Real-time Simulation Technology for Modular Multilevel Converter Based HVDC Transmission

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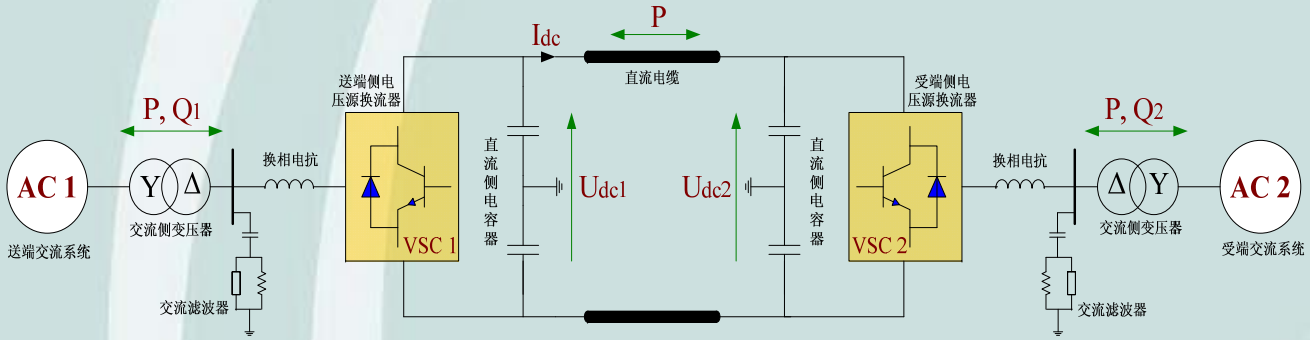
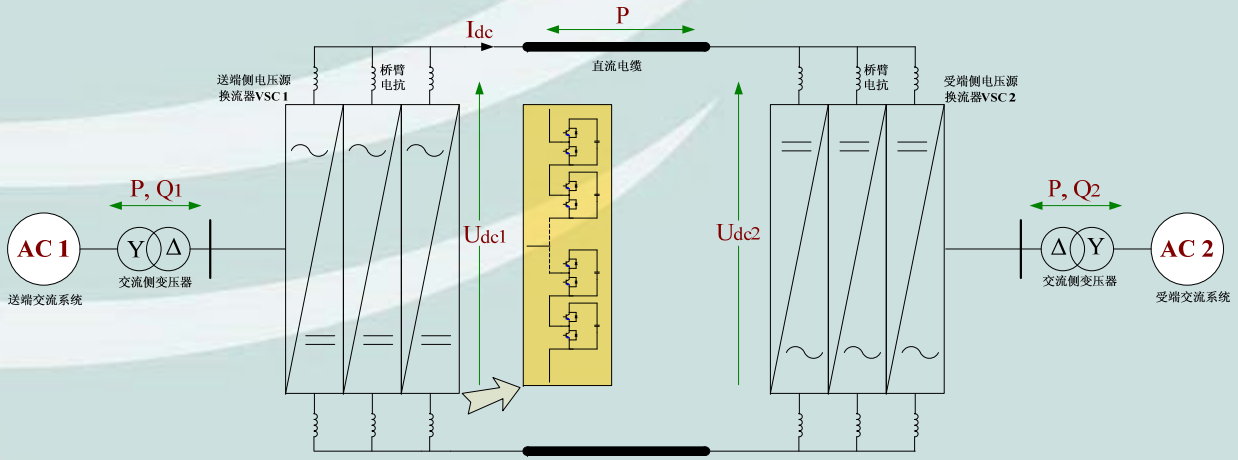
VSC-HVDC in Brief



VSC-HVDC based on two-level or triple-level converters

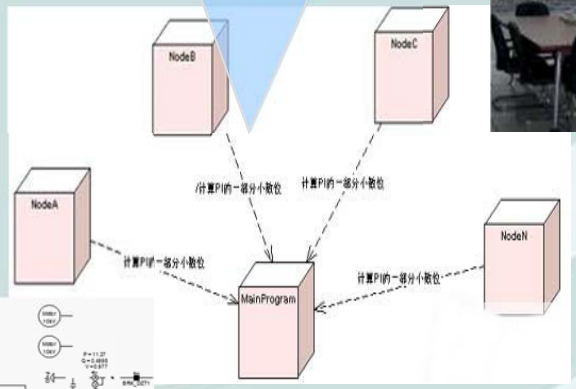
VSC-HVDC based on multi-level modular converters (MMC)

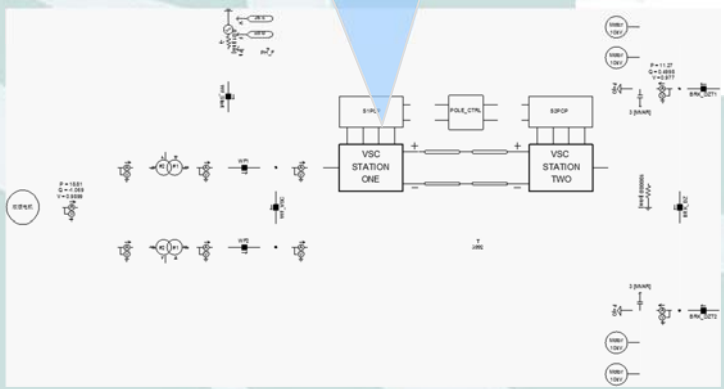


Simulation Technology for HVDC

Electro-magnetic simulation based commercial software

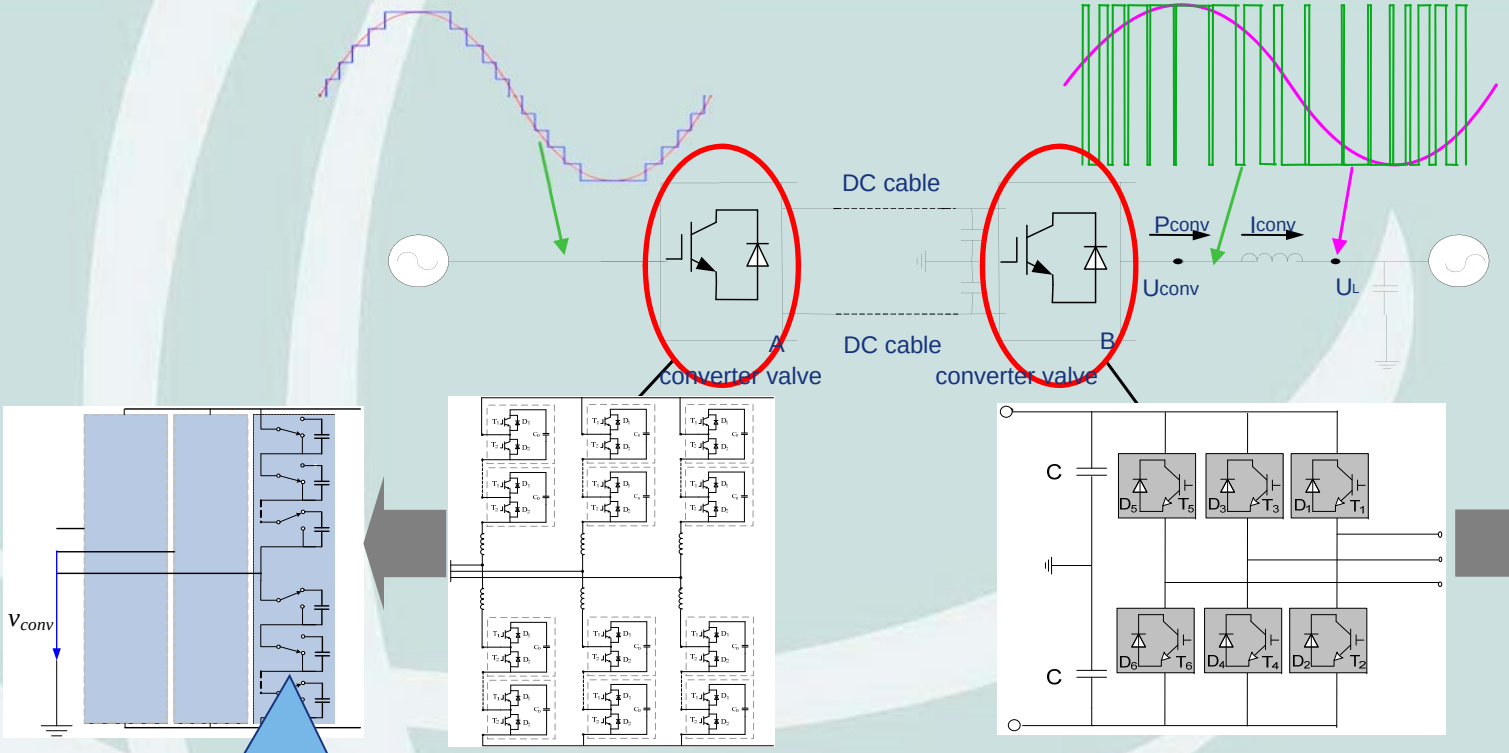
Electro-mechanical simulation based commercial software





Real time digital simulation system

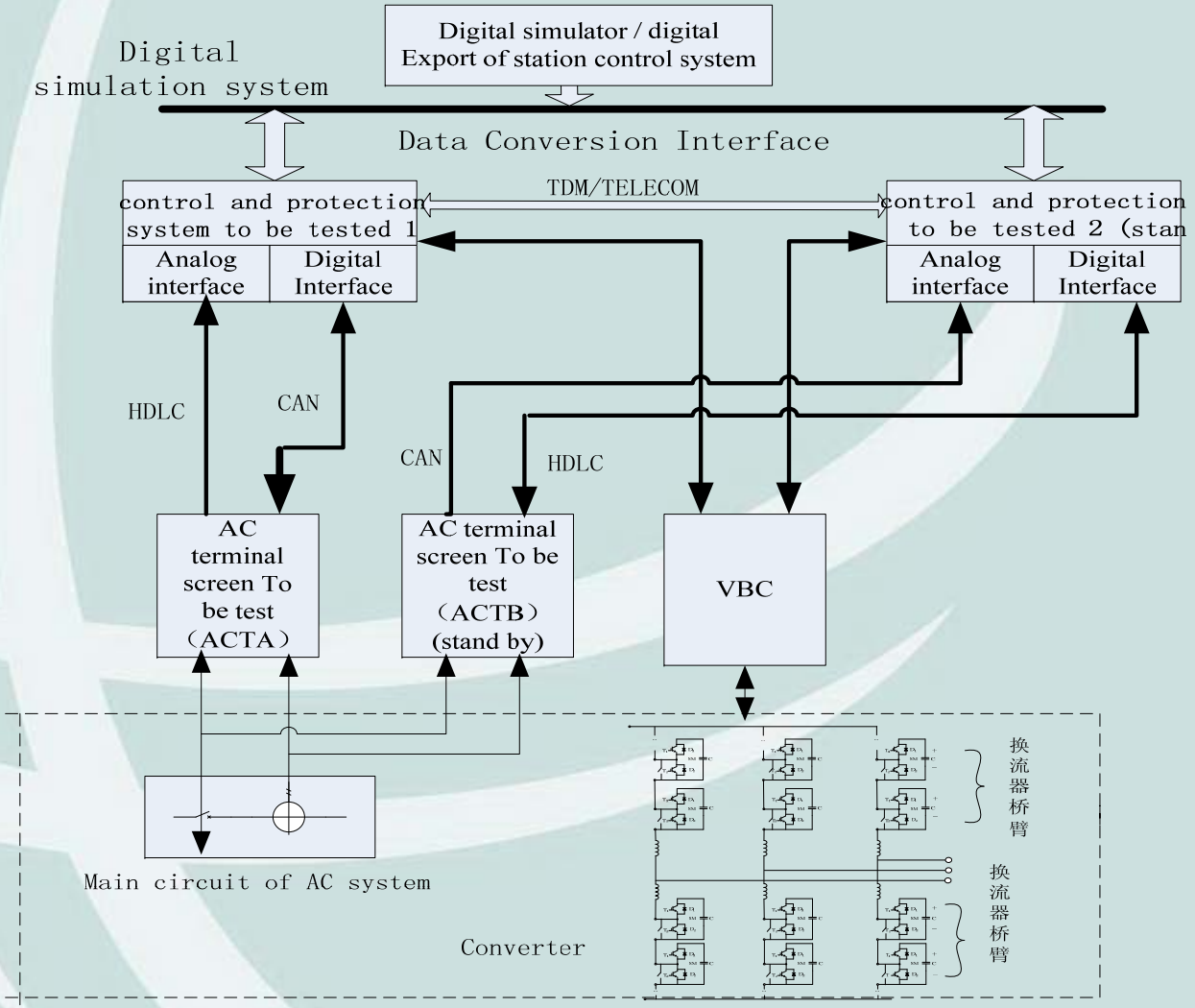
Difficult in simulation of MMC-HVDC



Large nodes in the modular multilevel converter

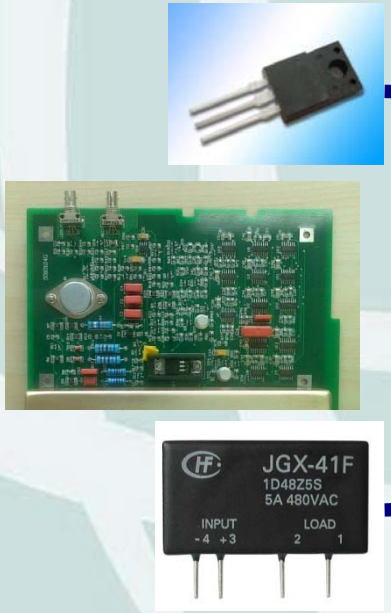
Small nodes in the two level or triple level converter

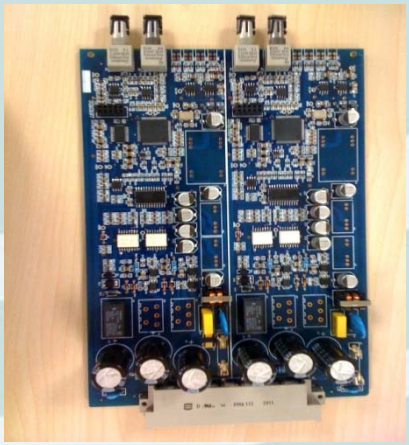
Structure of simulation system



Composite of simulation platform

Electronic device → Digital accessorial → Valve controller → Control and protect system





Prospect of simulation platform

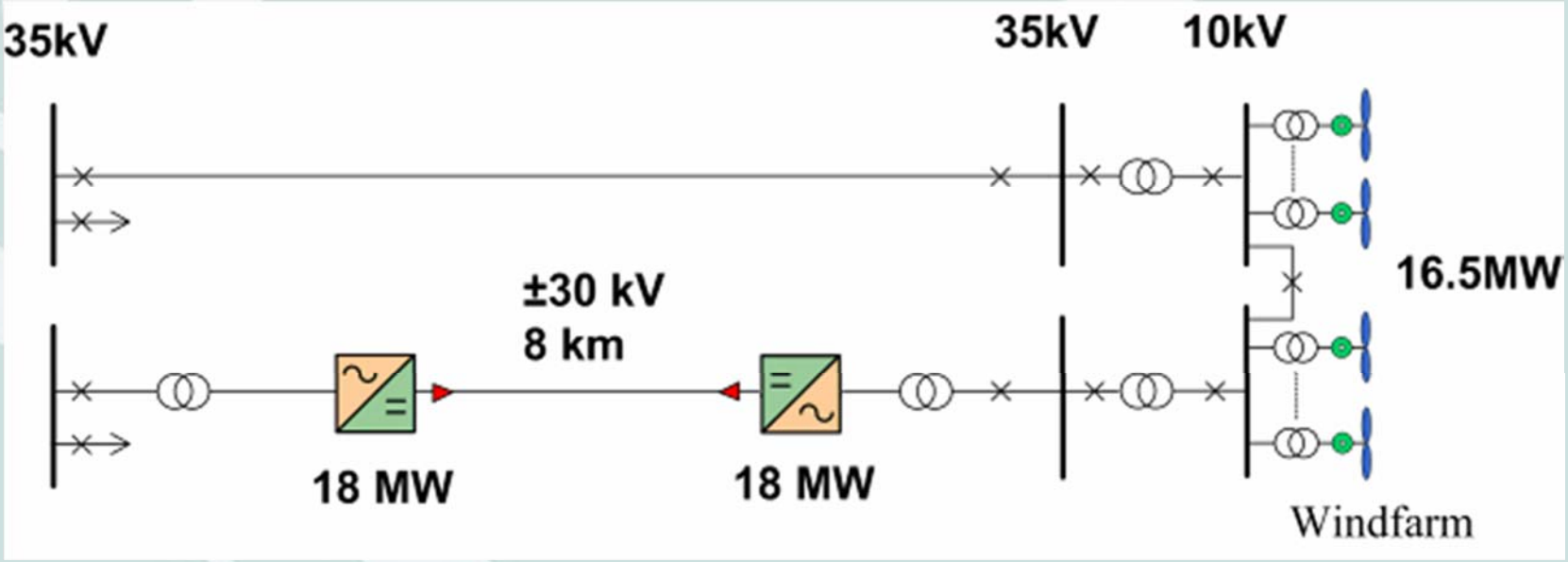
Picture of MMC-HVDC real time simulation platform

Function of simulation platform

- Control procedure of MMC-HVDC, such as charging process on system stirring
- Modulation control method of converter
- Operating performance under steady state and transient state
- Balance control to voltage and current of converter
- Response to power-step-order
- AC and DC network faults

Summary of Nanhui VSC-HVDC Project

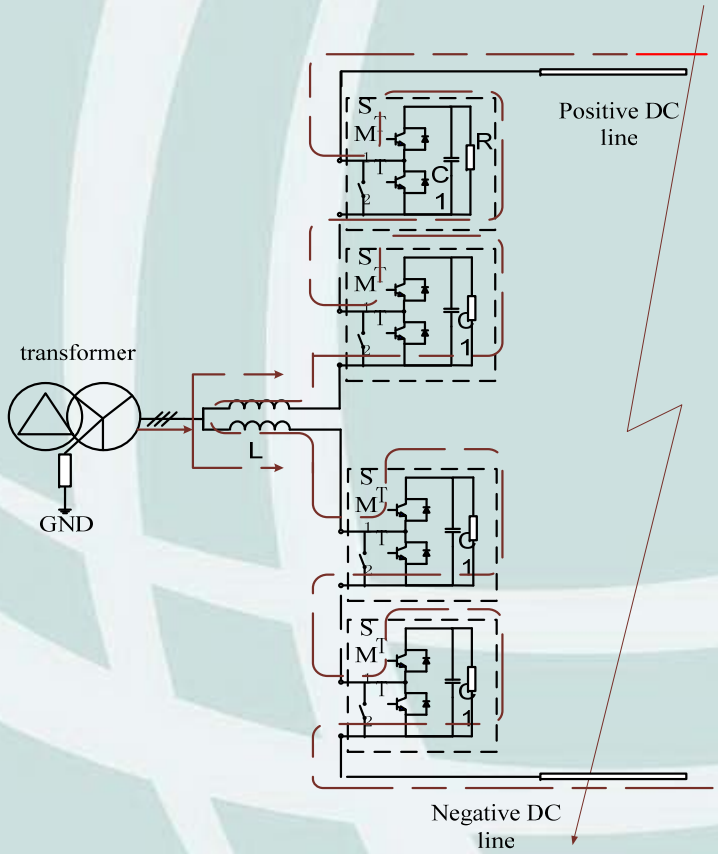
- Rated DC voltage of ±30kV
- Rated DC current of 300A
- Converter of 18MW with 49-level MMC
- The transmission line is about 8km cables

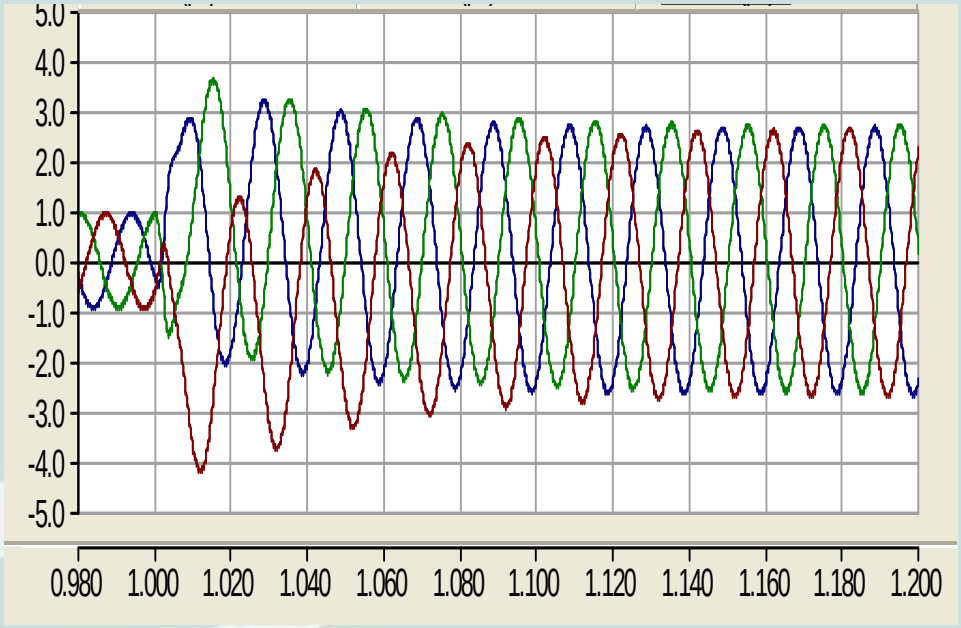


Summary of simulation system

- Capacity of 300VA;
- transformer voltage on valve side of 142V,
- short-circuit impedance ratio of 0.08;
- converter leg reactor of 0.15p.u.;
- DC voltage of ± 140V.

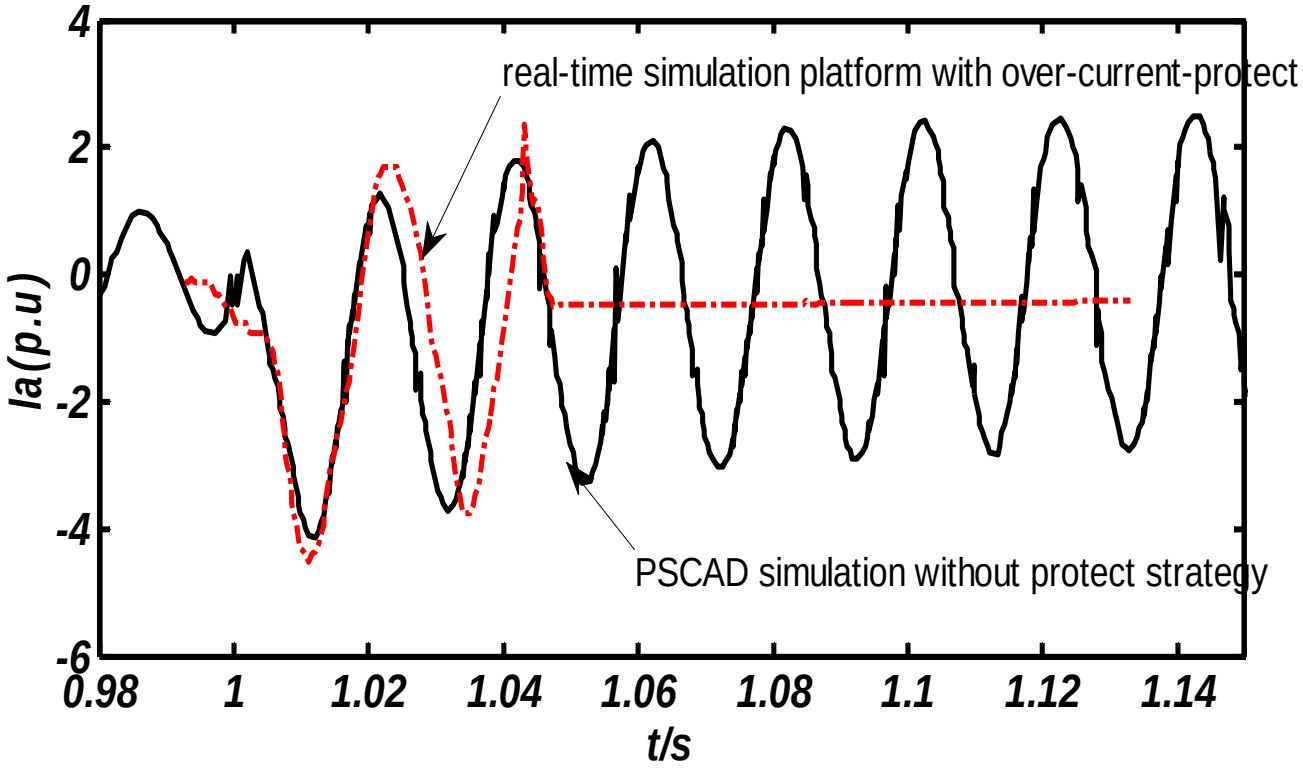
Study with simulation software





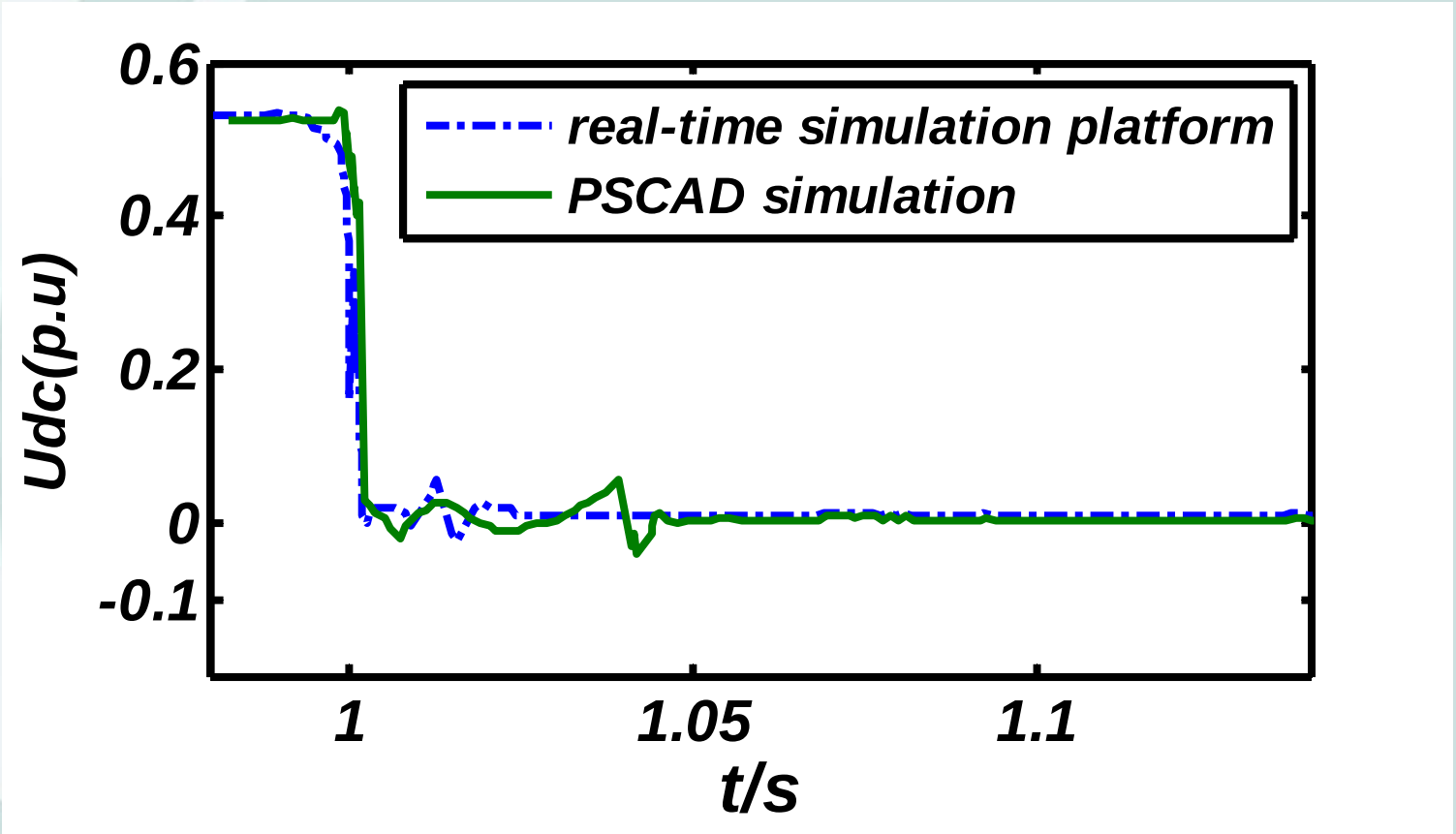
DC line fault analysis and simulation in PSCAD/EMTDC

Apply of dynamic simulation system



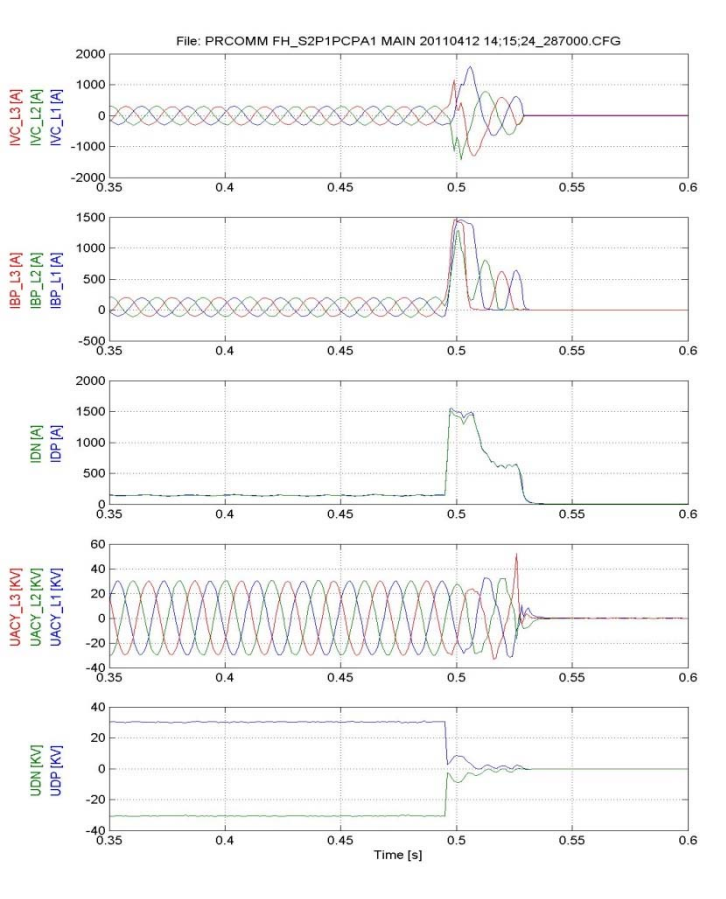
A phase current after fault

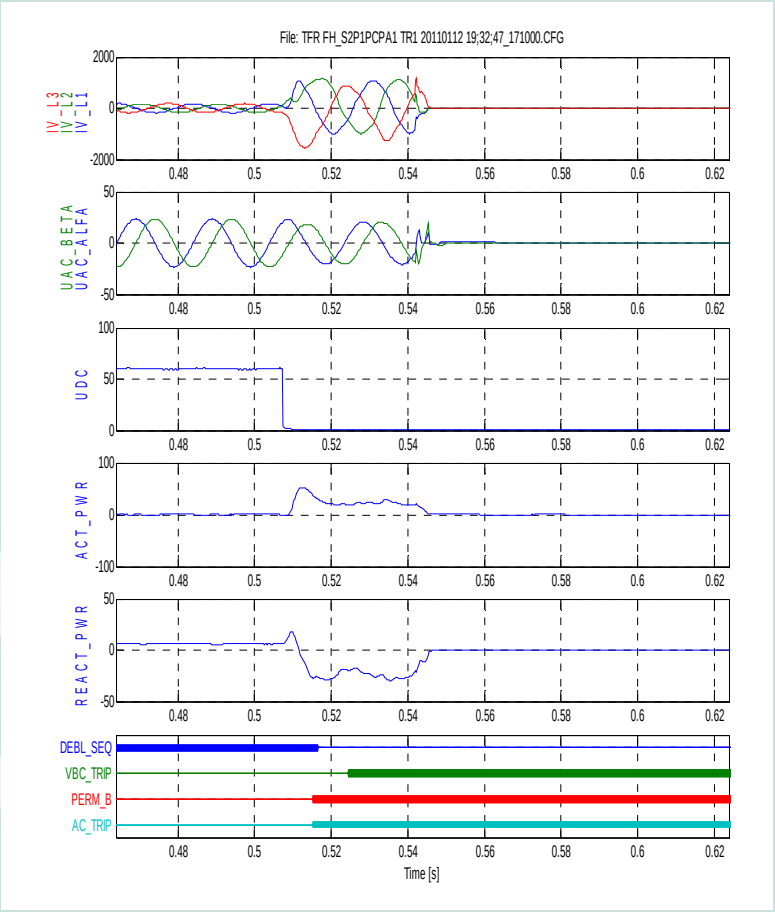
Apply of dynamic simulation system



Udc rapidly reduced to about zero after short-circuit fault

Wave record in the project





Wave record for protection after short fault in project

Conclusion

◆The dynamic simulation platform has a good equivalent and high accuracy in real time simulation for the valve base and station controllers which used in the project.

◆It fully consistent with the design and adjustment features testing for the demand of project.

◆Develop the digital simulation subsystem in order to achieve more application fields of AC network.

◆Increase the capability of converter in HVDC subsystem to meet the need of larger scale MMC-HVDC project.

Thanks for your attention!

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