

# Basic approach and some considerations for insulation coordination

## **Topic 5: Converters:**

### **Technical coordination of « cable / converters » system**

- **Coordination for the choice of Switching impulse and Lightning impulse voltage levels**
- **Understanding of behaviours after faults and polarity reversals**
- *DC circuit breakers*
- *DC harmonics and filtering*
- **Use of plastic insulation together with LCC converters**

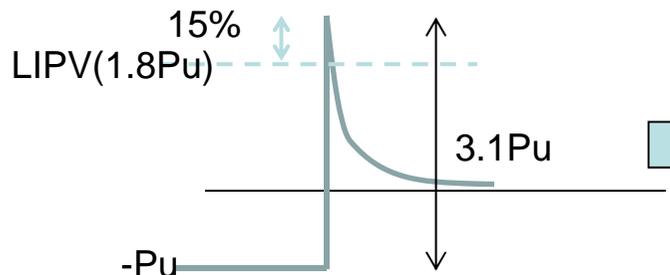


**SHOJI MASHIO**

# Coordination for the choice of Switching impulse and Lightning impulse voltage levels (CIGRE TB496)

	LCC	VSC
Lightning impulse protection level	LIPV	LIPV
LIWV (115% x LIPV )	Opposite polarity	Not required for type test in case of underground system (end to end)
SIWV	Opposite polarity (less important)	Same polarity Opposite polarity

Superimposed opposite polarity LIWV (1.15 x LIPV) (Common for VSC and LCC system)

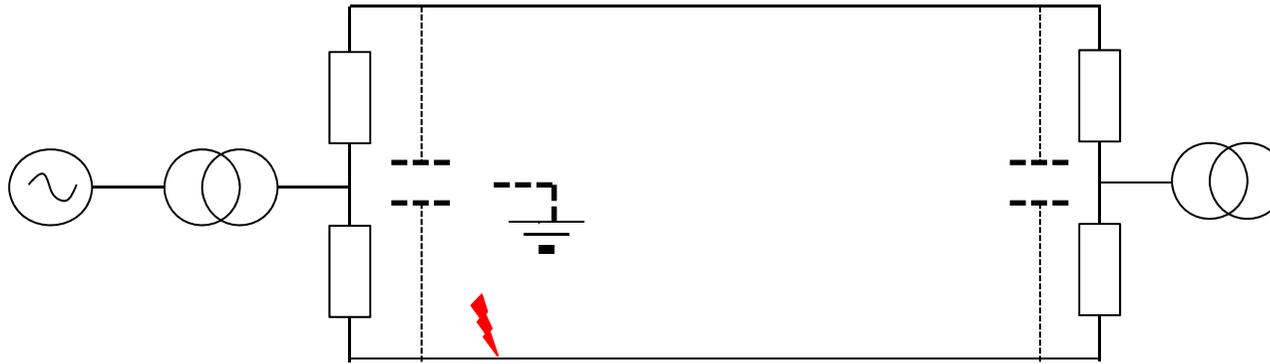


CIGRE TB496 PQ test LIPV = 1.8Pu ,  
 LIWV = 1.8 x 1.15 = 2.1 Pu  
 Cross over voltage = 3.1Pu

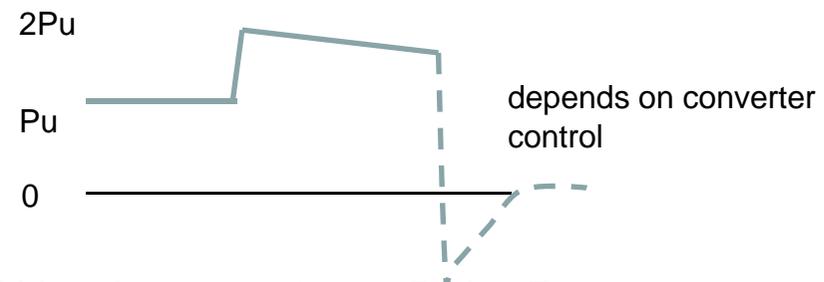
⇔ AC 400kV system LIWV = 1425kV (3.5U)



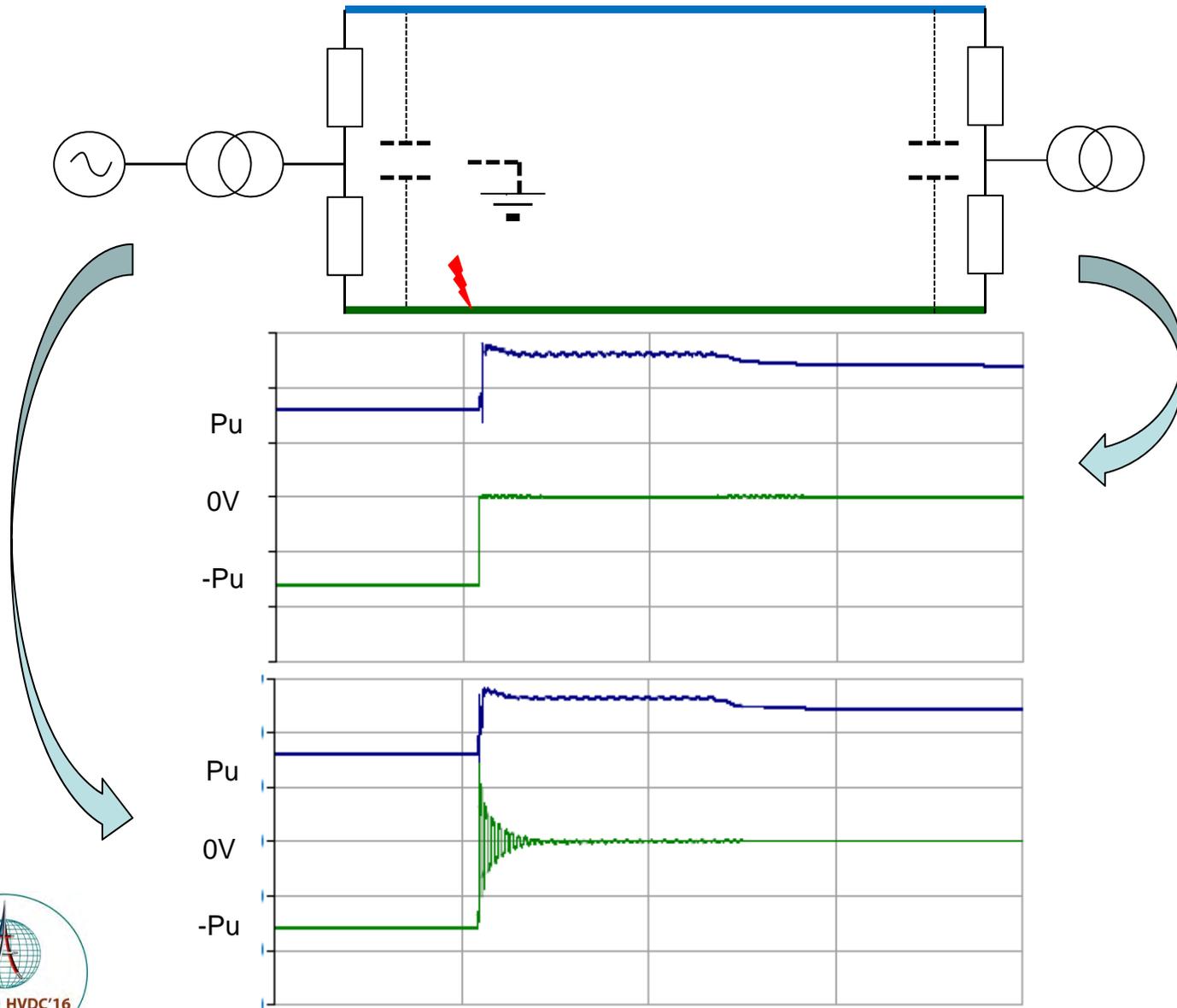
## Basic understanding of behaviours after fault



- Symmetrical monopoles converter doesn't have effective grounding,
- The non-grounded (healthy) pole can be blocked by protection but excessive charging cannot be avoided (upto  $2P_u$ )
- For restarting, the healthy pole shall be discharged by grounding system
- Fast grounding will result in superimposed opposite polarity surge



# Basic understanding of behaviours after fault



# Retrofitting 250kV LCC-HVDC Link in Japan (submarine, land & O/H)

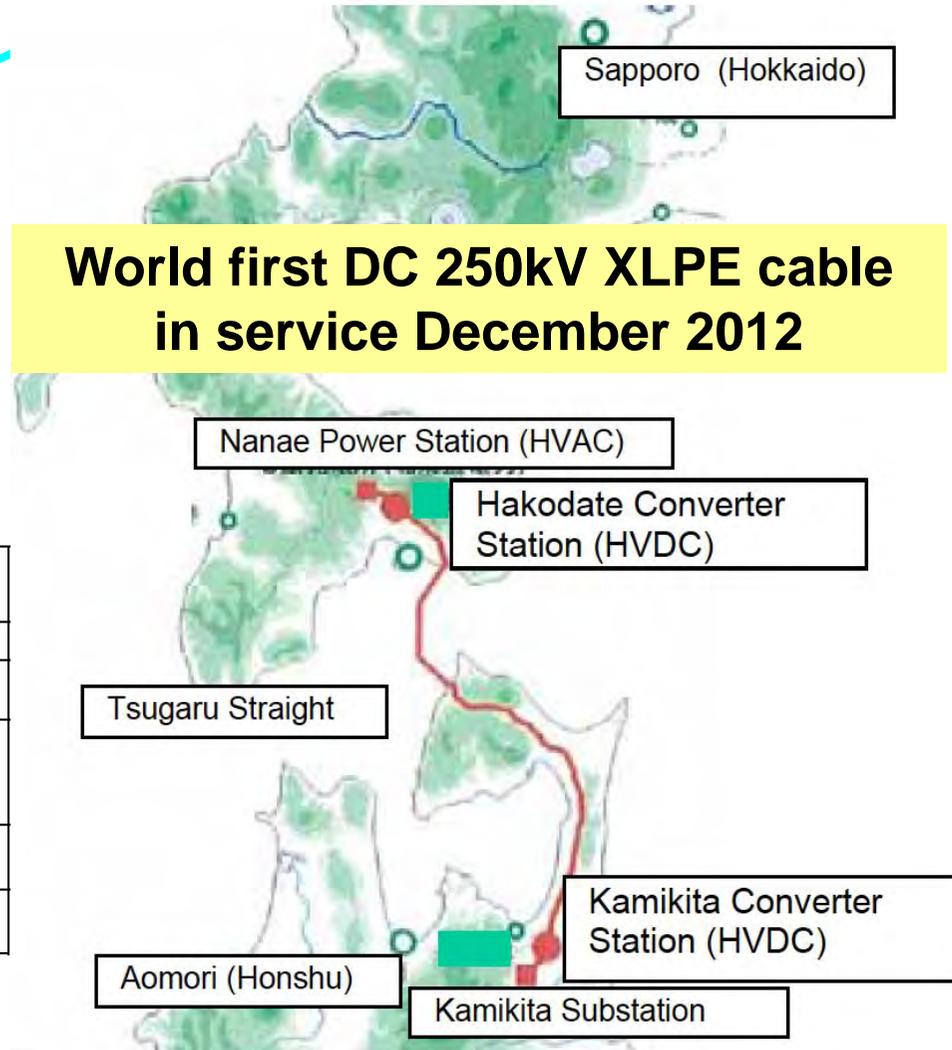
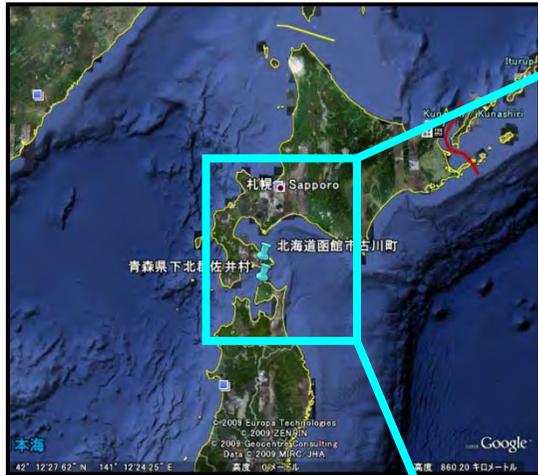


Table 1.  $\pm 250$  kV HVDC Transmission Line

Location	System	Approx. distance
Hokkaido Is. (north)	Overhead	27 km
	Land	0.6 km
Tsugaru Strait	Submarine	44 km
Honshu Is. (south)	Land	0.5 km
	Overhead	93 km



## *Considerations*

For LCC system, opposite polarity superimposed LIWV test have been demonstrated to confirm dielectric strength against lightning strike as well as system surge for MI cable. Same analogy is applicable for DC extruded cable

Since LCC has been used for most of hybrid systems, as far as LCC type test protocols is applied, hybrid system is not threatened in operation conditions.

For VSC system, current CIGTR TB496 focuses on SIWV for the provision of abnormal voltage in symmetrical monopole system with underground cable, but does not fully cover operation conditions for hybrid system.

JWG B4/B1/C4 launched to set up new coordination

