

# Status of Accelerator Driven Systems Research and Technology Development



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## China ADS project

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ADS has been evolving as ADANES (Accelerator Driven Advanced Nuclear Energy System) after intensive R&D last 5 years in CAS (Chinese Academy of Science). ADANES consist of the recycle fuel burner and the used fuel recycle. ADANES burner is optimized as nuclear waste transmutation, fissile material breeding and energy production in situ from traditional ADS. The fast core/blanket is designed to operate in the subcritical or critical state with or without accelerator driven respectively and burn "raw" recycle fuel which contain >50% FP (Fission Products). The fuel recycle is designed to remove > 50% volatile FP by the extend "AIROX" and lanthanide FP by Rare Earth extraction from used fuel of LWR, then, form other residual as recycle fuel. Consequence, ADANES is the ideal to close fuel cycle as utilizing fissile fuel  $\approx$  95% which means the fission energy could be sustainable for  $\sim$ 10000 yr. and minimizing radiotoxicity <4% with live time < 500 yr. In the approaches, the accelerator play important role of the burner starter which is 10%~15% duration of the burner operation due to the long refueling ( $\sim$ 30 yr.), the much simplified procedure of no water "raw" recycle fuel and the easier for storing small quantity waste (<4%) with lower decay heat by dry storage. Therefore, ADANES' s nuclear power plant could use an accelerator to drive  $\sim$ 10 set of the fast reactor and transmute the minor actinides about  $\sim$ 50% of those transmuted by traditional ADS in same beam power.

Up to now, the key technical R&D make a significant breakthrough. Injector I is 325 MHz option with ECR+RFQ+2CM (7 spoke cavity) and Injector II is 162.5 MHz option with ECR+RFQ+2CM (6 HWR cavity). The lower frequency is the lower RF power density which is benefit to meet RAMI requirements in low energy part of LINAC. Both optional SCL injectors have extracted  $\sim$ 10MeV&1.1~2.7mA CW proton beam. 25 MeV SCL [ECR+RFQ+3CM(6HWR)+1CM(7 spoke cavity)] is assembling and plan to extract beam during first half year of 2017. The new concept of the granular target had been introduced, in which millimeter size solid grain, which is made by target material, driven by gravity, the beam bombarding the grains from top to down to produce intensive neutron and the deposited heat fluid with the grain out of target chamber, then treated off line. Therefore, the granular target power should be jump to  $10^{\sim}$ 100MW, and withstand the impact by high power CW beam trip within 10 sec. as grain is discrete medium and selectable the different material of target. The prototype of  $10^{\sim}$ 100 kW granular target has been test and preliminary results shown the agreement with design.

There are 4 phases in Chinese ADS/ADANES burner development roadmap and new research sites are starting to construct. The 1st phase close finish within half year, the key technique setups at the institutes separately, the 2nd phase will start this year and finish around 2022, the burner is 10MW scale which consists of the high average beam power  $\sim$ 4 MW,  $400^{\sim}$ 600MeV&5~10mA proton beam LINAC and the blanket.

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