



e-Flight-Forum

未来已经开始

2017国际电动航空论坛（北京）



分布式电推进翼身融合布局缩比验证机飞行控制

**Control of an Electric Distributive Propulsion Subscale
Blended Wing Body Demonstrator**

张曙光

Prof Dr ZHANG Shuguang



北京航空航天大学
BEIHANG UNIVERSITY

Outline

- **Motivation**
- **BUAA family of HWB testbeds (BHWB)**
- **Emphasis on flight control**
- **Conclusions**

Green aviation strategy

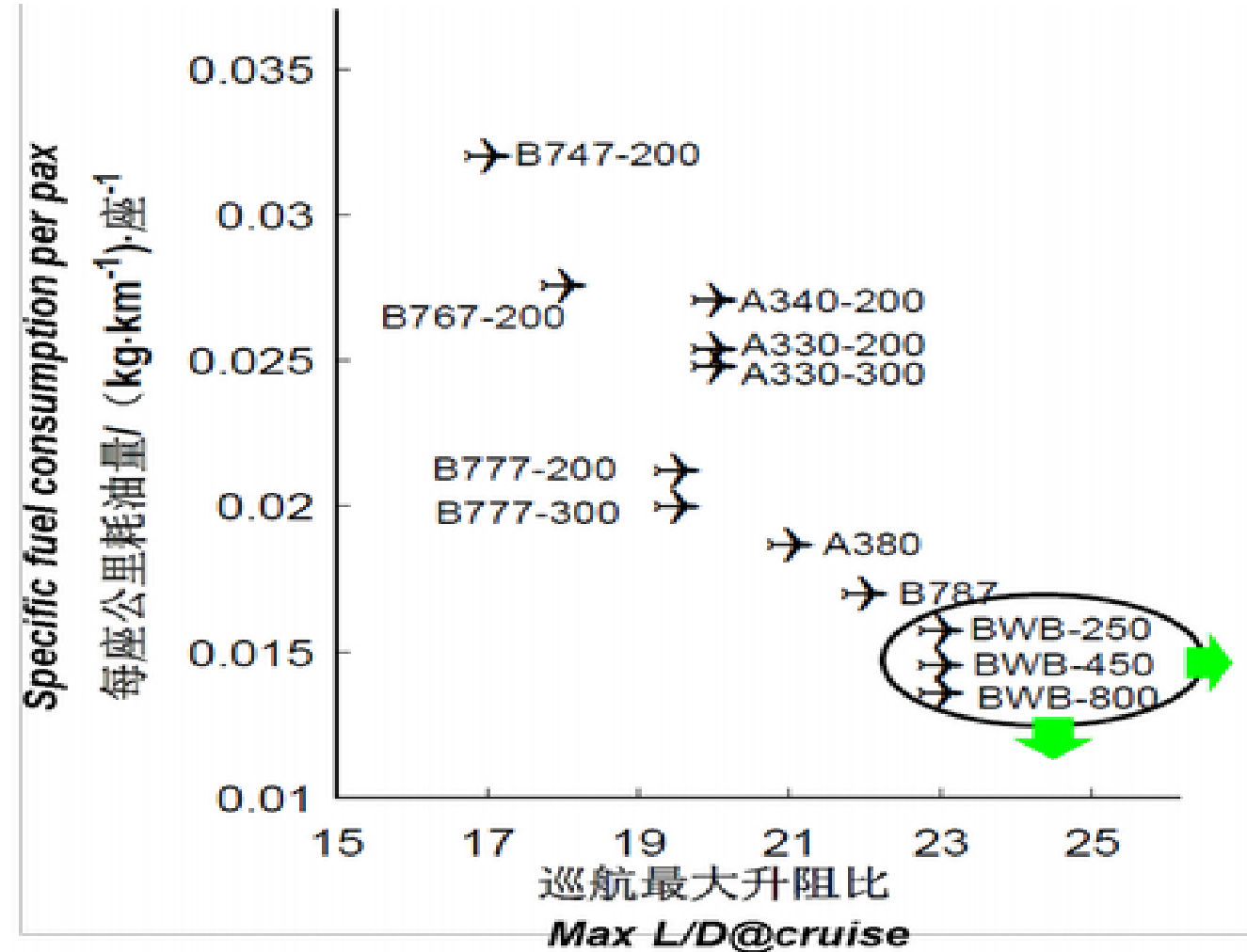
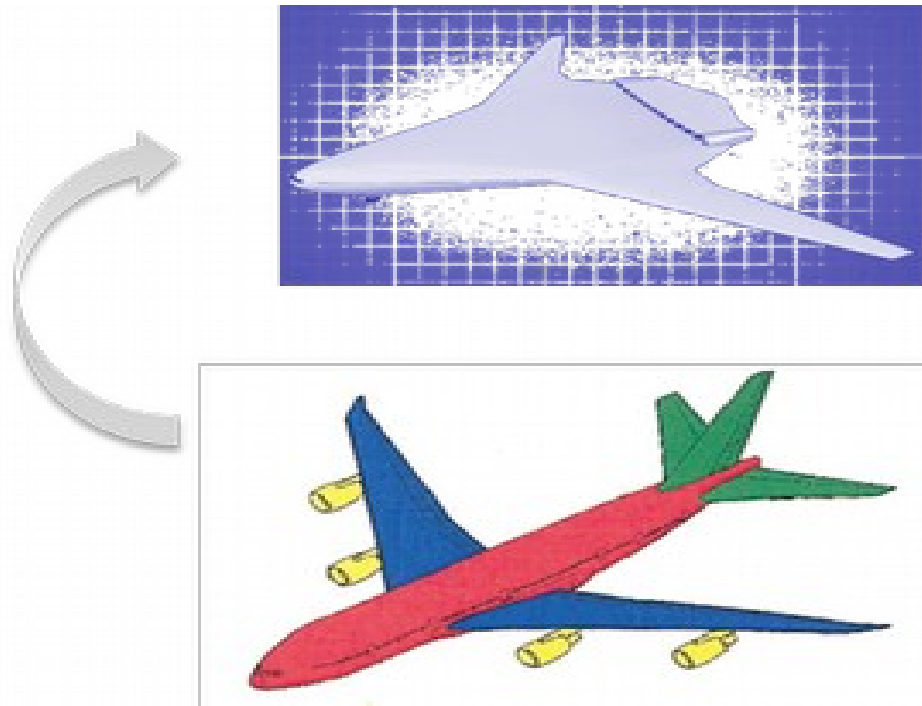
- Technology
- Aircraft Operation
- Infrastructure
- US: NextGen
- Europe: Sesar



Accra Climate Change Talks 2008

Claimed benefit from BWB

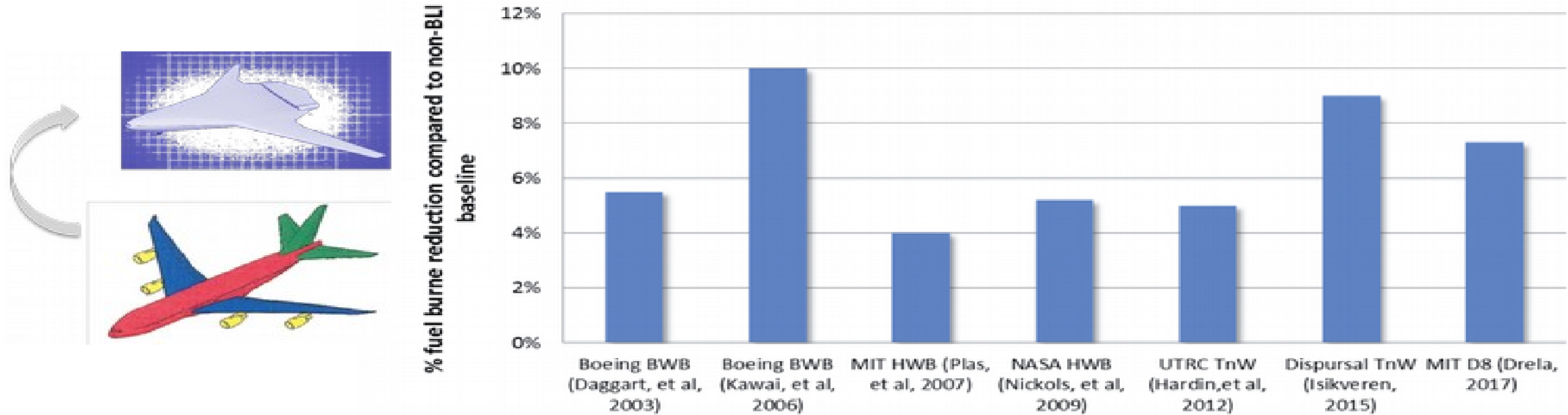
→ 从机身 - 机体分离到耦合



延伸阅读：赵志高，张曙光．BWB 客机经济性相关设计参数的影响分析．北京航空航天大学学报，2011，37(8)

Claimed benefit from BLI

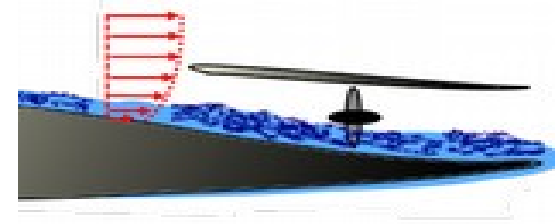
→ 从飞机 - 发动机分离到气动耦合



A. Turnbull, et. al, "Modeling Boundary Layer Ingestion at the Conceptual Level" ISABE-2017-22700

Challenges

- ➔ BLI benefit vs. inlet flow distortion loss
- ➔ BLI benefit vs. weight penalty from electric power distribution and transmission
- ➔ Electric power generation with high efficiency and high density
- ➔ Flight control of coupling configuration
 - Relaxed stability in pitch and yaw axes
 - Large pitch control force
 - Coordination of multi control effectors
 - Less effective yaw control without regular rudders
 - Integrated flight / propulsion control with distributive propulsion system



BHWB family of testbeds



Emphasis on flight control

- *Compensation on takeoff / landing pull-up plunging*
- *Lateral oscillation compensation*
- *Spin protection*
- *Avoidance of high speed heavy landing*
- *Compensation on asymmetric thrust*
- *Flight path optimization and energy management*

Adverse / hazardous scenarios



Lateral oscillation and pull-up plunging

Wing drop into spin

Bump in landing



Conclusions

- *In order to meet the requirements on future green aircraft in terms of emission, the concept of distributive propulsion blended wing body is potentially beneficial.*
- *The optimization of the coupling configuration is basically multidisciplinary and hence challenging.*
- *Recent progress on the BLI benefit exploration and inlet flow distortion loss suppression looks to be positive.*
- *With clearance of difficulties expected or encountered, ever more confidence is built on its control.*

Conclusions



