Accelerator physics work in Beam Delivery area in Engineering Design phase

For discussion in
SLAC ILC Accelerator physics group
and ILC Simulation area group

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Global Design Effort

In the ED phase…

- The Engineering Design Report will document
  - **the baseline design, including detailed engineering and justification of design criteria; …**
- The cost containment effort is critical, including performance/cost optimization, and an understanding of the performance/cost derivatives (value engineering)…
- Initial phase will be accelerator -physics (AP) driven in order to evaluate the performance / risk trade-off for cost reduction…

Quotes from Draft “ILC Project Management Plan for the Engineering Design (ED) Phase”, by International Linear Collider Project Management Team, Marc Ross, Nicholas Walker, Akira Yamamoto (Project Managers)

ED phase … CFS…

- Goals:
  - **iteration of CFS requirements with accelerator designers / engineers (value engineering);**
  - **Detailed evaluation of alternative solutions (e.g. shallow site);**
  - **Preparation of critical information for specific site selection / development;**

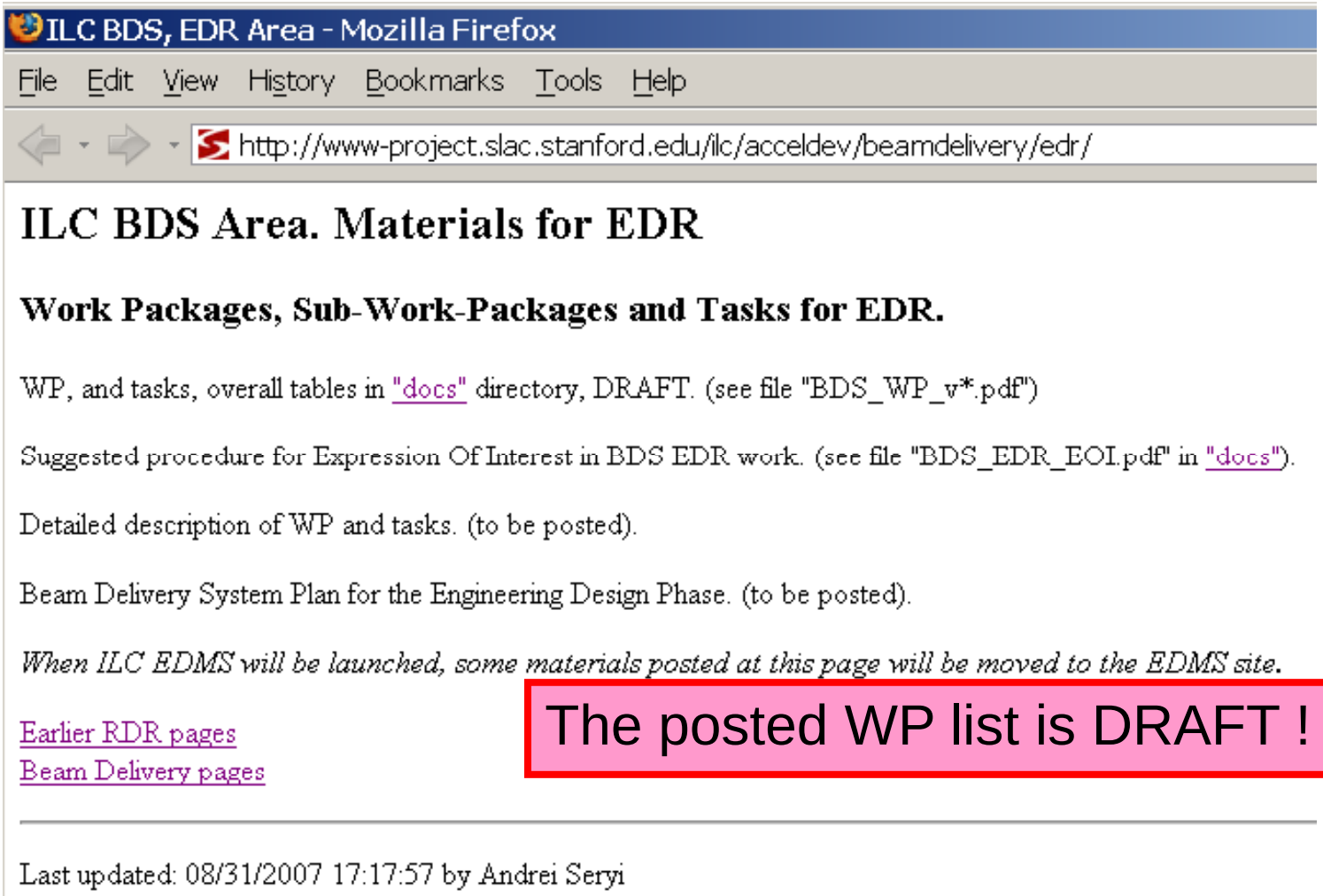
ED phase… Accelerator Systems goals

- Define and clearly document performance-driven specifications for the accelerator components and – more critically – CFS;
- Iterate with the relevant engineering groups to understand the cost/performance trade-offs, with CFS as a focus;
- Demonstrate that the accelerator design fulfills the required performance goals (in a cost-effective way), by demonstration via critical R&D or by simulation.
- Maintain design-related risk register, and develop alternative fall-back (risk-mitigating) solutions.

BDS Acc. ph. work in ED phase

- The following slides sometime describe the work which goes beyond BD scope
- Also, the work to be done may be taken by
  - **BDS group**
  - **or Integration group**
  - **or Simulation group**
- Discussion of the work scope and allocation should follow

The following slides show Acc. Ph. related WP from the list posted here:



The posted WP list is DRAFT !

http://www-project.slac.stanford.edu/ilc/acceldev/beamdelivery/edr/

Full source at V:\ilc\Drop Boxes\Andrei Seryi\08_FY_WP_planning\

ATF
Accelerator Test Facility

ATF2

Scaled down model of ILC final focus

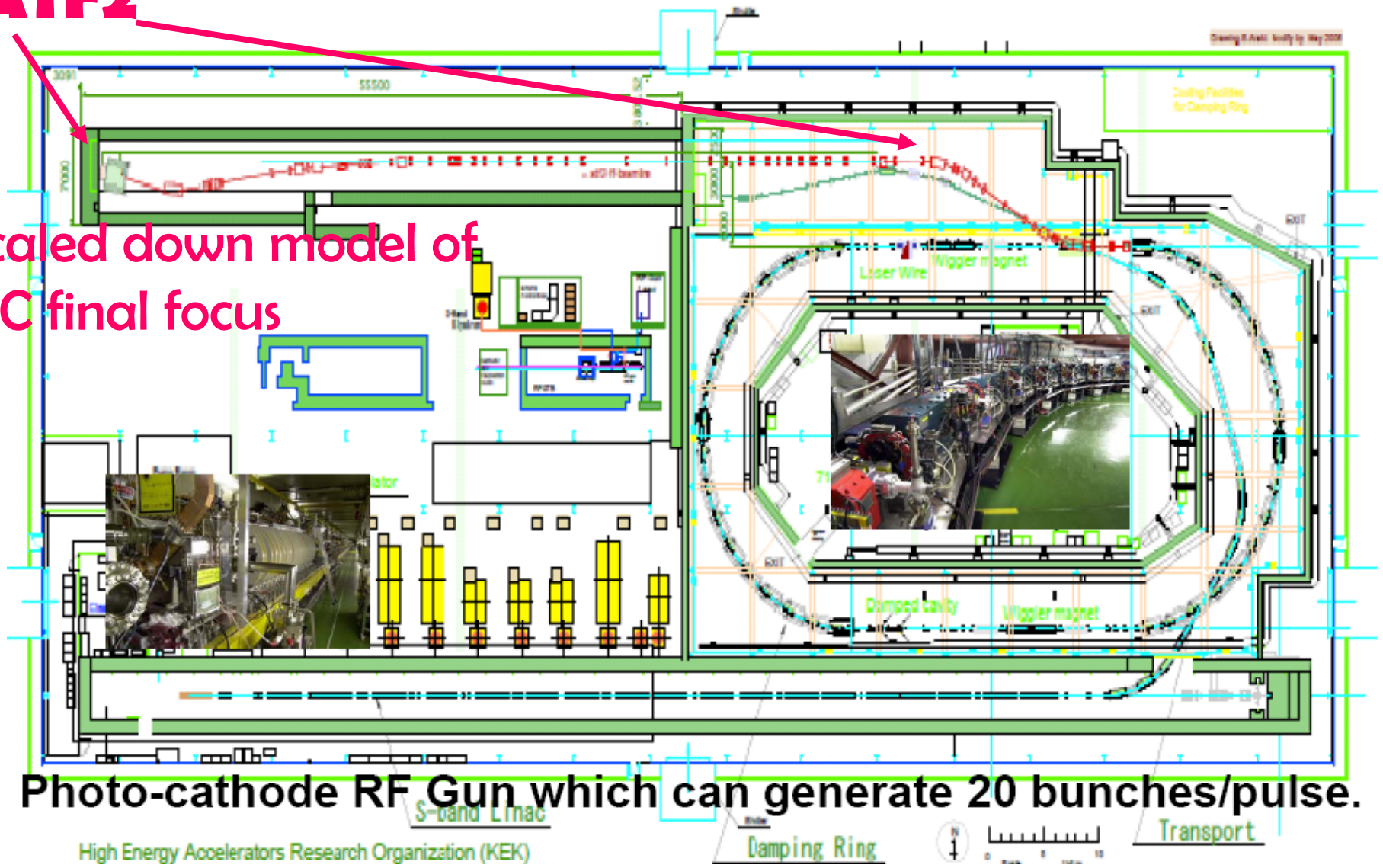
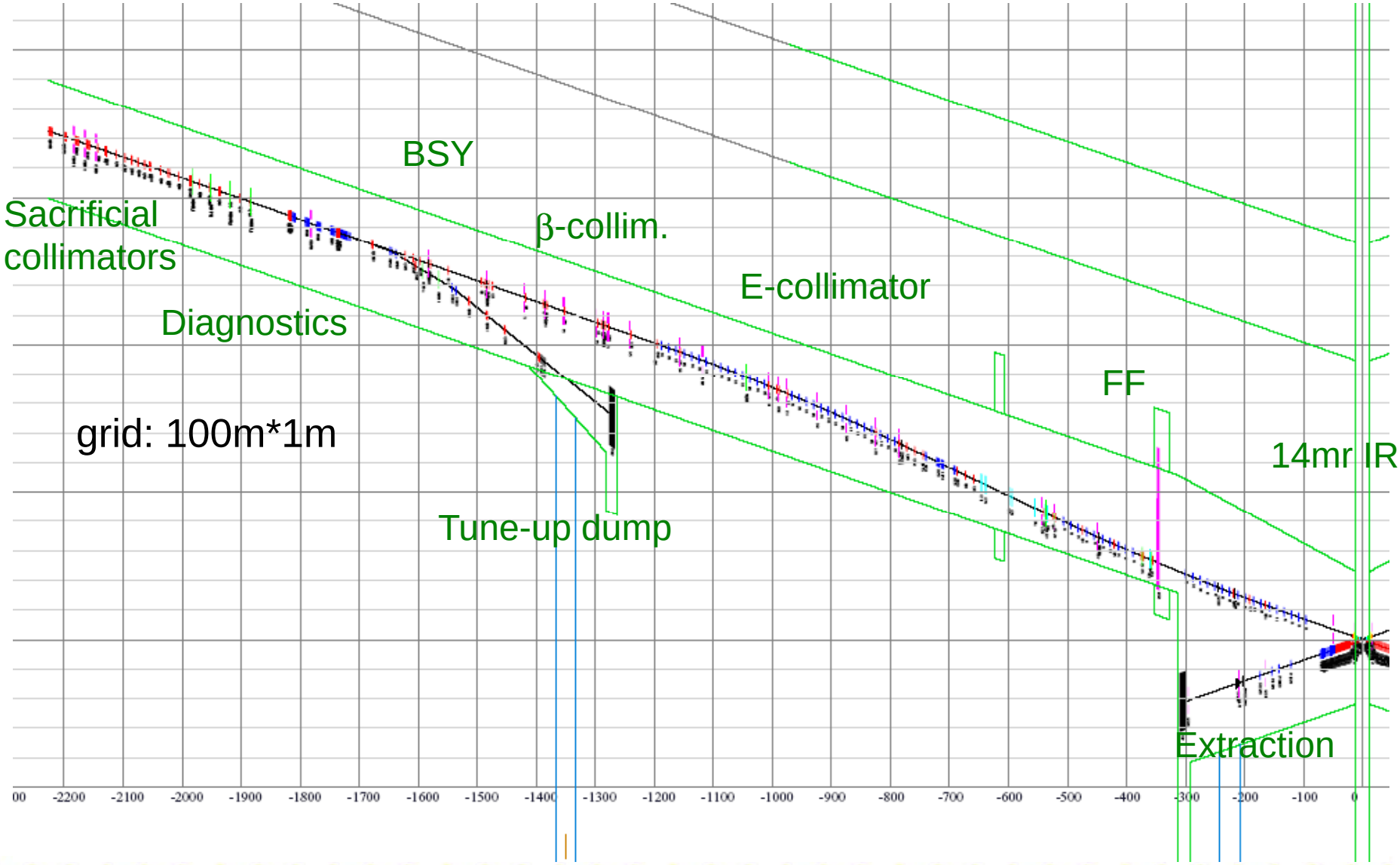


Photo-cathode RF Gun which can generate 20 bunches/pulse.

ATF2 constr., commiss. & oper.

- Develop control & operation tools
  - Develop BPM & mover control tools
  - Develop flight simulator
  - Develop HA PS control tools
  - Develop tuning & commissioning strategy
  - Develop tuning & commissioning tools
- ATF/ATF2 commiss., operation & beam study
  - ATF beam orbit study
  - Commission and operate
  - Investigate ATF extraction emittance
  - Ring-extraction jitter correlation study

BDS beamline



Acc & phys reqts & design integ

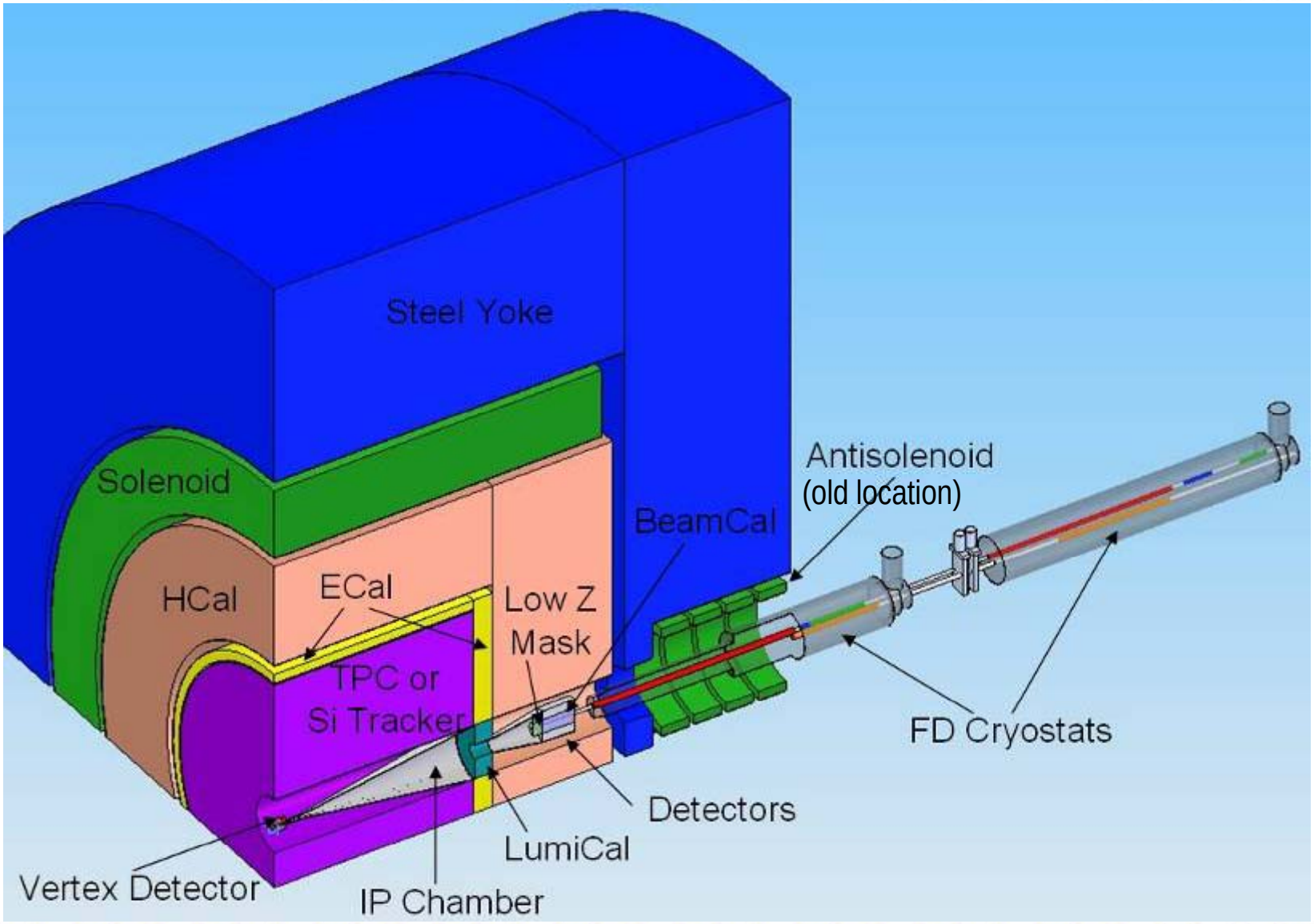
- Acc & Det phys. design & optimiz.
  - need to include more explicitly: evaluate performance vs parametrs (length of systems); document; optimize if needed
  - …
  - BDS Radiation physics study (new: shallow site)
  - Design feedback and tuning procedures
  - Extraction line integrated optics design
  - IR & BDS wakefield study
  - Optimize IR orbit correction
  - Determine field, stability and other tolerances
  - Study optics for magnet standardization
  - Study optics for aperture standardization
  - Different L* optics perf. & tunability
  - Study abnormal optics & MPS issues
  - Study Z, 350, 1000 GeV CM performance
  - Study High Lumi upgrade path
  - Study 1TeV upgrade path for FD, PS, magnets
  - Study head-on IR alternative
  - Study 2mr IR alternative

Acc & Det phys. design & optimiz.

- Determine specs & interfaces
  - **Define air requirements for CFS**
  - **Define water reqts for CFS**
  - **Define stability reqts for CFS (esp. shallow site)**

- Options design study
  - **Gamma-gamma requirement study**
  - **Fixed target requirement study**
  - **e-e- requirement study**

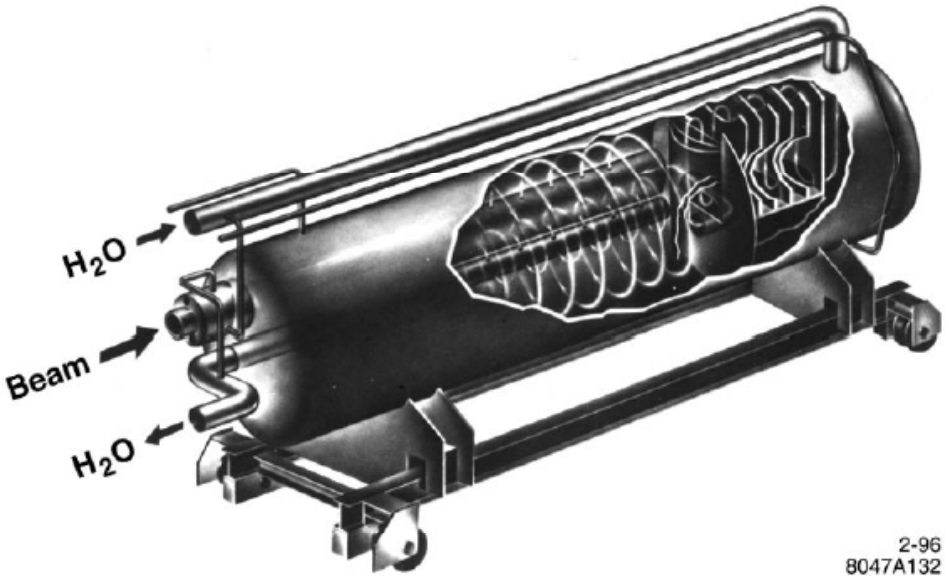
IR integration, a start



IR & IR integration

- IR physics design
  - IR & FD accel. phys. design
  - FD Vibration design study

Beam dump

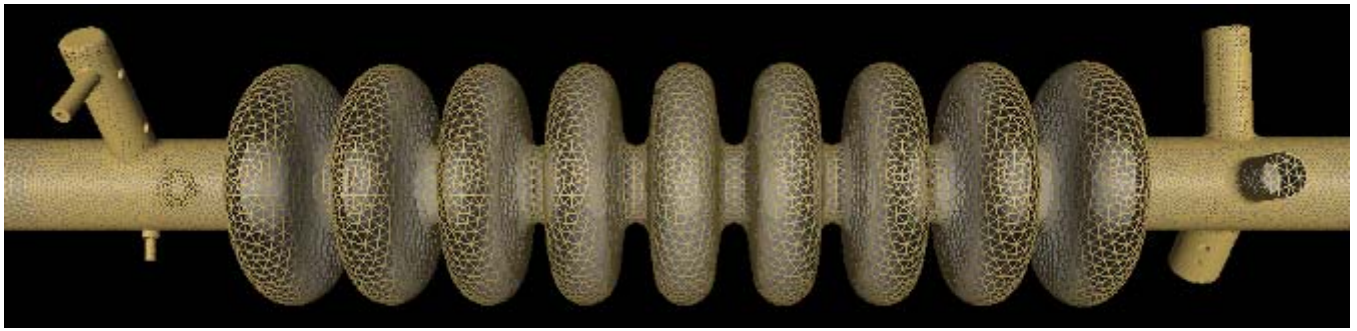


- Design is based on MW dump designed and built at SLAC
- ILC beam dump features
  - **17MW power; rastering of the beam on 30cm double window; upstream donut collimators**
  - **6.5m water vessel; 1m/s flow; beam 0.3m off-center; 10atm prevent boiling;**
  - **three loop water system; catalytic H_2-O_2 recombiner; filters for 7Be;**
  - **Shielding 0.5m Fe & 1.5m concrete**
- EDR work will include physics & engineering design, studies of window irradiation and possibly prototyping the front-end of the window exchange mechanism

Beam dump system

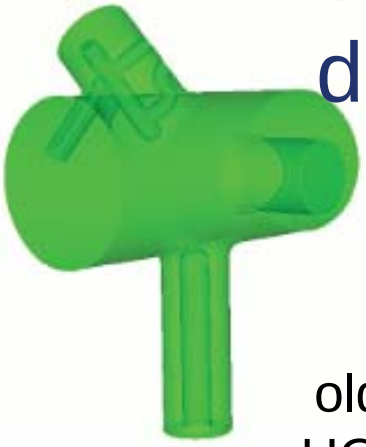
- Phys. design of beam dump
  - **Radiation study of dump area**
  - **Muons and radiation with shallow dump**

Crab cavity design

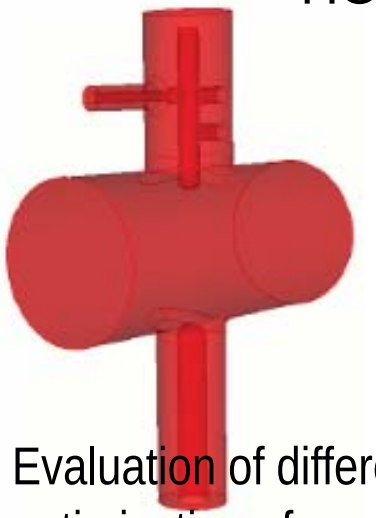


3.9GHz 9-cell cavity in Opega3p, (K.Ko et al, SLAC)

3.9GHz cavity achieved 7.5 MV/m (ILC operating field at 500GeV/beam is 5MV/m (FNAL)



old / new HOM coupler



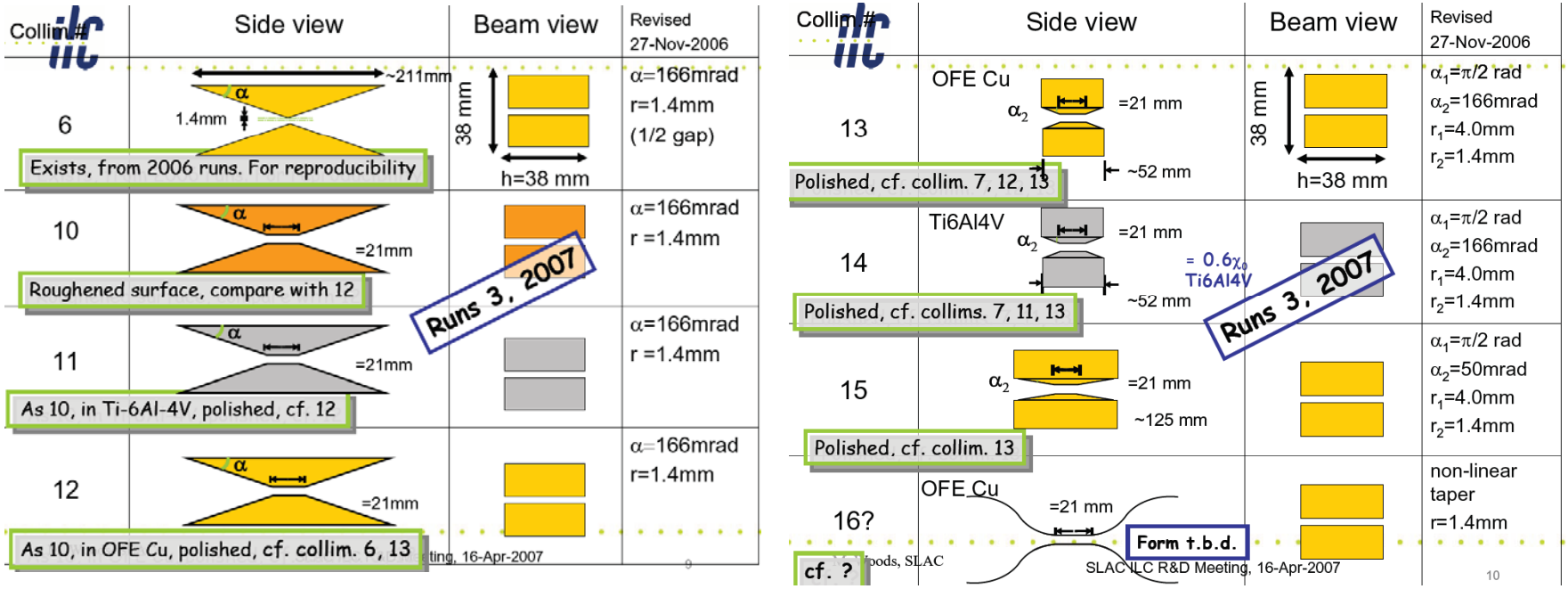
Evaluation of different designs and optimization of couplers to reduce sensitivity to notch filter gap (Z.Li et al, SLAC)

- Challenges:
- LLRF phase and synchronization stability
  - **Required phase stability ~67fsec or 0.094° for <2% luminosity loss** (7 cell 1.5GHz cavity at the JLab FEL achieved a 37fsec)
- Couplers, tuning, cryomodule

Crab cavity system

- Design of crab cavity
  - Optimize rf design of cavity & couplers
  - **need to add explicitly: evaluate effect on the beam, define requirements on mode damping..**

Collimation wakefield study in ESA



- Results from 2006 run:
  - **measurements, analytic & 3d modeling differ by up to factor of 2**
- March 2007 run was focused on tests of
  - **importance of tapers in region away from gap center**
  - **tapers with shallow part only near beam axis**
  - **explicit tests of surface roughness**
  - **non-linear exponential form taper**
- Results are being analyzed

Collimation system

- Phys. design of collimators
  - Optics design of collimators
  - Phys. design of collimators
  - Theoretical analysis of collimator wakes
  - Computing analysis of collimator wakes
  - …

BDS magnets & PS

- all AP related study (like minimization of the number of types or optimization of apertures) is in "Acc & phys reqts & design integ" WP or should be moved there, including AP part of:

- Design, specify & optimize DC PS
  - …
  - Determine 500GeV => 1TeV upgrade path
  - Investigate stringing-corrector option

BDS instrumentation

- Specify reqts, interfaces, location & use
  - Alignment system
  - Specify deflecting y-t cavity
  - Specify OTR monitors
  - Specify X synch light profile monitor
  - Specify BDS BPMs
  - Specify PMT & ion chamber loss monitors
- Alternative instrumentation concepts
  - Study GAMCAL
  - Study Compton edge spectrometer

BDS vacuum system

- Physics design of vacuum system
  - **Physics & impedance design of vacuum sys**
  - **Desoprption model for IR, material, coating**
  - **Impedance design of vacuum system**

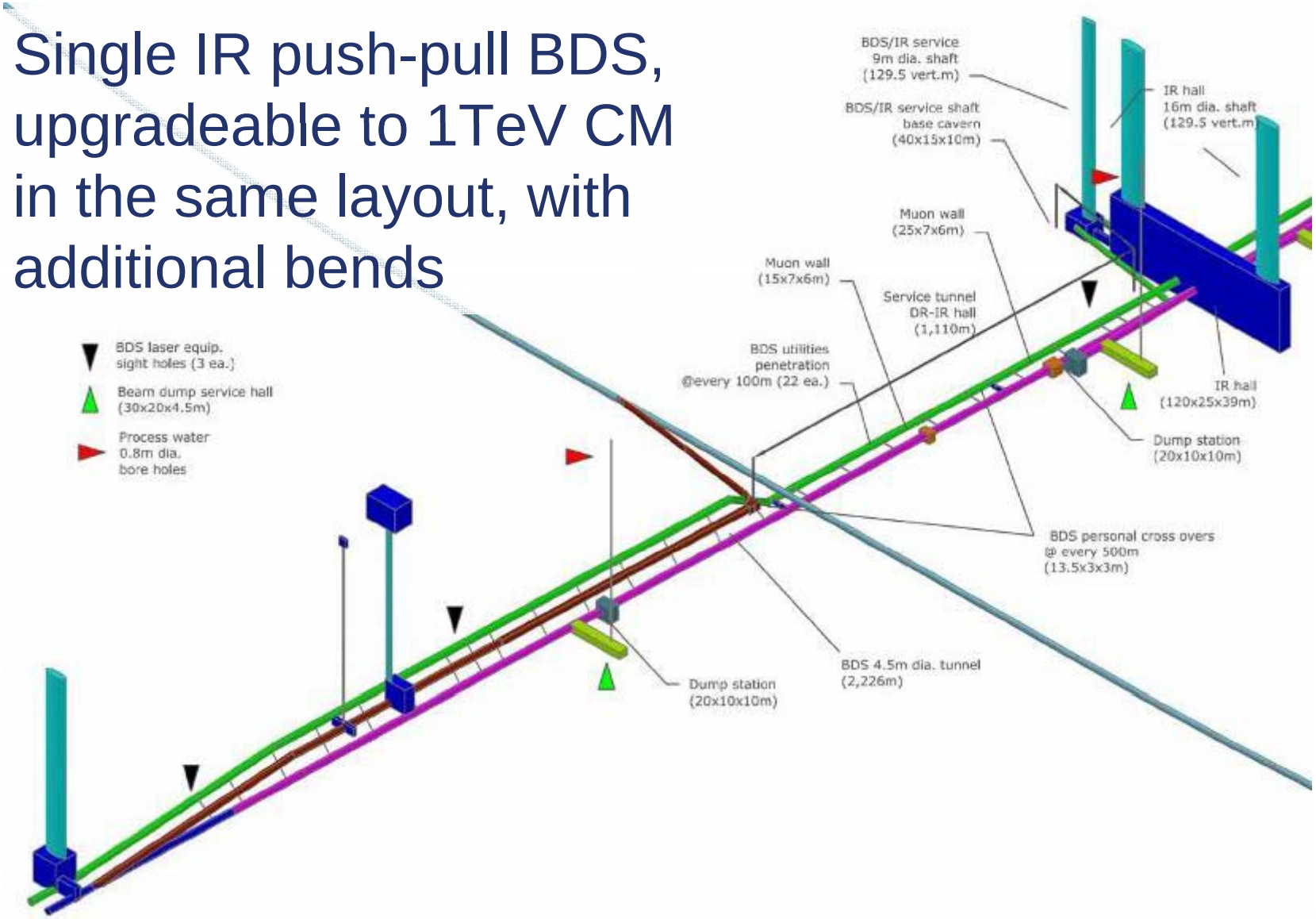
An older list…cross-check… All this is included in WP

- Develop BDS feedback and tuning.
- Develop BDS tolerances for various errors and parameters, PS, stability, …
- Develop flight simulator for ATF2 linked to control software.
- Study emittance growth in ATF extraction beamline, suggest and conduct experimental test and mitigation.
- Evaluate high frequency RF losses in IR region and develop damping scheme.
- Develop RF shielding requirements and solutions for BDS vacuum components including transitions to collimators, bellow, etc.
- Optimize vacuum chamber aperture in the view of minimization of impedances and emittance growth, and minimizing the cost.
- Study and verify beam dump shock wave developments and mitigations.
- Develop improved modeling tool for IR and solenoid, with capability to simulate SR.

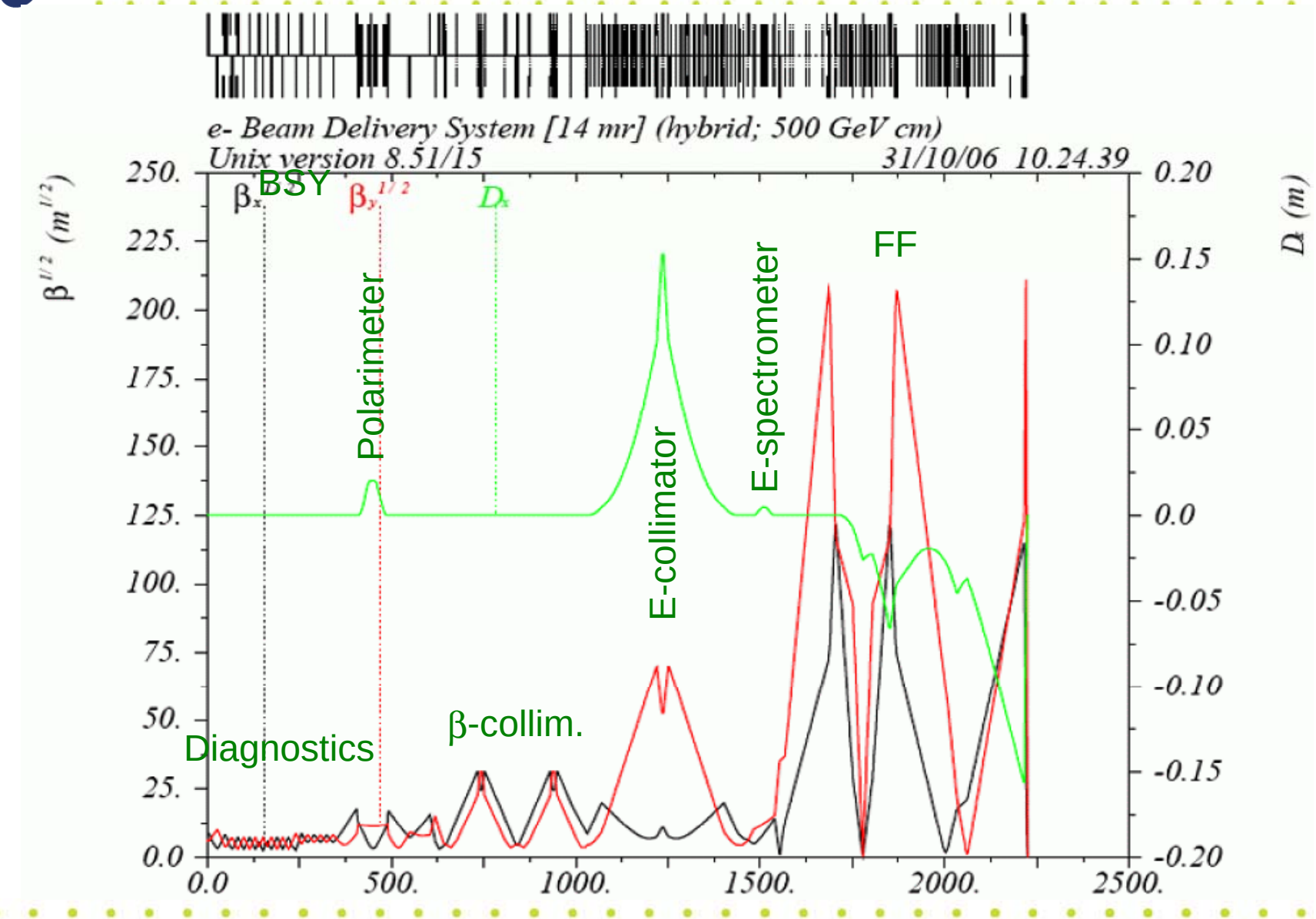
Other slides for illustrations

BDS layout

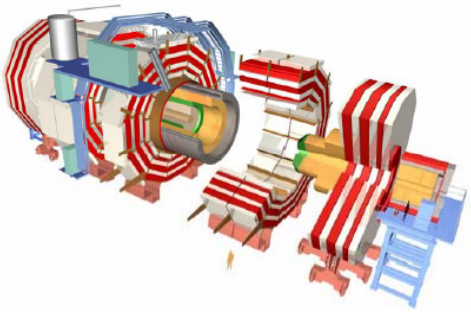
- Single IR push-pull BDS, upgradeable to 1TeV CM in the same layout, with additional bends

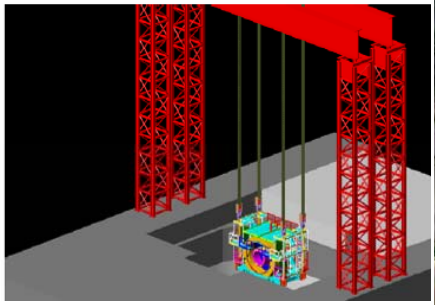


BDS optics for incoming beam

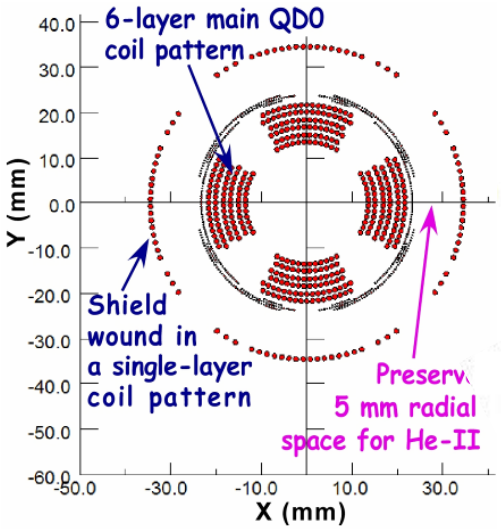


Detector assembly

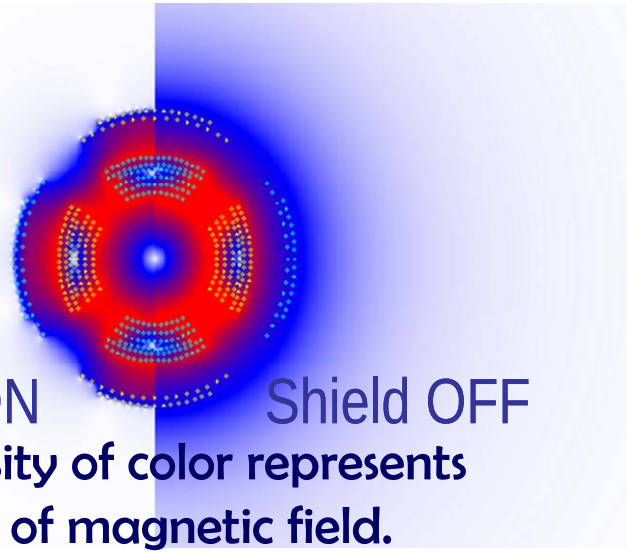




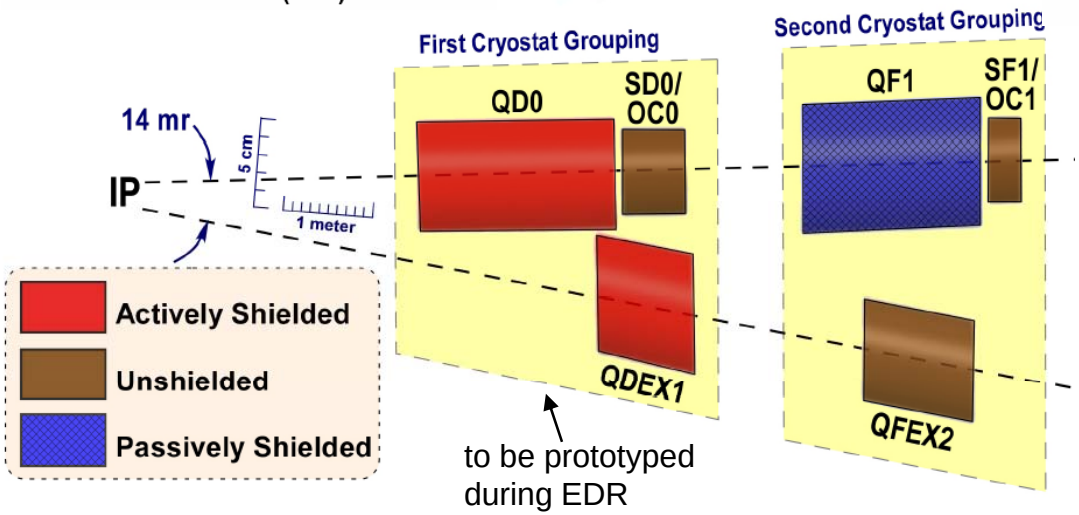
- CMS detector assembled on surface in parallel with underground work, lowered down with rented crane
- Adopted this method for ILC, to save 2-2.5 years that allows to fit into 7 years of construction
- This also allowed to optimize & reduce CFS EXP cost
- SiD and other detector concepts implementing this strategy into their design



Actively shielded QD0

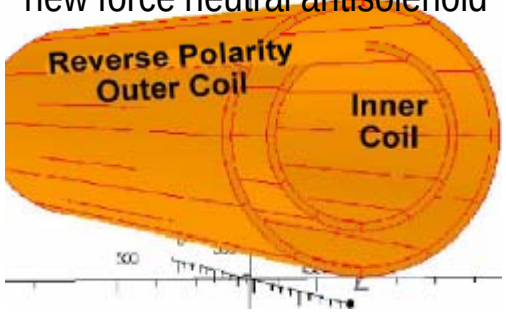


Intensity of color represents value of magnetic field.

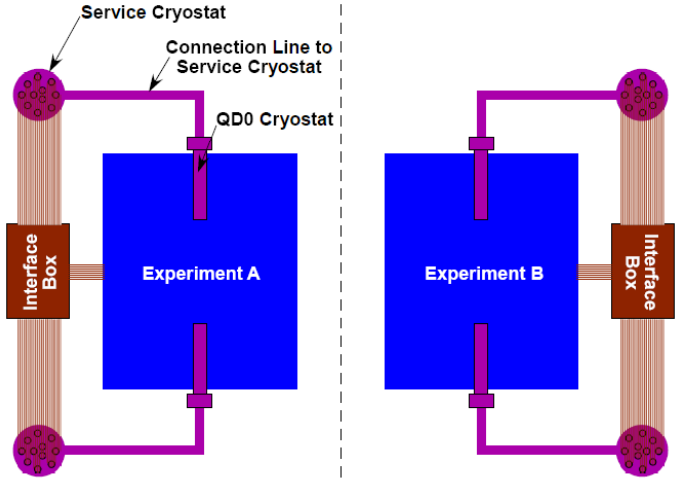


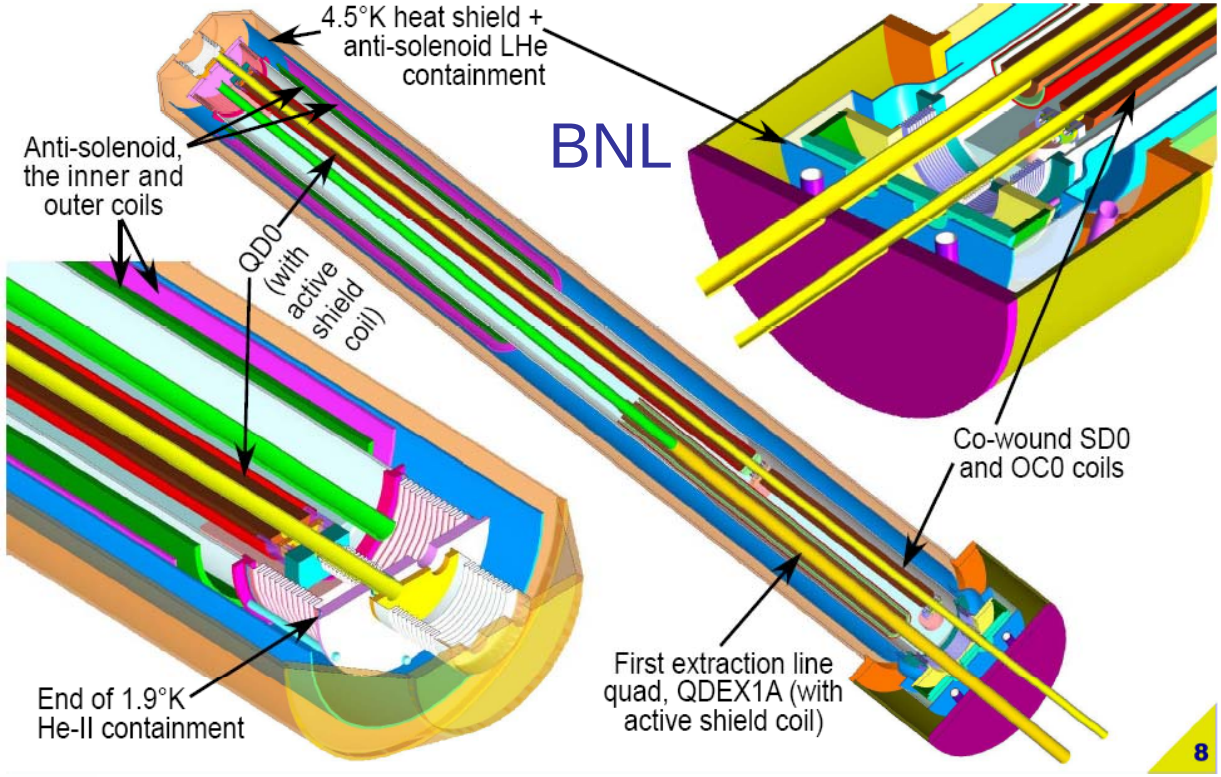
Two Coils; Different Radii

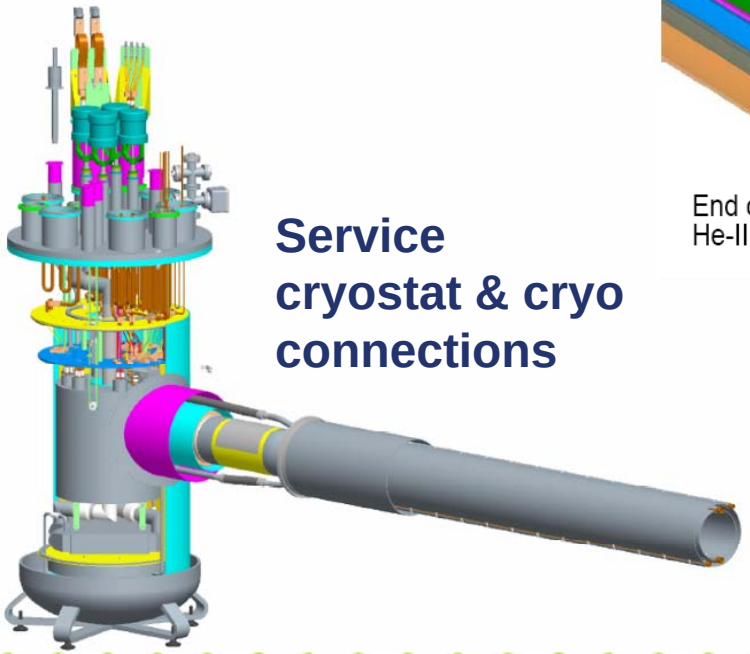
new force neutral antisolenoid



IR integration



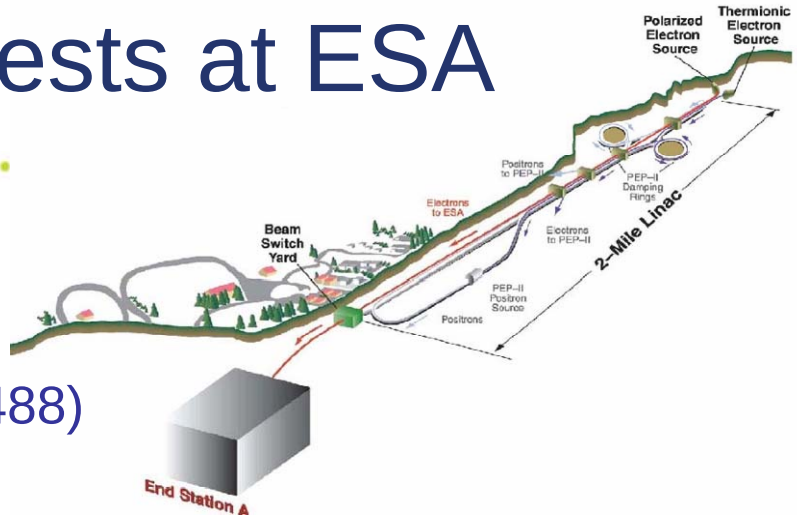


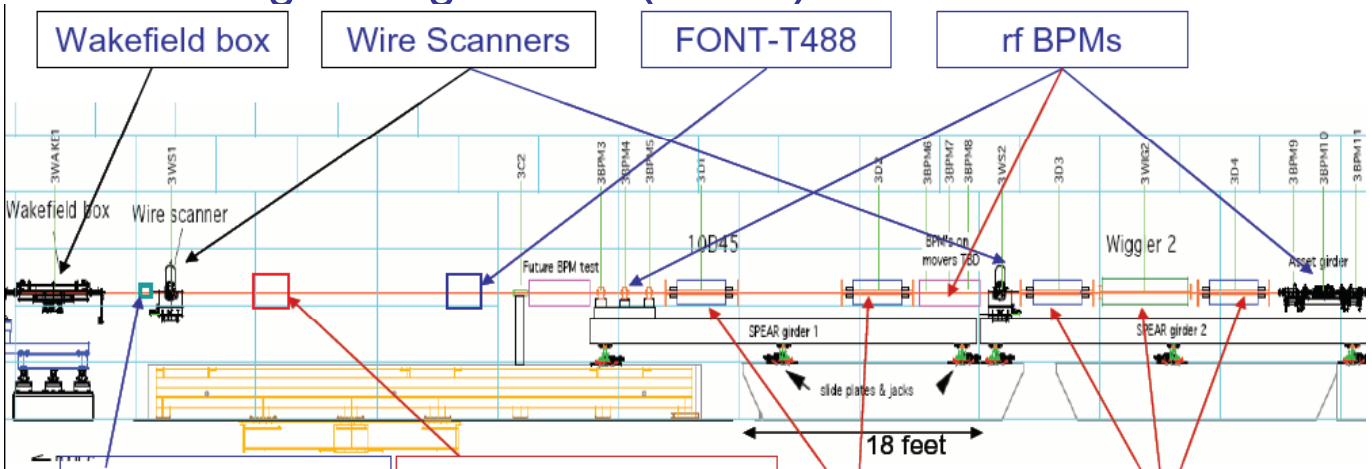


Service cryostat & cryo connections

BDS beam tests at ESA

BPM energy spectrometer (T-474/491)
Synch Stripe energy spectrometer (T-475)
Collimator design, wakefields (T-480)
IP BPMs/kickers—background studies (T-488)
EMI (electro-magnetic interference)
Bunch length diagnostics (T-487)





Upstream (not shown)

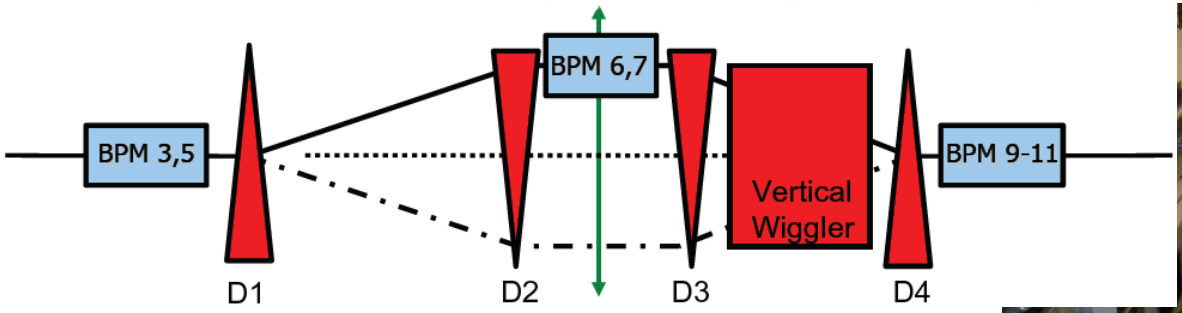
4 rf BPMs for incoming trajectory
Ceramic gap w/ rf diode detectors (16GHz, 23GHz, and 100GHz) and 2 EMI antennas

Downstream (not shown)

Ceramic gap for EMI studies
T475 Detector for Wiggler SR stripe

Runs: three 2-week runs in 2006 & 07; request two runs in 2008

Energy spectrometer at ESA



- BPM & SR based
- Interferometer metrology grid for BPMs
- NMR probes in magnets
- 0.5um BPMs with η=5mm => 1e-4 energy resolution
- Study calibrations, systematics, stability
- SR version with quartz fiber detector will be used next run