# TILC08 仙台GDE会議
# WG-1 活動報告

GDE活動報告会

３月１１日１０：００-

３号館７階会議室

設楽

http://ilcagenda.linearcollider.org/conferenceOtherViews.py?view=standard&confId=2432
参照のこと

# WG1: Cost Reduction Studies

Reported by J. Carwardine, T. Shidara, N. Walker

- We must reduce the cost– 20% i.e. 1.3 BILCU. (in view of construction & operation)
- Targets
  - **Staging / Scope**
  - **Main Linac Technology**
  - **CFS -- Scope of halls, caverns, shafts, etc.**
  - **Two vs one tunnel, and Shallow vs deep sites**
- Premise for WG-1
  - **Invite new ideas, provide a forum for open discussion.**
    - RDR is technically sound but not optimised for cost.
  - **No changes in scientific scope without engaging the physics community.**
    - WG-1 is not a decision-making group.
- Began sessions with >100 suggestions
  - **that came from a call for cost reduction ideas.**
  - **Small sub-groups selected their 'top-10's.**
- Specific topics highlighted

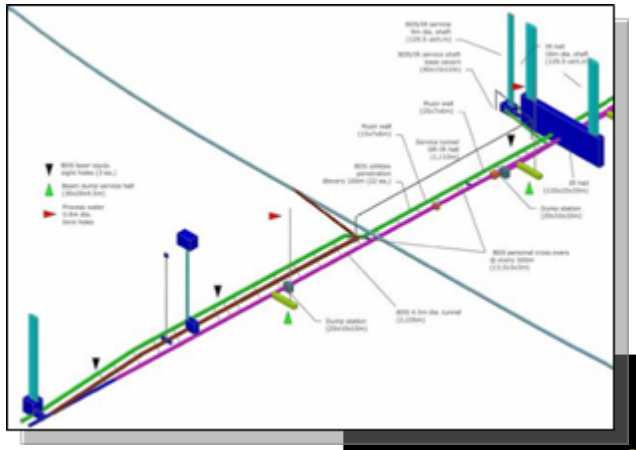
1. Civil/siting: major theme of Dubna GDE meeting
2. Positron source integration study.
3. Technical systems impact of high cooling delta T.
4. Magnet power supply stringing and space utilization.

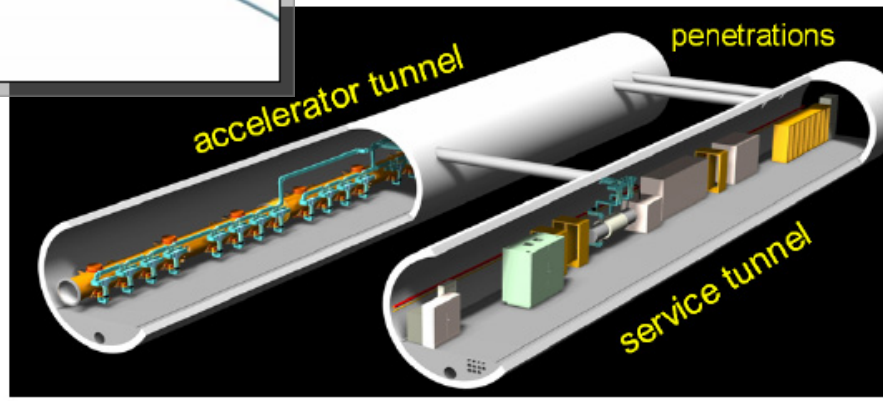
- **Aim to have initial assessments on key items by the Dubna meeting**

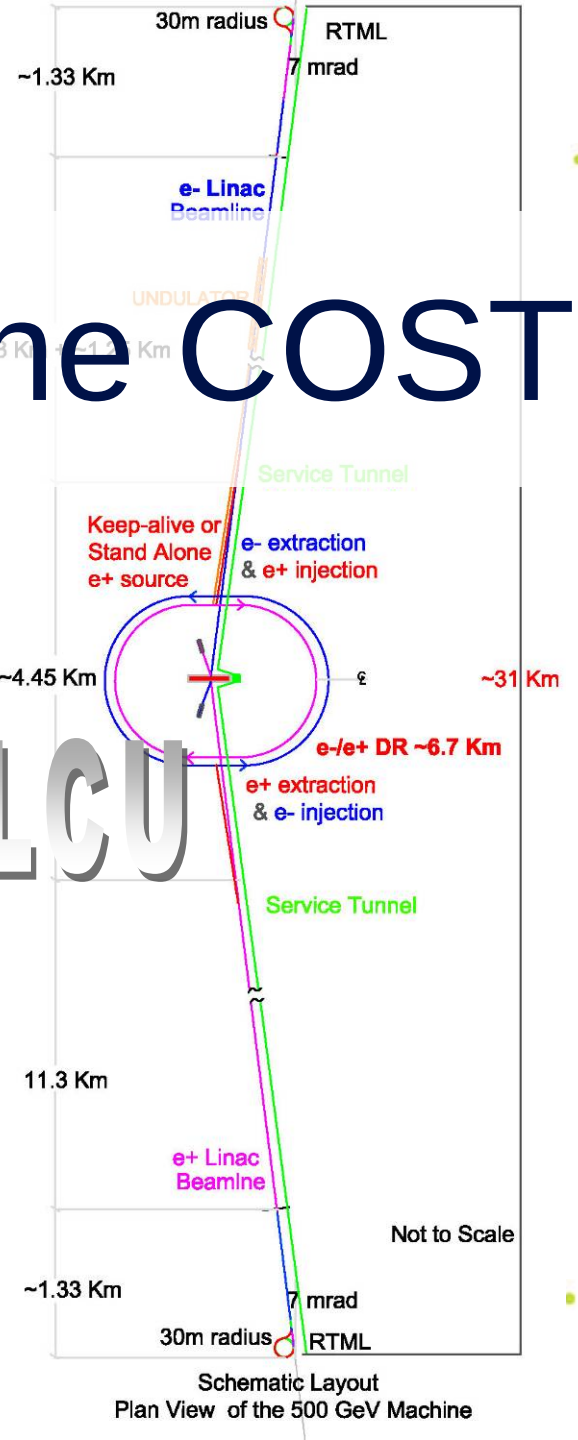
# WG-1: Cost Reduction Studies

J. Carwardine, T. Shidara, N. Walker
(For WG-1 participants)

# Reducing the COST






6.7 Billion ILCU

# TILC – Working Groups

- WG-1 Cost Reduction Studies

**APPROACH**

- **Review and evaluate RDR design**
- **Re-visit (Caltech) cost reduction lists**
- **Brainstorming**

**SPECIFIC TARGETS (Cost Drivers)**

- **Staging? / Scope?**
- **Main Linac Technology**
- **CFS -- Scope of halls, caverns, shafts, etc. Two vs One tunnel. Shallow vs Deep sites**

**GOALS**

- **Sendai – establish cost reduction goals**

**NOTE**

- **NO CHANGES OF PHYSICS SCOPE WITHOUT ENGAGING EXPERIMENTAL COMMUNITY**

B. Barish

# Cost Containment / Reduction

- Stated **Priority TD Phase Goal**

- Primary focus: CFS via
  - **Better-defined requirements**
    - From Accelerator Designers
    - From Technical System engineers
  - **VALUE ENGINEERING**

- Basic premise:
  - **RDR design is "sound"**
  - **CFS design is conservative**

Iteration required

- Premise for WG-1
  - **Invite new ideas, provide a forum for open discussion.**
  - **WG-1 is not a decision-making group.**
  - **No changes in scope without engaging the physics community.**

# Cost Reduction is Not Easy!

- Goal: We want to reduce RDR value by 20%
  - **Approx: 1.3 BILCU**
- Easy way:
  - **Reduce length of main linacs by 40% and therefore the $E_{cm}$ to 300 GeV**
- Hard way:
  - **Find 20×1% effects or 40×0.5% effects or 200×0.1% effects**
- The “Hard Way” is clearly more desirable
  - **Every %-level amount will count!**

# WG-1 Schedule

**Tuesday 4/3/2008**

**coveners: Walker, Carwardine, Shidara**

| | | | |
|---|---|---|---|
| 09:00 | 30 | Walker | Possible cost reduction strategies |
| 09:30 | 30 | Raubenheimer | The cost of performance: cost-performance derivatives |
| 10:00 | 30 | Himel | Quantifying the trade-offs |
| *10:30* | *30* | *coffee* | |
| 11:00 | 30 | Garbincius | RDR value breakdown for cost reduction studies |
| 11:30 | 30 | *discussion on afternoon study groups* | |
| *12:00* | | *lunch* | |
| 14:00 through 18:00 | | study group 1,2,3,4. | * **SG-1** Approaches to staging (E. Patterson) |

**Wednesday 5/3/2008**

**coveners: Walker, Carwardine, Shidara**

**ILC-CLIC collaboration: conveners Delahaye, Raubenheimer (WG-1a)**

| | | |
|---|---|---|
| 09:00 | 90 | Discussion on joint studies with CLIC (sources/DR?) |
| *10:30* | *30* | *coffee* |

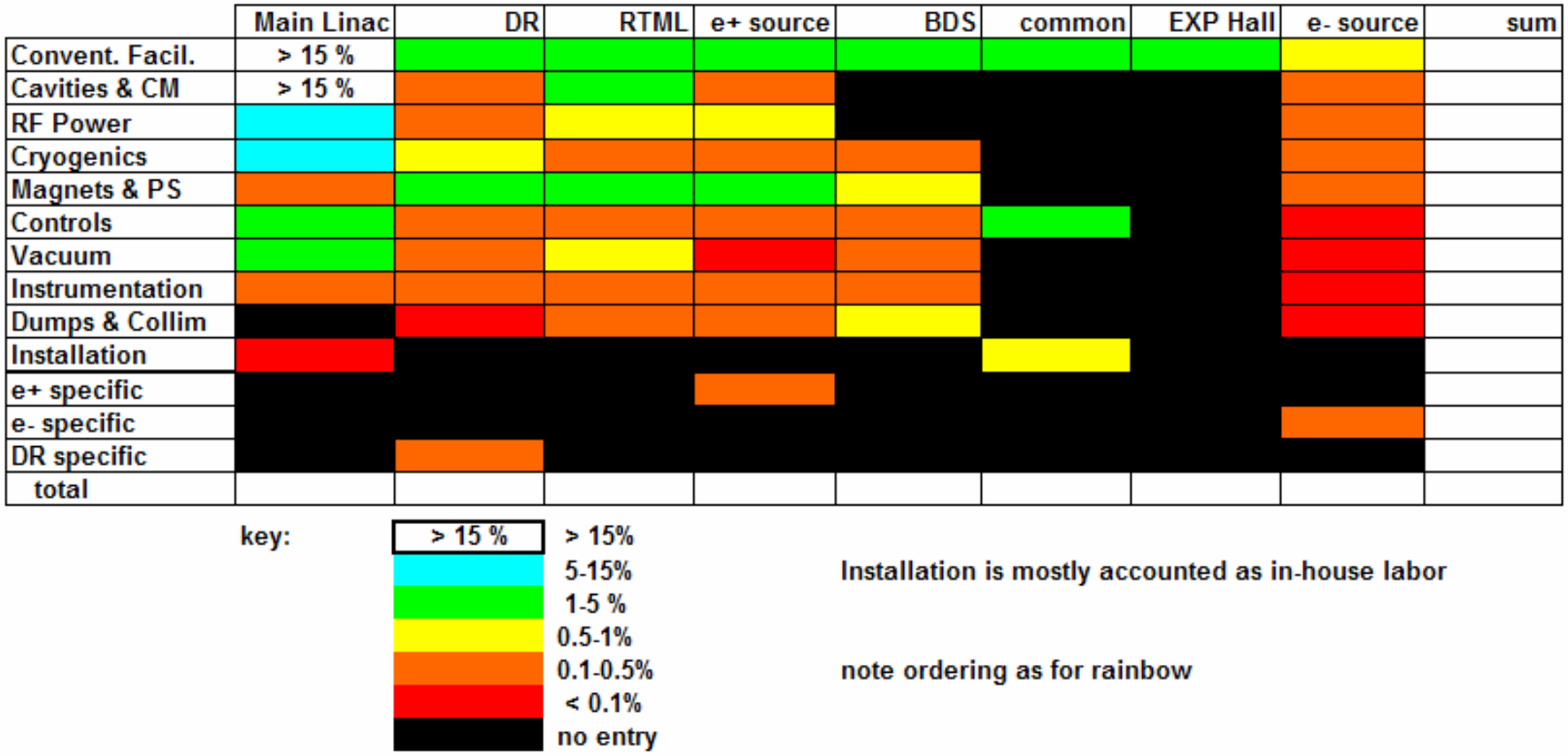
**CFS cost reduction: convener: Marc Ross**

| | | |
|---|---|---|
| 11:00 | 30 | Processed water |
| 11:30 | 30 | Underground volume |
| 12:00 | 30 | Shallow site studies |
| *12:30* | *30* | *lunch* |

**Study group feedback and consolidation (Walker,Carwardine,Shidara)**

# Goal is to save 1.32 B out of 6.6 B = ***20%***

## where do we find it?




P. Garbincius

# CF&S breakdown + electrical & cooling loads

| Conventional Facilities average over 3 regions | Main Linac | Damping Rings | Rings to ML | Positron Source | BDS & Dumps | Common | Exp Hall | Electron Source | sum |
|---|---|---|---|---|---|---|---|---|---|
| Civil Engineering: | | | | | | | | | |
| Outsourced Engineering | | | | | | | | | |
| Underground Facilities: | | | | | | | | | |
| * Shafts | | | | | | | | | |
| * Tunnels | | | | | | | | | |
| * Caverns & Exp Hall | | | | | | | | | |
| * Crossovers & Penetrations | | | | | | | | | |
| Surface Structures | | | | | | | | | |
| Site Development | | | | | | | | | |
| Electrical | | | | | | | | | |
| RF power (MW) | 75.7 | 14.0 | 7.1 | 4.1 | | | | 1.1 | 102.0 |
| Conventional power (MW) | 13.5 | 1.7 | 3.8 | 7.3 | 4.9 | | | 1.2 | 32.5 |
| Room Temperature Magnets | 0.8 | 7.9 | 4.7 | 8.9 | 2.6 | | | 0.7 | 25.6 |
| Water Systems power (MW) | 9.9 | 0.7 | 1.3 | 1.3 | 3.5 | | | 1.3 | 17.9 |
| Cryogenics power (MW) | 33.9 | 1.8 | 0.0 | 0.5 | 0.3 | | | 0.5 | 36.9 |
| Emergency power (MW) | 0.4 | 0.2 | 0.2 | 0.2 | 0.3 | | | 0.1 | 1.4 |
| Total Power (MW) | 134.2 | 26.3 | 17.2 | 22.3 | 11.7 | | | 4.8 | 216.3 |
| Air Treatment | | | | | | | | | |
| Piped Utilities | | | | | | | | | |
| Process Cooling Water | | | | | | | | | |
| LCW load (MW) | 56.0 | 17.7 | 9.3 | 17.5 | 46.3 | | | 2.9 | 149.6 |
| Chilled Water (MW) | 21.1 | 1.8 | 1.3 | 5.3 | 1.0 | | | 1.4 | 32.0 |
| ** Cryo Air Towers (MW) | 33.9 | 1.8 | 0.0 | 0.5 | 0.3 | | | 0.5 | 36.9 |
| Handling Equipment | | | | | | | | | |
| Safety Equipment | | | | | | | | | |
| Survey & Alignment | | | | | | | | | |
| sum | | | | | | | | | |

* scaling underground facilities components: UF(i,j) = UFavg(i)*UFamericas(i,j)/ΣUFamericas(i,k)
i = ML, DR, RTML, e+ source, BDS, common, Exp Hall, e- source
j = shafts, tunnels, caverns & halls, crossovers & penetrations

** cooling systems are included in cost of cryogenics plants

key: > 5 % | 1-5 % | 0.5-1 % | 0.1-0.5 % | < 0.1 %

P. Garbincius

# Process for WG-1

- Look for ways to reduce the cost
  - **More than walking through each line of the cost estimate.**
- Started with >100 suggestions from various sources
  - **Wide range of suggestions, topic areas, and scope.**
  - **Too many for this group to evaluate quantitatively.**
  - **Many ideas not new.**
- Different ways to group the ideas, eg:
  - **By technical area, technical system**
  - **By topic, eg engineering integration, lattices, staging, operating margins.**
- Four sub-groups individually considered the full list, identified their ‘top 10’ for further consideration

# Cost Reduction List (partial)

| Primary Impact | | Short Description of the Proposal | Synopsis | Barry, EC | PMs | AP | Eng | SRFT | CFS | Potential cost savings |
|---|---|---|---|---|---|---|---|---|---|---|
| | Technical System cost reduction proposals | | | | | | | | | |
| ALL | | Remove the peak cooling (and cryo) capacity that's needed to operate on the hottest days | Reduces spare capacity that could be replaced during an upgrade, but spare capacity is high for peak load compared with normal requirements | | | | X | X | X | |
| ML | | Use re-entrant cavities and increase the design gradient to 40MV/m | | | | | X | X | | |
| CFS/ML | | Substantially increase the cooling water delta T (eg 60 degree C) | | | | | X | X | X | |
| CFS | | Reduce diameter of largest shafts, lower the cryomodules into the tunnel vertically | | | | | X | X | X | |
| CFS/ML | | Single tunnel solution | | | | | X | | X | |
| CFS | | Build equipment alcoves inside the tunnel envelope to avoid having to dig separate spaces | | | | | X | | X | |
| CFS | | Optimize locations of technical equipment to reduce overall tunnel volume | | | | | X | | X | |
| PSRC | | Replace the undulator positron source with a conventional source | | | | X | | | X | |
| ALL | | Shallow site solution | | | | | | | X | |
| BDS | | Remove anything previously included for 1TeV | | | | X | X | X | X | |
| ML | | Use common charging supplies for multiple RF modulators | | | | | X | X | | |
| ML | | Flywheel generator for RF modulator | | | | | X | X | | |
| PSRC | | Remove the positron keep-alive sources | | | | X | X | | | |
| PSRC | | Shorten undulator-based positron source by 200-400m | | | | X | | | X | |
| ML | | Robotic "paint sprayer" concept for cavity processing for consistency and automation. Vacuum head could remove chemicals from enclosed spaces (eg re-entrant cavities)" | Reduce processing cost for cavities, increase consistency of processing to increase yield | | | | | X | | |
| RTML/DR | | Accept Short Bunch Design in DR and Single Stage Bunch Compressor | | | | X | | X | X | |
| ALL(?) | | Give up on self reproducing bunch patterns | | | | X | | | X | |
| ALL | | Cut/cover solution | | | | | | | X | |
| ML | | Reduce peak RF power by relaxing requirement for simultaneous peak energy and peak luminosity. | Reducing the power envelope would allow lower power klystrons, reduce electrical utility, cooling water, and cost of HLRF | | | | X | X | | |
| ML | | Marx modulator instead of bouncer | Not clear what it takes to re-open the BCD/ACD decision | | | | X | X | | |
| ML | | Sheet-beam klystron | | | | | | | | |

# Different ways to assess benefit / impact

1. Estimate capitol cost saving
   - ***Is this a cost reduction at all?***
2. Direct physics parameter impact
   - ***Initial capability***
   - ***Maximum Reach***
3. Staging → *SG-1*
   - ***Can impact be later mitigated with an "upgrade"?***
4. Risk impact
   - ***on reaching nominal performance***
5. Scope of proposed modification
   - ***Major layout change to plug-compatible component change***
6. Technical systems overhead
7. Impact on operations
8. Machine reliability
9. Scope of necessary R&D programme
10. Impact on TD phase planning
11. Impact on construction schedule
12. Site dependency issues
13. Initial study effort (primary required resources)

# An example top 10 from one sub-group

| Index # | Area Sys | Tech Sys | Comment | ranking | Proposal |
|---|---|---|---|---|---|
| 17 | All | Civil | yes but cut/cover difficult | 1 | Shallow site solution (cut & cover) |
| 74 | ML | Civil | yes | 2 | Single tunnel solution |
| 90 | ML | HLRF | yes | 3 | Eliminate secondary cooling loops on klystron collectors (boil the water) |
| 96 | ML | HLRF | explore cost? | 4 | Marx modulator instead of bouncer |
| 97 | ML | HLRF | try | 5 | RF distribution system without circulators |
| 114 | RTML | HLRF | yes | 6 | Remove the spare klystron and mod in BC1 |
| 59 | E+ SRC | Undulator source | yes if big saving | 7 | Replace the undulator positron source with a conventional source |
| 44 | DR | Underground space | yes | 8 | Removal of "safety tunnel" |
| 55 | E+ SRC | Keep-alive source | yes | 9 | Remove the positron keep-alive sources |
| 50 | E- SRC | Spin rotator | try | 10 | Deploy spin rotator at lower energy (see also E+ SRC) |
| 57 | E+ SRC | Spin rotator | try | 10 | Deploy spin rotator at lower energy (See also E_ SRC) |
| 25 | BDS | Lattice | yes | 14 | Remove anything previously included for 1TeV |
| 98 | ML | HLRF | to be demonstrated | 15 | Sheet-beam klystron |
| 99 | ML | HLRF | requires test with beam | 16 | Reuse RF power reflected from 2 (or 3) cryomodules to feed 3rd (or 4th) cryomodule |

# Some themes from Top-10 lists

- Civil, siting:
  - **Single tunnel, shallow site,..**
  - **Underground space utilization**
- Accelerator
  - **Positron source**
  - **DR short-bunch design, eliminate BC2**
- Engineering
  - **HLRF: Marx, no circulators,…**
  - **Magnet stringing, power supply**
  - **Increase cooling water delta-T**

# ILC-CLIC Cooperation

## launched in Nov. 2007

**Objectives:**

- Develop common knowledge of both designs and technologies,
  - **CF&S, BDS/MDI, Detectors, Cost estimates, Beam dynamics/simulations, etc.**
- Common Preparation of the (unavoidable) evaluation of technology, in credible and common basis,
- Most efficient use of limited resources,

- ILC-CLIC special session held in GDE/Tohoku,
- Important CY 2008 initiative
  - **Expectations for November**

# CFS Session One - Processed Water

- **Review of Current RDR Design**
  - Three Loop System for Process Water
  - Two Loop System for Chilled Water
- **Description of Two Alternative Design Solutions**
  - Use Process Water for All Cooling Requirements
  - Use Chilled Water for All Cooling Requirements
  - Several Other Ideas and Suggestions were Proposed for Continued Study as Resources Allow
  - Further Work is Needed to Develop an Accurate Cost Analysis of Various Alternatives
- **Resources Available Include:**
  - Minimal Engineering Support from FNAL
  - Possible Additional Support from KEK
  - Effort at CERN Based on Common ILC/CLIC Interest

V. Kuchler

# CFS Session Two - Underground Volume

- Currently Not Optimized for Equipment Size or Layout
- Primary Space Requirements Determined By:
  - Cryogenic Equipment
  - Process Water Equipment
  - HVAC Equipment
  - Installation and Material Handling Requirements
- Opportunities for Cost Reduction:
  - Revised Process Cooling Design May Result in a Reduction of Equipment Space Required
  - Revised HVAC Design May Result in a Reduction of Equipment Space Required
  - Overall Optimization of Equipment layout is Essential
  - Adjustment of Shaft Usage and Size will Affect Cavern Space Requirements
- CFS Will Try to Make Some Progress on this Effort in Spite of Resource Limitations

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# CFS Session Three - Shallow Site Studies

- *Several Variations Were Noted*
- *Near-Surface Solutions Include Actual Cut and Cover Excavation as well as Near Surface Tunnel Boring Techniques*
- *Other Aspects of General Tunnel Configuration Include:*
  - *Single Tunnel Solutions*
  - *Material Access and Life Safety Egress Impacted by Tunnel Configuration*
  - *Shaft Diameter Reduction or Further Shaft Elimination*
  - *Horizontal verses Vertical Cryomodule Installation*
- *Various Alternatives Noted May Preclude Construction in Certain Siting Locations*
- *Resources Will be Identified to Make Progress on this Topic Prior to the Dubna Meeting*

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# Next steps

- Follow through on the 'Top-10' items from this meeting
  - **Several items need more thorough evaluation for feasibility, cost savings, risk, etc**
  - **Several items are already on the list and we need to get people working on them.**

- Continue to solicit and evaluate new proposals.
  - **Maintain an active list of possible cost reductions.**
  - **Distribute the outcomes from this meeting.**

- Specific items for further study
  - **Civil/siting: major theme of Dubna GDE meeting**
  - **Positron source integration study.**
  - **Technical systems impact of high cooling delta T.**
  - **Magnet power supply stringing and space utilization.**

# Summary

- There is clearly benefit in having a forum for open discussion and evaluation of new cost reduction ideas.

- Open discussions with this ad hoc group were very positive.
- Formal engagement is also needed, eg from Technical Area Group Leaders.

- The real benefit will come from following through on the most interesting ideas (need people to work on them).