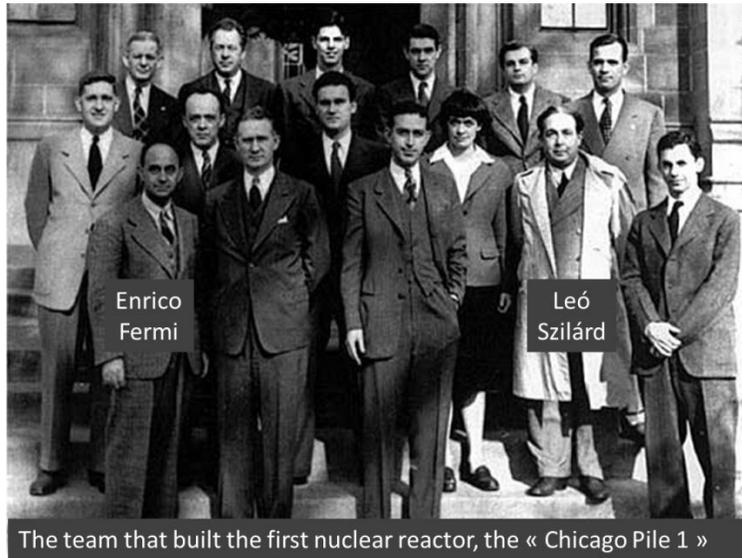


Stop Designing Reactors!

Leo Szilard was a physicist. On 12th September 1933 he had a remarkable idea which would become known as the nuclear chain reaction. Enrico Fermi was also a physicist. He headed a team which designed and built the world's first nuclear reactor, achieving criticality on 2nd December 1942. The staggering intellectual achievements of these and many other physicists brought humanity into the nuclear age.



The Manhattan Project laid the foundations of the design philosophy for the first nuclear era. The physicists had worked out and mathematically proven the fascinating new science of neutronics, so they were the ones tasked with designing the first nuclear bombs. Armies of people from other scientific and technical disciplines laboured to provide the materials to build them, the bombs worked, and the Second World War was brought to an end. The physicists were heroes.

In the first nuclear era, fission is physics.

The champion of the first nuclear era is the Reactor Physicist.

This 'successful' design philosophy was then applied to the peaceful use of nuclear fission for the generation of power. The physicists would design the reactor, and then everyone else would design and build a nuclear energy system around it.

The nuclear energy system includes all activities, equipment, disciplines and resources associated with the generation of nuclear power. For example: mining, milling, transport, enrichment, fuel fabrication, facility fabrication, irradiation, power conversion, maintenance, retreatment, geological isolation – basically everything from digging up the fuel until the radioactivity from the waste has decayed to background levels.

The failure of the first nuclear era is its design philosophy.

In a world which is largely and increasingly democratic and market driven, putting the technology first and the customer second is a flawed strategy. People want to consume energy that is **reliable, cheap, safe, sustainable and clean**. It is essential to start with a deep and fundamental understanding of those customer requirements before even **starting** to think about how to fulfill them.

For over 60 years, we have been designing the wrong thing. To begin the second nuclear era a paradigm change is required. Instead of designing reactors we need to be thinking primarily about the design of the **nuclear energy system as a whole**. Obviously, those systems will have a nuclear reactor as a very important **component**, but the detailed design of the reactor should not be pursued unless the overall system gives very substantial improvements in **all areas** of customer requirements. To do otherwise is a waste of scarce scientific and technical resources.

The [ThEC13 conference at CERN](#) discussed 3 approaches for extracting energy from thorium:

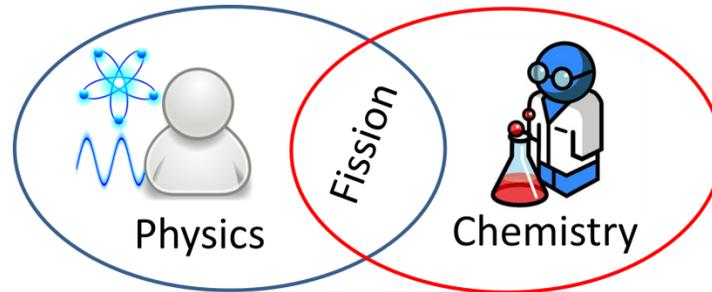
Possible systems for extracting energy from thorium <small>(compared to generation 3 uranium Pressurized Water Reactors - PWRs)</small>	Solid thorium fuel in PWRs	Liquid fuel	Accelerator Driven Systems
Reliable			
Cheap			
Safe			
Sustainable			
Clean			

Concerning Accelerator Driven Systems, there was considerable discussion of potential benefits through design of reactors that are safe, sustainable and clean. But by ignoring cost and reliability, physicists working on these reactor designs seem to be perpetuating the failures of the first nuclear era.

In a nuclear energy system, many different disciplines are involved. Designing an effective system therefore requires a multi-disciplinary approach. Important synergies are possible through close collaboration between experts.

In the second nuclear era, fission will be re-positioned at the interface between physics and chemistry.

The champion of the second nuclear era will be the Nuclear Energy System Architect.



This message is going to be rather unpopular with physicists, who have after all been at the centre of massive advances for humanity in the first nuclear era. But fighting climate change and energy poverty in the 21st century may well **depend** on whether the physics community is willing to **share** nuclear fission with other disciplines.

John Laurie, <http://energieduthorium.fr>, January 2014