

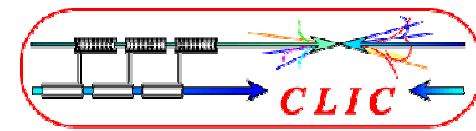
Cost-related issues

Philippe Lebrun

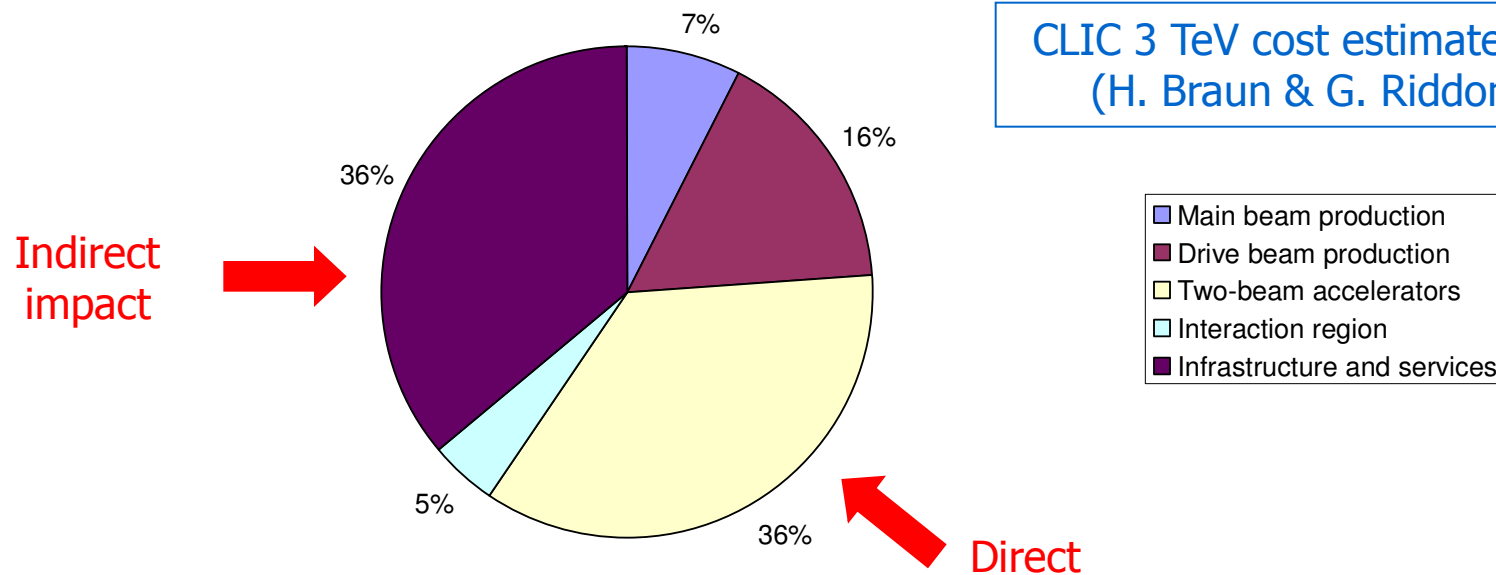
CLIC Two-Beam Module Review
15-16 September 2009



A major cost driver

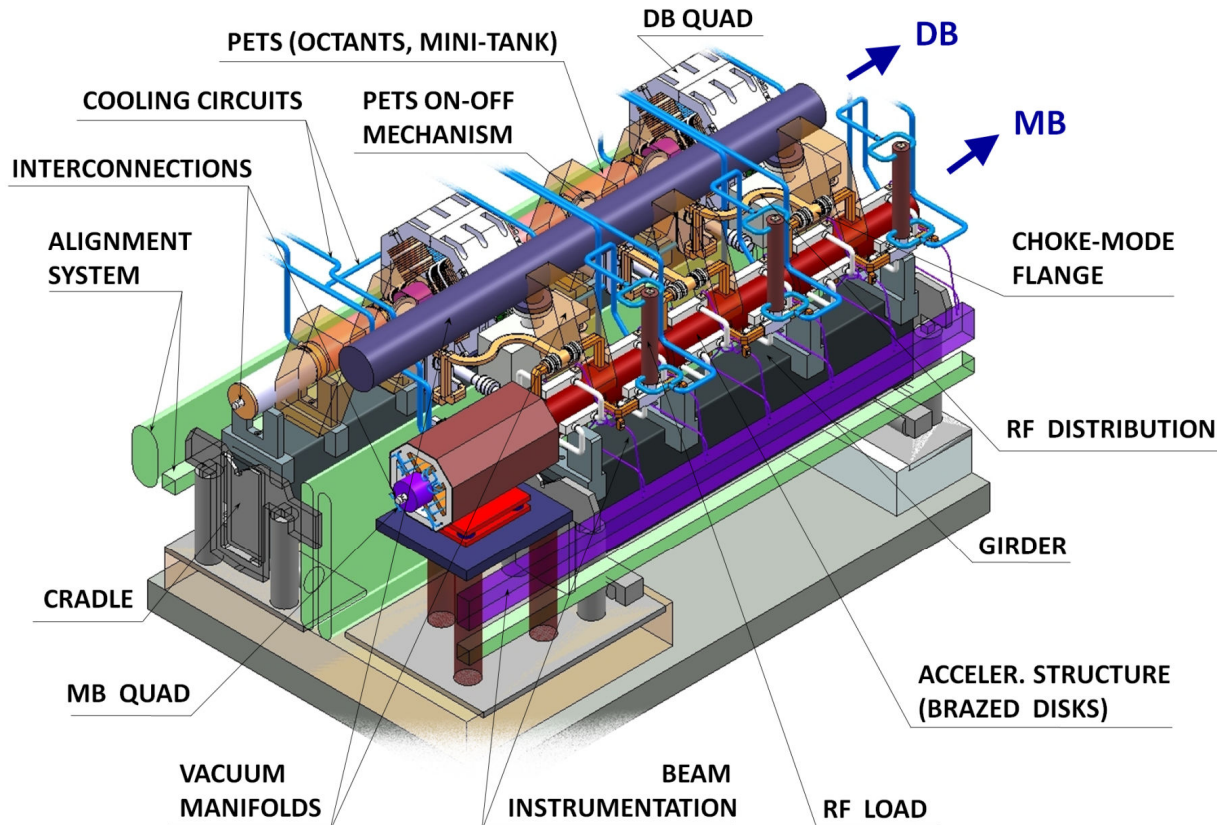
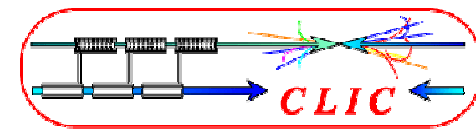


- Two-Beam Modules account for a large fraction of CLIC cost
 - Amount to $\sim 36\%$ direct capital cost
 - Impact on other capital (tunnel, infrastructure, services) and operation (electricity, cooling, maintenance) costs





Complexity, number, integration



CLIC 3 TeV

Modules: 10462

Accelerating str.: 71406 PETS: 35703
MB quadrupoles: 1996 DB quadrupoles: 20924

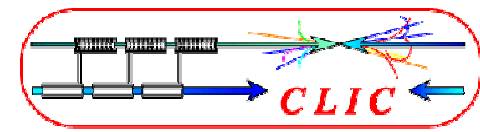
CLIC 500 GeV

Modules: 2124

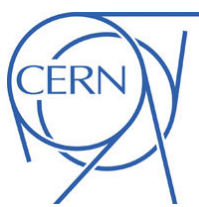
Accelerating str.: 13156 PETS: 6578
MB quadrupoles: 929 DB quadrupoles: 4248



Update of TBM cost estimate



- Analytical cost estimate being reviewed/updated, to be presented at C&S WG of 26 October 2009
- Main difficulties
 - Configuration not entirely settled
 - Non-standard, non off-the-shelf components
 - Open issues in manufacturing techniques
 - Learning curves for very large-series accelerator components (> 1 order of magnitude above LHC)



Cost of large-series components strongly affected by learning curve

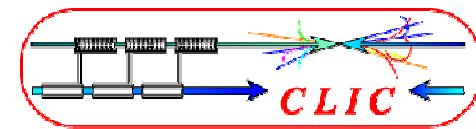
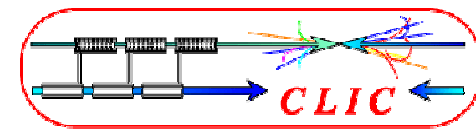


TABLE IV
LEARNING PERCENTAGE OF SELECTED REFERENCE INDUSTRIES

Industry	ρ
Complex machine tools for new models	75%-85%
Repetitive electrical operations	75%-85%
LHC magnets	80%-85%
Shipbuilding	80%-85%
Aerospace	85%
Purchased Parts	85%-88%
Repetitive welding operations	90%
Repetitive electronics manufacturing	90%-95%
Repetitive machining or punch-press operations	90%-95%
Raw materials	93%-96%
CLIC Two-Beam Modules	?



Open issues on TBM direct costs



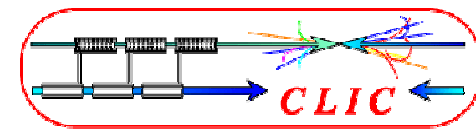
- Accelerating structures
 - Material, precision, manufacturability, production yield
 - Very large number
 - Quadrant versus stacked discs (*H*)
 - Vacuum tank vs. sealed (*M*)
- PETS
 - Very large number
 - On-off mechanism (*M*)
- Quadrupoles
 - Very large number
 - Power dissipation (capital vs operation)

Cost impact

- *H* : high, order (BCHF)
- *M* : medium, order (100 MCHF)
- *L* : low, order (10 MCHF)



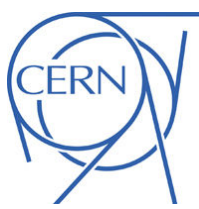
Open issues on TBM direct costs



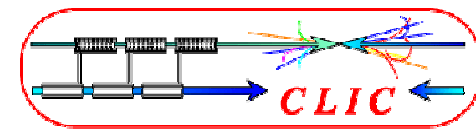
- Active alignment system
 - Very large number
 - Common girder would reduce number (*M*)
- Stabilization system
 - Very large number
 - No large-scale industrial experience (*M*)
- Instrumentation
 - Very large number
 - Novel instruments
 - Standardize electronics (*M*)

Cost impact

- *H* : high, order (BCHF)
- *M* : medium, order (100 MCHF)
- *L* : low, order (10 MCHF)



Open issues on TBM indirect costs



- Power dissipation in air
 - Ventilation scheme (*M*)
 - Tunnel transverse cross-section (*M*)
 - Sector length
- Overall power consumption
 - Capital & operating costs

Cost impact

- *H* : high, order (BCHF)
- *M* : medium, order (100 MCHF)
- *L* : low, order (10 MCHF)