Vertex Detector Mechanical R&D
Design Questions and Issues

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Sensor Properties

1. For each technology, what limits are there on sensor dimensions: thickness plus each transverse dimension?
2. How do active and cut dimensions compare?
3. Does the sensor require out-of-plane features, for example, separate readout chips?
4. What stress and strain can a sensor tolerate without damage?
5. Can the sensor be formed into a partial cylinder or non-flat shape?
   - If so, what is the minimum bend radius?
6. At what temperature is the sensor expected to operate? Humidity?
7. How stable need the temperature be?
8. Are temperature requirements different for various sensor regions?
9. How uniform is the coefficient of thermal expansion through the sensor thickness and in different transverse regions?

Handling and Assembly Requirements

1. Where / how is a sensor to be singulated from a wafer?
2. How is it to be handled thereafter?
3. How robust are sensor surfaces?
4. What is known about sensor wire-bonding and bump-bonding properties?
5. Are sensors sufficiently flat as fabricated, or do they need to be flattened by support structures?
6. How sensitive is the sensor to static discharge?
7. In what gas environment should the sensor be maintained?
8. Are environmental requirements different when a sensor is not powered?

Power Consumption / Delivery

1. What is the expected power dissipation per unit area?
2. Is the dissipation uniform over the sensor or concentrated in specific areas?
3. If it is concentrated, what is the dissipation within each area and on each sensor surface?
4. If power cycling is required, is it integral with the sensor or must it be provided separately?
5. What are the design requirements and implications of serial power?

Controls, I/O, and Cabling

1. How many control signals are needed?
2. When and how often are they downloaded?
3. Are signal receivers and output drivers integral with the sensor or separate?
4. How are connections made?
5. How many separate power and signal connections are required?
6. Are optical transceivers incorporated in one of the sensor layers?
7. Are cables attached directly to sensors or via connectors?
8. How are cables and optical fibers anchored to prevent transmission of forces and moments into a sensor?

B-field and Implications

1. How sensitive is the sensor to magnetic field magnitude and direction?
2. How are current-carrying elements aligned with the field direction?
3. How are cables anchored to prevent motion due to the B-field?

Noise: Pick-up / Generation / Shielding

1. How sensitive is the sensor to noise pick-up?
2. Does the sensor or its readout generate noise which could adversely affect other portions of the detector, such as calorimetry?
   – This may be less of an issue if I/O is via fiber optics.
3. What are the requirements for support structure grounding?
4. Is a Faraday cage needed?
5. What about noise traveling down the beam pipe?

Geometry, Support, and Cooling

1. Barrel and disk support
   - Geometric acceptance
   - “Mass”
   - Ease and precision of fabrication and assembly
   - Alignment provisions and requirements
     - Vertex detector positioning relative to the beam
     - Vertex detector positioning relative to the outer tracker and other sub-detectors (calorimeters, muon system, etc.)
   - Simulations
2. Design and prototyping
   - Ladders and barrels
   - Wedges and disks

Geometry, Support, and Cooling

3. Cooling
   - Assumed to be via dry gas
   - Supply and distribution ducts and manifolding
   - Vibrations, flow rates and regimes, temperatures, etc.

Installation, Servicing, and Beam Pipe

1. How is the vertex detector installed and aligned?
2. How is it serviced later?
3. What are the detailed paths to the outside world for power, cabling, fiber optics, and cooling gas?
4. If power conditioning is needed, where and how would that be done?
5. How is the vertex detector integrated with the beam pipe, associated “vacuum chambers”, and other sub-detectors?
   - Beam pipe contour
   - Support
   - Geometry and constraints
   - Integration of the vertex detector with forward calorimetry, beam monitoring, and other sub-detectors

Technology Dependencies of Solutions

- We received a suggestion that mechanical design approaches be characterized by the extent to which they are sensor technology dependent (or independent).
  - A reasonable suggestion, but beware the quicksand!
- It seems likely that some mechanical designs will be more suitable for one sensor technology than another.
- It seems equally likely that the some sensor technologies will require specific mechanical design features.
- We should be aware of those dependencies, and even tabulate them, so that they can be taken into account if resources limit our investigations.
- In the ideal world, optimal combinations of mechanical designs and technologies would become self-evident as R&D progresses.

Issues and People

- The list of issues is certainly incomplete and needs to be tuned.
- We invite people to suggest changes and to sign-up to investigate specific issues:
  - Sensor properties
  - Sensor handling
  - Power
  - Controls, I/O, and cabling
  - B-field
  - Noise, pick-up, shielding
  - Geometry, support, and cooling
  - Installation, servicing, and beam pipe
  - Technology dependencies
- We hope some names can be associated with tasks before the next meeting.