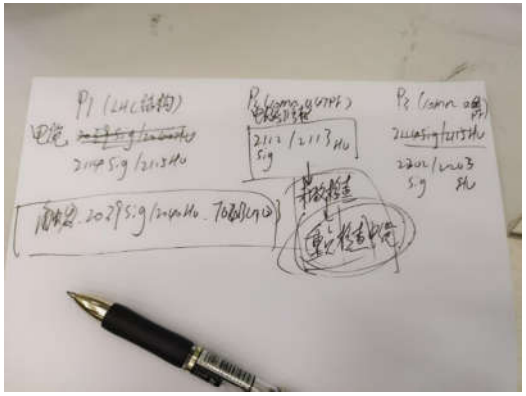
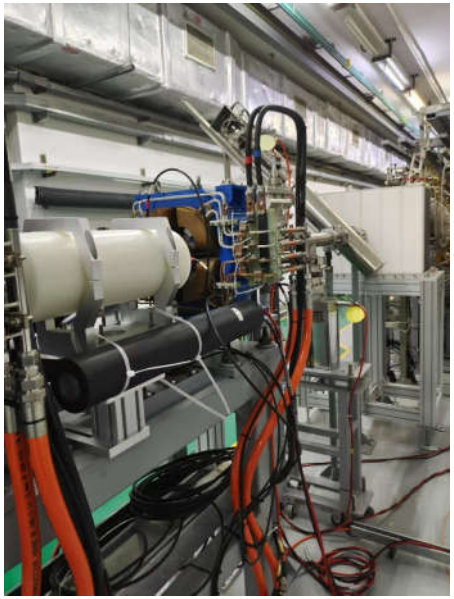
SC-BLM系统测试

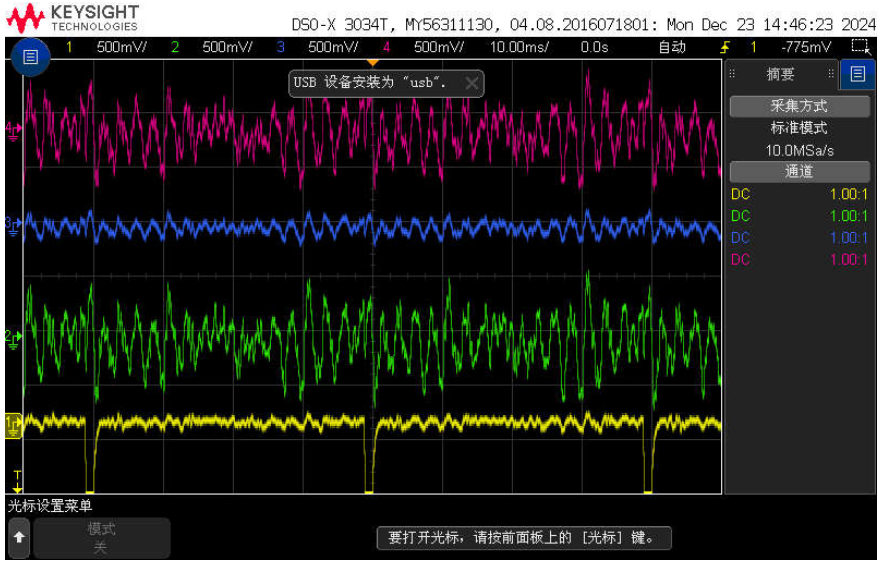
20250208

BLM探头更换位置

- LRBTWS00后1.6米位置。
  - 可以申请机器调束时间进行观测，采用CFC电子学和IV变换低档位进行观察上升时间和束损信号的宽度。







20250208LRWS00剖面结果

- 束损试验方案

实验人员：曾磊，田建民
实验目的：观测 BLM 系统响应时间
实验方案：

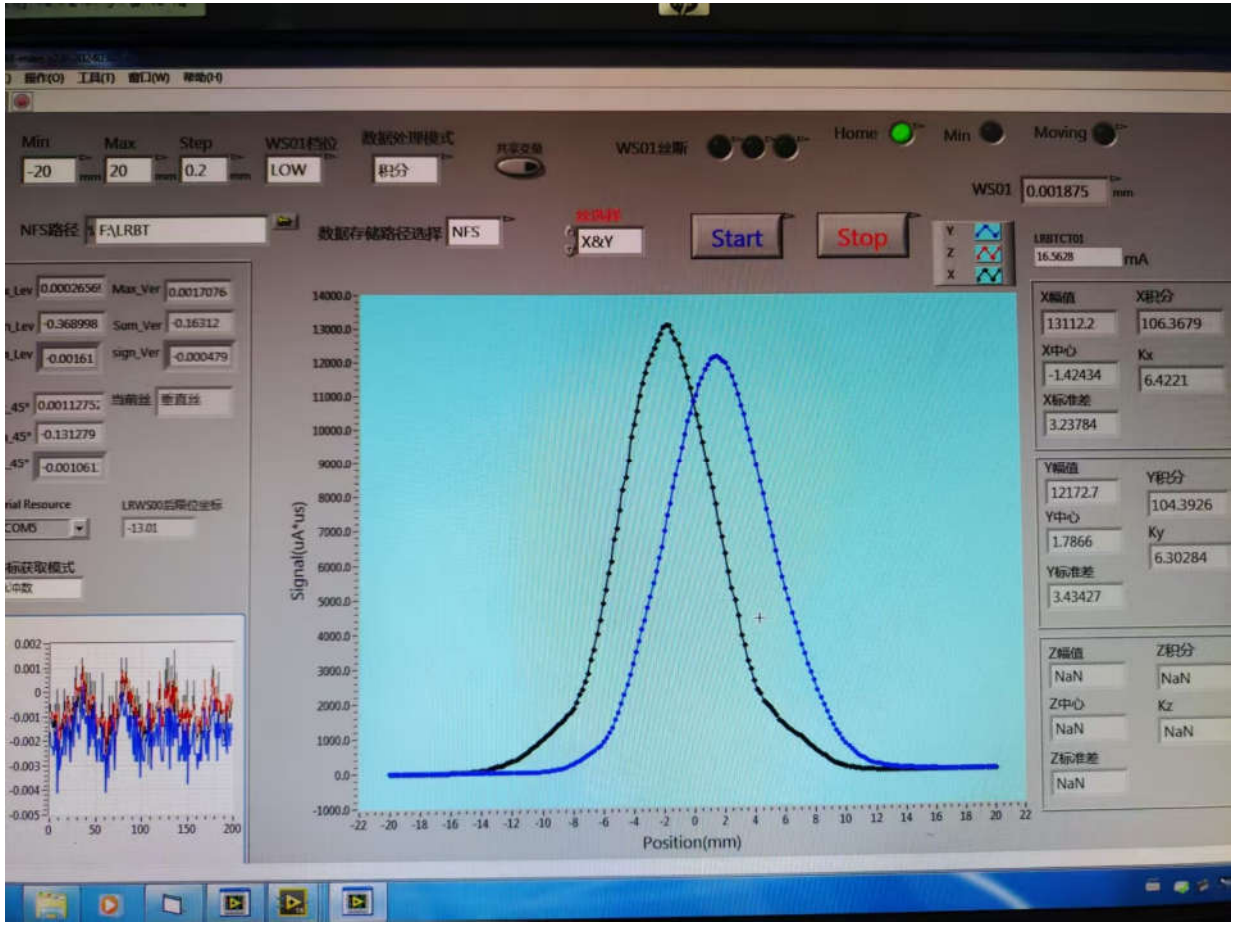
现在有两支探头放在直线段丝靶 LRWS00 下游 1.8 米左右位置，束流脉宽暂定设为 5 us -10 us -20 us -50 us -100 us -200 us -500us 七个脉宽出束。

稳定一个脉宽及机器条件后 LRWS00 完整扫描几次剖面，保存束流剖面数据。期间观察电离室探头+示波器、电离室探头+一期电子学低增益档位+示波器、电离室探头+CFC 电子学+示波器这几种组合的实验数据并保存。

计算丝靶的丝停留在真空管道中相对束流位置，并通过手动调整 NI 软件至该位置，保存该位置的丝靶信号，结合剖面结果用于后期估算多少粒子被挡住产生束流损失。进而计算出束流损失百分比和相当 1W/m 的百分比。观察上述 3 种情况的示波器输出，并保存数据。

电离室探头+示波器、电离室探头+一期电子学低增益档位+示波器组合观测束流损失系统，监测系统上升时间。一期电子学低增益档位有 3 种组合：1MΩ、100KΩ、10KΩ，结合三个档位的上升时间分别观测下不同位置对应束流损失信号的上升时间和束流损失的信号宽度。

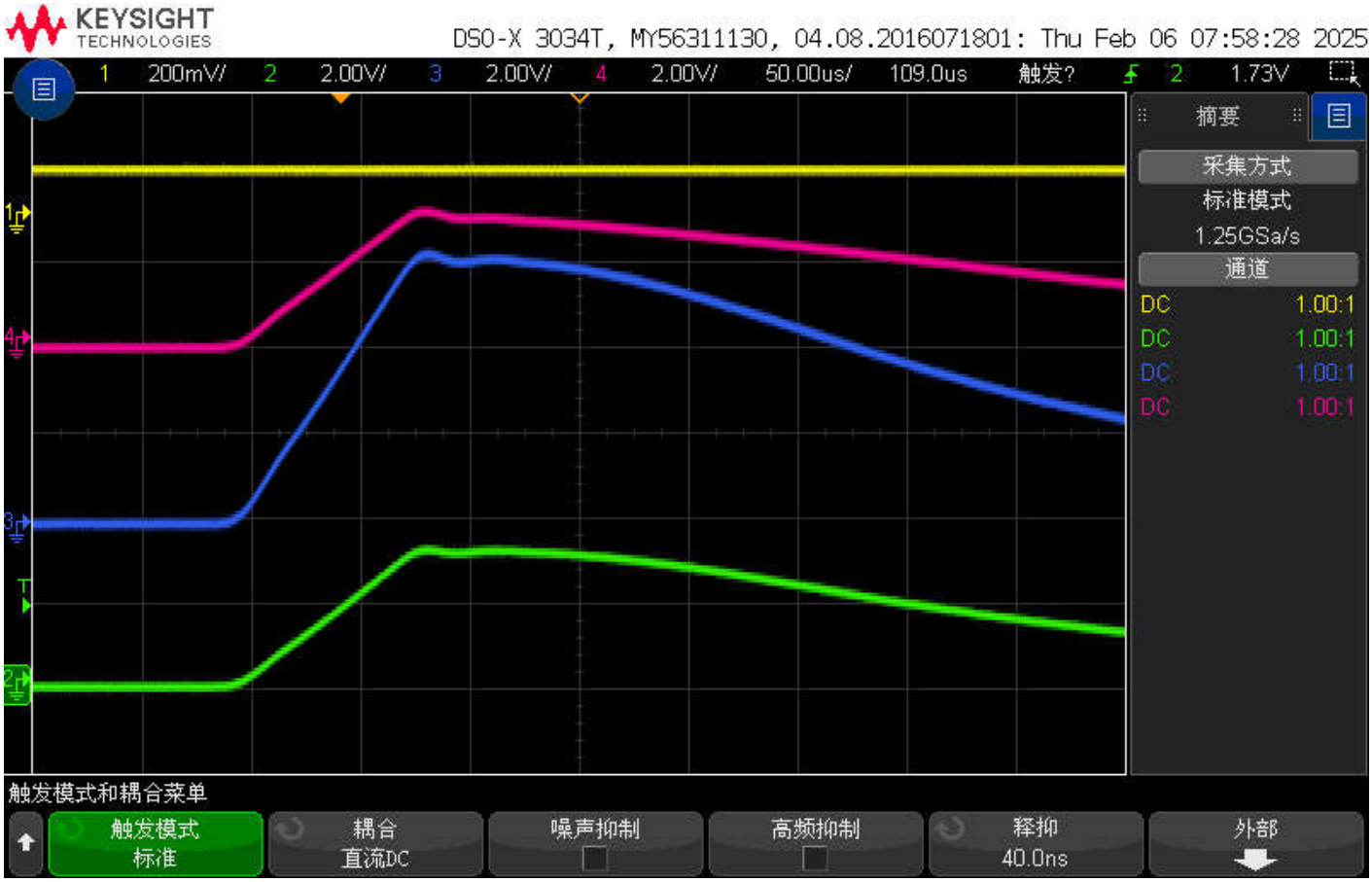
电离室探头+CFC 电子学+示波器观测束流损失对应的电荷量，对不同丝位置的束流损失产生的电荷量进行数据采集，用于 CFC 电子学设计 Iref 电流。目前电子学已经设计了 166uA、45uA、12.2uA、3.5uA 四种不同的 Iref 参考电流源。观测并保存不同丝位置不同脉宽的束流损失条件下的脉冲数据。



100uS脉宽1M档位积分路实验

- 机器参数
  - 15mA、100us、1Hz
- 电子学1期1M档位积分
  - 电子学上升时间7us

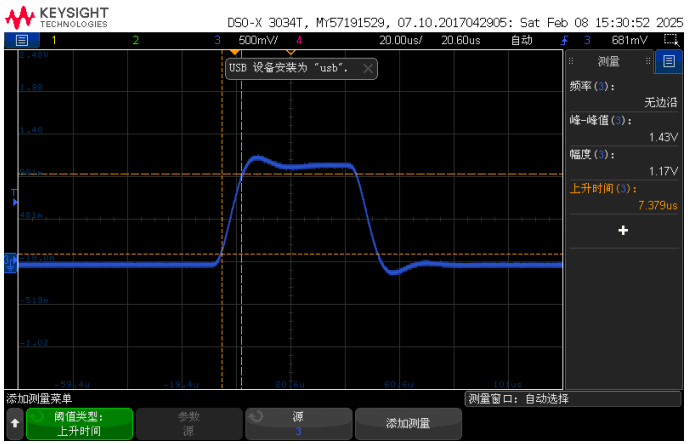
LRWS00-X方向至于束流中心



HV-800V--3个新探头

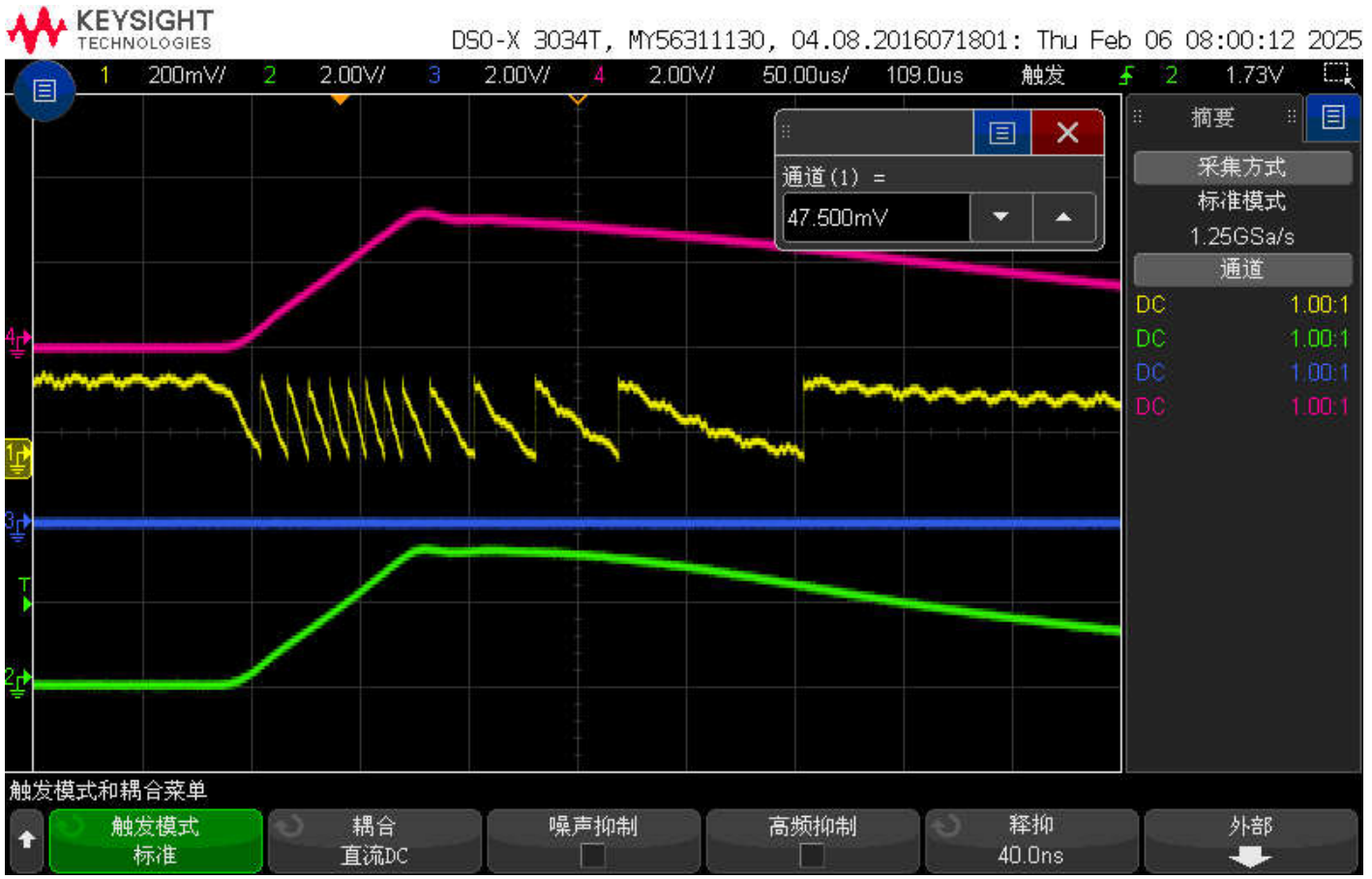
100uS脉宽100k档位积分路实验

- 电子学100K档位积分路



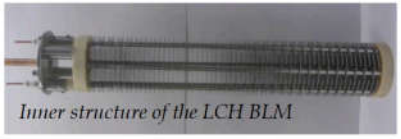
100uS脉宽CFC实验

- CFC电子学测试
  - 接最大束损信号通道
  - 改变高压信号大小不变，800V~1800V
  - 束损信号太小，无法10us内产生2个脉冲。



icBLM

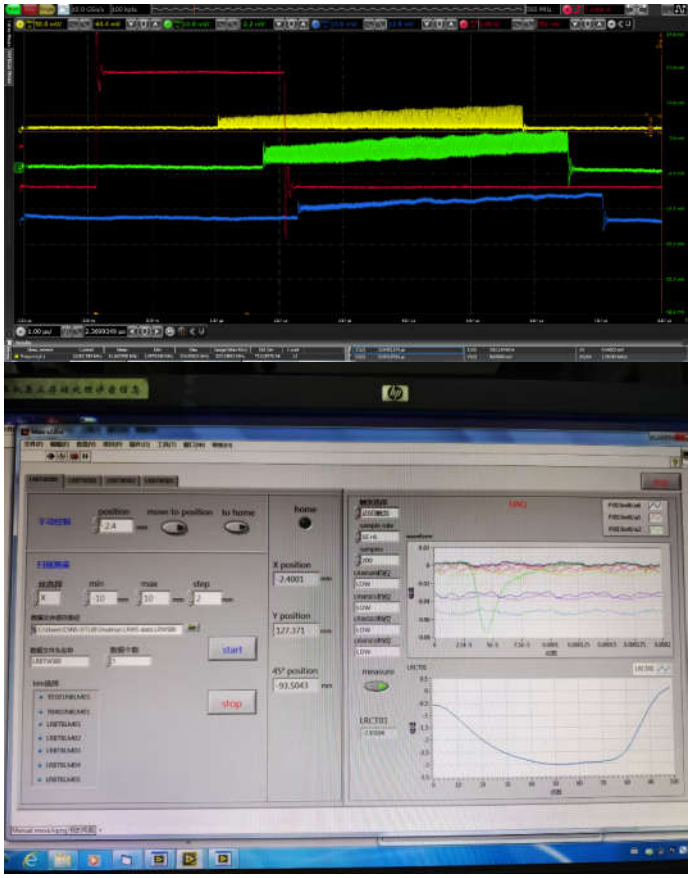
- Parallel plate gas Ionisation Chambers (Ics) developed for the LHC BLM system will be used
- Primary BLMs in SCL
- Beam loss information based on **ionisation current** measurement of secondaries.



Detector property property	Value
detector gas	N_2
pressure	1.1 bar
diameter	9 cm
length	50 cm
sensitive volume length	38 cm
num. of electrodes	61
electrode spacing	5.75 mm
electrode thickness	0.5 cm
electrode diamater	75 mm
bias	1.5 kV
max e^- drift time	300 ns
max ion drift time	83 μs
<energy> to create ion-e^- pair in N_2	35 eV
wall thickness:	
tube	2mm
bottom plate (facing el.box)	4mm
top plate	5mm

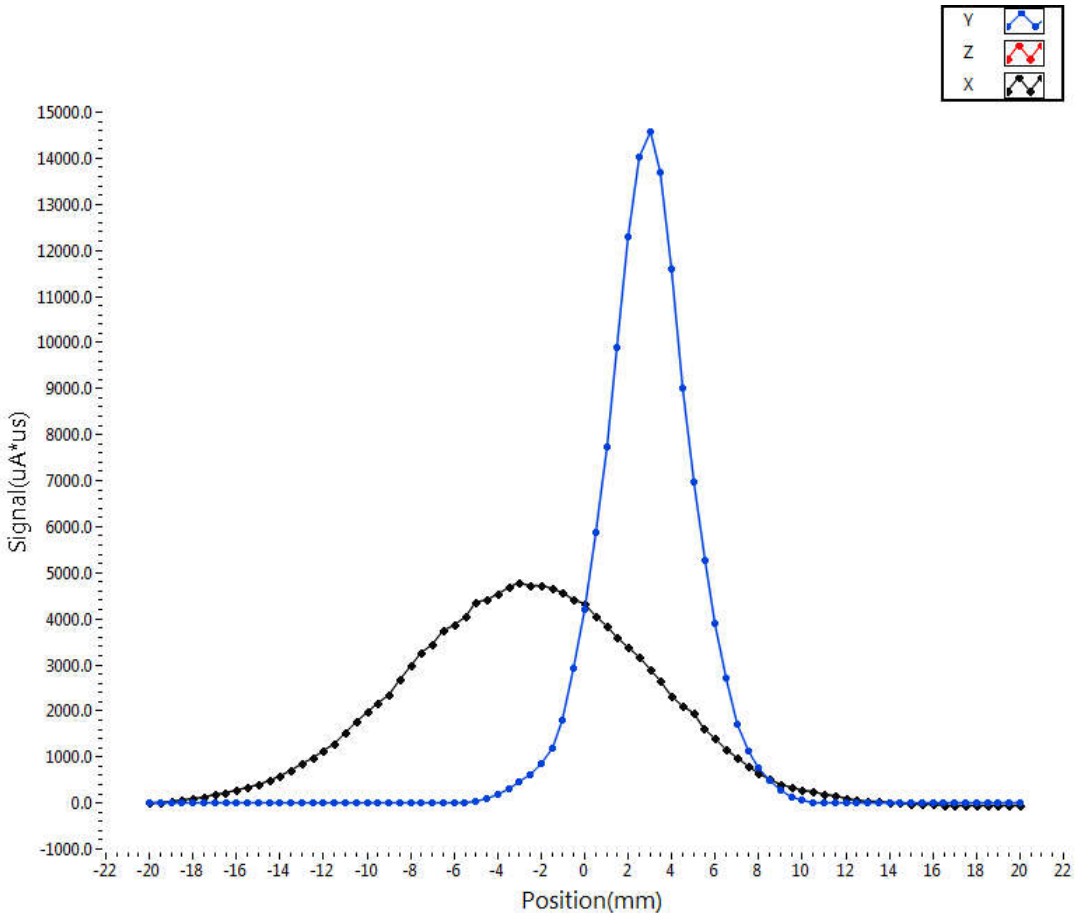
5us脉宽1M档位积分路实验实验

- 电子学1M档位积分路



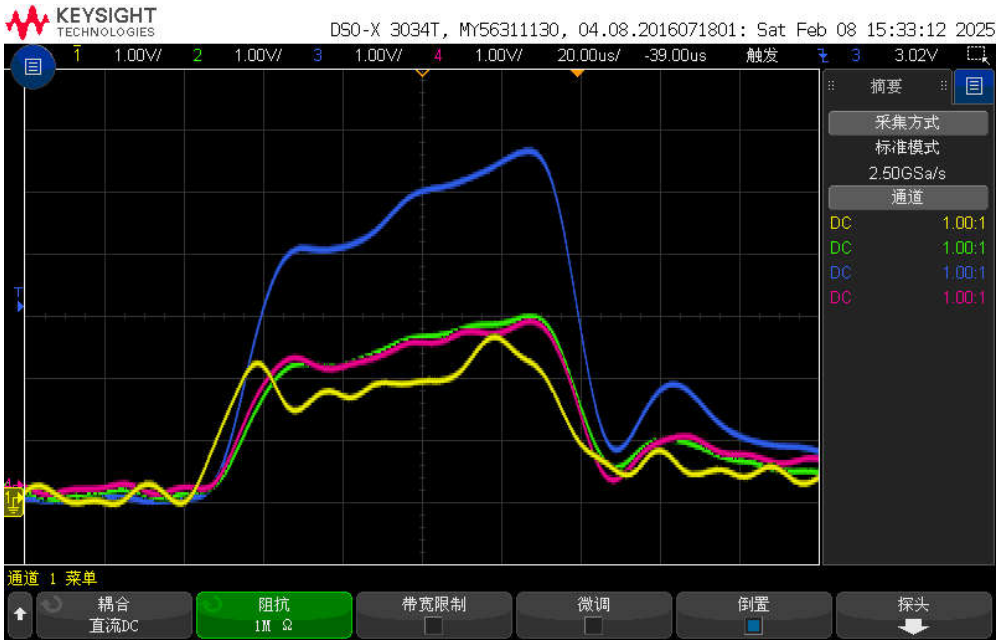
20250209LRWS00剖面结果

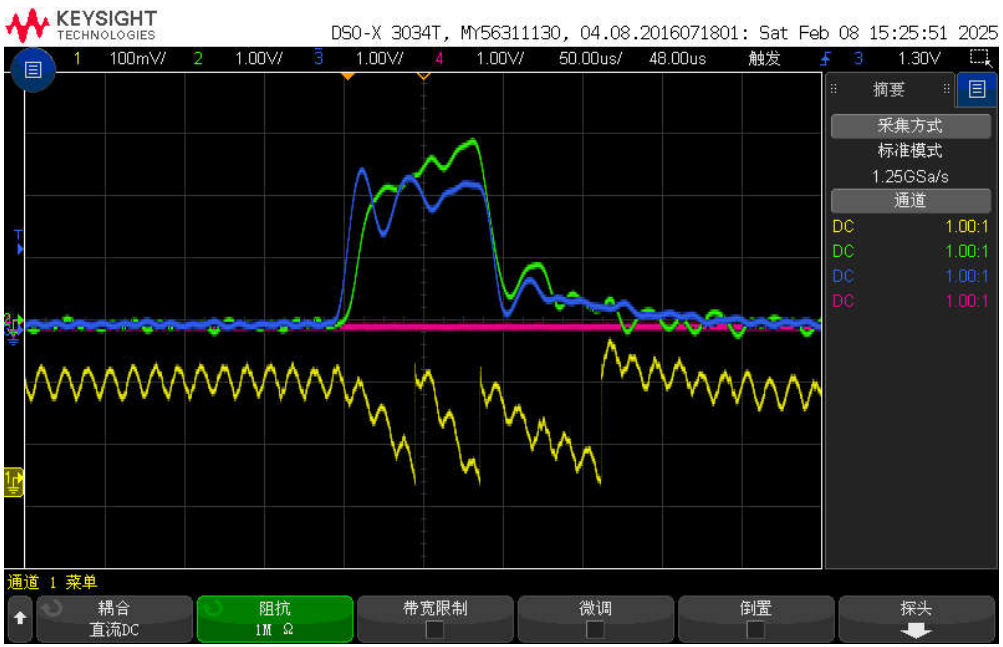
- 新的机器模式LRWS00剖面



100uS脉宽100k档位直接比较实验

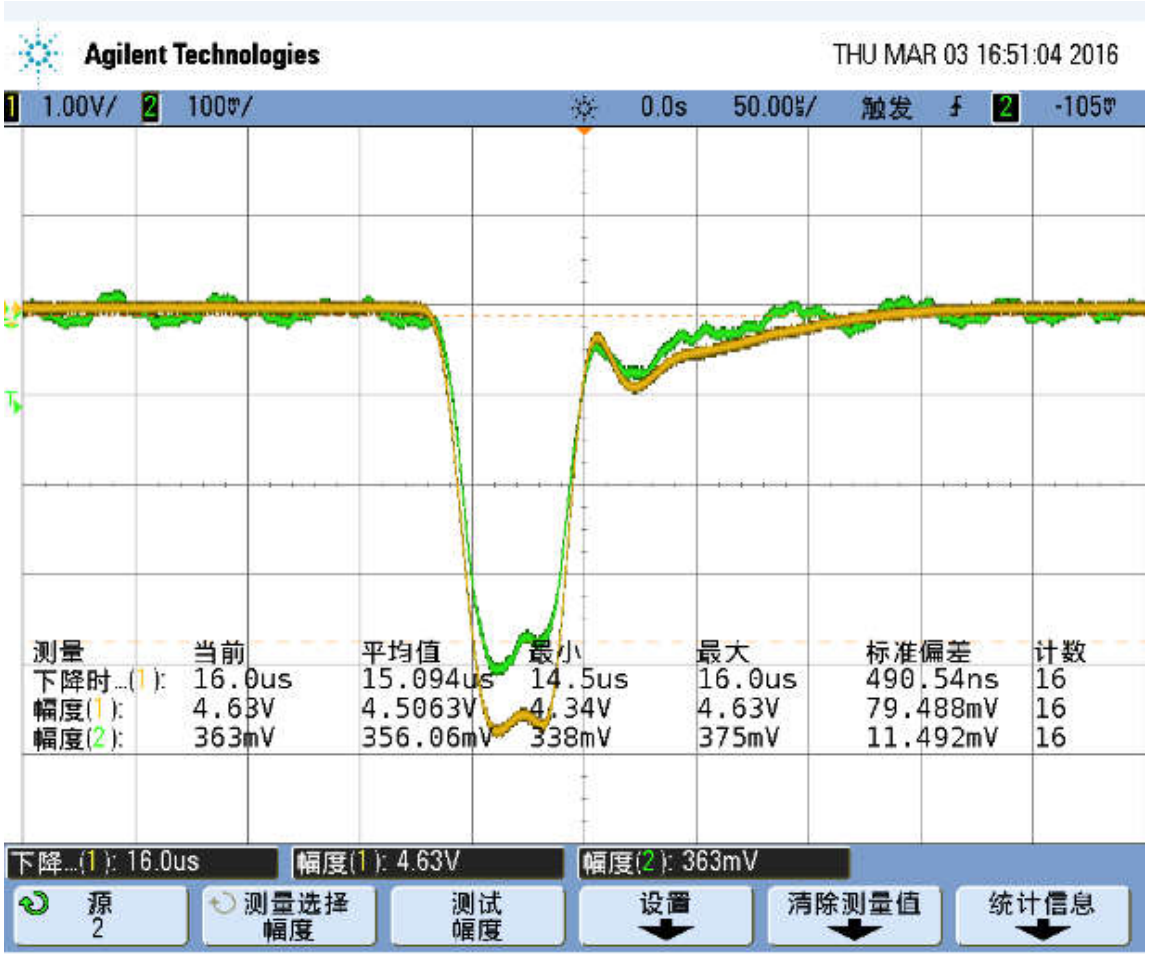
- 新的机器参数LRWS00剖面参数
  - 初步评估束损电离室大小及整个系统上升沿





2016年DTL临时调束线

- BLM系统的最快上升时间约为15us
- 下一步计划使用IPM电子学，放置于隧道内、外，尝试观测电离室束损波形的上升沿及波形。



谢谢！

ESS资料

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ESS BLM dynamic range specifications

- **nBLMs:**
  Once detector locations and dimensions are fixed, count rates can be calculated:
  - Upper limit: can be set by assuming total beam loss with a focused beam under "worst case" incidence angle.
  - Lower limit: can be set to a fraction of the neutron flux expected during the normal operation.
  - Suggestion for the detector development regarding the lower limit:
    - Check the expected flux at normal operation at detector location with lowest expected flux. Select 1-10% of this flux for the lowest limit, the exact number depends on the detector size and should be adapted to give a reasonable dynamic range
- **ICBLMs**:
  - Preliminary values set in the past [11]:
    - "BLM is required to be able to measure at least 1% of 1W/m loss during normal. operation and up to 1% of the total beam loss".
    - Gave estimation on the ICLBM current range: **~800nA – few mA**.
  - Plan to re-assess that once the ICBLM detector locations are fixed.
  - However for now assume the preliminary values when talking to CERN/CAENels regarding the input currents for the BLEDP and time constant tuning.

icBLM

- Parallel plate gas Ionisation Chambers (Ics) developed for the LHC BLM system will be used
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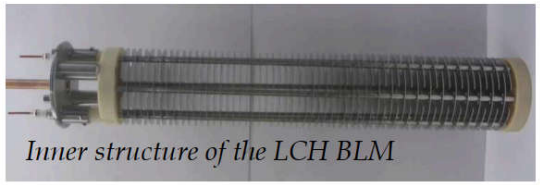

Inner structure of the LCH BLM

Detector property property	Value
detector gas	N_2
pressure	1.1 bar
diameter	9 cm
length	50 cm
sensitive volume length	38 cm
num. of electrodes	61
electrode spacing	5.75 mm
electrode thickness	0.5 cm
electrode diamater	75 mm
bias	1.5 kV
max e^- drift time	300 ns
max ion drift time	83 μs
<energy> to create ion-e^- pair in N_2	35 eV
wall thickness:	
tube	2mm
bottom plate (facing el.box)	4mm
top plate	5mm

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ESS资料

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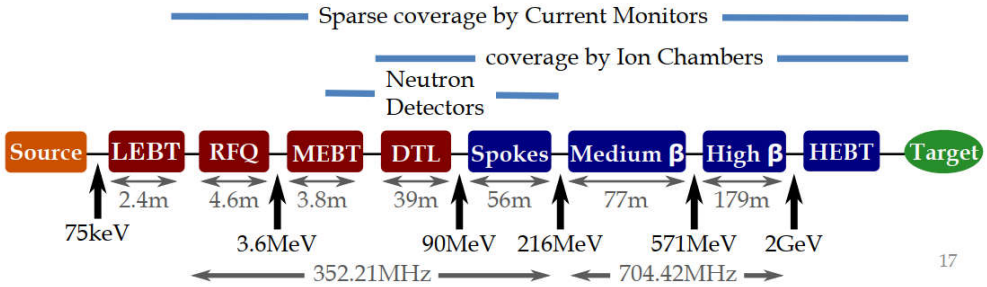
- **Total beam loss**, microsecond measurement latency required for protection
  - BCM, icBLM (saturation, nBLM (current mode) ➔ Interlock; Threshold/derivative term for fast protection
- **> 1.6 milliamp lost for up to 200 µs**
  - BCM, icBLM, nBLM -> Interlock; Damage model for protection
- **~ µC lost over 200 µs to many seconds** (diffusion time)
  - icBLM, nBLM -> Interlock; Damage model for protection
- **~ "1 Watt/meter" radiation dose management**
  - icBLM, nBLM -> alarm based on dose/activation plan



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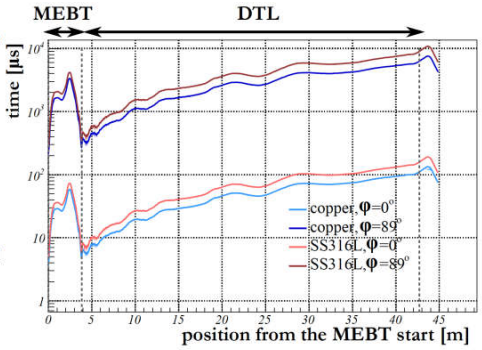
- Required response time set in the past:
  - NC linac (MEBT-DTL): ~5 µs.
  - SC linac: ~10 µs.
  - Numbers based on a simplified melting time calculations, where a block of material (copper or stainless steel) is hit by a beam of protons with a uniform profile under perpendicular incidence angle, no cooling considered [9].
- Numbers re-checked with a Gaussian beam and update beam parameters:
  - **NC linac:** calculated melting time values of 3-4µs imply even stronger demands on the response time (confirmed with a MC simulation as well).
  - **SC linac**: the 10µs requirement for response time fits well with the results of this calculations.
    However: other damage mechanisms ma mandate even shorter response time SCL (discussed further).

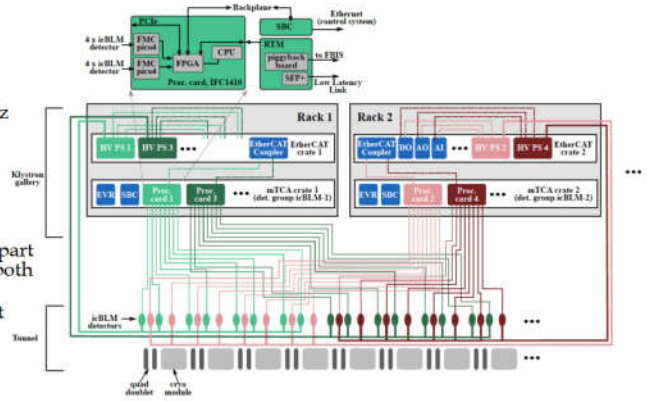


ESS资料

- 2

BEE – final selection

- IOxOS IFC1410 - ICS standard platform
- Pico4, FMC digitizer (CAENels)
  - Modified COTS
  - 1MS/s, 20-bit ADC, 300kHz bandwidth
  - Dynamic range:
    - 0 – 500µA,
    - 0 – 10mA
- FBIS interface
  - Piggyback board on RTM, part of ICS standard platform (both still under development)
  - Temporary solution for test purposes: IOxOS DIO3118 FMC
- Low Latency Link
  - SFP+ on RTM
  - Temporary solution: existing RTM from IOxOS



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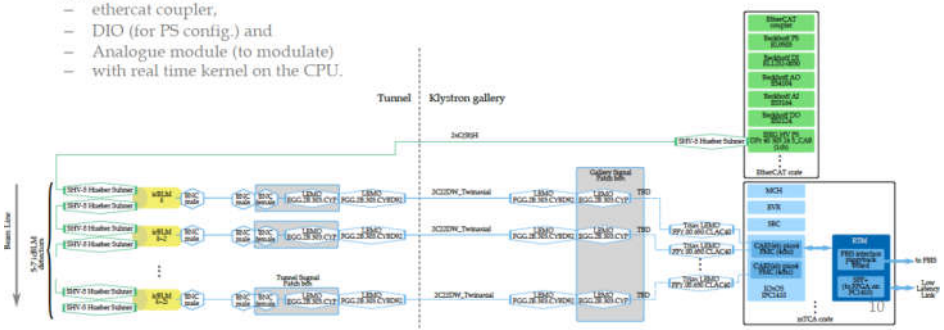
HV PS

- Provides:
  - Power the ICs (1.5kV) – several ICs are daisy changed and connected to one HV ch
  - Modulation voltage for system HEALTH check.
- HV module (1ch):
  - ISEG DPr 40 305 24 5_CAB High Precision HV-PS
- Ethercat crate with
  - ethercat coupler,
  - DIO (for PS config.) and
  - Analogue module (to modulate)
  - with real time kernel on the CPU.

BEE alternatives

- Digitiser: BLEDP card
  - Developed for CERN injector complex
- Processing board:
  - Struck SIS8300-KU (BLEDP)
  - DAMC-FMC25 (pico4)



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