Dumps and Collimators
S4 Meeting
EDR Plan

3(EDR) + 2(Politics) + 7(Build) year model

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representing SLAC perspective
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Component Types

Parts list corresponding to current assumed design (IWA)

- **Dumps (26)**
- **Fixed aperture collimation devices (85)**
- **Variable aperture collimation devices (85)**
- **MPS and PPS stoppers (25)**

Basic Device Technology assigned based on incident power, beam energy and particle type

- **18MW-600kW: Pressurized water dump**
- **600kW-40kW: Metal balls in water bath**
- **40kW-25W Peripheral cooled solid metal**
- **25W – 0W Un-cooled metal**

18MW Water Dump Technical Issues

BDS features
- **Optics & drift to increase undisrupted beam spot size on window**
- **Raster beam in 30mm radius circle in 1 ms; interlock to MPS**
- **Hi-power donut collimators to protect vessel window**

Vessel
- **6.5m ($18X_0$) water followed by 1m water-cooled Cu ($22X_0$)**
- **1.5m diameter with vortex flow water, v=1.0-1.5 m/s , at r=30cm**
- **10 atm to prevent boiling**
- **30 cm diameter 1mm Ti vessel window with water cooling nozzles**

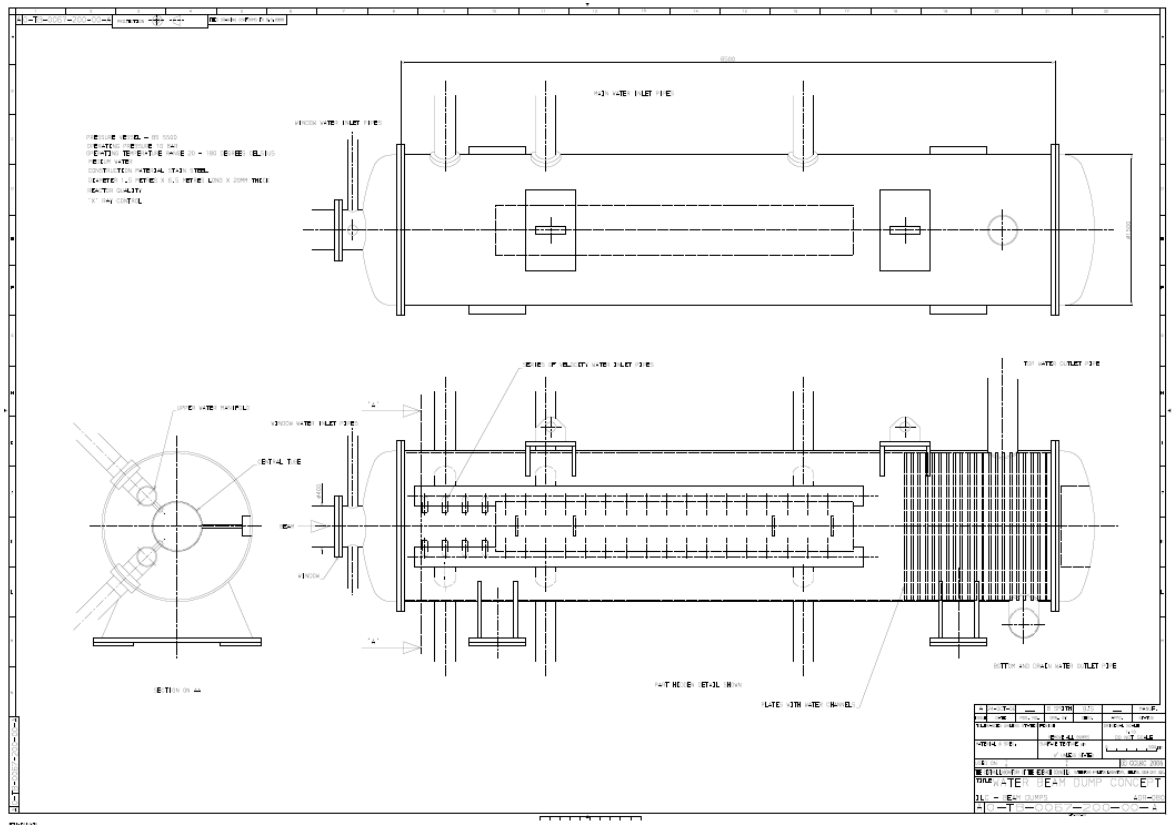
Rad water system
- **2300 gpm three loop water system**
- **18 MW heat exchanger & ~400HP of pumps per loop**
- **Catalytic H_2-O_2 recombiner**
- **Mixed bed ion exchange column to filter 7Be**
- **Containment for tritiated water**

Shielding
- **50cm Fe + 150cm concrete 'local' protection for personnel & beamlines**
- **200cm site dependent to protect ground water**

18MW Water Dump Safety Issues

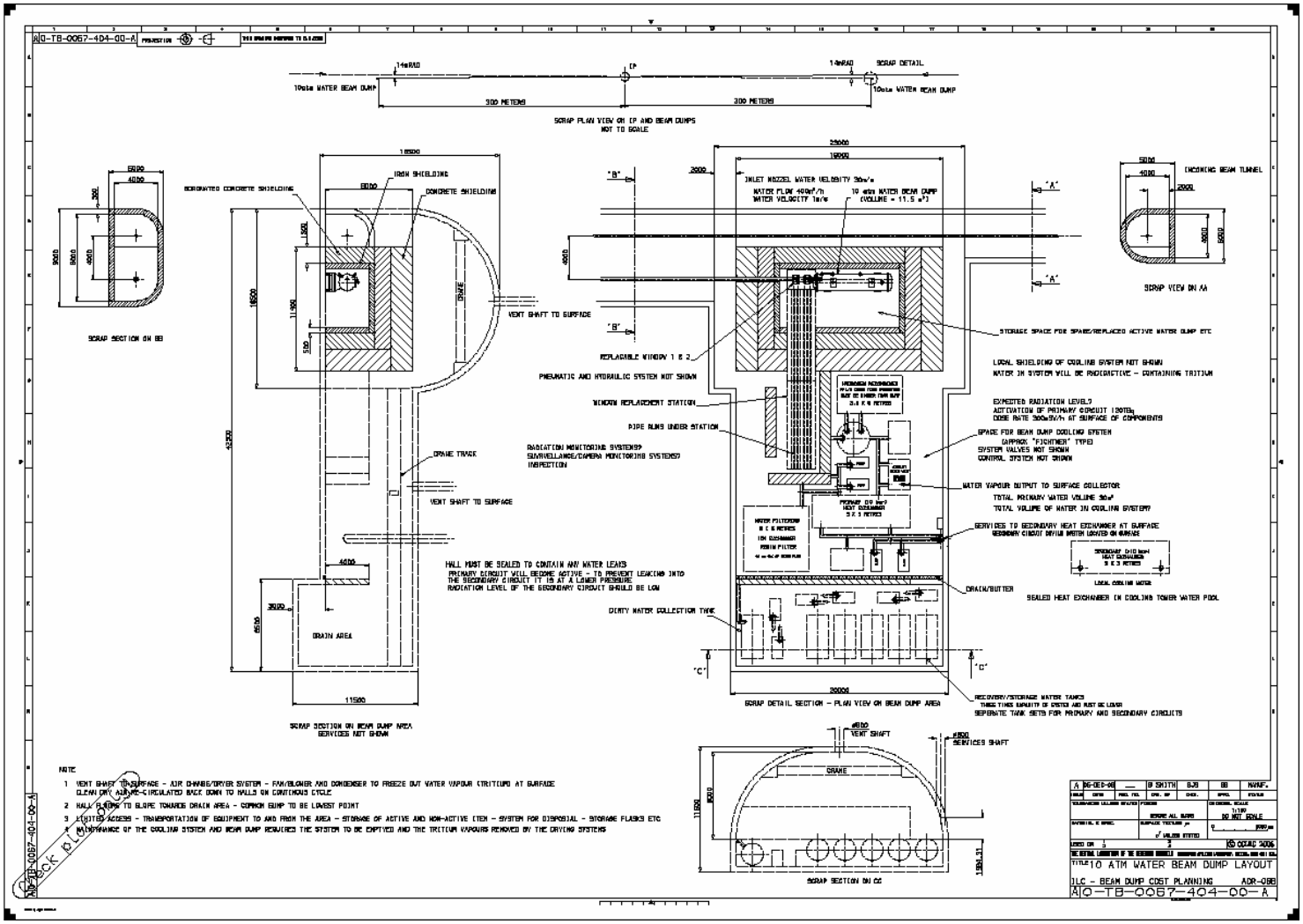
- Window lifetime & vessel maintenance
  - **Remotely replaceable thin vacuum window**
  - **Remotely replaceable water dump window**
  - **Remotely replaceable passive beam expander**
  - **Air exchange & control system**
- Vessel Failure
  - **Vent & scrubbing system**
  - **Air drying & vapor recovery system**
  - **Parking area for dead dump**

Current Vessel Design



B. Smith, RAL

Current 42m x 20m Service Cavern Layout



Other ‘known unknowns’*

- Potential need to plan for MPS, window or vessel failure
- Regulatory costs – concerns re high tritium production and radiolysis of water.
- Disposal of active water. System for solidification of waste may need to be included in construction.
- Requirements for remote handling of activated dumps and collimators. Hot cell and special tooling? Active ventilation systems? What is remote handling philosophy for ILC? Small allowance made for 18MW dump window replacement only.
- Are civil engineering specifications adequate? No ‘handshake’ on civil engineering requirements yet. Detailed physics & engineering simulations may reveal necessity to increase space to reduce power density on dumps.
- Post-ILC disposal of dumps

C. Densham, Valencia 2006

* D.Rumsfeld

18MW Water Dump EDR R&D Plan

Window fatigue after long irradiation

- **Candidate materials in BNL 200 MeV proton BLIP**
  - under temperature control?
- **Tests in BNL Hot Cells**
  - Failure testing under pressure
    - "Weeping" at grain boundaries
    - Destruction
  - Measurements of physical properties
    - Ductility, Thermal conductivity, …
- **Deliverable: demonstration of several viable materials over a range of irradiation dose and working pressure by time of EDR**
- **Costs: BLIP & Hot cell use fees and 0.25 FTE BNL physicist/yr.**

Instrumented mini-dump

- **pressure bumps & vacuum bubbles**
- **not deemed needed**

18MW Water Dump EDR Engineering Plan

Design Issues

- **Dump**
  - Window replacement
  - Tritium containment
    - rain water & dump water
  - Dump removal
- **Rad Water System**
  - Access for service
  - Component exchange: infrastructure, space, storage

Engineering prototype

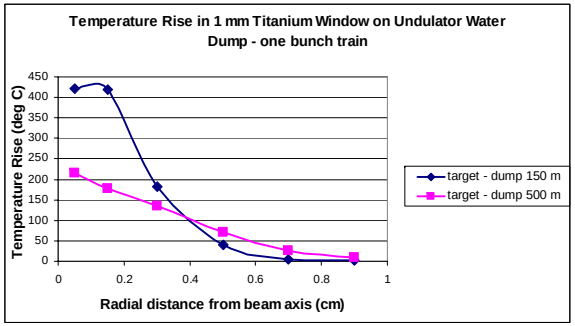
- **Window replacement mechanism**

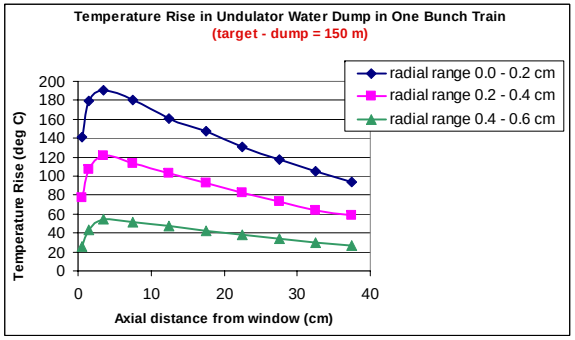
EDR Deliverables

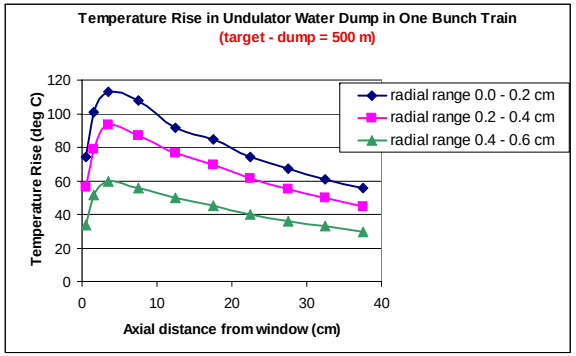
- **3D Layout of dump and rad water plumbing**
- **80% developed solid model of main vessel**
- **Shielding design with associated calculations**
- **Specification of parts by manufacturer & model #**
- **Civil layout accurate to 1m**
- **Cost accurate to 20%**
- **Text to include operation, servicing, safety & accident scenarios**

Regulatory approval in 2-year political era

Undulator Photon Dump







- Undulator dump absorbs 2E17 10 MeV photons/sec (300kW) that do not interact in rapidly spinning Ti e+ target
- If dump is 150m behind target (as in current RDR) 1mm Ti window temp rises 400°C and water 190°C
- Cost as small (10cm x 1m?) 10-12atm water dump as 50% 18MW plus 25% ED&I = $3.9M
- Recommend increasing distance from target to 500m to reduce window temp to 200°C and water to 110°C

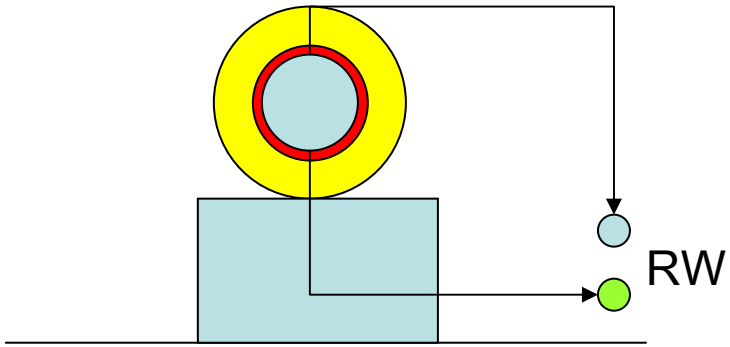
Undulator Dump EDR Plan

New device with no existing proof of principle

- **Complete EGS study to optimize geometry & high Z back end**
- **Detailed hydrodynamic study of window cooling**
- **Experimental study of window material fatigue under irradiation**
  - Not obvious what/where/how to get 10 MeV gammas
- **Window and dump replacement scheme required**

9 ~240kW Aluminum Ball Dumps

50cm Diameter x 2m long Aluminum Ball Dump with Local Shielding

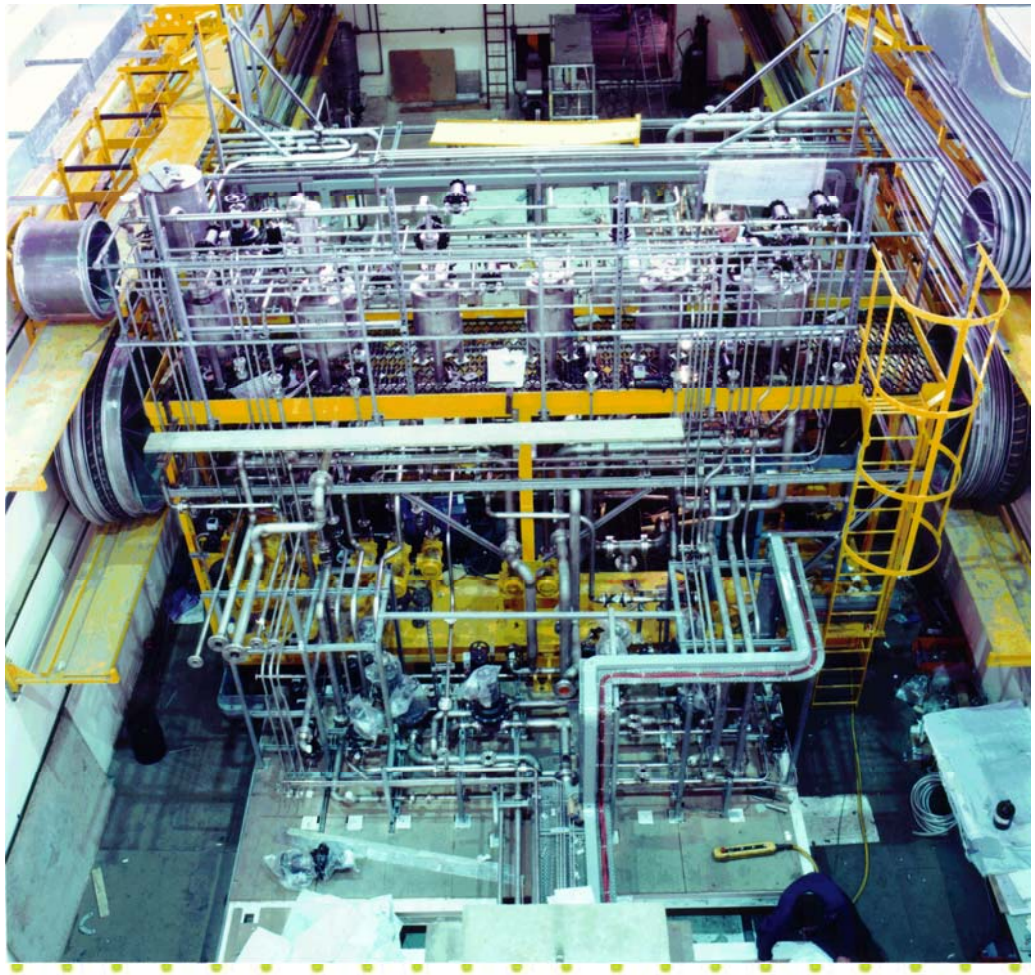


Cost Basis

- **100k$ vessel (Walz)**
- **300k£ ISIS plumbing**
- **150k£ ISIS controls & monitoring**

Total $1M each

50kW 3-loop 2006 Rad Water Cooling for ISIS Neutron Spallation Targets



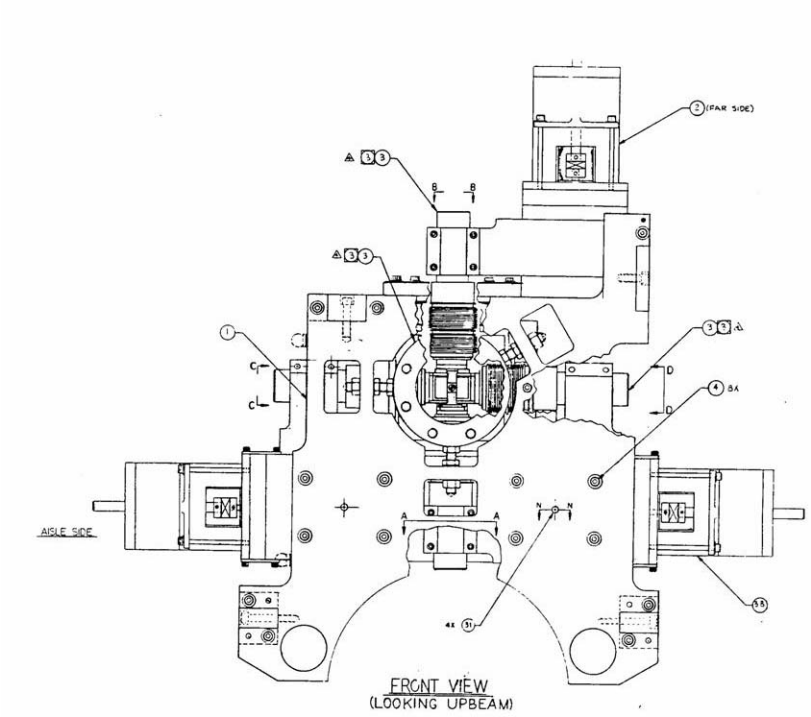
Ball Dump EDR Plan

- Design realistic cost-effective 30gpm rad water system
  - **minimize cost**

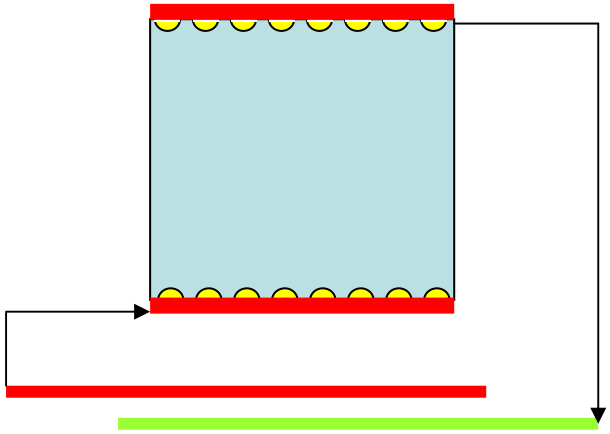
    12-2006 US Quotes (Walz)
    - 18MW Parallel plate heat exchanger (API)
      - » $53k (gasketed: request for welded quote requested)
      - » 2.5m x 1.2m x 3.5m
    - 200HP, 1150gpm pumps w/ motors (4/6 needed)
      - » $30k each
      - » 1m x 3m x 1m
    - Schedule 12 Stainless Pipe, 316L , Installed
      - » $125/ft
  - **minimize civil footprint**
- Cost optimization of safety related aspects
  - **Do tune-up dumps require**
    - Window replacement
    - In situ dump replacement mechanics

Collimator Cartoons

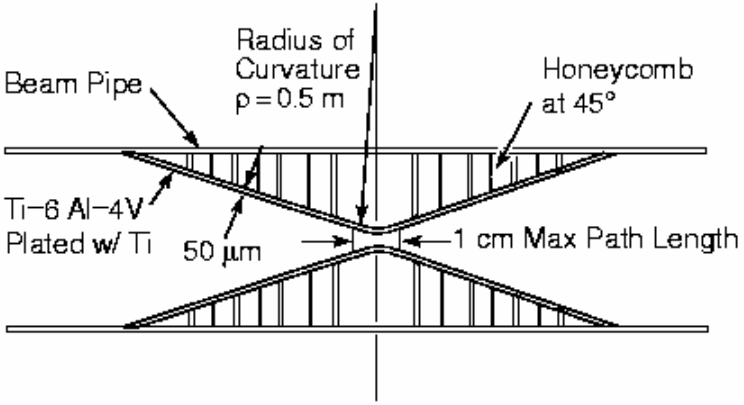
SLC Sector 30 4-Jaw collimator



50cm Diameter x 50cm long Peripherally-cooled Solid Cu or Aluminium Dump (before local shielding added)



LCW



Tapered NLC Spoilers & Absorbers

Collimator EDR Plans

Beam Tests

- **Coupon tests of 0.6 and 1.0 X_0 Ti in SABER**
  - presume tests will validate assumption that rotatable spoilers not required

Engineering prototypes

- **Tapered spoiler: honeycomb, Be, etc.**
  - most likely done by UK
- **30 X_0 Adjustable jaw absorber**
  - desirable but not 100% required

Design Report

- **particular attention to shielding and civil aspects**
- **full mechanical design of long collimator**

EDR Manpower & Cost

For items covered in this talk, over 3 year period, assuming all are co-located:

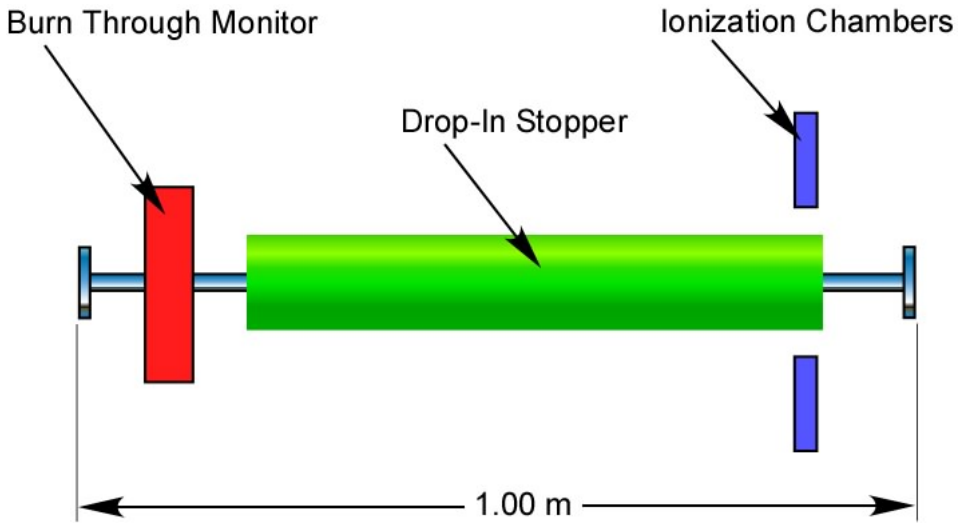
- **3 Mechanical engineers/year**
- **3 Designers/year**
- **1.5 Physicists/year**
- **$1M Shop & M&S over the 3 years**

Rough sharing model

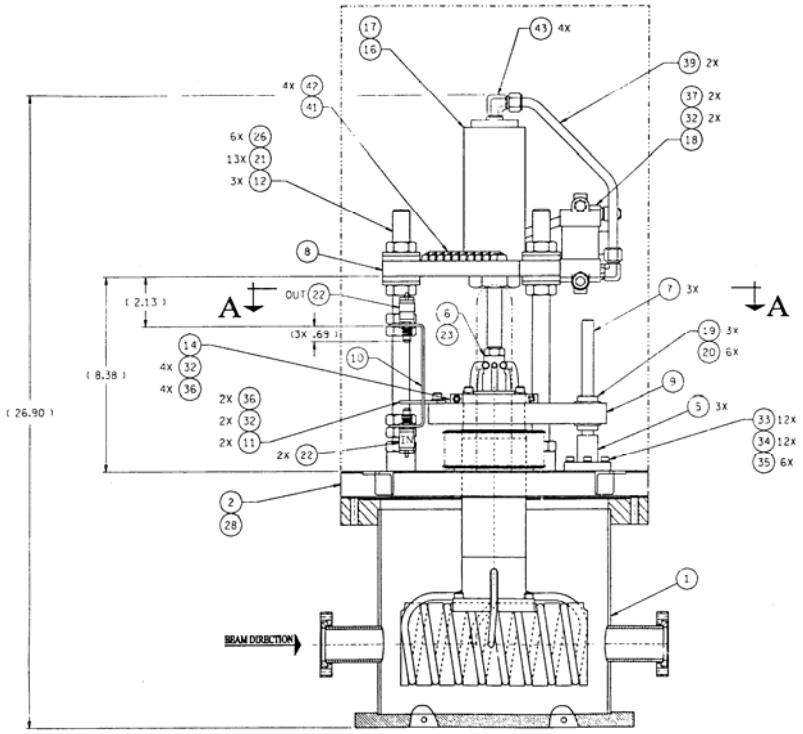
- **50% BDS**
- **25% e+ source**
- **25% RTML**

Bonus Slides Follow

Stopper Cartoons



JC Sheppard Stopper

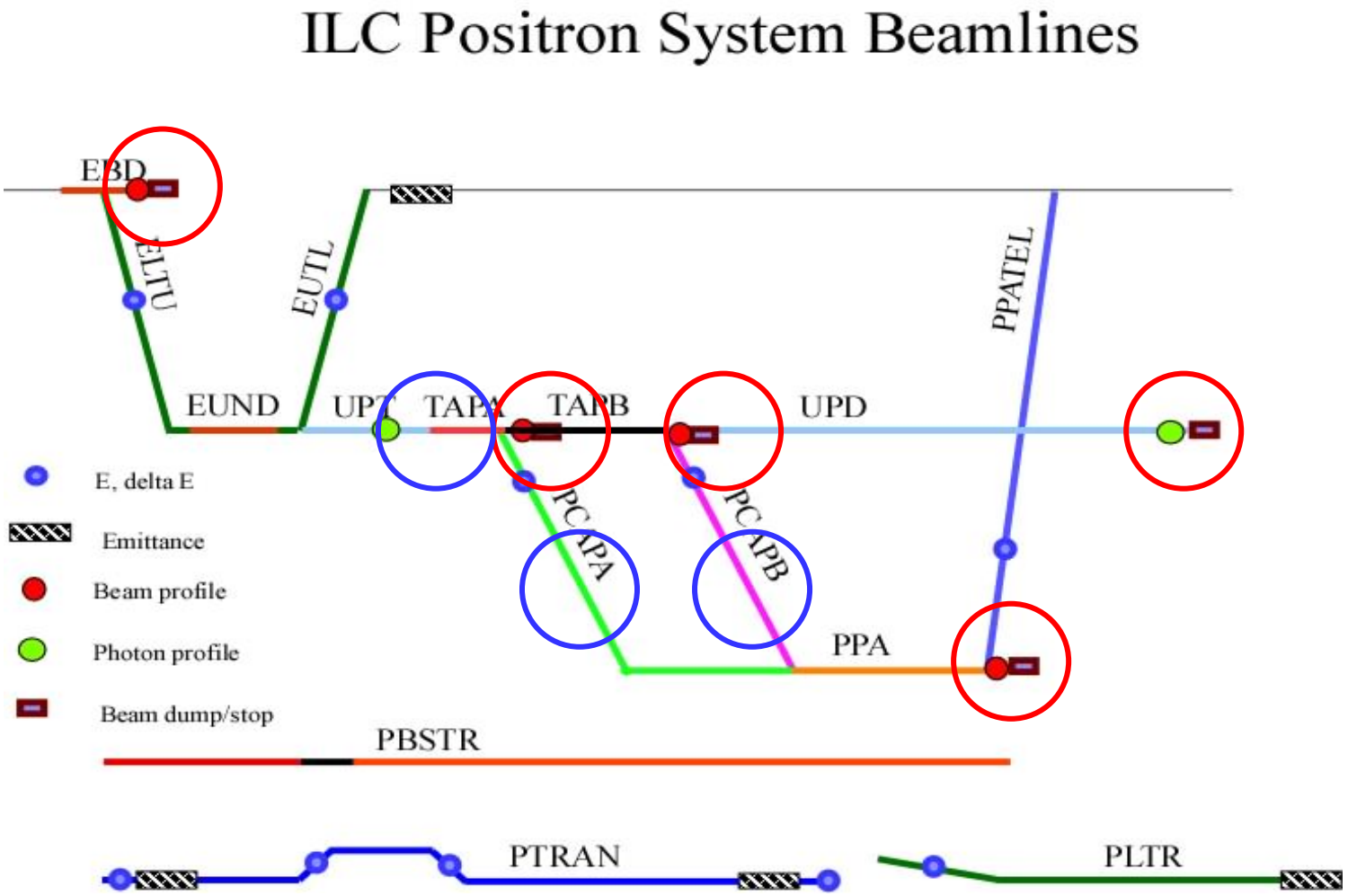


PEP-II Stopper

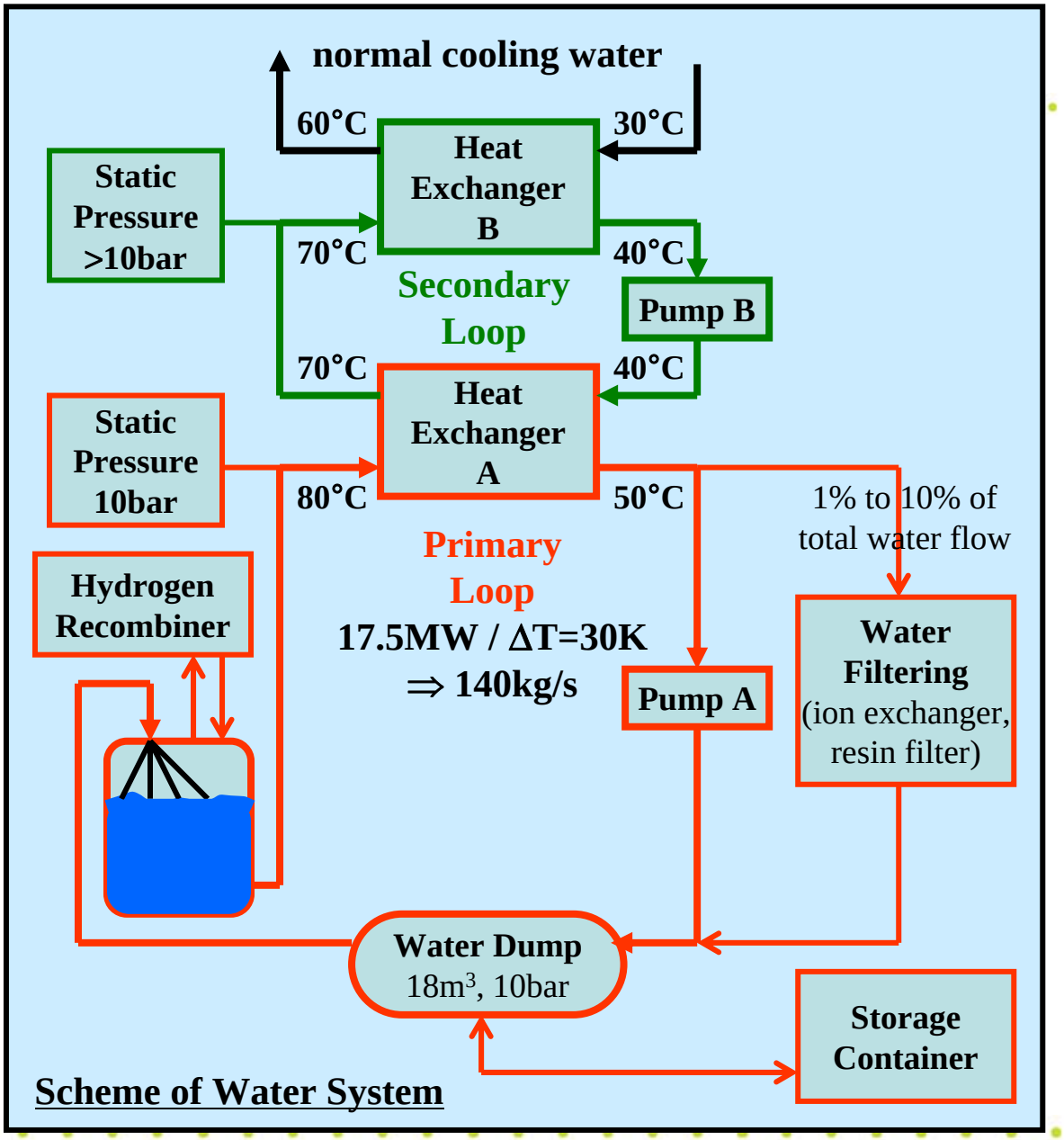
Cost Uncertainty

- Fitchner + RAL estimate for 18MW dump differ from a Walz estimate by x2
- ISIS 50KW water system seems 10x SLAC experience
- Also concerned that CF&S related costs will dominate total D&C related costs
  - **beam line plus civil housing drawings do not exist except for BDS**
  - **tighter hand shake required**
- Largest cost risks:
  - **items falling through cracks**
    - installation/replacement model
  - **implications from technical risk of difficult devices or regulatory issues that we have not begun to consider**
- No real effort yet to estimate accurately ED&I, economies of scale or required site resources

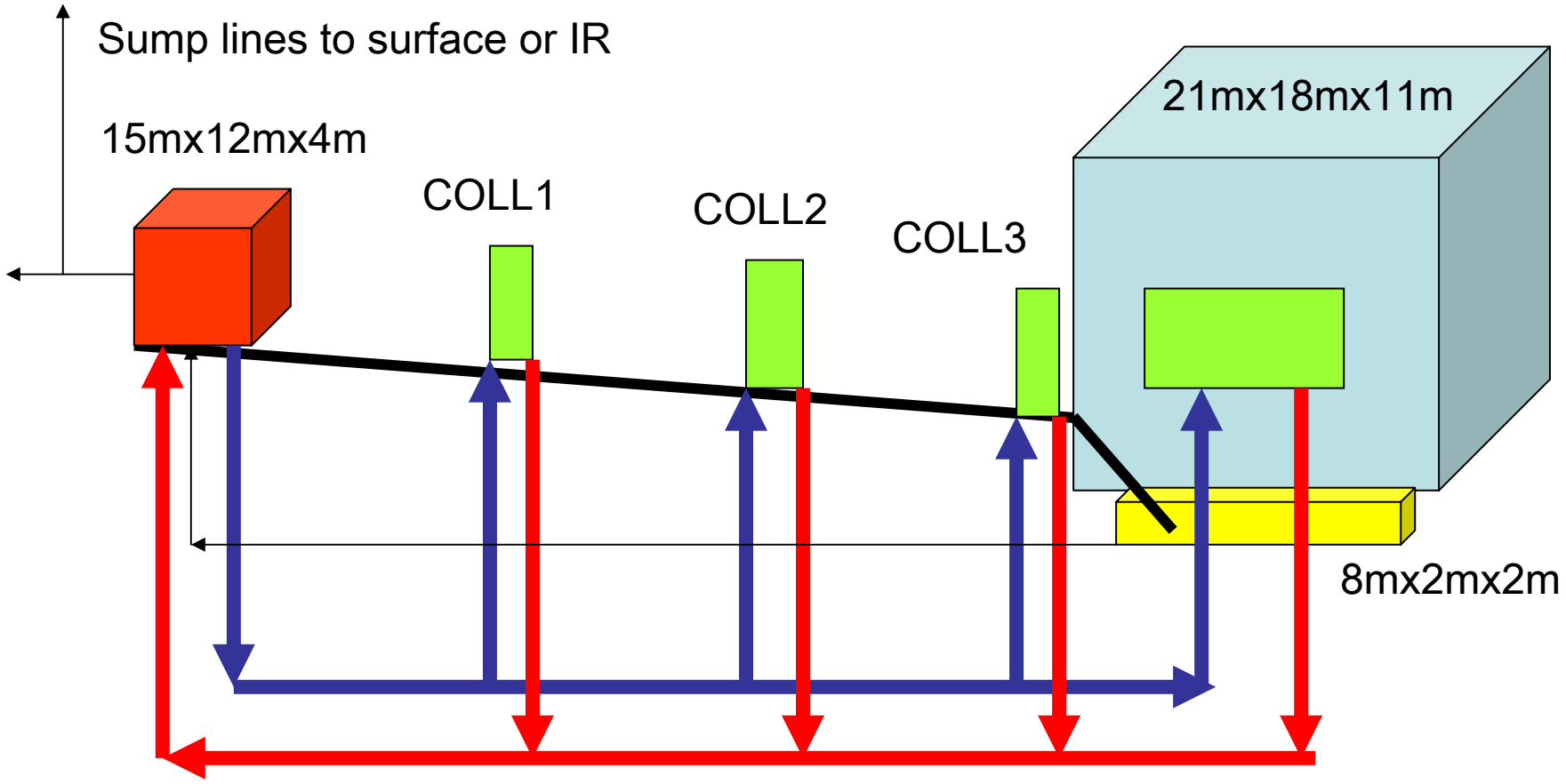
Positron Source D&C



10 bar H2O Dump Plumbing



Plumbing near 10bar H2O dumps



1mrad sloped floor w/ stainless barrier to common sump

6” Supply/Return with ~2200gpm