NOTES ABOUT ACCURACY OF EXPERIMENTAL DATA FOR NUMERICAL METHODS VALIDATION

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TsAGI, MiPT

Road map

- **Technical requirements**

- Blockage and upwash

- Sing and cavern

- Stall

- Deformation

- Range

Useful information about technical requirements

Parameter\error	Company			
	TsAGI, Design Companies (Russia)	Airbus	Boeing	Embraer
ΔCxa		±0,00005	±0,00005	±0,0001
ΔCya				±0,001
Δmza				±0,001
Δα			±0,005°	
ΔK	±0,1			

Parameter	Cruising regime	Take-off regime	Landing regime
ΔCxa	±0,00005÷0,0001	±0,0005÷0,001	±0,001
Δα	±0,005°÷0,01°	±0,01°÷0,03°	±0,01°÷0,03°
ΔCya	±0,002÷0,005	±0,002÷0,005	±0,005÷0,01
Δmza	±0,001	±0,002÷0,005	±0,005÷0,008

These data are prepared by A.R.Gorbushin

Numerical data obtained by different authors

CRM data, DPW-4 data, two positions of stabilizer
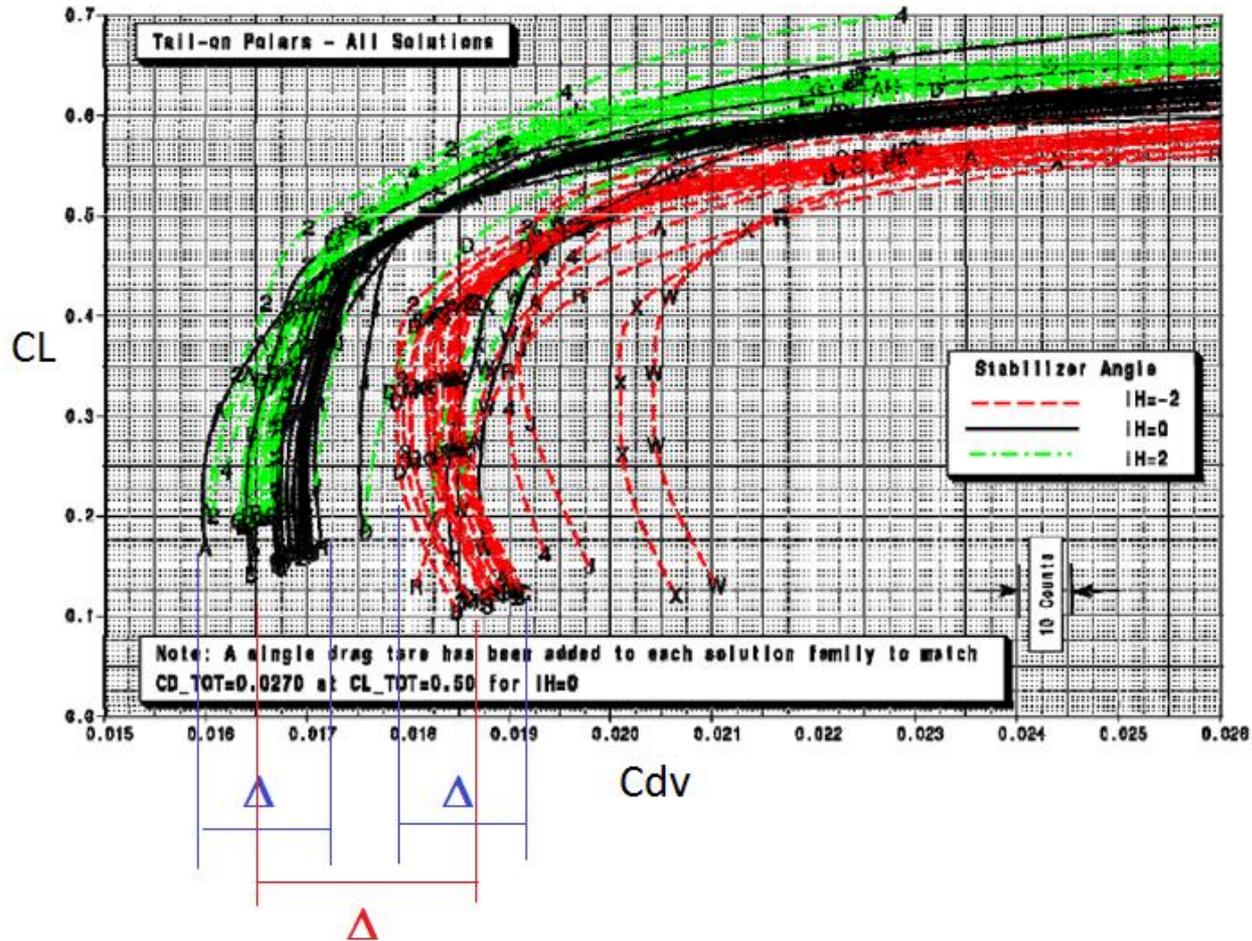
Difference between experimental data in different WT

CRM model, tests in three WT of comparable size

Many thanks to EsWIRP
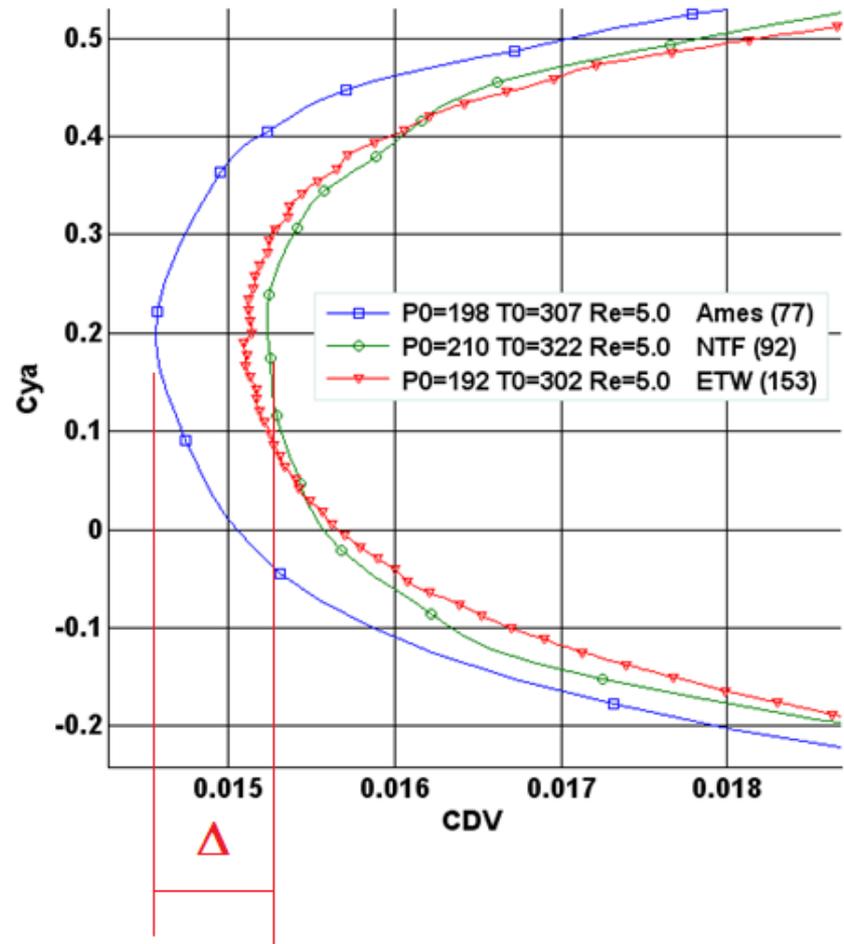
Road map

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Influence of WT walls. Blockage and upwash

M	0,85	0,85	0,85	0,85	0.85
α˚	-2	0	1,56	3	5
M ref	0,848	0,849	0,848	0,847	0,846
α ref	-2.01	-0.05	1.36	2.62	4.36

T-128 TsAGI   Thanks to S. Glazkov (TsAGI)

Road map

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Sector and support

ETW. Thanks to FLIRET

Sting influence
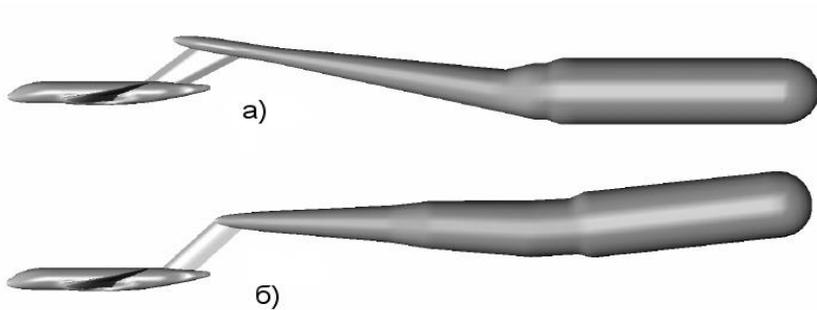

dCx = 0.0017;   dCy = 0.0180

ΔM=~ 0,004

Data are prepared by I. Kursakov
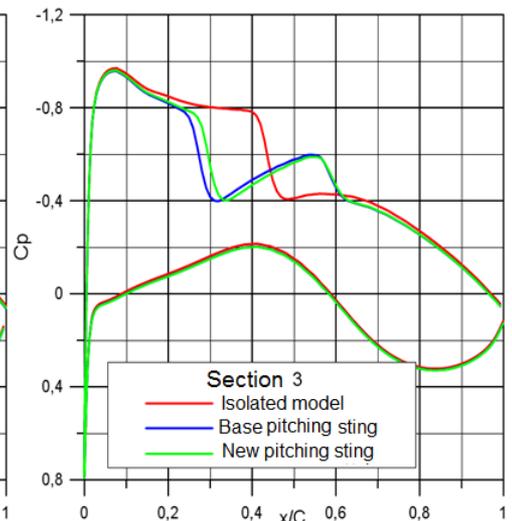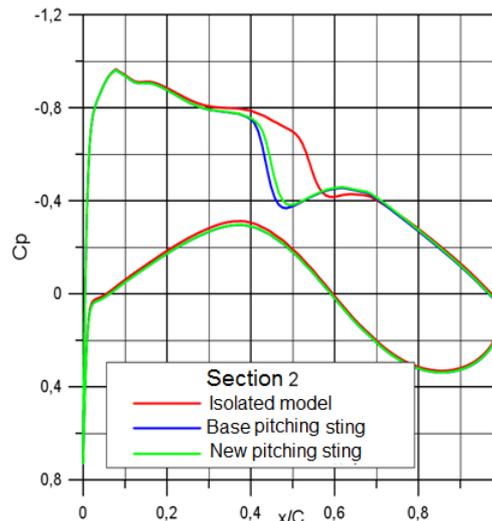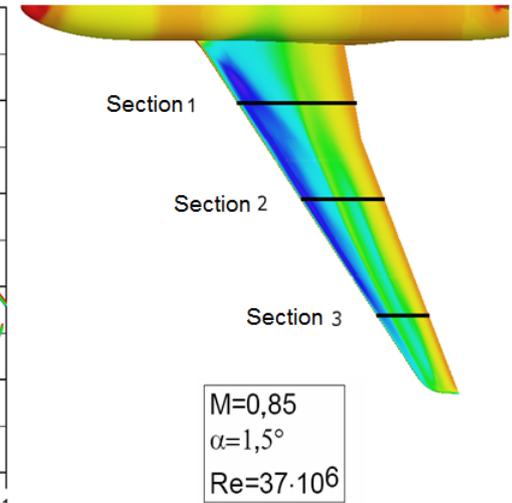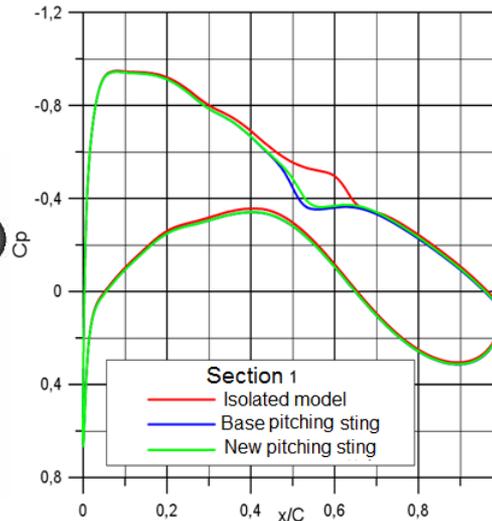
Influence of cavern between sting and model
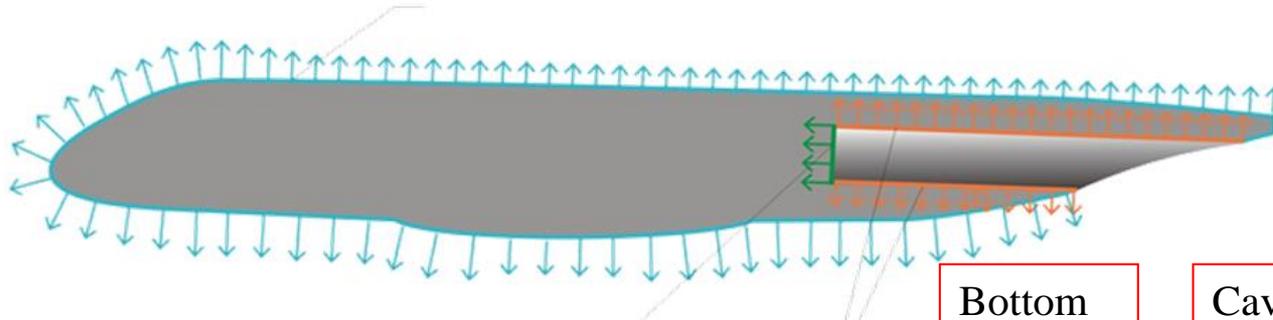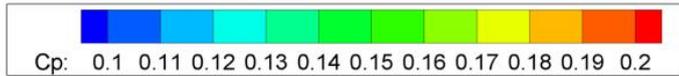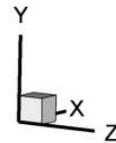
Bottom

Cavern

Mach=0.8018, alpha=2.492

Cp: 0.1 0.11 0.12 0.13 0.14 0.15 0.16 0.17 0.18 0.19 0.2

M	a[°]	Cx_{bottom}	ΔCxa	ΔCya
0.70	-1.25	0.00233	0.00009	0.0091
0.70	2.50	0.00228	0.00067	0.0089
0.80	-1.25	0.00245	0.00009	0.0096
0.80	2.50	0.00240	0.00070	0.0094
0.88	-1.25	0.00253	0.00009	0.0099
0.88	2.50	0.00244	0.00071	0.0095

ETW model to study cavern

Cavern influences the flow irregularly depending on inclination angle

ETW. Thanks to J, Quest

# Influence of cavern between sting and model
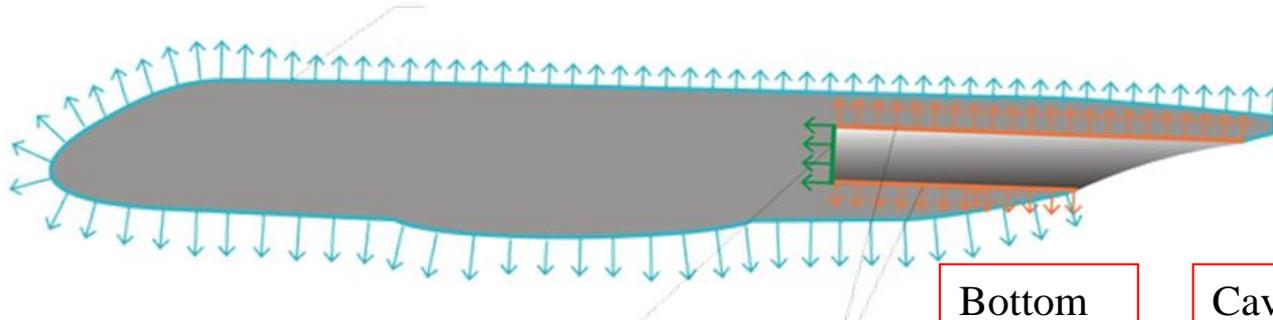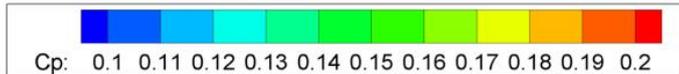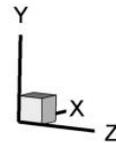
Bottom | Cavern

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0.88	-1.25	0.00253	0.00009	0.0099
0.88	2.50	0.00244	0.00071	0.0095

Model - peniche cavern influence on full-scale WT results
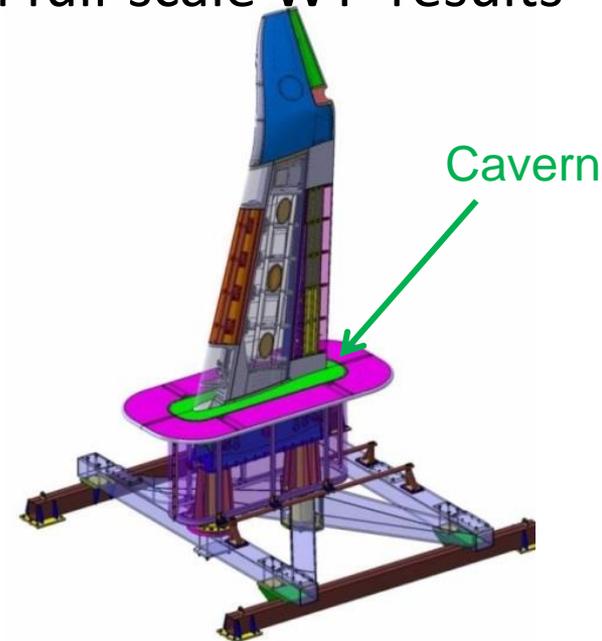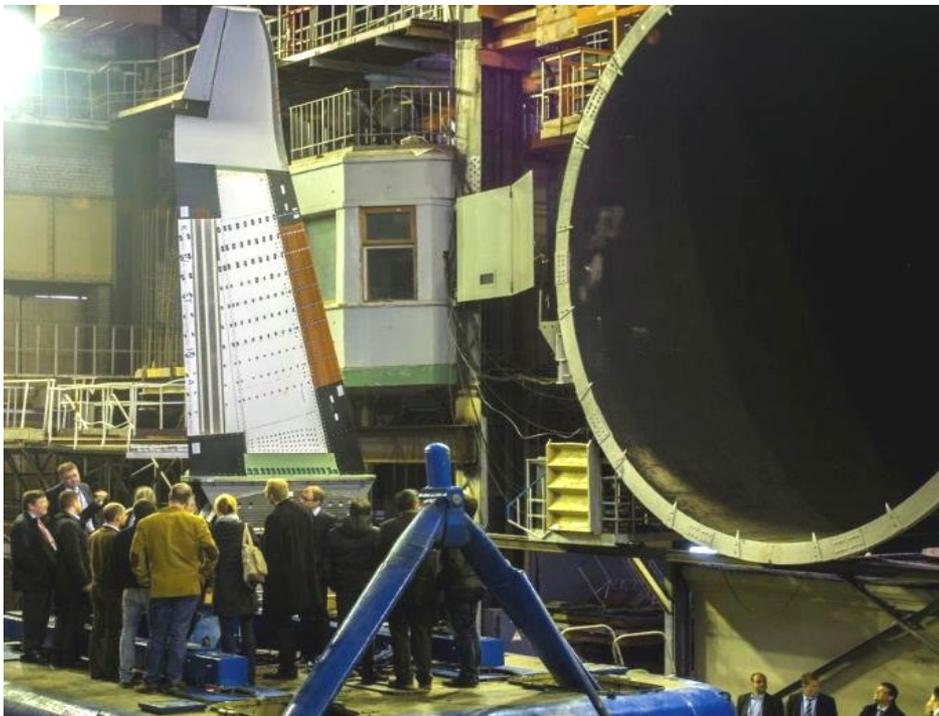
Cavern

Testbed for testing the full-scale wing part in T-104 (TsAGI), Project 7 «SARISTU»

- TsAGI CFD free
- TsAGI CFD in WT
- ▲ Test without corrections
- ■ Test with correction

Cl

0.2

AOA

-6   -1   4   9
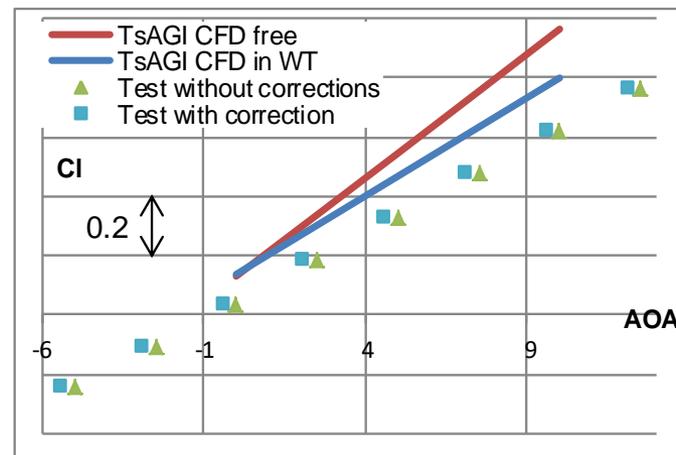
Thanks to SARISTU and   A. Lysenkov (TsAGI)

Road map

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- **Stall**

- Deformation

- Range

Re impact on stall. Large scale wind tunnel

"Large Scale" T-101 TsAGI (24x14 м)
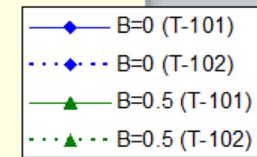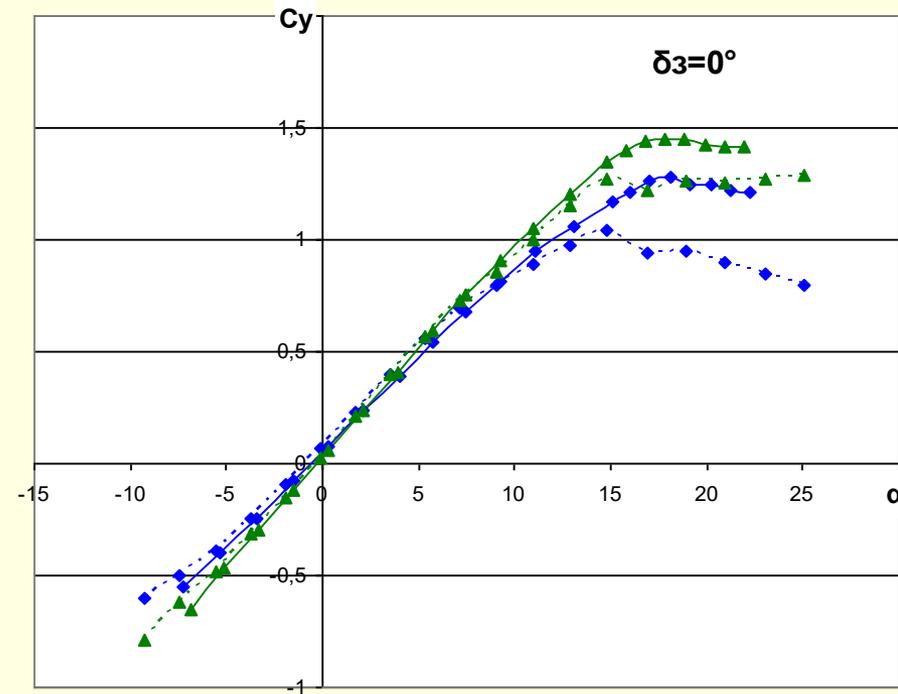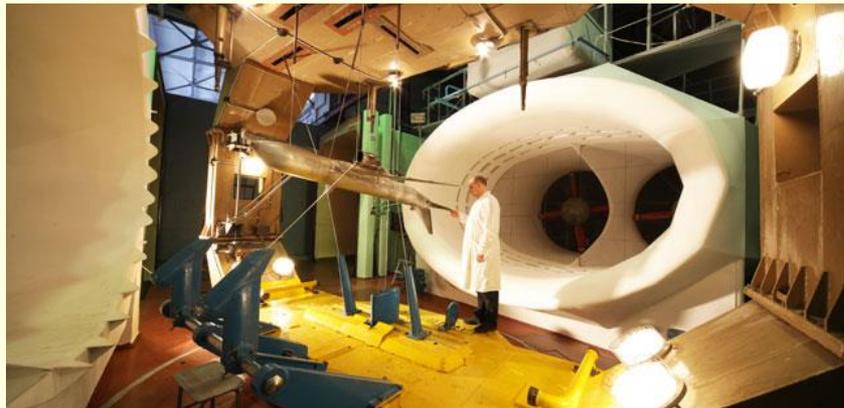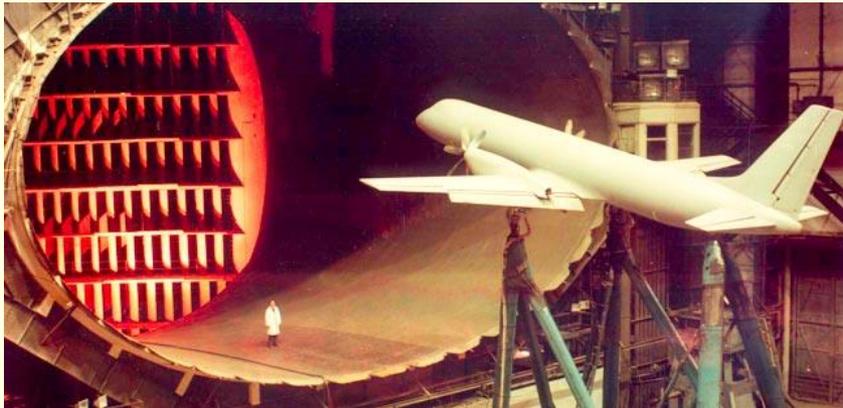

"Low scale" T-102 TsAGI (4x2,33 м)

Thanks to A. Petrov TsAGI

δз=0°

Cy

- B=0 (T-101)
- B=0 (T-102)
- B=0.5 (T-101)
- B=0.5 (T-102)

WT walls impact on stall. High lift model
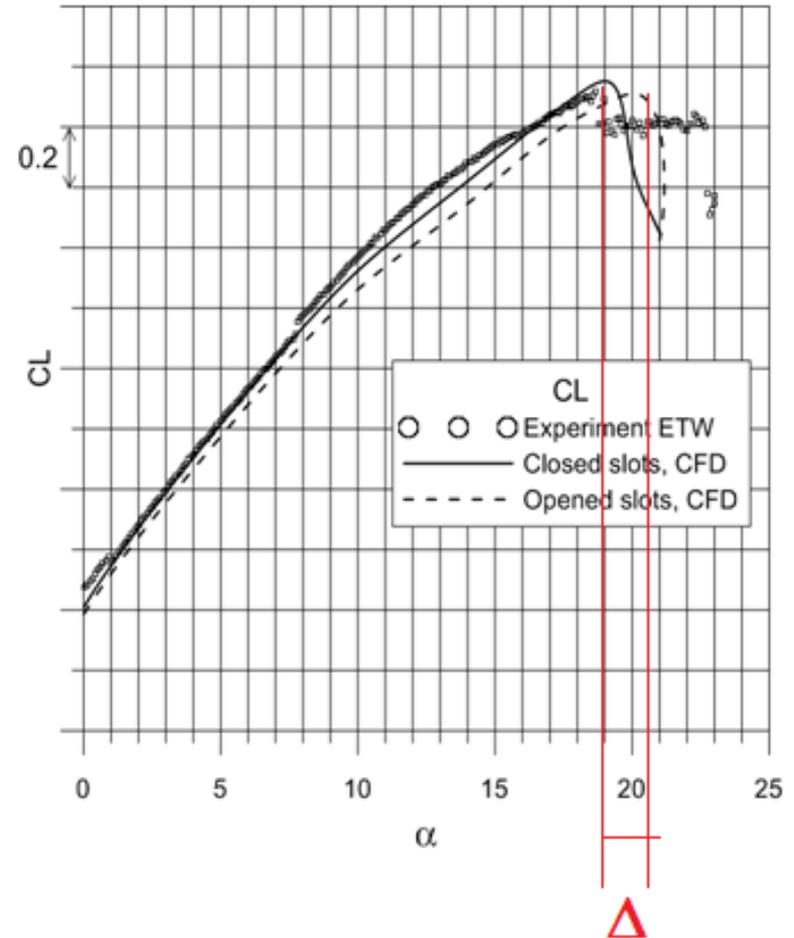

Thanks to DeSiReH

Two sources of HLW-2 misunderstanding
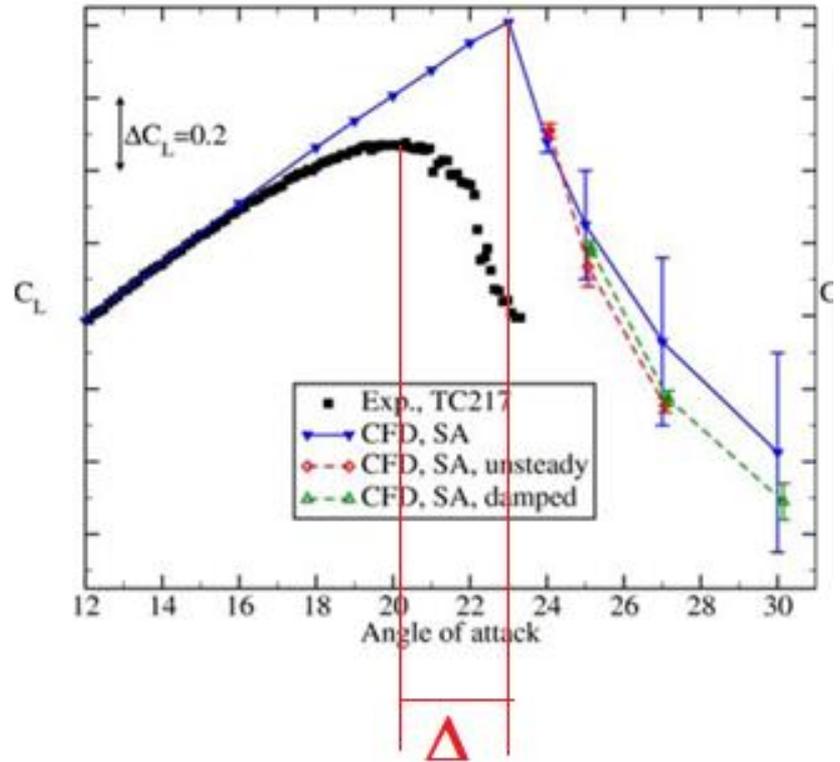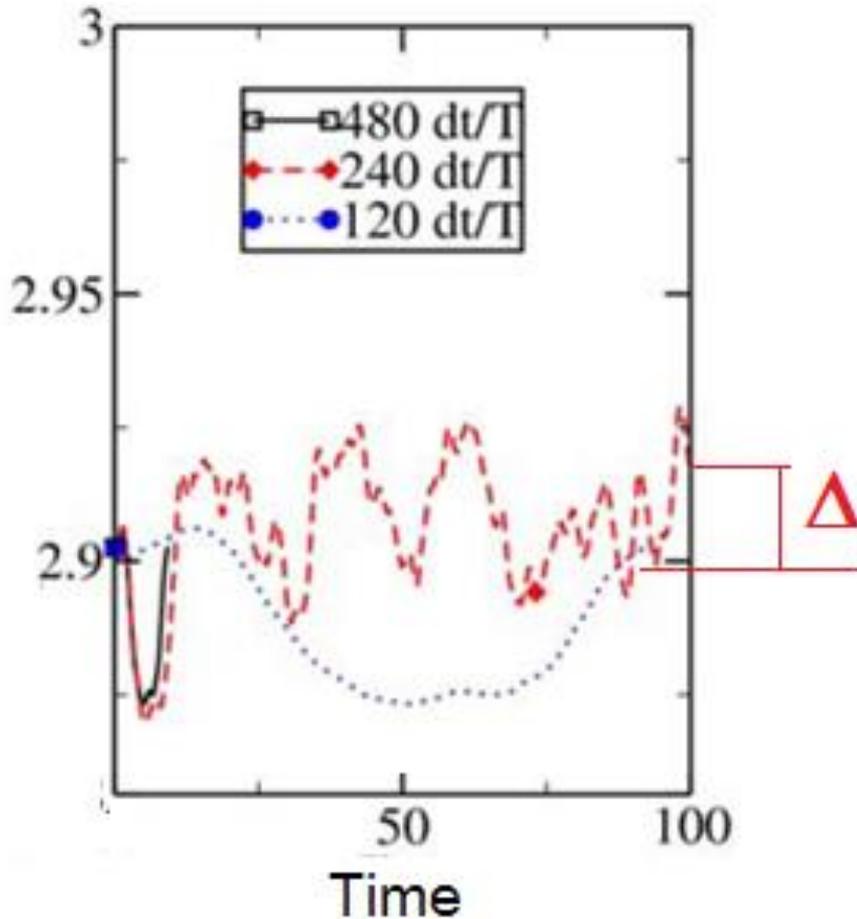
1, Experimental data uncorrect using
2. Time stepping

FOI procedure. Thanks to P, Elliason

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Model deformation
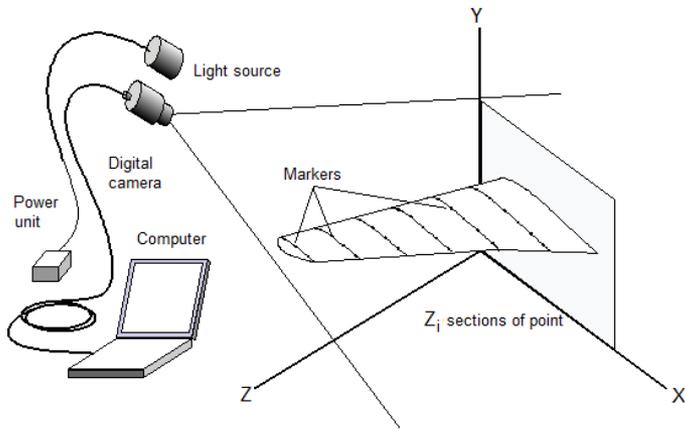
Thanks to ESWIRP
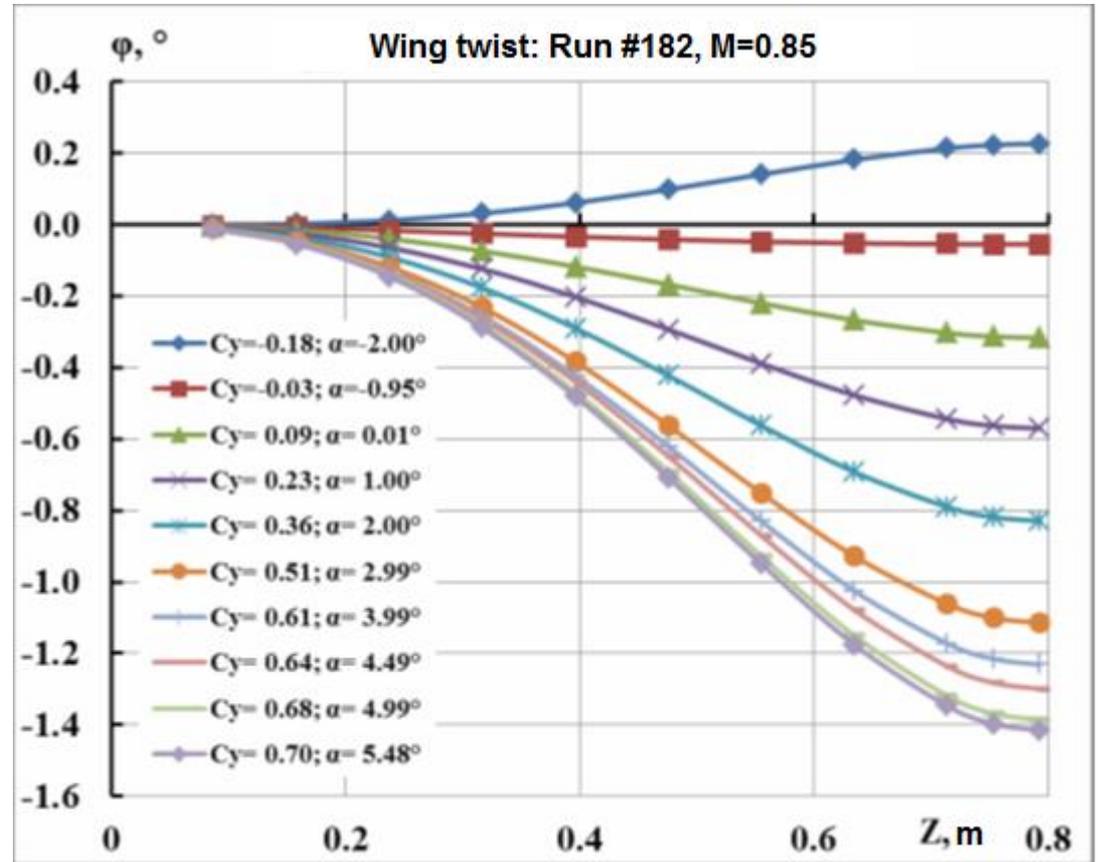
Model deformation as Re function

Dynamic pressure/Junge module = const (Red & Blue)

bend

span

Re = 5 MiO
Re = 19.8 MiO
Re = 30 MiO

twist

span
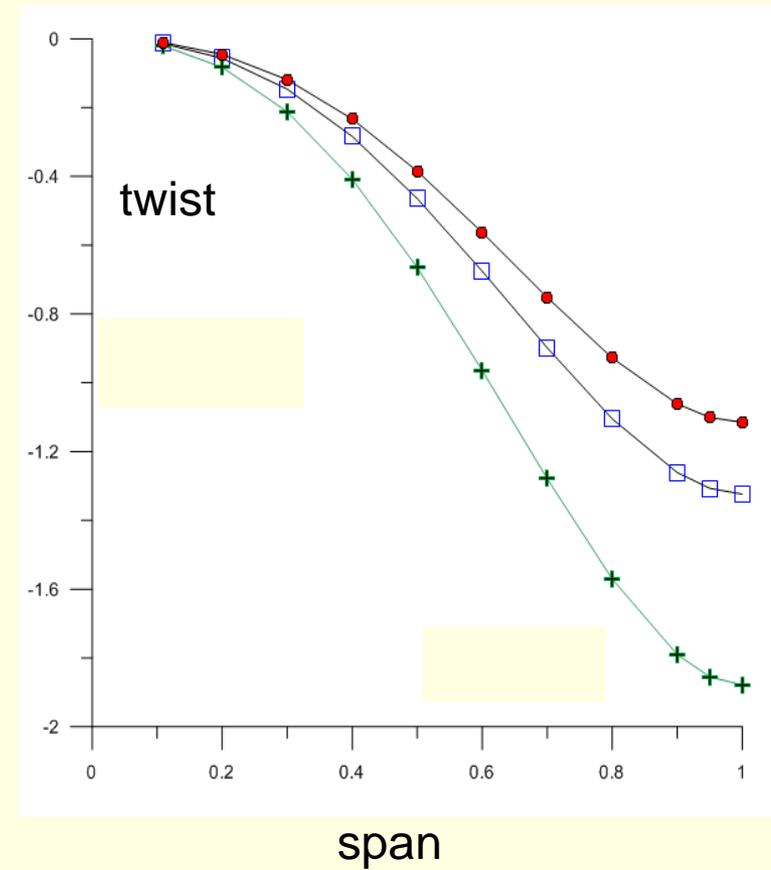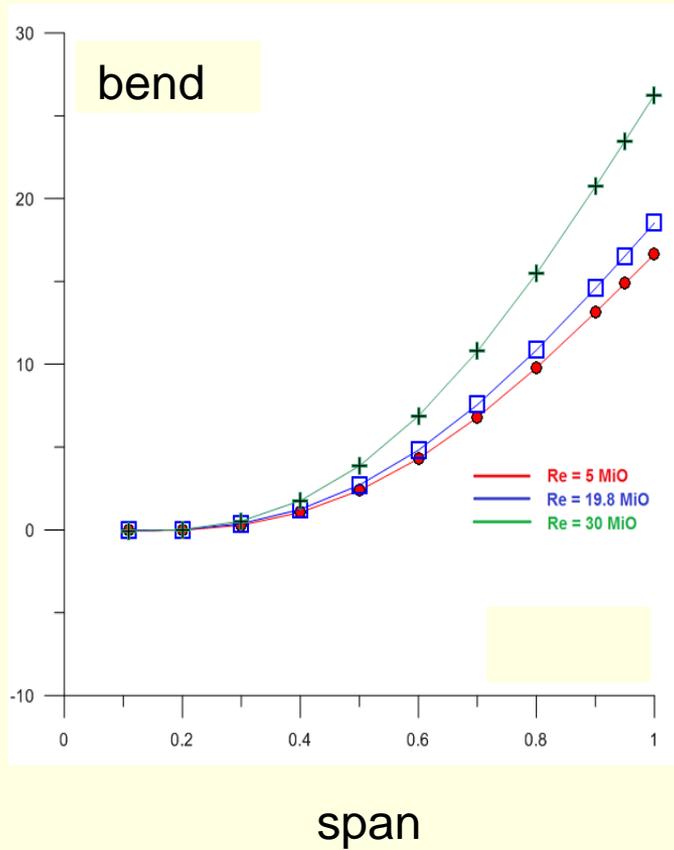
Thanks to ESWIRP

Non-linear effects. Re number
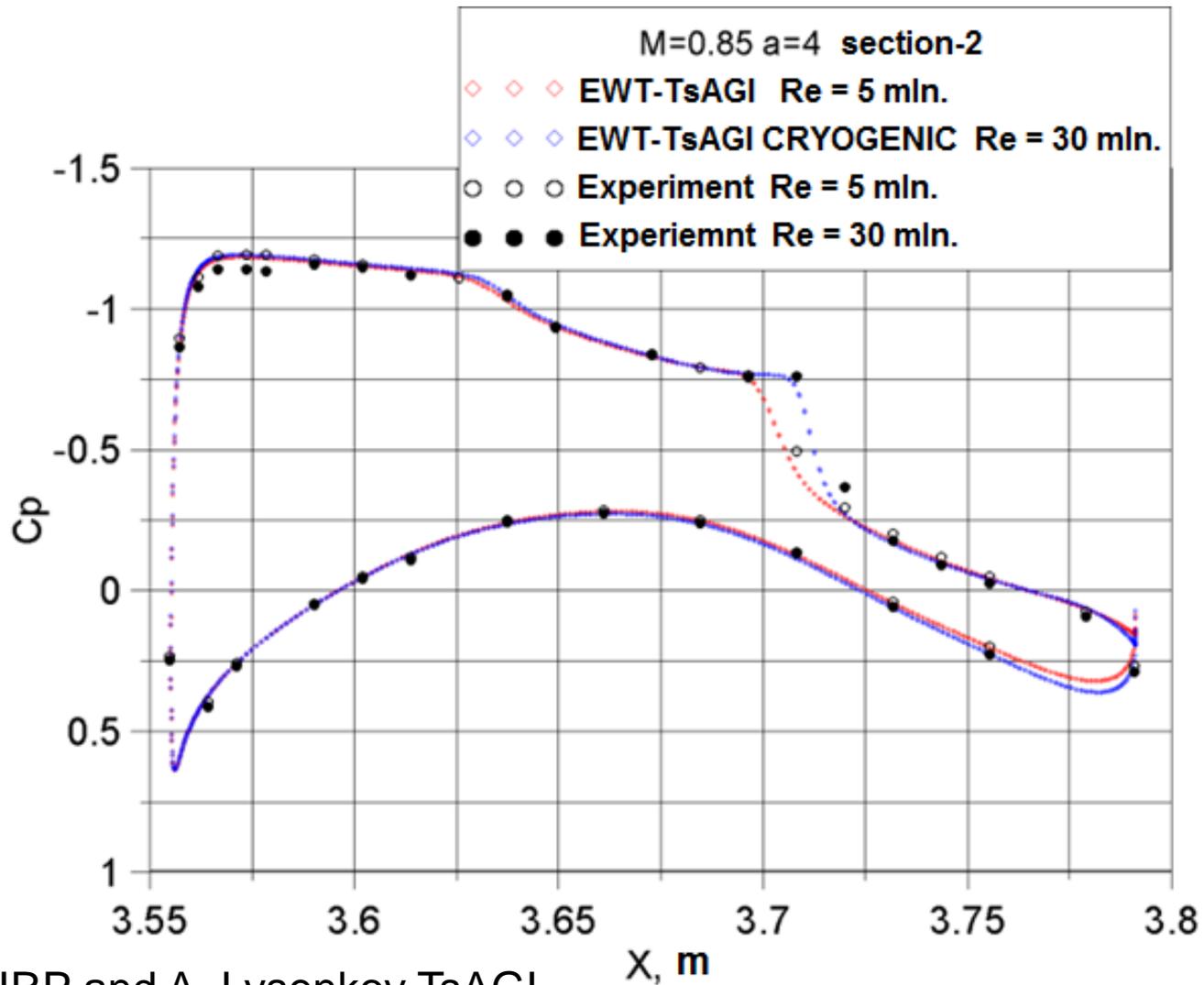
Thanks to ESWIRP and A. Lysenkov TsAGI

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Range is essential part of validation

Scientific grade – wide
Industrial grade - narrow
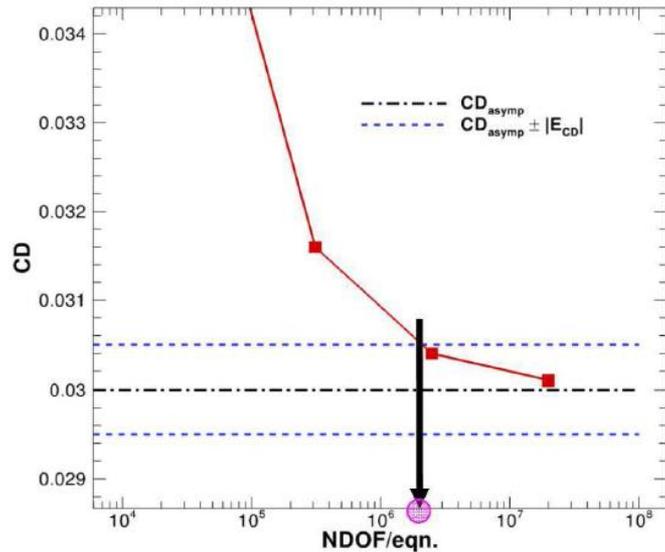
1) Richardson's extrapolation
2) Expert evaluation of the main errors
3) Estimation of error influence on result
4) Range is weight averaged error

Proposed by CASSIDIAN
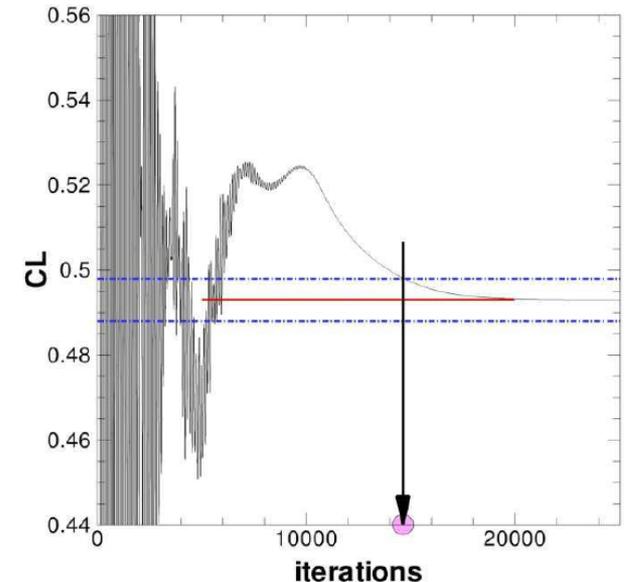
# Euro Test Case Cruiser Configuration
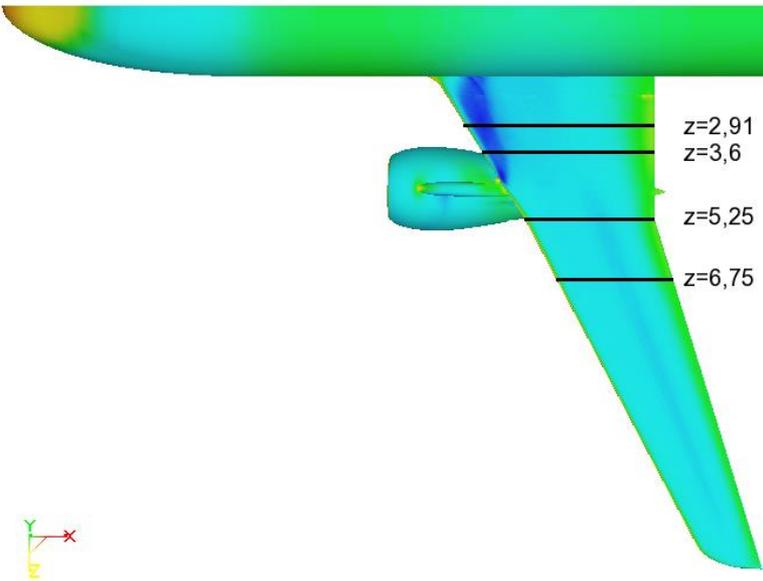
M=0,7795

$\alpha = 2{,}2942°$

$\Delta Cp \sim 0{,}03$
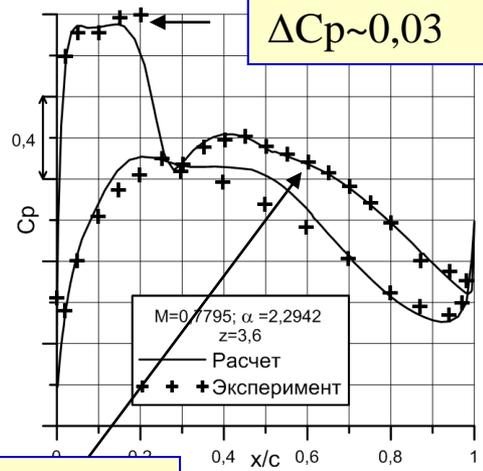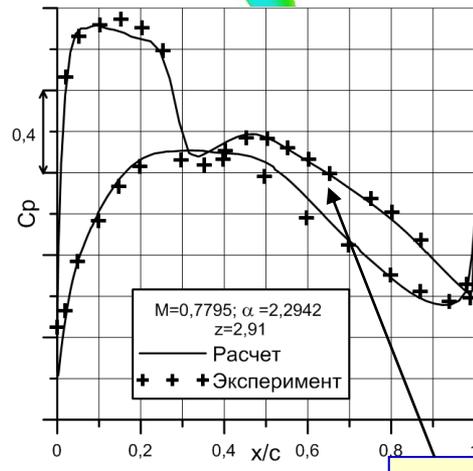
$\Delta Cp \sim 0{,}01$
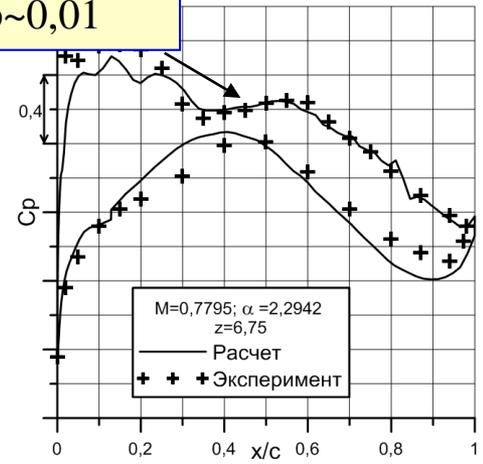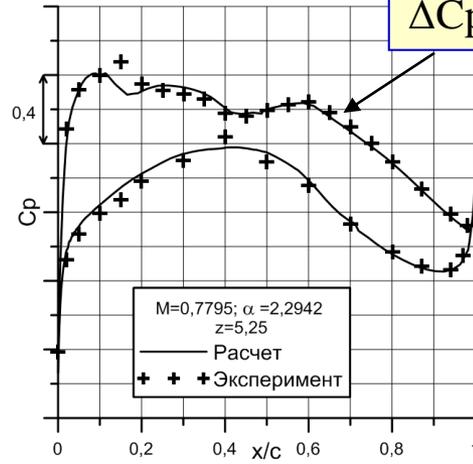
Quality of results are inside of Technical Requirements

EWT – TsAGI official software

<Bosnyakov S., et al, Notes about accuracy of experimental data for numerical methods validation >
CEAA2016, 19-24 September 2016, Svetlogorsk

Proposed range for CRM
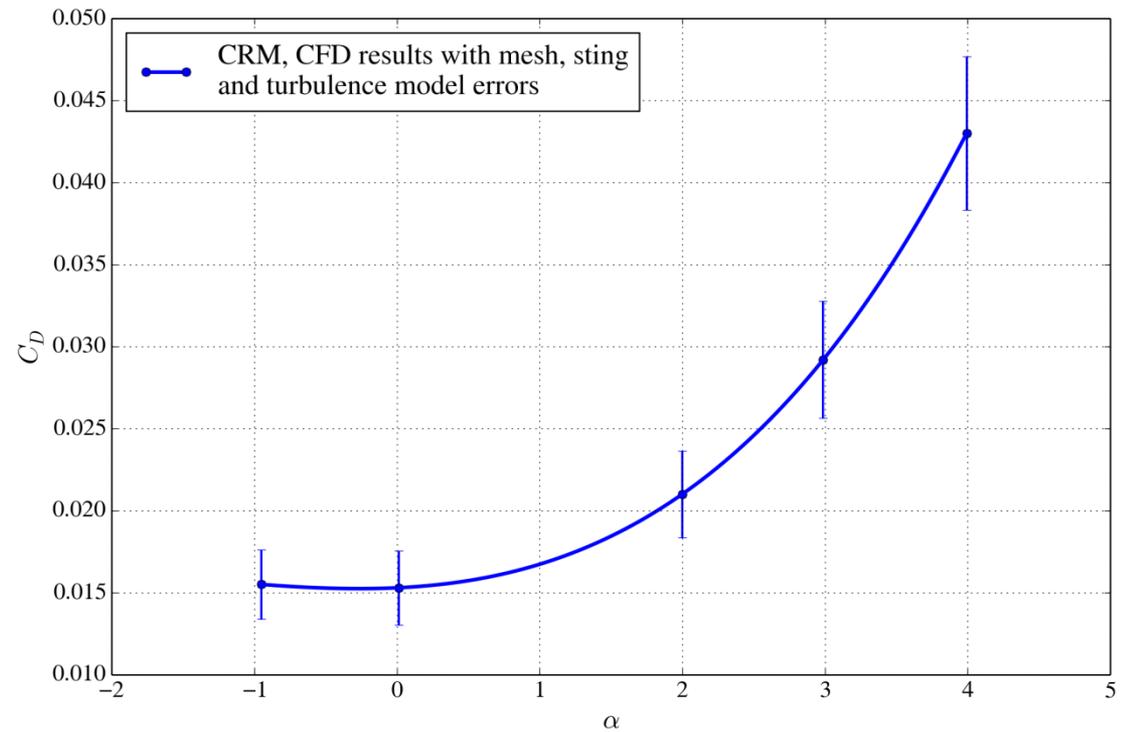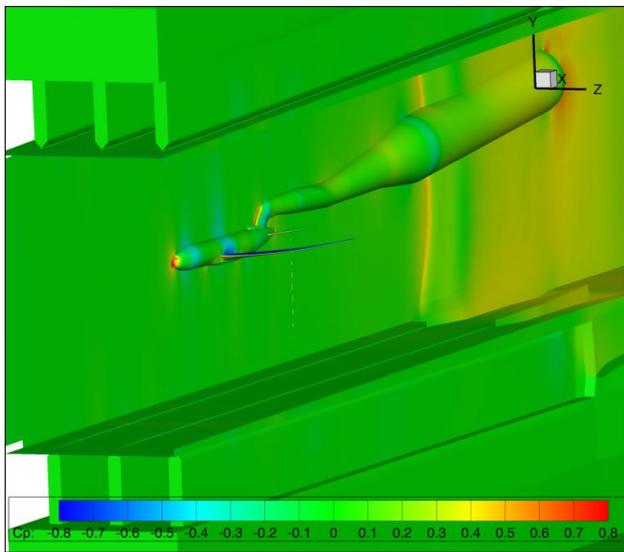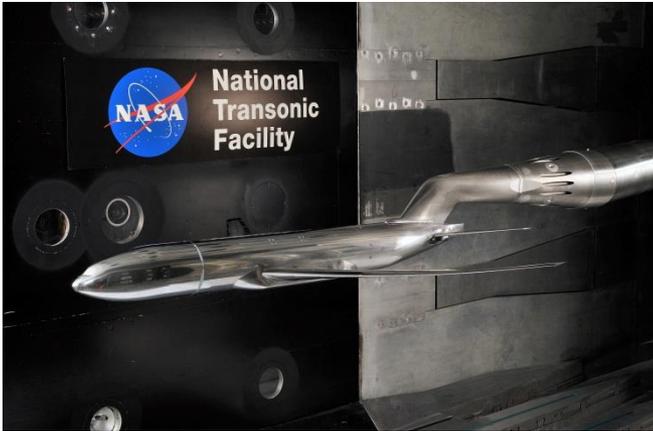
EWT – TsAGI official software

Questions?