

Costing Workshop Summary

Chris Rogers, RAL, 30 Mar 2010



- Establish a common framework for costing of neutrino facilities
 - Compare Beta Beam, Super beam and Neutrino Factory on an equal footing
 - In context of EuroNu – EU “funded” neutrino facility study
- Well attended by European Neutrino facility community
 - 30 registrants, mostly work package managers etc
 - (But all projects have more managers than workers it seems)
- Discussion:
 - How is project costing done in general
 - What goes in the costing – and what is excluded
 - Practicalities – which site, which currency, etc
 - Who has responsibility for which bit (e.g. detectors, proton driver)
 - Costing Tools
 - Case Studies/EuroNu cost status
- Some things loosely decided, TBD by costing subcommittee
 - First iteration – another workshop in November/December
- Disclaimer: my own personal view

Project Costing in General

- Basic approach:
 - Split project into portions (Project Breakdown Structure) and cost portions based on parameter fit to historical data
 - Iterate at successively higher levels of detail until you run out of time or you are getting quotes from manufacturers
- E.g. for a house,
 - First costing based on number of floors, area, ground conditions
 - Second costing based on cost of each bathroom, kitchen, etc
 - And so on
- For comparison with historical data
 - Use scale factor for relative costs between different countries
 - Currencies and economic factors (plumbers in UK are expensive)
 - Use scale factor for different years
 - Inflation and economic factors
 - Published tables e.g. costdataonline.com
- I expect we can't make a useful costing unless we at least break down to level of individual magnets, cavities, power supplies

More on Project Costing

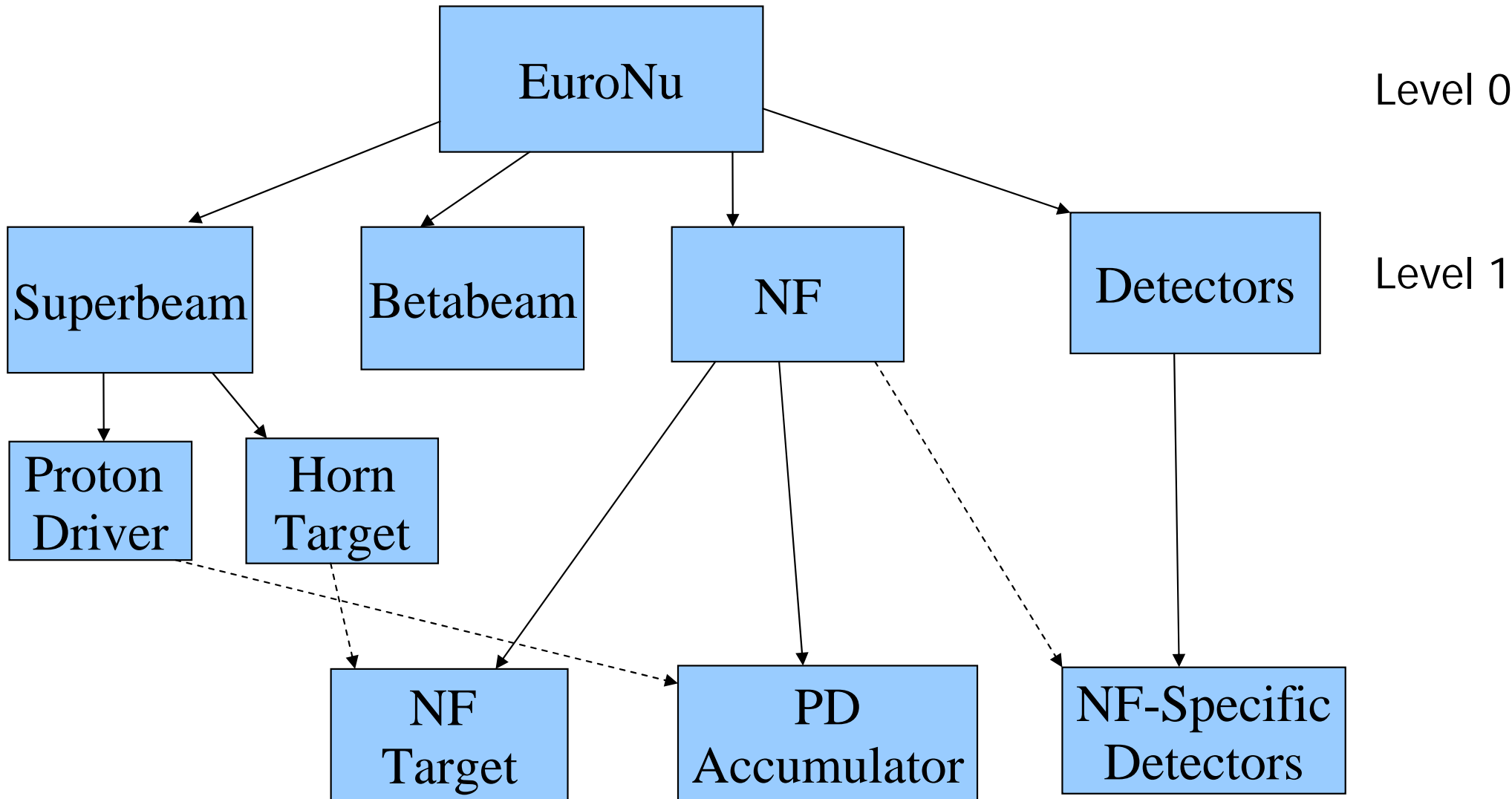
- Need to enumerate risks
 - Expensive, high-risk items are bad
- Include cheapest solution as baseline
 - If risk mitigation is needed, include it as a (costed) alternative
- Cite sources for costings
- Cost at <today's date> in <project currency>
- Include non-financial criteria
 - Location, eco-impact, etc

Practicalities

- Discussed site independent cost with site-dependent terms added
 - Sounds difficult/impossible
- Suggestion of study at CERN (EuroNu context)
 - Do we do a study for CERN and a study for e.g. Fermilab?
 - We need to put everything in tunnels
 - Is this necessary anyway? Muons loose about 0.5 GeV/m in concrete, => 5 GeV muons need about 10 m shielding
 - Depending on pessimism of safety guys
 - Relies on engineering, civil engineering support from CERN
- Presumably costs in Euros or Swiss Francs (TBD)
- R&D to be costed but not included in the final total
- Include maintenance, operation, dismantling
- Manpower estimate included as FTE

Division of work


- Interface between overlapping work packages not entirely clear
 - Most Work Packages are not shown!



Costing Tool

- Costing tool to handle some bureaucracy
 - I couldn't find a URL – so haven't looked at it directly
 - Actively supported by CERN
 - And they have promised to support us also
 - Used for CLIC – they are keen for more users
 - About 1-2 years old
- Keeps a list of Project Breakdown Structure
 - Version control
 - Handles currency conversion, Economic factors conversion, etc
 - Various reporting tools
 - Export to excel, etc
- It does not tell you the cost of an RF cavity, magnet, etc
 - AFAIK

Costing Tool



Costing Tool v 0.4

Open PBS | Save | Cancel | Crosstab Report | Activity Logs Report | Use estimates from: Highest level possible | Lookup

PBS 3TeV 2007

Name

- ✖ CLIC
 - ▶ 1. Main Beam Production
 - ▶ 2. Drive Beam Production
 - ▶ 3. Two-beam accelerator
 - ▶ 3.1. Main linacs
 - ▶ 3.1.1. Two-Beam Modules Type 0 e+
 - ▶ 3.1.1.1. RF System
 - 3.1.1.1.1. Accelerating Structures
 - 3.1.1.1.2. PETS
 - 3.1.1.1.3. Loads - directional couplers
 - 3.1.1.1.4. Waveguides
 - 3.1.1.1.5. Choke mode flanges
 - 3.1.1.1.6. Simplified mode flange
 - 3.1.1.1.7. Front end electronics
 - ✖ 3.1.1.2. n.a.
 - ▶ 3.1.1.3. Vacuum System
 - ✖ 3.1.1.4. Magnet Powering System
 - ▶ 3.1.1.5. Magnet System
 - ▶ 3.1.1.6. Cooling System
 - ▶ 3.1.1.7. Beam Instrumentation System

General | Input estimates

Domain:

Sub-Domain:

System:

Component type:

Component:

Multiplicity:

Expected offers:

Technical uncertainty:

[EDMS Link to element documentation:](#)

Date of the estimate:

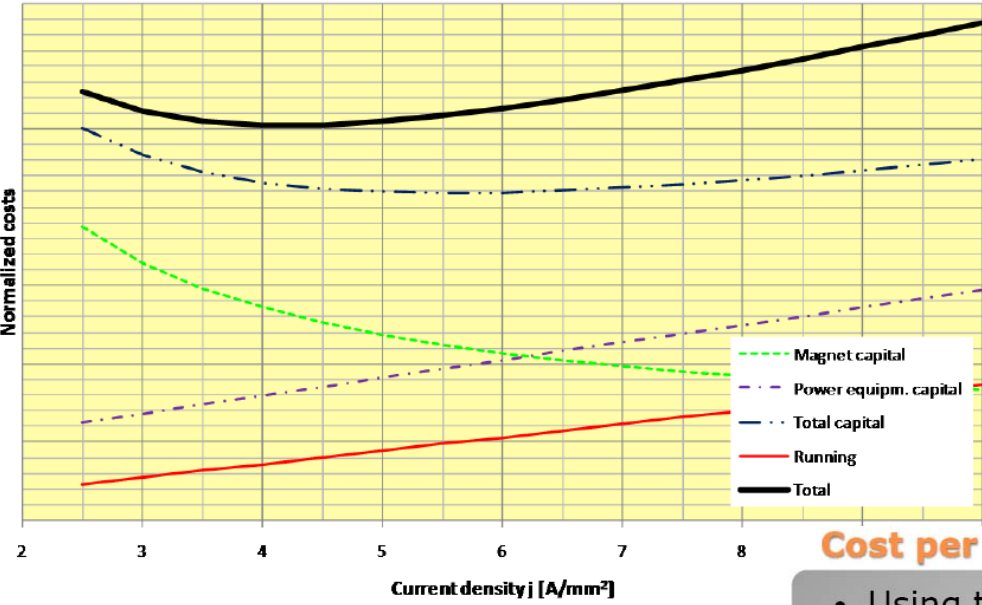
Case Studies

- Summary of case studies
 - Needs contribution from hardware experts involved in design
 - Takes significant resources
 - Needs quite a bit of detail
 - Determine tunnel layout => determine tunnel size => CE cost

- Speaking qualitatively
 - NuFact is most organised, most advanced
 - Technical solutions, lattice design + R&D programmes in place
 - But NuFact has most accelerator subsystems, most work
 - NuFact costing aim:
 - Capital cost, staff effort, timescale
 - Uncertainty, risk analysis
 - Present, and prepare, cost for different funding agencies, etc

| Level 2 | Level 3 |
|---------------------------|---|
| accelerator | proton driver |
| | pion production |
| | proton beam dump |
| | decay region |
| | phase rotation region |
| | bunching region |
| | cooling channel |
| | cooling→linac transfer line |
| | muon linac |
| | linac→RLA 1 transfer line (double chicane 1) |
| | muon RLA 1 |
| | linac→RLA 2 transfer line (double chicane 2) |
| | muon RLA 2 |
| | RLA 2 → FFAG transfer line |
| | muon FFAG |
| FFAG → ring transfer line | |
| muon decay ring | |

E.g. CLIC



Cost per MW

- Using the above model, here's the klystron cost per MW (peak)

E. Jensen

This log-log plot shows the relative cost per MW versus klystron peak power in MW. The x-axis ranges from 1 to 100 MW, and the y-axis ranges from 0.01 to 1 relative cost/MW. Two data series are plotted:

- Blue line (present state of the art):** Shows a decreasing trend from approximately 0.35 at 1 MW to a minimum of about 0.08 at 30 MW, followed by a sharp increase to 1.0 at 100 MW.
- Red line (dedicated 30 MW tube):** Shows a similar trend but with a much lower minimum cost of approximately 0.06 at 30 MW, and a lower cost at 100 MW (around 0.3).

- Blue: present state of the art
- Red: assuming a major investment into the development of a dedicated 30 MW tube