# LOI task review

SiD meeting

26 October 2007

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*Argonne National Lab*

Draft version

# Overview

Short summary of LOI plans we have heard

Comments on time line for LOI

Decisions about technology choices

Price tag for detector

Idea was: review and see whether LOI plans are realistic/coherent, lead towards an LOI.

# PFA--- cornerstone of SiD

## Round-up of other PFAs

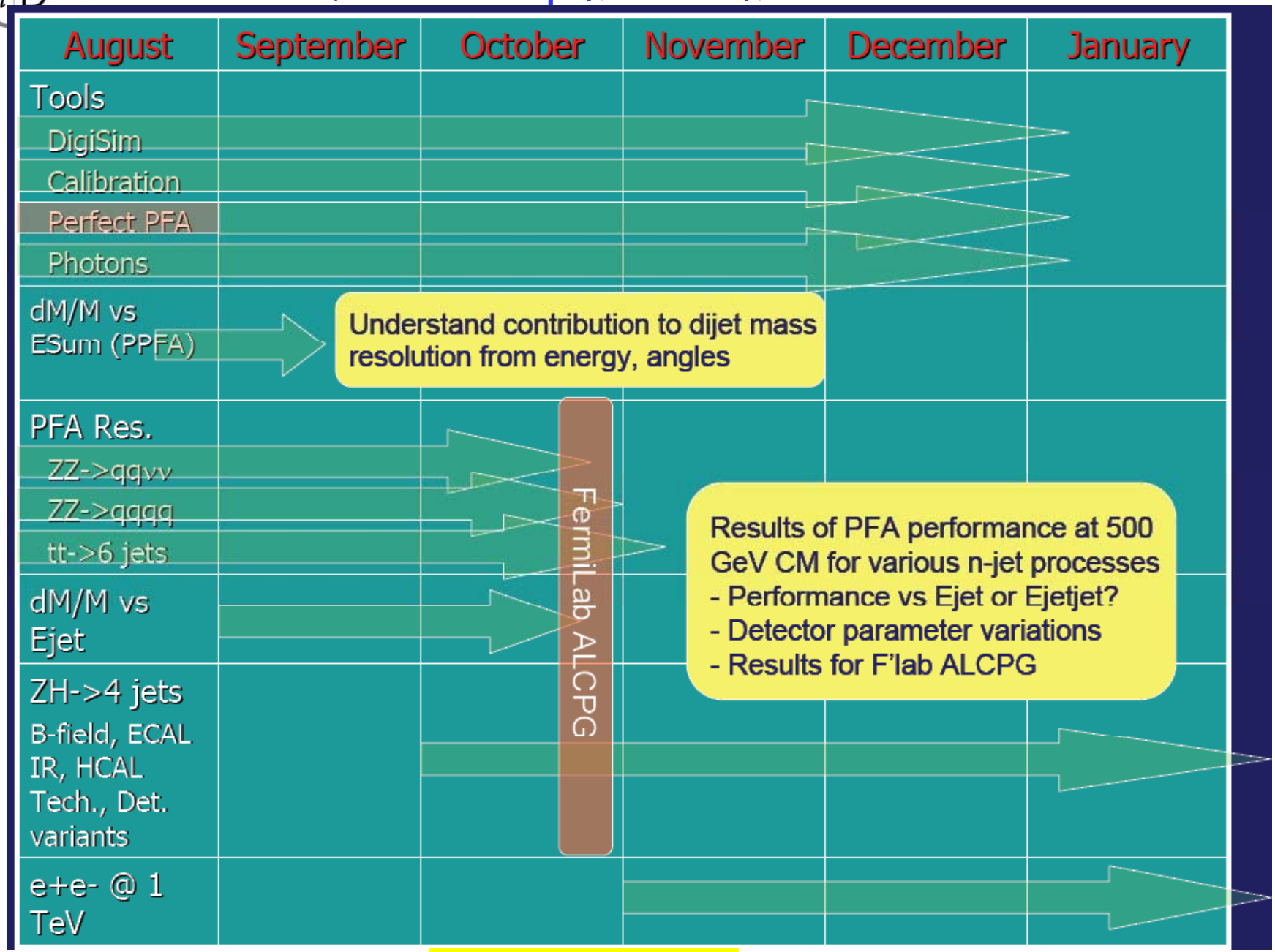
Table idea stolen from Lei Xia (ANL)

rms90 of energy sum [GeV]

rms90 of dijet mass residuals [GeV]

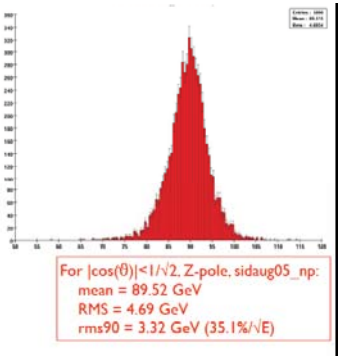
| PFA/Group | Detector | uds dijet 91 GeV | uds dijet 200 GeV | uds dijet 360 GeV | uds dijet 500 GeV | ZZ 500 GeV |
|---|---|---|---|---|---|---|
| PandoraPFA | LDC00 | 2.2 | 4.1 | 7.5 | 11.9 | |
| Wolf | LDC00 | 5.1 | | | | |
| TrackBasedPFA | LDC00 | 3.9 | | | | |
| ANL(I)+SLAC | SiD | 3.2/9.9 [dbl gaus] | | | | |
| ANL(2) | sidaug05_np | 3.3 | 9.1 | | 27.6 | |
| Iowa | sid01 | | | | | 5.6 |
| NIU | sidaug05_tcmt | 3.9/11.0 [dbl gaus] | | | | |
| GLD | GLD | 2.8 | 6.4 | 12.9 | 19.0 | |
| Needed for dM/M = 3% | | 1.9 | 4.2 | 7.6 | 10.6 | 2.7 |
| Needed for dM/M = 4% | | 2.6 | 5.7 | 10.2 | 14.1 | 3.6 |

# PFA development time line




Need results ……

# PFA approach / jet energy approach




**e+e- -> ZZ -> qq + νν @ 500 GeV**

Development of PFAs on ~120 GeV jets – most common ILC jets
Unambiguous dijet mass allows PFA performance to be evaluated w/o jet combination confusion
PFA performance at constant mass, different jet E (compare to ZPole)
dE/E, dθ/θ -> dM/M characterization with jet E

**e+e- -> ZZ -> qqqq @ 500 GeV**

4 jets - same jet E, but filling more of detector
Same PFA performance as above?
Use for detector parameter evaluations (B-field, IR, granularity, etc.)

**e+e- -> tt @ 500 GeV**

Lower E jets, but 6 – fuller detector

**e+e- -> qq @ 500 GeV** -> 1 TeV?

250 GeV jets – challenge for PFA, not physics

A lot has been said about PFA performance in SiD.
Will not repeat anymore

Trying to increase effort on PFA, bring in more manpower
Coordination between efforts
Weekly meetings

PFA is THE central assumption in SiD.
Are there alternatives we should consider i.e. options ?

More in HCAL

# Benchmarking LOI tasks -summary

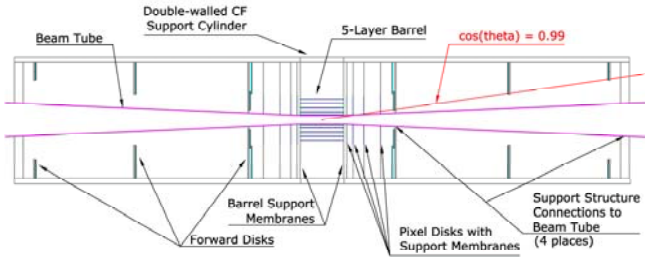
Benchmarking: Oct 2008 submit LoI
July 2008 Benchmarking studies ready
Feb 2008 All key analyses on-going
Dec 2007 First sample analysis
Oct 2007 Decide what's needed for LoI

- New phase of physics studies
- Need to cover 7-8 "obligatory" processes

- Resumed benchmarking meetings: biweekly on Tuesday 9 am SLAC/ 11 am Fermilab/ 5 pm UK
- Talking to subsystem to identify additional processes
- Physics studies are ideal for newcomers, fast track way to contribute to LoI

- Talk to us about your favourite physics process or how you'd like to benchmark your favourite detector system!

# LOI: VXD list

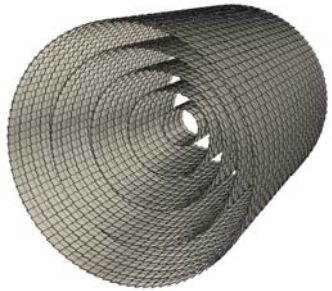



- Power delivery design and R&D.
- Readout scheme details data transmission R&D.
- Mechanical design consolidation with prototype R&D tests.
- Further develop mixed sensor configuration optimization and focused R&D goals for different sensors.
- Endcap sensor segmentation and layout.
- Service routing schemes.
- Additional cooling ?
- Stretched VXD or additional layer for long Vs ?
- Integrating forward tracking with pixel technology ?
- Simulation/reconstruction studies for hit density sensitivity and spatial resolution optimization.
- Higher level vertexing and bench mark studies.

**Comment:** A time line would be useful .

Standard comment: "drop in at last minute……."

# Tracking: LOI



- Technology choice: silicon
- Motivated layout of the detector
  - General layout
    - Description of detector geometry, including number and locations of barrel and forward tracking layers
    - Average number of measurement planes intersected by infinite momentum particle as function of angle
    - Material budget as function of angle
  - Particle densities for background and physics processes
    - Motivates technology choice in certain regions: pixels versus strips
  - Segmentation and tiling
    - Longitudinal segmentation in barrel
    - Tiling in forward region
    - Occupancies (averaged over full layer and peak occupancy in jet core)
  - Detailed detector description
    - Describe baseline design and possible alternatives
    - Sensors, readout, modules, mechanical supports, cables, alignment, power, etc.
    - Some of this may need to be in a supplementary document

What are alternatives ? Is there a finite list ?

# Tracking : Performance Characterization – Step 1

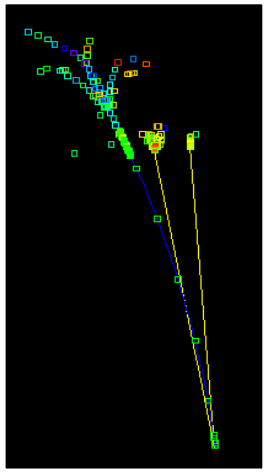
- Characterization of performance using traditional metrics
  - Momentum resolution as function of $p_T$ and angle
  - Impact parameter resolution as function of $p_T$ and angle
  - Track finding efficiency as function of $p_T$ and angle
    - Isolated tracks as function of angle
    - Inside jet cores: Z-> qqbar @ 500 GeV as function of angle
    - $K_S$ efficiency
  - Fake rate as function of angle and momentum
- Goal is to have all infrastructure in place by SiD Workshop planned for Jan. '08 with a first pass at characterization of detector performance

# Tracking: Performance Characterization – Step 2

- Move towards benchmark physics processes: develop the metrics that measure physics performance
  - Physics will apply a non-uniform weighting to the traditional metrics
    - Inefficiency at high momentum more critical than at low momentum
  - Weighting may depend on physics
    - For example, leptonic ZH heavily weights momentum resolution
      Characterization of performance using physics benchmark processes
- Some potential tracking benchmark processes
  - ZH missing mass distribution
  - $H \rightarrow \mu\mu$ mass resolution
  - b/c tagging efficiency in Higgs decays
  - Acollinearity of forward Bhabhas (luminosity spectrum)
  - Long-lived charged particles (e.g., GM SUSY)
  - Need some good ideas for forward benchmarks

**Comment:** Extensive and ambitious LOI plans
Focused on right issues

# ECAL: Proposed technical solutions in SiD



A) Tungsten & "traditional" silicon diodes/ Tungsten with integrated readout

Transverse segmentation 3.5 mm (Moliere radius ≈13 mm)

B) Tungsten & MAPS active CMOS pixels (Terapixel option)

Transverse segmentation 0.05 mm (Moliere radius ≈13 mm)

Steps towards LOI:

- Technology choice
  - MAPS terapixel still needs to be proven as a viable ECal technology
  - Si diode/W ECal technology is well established for relatively small calorimeters. But the integrated electronics needs to come together.
  - What does the physics say? Is there a physics case for segmentation<< $R_m$ ? Perhaps. The case needs to be made and weighed against the risks.
  - Suggestion: Make Si diodes the default, but continue the R&D and studies for terapixel. Attempt to make an ECal mechanical structure which can accommodate either without important compromise.
- We need to do a lot of work to solidify and amplify the physics case for the LOI --- simulation studies at all levels.

**Comment:** Time line ? Need for simulation. Have manpower ?

# HCAL: towards LOI

## Towards the LoI

- Baseline choice with possible alternates
- The LoI should serve as the mechanism by which SiD arrives at a baseline design
- Especially relevant for HCAL as multiple technologies are being pursued
- Series of hardware and software benchmarks that the technologies have to address for inclusion in the LoI
- Operationally propose a series of reviews...
- Who reviews ?

## Performance Criteria

- MIP efficiency/pad
- Hit multiplicity/MIP
- Uniformity of response
- Need for, or ease of calibration
- Recovery time
- Discharge rates
- Magnetic field issues
- Track-cluster separability
- PFA jet resolution

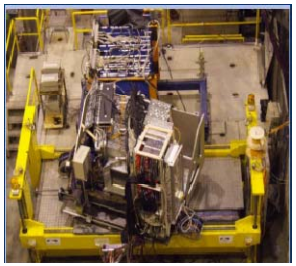
## Technology Issues

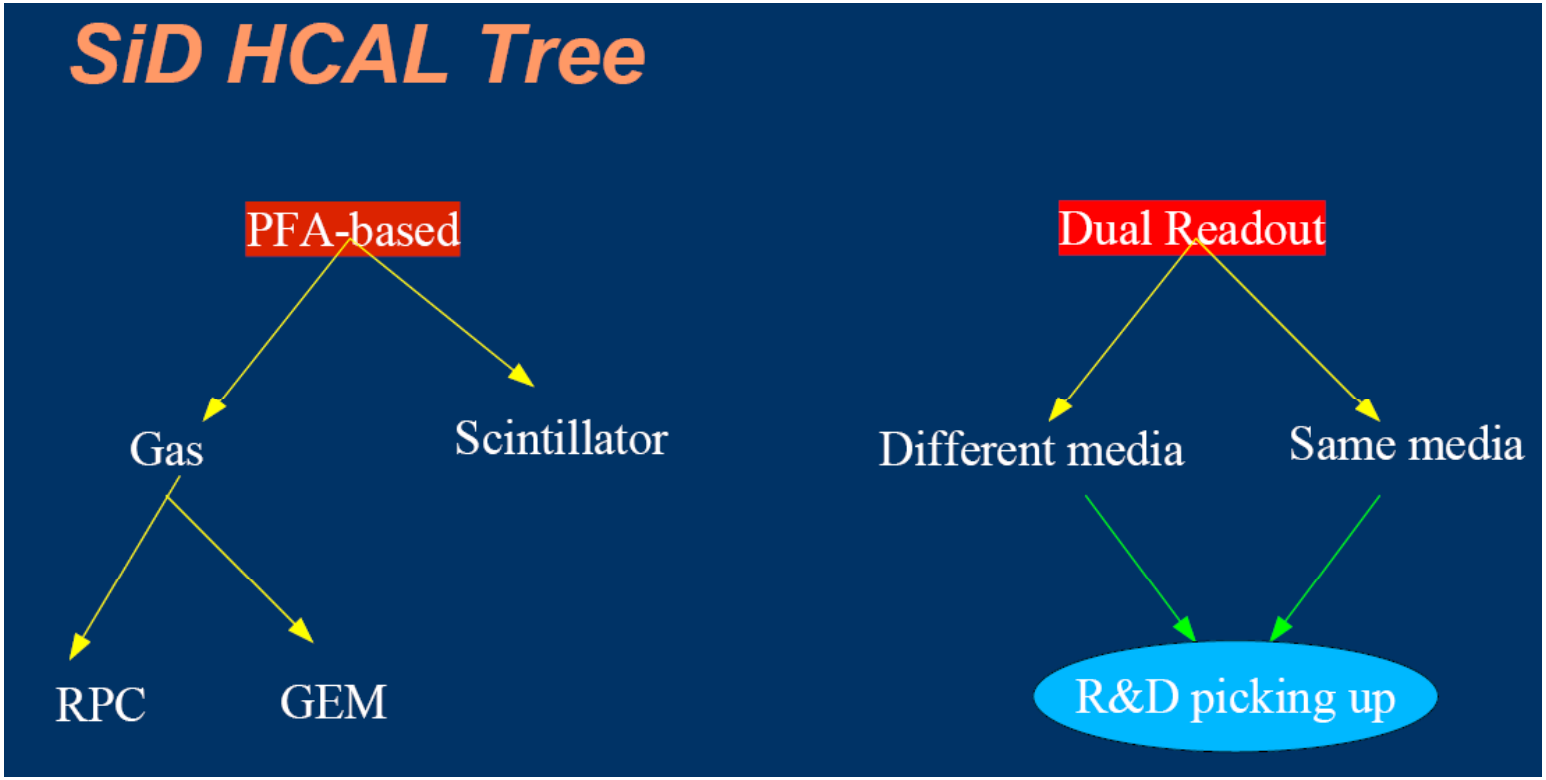
- Reliability
- Availability of components
- Active layer thickness
- Segmentation achievable
- Scalability
- Aging
- Cost

Comments:

A lot to do.
Most controversial area
Have suggested reviews for baseline choice
Tight connection to PFA
Need to watch time line

# HCAL






Vishnu showed this…… without further comment

**Comment:** Should SiD consider "not strictly PFA" based approach?

HW Answer: yes if we have manpower & implementation that fits SiD

# FCAL

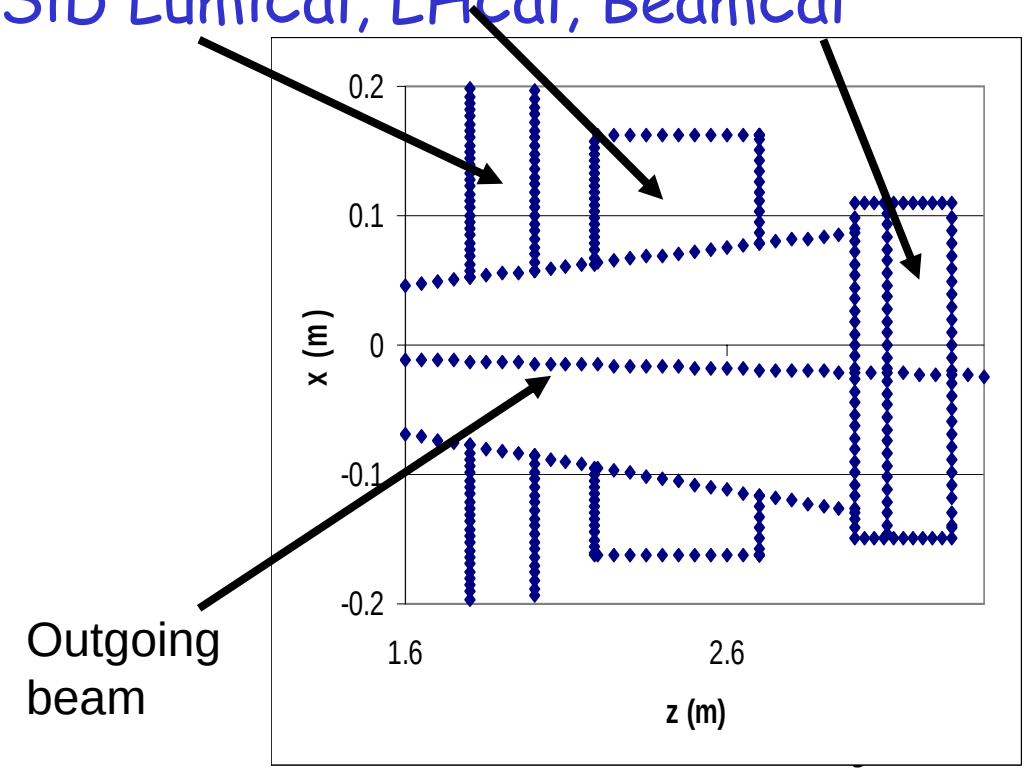
## Work done very well within global R&D collaboration

- W. Lohmann (DESY Zeuthen) spokesman
- W. Morse (BNL) beam diagnostics (BeamCal/GamCal) coordinator – also SiD forward coordinator
- B. Pawlik (Cracow) simulations coordinator
- W. Lange (DESY) sensors coordinator
- TBD electronics coordinator
- W. Wierba (Cracow) LumiCal laser alignment coordinator

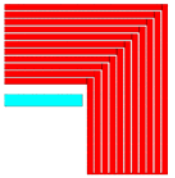
Specific SID FCAL group working on SiD design

LOI tasks….

SiD LumiCal, LHCal, BeamCal

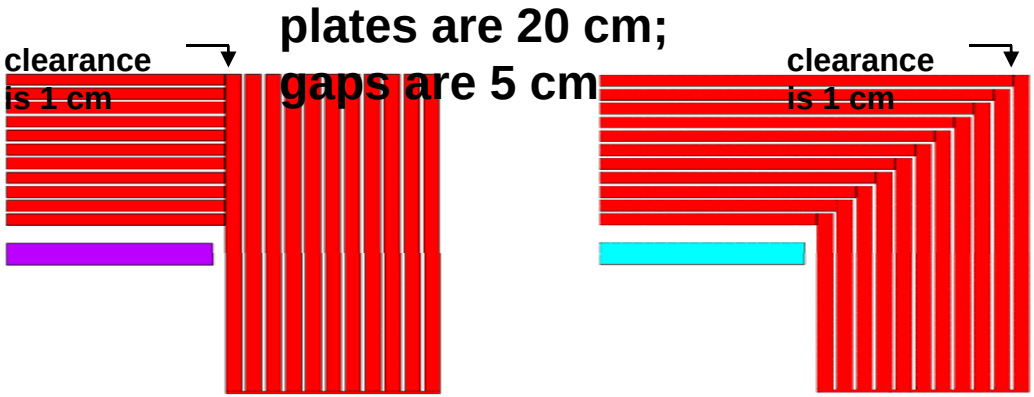


# Solenoid



## Baseline:

- 5 Tesla
- 5m diameter clear bore
- 5m Long
- 6 Layers
- Stored Energy 1.4 GJ
- Water Cooled Dump Resistor

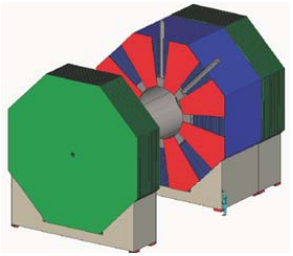



Flux return configurations

**Comments:**

Work is on going
Interaction with MDI
What are our plans/goals for LOI ?

# Muon system



- Benchmarks
- Performance studies ⟶ Needed for LOI
- Engineering design
- Technology options
  - Scintillator
  - RPC
- Schedule
  - Technology choices
  - LOI – Oct. 08
  - EDR – fall 10
- Open projects – All of the above!

Quote:

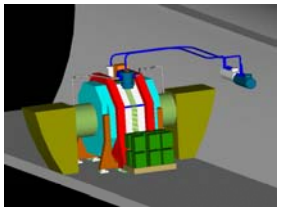
Easy to contribute because "not a Black Hole like PFA…… "

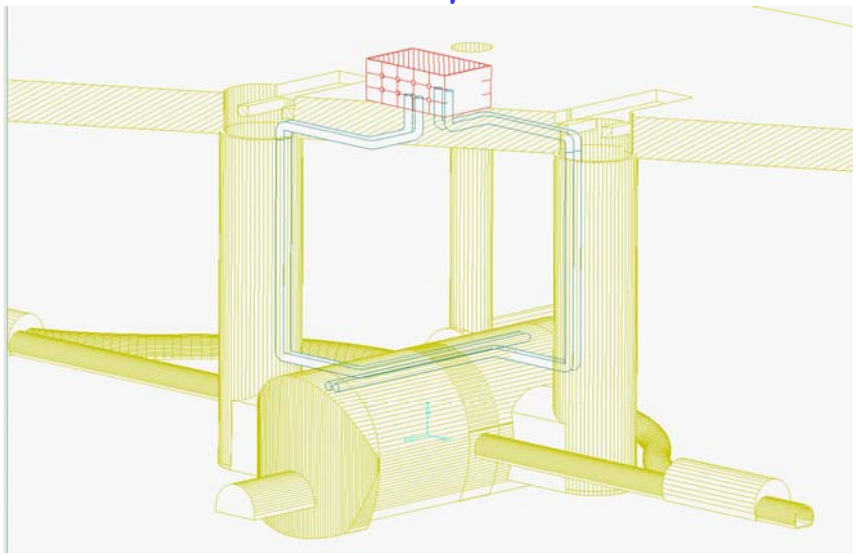
Comments:

Manpower shortage
Emphasis on detector technologies
What is our plan/goals for LOI ?

# IR and MDI

Detailed talk by Tom Markiewicz





SiD lagging behind IR design engineering

Worrying about push pull and related issues

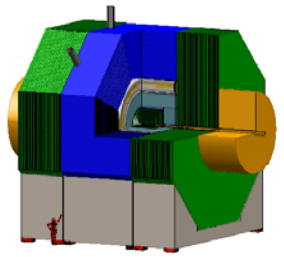
Comments:

Efforts obviously well connected to BDS
A lot of progress during IRENG07
Large impact on forward regions of SiD
Not clear about LOI goals

# Electronics/DAQ

No comments.

# Engineering



LOI plans:

10/07 to 2/08

- Identify liaison from each Sub-detector group to work closely with SiD Engineering group. → done
- Understand and refine the DOD SiD starting point.
- Define the sub-detector space and parameters(Global Parameters)
  - Sub-detector modules-weight/size/cables/utilities/dead space
  - Sub-detector assemblies-clearances/dead space
  - Sub-detector assembly supports
- Create Control Board/Committee
- Create engineering drawing/database

Comments: Team assembled; work started

# Optimization

Marty summarized that in previous talk.

Should still be fresh on our mind.

# Time line and order suggested to get to LOI

| Date | Milestone |
|---|---|
| 10/1/08 | Submit LOI |
| 9/1/08 | Begin Final Edit of LOI; complete authorlist |
| **8/1/08** | **Complete LOI Draft**<br>Collaboration Review and Comment |
| 6/1/08 | **GEANT4 Description Ready**<br>Performance Studies Ready<br>Benchmarking Studies Ready |
| **5/08** | **Freeze Detector Design**<br>SubSystems Fully Specified<br>Subsystem Technologies/Alternates Selected<br>Conceptual Engineering Designs Ready |
| **3/08** | **Freeze Global Parameters**<br>First Pass Detector Design |
| 2/08 | **First Pass Global Parameters** |
| **12/07** | **Subgroup Plans Defined**<br>Milestones and Deliverables<br>Manpower Resources Needed |

# LOI time line; check points….

SiD is "resource limited" and progress is slow: simple fact

However no matter what, we want to submit LOI in Oct 2008

Need fall back positions at certain points….

( from remarks by Grannis, Breidenbach… what if ?)

Examples

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If not ➔ limit scope, redefine plan

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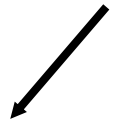

Example: just simulate fully SiD00

# Choices

Resolved: There should be definite technology choices in the SiD LOI

**YES**

SiD is not defined, performance is not defined, costs are not defined if technologies aren't chosen

An indefinite SiD design weakens the LOI

Can't afford time or $ or manpower to do multiple engineering designs for each tech choice

Can't afford to benchmark a multi-dimensional matrix of possibilities

Learn from the machine: Choose now, allow change control later

SiD has to learn to make choices. Start now.

Process demonstrates maturity of collaboration, a plus for LOI

Selection process focuses our attention on outstanding issues

**NO**

There is insufficient data to choose some subsystem technologies rationally

If choose technology A, SiD may lose proponents of technology B

Some technology decisions can be made later, without impacting overall SiD design

Arbitrary choices weaken the LOI case

Choosing too soon could compromise SiD performance

We can evaluate performance and engineer designs for at least a couple of alternatives

Choice of words: Not making technology choices, but selecting baseline with options

Some remarks:

- This is the LOI phase, to be followed by the EDR phase and then the building phase
- Where choices can be made they should be made and we have done so (it is after all a Si based detector)
- It is good to have a baseline.
- Need to attract more collaborators at this time ➔ keep options open

Special: SiD is PFA based/driven design. If PFA performance can not yet tell us the technology, may be we should not make a choice ( HCAL).

(people probably think I am biased here…..)

# The price tag….

Some comments….

Yesterday we heard that price tag/detector is supposed to < ~$500M.

It is somewhat of a mystery to me why there is already a rather low limit on the price tag for the detectors given that:

- Technologies are undecided/somewhat unknown
- Performance has to exceed anything built up to now
- There are only two
- Supposed to last for decades
- Have to operate at 500 GeV as well as at 1TeV ( machine price tag will >>> for upgrade)
- Out of proportion compared to machine price tag
- Mechanisms for contribution to detectors ( from different countries) have not been explored yet

Costs should be considered in the design and play a role.
Should they be limited before we know what to built ?

( was not the case for machine)

THE END