

Conceptual plan of ILD solenoid magnet manufacture

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It has been considered that final assembly of the ILD solenoid should be carried out at an assembly hall which is ground floor of the experimental cavern, because the completed ILD solenoid is too huge to be delivered from the factories.

While referring to CMS fabrication experience, we have been discussing manufacture plan with production companies.

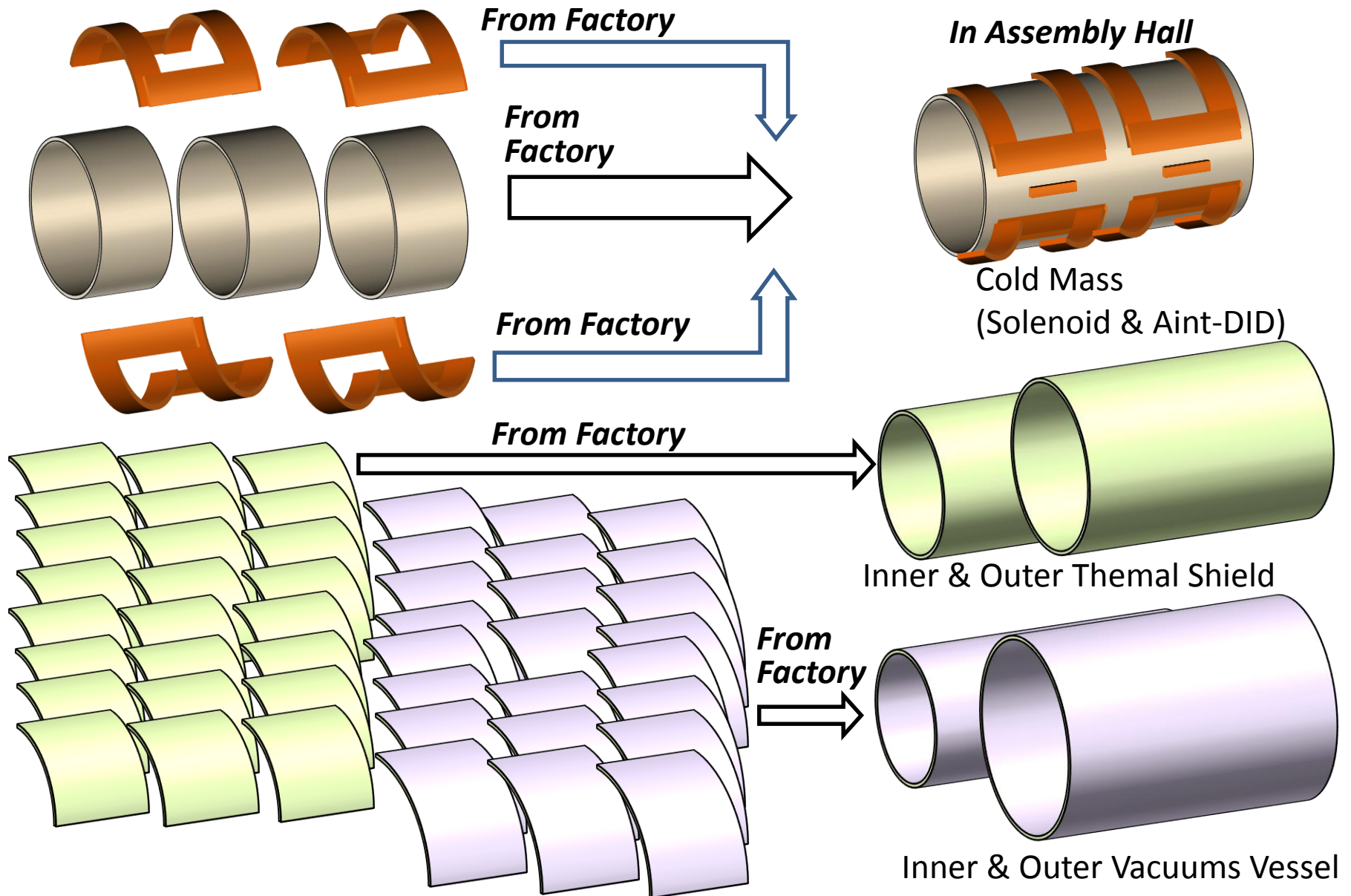
It is reviewed that one third module of coil can be transported to the assembly hall, but there are many obstacles along the way. And large transportation cost has been estimating.

Status of research on fabrication will be presented.

Contents

1. Conceptual manufacture plan.
2. Transportations, solenoid modules and Anti-DID coils.
3. Summary & Consideration.

Outline of ILD Coil manufacturing process (1)



Outline of ILD Coil manufacturing process (2)

Learning from CMS experience



Descent to cavern



Arrival to cavern

Cold mass rotated 90° and inserted

Outer Vacuum V
in Barrel Yoke



Cryostat welded

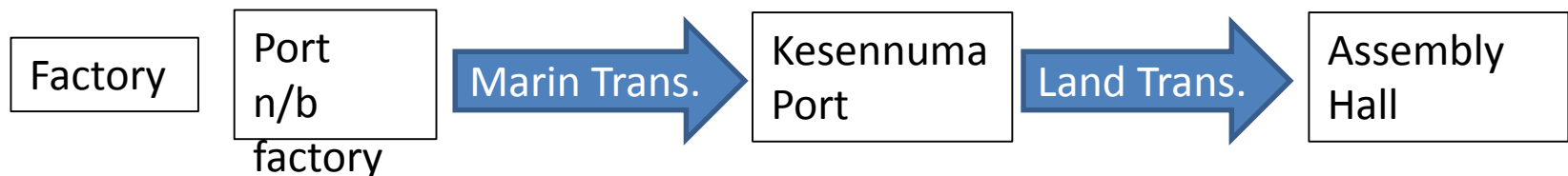


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Module Transportation

- Transportation of CMS modules ($7.4 \times 7.4 \times 3.0 \text{ m}^3$) was a hard task (at the limit of what can be transported on the road).
- ILD module has larger dimensions ($8.0 \times 8.0 \times 2.5 \text{ m}^3$)
- Possible route and cost for transportation have been investigated by **Hitach Transport System** (<https://www.hitachi-transportssystem.com/en/>).



Solenoid Coil Dimensions and Field

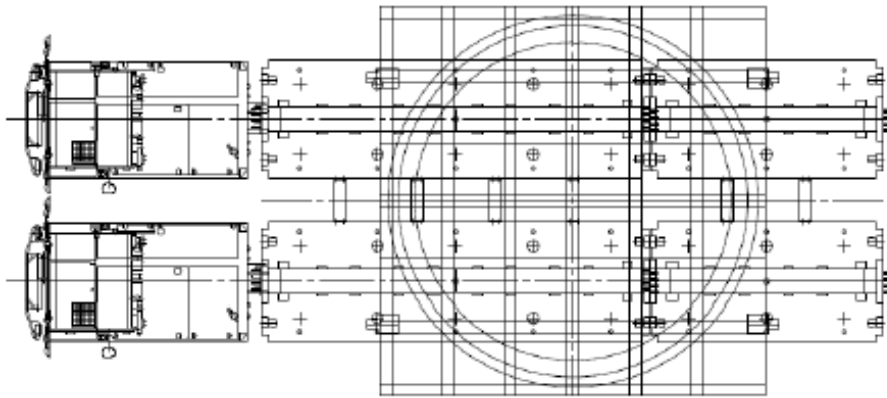
Coil Inner Diameter (mm)	7230
Coil Outer Diameter (mm)	7940
Coil Weight (ton)	170
Length (mm)	7350
Each Block Length (mm)	2450
Turn × Layer	309 × 4
Nominal Current (A)	22400
Current Density (A/mm ²)	10.6
Central Field (T)	4.0
Maximum Field (T)	4.6
Support Shell Thickness (mm)	50

Land Transportation of Solenoid Coil Module

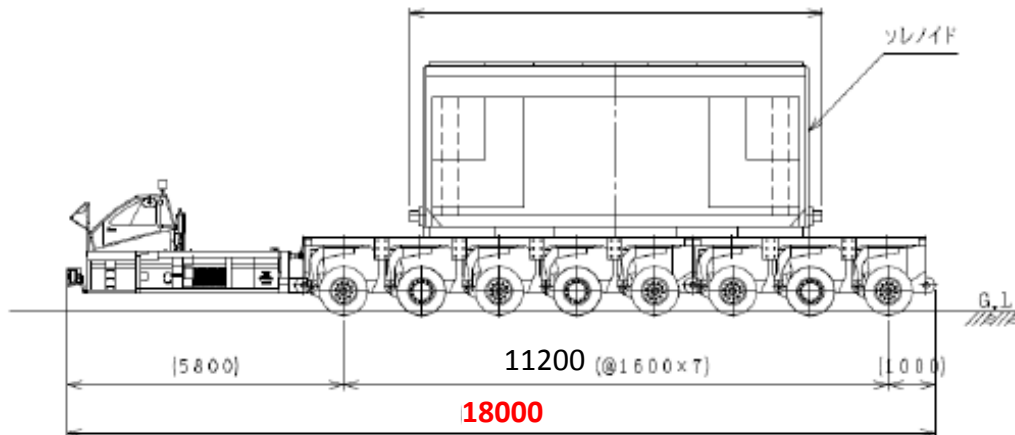
Solenoid Coil Package

Dimension	8500 × 8500 × 3608 mm ³
Weight	90.0 ton (module 57 ton)
Package No.	3

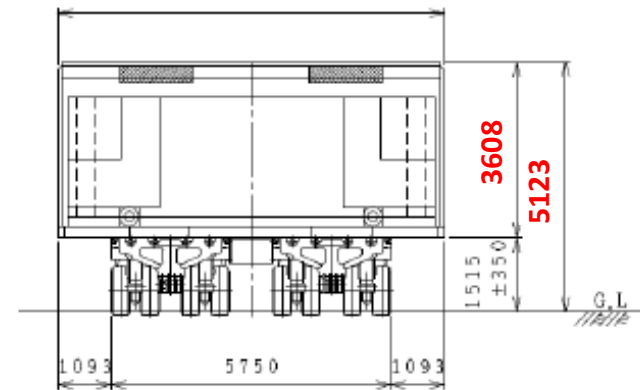
Carrying condition		Per axle 8 wheels	Total 64 wheels
Axle load w/o goods		12,15 kg	97,200 kg
Goods weight		11.25 kg	90,000 kg
With goods	Axle load	23,400 kg	187,200 kg
	Wheel load	2,925 kg	
Ground Pressure	Pressurized area	1.60m × 7 × 4.86m = 54.43 m ²	
	Pressure	3.4 ton /m ²	



8500



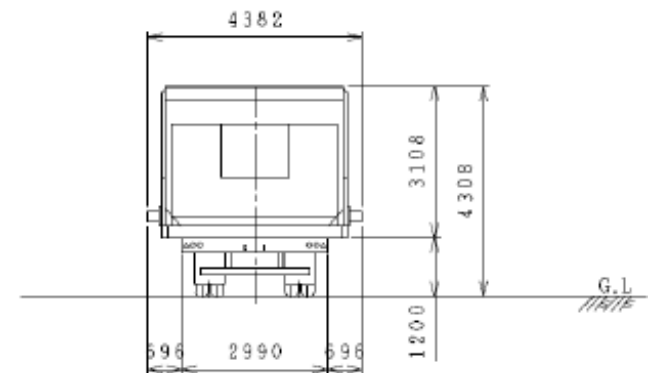
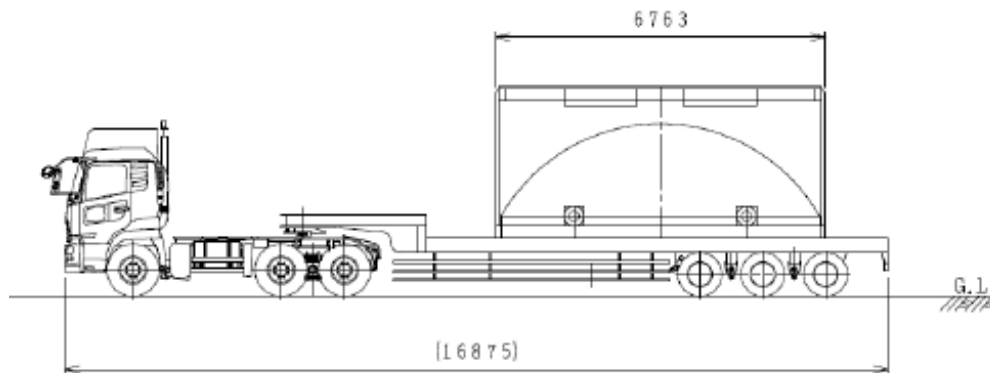
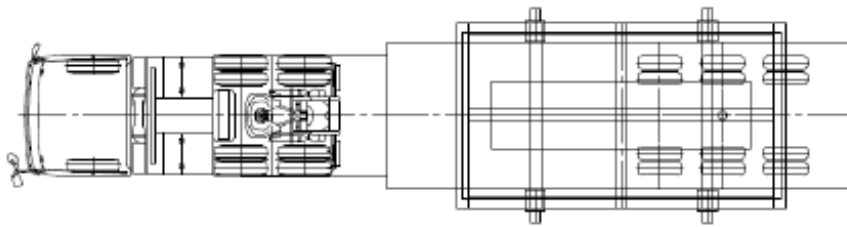
8500



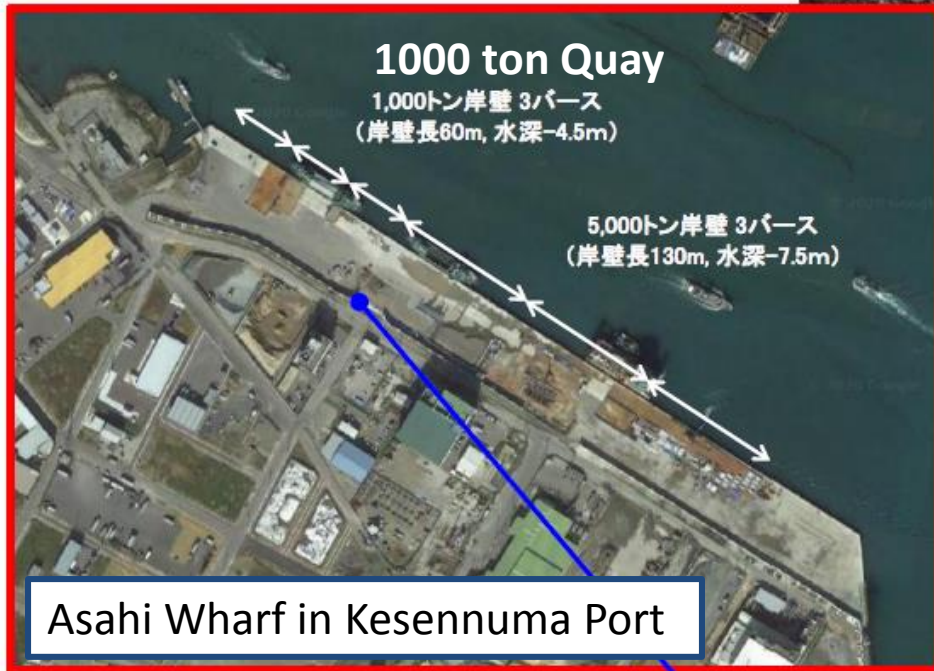
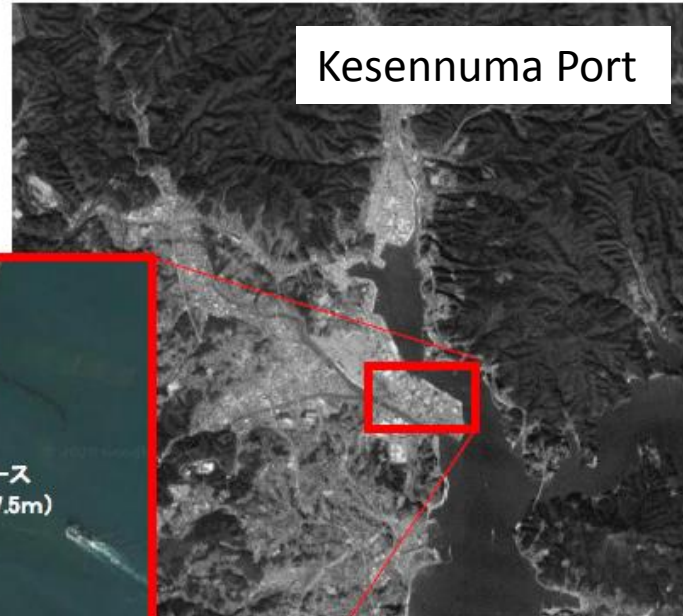
Land Transportation of Anti-DID

Anti-DID Package

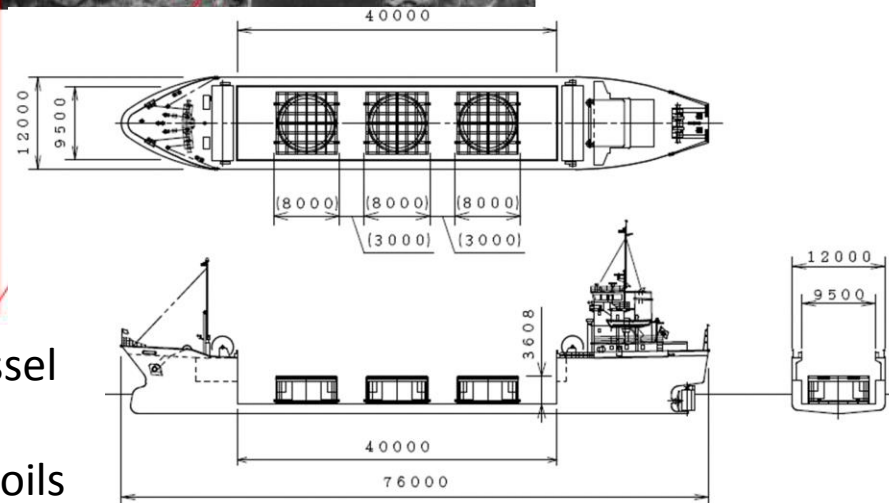
Dimension	6763 × 4382 × 3100 mm ³
Weight	16.0 ton (coil 3.6 ton)
Package No.	4



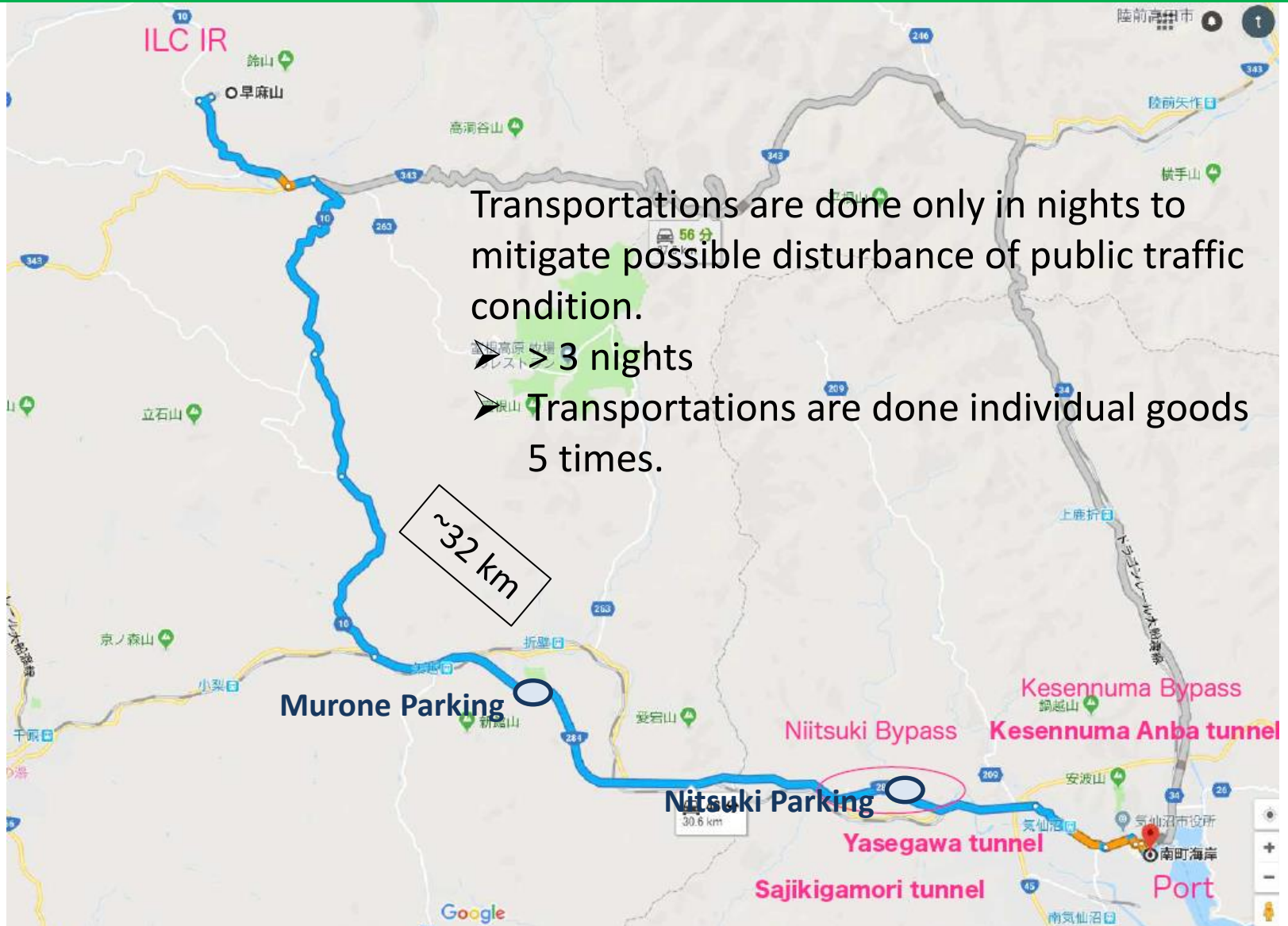
From Cargo Boat to Land Transportation @Kesenuma port



From factory by Coasting Vessel
Ship carries 3 solenoid
modules or 4 Anti-DID coils



From Port to ILC IR



Transportations are done only in nights to mitigate possible disturbance of public traffic condition.

➤ > 3 nights

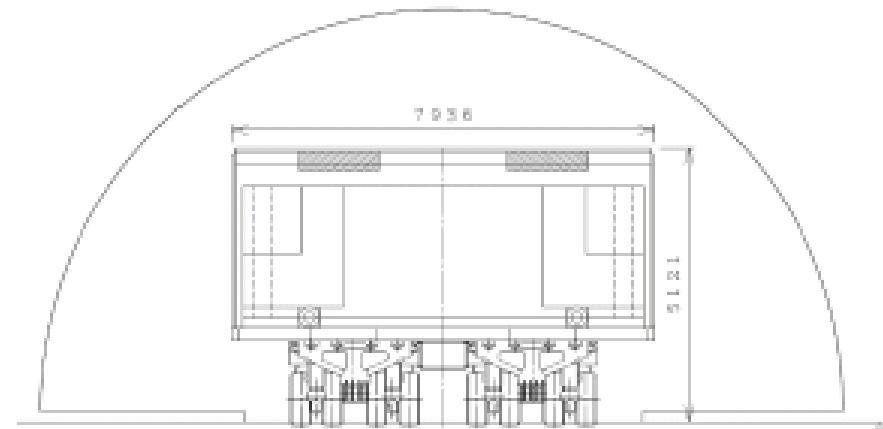
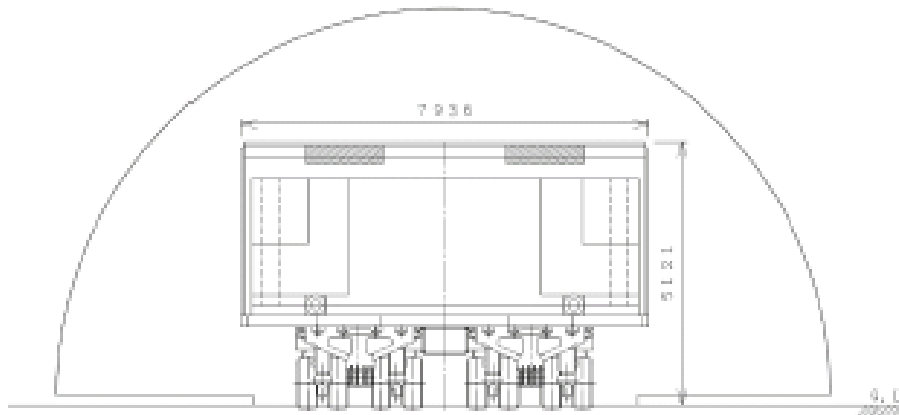
➤ Transportations are done individual goods 5 times.

Kesennuma Downtown

By running through the opposite direction to R284, one critical under pass crossing R45 can be avoided.



Passing Through Tunnels



Many Obstacles

- There are many traffic signs, signals, poles, lights and fences to be temporally removed.
 - 154 points (upper obstacle 60 points)
 - Trees are not counted.
 - Preparation and recovery cost may be comparable with transportation fee.



Cost Estimation & Comments by Hitachi-Trans.System

- Cost estimation is excluding **removal & recovery of obstacles** and keeping goods at port.
- Keeping stacking height less than GL4.9 m, number of obstacles is reduced to about 100. Keeping stacking width less than 6.0 m is more effective. **So, smaller package size should be considered.**

	Solenoid coil modules	Anti-DID coils
Marin Trans.	3.2M JPY (620 sea mile)	3.2M JPY (620 sea mile)
Land Trans	180M JPY(3 modules)	28M JPY (4 coils)
Sum	183.2M JPY	31.2M JPY

- Permission by road administrators and polices required. Approval by local residents for traffic regulations is necessary. This is Lab's responsibility.

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Summary & Consideration

- Transportation of coil modules is physically possible.
 - Cost reduction by smaller package size is necessary.
- Discussion with magnet products about solenoid fabrication in AH has been started, too.
 - Not only cost but also risk of transportation which needs permissions and public approval.
 - Contract by Pre-Lab has been rejected in AWLC2020. Contract will be made 2 year after ILC-Lab starts. So AH will be completed when coil winding starts.

