LII PANDA CM
Mar. 16-19, 2015
Gießen

KOALA at HESR/COSY

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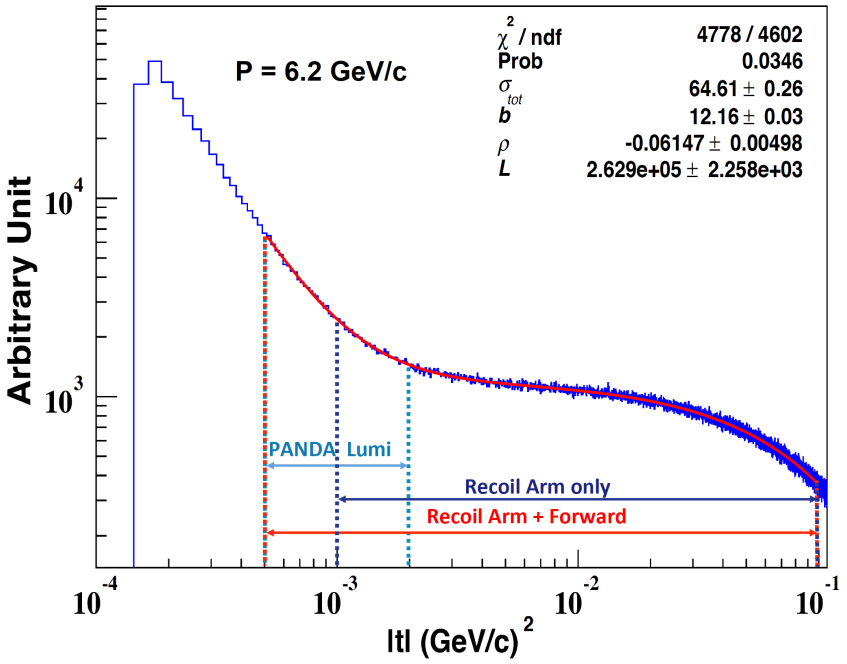
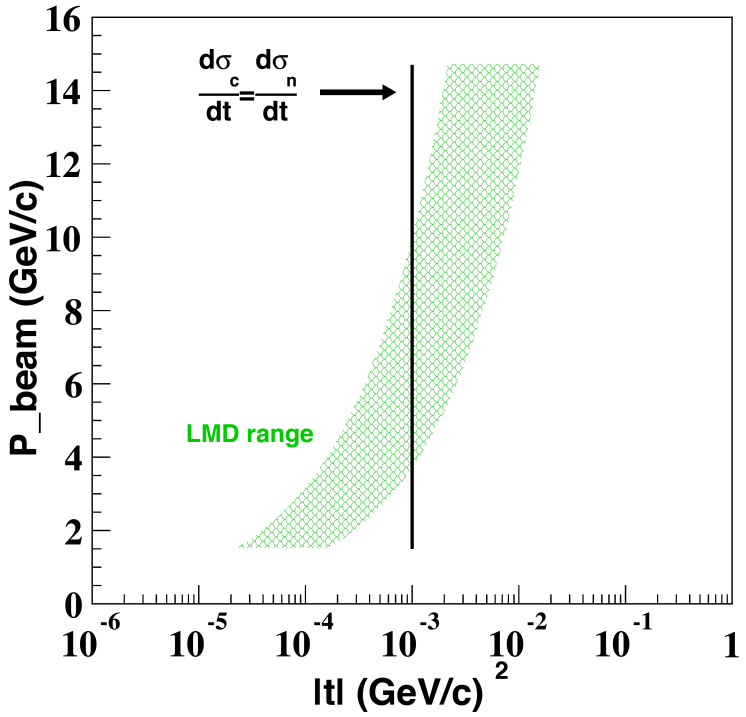
Outline

- Introduction to KOALA
- Status of KOALA
- Full setup of KOALA
- KOALA at HESR
- KOALA at COSY

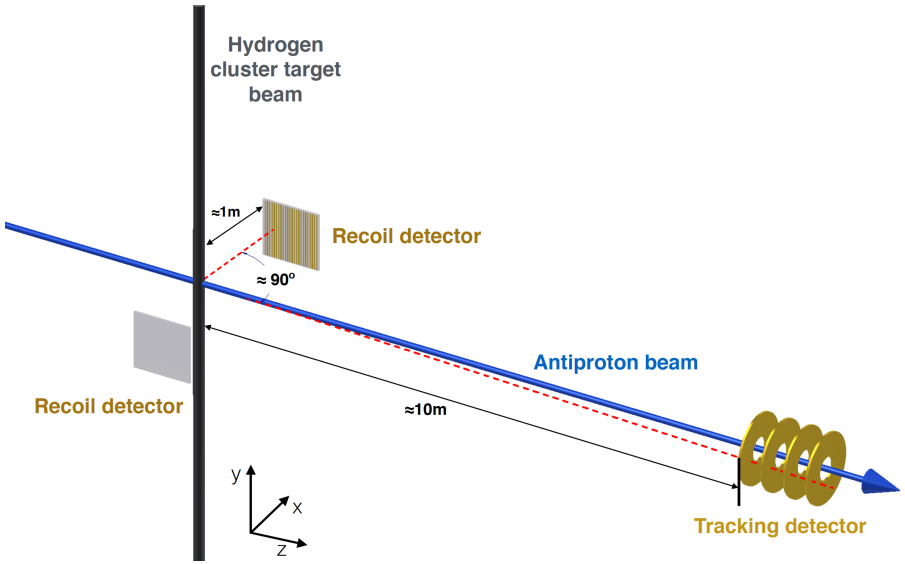
1.1 Challenge of PANDA Luminosity Monitor

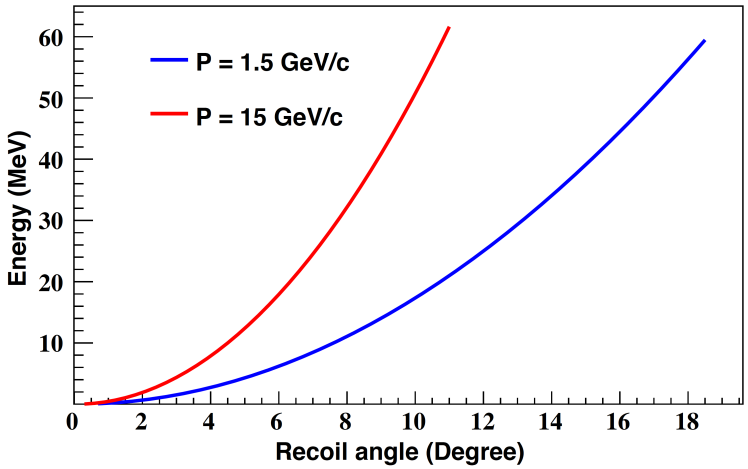
- Antiproton-proton elastic scattering at CNI region
- Limited measurable |t|-range
- To achieve desired precision of 3%, knowledge of σ_{tot} , ρ and b required



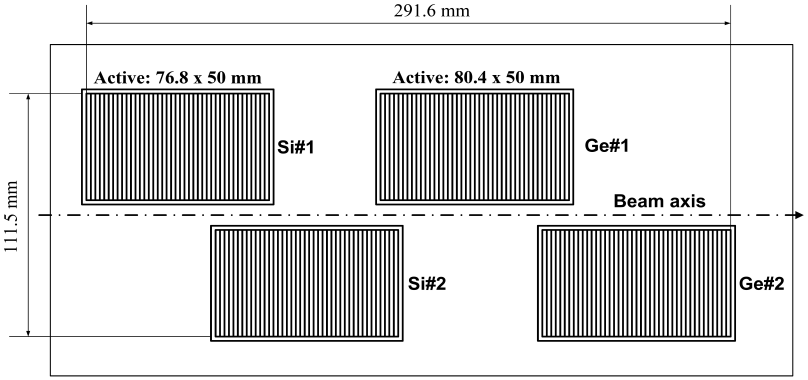


1.2 Proposal of KOALA Experiment

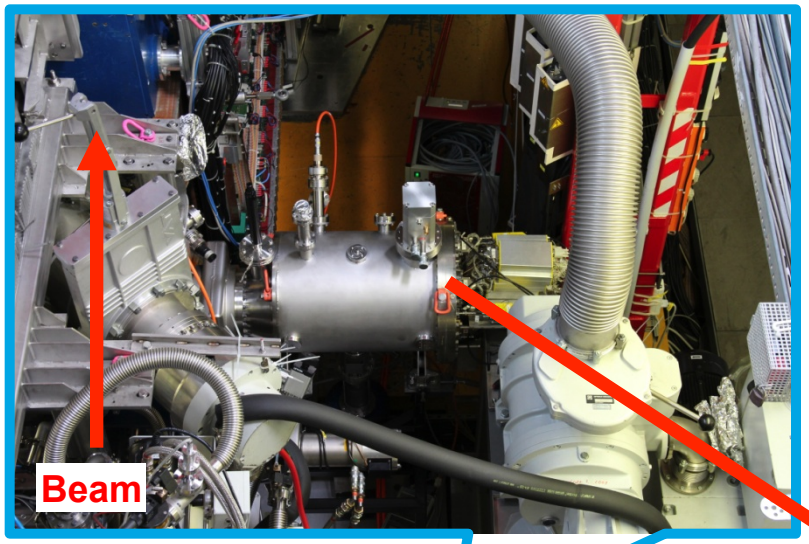


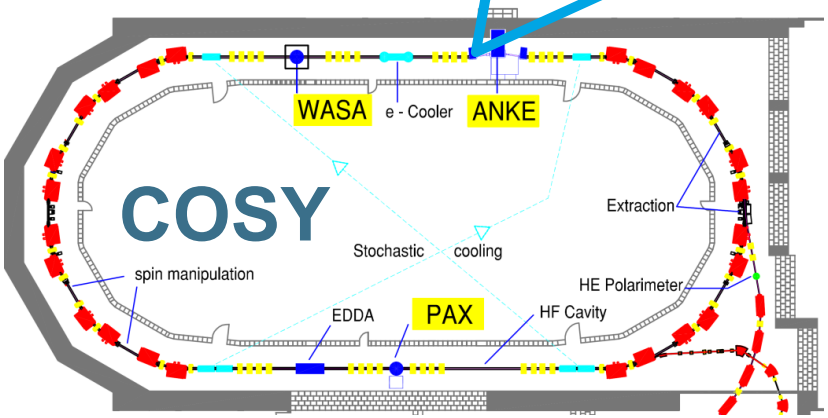


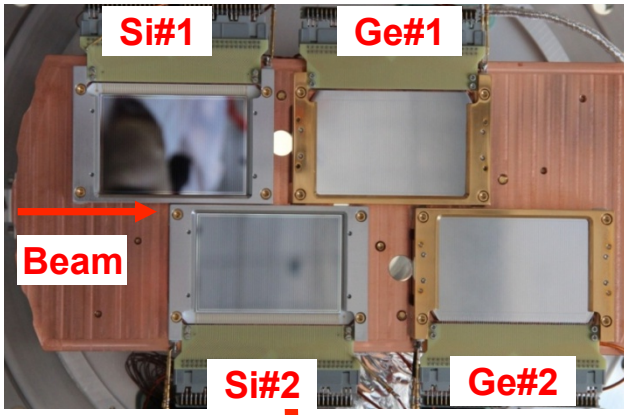
- Antiproton-proton elastic scattering
- Tracking detector for scattered beam particles
- Energy detector for recoil protons

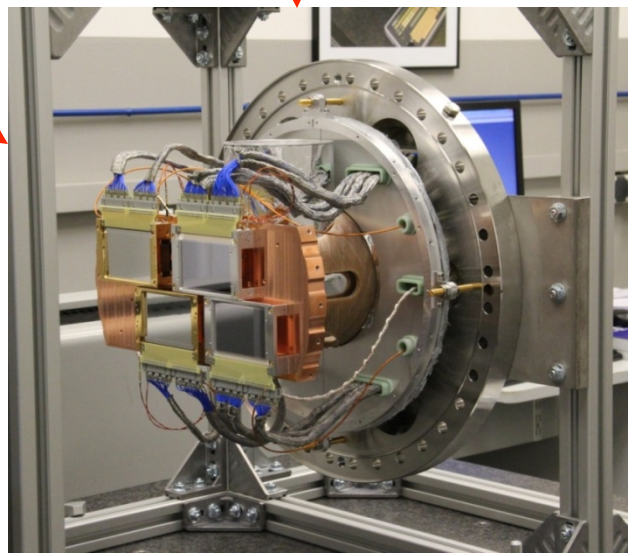


2.1 Commissioning at COSY

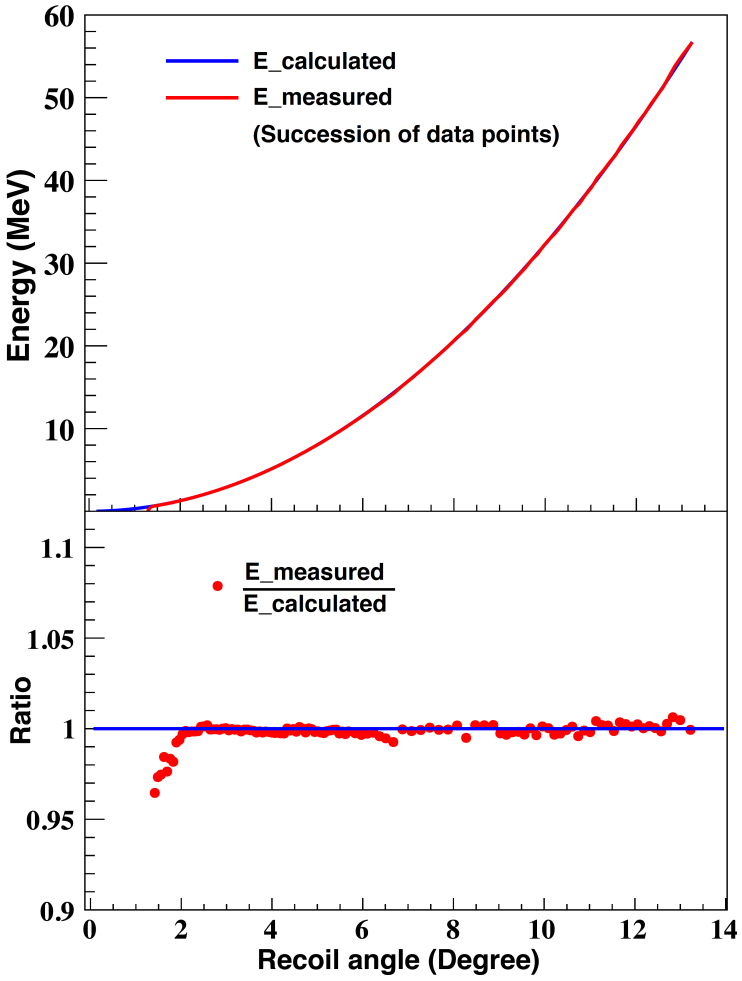


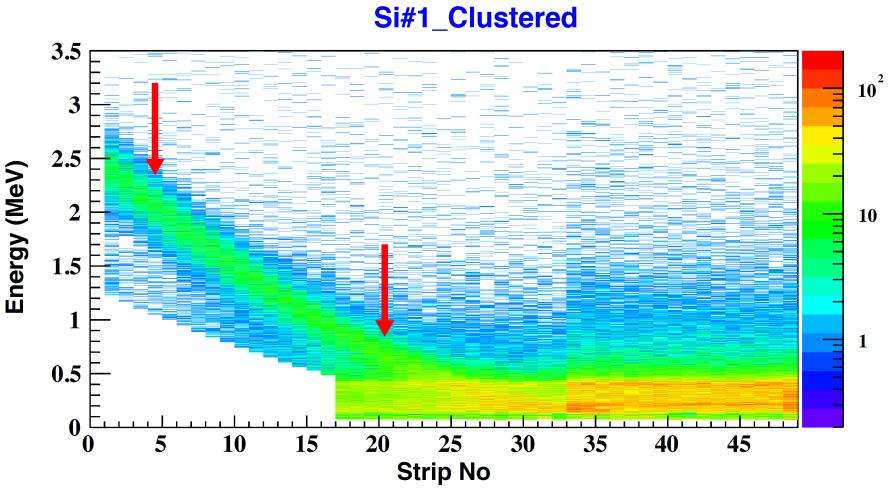


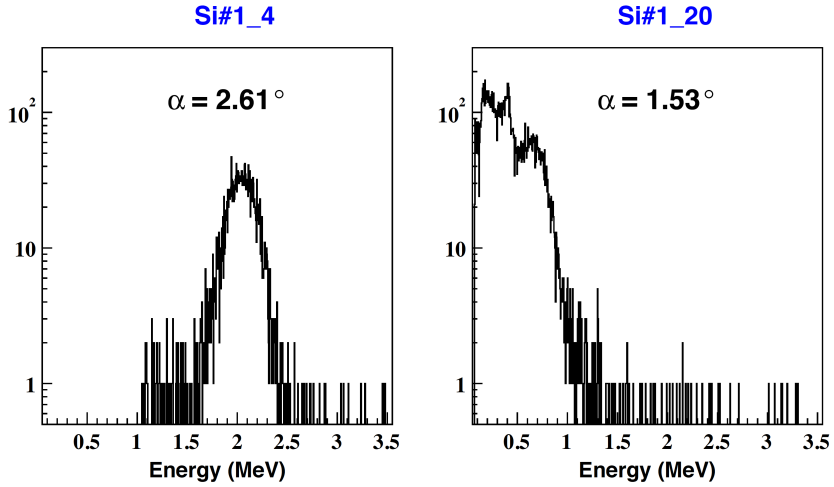




2.2 Precision and Threshold (3.2 GeV/c)



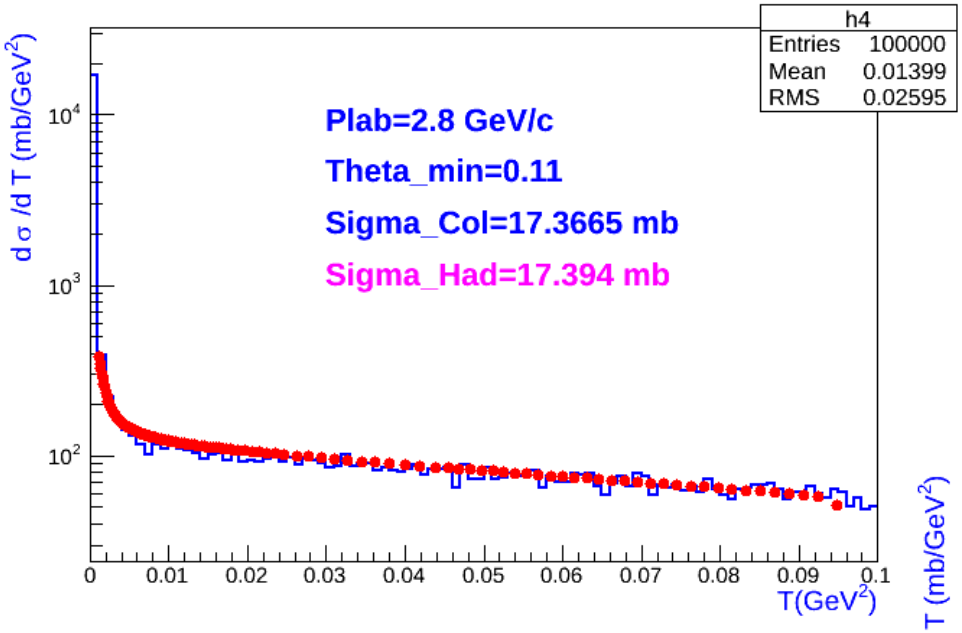




Precision <1%

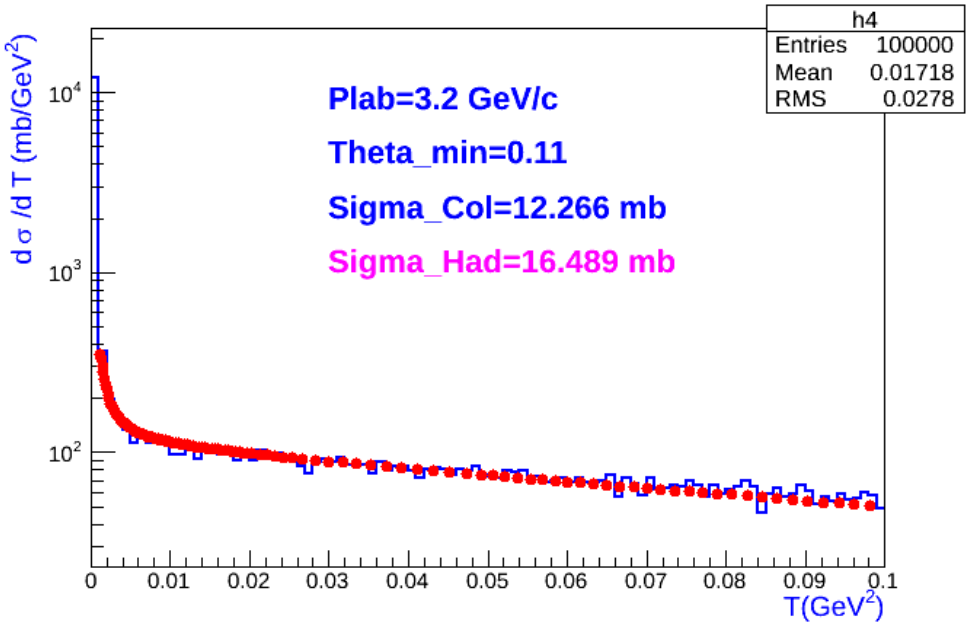
Threshold: ~ 600 keV
|t| ~ 0.001 (GeV/c)²

2.3 Differential Cross Section



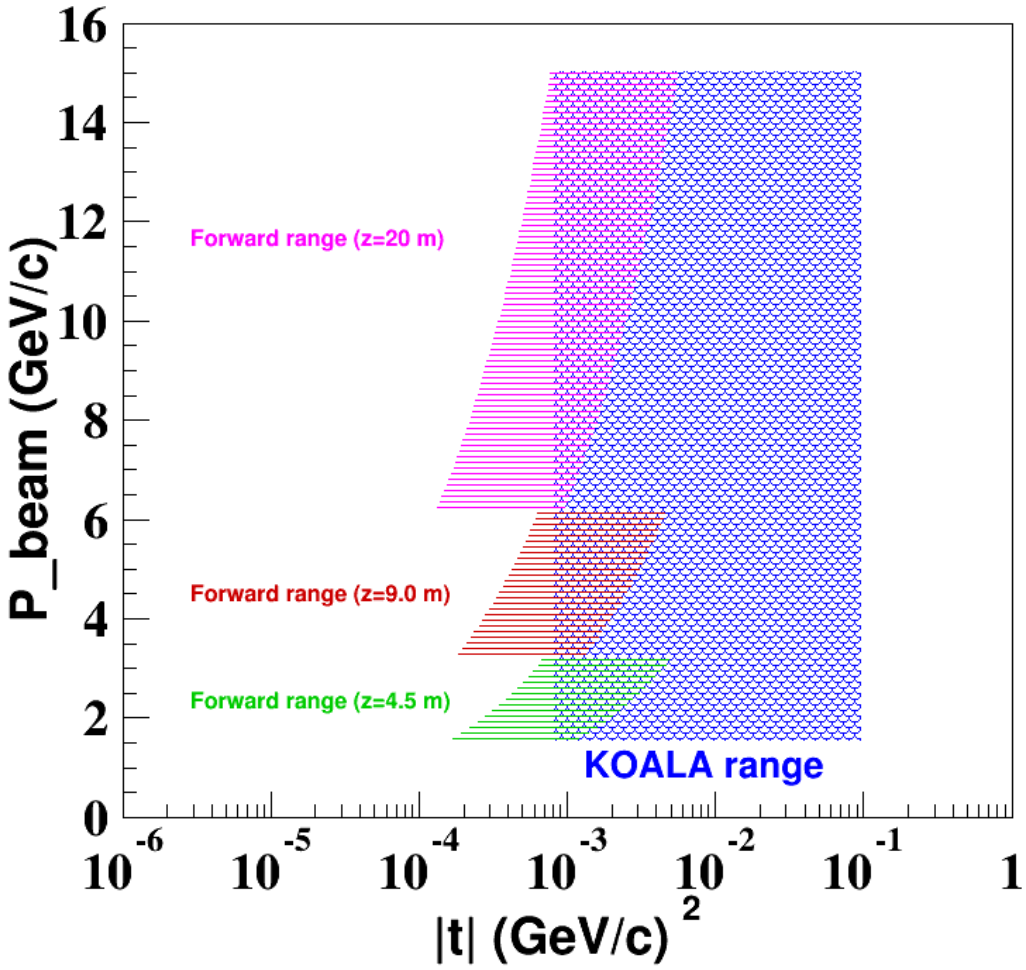
Figures from Aida

- Blue is from generator
- Red is KOALA data of pp



3.1 Coincidence of Forward and Recoil

- |t| range covered by LMD and KOALA



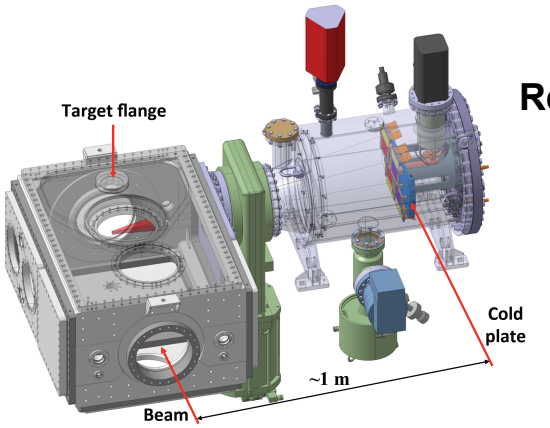
3.2 Ideas for Coincidence

- Taking bunch beam (e.g. ~2 ns size of bunch) instead of forward measurement
  - Bunch beam is available but not smaller than 300 ns at COSY and 100 ns at HESR
  - No chance to take time information from machine
  - **Option 1 doesn't fit at all**

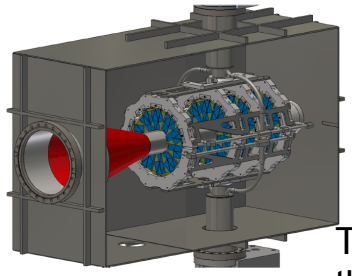
- Forward measurement, to measure elastically scattered beam particles
  - Build new detectors
  - Build customized beam pipe
  - Set the forward detector at different location

3.3 Full Setup of KOALA

- TOF of recoil protons and scattered beam particles
- Space depending on beam momentum
- Beam pipe modification
- Thin cluster target



Recoil arm



Forward arm (PANDA LMD)

To be ready by the end of 2016

PLB 638(2006)P450

RHIC measurement P=100 GeV/c

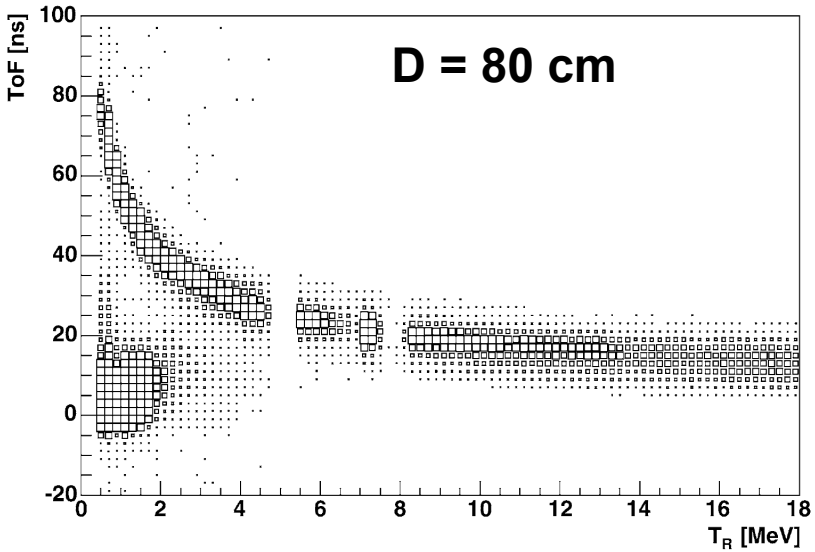


Fig. 2. ToF vs. T_R scatter plot for all recorded events. The locus is populated by recoil protons, while the bulk of events on the bottom left is due to prompt and beam halo events. The *empty* vertical bands are populated by the calibration α sources and have been removed from the plot.

3.4 TOF of Beam Particles & Recoil Protons

ToF of beam particle and recoil proton

Constant	Light spe	s->ns	proton (MeV)
	30	1E+09	938,3

Recoil protons

Energy (MeV)	Gamma	Speed (unit c)	Flight1 (cm)	ToF1 (ns)	Flight2 (cm)	ToF2 (ns)	Flight3 (cm)	ToF3 (ns)
10	1,011	0,145		16,1		18,4		20,7
5	1,005	0,103		22,7		25,9		29,2
3	1,003	0,080		29,2		33,4		37,6
2	1,002	0,065		35,8		40,9		46,0
1,5	1,002	0,056		41,3		47,2		53,1
1	1,001	0,046	70	50,6	80	57,8	90	65,0
0,8	1,001	0,041		56,5		64,6		72,7
0,6	1,001	0,036		65,3		74,6		83,9
0,4	1,000	0,029		79,9		91,4		102,8
0,2	1,000	0,021		113,0		129,2		145,3
0,1	1,000	0,015		159,8		182,7		205,5

Recoil protons

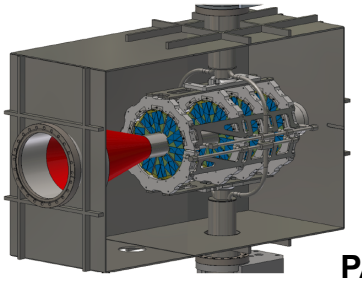
Scattered beam particle

Energy (MeV)	Gamma	Speed (unit c)	Flight1 (cm)	ToF1 (ns)	Flight2 (cm)	ToF2 (ns)	Flight3 (cm)	ToF3 (ns)
1500	2,599	0,923	500	18,1	430	15,5		
2000	3,132	0,948	500	17,6	430	15,1		
3000	4,197	0,971	500	17,2	430	14,8		
6000	7,395	0,991	900	30,3				
9000	10,592	0,996	2000	67,0				
15000	16,986	0,998	2000	66,8				

Beam particles

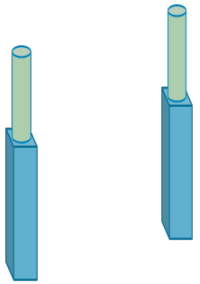
3.5 Forward Measurement

- Detector concept 1: (doesn't fit)
  - the prototype of PANDA luminosity detector, time resolution of HV-MAPS **70 ns** and **50/25 ns** window of clock.



PANDA LMD

- Detector concept 2:
  - Time resolution better than 1 ns
  - Fast timing detector e.g. plastic scintillators.
    - *r-min: 37 mm*
    - *r-max: 102.3 mm*

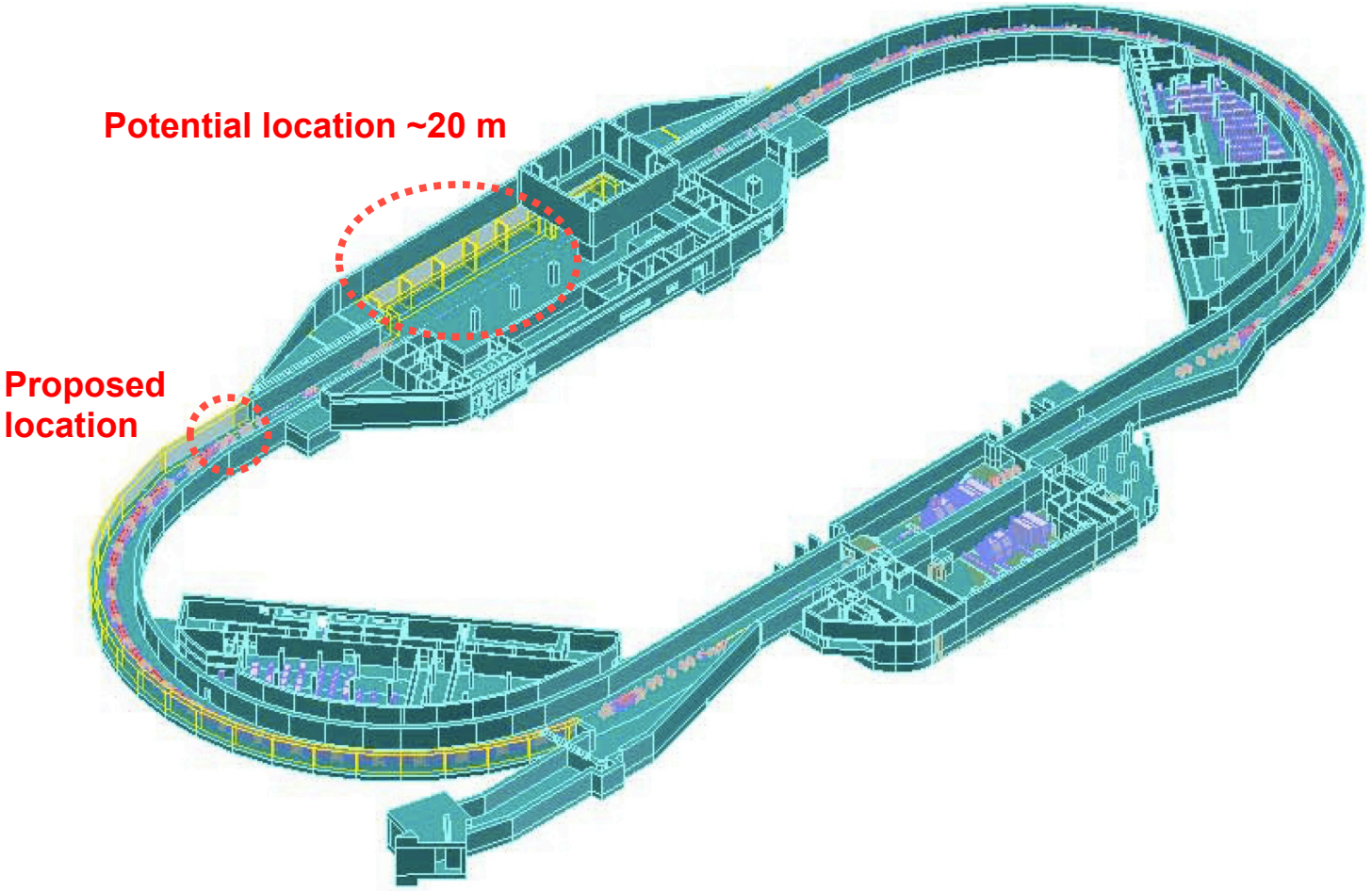


Scintillator readout by PMT

- Beam pipe: (customized beam pipe)
  - Cascade beam pipe from target chamber to z = 20 m.

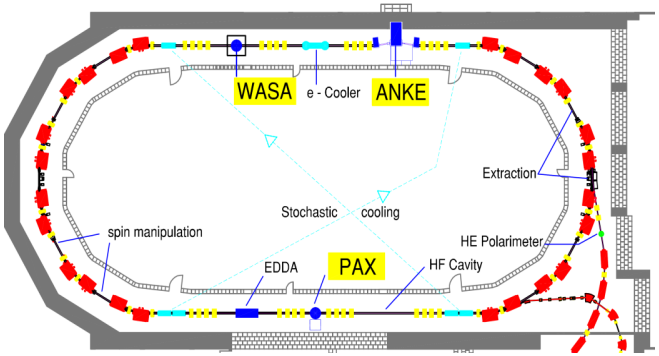
4 Full Setup of KOALA at HESR

- 20 m space for 3 detector position, i.e. 4.5, 9 and 20 m
- Cluster target (new or existing)



5.1 Full Setup of KOALA at COSY

- Beam momentum max. 3.7 GeV/c
- Cluster target
- Linear section (4.5-5 m long?)
- Beam pipe modification

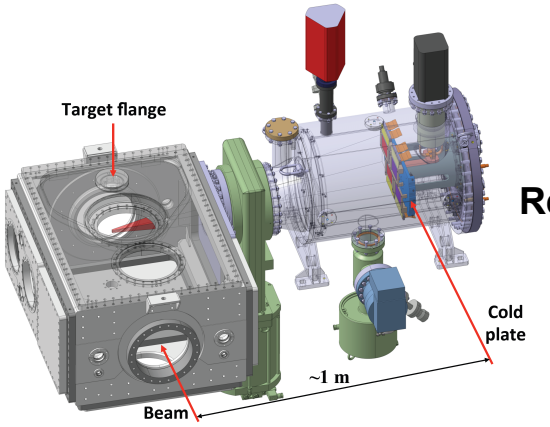


Beam pipe customized

Z = 0
Target chamber

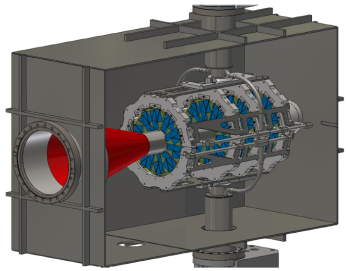
Z = 1.5 m
ϕ89 mm

Z = 5 m
ϕ210 mm



Recoil arm

PANDA LMD



HV-MAPS on Diamond

Retractable halfplanes

Two vacuum compartiments

Inner beampipe

5.2 Location at COSY for Beam Test

At ANKE target station:

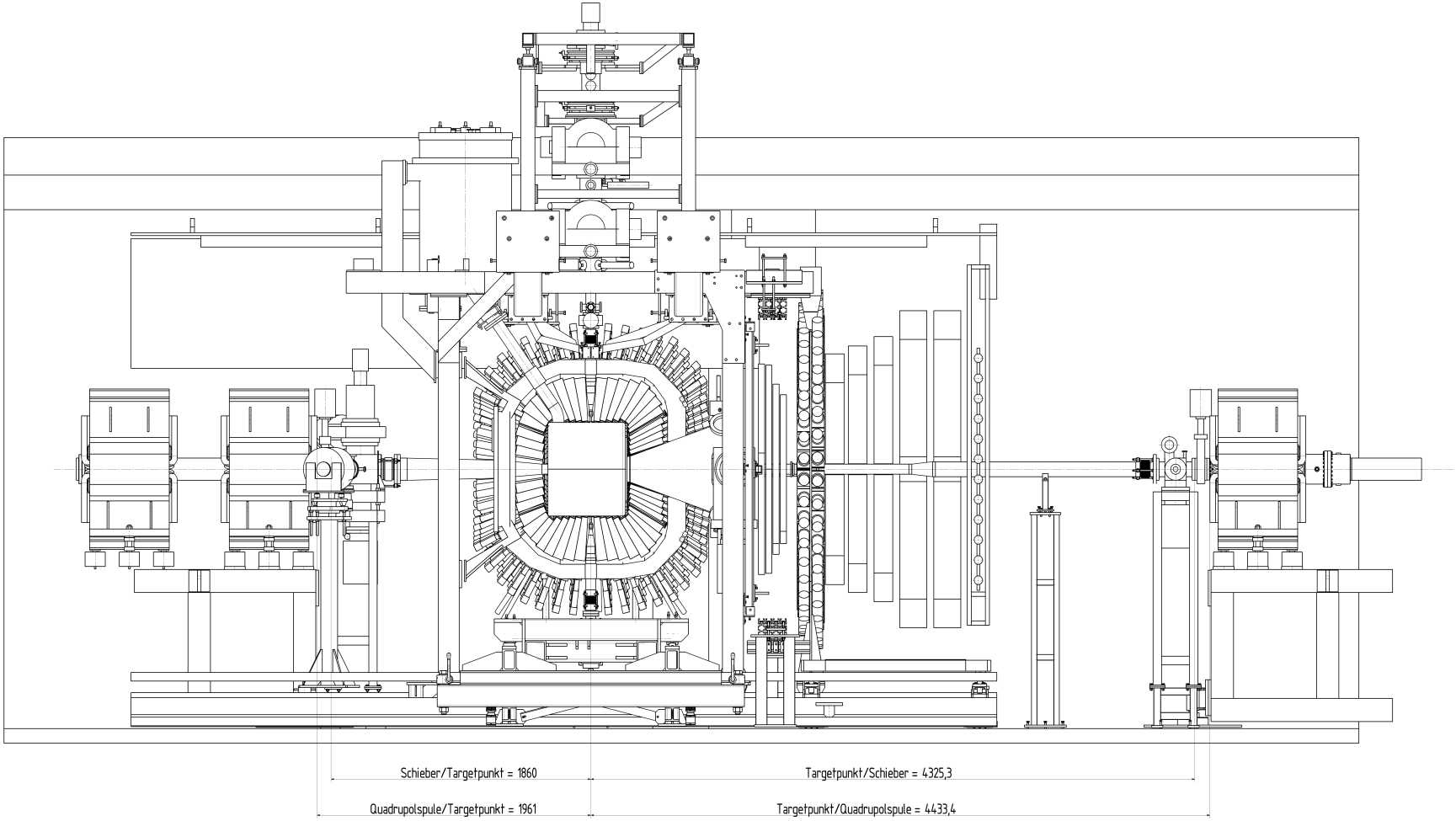
- Cluster target & scattering chamber (available)
- Existing KOALA chamber (fits with the scattering chamber)
- **Space 3.2 m** (**not suitable for coincidence**)

At WASA location

- To be built
  - *New scattering chamber for cluster target*
  - *Adaptor flange*
  - *Supporting frame*
- **Space 4.3 m** from current WASA IP to the gate valve
  - *Beam momentum maximum 2 GeV/c (**compromise**)*
  - *Detector must be, e.g. 80cm, to IP (**60 cm for chamber and valve**)*
  - *Recoil angle must be ~19 degree*
- If shifting target position to upstream by e.g. 60cm? **(doesn't fit)**
  - *Beam momentum 2-2.8 GeV/c*
  - *Detector 90cm to IP*
  - *Recoil angle ~16 deg*

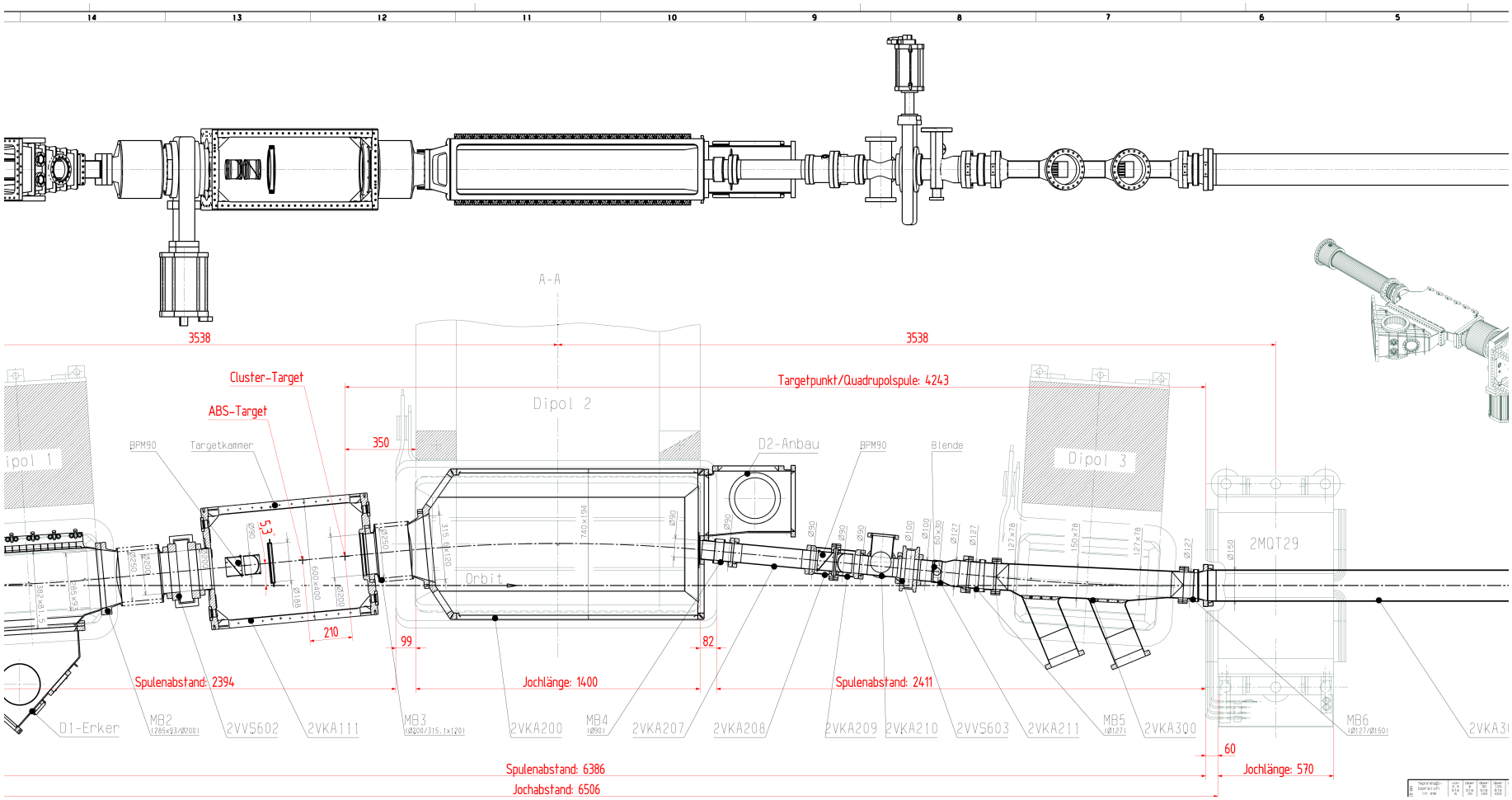
- Space at WASA

- 4.3 m from WASA target to valve before Quadrupole, could shift target to upstream by e.g. 0.5-1 m



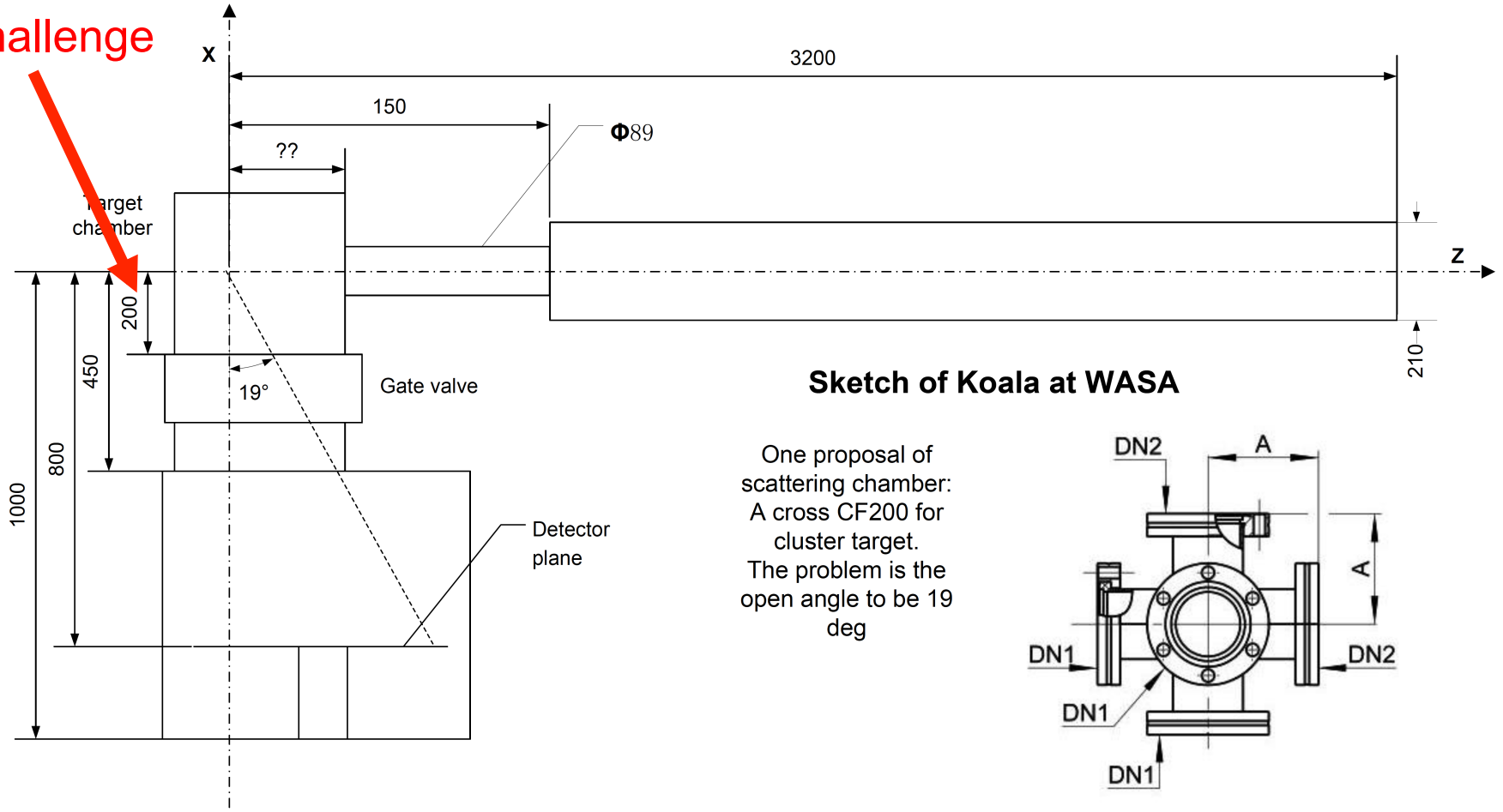
- Space at ANKE

- ~3.2 m from cluster target to Dipole 3, could not shift target



Sketch of KOALA at WASA

Technical challenge



Sketch of Koala at WASA

One proposal of scattering chamber:
A cross CF200 for cluster target.
The problem is the open angle to be 19 deg

WASA location could be a acceptable compromise!

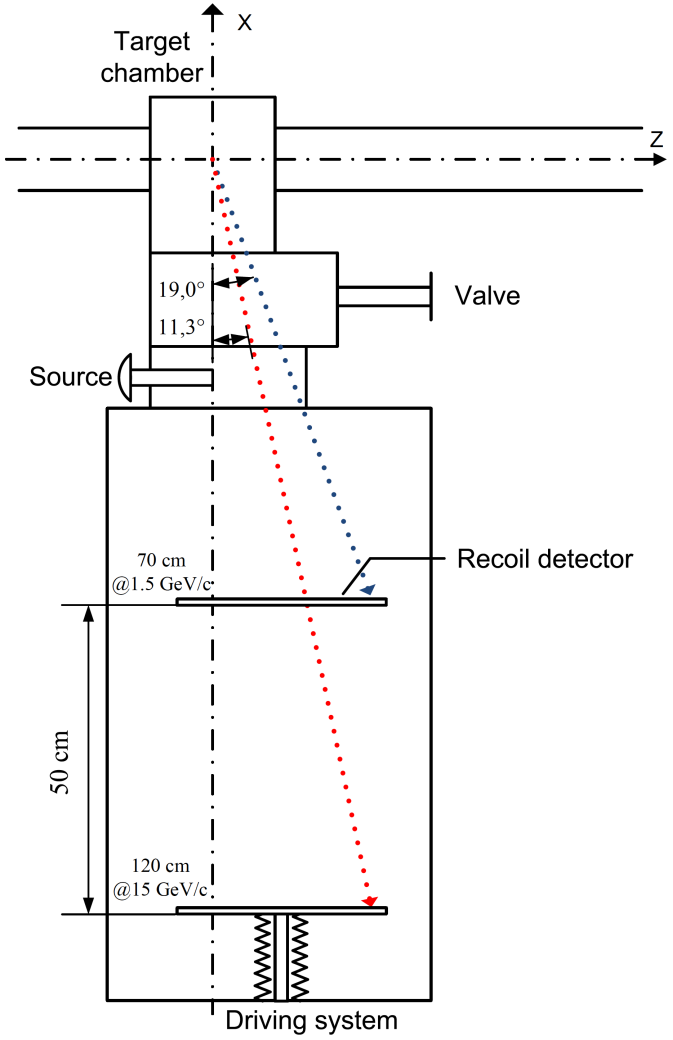
Summary of Requirements

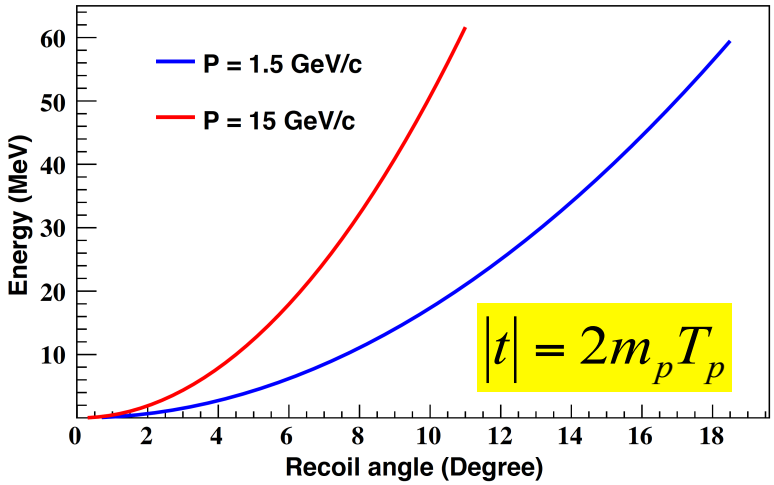
- **Build forward detector**
- **Experiment at HESR:**
  - 20 m space for 3 detector position, i.e. 4.5, 9 and 20 m (?)
  - Cluster target (new one or existing one?)
  - Beam pipe modification (which procedure to follow?)
- **Commissioning at COSY:**
  - Beam time this autumn (to be applied)
  - Cluster target
    - *Existing one at ANKE*
    - *PANDA cluster target at WASA*
  - Linear section (4.3 m long at WASA?)
  - Beam pipe modification (which procedure to follow)

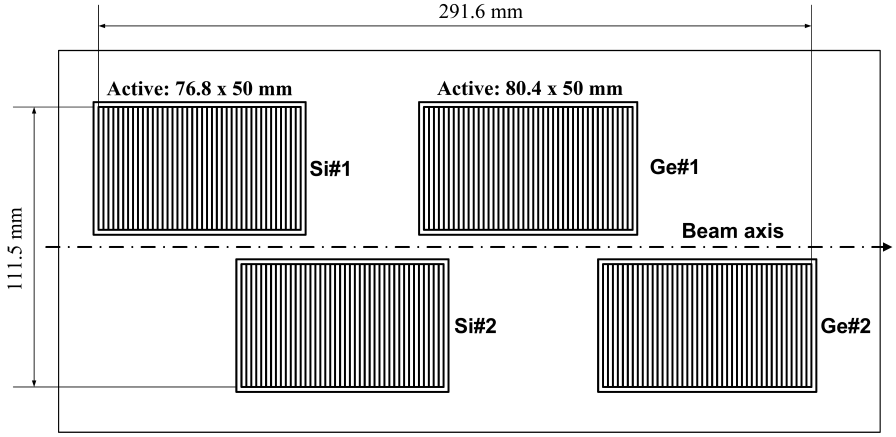
Thanks for your attention!

Backup

1.3 Concept of Koala Recoil Detector







Plans and Requests of Koala at COSY

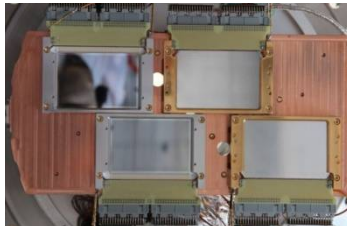
Plans of beam test for/with

- Better DAQ performance (to be realized in the first half of 2015)
  - Trigger signal handling or IRQ mode of ADC
- Coincidence with forward measurement (2017-)
  - Waiting for a prototype of PANDA luminosity detector
  - Finding place to set forward setup

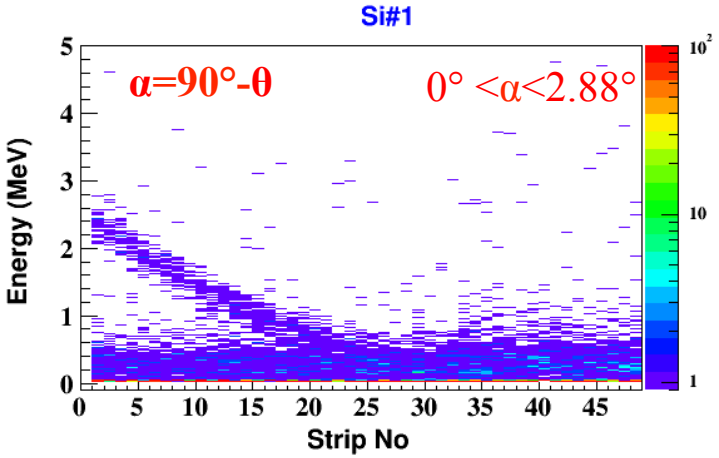
Requests

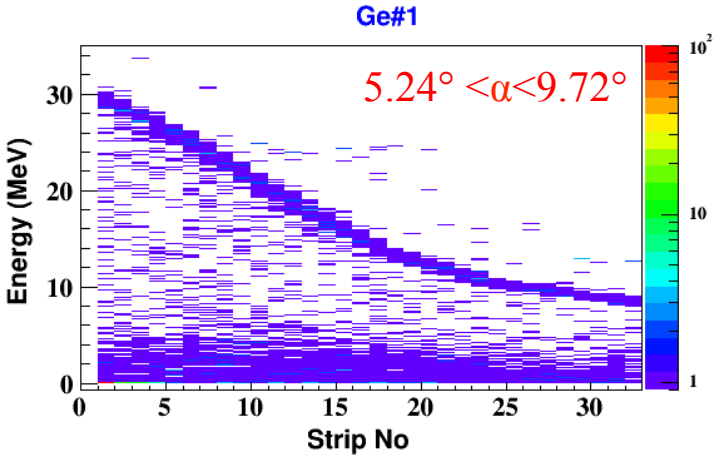
- Cluster target
  - Benefits from ANKE : Forward scintillator detectors & Logic electronics for beam cycle signals
- 2 weeks (1+1) beam time in the second half of 2015

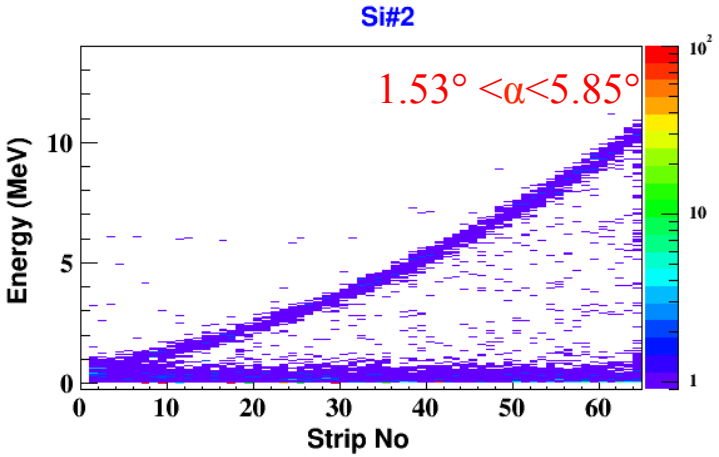
Online Data of Commissioning

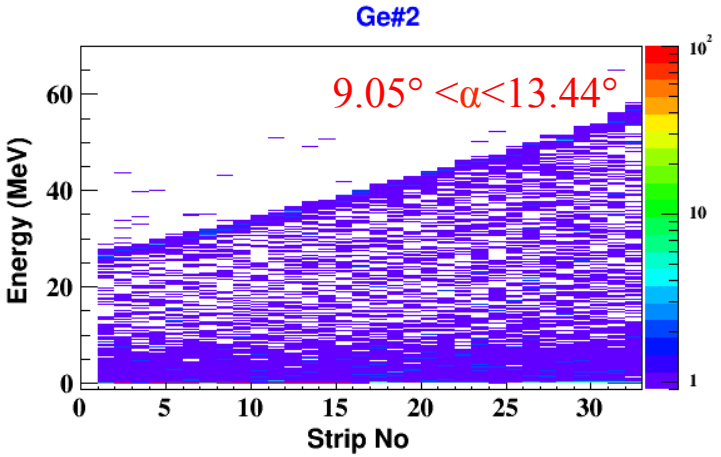


P = 3.2 GeV/c









Energy of recoil protons clearly observed.

Data Acquired

- Data have been taken at 1.7 GeV/c, 2.5 GeV/c, 2.8 GeV/c and 3.2 GeV/c.

	Run1, 2013	Run2, 2013
Beam intensity	1E10 protons	2-3E10 protons
Data file size	27 GB @ P = 3.2 GeV/c 19 GB @ P = 1.7 GeV/c (1GB ~1M entries)	41 GB @ P = 3.2 GeV/c 53 GB @ P = 2.8 GeV/c 24 GB @ P = 2.5 GeV/c
Elastic events	~ 60% of entries	~ 50% of entries

- Schottky measurements have been performed at 2.5 GeV/c and 3.2 GeV/c