(Lattice) Design Integration

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DESY

Joint Session: Sources and Damping Rings

26.9.2011

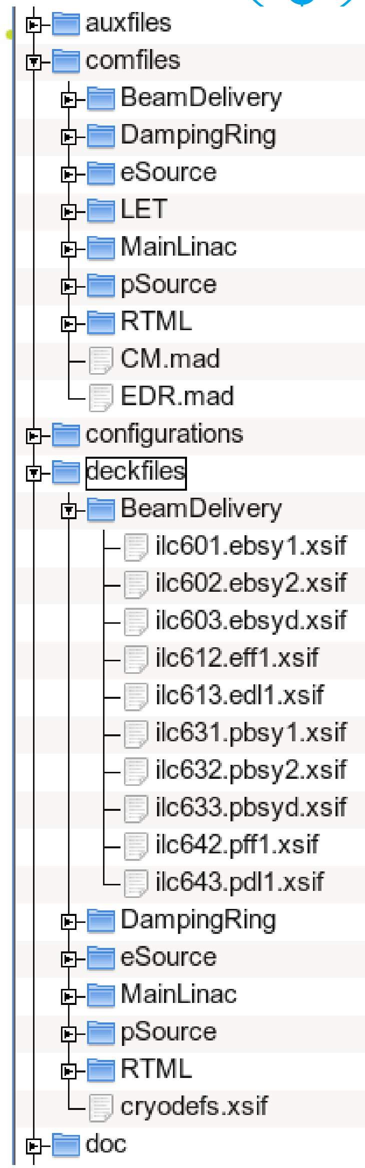
- Towards an Integrated Lattice for the ILC TDR
- Central Region issues
- Preparation for the BTR at DESY Oct. 24-27

Towards an Integrated Lattice

- For RDR: Complete, integrated Lattice exists: ILC2007b
  → avaliable from EDMS: D*0966355
- Goals for the TDR:
  - **Have again a complete, consistent and correct lattice <u>in EDMS</u>**
  - **Component lists (at least for magnets and cavities) directly derived from this lattice, usable for cost estimate**
- This needs <u>formal specifications</u> **now**:
  - **of all <u>beamline section</u> names**
  - **of all <u>treaty points</u> (geometry, twiss, and beam parameters!)**
- I will present <u>proposals</u> that facilitate exchange of information during design process and derivation of component lists etc: Open for discussion
  → Needs your input now and your cooperation later

Lattice File Organization

- RDR lattice used complicated file organization scheme with many include relations
- For TDR we want more „local“ lattice file organization:
  - One directory per TAG
  - No inclusion across directories!
  - Please: separate beamline description („xsif“) files and command („mad“) files
  - Please: provide SURVEY and TWISS output files for your system
- Consequence:
  - Some information will be duplicated (e.g. SCRF cavity wakefield data)



MAD / MADX / BMAD

- Different accelerator development softwares make exchange of lattice file difficult
- Nonstandard components (LCAV, WIGG) necessary for correct simulation
- Proposal:
  - **Always provide the original files that you used for the original design**
  - **Please provide <u>in addition</u> a variant that can be read by MAD8s (with SLAC addition of LCAV) and produces at least correct SURVEY output**
  - **This should be done by the original designer**

Coordinate Systems

- Global ILC Coordinate System:
  - Origin in IP, right handed
  - y axis: up
  - z axis: in electron beam direction
  - x axis: towards DR
  - theta: angle in x/z plane, theta=0: +z direction
  - electron beam direction: theta=-7mrad
  - positron beam: theta = pi-7mrad
- Local coordinate systems can be used, but this should be
  - Clearly communicated
  - Transformation to global ILC system must be specified!

Treaty Point Definitions

- Treaty Points between DR and Sources / RTML: D*0966225
- Treaty Point Definition entails:
  - Input to SURVEY: x0, y0, z0, theta0, phi0, psi0
  - Input to TWISS: alfx, alfy, betx, bety, dx, dpx, dy, dpy
  - Input to BEAM: energy, ex(n), ey(n), sige
- PLEASE:
  Provide output of SURVEY and TWISS with initial values given by the Treaty Point definition

Lattice Integration @ DESY

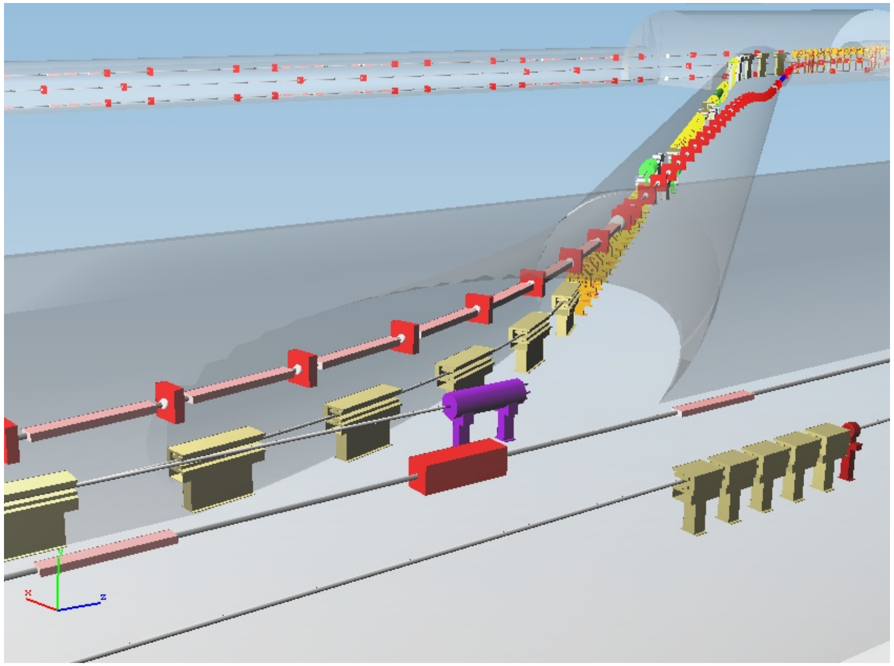
- Our group (DESY-IPP) offers to coordinate the ILC Design Integration
- Service offered:
  - **Checking / documentation of beamline geometry**
  - **(Rapid) visualization of beamlines**
  - **Automatic generation of list of elements (magnets, RF) used in lattice**
  - **Component counts derived directly from lattice for cost and CFS purposes**
- This needs: Your cooperation
  - **Willingness to provide your lattices**
  - **Willingness to cooperate w.r.t. conventions (mainly: markers) and to fill out „questionnaires“**

From Lattice to CFS and Cost

- SURVEY and TWISS output yield:
  - **Location of all magnets and RF cavities**
  - **Strength of all magnets → minimum field**
  - **Beam envelope → minimum aperture**
- But: A single physical part is typically represented by several and different lattice elements
  → need a mapping
- Mapping table links a pattern of beamline elements to a single element, with a specific design, e.g.:
  „Q101PB,M101PB,Q101PB“ → Q101PB (Q30L200)
- We (DESY) will generate tables of all magnets and RF components in the lattice files, TAGs have to provide the engineering name and the Cost WBS number for each lattice name
  → Allows automatic generation of component counts

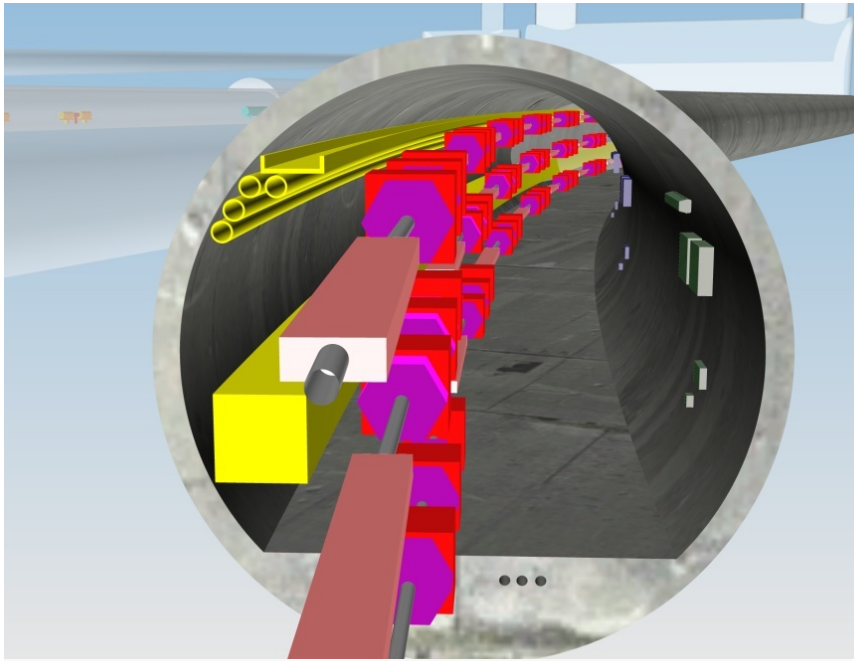
Visualization

- **Lattice integration** of different technical areas and **design integration** of different systems: Check interfaces and avoid collisions
- **Vision sharing**: Optimize contributions to overall performance and identify needs and opportunities for collaboration



Collision checks in crowded areas

Tunnel model: J. Osborne, CERN
PS and dump line: N. Collomb, STFC Daresbury
RTML and BDS lattices: N. Solyak, D. Angel-Kalin
Lattice visualization and Integration: B. List, DESY



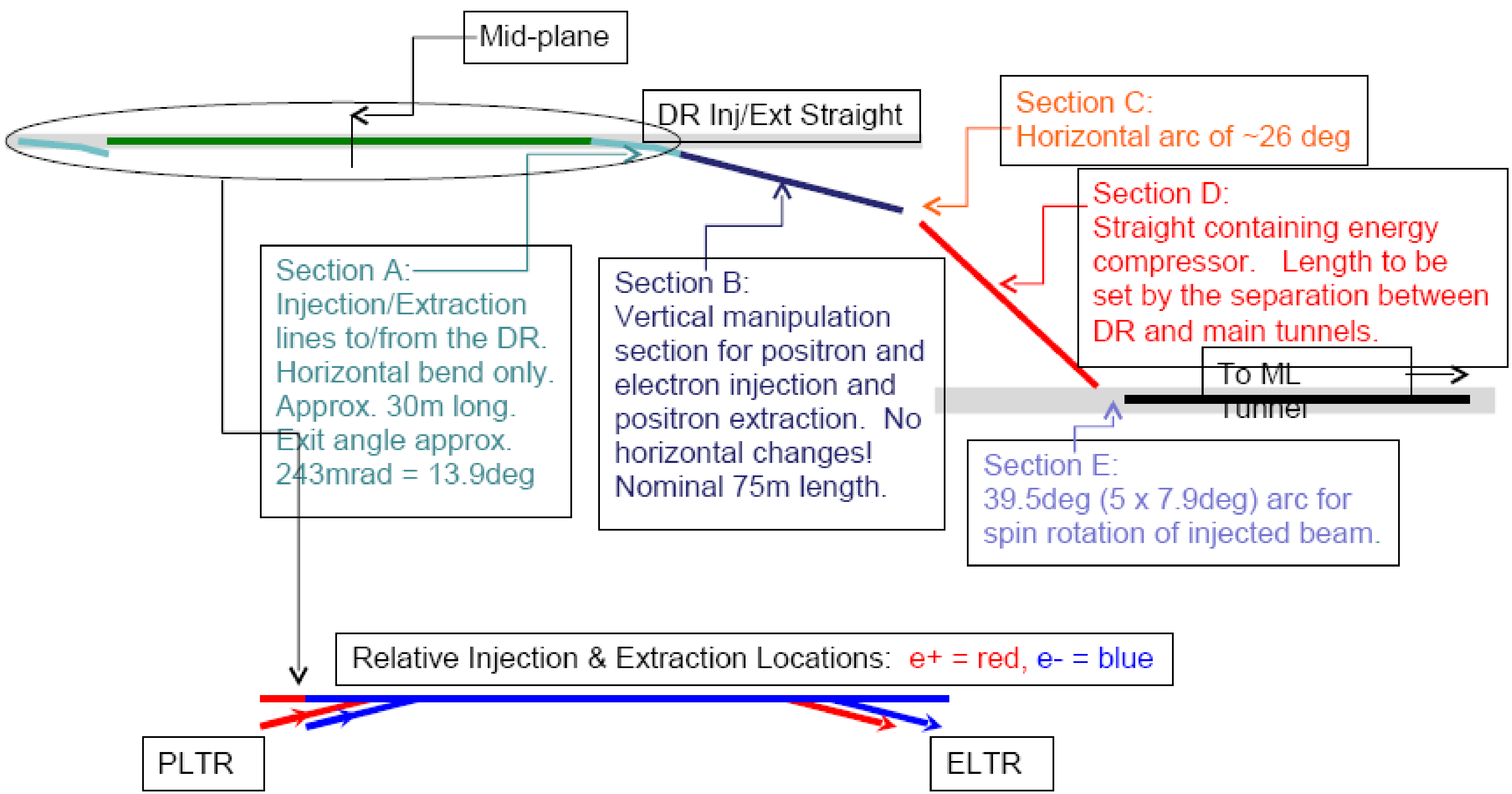
Accelerator and CF&S Integration

Tunnel models: J. Osborne, CERN and N. Welle, DESY
Based on tunnel cross section by Vic Kuchler, FNAL
DR lattice: D. Rubin, Cornell
Lattice visualization and Integration: B. List and S. Sühl, DESY

Part II

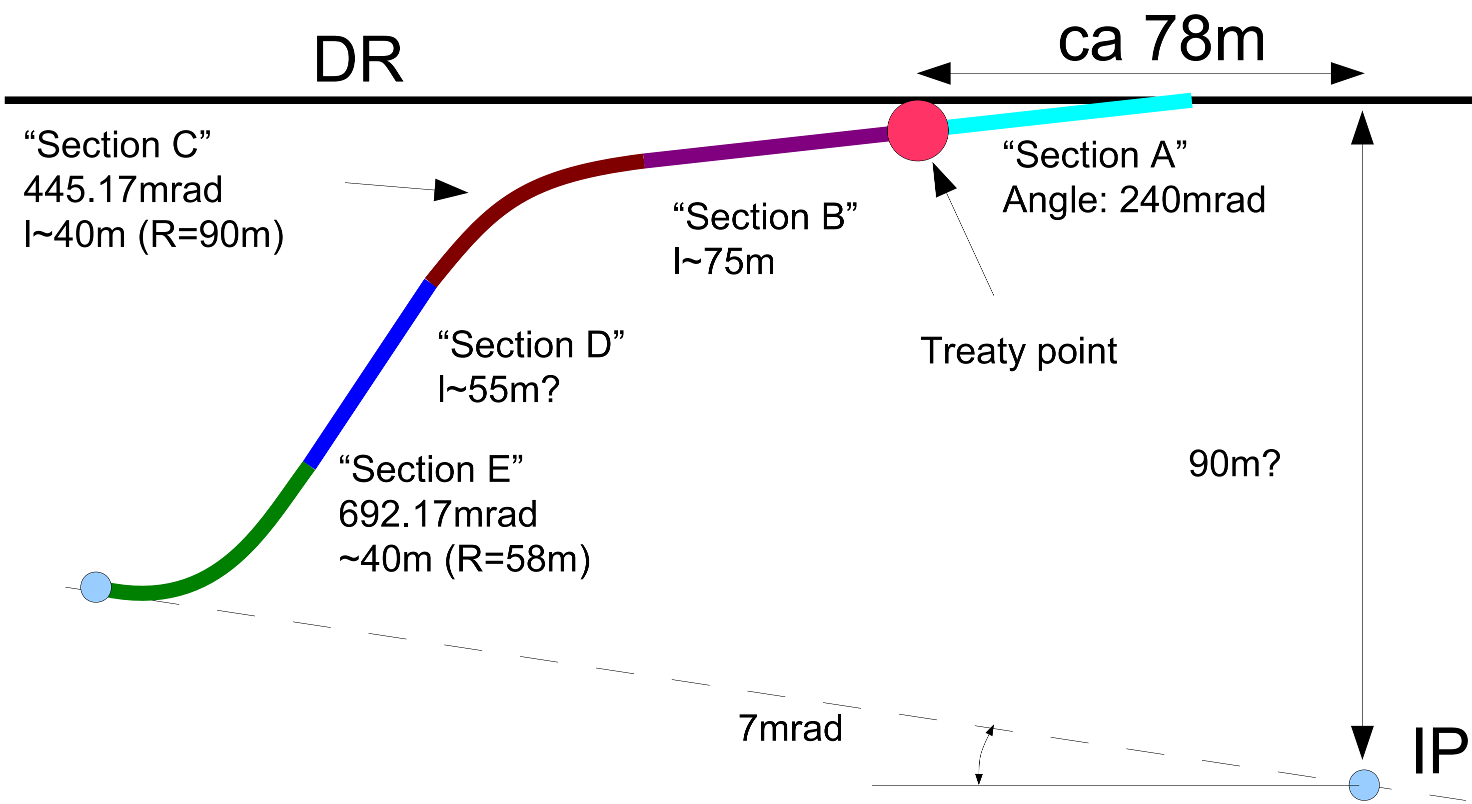
Central Region
Specific Issues

ELTR/PLTR Overview



Mark Palmer, Cornell

My Sketch



Angles: 5*138.43mrad = 692.17 = 445.17+240+7mrad given by Spin rotation angle
Lengths of Arcs: 40m (length of RTML arc design: dispersion freeness)

Section Names for ELTR/PLTR

- Proposed Naming Convention
- For 2nd Positron Ring: Add „U“ for „Upgrade“:
  PUDRINJ, PUDREXT,
  TPS2UDR, TPUDR2RTML,
  PLTRELEVU, PRTLCOMBU
- Treaty Point Definition: D*0966225

<table>
<tr><th>Section</th><th colspan="2">e- injection</th><th colspan="2">e- extraction</th><th colspan="2">e+ injection</th><th colspan="2">e+ extraction</th></tr>
<tr><td>A</td><td colspan="2">EDRINJ</td><td colspan="2">EDREXT</td><td colspan="2">PDRINJ</td><td colspan="2">PDREXT</td></tr>
<tr><td>Treaty</td><td colspan="2">TES2DR</td><td colspan="2">TEDR2RTML</td><td colspan="2">TPS2DR</td><td colspan="2">TPDR2RTML</td></tr>
<tr><td>B</td><td rowspan="4">ELTR</td><td>ELTRELEV</td><td rowspan="4">ERTL</td><td>ERTLCOMB</td><td rowspan="4">PLTR</td><td>PLTRELEV</td><td rowspan="4">PRTL</td><td>PRTLCOMB</td></tr>
<tr><td>C</td><td>ELTRARC2</td><td rowspan="3">ERTLTL</td><td>PLTRARC2</td><td rowspan="3">PTRLTL</td></tr>
<tr><td>D</td><td>ELTREC
ELTRSR</td><td>PLTREC
PLTRSR</td></tr>
<tr><td>E</td><td>ELTRARC1</td><td>PLTRARC1</td></tr>
</table>

Nailing down the numbers

- Length of straight section „D“: Driven by space required for PLTR
  - spin rotation solenoid(s), including branch for fast positron polarization switching
  - energy compression

  → need to wait for PLTR design
- Also: CFS sets a limit on minimum distance between IP and DR tunnels, from influence of detector movement on DR alignment
- Final design of RTML ERTL/PRTL waits for PLTR, but this is mainly a length adjustment

BDS Lattice: Some Numbers

- Official Lattice:
  „SB2009 AD&I, Nov 10 update“ → D*0947835
- End point of electron ML (start of PS undulator section):
  (x/y/z)=(27.116, 0, -3413.679)m
  → this is shifted w.r.t. the CAD model of N. Collomb
- Start of e- BDS: (17.44, 0, -2253.46)m
- This lattice is the best we have, but lacks several features:
  - **Beta function at IP not TDR value**
  - **Travelling focus not included**
  - **Push pull modifications missing**
  - **Collimation scheme not complete**
  - **Dump line for 10Hz operation missing**
- Problem: No personpower available
- Help from Daresbury group (D. Angal-Kalinin, J. Jones, N. Collomb) in spite of 0 funding and other obligations is greatly appreciated
- We need new ressources!

(Re)use of ML Cryo Modules

- Cryo modules: Check that your cryomodule definitions are consistent with ML cryomodules (applies to RTML, PS, ES bunch/energy compressors and PS/ES 5GeV boosters)
- Check in ILC2007b:
  - **doc/Module-9-8-9-8Dec06.xls**
  - **parameters/ilc007.ML_common.xsif**
- 5 GeV boosters will need new types of Cryomodules with more (2 / 4) quads → check how to make them compatible with ML modules, make sure that cavity lengths and spacings are correct

Part III

Preparations for the BTR at DESY

Preparations for BTR@DESY

- BTR is not a „workshop“, it is a **Review**
- **Baseline** Technical **Review**:
  - **Focus is the baseline design**
  - **R&D and alternative scenarios are less important**
- Baseline is defined by **Documents in EDMS**,
  not by talks given at the BTR:

  Power Point slides are not a surrogate for Technical Documents!

Power Point is no Documentation

COLUMBIA
ACCIDENT INVESTIGATION BOARD

See Report of Columbia Accident Investigation Board, vol I, p. 191 at http://caib.nasa.gov/news/report/volume1/default.html

Engineering by Viewgraphs

The Debris Assessment Team presented its analysis in a formal briefing to the Mission Evaluation Room that relied on PowerPoint slides from Boeing. When engineering analyses and risk assessments are condensed to fit on a standard form or overhead slide, information is inevitably lost. In the process, the priority assigned to information can be easily misrepresented by its placement on a chart and the language that is used. Dr. Edward Tufte of Yale University, an expert in information presentation who also researched communications failures in the *Challenger* accident, studied how the slides used by the Debris Assessment Team in their briefing to the Mission Evaluation Room misrepresented key information.[38]

The slide created six levels of hierarchy, signified by the title and the symbols to the left of each line. These levels prioritized information that was already contained in 11 simple sentences. Tufte also notes that the title is confusing. "Review of Test Data Indicates Conservatism" refers not to the predicted tile damage, *but to the choice of test models used to predict the damage*.

Only at the bottom of the slide do engineers state a key piece of information: that one estimate of the debris that struck *Columbia* was 640 times larger than the data used to calibrate the model on which engineers based their damage assessments. (Later analysis showed that the debris object was actually 400 times larger). This difference led Tufte to suggest that a more appropriate headline would be "Review of Test Data Indicates Irrelevance of Two Models."[39]

Tufte also criticized the sloppy language on the slide. "The vaguely quantitative words 'significant' and 'significantly' are used 5 times on this slide," he notes, "with de facto meanings ranging from 'detectable in largely irrelevant calibration case study' to 'an amount of damage so that everyone dies' to 'a difference of 640-fold.' "[40] Another example of sloppiness is that "cubic inches" is written inconsistently: "3cu. In," "1920cu in," and "3 cu in." While such inconsistencies might seem minor, in highly technical fields like aerospace engineering a misplaced decimal point or mistaken unit of measurement can easily engender inconsistencies and inaccuracies. In another phrase "Test results do show that it is possible at sufficient mass and velocity," the word "it" actually refers to "damage to the protective tiles."

As information gets passed up an organization hierarchy, from people who do analysis to mid-level managers to high-level leadership, key explanations and supporting information is filtered out. In this context, it is easy to understand how a senior manager might read this PowerPoint slide and not realize that it addresses a life-threatening situation.

At many points during its investigation, the Board was surprised to receive similar presentation slides from NASA officials in place of technical reports. The Board views the endemic use of PowerPoint briefing slides instead of technical papers as an illustration of the problematic methods of technical communication at NASA.

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Review Of Test Data Indicates Conservatism for Tile Penetration

- The existing SOFI on tile test data used to create Crater was reviewed along with STS-107 Southwest Research data
  - Crater overpredicted penetration of tile coating significantly
    - Initial penetration to described by normal velocity
      - Varies with volume/mass of projectile(e.g., 200ft/sec for 3cu. In)
    - Significant energy is required for the softer SOFI particle to penetrate the relatively hard tile coating
      - Test results do show that it is possible at sufficient mass and velocity
    - Conversely, once tile is penetrated SOFI can cause significant damage
      - Minor variations in total energy (above penetration level) can cause significant tile damage
  - Flight condition is significantly outside of test database
    - Volume of ramp is 1920cu in vs 3 cu in for test

BOEING 2/21/03 6

The vaguely quantitative words "significant" and "significantly" are used 5 times on this slide, with *de facto* meanings ranging from "detectable in largely irrelevant calibration case study" to "an amount of damage so that everyone dies" to "a difference of 640-fold." None of these 5 usages appears to refer to the technical meaning of "statistical significance."

The low resolution of PowerPoint slides promotes the use of compressed phrases like "Tile Penetration." As is the case here, such phrases may well be ambiquous. (The low resolution and large font generate 3 typographic orphans, lonely words dangling on a seperate line.)

This vague pronoun reference "it" alludes to *damage to the protective tiles*, which caused the destruction of the Columbia. The slide weakens important material with ambiquous language (sentence fragments, passive voice, multiple meanings of "significant"). The 3 reports were created by engineers for high-level NASA officials who were deciding whether the threat of wing damage required further investigation before the Columbia attempted return. The officials were satisfied that the reports indicated that the Columbia was not in danger, and no attempts to further examine the threat were made. The slides were part of an oral presentation and also were circulated as e-mail attachments.

In this slide the same unit of measure for volume (cubic inches) is shown a different way every time

3cu. in **1920cu. in** **3 cu. in**

rather than in clear and tidy exponential form 1920 in³. Perhaps the available font cannot show exponents. Shakiness in units of measurement provokes concern. Slides that use hierarchical bullet-outlines here do not handle statistical data and scientific notation gracefully. If PowerPoint is a corporate-mandated format for all engineering reports, then some competent scientific typography (rather than the PP market-pitch style) is essential. In this slide, the typography is so choppy and clunky that it impedes understanding.

The analysis by Dr. Edward Tufte of the slide from the Debris Assessment Team briefing. [SOFI=Spray-On Foam Insulation]

The New York Times **Magazine**

WORLD | U.S. | N.Y. / REGION | BUSINESS | TECHNOLOGY | SCIENCE | HEALTH | SPORTS | OPINION

PowerPoint Makes You Dumb

By CLIVE THOMPSON
Published: December 14, 2003

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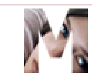


In August, the Columbia Accident Investigation Board at NASA released Volume 1 of its report on why the space shuttle crashed. As expected, the ship's foam insulation was the main cause of the disaster. But the board also fingered another unusual culprit: PowerPoint, Microsoft's well-known "slideware" program.

NASA, the board argued, had become too reliant on presenting complex information via PowerPoint, instead of by means of traditional ink-and-paper technical reports. When NASA engineers assessed possible wing damage during the mission, they presented the findings in a confusing PowerPoint slide -- so crammed with nested bullet points and irregular short forms that it was nearly impossible to untangle. "It is easy to understand how a senior manager might read this PowerPoint slide and not realize that it addresses a life-threatening situation," the board sternly noted.

Status of Mandatory Documents

- These Mandatory Documents are expected to be prepared **in advance** of the BTR
- Responsibility of the TAG Leader
- WBS, beamline summary and sketch: Support provided by DESY (B.L.)

	PS	ES	BDS	RTML	DR
WBS	OK				OK
System Overview					
Beamline Summary	OK				
Beamline Sketch	OK				
Parameter List	Parts				Parts
Lattice	Parts		Parts		OK
Treaty Point Definitions	Parts	Parts		Parts	OK
CFS Criteria	Parts				OK

Design Register

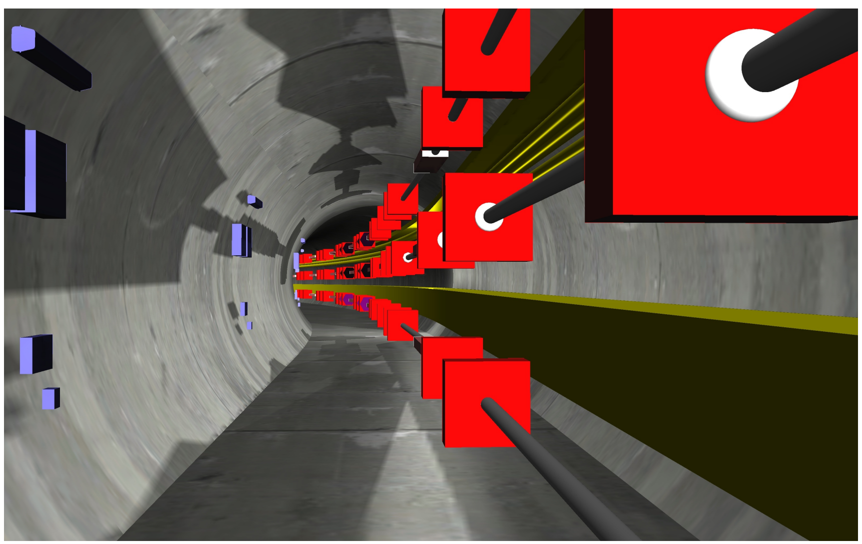
- Status of the Design Work and its Documentation is documented in the **Design Register** D*0959505
- TAG leaders (and lattice designers): check it!
- Design Register also contains references to EDMS documents, and remarks about open issues
- Design Register is a working document for Project Managers, but may be useful for you as well

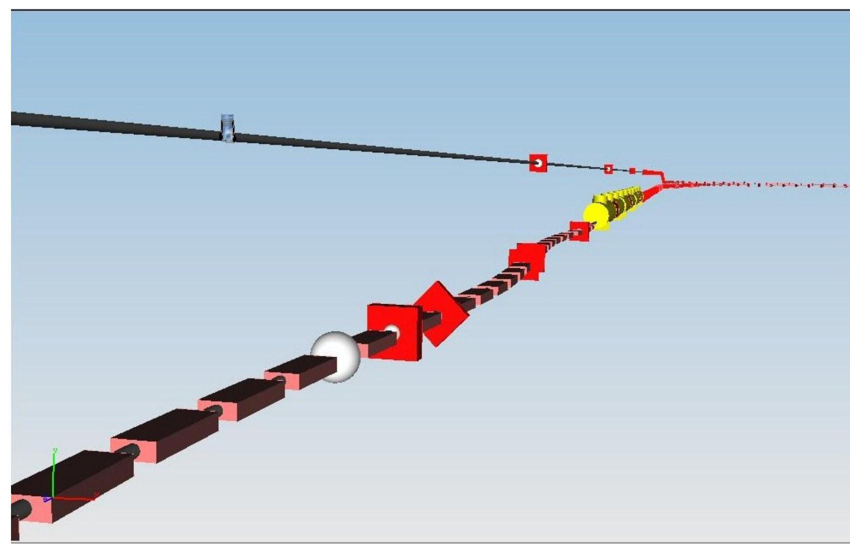
Parameter Lists

- Top Level Parameter List: D*0925325
- Subsystem Parameter Lists depend on the top level list
  → if top level list has been updated, all subsystems have to update their parameters as well
- Changes to the top level parameter set have to be approved by the Project Managers, and are communicated via EDMS to all TAGs
- This makes sure that all subsystems are aware of any parameter changes
- TAG Leaders must acknowledge such notifications, and must act on it

Summary / Conclusions

- Work on an integrated, complete ILC lattice for the TDR has started
- Goal is consistency and traceability of cost estimate and CFS layout with the lattice
- DESY's EDMS-group will support the Design Integration by providing 3D visualization and component lists derived from lattice files





Backup

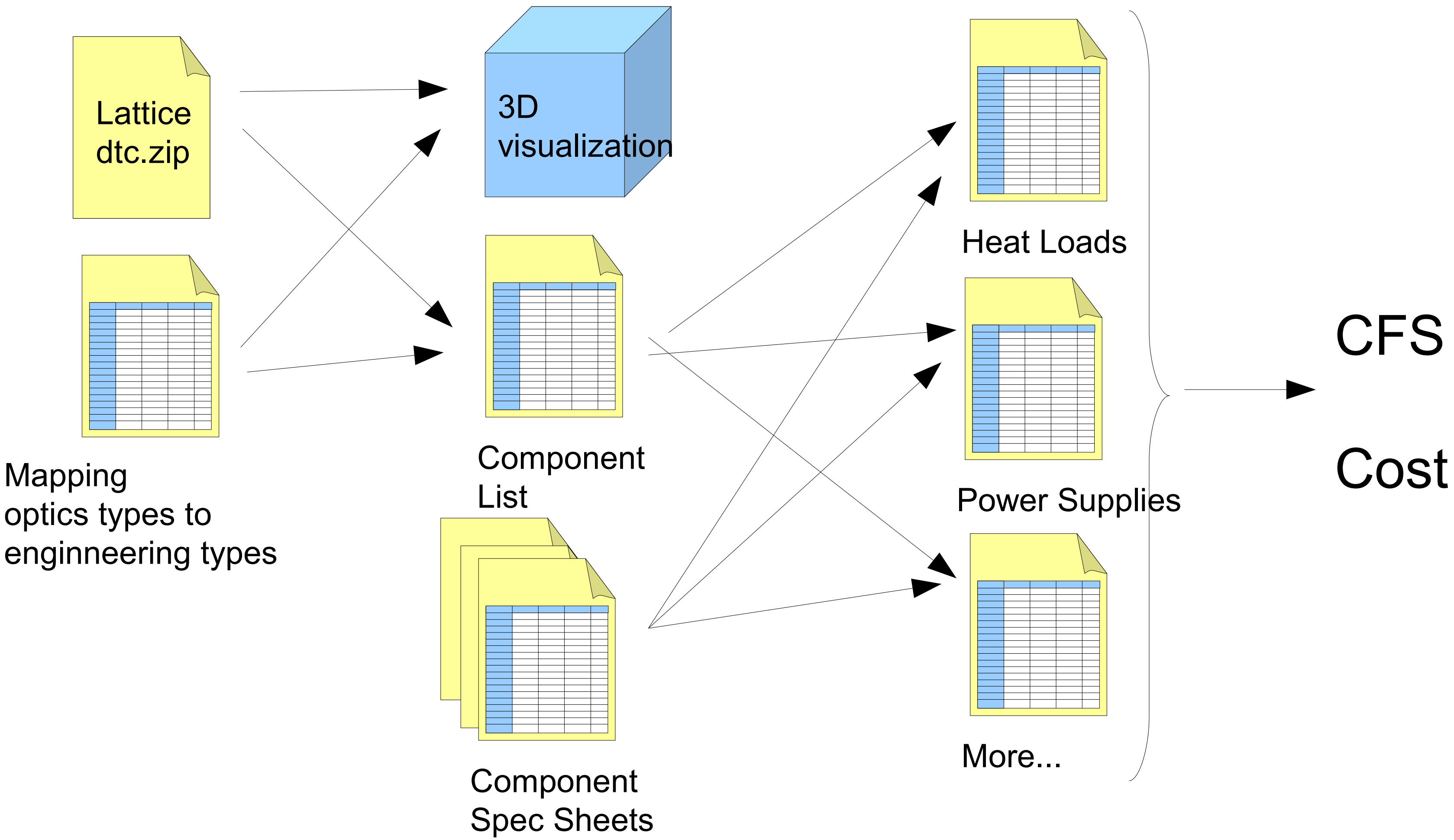
Goal: Traceability

- TDD should allow to trace
  - CFS requirements
  - Costs

from lattice to the final specifications/numbers

- Mandatory documents pave the way:
  - Parameter list
  - Beamline description
  - Lattice
  - Component lists
  - Component specifications
  - Derived calculations: Heat, Power supplies, Vacuum

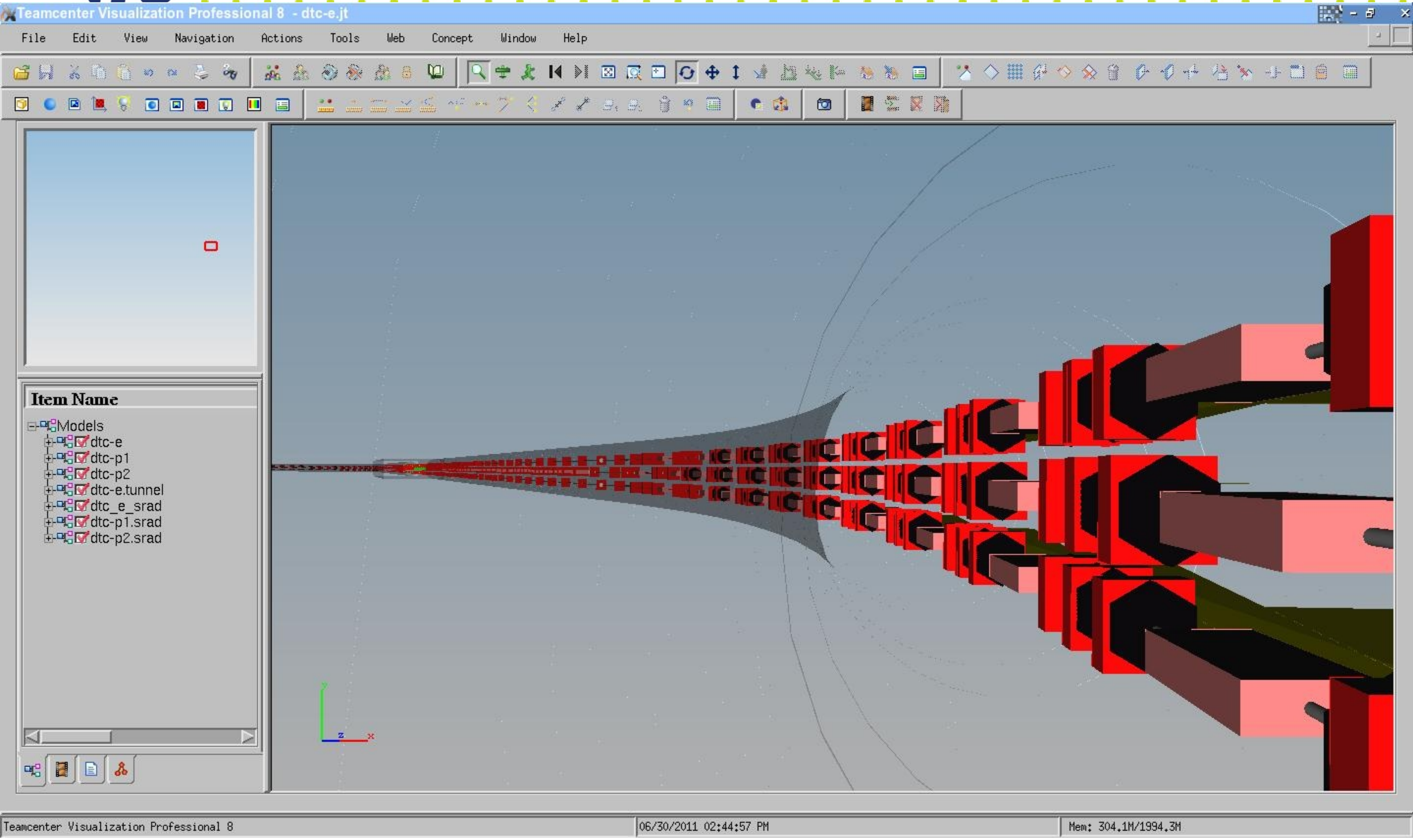
Documents


Lattice
dtc.zip
3D
visualization
Mapping
optics types to
enginneering types
Component
List
Component
Spec Sheets
Heat Loads
Power Supplies
More...
CFS
Cost

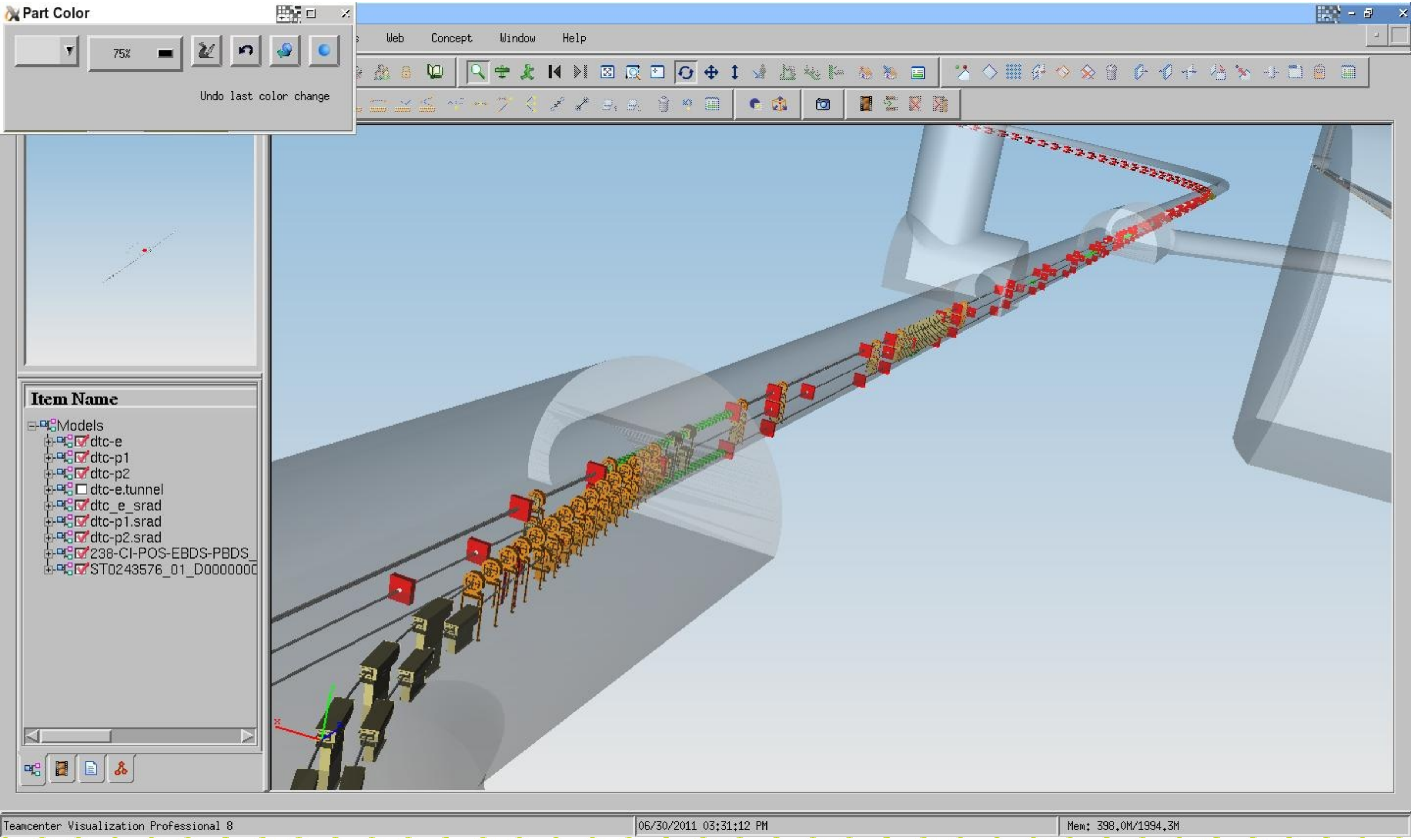
Automated Lattice Analysis

- We have automated tools to read in original lattice information and check them
- Needs some help from the lattice designer:
  - Markers between all sections
  - Lists of mappings from optics elements to physical parts
  - Output from SURVEY command in global coordinate system in MAD's format
    (BMAD needs to be investigated)
  - Output from TWISS command in MAD's format
- Can create:
  - 3D visualization
  - Component lists for checks agains official lists

Visualization: Example



Combination with Existing Models



Design Documentation

- Beamline designs are documented by
  - A parameter list (energy, emittance, aperture, timing...)
  - The lattice
- The lattice is the foundation of more detailed documents describing:
  - Magnets
  - Power supplies
  - Vacuum system
  - RF system
- These documents are the basis for
  - The CFS requirement documents
  - The cost documents
- → This reflects a certain work flow: Lattice and parameters first, then documentation and tally of components, then CFS and Costing
- The status of this is summarized in the Design Register

Mandatory Documents

- Mandatory Documents:
  A set of documents that should be prepared for all Accelerator Systems
- Mandatory Documents reflect the (idealized) work flow on the Technical Documentation (and Design itself)
- List (see EDMS D*0959595):

OK **1. WBS (Excel spreadsheet → Node structure in EDMS)**

2. System layout (Word): ~2 page summary of system

3. Parameter Table (Excel): Parameters of the system, including special parts (targets etc) and all beamline

4. Beamline summary: Written overview + sketch of all beamlines, including Treaty Points and Markers

OK **5. Lattice (xsif files): The lattice**

6. Component lists (Excel): List of components (magnets, cavities, BPMs, PS) [partially] derived from lattice

7. Component Specifications (Excel): ~1 page specification of each component (magnet, cryomodules, power supplies, vacuum systems, dumps)

(OK) **8. CFS Criteria (Excel): Summary of input data for CFS layout, plus detailed calculations of heat loads, power supply needs, cryo needs, ventilation, space (tunnel diameter, alcoves etc)**

9. Cost information (Excel): Input data to cost effort