BASELINE ASSESSMENT WORKSHOP 2

CONVENTIONAL FACILITIES AND SITING GROUP

Reduced Bunch Number

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Basic CFS Assumptions

- Main Linacs - "Full Power"
  - "SB2009 Design" Had to be Updated to Develop "Full Power Design" and Reflect Current Design Development
    - Main Linac Tunnel Diameter Increases from 4.5 m to 5.0 m Diameter (Waveguide and CTO's)
    - Tunnel Length Increases by 4 RF Units (140 m) (Overhead for Undulator)
    - Total Number of Klystrons Increases from 580 to 714 (Undulator, Spares and Energy Spread)
    - Klystron Surface Building Increases in Size by 714/580 %
    - 7 kw (of 10 kw) per RF Unit Stays in the Tunnel (Alcove) and Adds to the Cost of Process Cooling
    - Low Voltage Power Distribution Increases by 714/580 %
  - "Full Power" is Defined as 250 Gev e- & e+ Main Linacs with 2625 Bunches per Train at 5 Hz
  - "Reduced Bunch Number" (Low Power) Is Defined as 250 Gev e- & e+ Main Linacs with 1312 Bunches per Train at 5 Hz
  - This Presentation will Provide CFS Design and Cost Impact for Both KCS and DRFS RF Systems for the Americas Region
  - KCS Information is More Mature than the DRFS Design at this Time

Basic CFS Assumptions cont.

- Damping Ring - "Full Power"
  - "SB2009 Design" Had to be Updated to Develop "Full Power Design" and Reflect Current Design Development
    - "SB2009 Design" Damping Ring Length Taken to be 6.4 km (Reduced from RDR 6.7km)
    - "Full Power Design" Damping Ring Length is Also 6.4 km
  - Reduced Bunch Number is Based on a 3.2 km 7.5 m Diameter Damping Ring initially to House 2 Rings (1 e- & 1 e+) But Sized to Allow Upgrade Path to 3 Rings (1 e- & 2 e+)
  - The Cost Comparison will be Based on "Full Power" 6.4 km 5.0 m Diameter Tunnel to "Reduced Bunch Number" 3.2 km 7.5 m Diameter Tunnel
  - Unit Cost per m for 3.2 km Tunnel is increased Due to Customization of TBM for Tighter Turning Radius
  - Damping Ring Power/Heat Loads for 6.4 km are Assumed to be the Same as RDR Damping Ring Loads

CFS Impacts

- General Considerations
  - Only the 3 Major CFS Cost Drivers were Reviewed for this Exercise
    - Civil Construction
    - Process Cooling and HVAC
    - Electrical
  - Civil Construction
    - Tunnel Diameter
    - Tunnel Length
    - Surface Buildings
    - Utility Alcoves (DRFS Only)
  - Process Cooling and HVAC (Mechanical)
    - Surface Cooling Towers
    - Distribution Pumps
    - Distribution Piping to Surface Klystrons
    - Distribution Piping to DRFS Components
  - Electrical
    - High Voltage Distribution (69 kv)
    - Medium Voltage Distribution (34.5 kv)
    - Low Voltage Distribution (480 v and Below)
    - Low Voltage Distribution to Surface Klystrons

Reduced Bunch Number

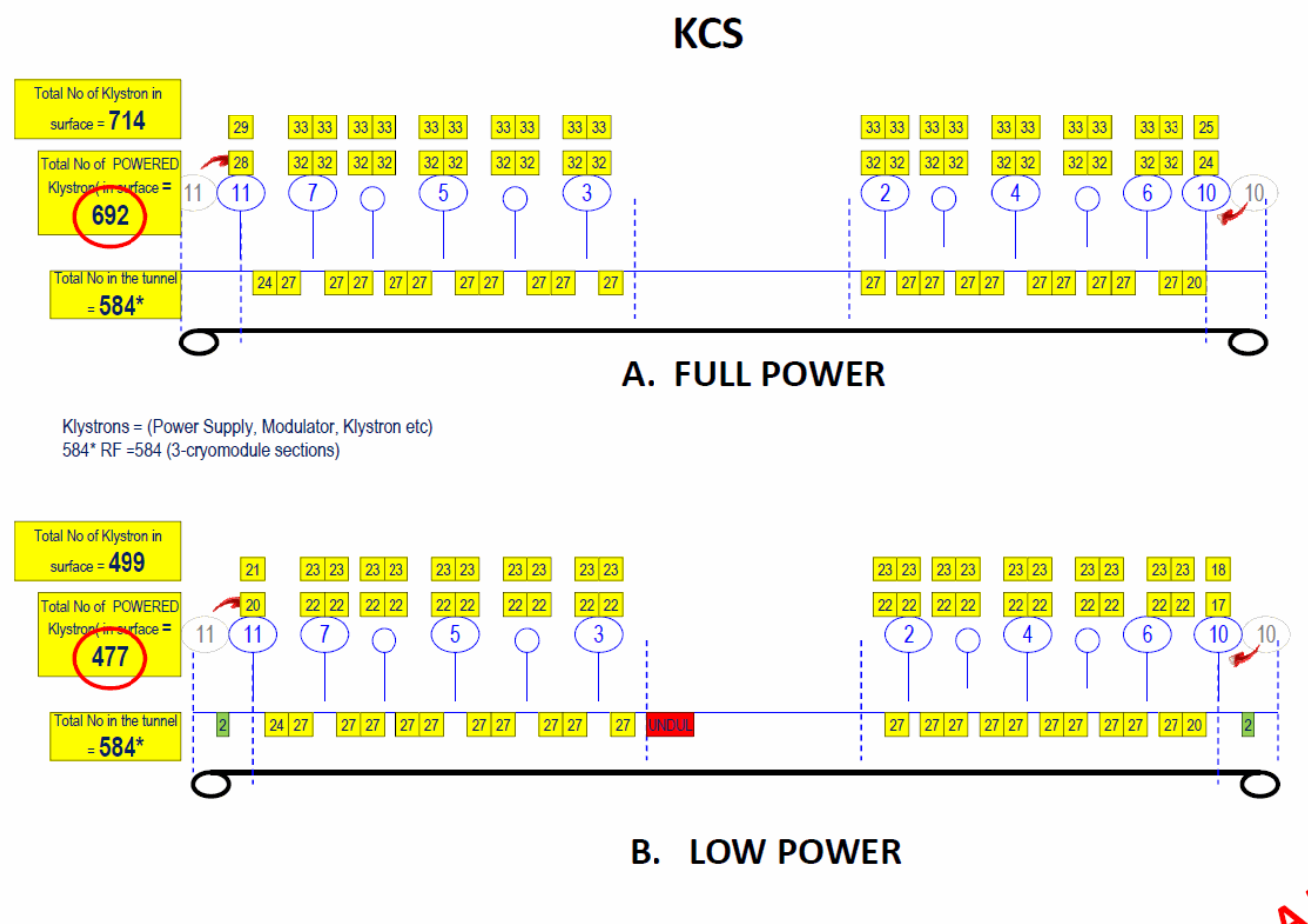

Diagram Courtesy E. Huedem
Information Courtesy of C. Nantista

Reduced Bunch Number

SUMMARY HEAT LOAD

Low=Reduced Bunch numbers*

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Low Power* = Reduced Bunch Number

	ML POWER in MW	
	Full-5Hz	Low*-5Hz
KCS	**79.8**	**63.6**
DRFS	**92.8**	**61.3**

RDR (ML) =134 MW (reference)

	DR total POWER in MW	
	Full-5Hz-2 rings-6.4Km-2 rings	Low*-5Hz-3.2Km-2 rings
DR	**19.5**	**8.44**

RDR (DR) =26.3 MW (reference)

green= numbers to be checked

Reduced Bunch Number

SUMMARY POWER LOAD

Low=Reduced Bunch numbers*

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Low Power* = Reduced Bunch Number

	ML POWER in MW	
	Full-5Hz	Low*-5Hz
KCS	**152**	**120**
DRFS	**164**	**131**

RDR (ML) =134 MW (reference)

	DR total POWER in MW	
	Full-5Hz-2 rings-6.4Km-2 rings	Low*-5Hz-3.2Km -2 rings
DR	**26.3**	**12.81**

RDR (DR) =26.3 MW (reference)

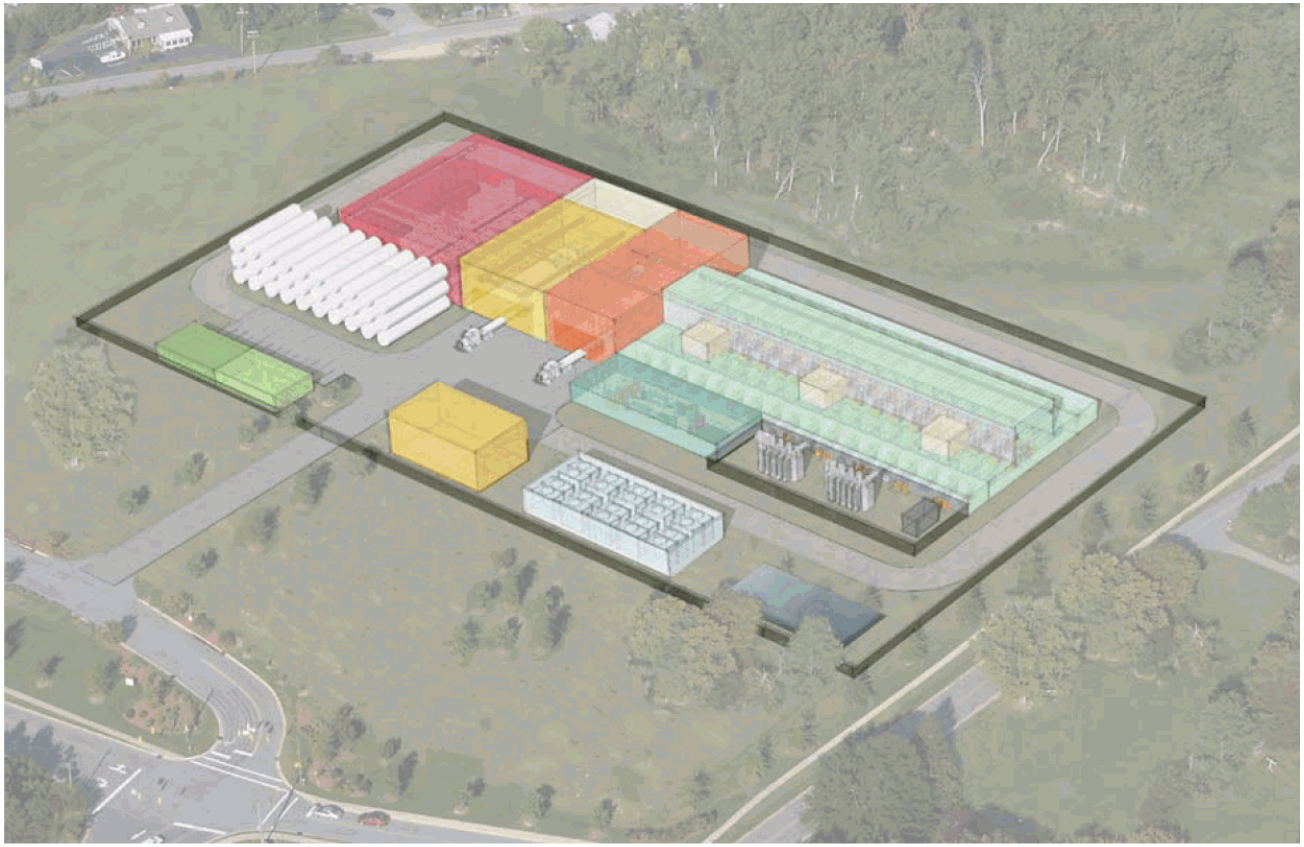
green= numbers to be checked

"Full Power" to "Reduced Bunch Number"

- **Civil Construction**
  - Klystrons Required at Surface are Reduced from 714 to 499 (ML)
  - KCS Surface Building Area is Reduced by 30 % (215/714) (ML)
  - DR Length Reduced to 3.2 km but Tunnel Diameter Increases to 7.5 m
- **Process Cooling and HVAC**
  - Reduction in Chilled Water Cooling Requirements for Surface RF Racks (ML)
  - Reduction in Cooling Towers for Process Water (ML & DR)
  - Reduction in Cooling Tower Pump and Accessories for Process Water System (ML & DR)
  - Reduction in RF Surface Water RF Pumping System (ML)
  - Reduction in RF Surface Water RF Piping System (ML)
  - Reduction in Chiller Capacity (DR)
  - Reduction in LCW System (DR)
- **Electrical**
  - Reduction in Medium Voltage Substations (ML & DR)
  - Reduction in Medium Voltage Distribution and Transformers (ML & DR)
  - Reduction Electrical Distribution for Reduced Number of Klystrons (ML)

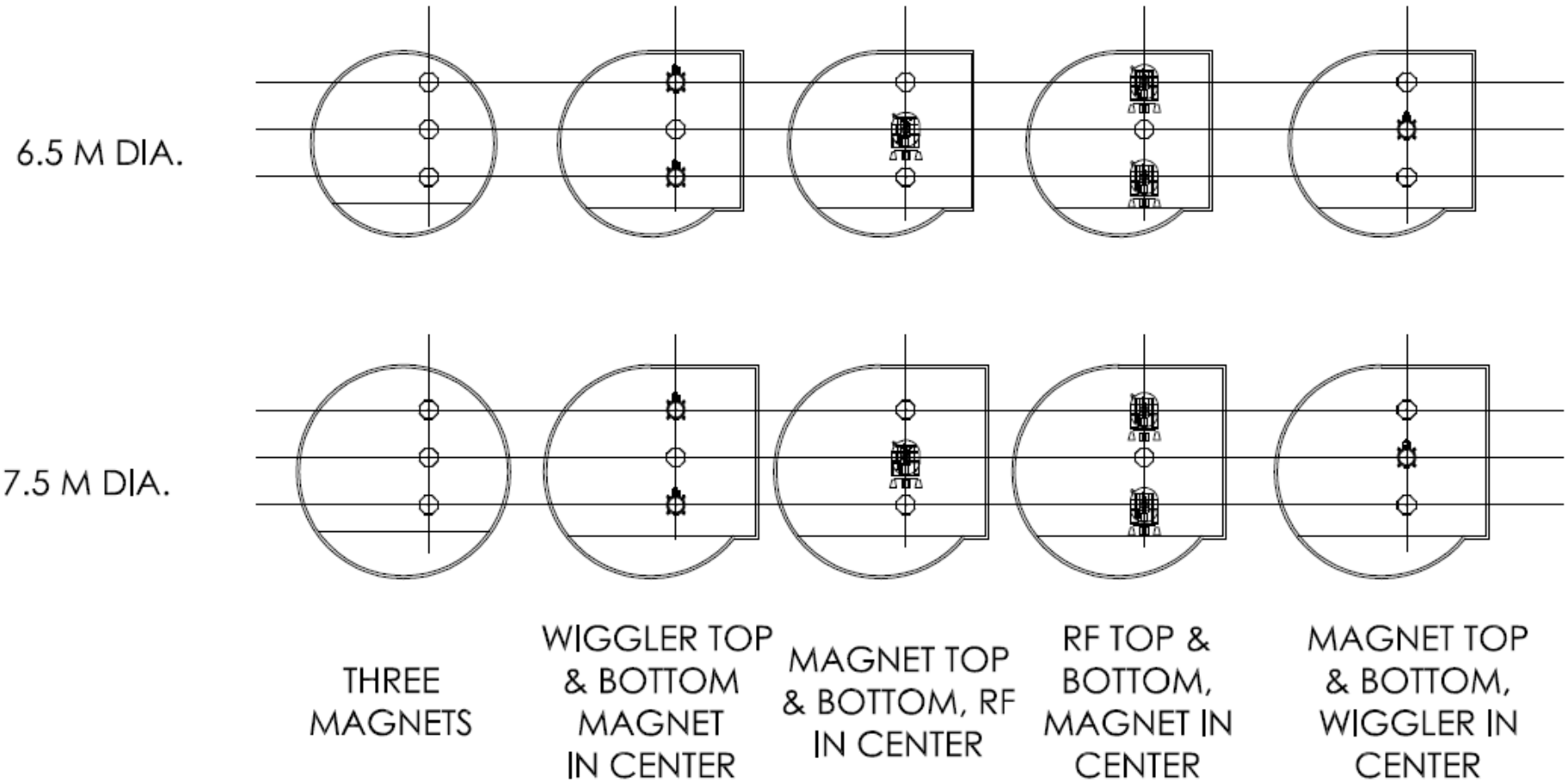
Reduced Bunch Number

Initial Surface Building Layout at Major KCS Shafts

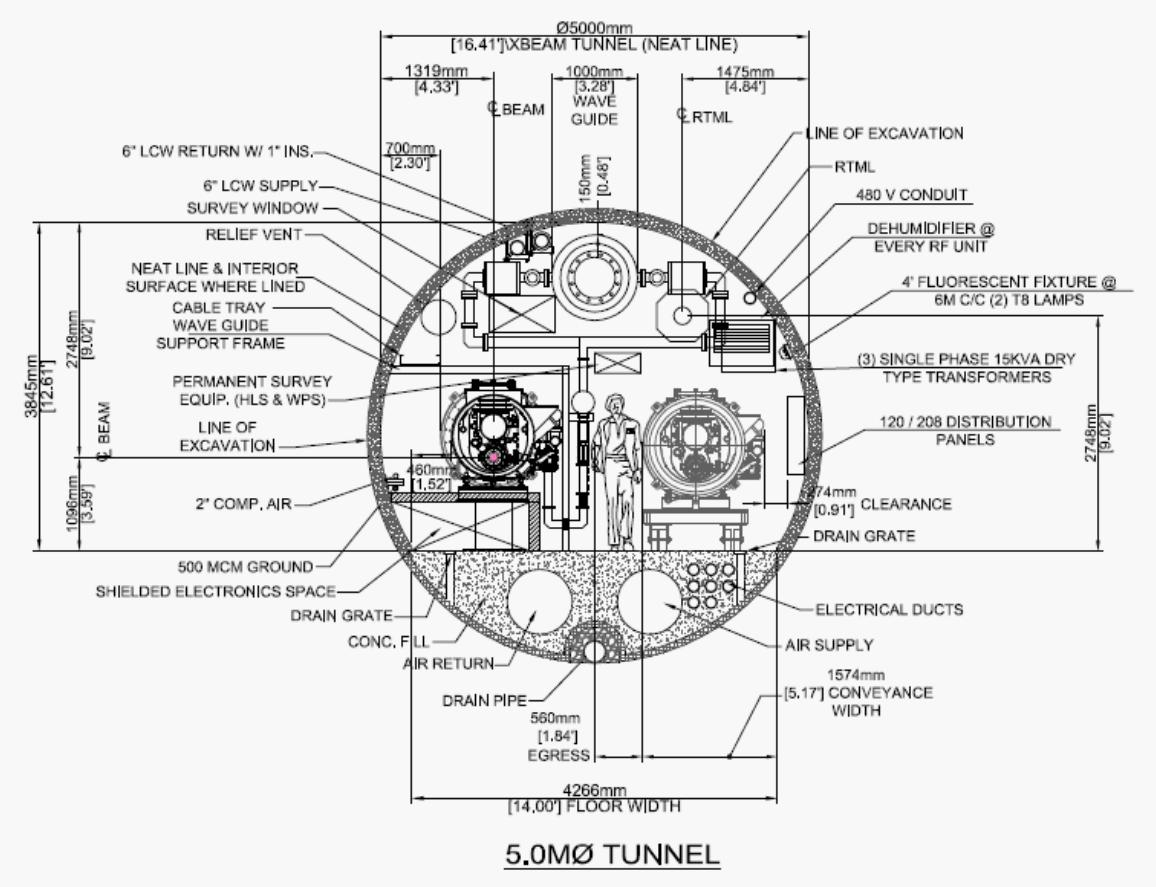


RF UNIT BUILDING
CRYO BUILDING
ADMIN
SURFACE PROCESS COOLING DI PLANT
SHAFT ACCESS BUILDING
WORKSHOP
FAN-HOUSE
SUPPORT
LOADING BAY

Reduced Bunch Number



Very Preliminary Cross Section Study for Damping Rings



Mature Cross Section Study for Main Linac

Reduced Bunch Number

SUMMARY COST DIFFERENTIALS JAN 13 2011

Low Power* = Reduced Bunch Number

** (CFS cost are for Civil, Mechanical, & Electrical only, in Million 2006$)*

	5Hz Full	5Hz Low*	delta in M$	
KCS CFS* cost	$ 796	$ 756	**$ (40.3)**	15M civil, 9M mech. 16M elec
DRFS CFS* cost				
	5Hz Full 6.4Km 2 Rings	5Hz Low* 3.2 Km 2 rings	delta in 2006 M$	
DR CFS* cost	$ 164.1	$ 134.8	**$ (29.3)**	19M civil, 7M mech. 4M elec

Upgrade Back to Full Power

- At this Level of Design Maturity the Upgrade Back to Full Power is Simply the Reverse of the Savings
- There is not Enough Detail in the Design to Identify any Premium for the Upgrade Back to Full Power Operation

Summary

- The KCS RF Option is the Most Developed to Respond to the "Reduced Bunch Number " Proposal
- The DRFS Alternative for the Americas Region is Only in the Preliminary Stages of Development
- The KCS and DRFS Main Linac Costs are Both Lower for the Reduced Bunch Number Option
- The Damping Ring Cost is Also Reduced Primarily Due to Reduced Overall Tunnel Length which Offsets the Increased Unit Costs of Larger Tunnel Diameter