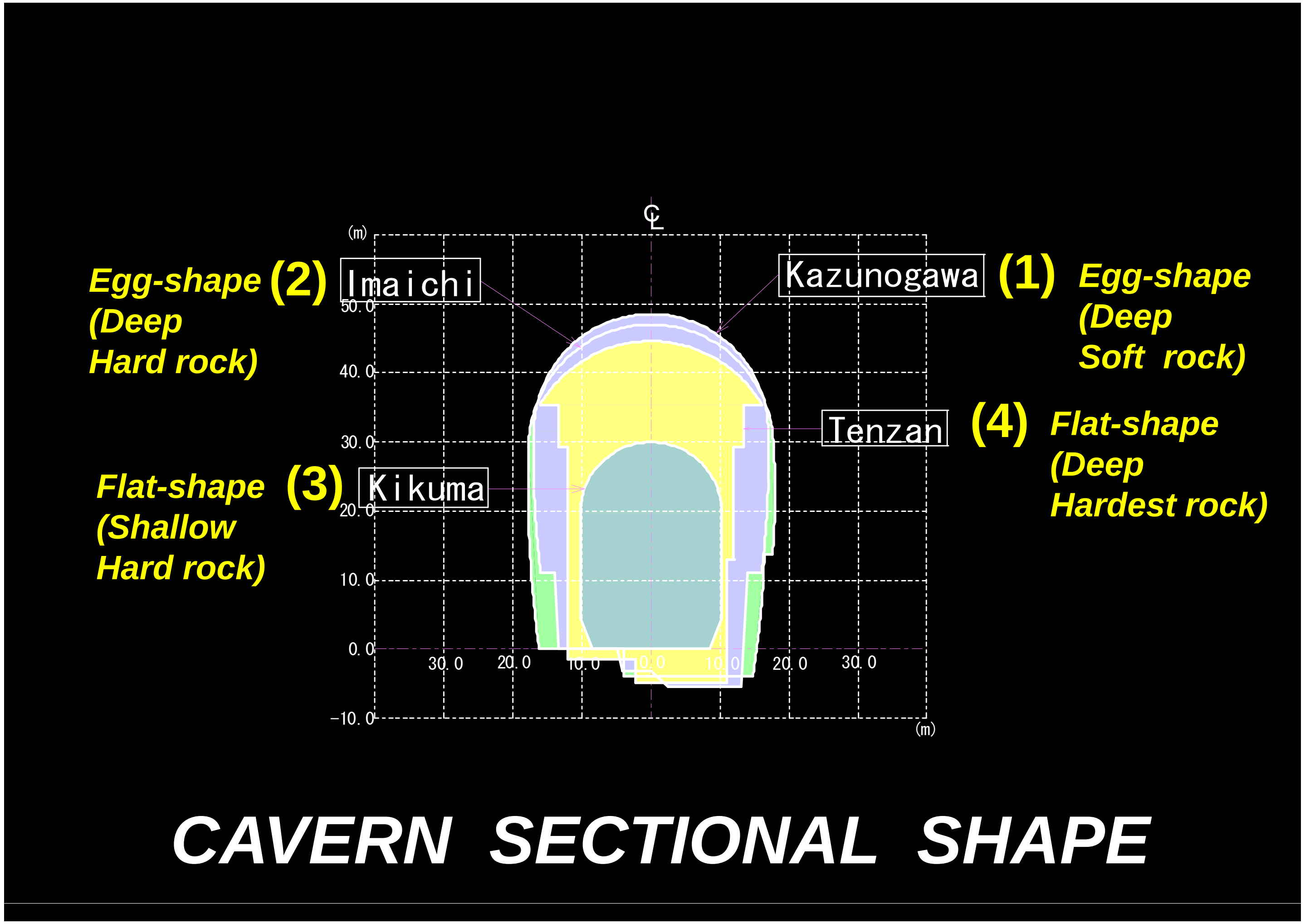


POWER STATION (CAVERN TYPE)

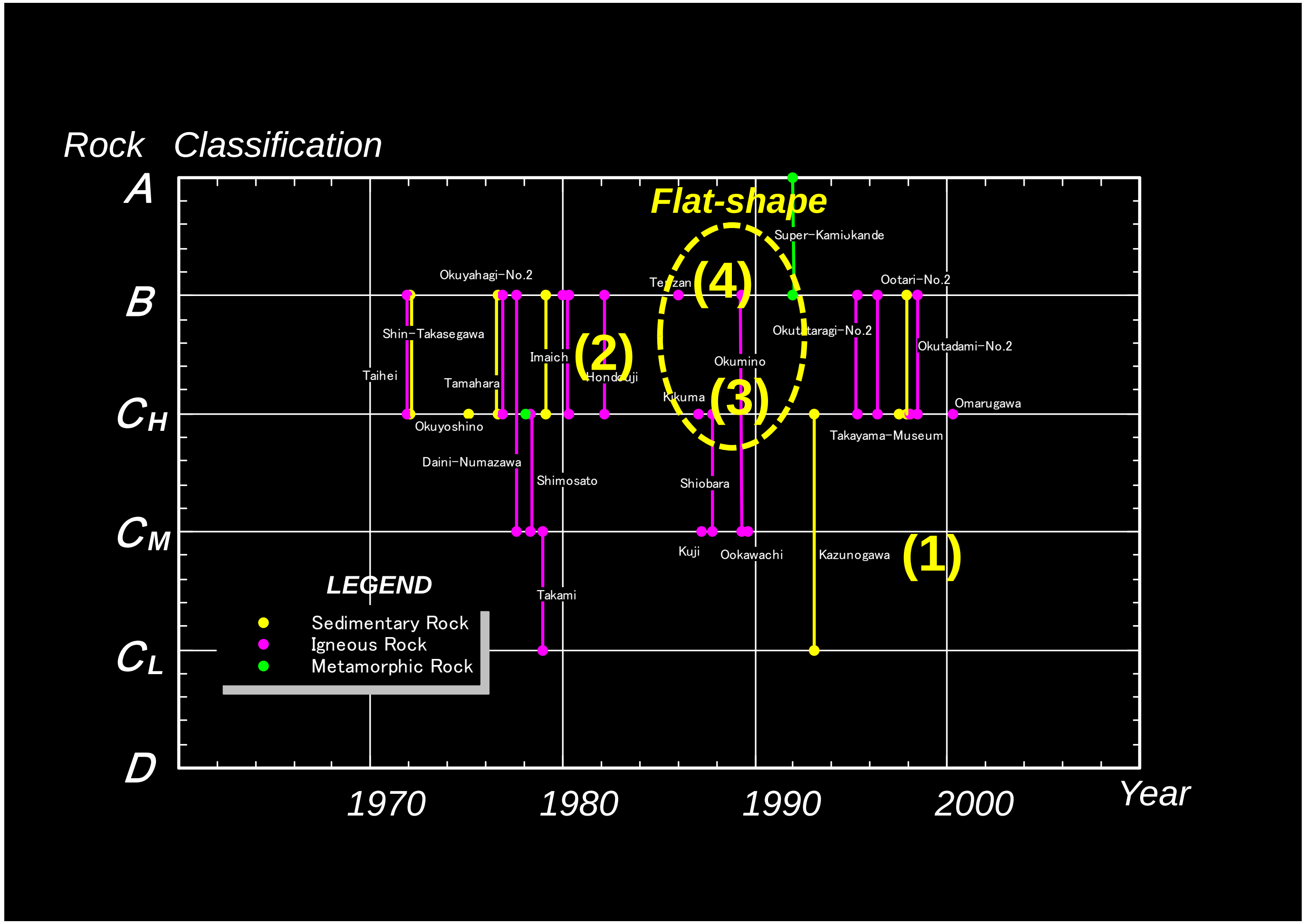
Tunnel Cross Section assumed in RDR



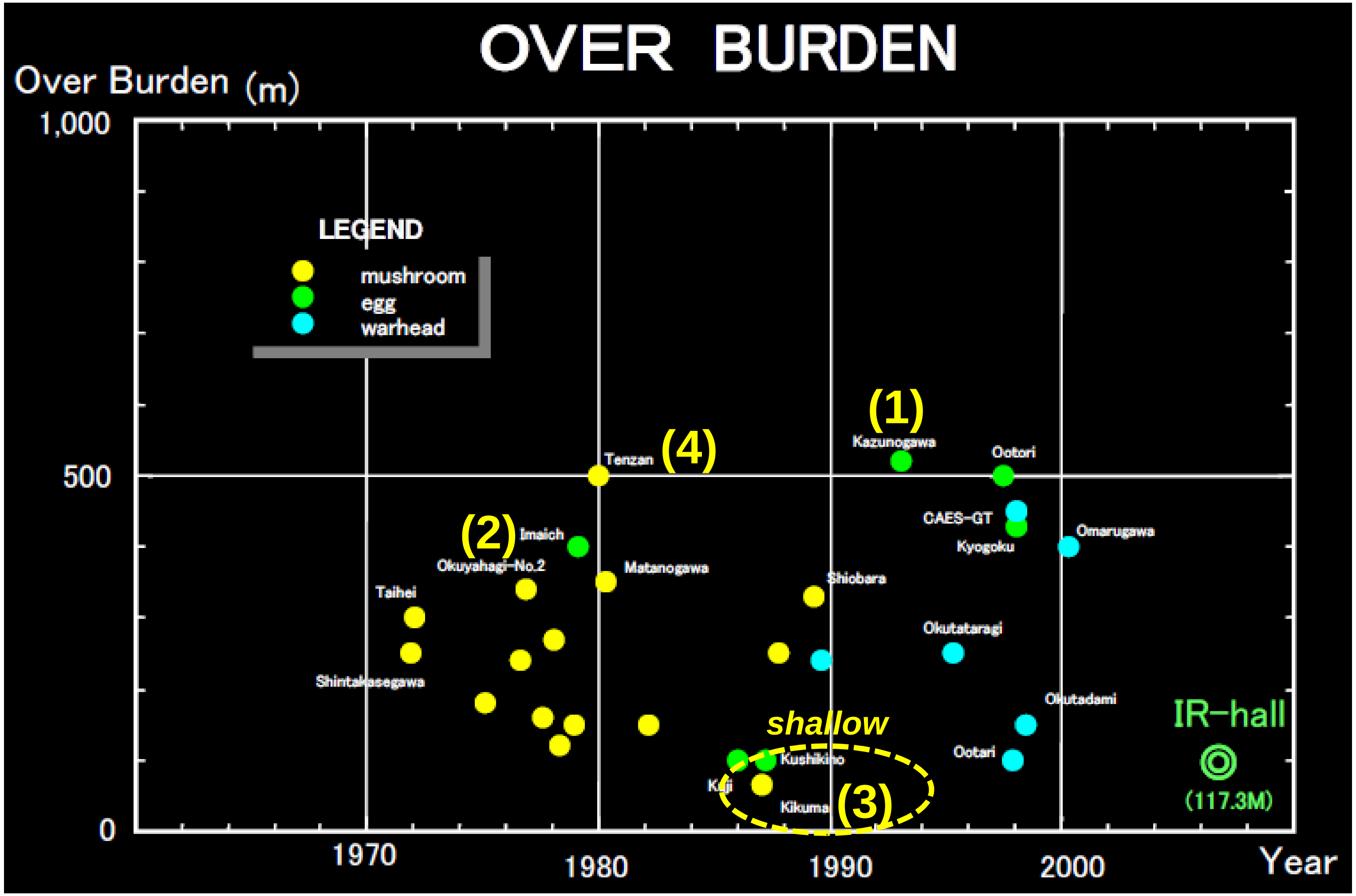
Tunnel Cross Section assumed in RDR



Tunnel Cross Section assumed in RDR



Tunnel Cross Section assumed in RDR



KCS and DRFS configurations

Work Assumption (proposal to avoid confusion)

Machine designs should be one for each

- Many designs need more studies and R&Ds

CFS designs should be arranged to match the machine designs even if it raise the CFS cost

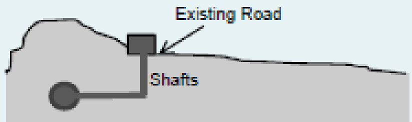
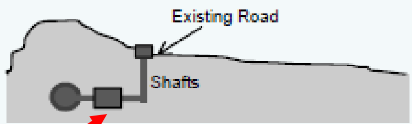
- For KCS jn Asian site we consider additional underground caverns
- For DRFS in CERN site how much is an extra cost to reinforce the ceiling

Safety solutions will be regional

- Solution of additional tunnel for safety under consideration in Asian team should be treated as an alternative at present.

Work Assumption for KCS (Asia)

Possibilities of reducing distance from surface to underground tunnel
----- though it may cost higher

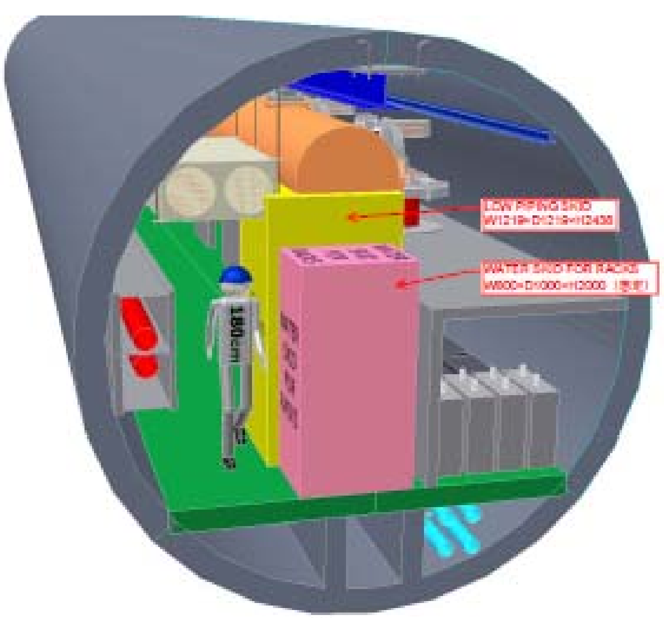
Case	Access way	Schematic Layout
RDR	Sloped Tunnel	
Case B	Shaft	
Case C	Shaft + Horizontal Tunnel (surface hall)	
Case D	Shaft + Horizontal Tunnel (underground hall)	

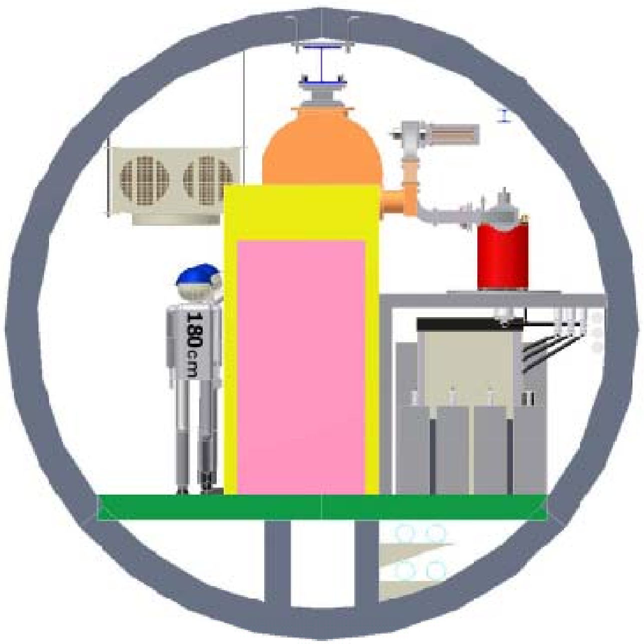
Beam Tunnel   RF Cluster

Additional KCS cavern

Work Assumption for DRFS (Asia)

Tunnel Inner Diameter 4.5 m

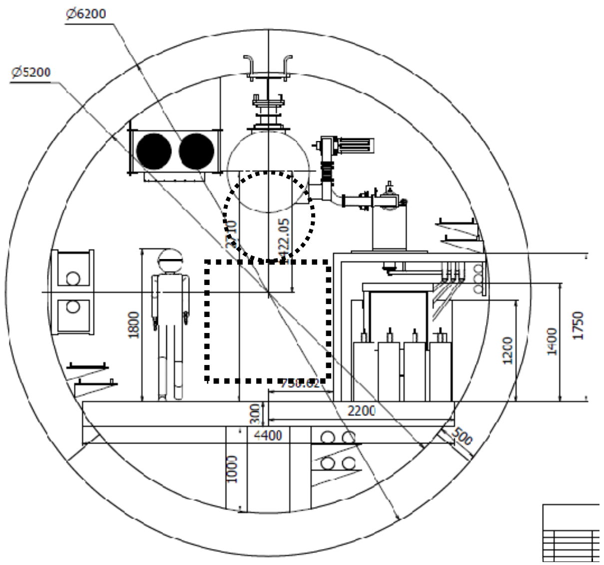




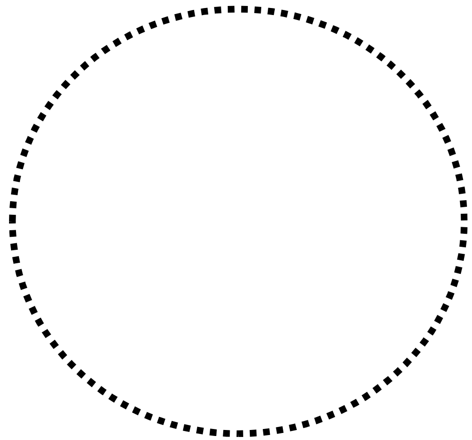
Space seems poor for Air conditioning / cooling water / He emergency system.
Need more diameter and alcoves for CFS equipment evry 4th RF unit.

Work Assumption for DRFS (Asia)

Tunnel Inner Diameter 5.2 m



Space seems better



Alternative solution for safety
(not included in SB2009 cost)

Summary

Summary of this talk

- Based on SB2009 CFS key plan, ways of access to the underground tunnel were studied.
- Some of the sloped tunnel can/should be replaced by shaft/ shaft+h. tunnel.
- Cavern section issue in Asian site was reviewed.
- A work assumption was proposed to avoid confusion about KCS and DRFS.
- As SB2009 ML single tunnel size, 5.2 m is chosen to develop civil design and cost.