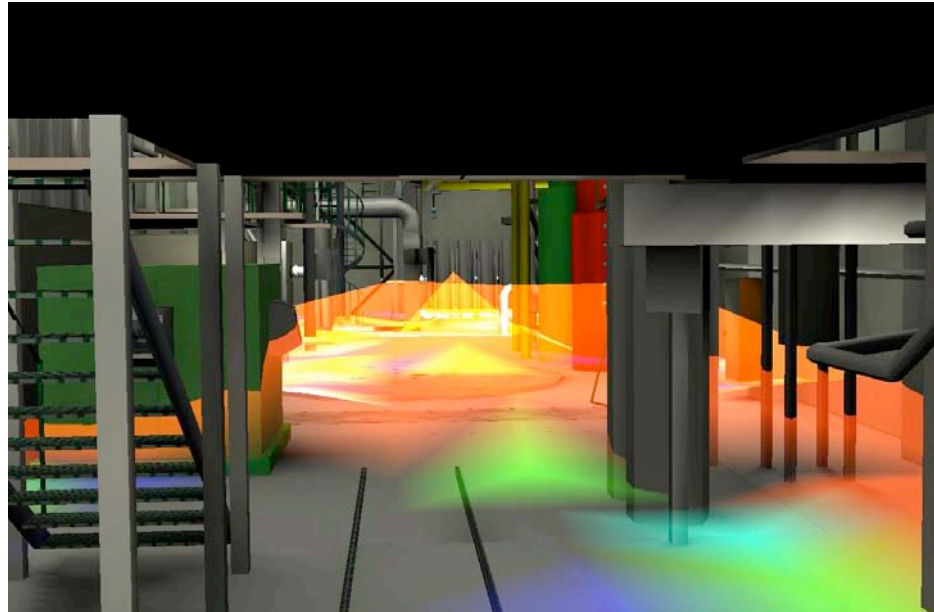


HALDEN VIRTUAL REALITY CENTRE

Applying advanced visualisation technologies and human factors to solve real-world challenges



Virtual Reality for Radiation Visualisation and Knowledge Management

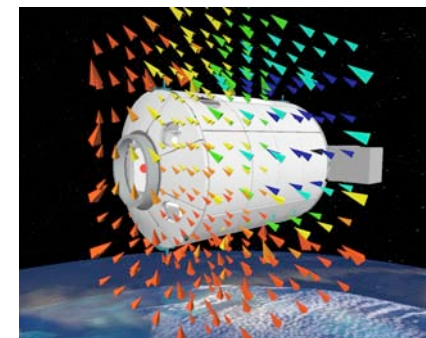
Halden, March 2005

Presentation prepared by:

Grete Rindahl, Geir Meyer, Michael Louka. and Terje Johnsen

Radiation Visualisation

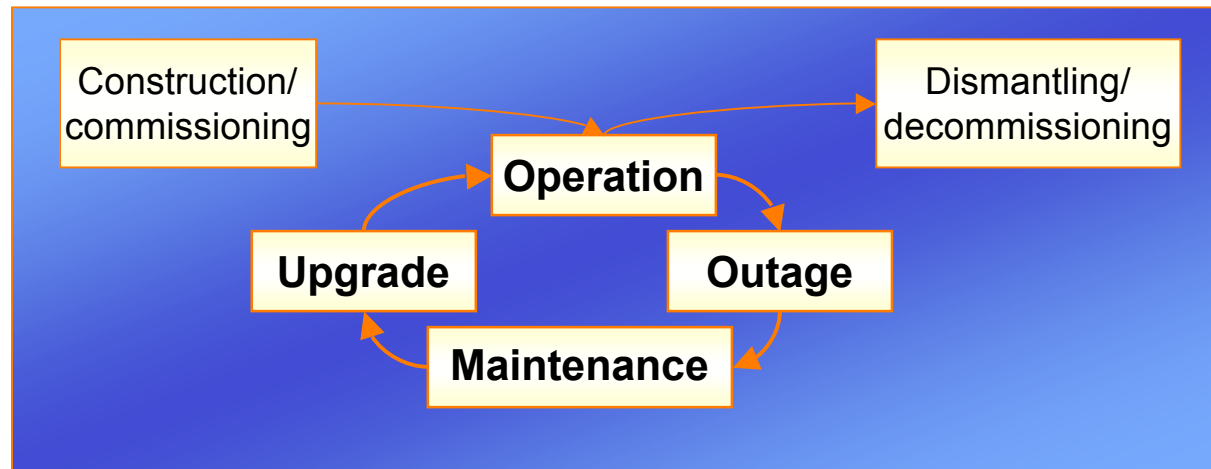
- 3D model of the premises with navigation
- Seeing invisible but measurable or computable phenomena such as
 - Contamination
 - Radiation or dose-rate
 - Temperature
 - Risk
- Displayed as colour coding or vector fields inside the 3D model



Knowledge Management (KM)

- The management of knowledge within organizations
- Seeks to make the best use of the knowledge that is available to an organization, creating new knowledge in the process
- Good KM tools should help to
 - Retain knowledge across staff generations
 - Share knowledge obtained by the staff through the years with external suppliers

Life Cycle KM



- During all phases in a facility's life cycle one will benefit from the expertise developed in performing or planning other phases

Virtual Reality (VR)

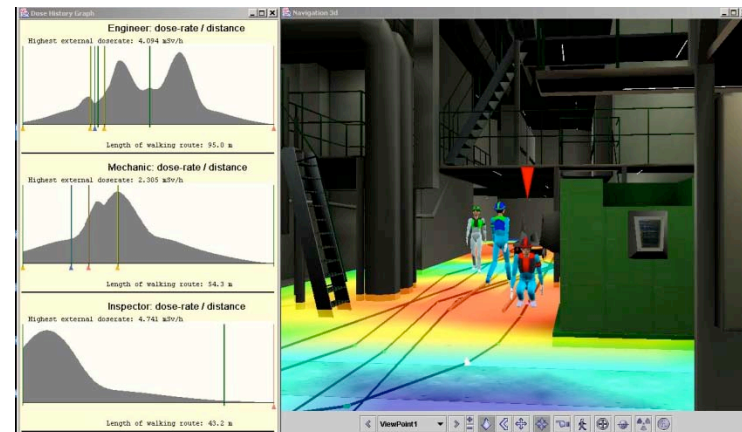
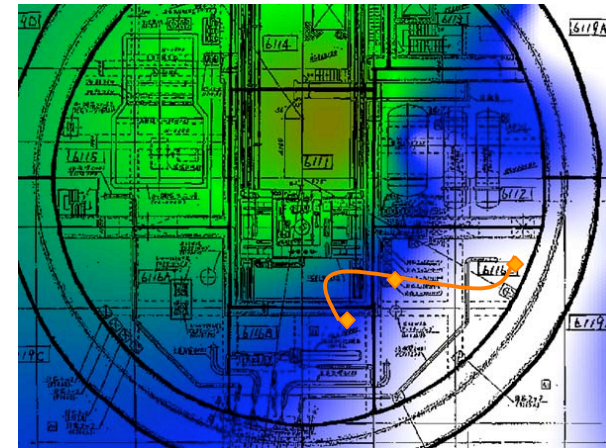
- Powerful tool for design, planning, and training
- 1000 words << 1 picture << VR model
- VR used as a KM tool can create new knowledge
 - Procedure optimization
 - Radiation awareness
 - Learn by doing
- The same tool can be used in all phases throughout the life cycle of the facility

Planning Reference List

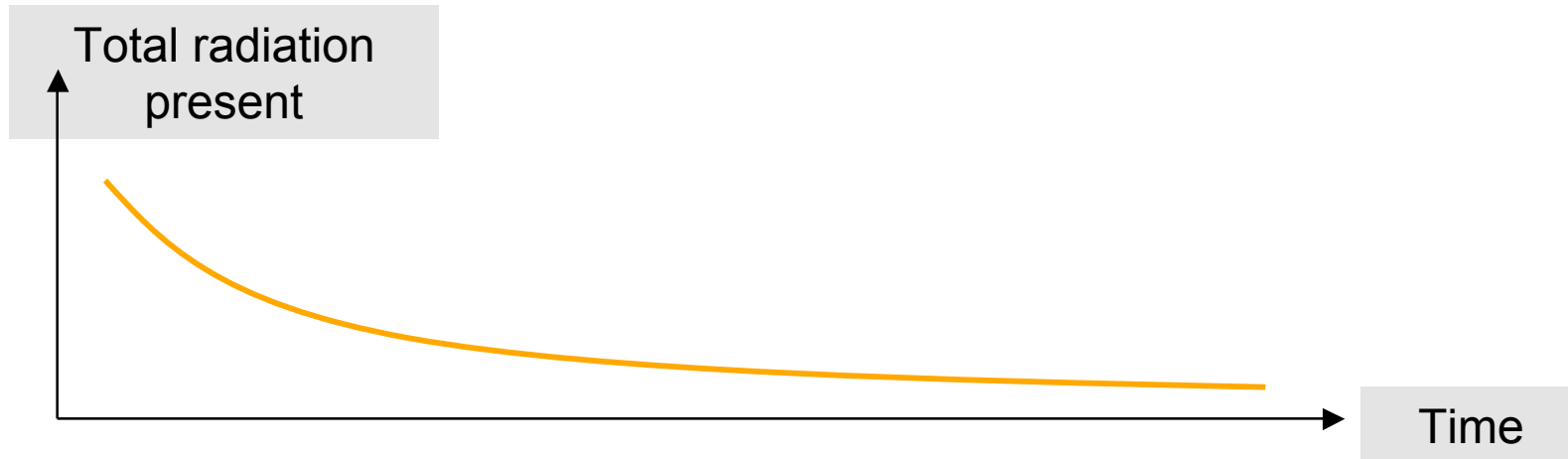
<p>Japan Nuclear Cycle Development Institute (JNC): The VRdose Software Planning and administration of the Fugen Nuclear Power Station decommissioning with focus on work simulation, radiation visualisation and dose calculation</p>	Japan	1999-2004
<p>Tokyo Electric Power Co. Inc. (TEPCO) and TEPCO Systems Corporation (TEPSYS) Technology for automatic radiation measurement and display using position tracking. KM, dose reduction and work planning.</p>	Japan	2005-
<p>SOcietà Gestione Impianti Nucleari (SOGIN) and Ente per le Nuove Tecnologie, L'Energia e l'Ambiente (ENEA): VirtualDecom Planning and administration for decommissioning of plutonium contaminated glove boxes.</p>	Italy	2002-2003
<p>European Space Agency (ESA): DESIRE RadVis, Cosmic radiation visualisation with KTH & ESA</p>	Europe	2003-2004
<p>NASA, Potential Alliance Radiation visualisation and dose optimisation</p>	USA	2004-

VRdose – “To See the Invisible”

- Fugen Nuclear Power Station, Japan
 - Decommissioning started 2003
 - Finished 2023
 - VR project started 1999
- VR based tool for planning and administration of decommissioning
 - Work simulation
 - Dose-rate visualisation
 - Occupational dose calculation
- Training prior to dismantling
 - Inaccessible areas
- Public acceptance purposes

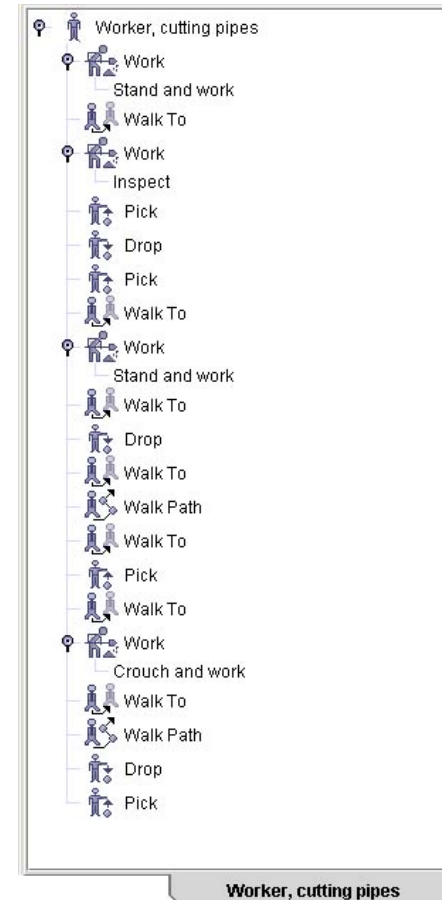
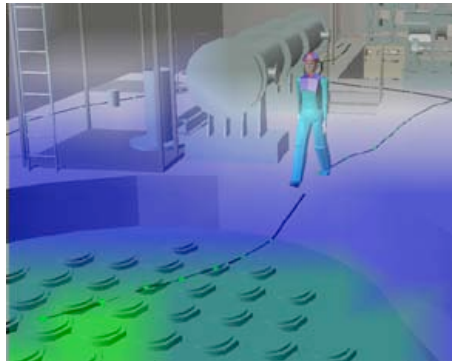


Decommissioning: What happens after the productive life?



Work Scenarios for Planning and Analysis

- Recording work scenarios inside the Virtual Environment (VE)
- Displaying and evaluating human movement in relation to the conditions of the VE



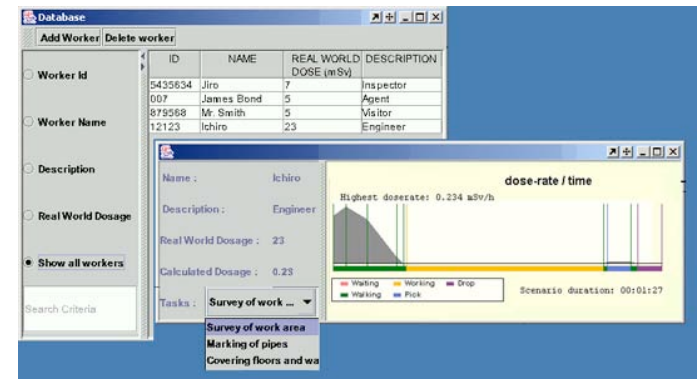
Keep Radiation Exposure at a Minimum

- Raising the radiation awareness in operators, work planners and decision makers
- Gaining more information on expected doses directly connected to work tasks
- Recorded work scenarios may be played back, edited and evaluated
- The dose-rate, the accumulated doses and other consequences for the operators may be analysed



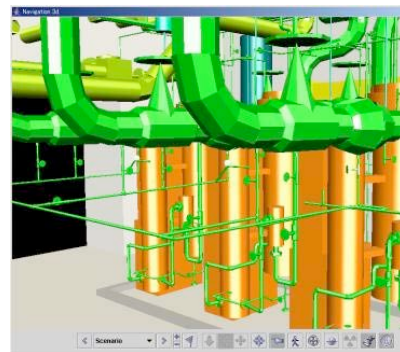
Keeping the Costs Down

- VRdose work scenarios may be assigned to real life workers in a database, making it easier to plan ahead for dose costly operations
- A sound dose budget makes it easier to obtain a sound work budget



Inventory Database

- Store inventory information in the nuclear practice
 - History
 - Contamination
 - Known risk connected to the object
 - Schedule for removal or dismantling
 - Photographs
 - Other relevant information



機種	PUMP		
系統	631		
デバイス	30		
機種名称	ポンプ		
系統名称	海水冷却系		
機種番号_名称	C-海水循環ポンプ		
計測ループ区分_機種			
計測ループ区分_系統			
計測ループ区分_デバイス			
型式	92"753"キ		
製造者コード	FEN	製造者名	富士電機
製造番号	63164E0-3	製造年月	
製作者コード	SHI	製作者名	住友重機械工業
製作年月		重量(kg)	4930
設置場所コード	60	設置場所	10.00.00
設置場所構造X座標	00	設置場所構造Y座標	05
外形寸法_高さ(mm)	2480	外形寸法_幅(mm)	630
外形寸法_奥行(mm)	1410	用途	
工業規格	JIS S1034L-2SSC/	メーカー名	2480Z
関係図番番号	JR1074C	系統図番号	JR-1809
流体種類コード		流体種類コード	
電源仕様	AV2Z	電源区分	
設置担当者コード		登録日	1999/7/8
更新日	1999/1/5	廃止日	1999/5/1
廃止物分類コード	I	供給電源コード	

VR Improves Communication...

- ..by being able to depict a situation to people with varying backgrounds in an unambiguous manor
 - Reaching public and authorities
 - Clarification between staff members
 - Talking to the future generations:
Preserving and building knowledge of the premises as time passes



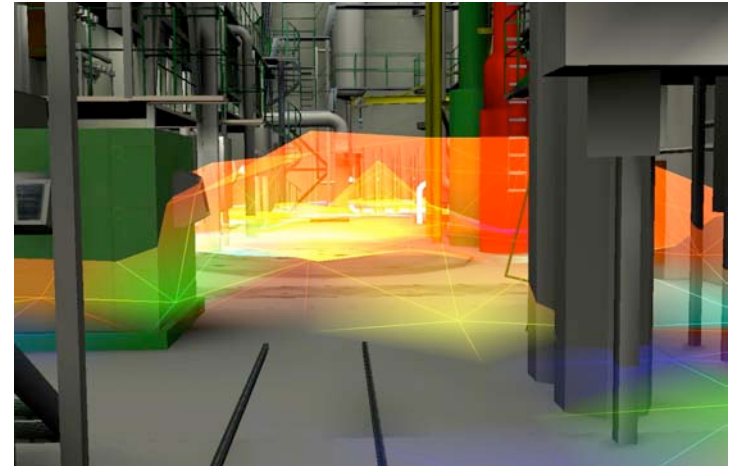
SOGIN: Virtual Decom

- Decommissioning of plutonium gloveboxes
- Displacement, dismantling and packaging
- Procedure testing and development
- Communication
 - Staff
 - Licensing authorities
- Draft procedures drastically changed already after first recorded scenario



TEPCO

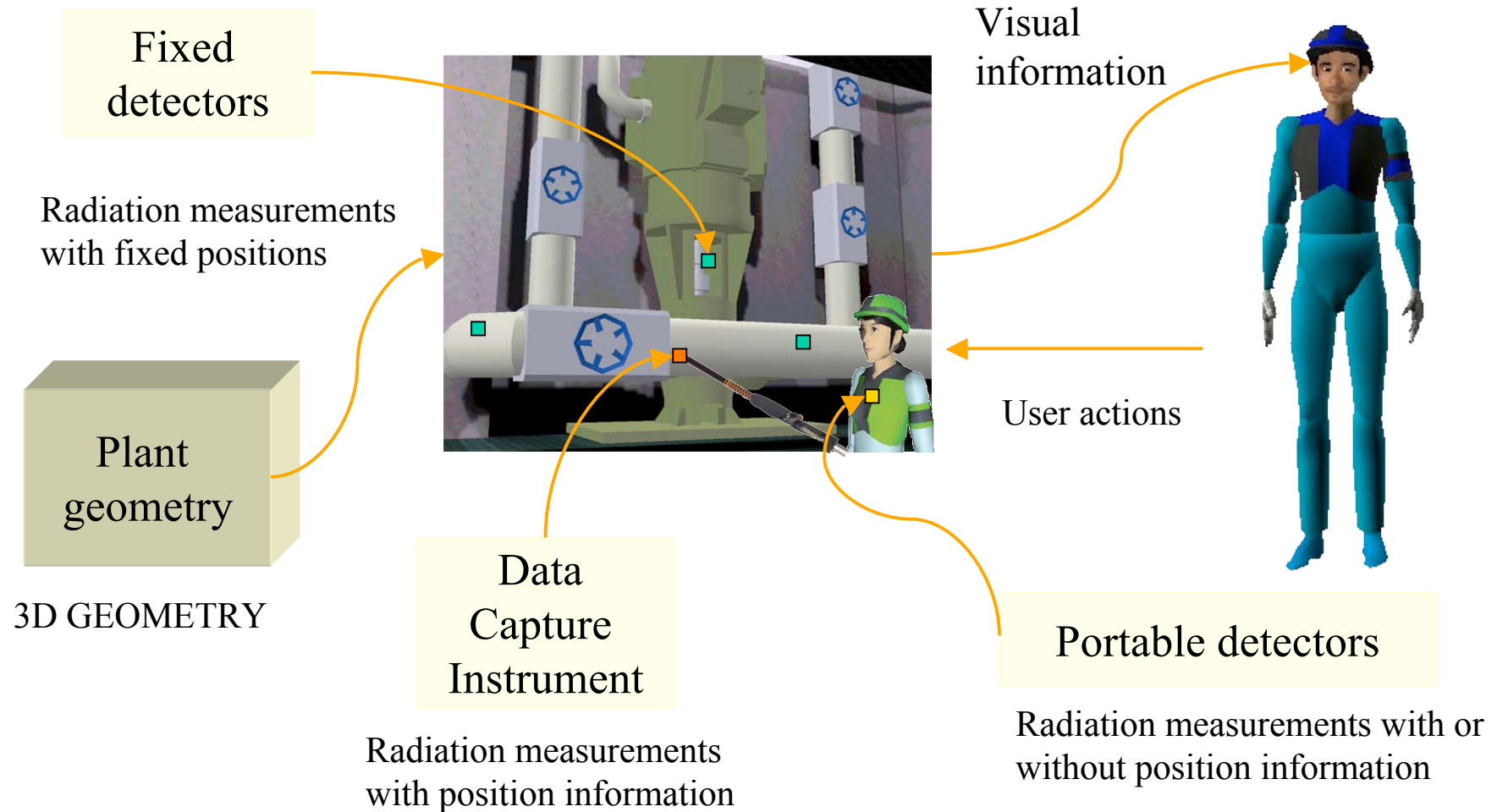
- Cooperation research project between IFE and TEPSYS for TEPCO
- The control room staff will be using VR software linked to devices for radiation measurement and position tracking to help operators minimize their doses



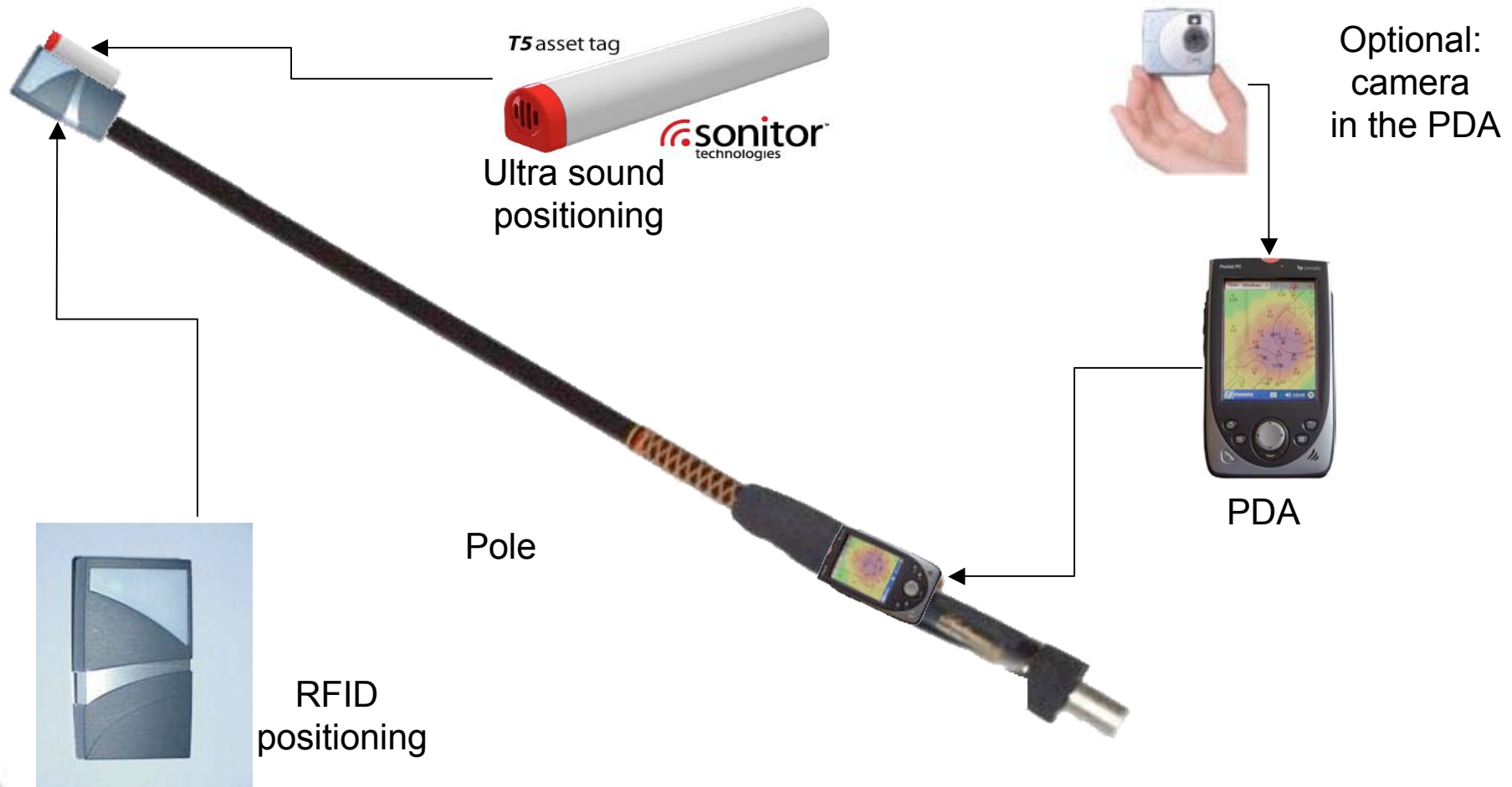
Purpose of the proposed system

- Offer a new and improved method for radiation data gathering
- Increase the radiation awareness of the personnel
- Reduce the radiation doses of the plant workers
- Improve communication by keeping the same frame of reference
- By achieving the above, costs can also be significantly reduced

Operational Environment

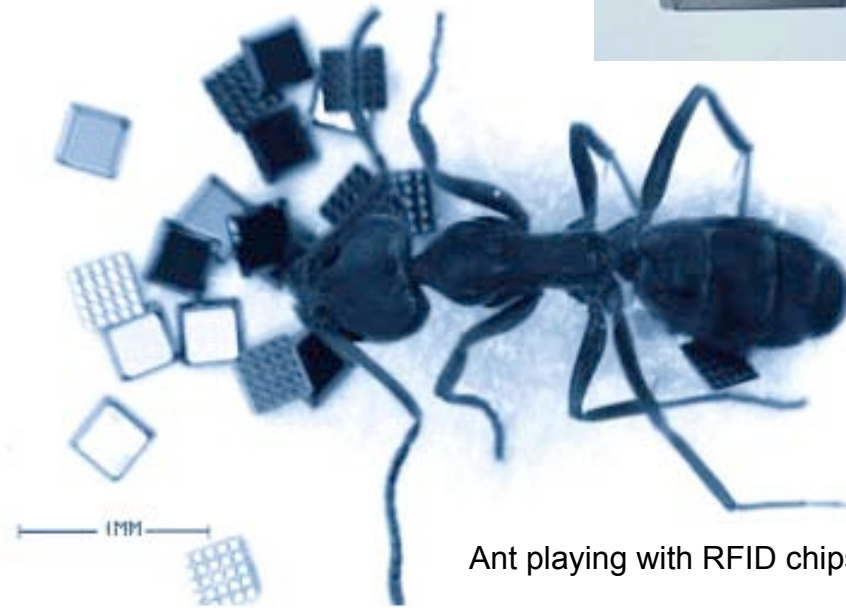


Data Collection Instrument (DCI)



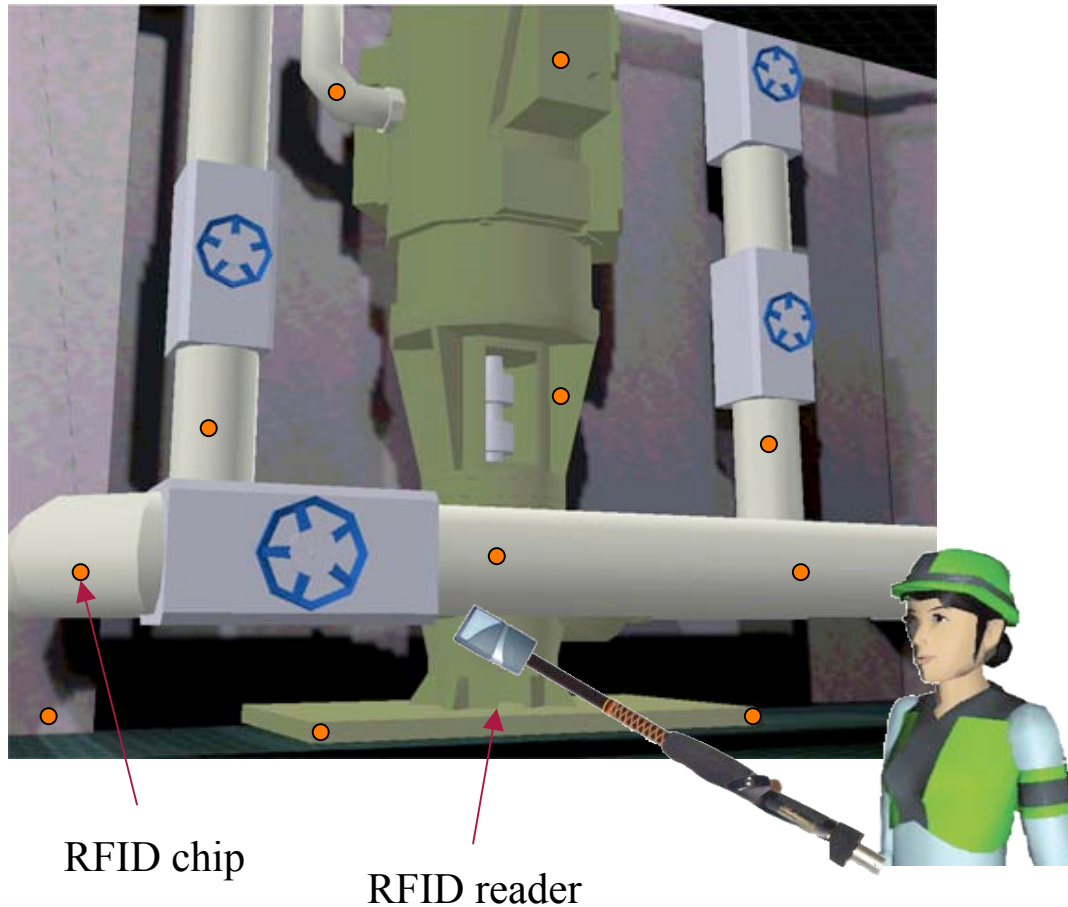
Radio Frequency Identification Tags (RFID)

- Small RFID chips will be placed at various locations in the environment
- An RFID reader placed at the end of a pole identifies each chip when near enough
- When a chip is identified, an action may be triggered
- In this case the action will be to perform a radiation measurement



Ant playing with RFID chips

RFID as aid to localize measurements



- Measured data is stored in the DCI
- Stored data can be transferred to the Visualisation System
- If the PDA has a wireless network connection, this can be done during measurements

Wearable detectors

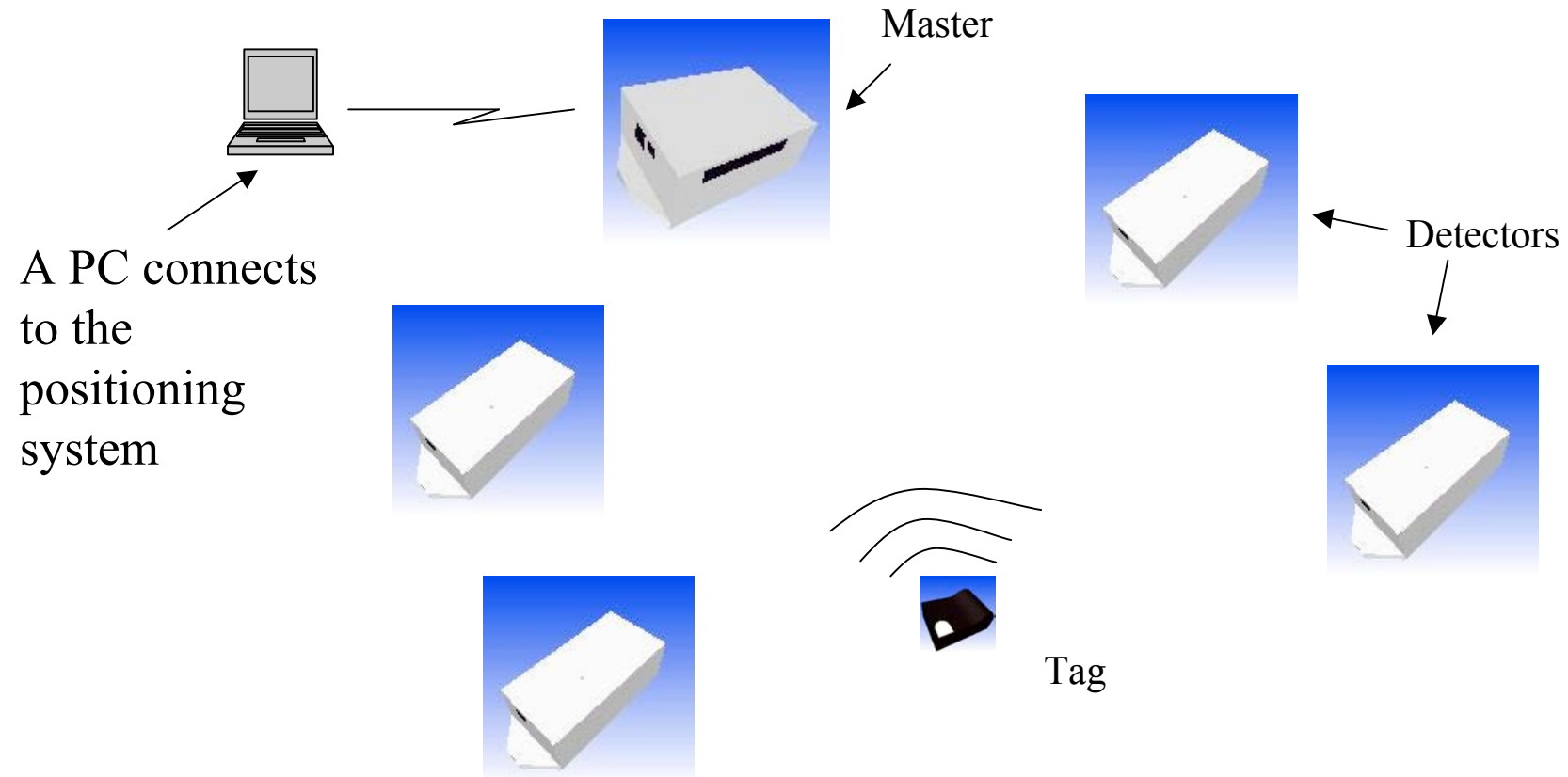
- The workers can also wear radiation detectors
- This can be regular dosimeters or dosimeter combined with position tracking
- If position tracking is chosen, this may also be used to track the operators position in the work area from the control room



Sonitor 3D Positional System

- Used to position objects in rooms
- Based on ultrasound (~40kHz)
- No interference with any electronic equipment
- Detectors placed in the room calculate position of small tags that emit ultrasound
- Detectors are grouped together with one acting as a master
- Tags can be worn by operators, giving their position in real time
- Tags can be attached to dosimeters to register positions with the measured values
- All masters are connected to a computer network
- A standard pc talks to the masters through the computer network

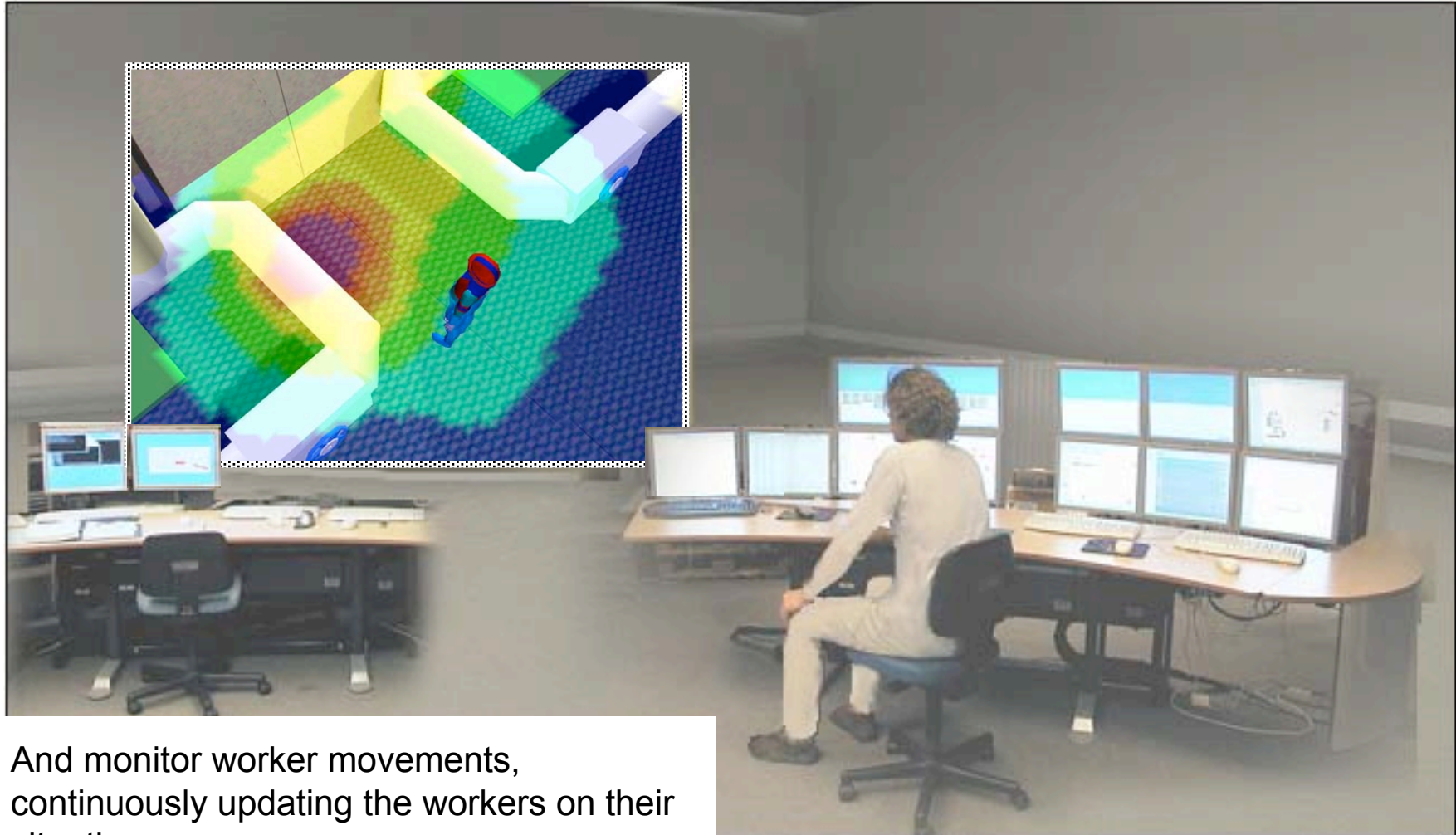
Sonitor equipment



PDA radiation visualisation

- The operators using the Data Capture Instrument inside the work area may see the real-time radiation situation projected on a map in a hand held PDA
- With each new measurement point the radiation map will be updated to higher accuracy
- It will be possible to have a list of all desired measurement positions stored in the tool
- The measurement points may be indicated on the PDA map
- If one or more points from the measurements list has not been measured, the operator will get a warning when finishing the procedure

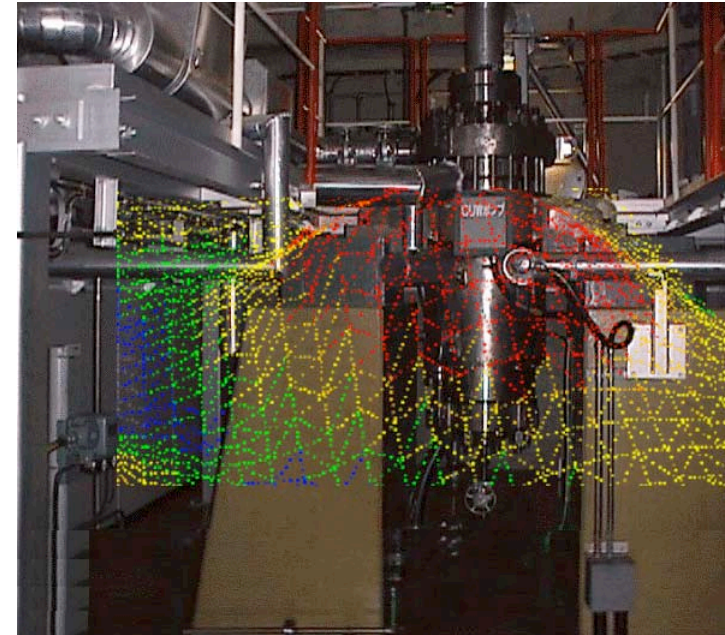
Remote Radiation Monitoring



And monitor worker movements, continuously updating the workers on their situation

Possible future extension

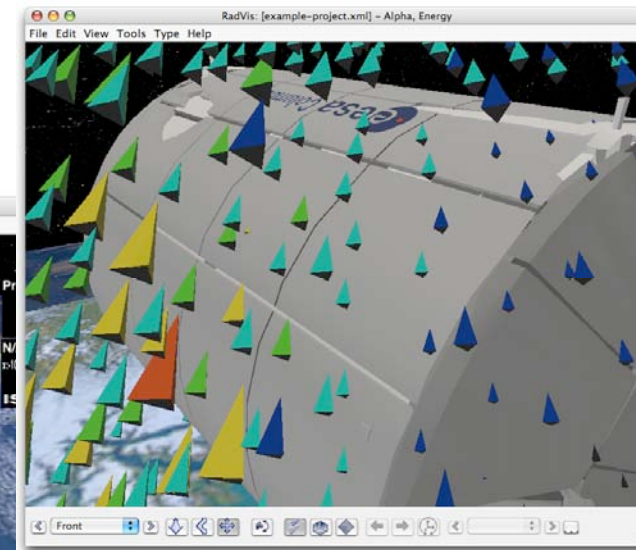
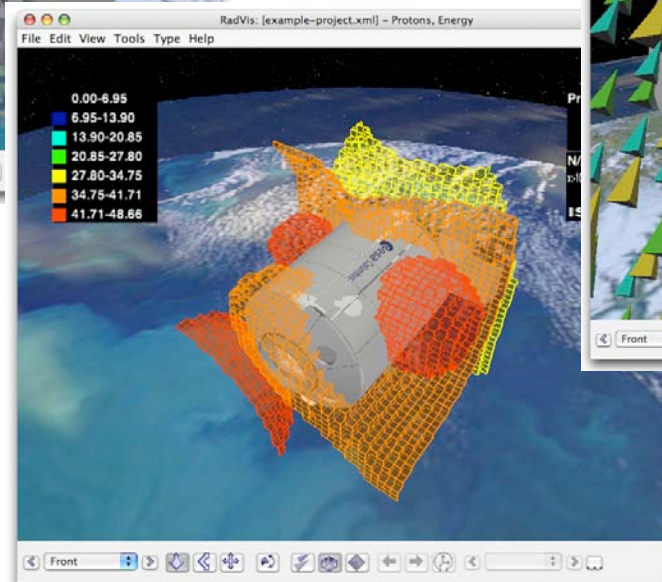
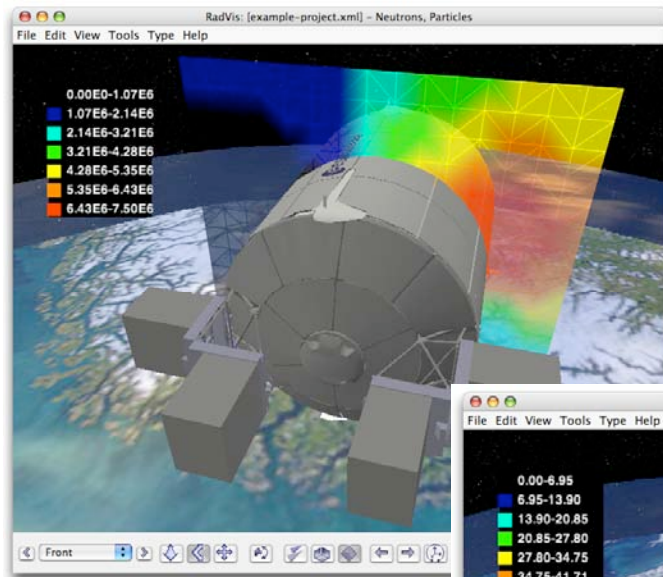
- Letting the workers wear special glasses to see the radiation fields...
- ..while the control room staff can monitor the workers' positions inside a VR model..
- ..and see what each worker sees.



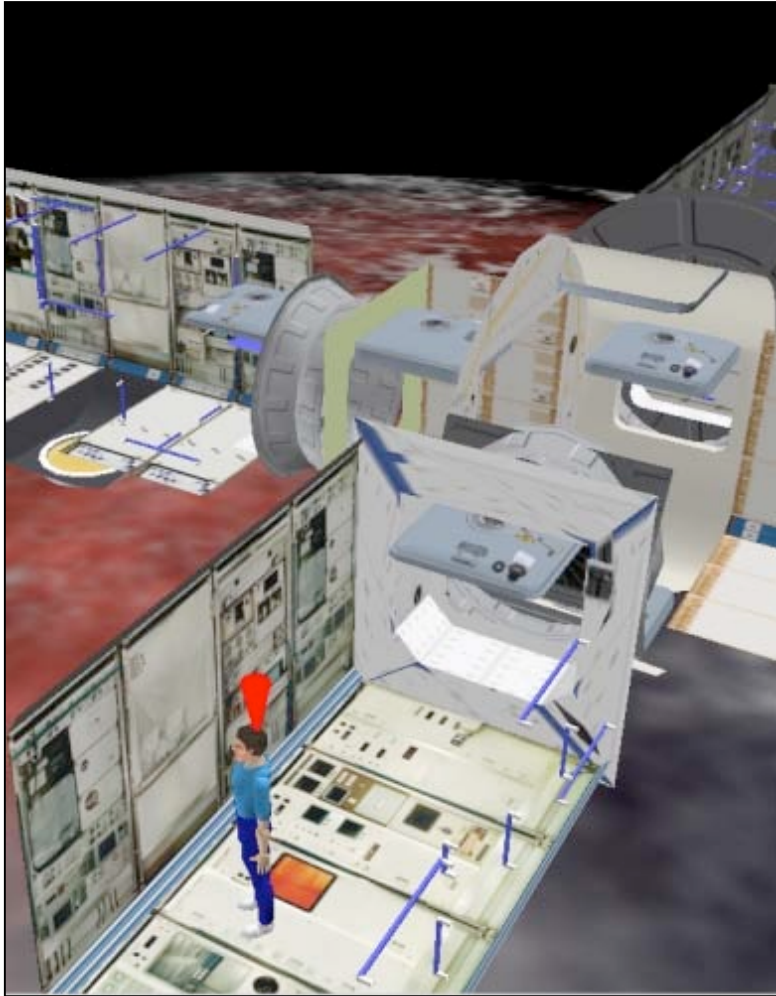
ESA

- Cosmic radiation permeates space
 - Sources located primarily outside our solar system
 - Sun also source of significant amounts of ionised radiation
 - extreme levels during solar flares
 - astronauts and equipment outside the protection of earth's atmosphere are at risk of exposure to severe radiation environments
- Space agencies would like an overview of radiation environments
 - based on predictions or measurements from on-board radiation sensors
 - To enable staff to rapidly assess a situation for design, training, or operations purposes

RadVis: Cosmic Radiation Visualisation



NASA cooperation being established



- NASA must protect astronauts
 - Vision of sending crew into deep space
- US Environmental Protection Agency
 - Risk of dying of cancer must be less than 15%
- Radiation levels at ISS
 - 1 millisievert a day – one year on Earth
 - Effective shielding is heavy

Some Quantifiable Economical Gains

- VRdose
 - JNC expects to save 2% on costs each year during 20 years for the decommissioning of the Fugen Nuclear Power Station by using virtual reality tools in planning and communication
- TEPSYS
 - Estimates that 100.000.000 Yen (1 M\$) will be saved for each mS avoided by better outage planning and raised radiation awareness

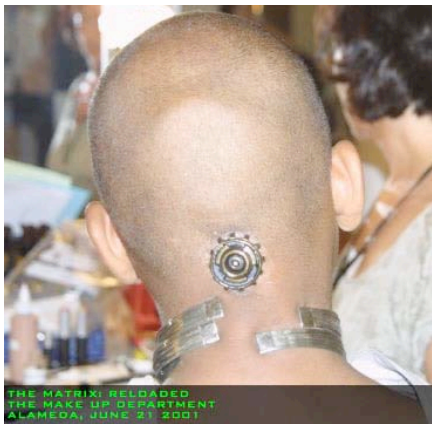
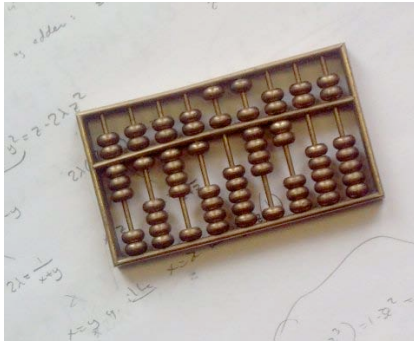
Information vs. useful information



What is sustainable?

Can the future users easily find the crucial information?

Platforms change faster and faster



Sustainability

- Sustainable Virtual Reality needs to be
 - Not depending on any vendor or developer staying in the market
 - Platform independent
 - Based on open source and open standards
- Strong requirements of sustainability must be put on any system chosen for documenting the state of a nuclear practice to the next generation

Why VR then?

A picture says more than a thousand words. A full 3D model is able to say a lot more..



...and in a language our children will easily understand.

Thank you for your attention!