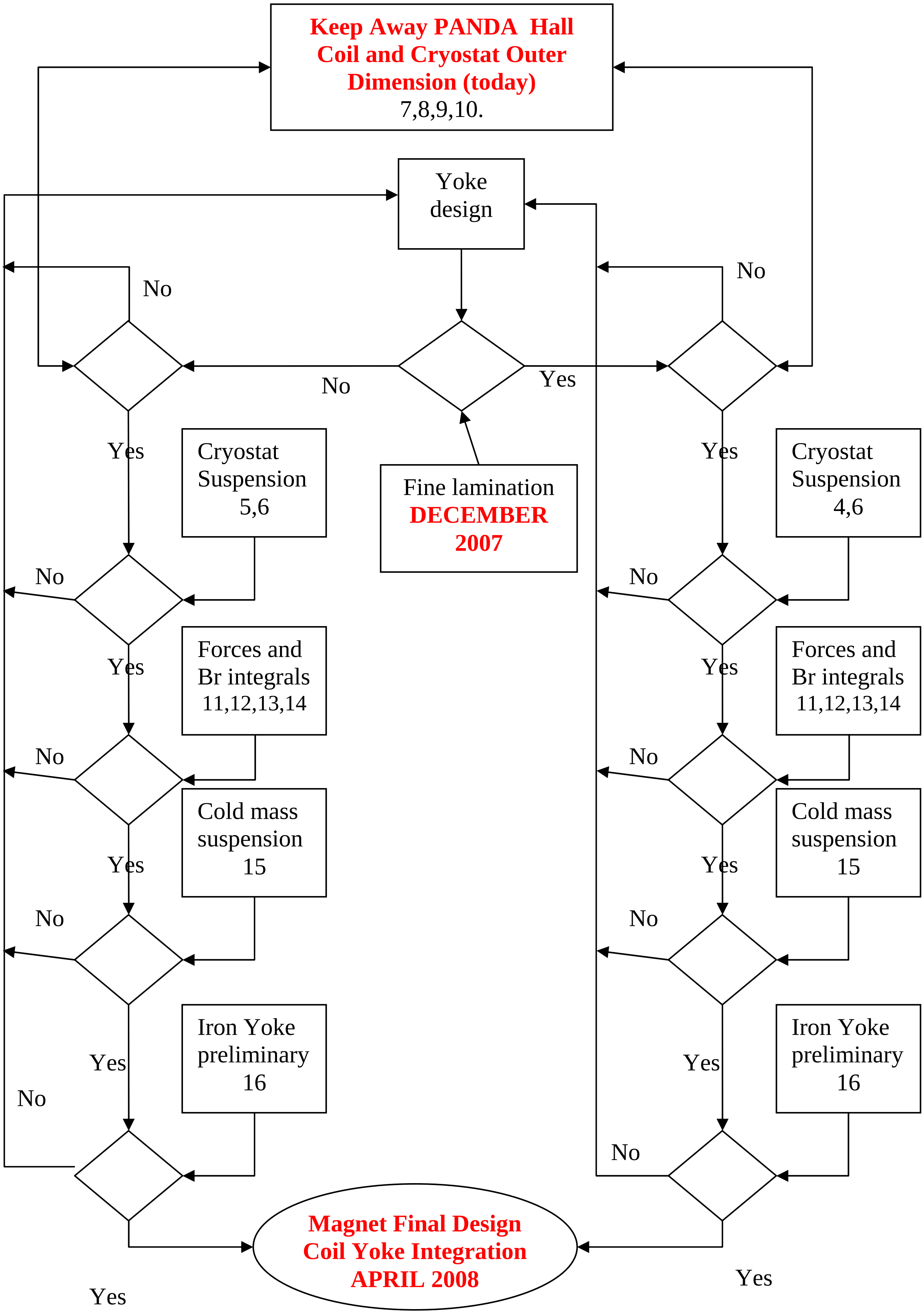
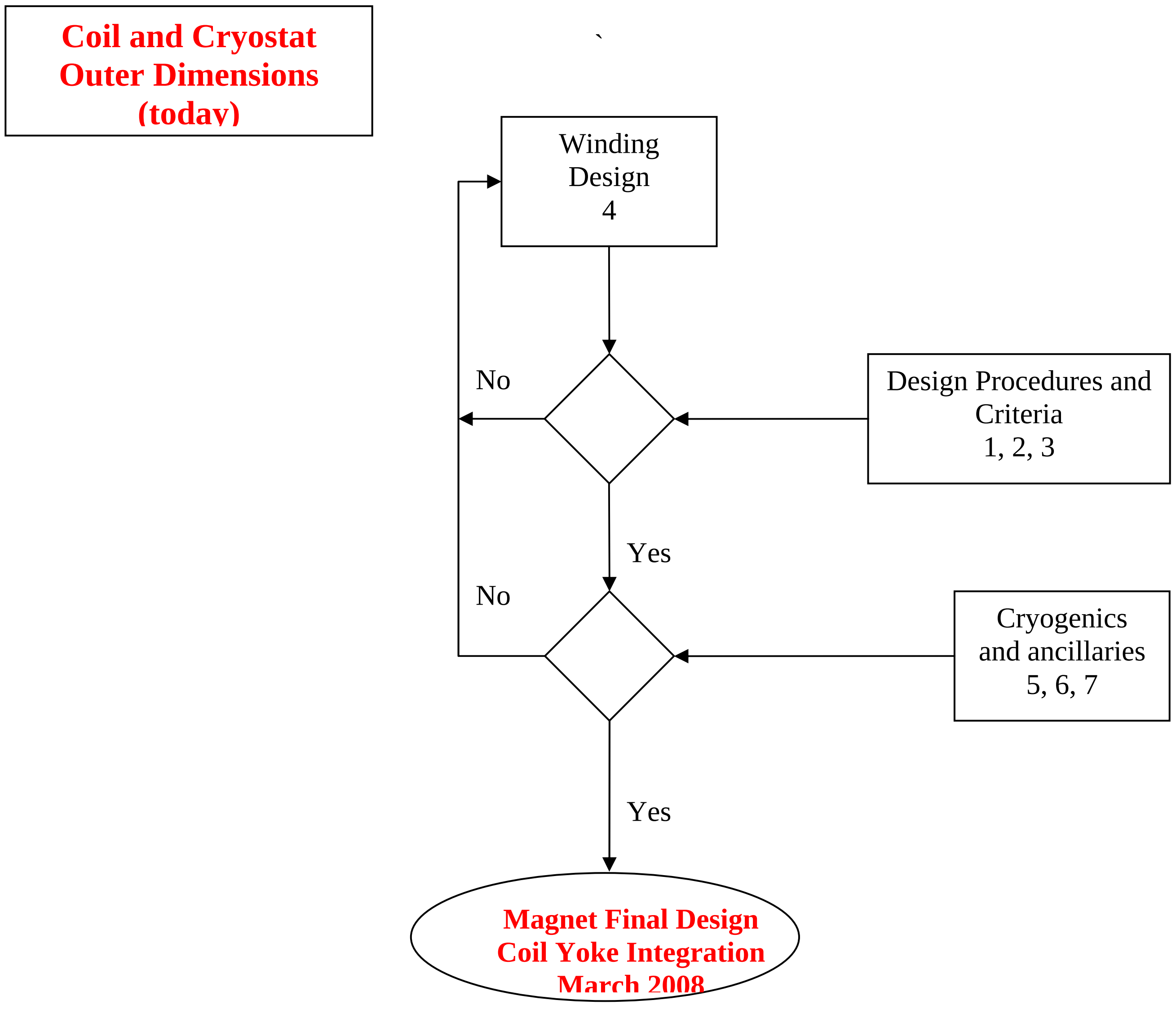
Iron Yoke Design (in parallel to the Coil design)

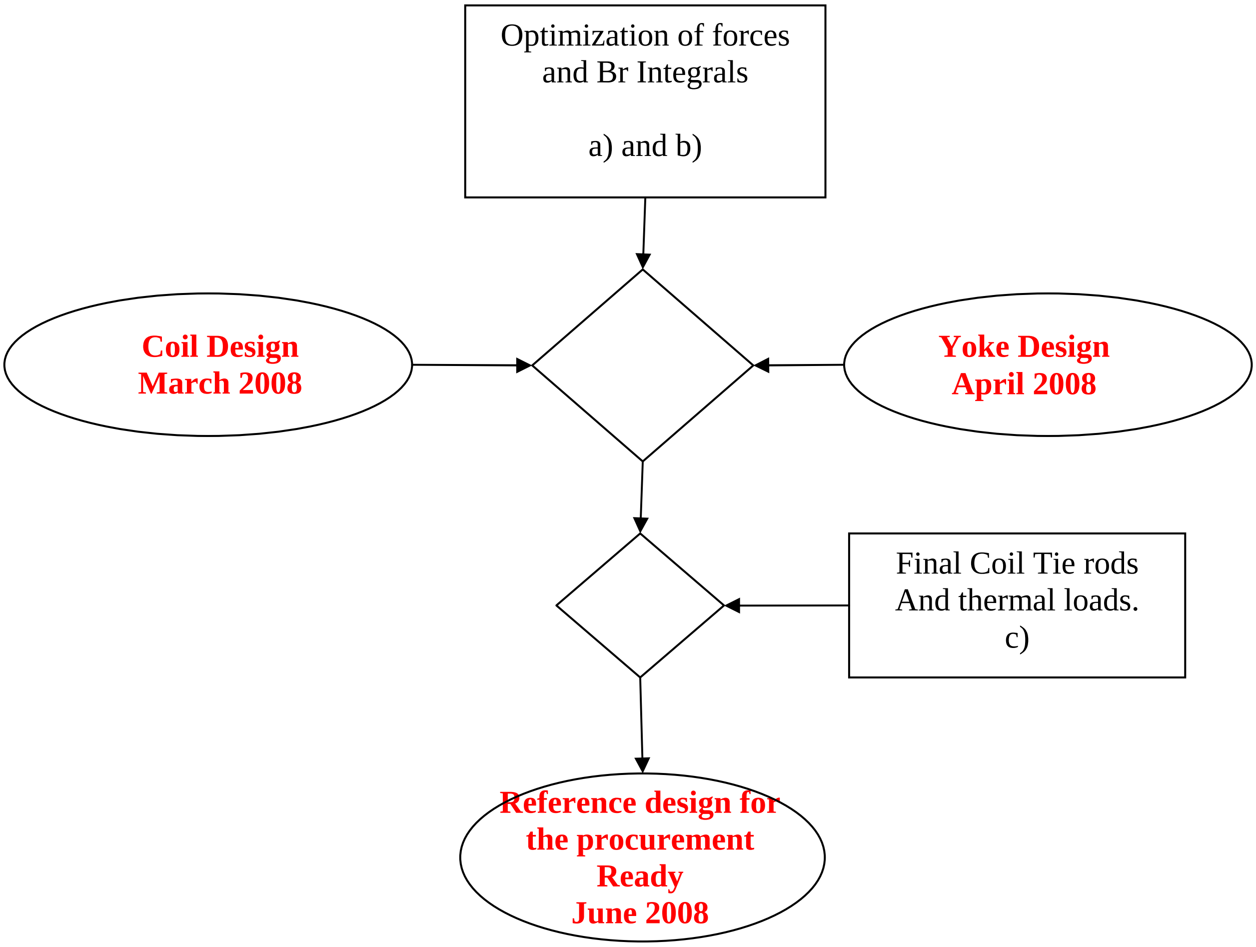


Coil_Cryostat Design Flow Chart
(in parallel to the Yoke design)



Magnet Final Design.

From this point any change in the Coil and Yoke Design is Really Dangerous



1. After this point the procurement Procedure need to go Trough the Quality control definition and the acceptance tests at the different stages of the construction.
2. Last the Economic issues need to be decided.

Panda Solenoid Timelines

General Layout constraints
and
HOLD POINTS

1. Definition of the “keep away” area around IP to allow operation both for HESR and Panda. At the moment we have only a “solid” limit downstream IP. (needed to have a limit for the magnet extension)
2. Solve once and forever the “iron segmentation - Muon detection” puzzle. We foresee a solid Physics program asking for this segmentation? If YES the iron must be segmented solving possible conflicts with point 1. If NOT let go ahead with the present segmentation
3. Once point 1&2 fixed we can freeze the design of the cryostat suspension (remember the cryostat is the cornerstone keeping in place the whole target spectrometer)

4. If the iron is fully segmented “a la BaBar” it is difficult to hang the cryostat in the middle of the Return Yoke. Again a solution “a la BaBar” with strong wedges at the Yoke barrel is a proven solution.
5. If the actual segmentation (few muon detector layers) is adopted, the coil can be hanged to the Yoke close to the Cryostat ends, saving useful space ad avoiding conflicts with the detectors and cables and services routing .
6. The Cryostat suspension is influenced by points 2-5. Forces and field quality in the tracker are strongly influenced both by the iron length upstream IP (see point 1), and (possibly) the iron radius.

7. It is of the outmost importance define the maximum allowable extension of the iron (and coil) in the upstream region.
8. It is also needed to know how much space we have between the panda Hall floor and the HESR Beam (iron+jet target ancillaries clearance).
9. We need to get a trade off between the segmentation and the inner radius of the iron, impacting the yoke radial extension.
10. We need to evaluate how much the total detector cost (magnet plus sub-detectors) is affected by a growth in size (compared to the TDR layout).

11. The iron Return Yoke impact on the coil design only on two correlated aspects☐☐
    - Net axial forces
    - Field quality.

    Both are related to the Br component of the magnetic field.
12. A great deal of design aspects of the coil are more related to the stored energy, operating current, mechanical and thermal properties of the materials used for the solenoid construction. These are substantially independent from the magnet layout and can be developed in parallel.

13. The yoke design affects the cold coil suspension (tie rods) through the net force on the coil, and the cryostat suspension to the iron.
14. The cold coil suspension affects the cryogenics load on the coil and refrigerator, the cryostat suspension affect the dead angle for the different sub-detectors.
15. Designing the cold suspension for the maximum foreseen force, allows to carry out the project of the cold mass and to resize the suspensions when the iron design (and detector layout) is frozen

16. It is of the outmost importance to outline, in the preliminary yoke design, the solutions to be adopted for the construction including:
    1. Mechanical connections of subdetectors and cryostat to the return yoke (dead angles)
    2. Signal and HV cables
    3. Services like cooling and gas for the subdetectors
    4. The assembly procedure of yoke, cryostat and subdetectors (especially muon chambers)

- □All this part of the work can be carried in parallel to the Coil and Cryostat design

IF

1. **we do not touch the outer dimensions of cryostat and coil**
2. **the mechanical suspensions are designed for the axial force foreseen in the worst case (~100 tons)**

Cold Mass design
HOLD POINTS.

1. First of all we need to define, decide, and agree the design procedures:
2. Use at the most the existing codes for industrial plants (mechanical and pressure vessels and seismic hazards) to be compliant with the rules of the host Institution and Country.
3. Define design rules for non standard items based on good practice and common knowledge coming from the design of similar devices.

4. Next we need to decide the winding technology and procedure.
    1. Outer coil former Vs. Yamamoto cable
    2. How many layers
    3. Winding technique, insulation, impregnation
    4. Operating current and safety issues (quench)
5. Define Ancillaries and Cryogenics
    1. Cooling (dedicated liquefier Vs FAIR central)
    2. Forced flow versus natural convection.
    3. Shields, suspensions and force sensors.
    4. Cryogenic turret, current leads, phase separators.

6. Define electronics and quench protection
    1. Power supply.
    2. Quench detection.
    3. Quench heaters to spread the quench.
    4. Fast and slow dump.
7. Define magnet controls
    1. Cool down and operation sensors (temperature, position and movements)
    2. Magnet Slow Controls and integration in DAQ
    3. Local control and interfaces with the PANDA, HESR and FAIR control and data Logging.

- All this part of the work can be carried in parallel to the magnet layout and iron optimization

IF

- **we do not touch the outer dimensions of the Cryostat and the Coil**

Starting point for the Iron_Coil integration

Once the Yoke design and the Detector layout are FROZEN, the concurrent design of the whole solenoid needs to be carried out as a single item with the last optimizations.

a) Optimization of Forces and B_r □integrals, freezing of the coil and winding dimensions.

b) Optimization of the B_r integral by fine tuning (few centimeters) of the coil and subcoils dimensions and currents.

c) Final design of the cold mass (and cryostat) tie rod optimization to keep the final Axial Force.

Since this step accomplished
NO
FURTHER
CHANGES IN THE
MAGNET LAYOUT
WILL BE ALLOWED