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# Status report of the TPC detector group

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Huirong

On behalf of CEPC Tracker Subgroup

2014.03.19

# Outline

- TPC探测器组参与人员情况
- TPC探测器组组织例会情况
- CDR之前需要了解部分信息
- TPC探测器组CDR撰写计划

# 人员情况(2013.10.23)

- 杨海军 (上海交大) yhj@umich.edu
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- 喻纯旭 (南开大学) yucx@nankai.edu.cn
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- 高原宁 (清华大学) gaoyyn@tsinghua.edu.cn
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- 杨玉娇 (南开大学) 86715486@qq.com
- 黄孟 (清华大学) hm.max@126.com
- 张慧君 (南京大学) zhanghj@ihep.ac.cn
- 胡碧涛 (兰州大学) hubt@lzu.edu.cn
- 张毅 (兰州大学) zhangyi.lzu@gmail.com

After kick-off meeting@Sep.14, 2013

# Participants @All regular meetings

<u>Tsinghua University</u>	<u>Gao Yuanning, Li Yulan, Li Bo, Deng zhi</u>
<u>IHEP</u>	<u>Li Jin, Qi Huirong, Zhang Yulian</u>
<u>Shandong University</u>	<u>Zhu Chengguang</u>
<u>UCAS</u>	<u>Zheng Yangheng, Liu Qian, Wang Binlong</u>
<u>Lanzhou University</u>	<u>Hu Bitao, Zhang Yi</u>
<u>Nankai University</u>	<u>Fu Chunxu, Yang Yujiao</u>
<u>Shanghai Jiaotong University</u>	<u>Yang Haijun, Fu Changbo</u>
<u>Nanjing University</u>	<u>Zhang Huijun</u>
<u>CIAE</u>	<u>Li Xiaomei, Zhou Shuhua, Zhoujing, Hu Shouyang</u>

# TPC Sub-group Regular meeting

## ■ 1<sup>st</sup> to 6<sup>th</sup> Group meeting

- 11, Nov. 2013 , with skype meeting
- 15, Nov. 2013 , with skype meeting
- 29, Nov. 2013 , with skype meeting
- 13, Dec. 2013 , with skype meeting
- 27, Dec. 2013 , with skype meeting
- 10, Jan, 2014 , with skype meeting

## ■ Conference Statistics

- 平均每次5人参加会议（到会3~4人+远程2~4人）
- 调研报告数量：3+3+3+1+2+3=15个
  - 硬件方面8个
  - 模拟方面4个
  - 物理方面3个
- 总结给Physics and detector组会报告：6个

# Some reviews for Tracker Detector

- A lot of issues needed to be addressed:
  - The physics goals and its requirement on TPC
    - Goals for performance and design parameters
  - The time structure of the beam
    - How is the ion back flow? Do we need a gating? Is it possible?
  - Material budget
    - Field cage construction
  - Readout electronics
    - Power management: pulsing power, cooling
    - Performance ~ readout channel
  - Magnetic field
    - Uniformity requirement
    - Calibration
  - Simulation
    - Physics event
    - E/B
  - .....

# Calibration and Internal alignment

- A laser system is foreseen and may be integrated into the field cage  
Another possible solution is to illuminate calibration spots on the cathode
  - Such a system is being tested at the LP
  - Is being used at the T2K experiment
- An important future task of the R&D:
  - to demonstrate experimentally using the LP that the distortions can be corrected.
  - E/B effect
- Magnet filed with cosmic ray test
  - 1.0T@KEK, the length:1.2m, inner diameter:0.8m
- Beam test

# Refer to the large prototype

- The Large Prototype has been built to compare different detector readouts under identical conditions and to address integration issues

- LP field cage parameters:

$$L = 61 \text{ cm}$$

$$D = 72 \text{ cm}$$

up to 25 kV

$$\rightarrow E_{\text{drift}} = 350 \text{ V/cm}$$

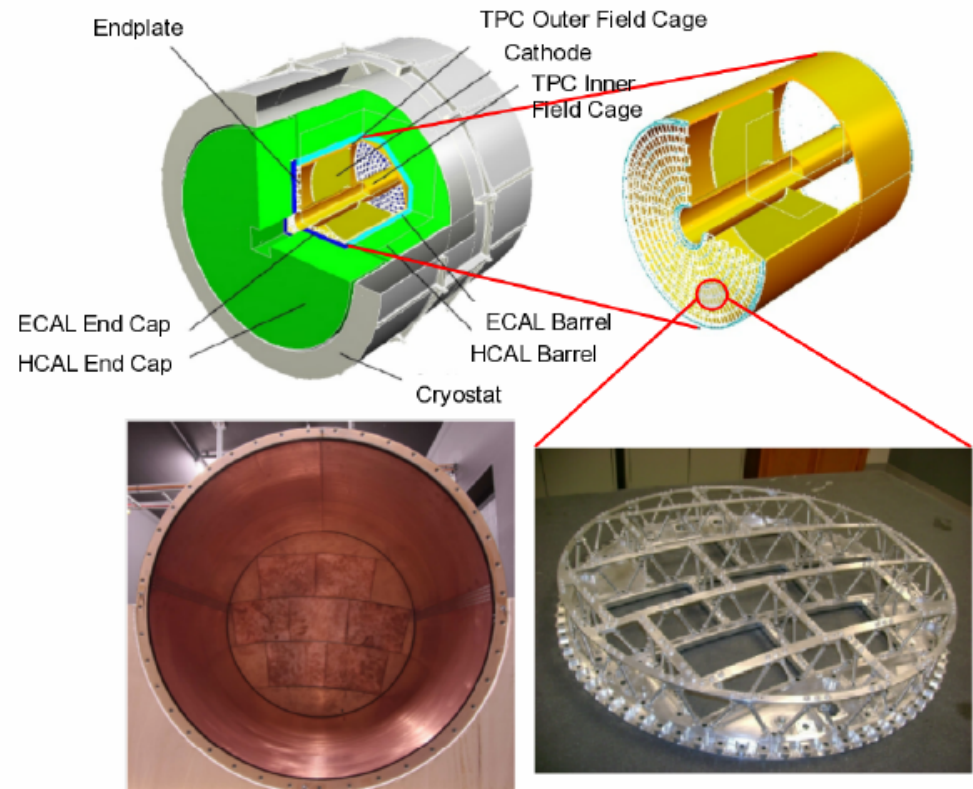
- Made of composite materials

$$\rightarrow 1.24 \% X_0$$

- Modular endplate

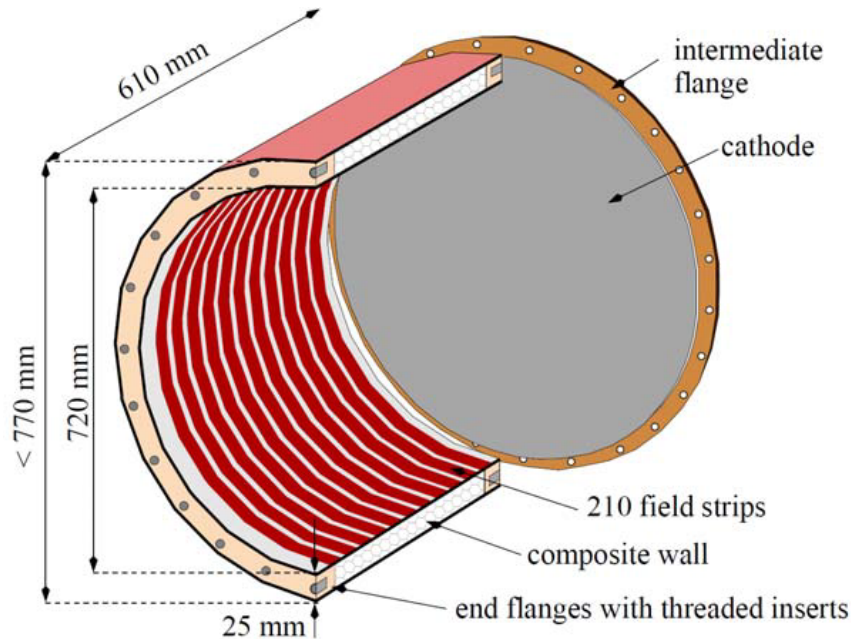
Space for 7 modules

$$\text{Area } 22 \times 17 \text{ cm}^2$$



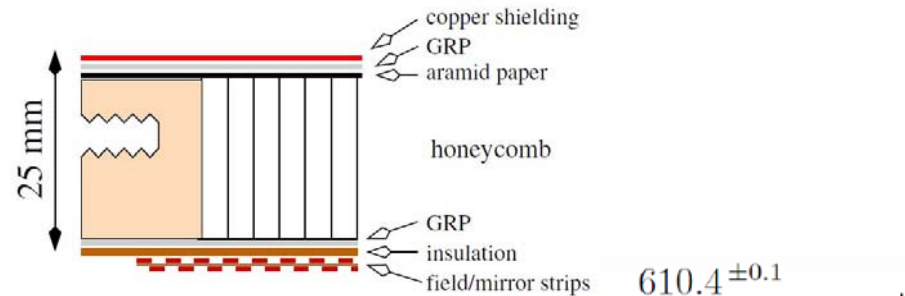


# Refer to the large prototype's field cage



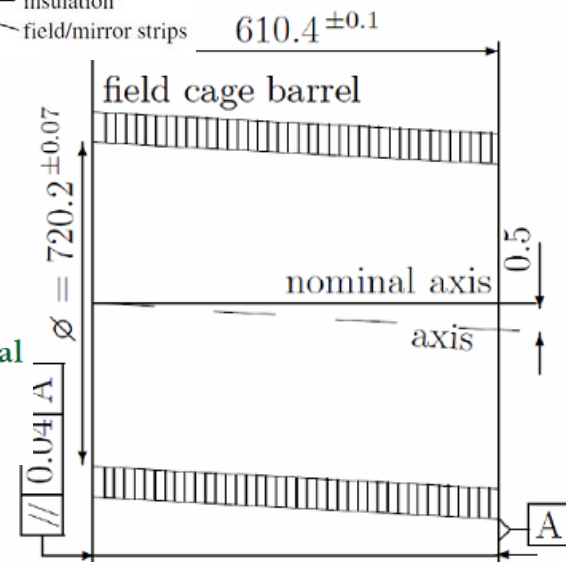
## Material budget:

- 1% X0 for the inner fieldcage
- 3% X0 for the outer fieldcage



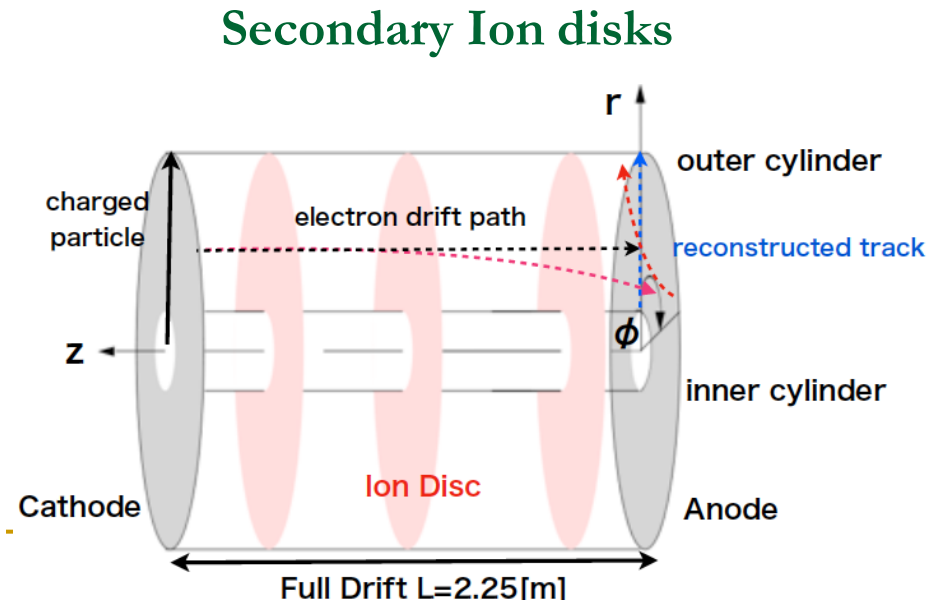
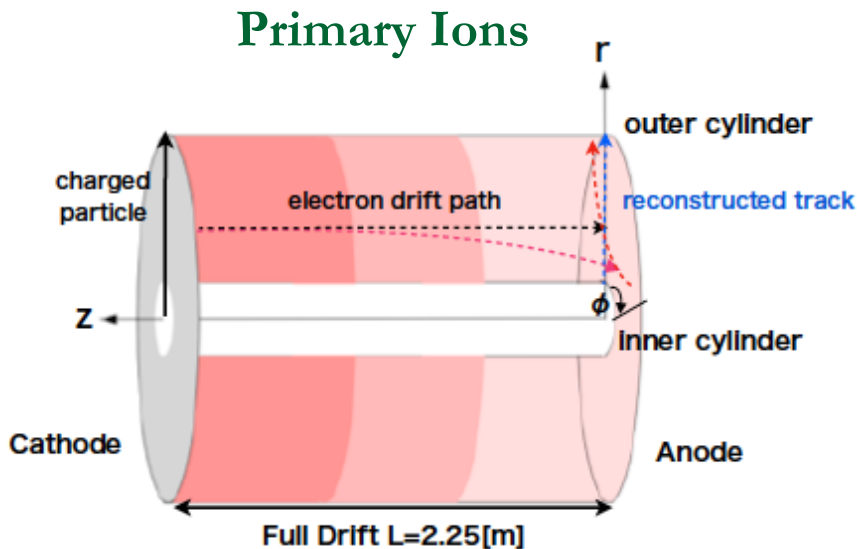
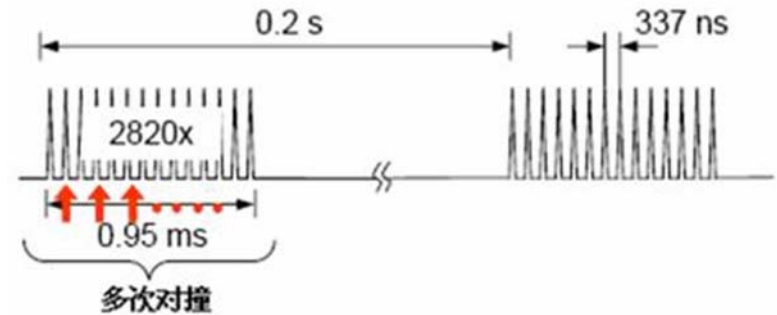
- Designs exist for the transition from the fieldcage to the endcap,
- add only minimal material in the corner region.

- Not better than  $\Delta E/E < 10^{-4}$
- The axis of the field cage barrel shows a shearing from the nominal axis of 0.5mm
- 0.1mm would be acceptable



# Gating needed for Ion backflow

- The time structure of ILC beam
  - The TPC is active during the 1ms bunch followed by a 199ms pause;
  - the backflow ions from the amplification region take about 1 s to drift out of the TPC.



# Need some info before CDR

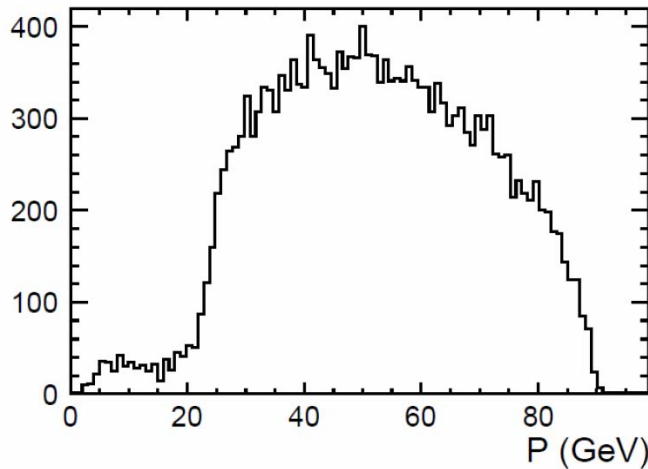
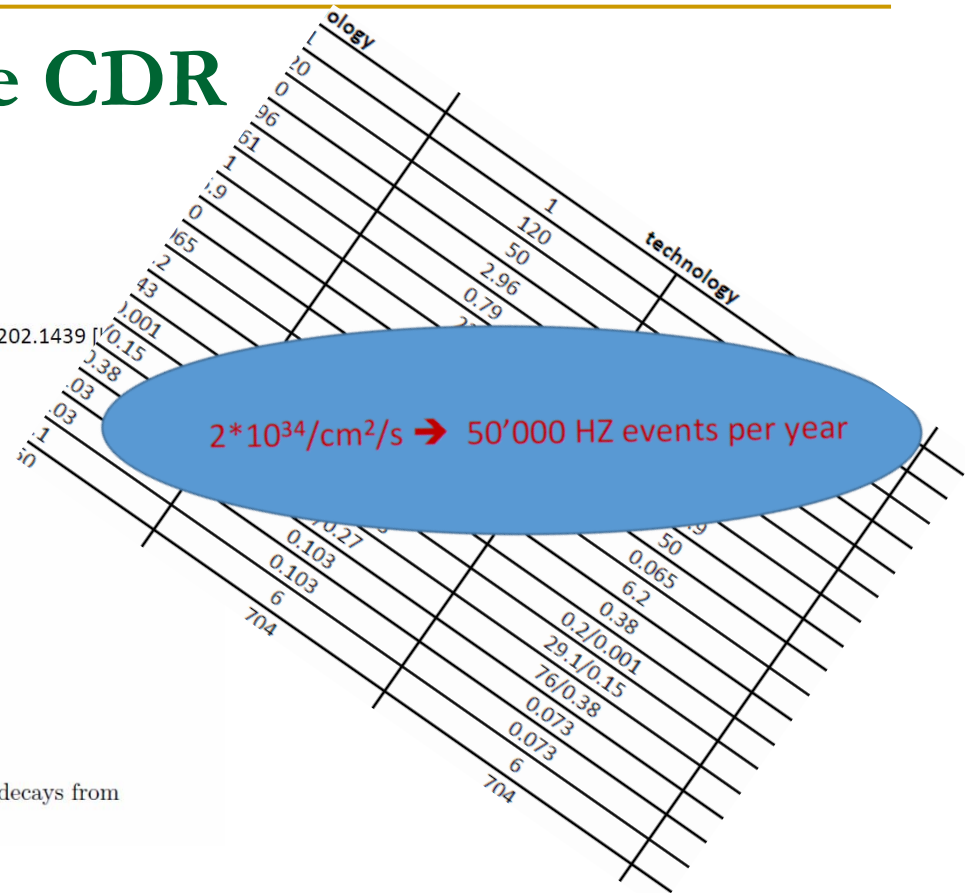
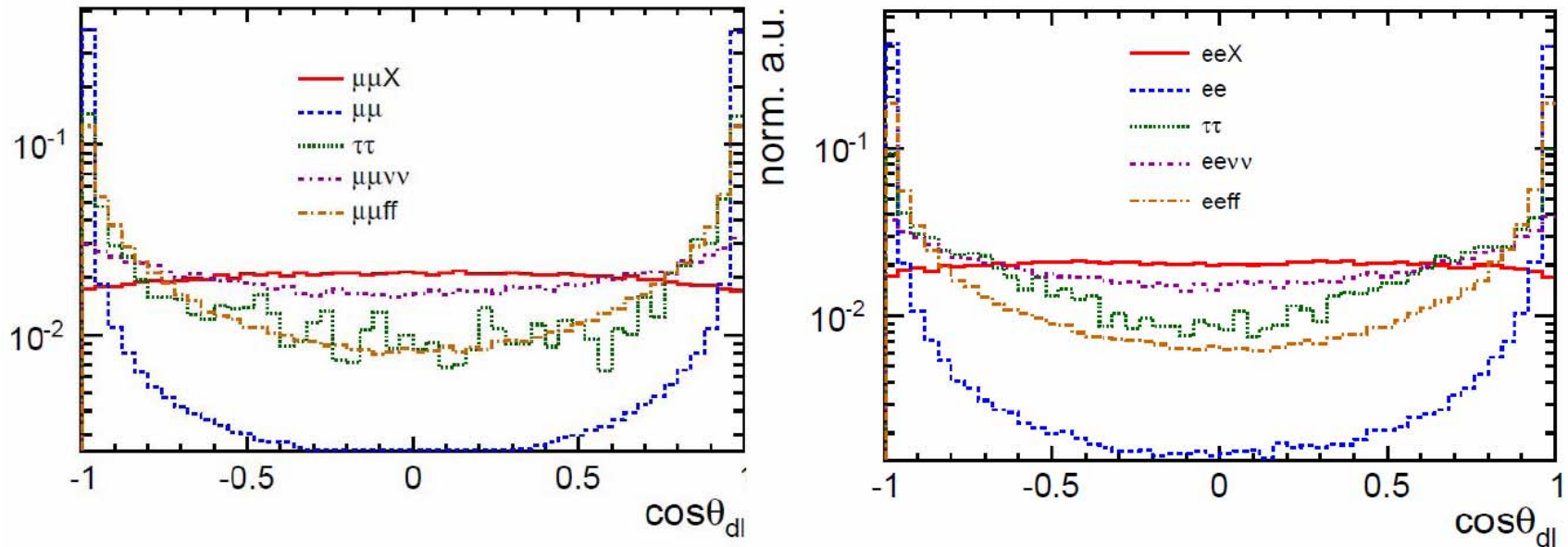


Figure 2: Momentum range of the final state leptons as produced in  $Z \rightarrow \mu^+\mu^-$  decays from  $e^+e^- \rightarrow HZ$  events at  $\sqrt{s} = 250$  GeV.



- 需要确认1: Higgs的末态主要有哪些 (rr、ee、ww、uu、zz?) 需要考虑末态的所有情况, 还是主要考虑Higgs mass (宽度~4MeV), 动量范围 (ww比较小, uu比较大, 90GeV@ILC), 精度为多少 (<100MeV?, 20MeV已经接近于统计误差), 极化Beam的影响 (误差? Energy spread?)

# Need some info before CDR



- 需要确认2: 低动量区间TPC测量不是很精确 (160MeV的能量展宽?) 动量分辨前角区40度锥角比较差 (取样少, 径迹短, 如果需要提高, 可能需要提高测量强度, 最小动量?)
- TPC是否是全部Higgs测量中精度要求最高的? 是否动态范围是最大的?

# Need some info before CDR

## ILD result

Pol.	Ch.	$M_H$ (GeV)	$\sigma$ (fb)
$e_R^- e_L^+$ $\mathcal{L} = 250 \text{ fb}^{-1}$	$\mu^+ \mu^- X$	$120.006 \pm (0.039)$	$7.89 \pm 0.28$ ( 3.55 %)
	$e^+ e^- X$	$120.005 \pm (0.092)$	$8.46 \pm 0.43$ ( 5.08 %)
	merged	$120.006 \pm (0.036)$	$8.06 \pm 0.23$ ( 2.91 %)
$e_L^- e_R^+$ $\mathcal{L} = 250 \text{ fb}^{-1}$	$\mu^+ \mu^- X$	$120.008 \pm (0.037)$	$11.70 \pm 0.39$ ( 3.33 %)
	$e^+ e^- X$	$119.998 \pm (0.085)$	$12.61 \pm 0.62$ ( 4.92 %)
	merged	$120.006 \pm (0.034)$	$11.96 \pm 0.33$ ( 2.76 %)

	$\Delta M_{tot.}$ (MeV)	$\Delta M_{mac.}$ (MeV)	$\Delta M_{dec.}$ (MeV)
$\mu\mu X$	650	560	330
$ee X$	750	560	500

- 需要确认3: 计数率问题, 在250GeV大部分末态应该为 $rr$ 、 $ee$ 、 $ww$ , 本底主要为 $uu$ 、 $zz$  (都是带电粒子), TPC探测的多重数问题 (平均事例率?), 需要前期模拟给出部分结论? 比如3.5Telsa下可以测量的最小动量范围? TPC尺寸?

# Our plan towards the pre-CDR (Draft)

- Approximately 25~30 pages@A4
- Four major sections
- 主撰写负责人：
  - 李玉兰（主要负责把关、建议以及最终文本的修订）
- 撰写协调人：
  - 祁辉荣（负责主要框架部分的撰写，整理各子部分的撰写材料）
- 材料准备人：
  - 祝成光（协商讨论，主要撰写硬件相关的物理部分，可确定）
  - 李波（协商讨论，主要撰写模拟计算部分，可确定）
  - 祁辉荣（主要撰写硬件部分，与物理子组协商讨论，可确定）
  - 刘倩（协商讨论，主要撰写正离子反馈部分内容）
  - 张毅（协商讨论，主要撰写E/B效应部分内容）

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# Our plan towards the pre-CDR (Draft)

- **Calibration and Internal Alignment of the TPC**
  - Alignment of the Tracking System
  - Hardware alignment system
  - Structural and Environmental Monitors
  - Track-based Alignment
  - Calibration Scheme
  - Monitoring Techniques
- **Challenge of TPC**
  - Calibration
  - Ion back flow
  - E/B Nonuniformity



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# Our plan towards the pre-CDR (Draft)

- **TPC tracking detector performance**
  - TPC tracker find and reconstruction
  - Coverage and material budget
  - Tracking Efficiency
  - Momentum resolution for the overall tracking system
  - Physics Requirements
  - DAQ and electronic requirements
- **Cost**
  - Hardware
  - Electronics



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# Thanks