# GDE Efforts for Cost-Containment in ILC-TDR
# - Public Report -

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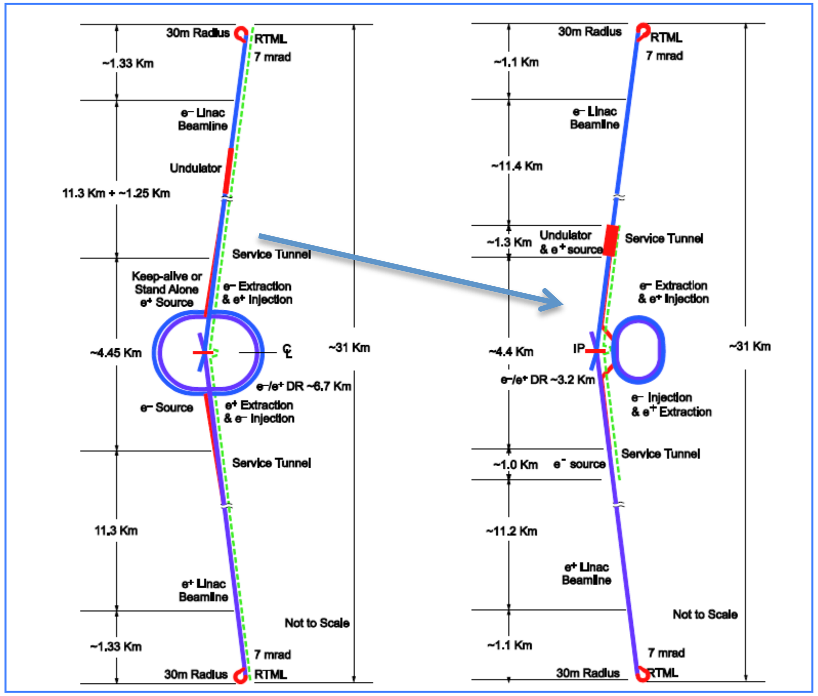
第15回 LC 計画推進委員会, 2012-1-10

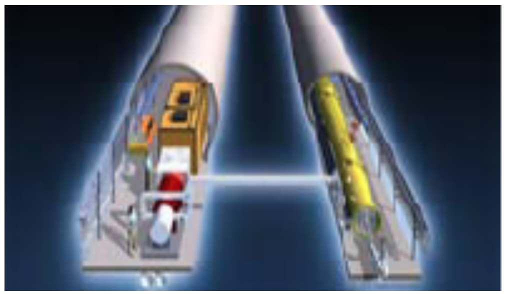
# ILC-GDE: 工学設計の進展

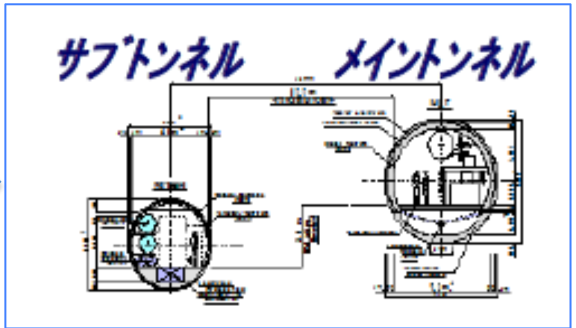


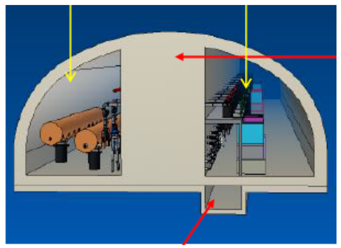

## 『性能／コスト』の最適化

- シングルトンネル化
- ダンピングリング、小型化
- 陽電子生成標的@中央部
- **空洞電界: 31.5MV/m+/-20 %**
- RF Powering: KCS/DRFS/RDR-RF
- → 効率的な加速器設計

**RDR2007** → **SB2009** → **TDR w/ mountain site**





# ILC 建設費見積もり (ILC RDR (GDE による))

| Area - M ILC Units | Total | Components | Conventional Facilities |
|---|---|---|---|
| Main Linac | 3,894 | 2,723 | 1,172 |
| DR | 630 | 398 | 231 |
| RTML | 554 | 320 | 234 |
| $e^+$ source | 398 | 232 | 166 |
| BDS | 408 | 157 | 252 |
| Common | 369 | 229 | 140 |
| Exp Hall | 200 | 0 | 200 |
| $e^-$ source | 165 | 87 | 78 |
| Sum | 6,618 | 4,146 | 2,472 |

Efforts in Progress

-11 %
Except for
ML Components
in SB2009

**Assumption in RDR: 1 ILC Unit = 1 US 2007$ (= 0.83 Euro = 117 Yen).**

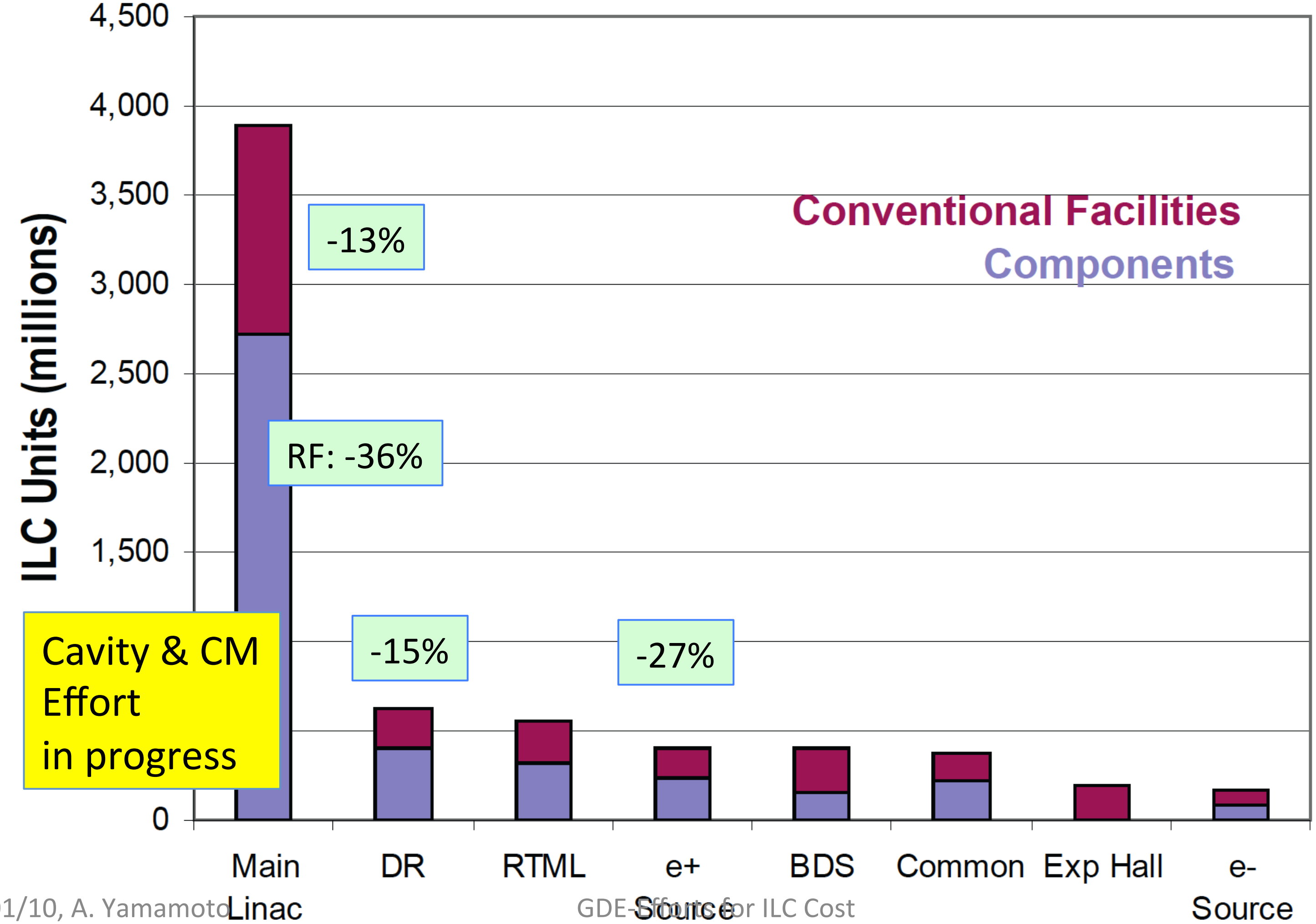
**→ Plan in TDR:**

**物価上昇： ~ 10 % (in case of the US)を想定,**

**為替レート：Purchasing Power Parity を採用(PPP: 購買力平価：OECD で採用）**

# ILC 建設費見積もり (ILC RDR)

FIGURE 6.2-1. Distribution of the ILC value estimate by area system and common infrastructure, in ILC Units. The estimate for the experimental detectors for particle physics is not included. (The Conventional Facilities estimates have been averaged over the three regional site estimates. )



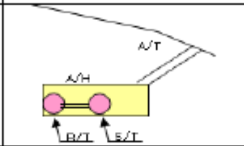
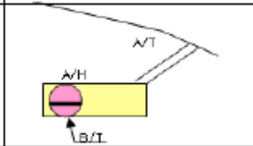
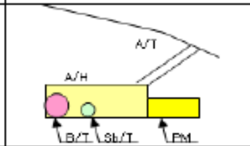
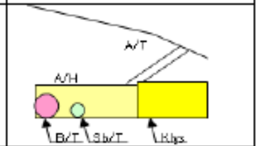
# Tunneling Study for Mountain Regions in Japan

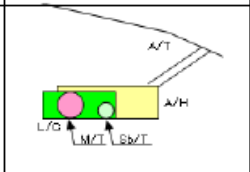
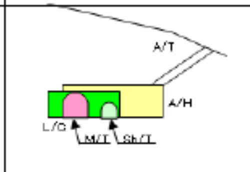
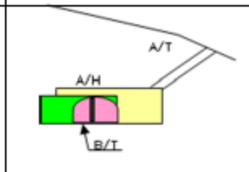
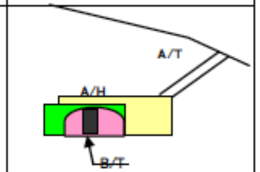
Courtesy: Enomoto/Miyahara
Study supported by KEK-DG

Global Design Effort - CFS

## 総括比較表

工事費凡例　〇標準より安価　△ほぼ同等　×標準より高価

| | CASE-1 D-T-R | CASE-2 S-T-R | CASE-3 JS-T-X | CASE-4 JS-T-K |
|---|---|---|---|---|
| 概念図 |  |  |  |  |
| 工事費 | 標準 | 〇 | △ | × |
| 工　期 | (74.1M) | (90.0M) | (83.6M) | (84.5M) |
| 機能性 | ◎ | △ | △ | △ |

| | CASE-5 JS-T-D | CASE-6 JS-N-D | CASE-7 S-N-D | CASE-8 wS-N-D |
|---|---|---|---|---|
| 概　念 |  |  |  |  |
| 工事費 | △ | 〇 | 〇 | 〇 |
| 工　期 | (79.9M) | (87.2M) | (78.0M) | (76.7M) |
| 機能性 | 〇 | 〇 | ◎ | ◎ |

2011/9/9　土木学会・研究討論集会

# Communication with Companies

## SC Cavity and Material Manufacturers

| | Date | Company | Place | Technical sbject |
|---|---|---|---|---|
| 1 | 2/8 | Hitachi | Tokyo (JP) | Cavity/Cryomodule |
| 2 | 2/8 | Toshiba | Yokohana (JP) | Cavity/Cryomodule, SCM |
| 3 | 2/9 | MHI | Kobe (JP) | Cavity / Cryomodule |
| 4 | 2/9 | Tokyo Denkai | Tokyo (JP) | Material (Nb) |
| 5 | 2/18 | OTIC | NingXia (CN) | Material (Nb, NbTi, Ti) |
| 6 | (3/3), 9/14 | Zanon | Via Vicenza (IT) | Cavity/Cryomodule |
| 7 | 3/4, | RI | Koeln (DE) | Cavity |
| 8 | (3/14), 4/8 | AES | Medford, NY (US) | Cavity |
| 9 | (3/15), 4/7 | Niowave | Lansing, MI (US) | Cavity/Cryomodule |
| 10 | 4/6 | PAVAC | Vancouver (CA) | Cavity |
| 11 | 4/25 | ATI Wah-Chang | Albany, OR (US) | Material (Nb, Nb-Ti, Ti) |
| 12 | 4/27 | Plansee | Ruette (AS) | Material (Nb, Nb-Ti, Ti) |
| 13 | 5/24 | SDMS | Sr. Romans (FR) | Cavity |
| 14 | 7/6 | Heraeus | Hanau (DE) | Material (Nb, Nb-Ti, Ti) |
| 15 | 10/18 | Babcock-Noell | Wurzburg (DE) | CM assembly study |
| 16 | 11/11 | SST | Maisach (DE) | Electron Beam Welder |

# Cavity Cost-study compared w/ RDR and EXFEL (updated, Nov., 2011)

Public

| | ILC: RDR | EXFEL: Original 300. | EXFEL: + 80 | ILC: E | A | J |
|---|---|---|---|---|---|---|
| Prep.+Prod. Yrs. | 2+3 | 1+2.5 | ? | 2+6 | 2+6 | 2+6 |
| Fraction | 100% | 2 x 50% | ~ same | 20% | 20% | 20% |
| # cavity | 17,000 | 300 | +80 | 3,200 | 3,200, | 3,200 |
| SC Material (supplied) | | | | | | |
| Mech. Fabrication including EBW | | | | | | |
| Chemistry | | | | | | |
| Ti He-Vessel | | | | | | |
| Accept. Test (RT) | | | | | | |
| Factory investment | | | | | | |
| Fab. Cost/cavity (+ SC-mat.= Sum) | | | | | | |
| Unit | | | | | | |
| Cost Comparison in ILCU | | | | | | |

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| Ti He-Vessel | | | | | | |
| Accept. Test (RT) | | | | | | |
| Factory investment | | | | | | |
| Fab. Cost/cavity (+ SC-mat.= Sum) | | | | | | |
| Unit | | | | | | |
| Cost Comparison in ILCU | | | | | | |

ILC コストを単純にEXFEL からエネルギーでスケーリングする事は無理がある。
但し、同様の技術となるSCRF 空洞について比較検討は意味あり。

Further mass production cost study with contracts in progress:

- RI-DESY: 50, 100 % production cost including facility cost
- AES-FNAL: 20 % (& more as option) facility investment cost
- MHI-KEK: 20, 50, 100 % production cost w/ facility cost

To be completed by spring, 2012.

# RDR: Cavity Fabrication Model

- Noell (Dornier-Astrium) report studied three scenarios:
  1. 6 EBW machines with 1 chamber
     - 3 'centres' either distributed or at central facility
  2. 7 EBW machines with 1 chamber
     - 4 centres, reduced shift operation at EBW 1-4
     - (variant on option 1)
  3. 4 EBW with 3 chambers (loading, welding, cooling)
     - 1 centre (monolithic fabrication plant)

- Option 3 studied in detail

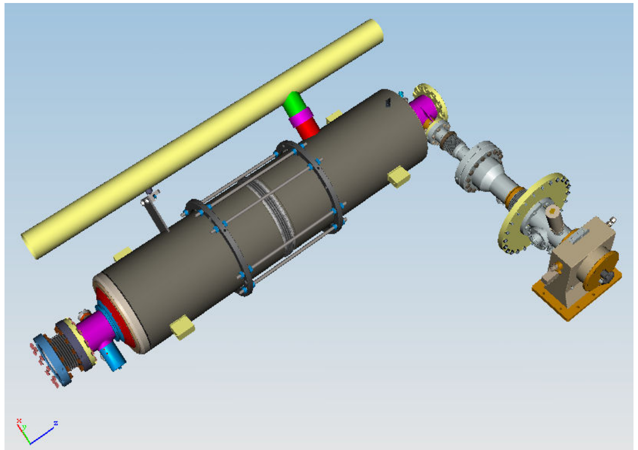
# TDR に於けるコスト削減への努力

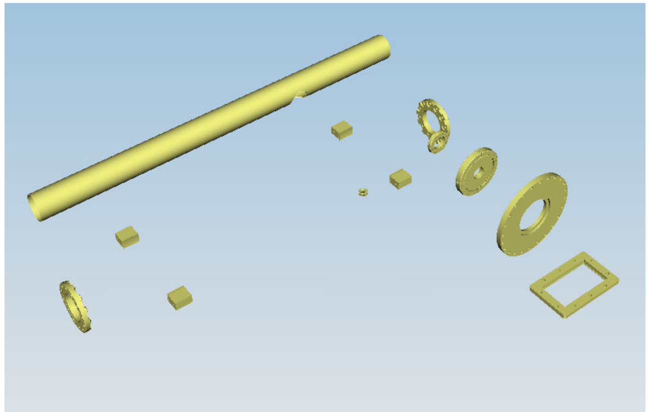
- **ILC 性能要求を満たした場合に経済性を優先する**
  - SB2009 での節約を基本、

  - 空洞設計：Tesla Type を基本
  - HLRF 設計：RDR-RF unit を基本(10 MW klystron)

  - 工業化：量産における集約型製造と国際協力による製造、試験評価分担の最適条件を探る

# Plug-compatible Conditions

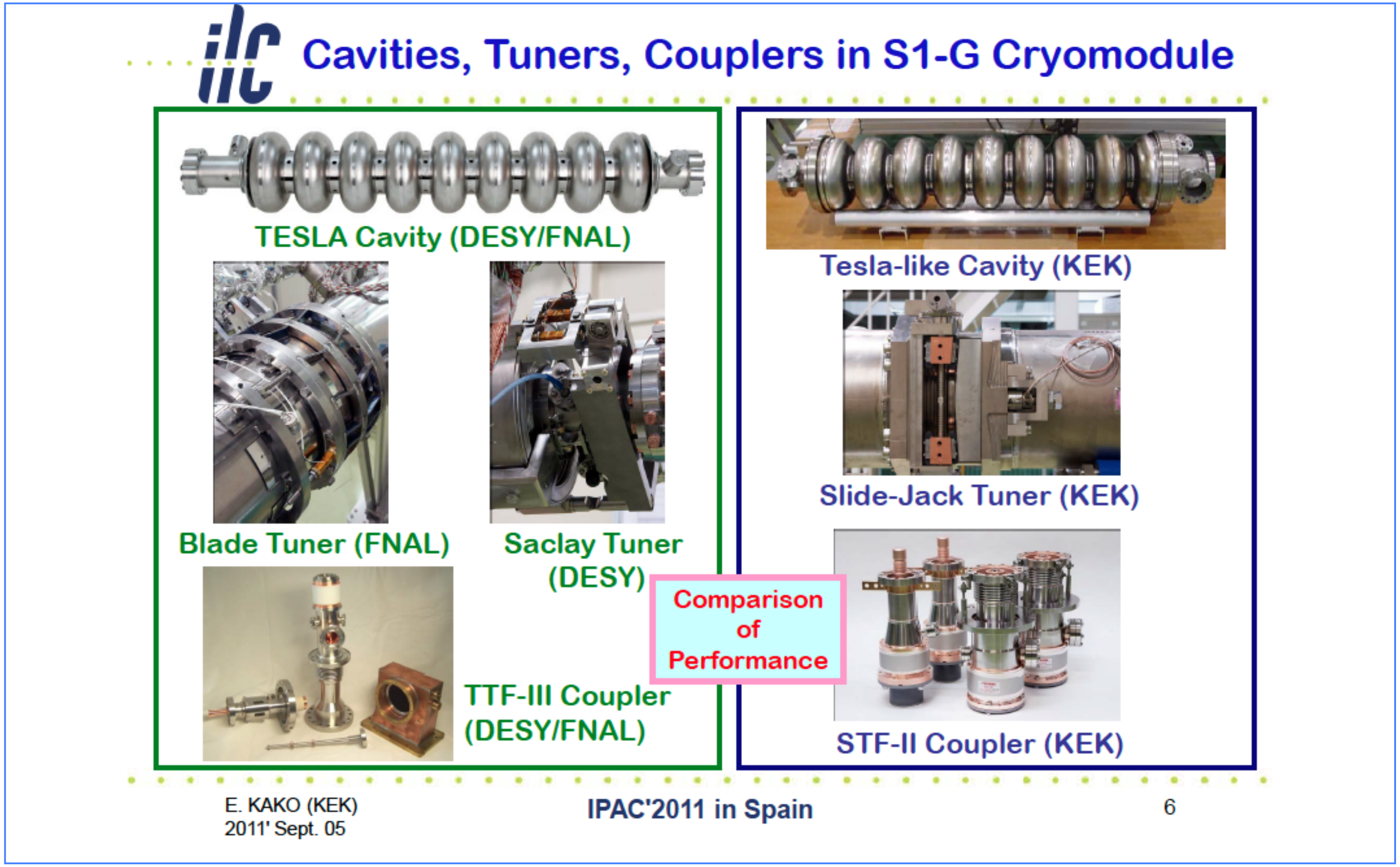




| Item | Possibilities | Plug-comp. |
|---|---|---|
| Cavity shape | TeSLA/LL/RE | |
| Length | | Fixed |
| Beam pipe flange | | Fixed |
| Suspension pitch | | Fixed |
| Tuner | Blade/Jack | TBD |
| Coupler flange (warm end) | | Nearly fixed (250 mm dia.) |
| Coupler pitch | | fixed |
| He –in-line joint | | Nearly fixed as shown here, |

Plug-compatible i

# Variety of Cavity Assembly



# Cost-Study Status and Further Plan

Confidential

- **Cost-study in Communication with industry**
  - More than half companies responded to our ‘request for information’, and we have received costing information.
  - We are continuing to seek for cost effective production.
  - We are in progress to communicate with industry, to prepare for the information on the model dependent cost estimates (20 ~ 100 %).

- **Cost study in Communication with Laboratories**
  - Communication with potential regional hub-laboratories will be important to establish a whole scope of the cryomodule assembly and test.
  - CERN’s contribution is expected to figure out a lab-hosting cryomodule assembly and test in contract with industry

# Production Process/Responsibility

| Step hosted | Industry | Industry/ Laboratory | Hub- laboratory | ILC Host- laboratory |
|---|---|---|---|---|
| Regional constraint | no | yes | yes | yes |
| Accelerator - Integration, Commissioning | | | | Accelerator sys. Integ. |
| SCRF Cryomodule - Perofrmance Test | | | Cold, gradient test | As partly as hub-lab |
| Cryomodule/Cavity - Assembly | | Coupler, tuner, cav-string/ cryomoduleassmbly work | | As partly as hub-lab |
| Cryomodule component - Manufacturing | V. vessel, cold-mass ... | | | |
| 9-cell Cavity - Performance Test | | | Cold, gradient test | As partly as hub-lab |
| 9-cell Cavity - Manufacturing | 9-cell-cavity assembly, Chem-process, He-Jacketing | | | |
| Sub-comp/material - Production/Procurement | Nb, Ti, specific comp. … | | Procurement | |

# TDRにむけたGDEの努力

- **SB2009 設計改訂を基本として**
  - ILCの要求を満たす設計から最も経済的な設計を TDR Cost Baseline Design とする
- **Single-tunnel, Low-power (DR), e+ source location等で、RDR cost-estimate に対して 11 % の節約の見通し**
  - 山岳トンネルで蒲鉾型トンネルの採用はこれに整合する。
- **SCRF、特にCavity Productionでのコスト評価に力を注いでいる。**
  - コストの増加をSB2009での節約の範囲に収まる努力 (Cost Containment Effrort) を続ける。

# Backup

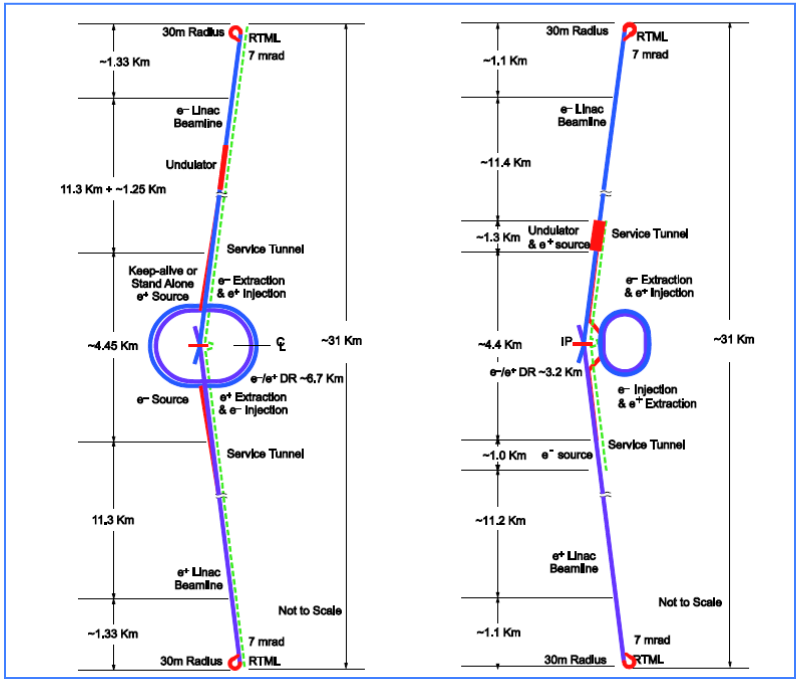
- **SCRF Cavity Material**

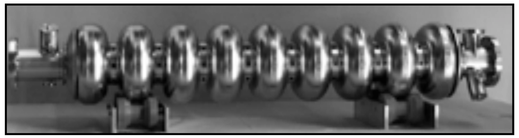
# Design Update in SB2009

## Motivation: Cost containment

- Single accelerator tunnel
- Smaller damping ring
- e+ target location at high-energy end,
- **SCRF:** Gradient variation of 31.5 MV/m +/- 20 %,
- **HLRF:** KCS and DRFS with RDR-RF unit as backup

**RDR → SB2009**



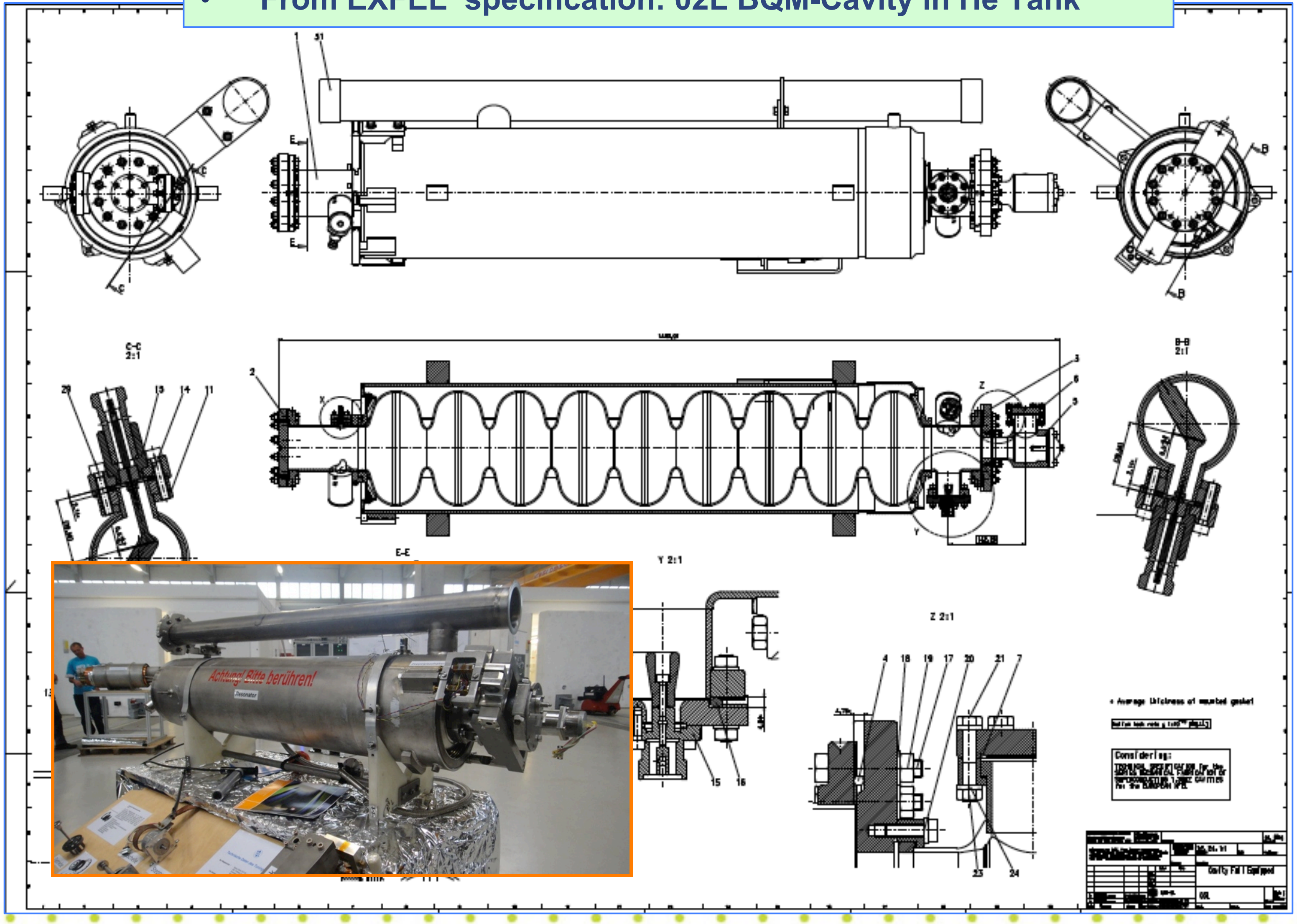



# Cavity Deliverable

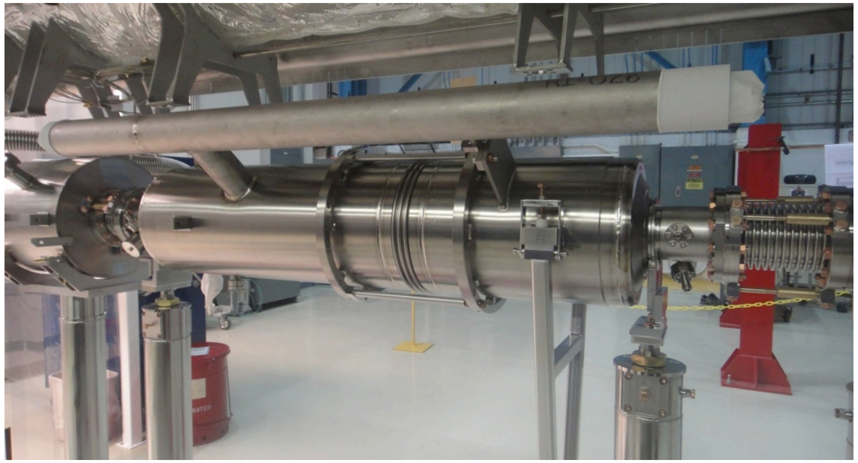
## assuming EXFEL cavity specification

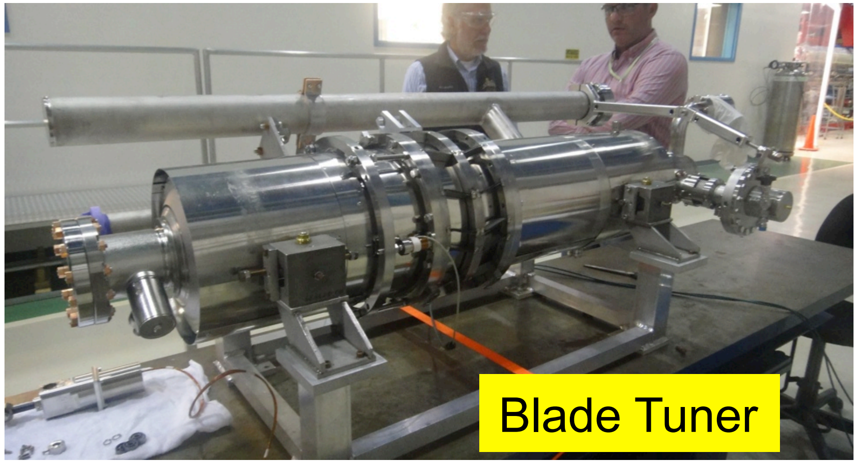
Courtesy:
W. Singer

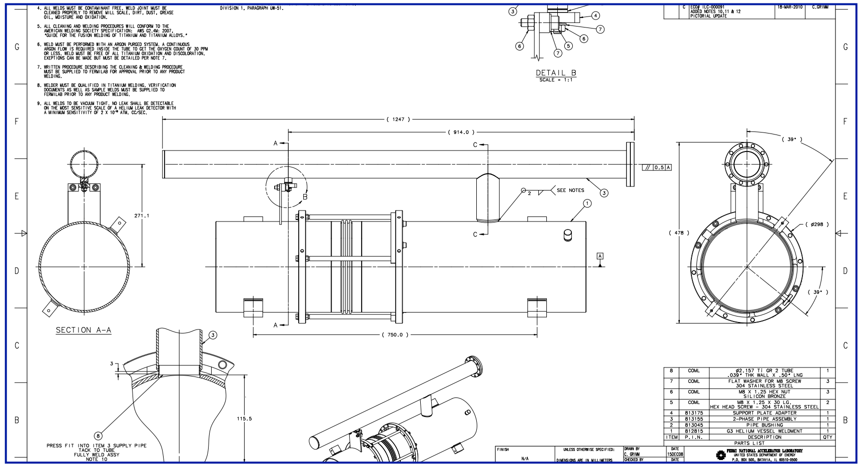
- From EXFEL specification: 02L BQM-Cavity in He Tank

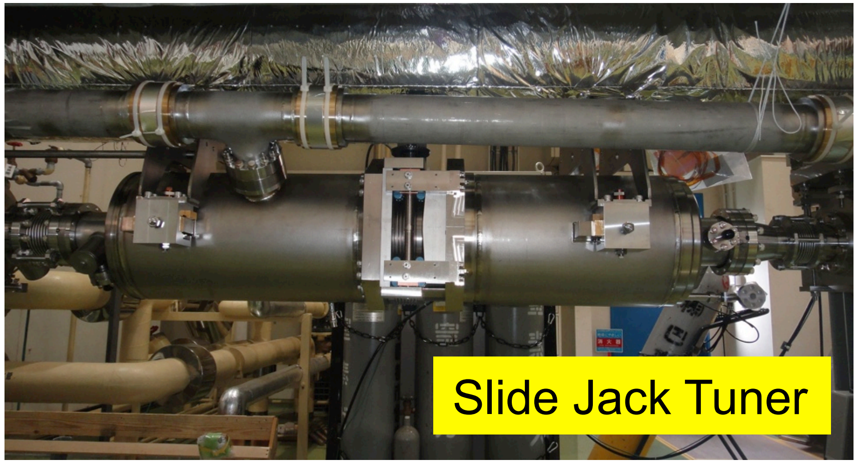


# Blade and Slide-Jack Tuners





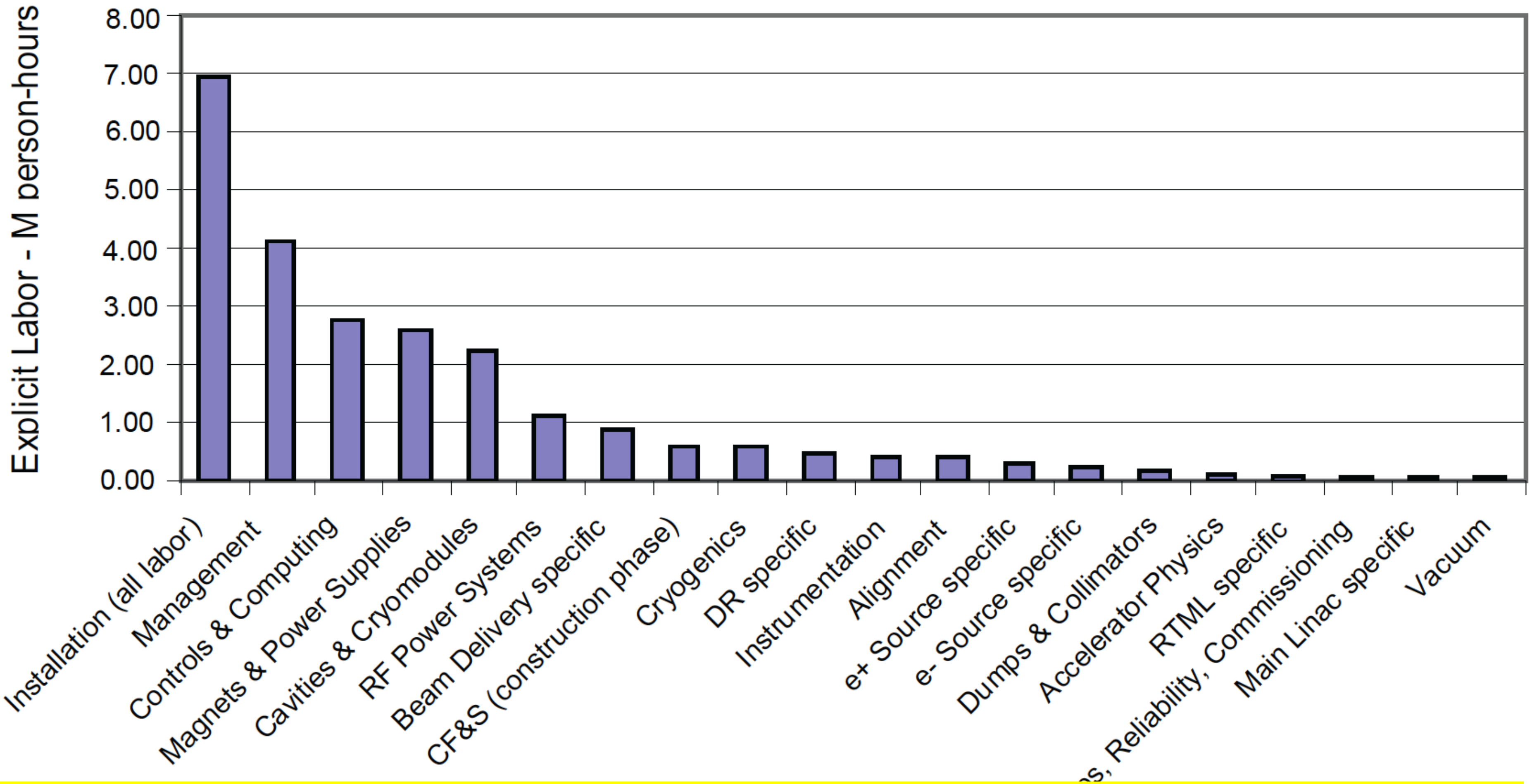
# ILC 人件費見積もり (ILC RDR)

TABLE 6.2-3: Explicit labor, which may be supplied by collaborating laboratories or institutions, listed by Global, Technical, and some Area-speci c Systems.

| Explicit labor | M person-hours |
|---|---|
| Installation (all labor) | 6.91 |
| Management | 4.09 |
| Controls & computing | 2.76 |
| Magnets & Power Supplies | 2.60 |
| Cavities & cryomodules | 2.23 |
| RF Power Systems | 1.12 |
| Beam Delivery System specific | 0.89 |
| CF&S (construction phase) | 0.60 |
| Cryogenics | 0.56 |
| DR specific | 0.46 |
| Instrumentation | 0.44 |
| Alignment | 0.42 |
| $e^+$ Source specific | 0.31 |
| $e^-$ Source specific | 0.24 |
| Dumps & Collimators | 0.19 |
| Accelerator Physics | 0.11 |
| RTML specific | 0.09 |
| Ops, Reliability, Commissioning | 0.07 |
| Main Linac specific | 0.06 |
| Vacuum | 0.05 |
| Sum | 24.19 |

# ILC 人件費見積もり (ILC RDR)

FIGURE 6.2-2. Explicit labor, which may be supplied by collaborating laboratories or institutions, listed by Global, Technical, and some Area-specific Systems.




**人件費のうち2番目に大きい "management"は、日本の場合は、ほとんどが 研究機関、大学等のスタッフなので勘定に入れないのが正しいと思われる。 management には管理局な仕事だけでなく、現場の指揮(こちらが多い)も含まれる。**