

AFCI RACE (Reactor-Accelerator Coupling Experiments) Project response to a data request from the European ECATS (Experiment on the Coupling of a spallation Target and a Subcritical blanket) team for information on RACE Project configurations at UT-Austin and Texas A&M University

ECATS Request:

Information on the following major areas was requested:

- General Core Characteristics
- Thermohydraulics
- Thermo-mechanical Issues
- Instrumentation
- Characteristics of accelerator and targets.

Response:

Prof. O'Kelly at UT-Austin and Prof. Charlton at Texas A&M will provide data from their TRIGA reactor Safety Analysis Reports (SAR), technical specifications, etc. They will provide this information on or before Feb. 28, 2005. Prof. Beller, the Director of the RACE Project, will provide detailed information on accelerator, target, and instrumentation systems. Some specific responses to requested information are in the following sections and tables. This includes straight-forward, brief answers, availability of information and/or data, plans, etc. Texas A&M has many master's theses from their experiments. Substantial, detailed information can be made available, but this will take some effort that was not planned at this time.

RACE Project response to request for General Core Characteristics.

	UT-Austin	TAMU
1. the normal description of the TRIGA core and fuel geometry (number of fuel rods, pin diameter, pin pitch, axial dimensions, etc.)	Standard TRIGA Mk II, hexagonal geometry, cold critical configuration at 50 W is available	TRIGA with FLIP fuel (reconverted Materials Test Reactor, rectangular grid plate)
2. Fuel and cladding description, type of fuel and cladding.	From SAR, 8.5 w/o, 20% enr.	From SAR, 8.5 w/o, 70% enr.
3. Corresponding material property data such as thermal conductivity, heat capacity, density of the fuel and cladding materials.	From SAR	From SAR
4. Power level, coolant flow rate. Is it all natural circulation?	50 W to 1 MW, all natural circulation, flow rates are unknown	50 W to 1 MW, all natural circulation, flow rate at 1 MW is 7,890 kg/s
5. Coolant temperature drop across the core vs power level.	Not available	67.2 C at the top, T vs axial height is available.
6. Transient data that may have been collected during the normal operational modes of the reactor, i.e. power, fuel and coolant (core inlet, core outlet) temperature traces vs time with the corresponding reactivity inserted (control rod position)	Not available, measurements may be made during current reactor experiments course	Some may be available, for pulsed experiments this can be provided.
7. Detailed control rod calibration curve, i.e. reactivity vs rod position.	6-month-old data is available, excess k has not changed	6-month-old data is available
8. Detailed burn-up history to predict the level of criticality and possibly determine corresponding temperature reactivity coefficients.	Available	Calculated from power map of core and operating history.
9. Added by G. Imel: detailed power versus control rod position (e.g. compensation for thermal response).	One paper published, will provide, may do additional experiments during the next year	Probably available in existing reports from lab classes
10. What is the starting neutron source?	AmBe, 2 Ci ²³⁸ PuBe, 20 & 40 Ci ²³⁹ PuBe, 1, 5, & 6 Ci	SbBe

RACE Project response to request for Thermalhydraulics information:

	UT-Austin	TAMU
Geometry of the whole core configuration	See previous section	See previous section
○ Pool geometry and core position		
○ External cooling configuration and circuit		
○ Singularities geometry and if possible singular pressure drop coefficients	Item needs clarification, we don't have pressure drop data	
Geometry of the initial TRIGA core	See previous section	
Geometry of the foreseen experiment within the TRIGA core. ○ Place of the target ○ Modification of the fuel positions inside the core (for example removal of the first fuel ring in the TRADE experiment)	Various, open for discussion. B-ring will be removed for central target experiment, others.	Two internal locations for target placement without removing fuel rods, can run under standard operating configuration
Target geometry (specially external surface)	Design is in progress, could collaborate	Same as UT
Axial distribution of power on the target surface	Typically gaussian in r, few mm spot size	Same as UT
Axial and radial distribution of power within the core	Depends on the experiment, to be determined by calculations	Same as UT
Limit conditions (pressure, inlet temperature, power) for the core under normal operations	From tech specs, LCOs are available	Same as UT
Cooling mode whether free convection or assisted cooling	free convection	Same as UT
If available in core measurements of flow rate and outlet temperatures	Not available now, will do	available
<u>If observed</u> details concerning possibility of nuclear power oscillations at some power rates	Not observed with hexagonal TRIGA cores	Never been observed, however, an automatic reg rod adjusts power

RACE Project response to request for Thermo-mechanical information:

	UT-Austin	TAMU
Target geometry	TBD, design in progress, can provide current information and collaborate	Same as UT
Target material: <ul style="list-style-type: none"> * Temperature-dependent physical properties (density, thermal conductivity) * Temperature-dependent mechanical properties (Young's modulus, Poisson's ratio, thermal expansion coefficient, yield stress) 	W-Cu alloy (75 w/o W), machined for U-Al rods to enhance neutron production. Data on W-Cu alloy is available. Most power will be dissipated in this material	Same as UT
Power density distribution inside the target (at least, the expected axial linear power profile)	Can be calculated, most power is in the first few mm of the face.	TBD
Boundary conditions (pressure and cooling conditions around the target) for the target module under normal and transient conditions	Ambient, bulk water temperature. For BP-5, forced convection/cooling jacket	TBD
Power time-history (determination of the type and number of cycles imposed to the target)	See previous information, assume square pulse, ~2 kW average, ~2 MW in each pulse @ 100 Hz.	TBD

RACE Project response to request for Instrumentation information:

	UT-Austin	TAMU
A detailed list of available neutron detectors.	Limited, we have funds to purchase new systems, will do so with G. Imel's guidance, will also use TRADE instrumentation if collaboration goes forward	Fission chamber in the core for pulse-power monitoring, thermocouple for temperature meas; small fission chambers and BF ³ tubes.
A detailed list of the corresponding signal conditioning electronics (rack, preamp., amp., ...)	Will be available	Ditto
Are Cd-foils available for wrapping neutron detectors in order to turn them into epithermal neutron detectors? Polyethylene block would work as well.	Yes?	Ditto
Does there exist a mechanism for having a Cf-252 source oscillated?	Yes, but it is bulky and awkward, so we may develop a new one.	yes

RACE Project response to request for characteristics of accelerator and targets (external neutron source):

Is the external neutron source continue or pulsed?	pulsed
What is the frequency range exactly?	From a single pulse up to 180 Hz for current 12 kW modulator, up to 300 Hz for upgrade modulator.
What is the frequency accuracy?	Can be synced to power line; in the free running state the clock is stable to <1%.
Is the pulse width fixed at 3 microseconds only?	no, the pulse width can be varied from ns to 5 μ s with the existing 12 kW power source. The upgrade modulator will provide repetition rates to 200 Hz, 15 μ s pulses, and 40 kW.
Does there exist a source triggering signal?	Yes, logic triggers are available
What is its shape and amplitude?	5-15 volts ~2 micro sec
Can this triggering signal be delayed?	Yes.
It has been said that there exists "a prompt, strong-energy gamma ray signal" when the source neutron is produced by the electron beam impinging onto the target.	True, this is in addition to electromagnetic noise from the from the modulator (which can be located at same distance from the accelerator).
Could this gamma flash prevent fission chamber from detecting neutrons?	No, but it does produce a signal that masks the neutron signal for a few microseconds.
Is there some information on this side-effect?	The "flash" affects different instruments differently, depending on beam magnitude, shielding, and location of instruments, electronics, modulator, etc.
How long can the external neutron source continuously work?	Continuously, no known limitation.
How long does a target last?	Indefinitely; the target is essentially a high-Z piece of metal. It simply needs to be cooled adequately.

Our current target is a piece of tungsten-copper alloy, 75 w/o W and 25 w/o Cu, 2.75" OD x 3" long. The front was cut 1/2" to accommodate a 2.75" Conflat flange, which was soldered to the W-Cu target. ISU-IAC will supply a report on this target as well as concepts for targets for UT and TAMU, including targets with imbedded uranium rods to increase neutron production.

