THE COMPRESSOR BLADE DEFINITION

The flow problems in axial flow compressors are two-fold for what concerns the computational methods :

- a high turning rotor root or stator blade with transonic flow conditions;
- a low turning supersonic rotor tip section.

The test cases should be chosen in such a way as to have stage and cascade data to confront with the calculation methods.

The NASA fan stages looked very promising and ample experimental data are available.

The final choice was guided by the following principles:

- a mid blade height section did not provide a high enough inlet Mach number for the rotor and will be influenced very seriously by the rotor part span shroud wake;
- the tip section, giving the highest Mach number, is not chosen because of the important influence of the secondary flow. These data are unsuited for cascade mid-span comparison.

The following blade sections were chosen :

- a supersonic DCA rotor section (30% immersion) out of the tip region and not too close to the part span shroud;
- a high turning DCA stator section (31% immersion) and out of the wake produced by the part span shroud.

Stage data are available for these two blade sections. The cascade data were produced in the DFVLR tunnel on the occasion of this lecture series.

I. THE LOW CAMBERED DCA AIRFOIL

The supersonic blade section was chosen from NASA CR-54584, single stage experimental evaluation of high Mach number compressor rotor blading, Part 4 - Performance of rotor 2D by K.W. Krabacher and J.P. Gostelow, October 1967.

The double circular arc section is the one of streamline 0.70 and has the following characteristics:

chord	$c = 90$ mm	
camber angle	$\phi = 9°57$	
maximum thickness	$\frac{t}{c} = 4,66\%$	
solidity	$\sigma = 1.4618$	
stagger angle	$\gamma = 51°35$	
inlet angle	$\beta_1' = 56°14$	→ $i_c = 0°$ incidence angle with respect to camberline
outlet angle	$\beta_2' = 46°57$	→ $\delta = 0°$ deviation with respect to camberline
leading edge / trailing edge	radius $R_{LE} = 6\% \left(\frac{t}{c}\right)_{max.}$	
	$t_{max} = 4.194$ mm	
	$R_{LE} = 0,2516$ mm	
suction surface radius	$R_{SS} = 271.120$ mm	
camberline radius	$R_c = 536,6154$ mm	
pressure surface	R_{PS} = flat plate within 0.02 mm the manufacturing accuracy	
suction surface angle	$\phi_{SS} = 19°12$	

The blade coordinates are given in the following table

X_{mm}	Y_{mm}
0.0	3.966
1.0	3.964
2.0	3.958
3.0	3.949
4.0	3.936
5.0	3.920
6.0	3.899
7.0	3.875
8.0	3.848
9.0	3.816
10.0	3.781
11.0	3.742
12.0	3.700
13.0	3.654
14.0	3.604
15.0	3.550
16.0	3.493
17.0	3.432
18.0	3.367
19.0	3.299
20.0	3.227
21.0	3.151
22.0	3.072
23.0	2.988
24.0	2.901
25.0	2.811
26.0	2.716
27.0	2.618
28.0	2.516
29.0	2.410
30.0	2.301
31.0	2.188

X_{mm}	Y_{mm}
32.0	2.071
33.0	1.950
34.0	1.825
35.0	1.697
36.0	1.565
37.0	1.429
38.0	1.289
39.0	1.146
40.0	0.999
41.0	0.848
42.0	0.693
43.0	0.534
43.2	0.502
43.3	0.486
43.4	0.469
43.5	0.453
43.6	0.437
43.7	0.421
43.8	0.404
43.9	0.388
44.0	0.371
44.1	0.355
44.2	0.338
44.3	0.322
44.4	0.305
44.5	0.289
44.6	0.272
44.7	0.255
44.8	0.239
44.9	0.222
45.0	0.205

Blade II - V.K.I. - D.V.L. TUC 73-03

The figures 1, 2, 3 show the details and the reference frame for the blade parameters.