NEA-CRP-L-142

Danish Atomic Energy Commission
Research Establishment Risø
Department of Reactor Technology
Reactor Physics Section

RP-5-75
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IM/rj
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3D IAEA Benchmarkproblem
3rd order FEM calculation

by

Ib Misfeldt

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85210001

Code name FEM 3D

Organisation Risø. DK.

3D Benchmark Problem

Result Scheme 1, Page 1

(to be filled in by type-writer)

1. Name of participant: Ib Misfeldt

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2. Computer code name: FEM 3D

Description (max 20 lines):

FEM 3D is a three-dimensional finite-element flux calculation programme. The programme uses box-formed elements with Lagrange interpolation. The order of the interpolation might be 1., 2. or 3. order. The programme uses an ordinary power iteration technique with one inner iteration per outer. The group equations are solved by SOR and the iterations are accelerated by extrapolation.

References:

None so far.

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Code name FEM 3D

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3D Benchmark Problem

Result Scheme 1, Page 2

(to be filled in by type-writer)

3. Calculation description (simplifications, meshes, iterations, problems, etc.) (max. 15 lines):

This calculation is performed with 3rd order interpolation. The mesh used was 9 x 9 x 4 (28 x 28 x 13 flux points). The solution is not yet sufficiently converged so the local error is large, but less than 5%.

The mesh in the z direction is too coarse so the precision will not be as high as predicted in RP-3-75 (6%) for the xy-plane.

These results do mostly serve the purpose to prove that 3rd order FEM calculation is possible on a realistic 3D-problem.

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4. Computer type: Burroughs 6700
Calculation time: 9.5 hours

Computer speed relative to one or two well-known computer types:

1 hour on CDC 6600 ~ 10 hours on B 6700.

An extra page A4 with information may be added if necessary.

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3D Benchmark Problem

Results Scheme 2.k_{eff} and flux points

k_{eff} = 1.0287

Write φ_1 and φ_2 relative to $\varphi_{2,average,core}$

	Co-ordinates cm			Relative fluxes	
	x	y	z	φ_1	φ_2
			193		
core	80	40	~~196~~	7.626	1.796
midplane	80	80	~~190~~	3.899	0.602
	100	80	~~190~~	4.395	1.095
	120	40	~~190~~	6.289	1.541
			293		
10 cm's up	0	0	~~290~~	2.760	0.426
the partially	40	0	~~290~~	4.246	0.988
inserted	80	40	~~290~~	3.924	0.914
control absorber	140	0	~~290~~	2.624	0.646
	150	0	~~290~~	1.339	0.984
Core bottom	0	0	20	692	0.150
	0	40	20	1.092	0.346
Power	130	56	175	3.229	2.389
peak	34	34	175	9.481	2.250

Relative fluxes and position, where φ_2 has its maximum in the core

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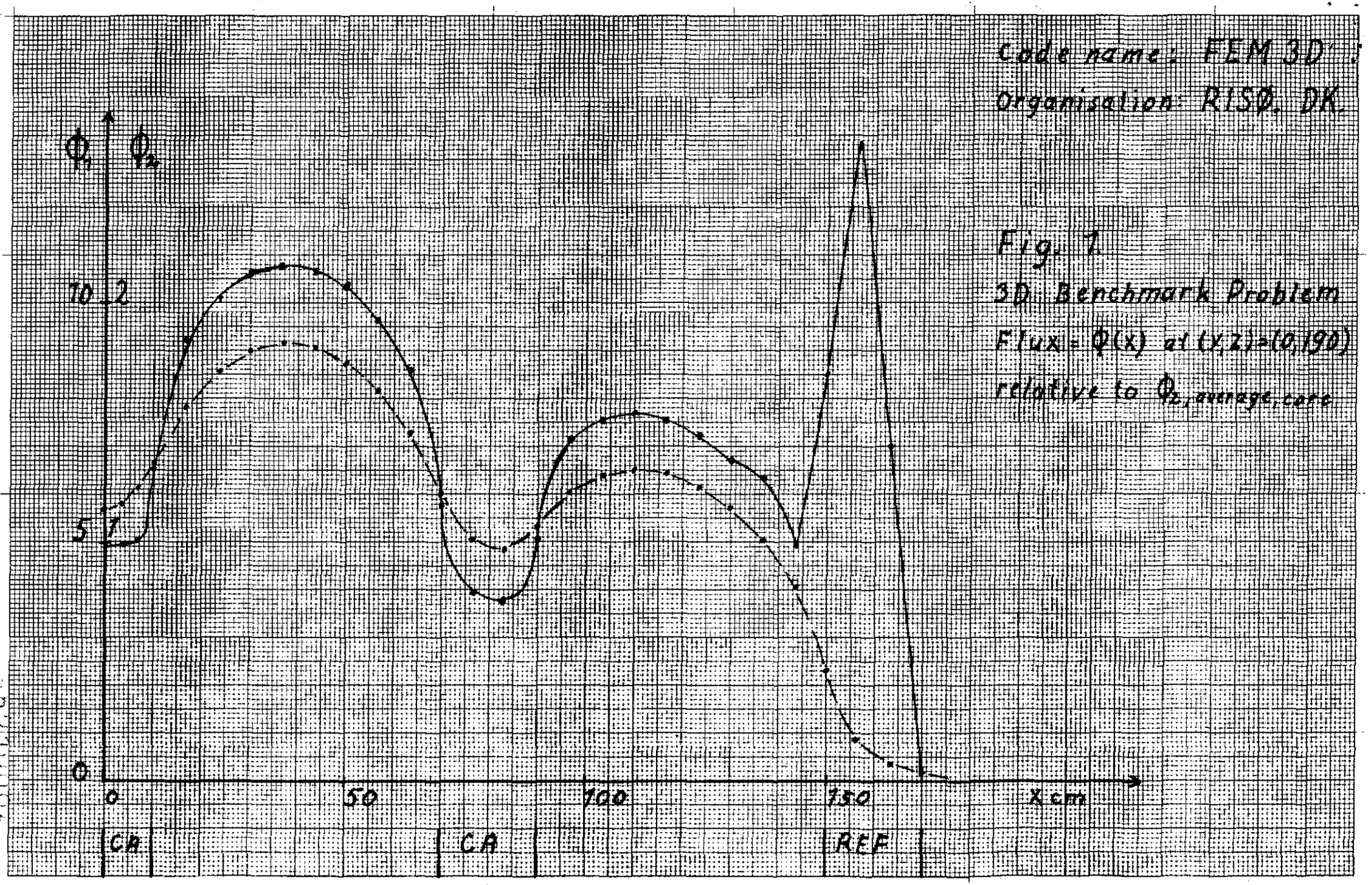
code name: FEM 3D
organisation: RISØ, DK
Fig. 7.
3D Benchmark Problem
Flux = Φ(x) at (y,z)=(0,190)
relative to Φ2,average,core
Φ1
Φ2
10
2
5
1
0
0
50
100
150
x cm
CR
CR
REF

Code name : FEM 3D

Organisation: Risø. DK.

Fig. 2. 3D Benchmark problem

Flux $\phi(z)$ at $(x,y)=(40,40)$ relative to ϕ_2, average, core