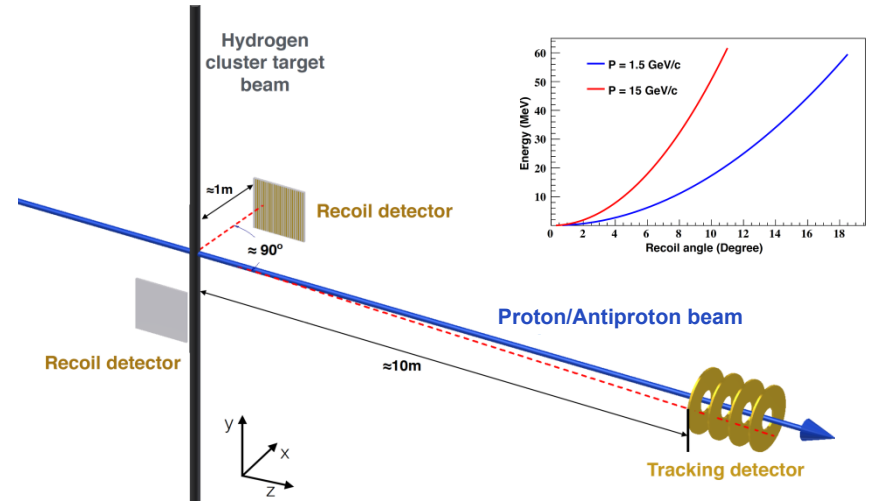
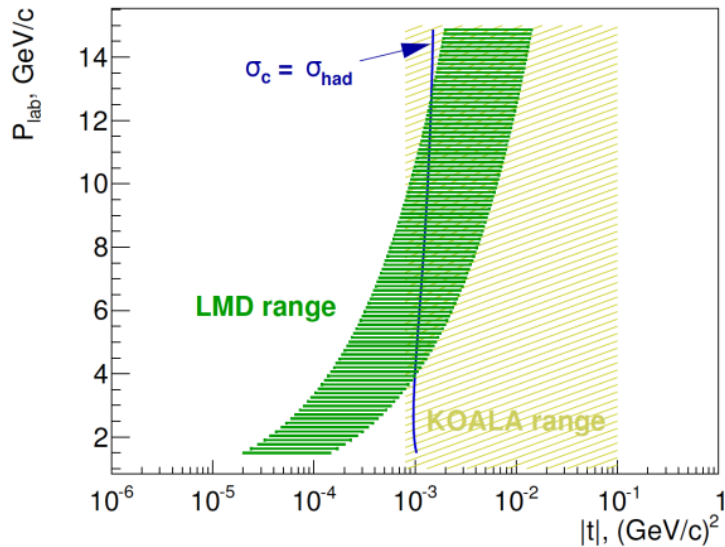




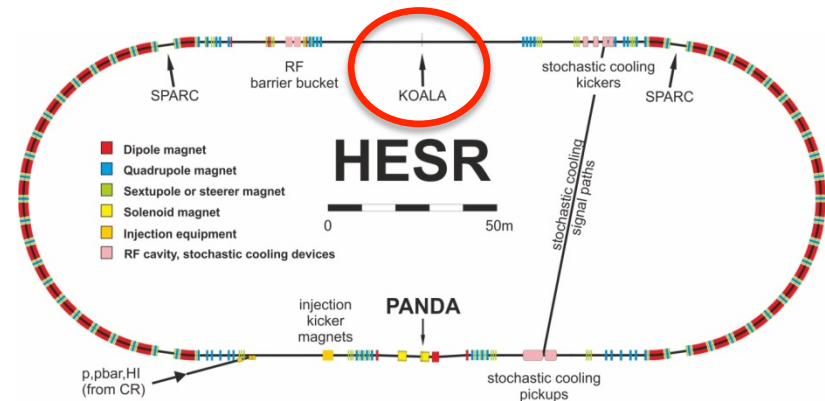
KOALA COMMISSIONING AT COSY

5 NOVEMBER 2019 | HUAGEN XU

PROPOSAL OF KOALA EXPERIMENT



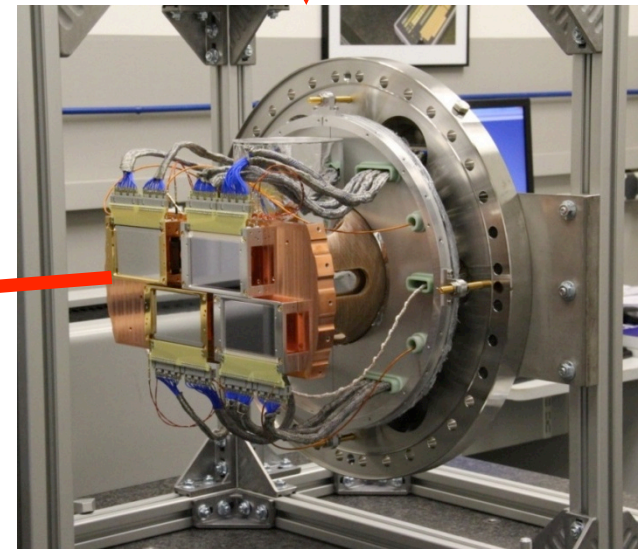
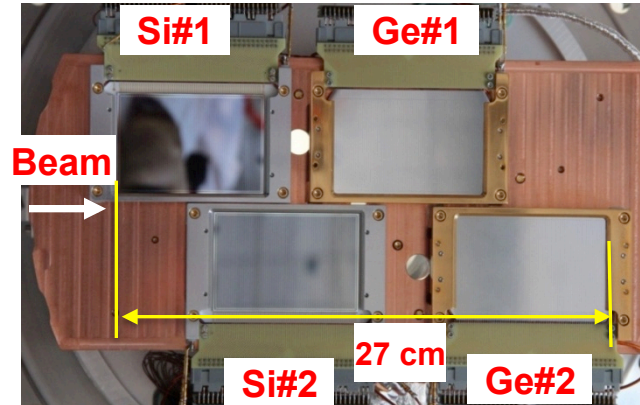
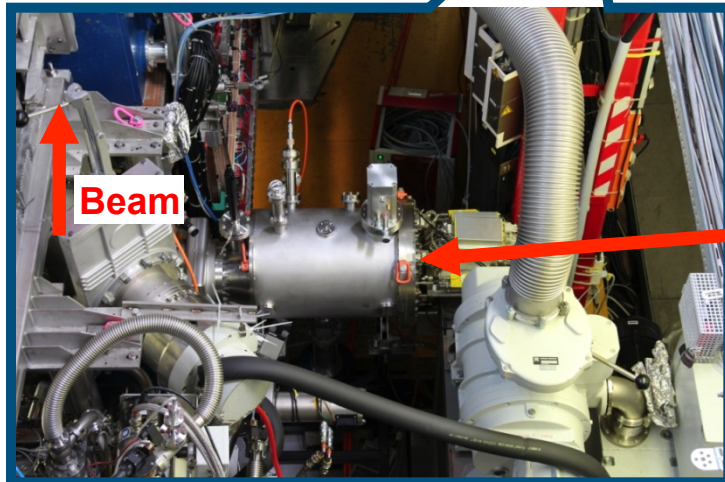
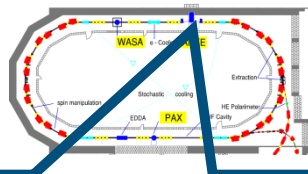
- Elastic scattering at CNI region
- Large range of $|t|$, $[0.0008-0.1] \text{ (GeV/c)}^2$
- Coincidence
 - Forward for small t
 - Recoil covers full t range



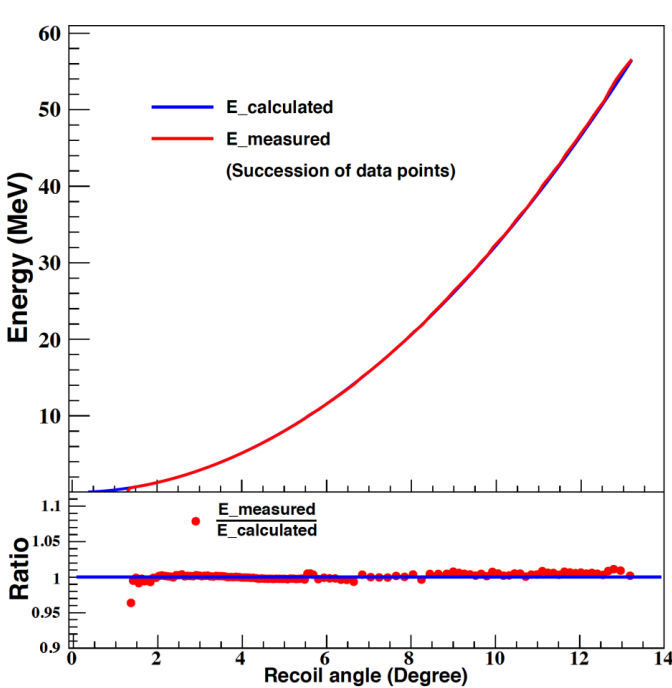
RECOIL DETECTOR MEASUREMENT

- Recoil angle: $\alpha = [0^\circ, 13.6^\circ]$ ($\alpha = 90^\circ - \theta$)
- Si, 75.8x50x1 (mm), 64 strips
- Ge, 80.4x50x5/11 (mm), 67 strips
- Operating temp: 70-300 K

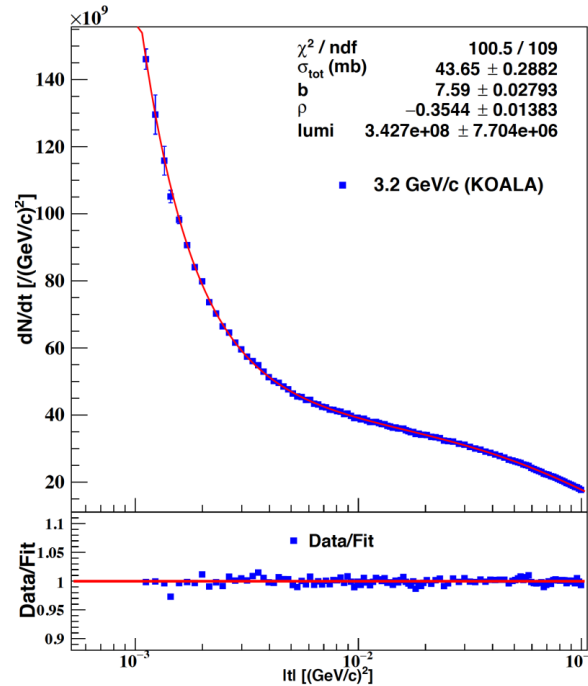
At ANKE target station



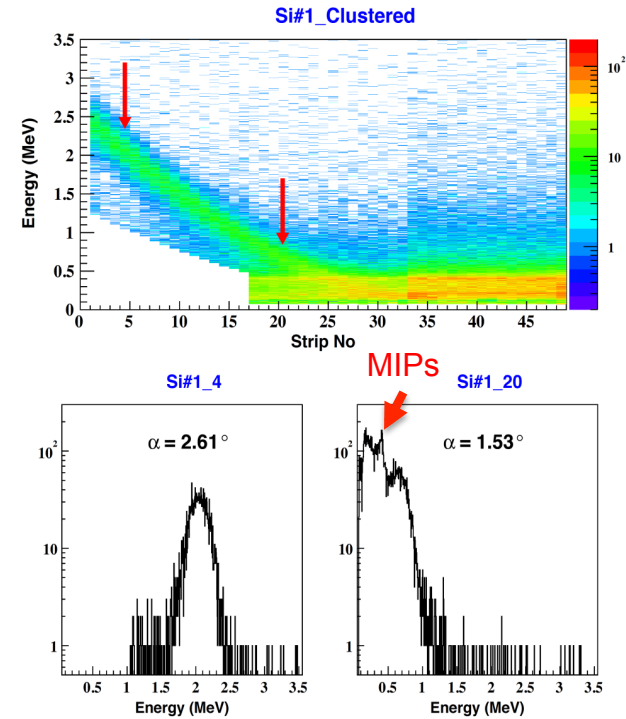
ACHIEVEMENTS OF RECOIL DETECTOR



$\Delta E/E < 1\%$

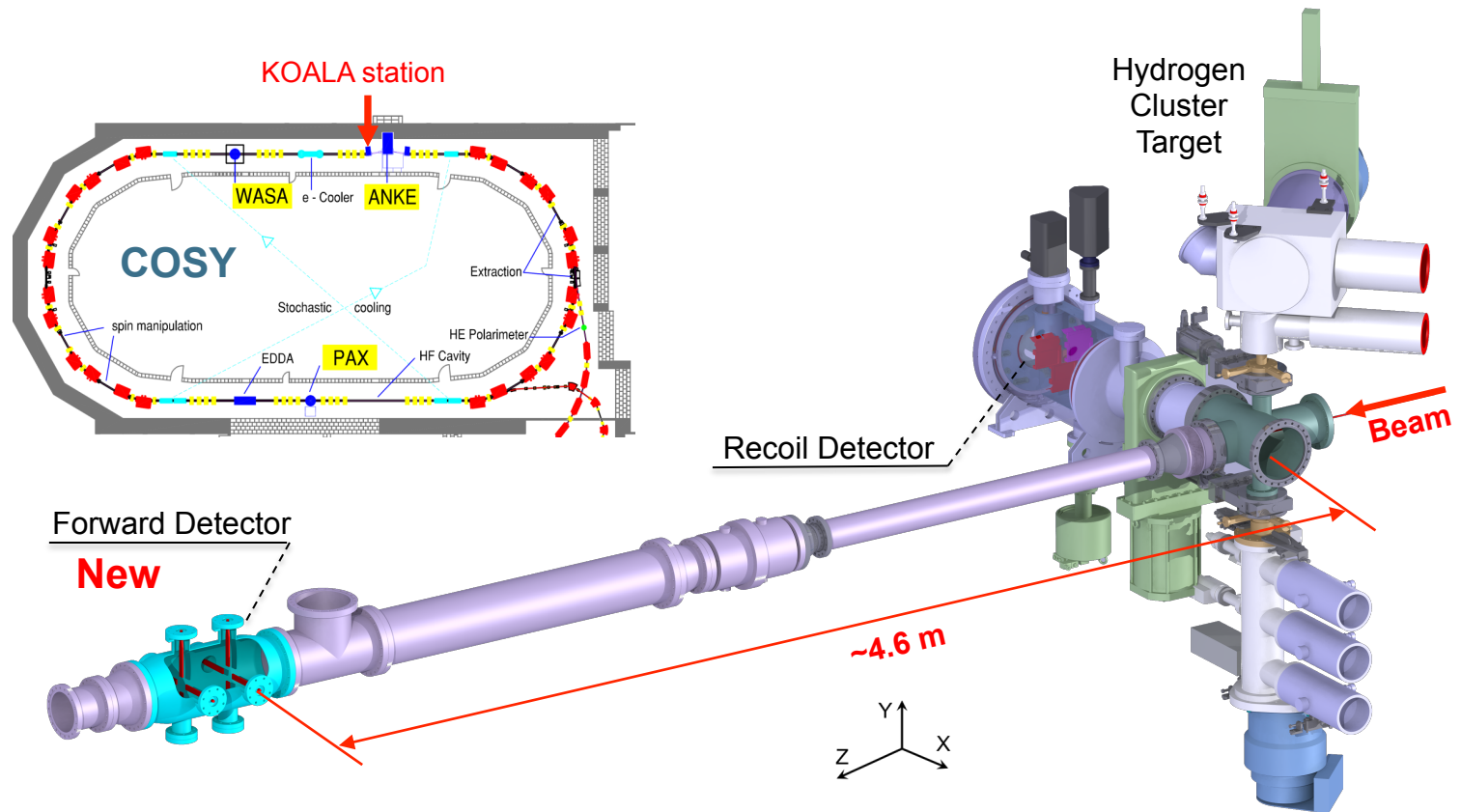


Reconstructed t-spectrum

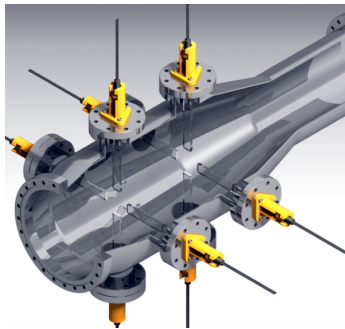


Threshold: $\sim 600 \text{ keV}$

FULL SETUP OF KOALA



- Thin target: 1~2 mm, $\sim 10^{14}$ /cm²
- Acceptance: $0.36^\circ < \theta < 1.2^\circ$
- Position: z=4.6 and 4.8 m
- Scintillator: 90x20x6 (mm)

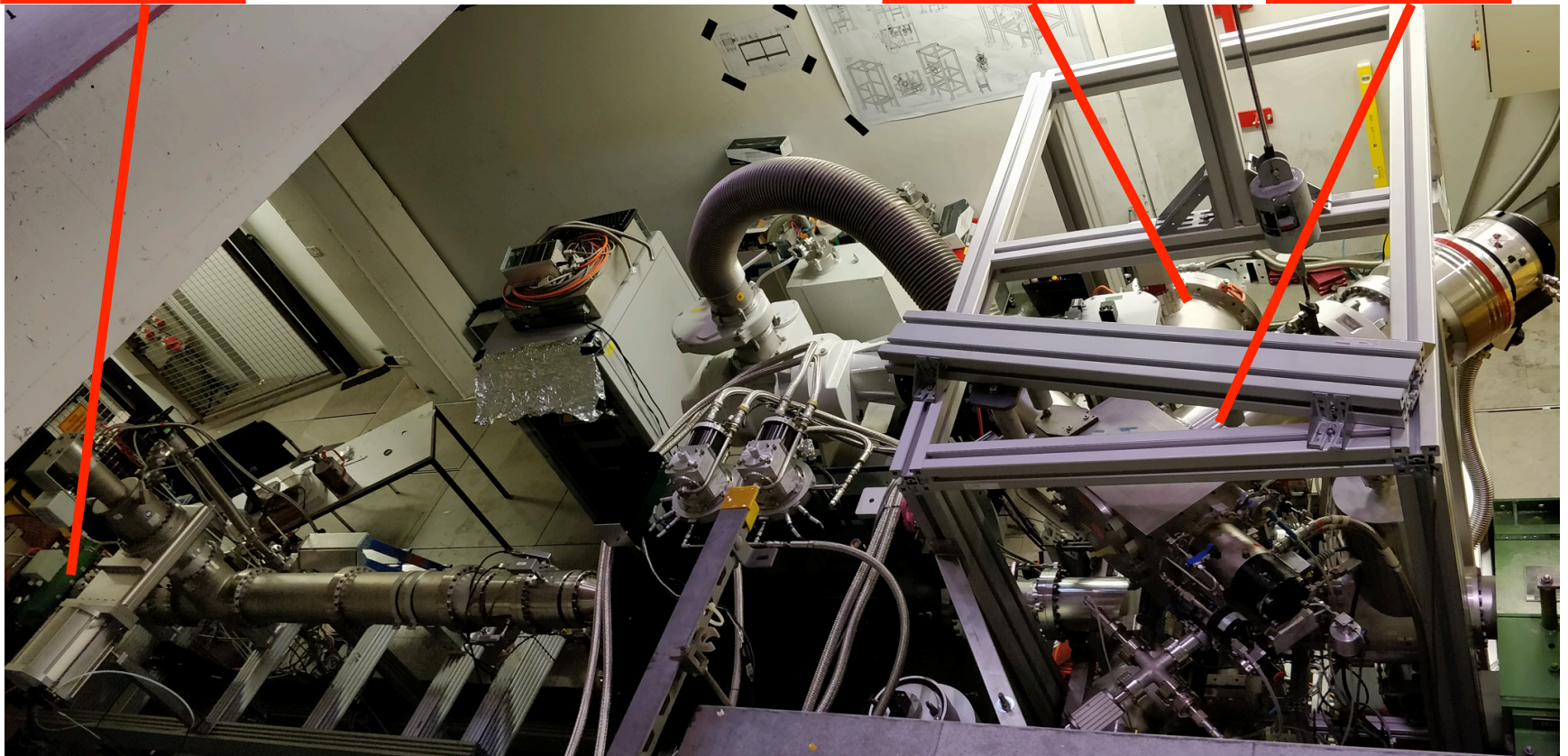


INSTALLATION OF KOALA AT COSY

Forward chamber

Recoil chamber

Target generator



- ~6 m linear space

BEAM TIME SCHEDULE

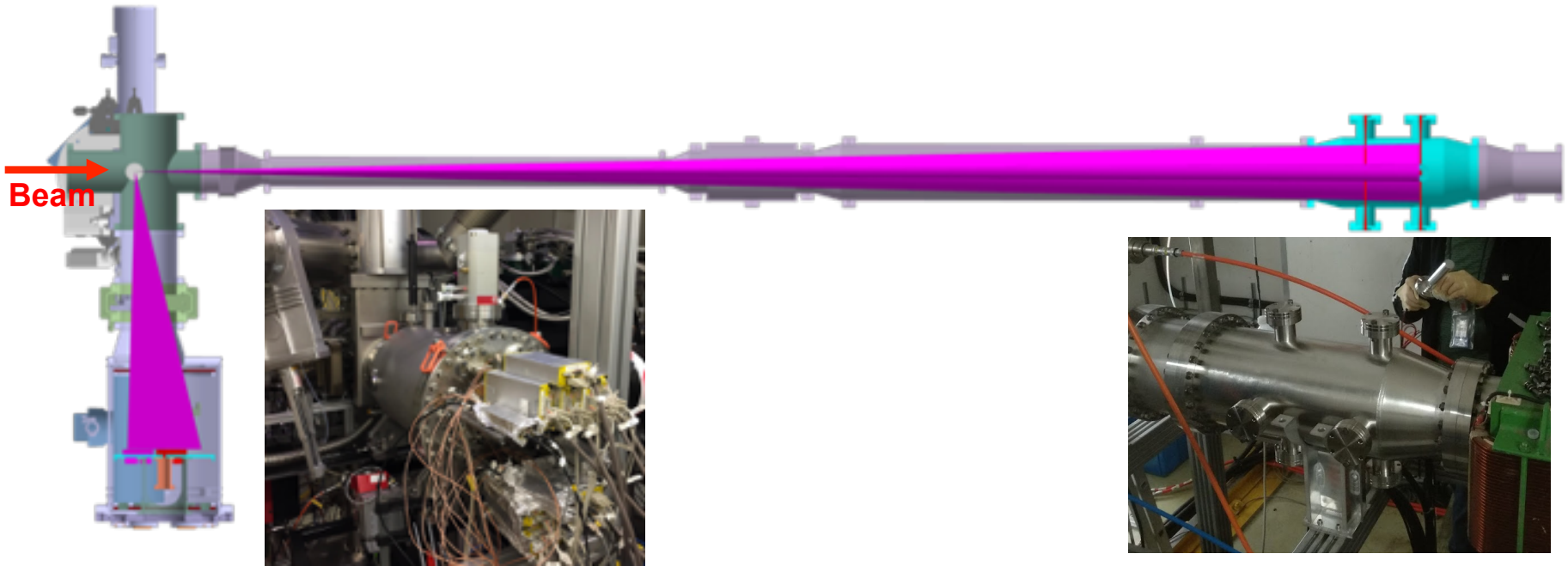
beam time schedule 2019, 1st half

January 2019													February				March		
Week	1	2	3	4	5	6	7	8	9	10	11	12	13						
	31/12/18	07/01/19	14/01/19	21/01/19	28/01/19	04/02/19	11/02/19	18/02/19	25/02/19	04/03/19	11/03/19	18/03/19	25/03/19						
Monday	Maintenance	Maintenance	CBAC-09 Maintenance	MD	COSY beam studies (A005.4)	JEDI beam based alignment (A015)	MD	PANDA STT (D002.3)	MD	PANDA Koala (D005)	PANDA Cluster target (A009)	Maintenance	Maintenance						
Tuesday																			
Wednesday																			
Thursday																			
Friday																			
Saturday																			
Sunday																			
unpolarized protons																			
April				May				June											
Week	14	15	16	17	18	19	20	21	22	23	24	25	26						
	01/04/19	08/04/19	15/04/19	22/04/19	29/04/19	06/05/19	13/05/19	20/05/19	27/05/19	03/06/19	10/06/19	17/06/19	24/06/19						
Monday	MD	EDM Spin dynamics (E007.1) and Axion EDM (E008.1)	Feiertag	Feiertag	MD	JEDI Polar. (E002.6)	MD	CBM (D004.6)	MD	COSY beam studies (A005.4)	Feiertag	Orbit feedback (A014.1)	Maintenance						
Tuesday																			
Wednesday																			
Thursday																			
Friday																			
Saturday																			
Sunday																			
(un-)polarized deuterons							unpolarized protons												

beam time schedule 2019, 2nd half

July													August				September		
Week	27	28	29	30	31	32	33	34	35	36	37	38	39						
	01/07/19	08/07/19	15/07/19	22/07/19	29/07/19	05/08/19	12/08/19	19/08/19	26/08/19	02/09/19	09/09/19	16/09/19	23/09/19						
Monday	CBAC-10 Maintenance	Maintenance	Maintenance	Maintenance	Maintenance	MD	stochastic cooling (A001.8)	FAIR PANDA Cluster target (D009.3)	PANDA Koala (D005)	MD	Lumi-Det. (D011)	HBS	Beam based alignment (A015.1)						
Tuesday																			
Wednesday																			
Thursday																			
Friday																			
Saturday																			
Sunday																			
Reparatur Dipolnetzgerät					unpol. protons					unpol deuterons									
COSY internal beam					JESSICA			Cyc. - Big											
October				November				December											
Week	40	41	42	43	44	45	46	47	48	49	50	51	52						
	30/09/19	07/10/19	14/10/19	21/10/19	28/10/19	04/11/19	11/11/19	18/11/19	25/11/19	02/12/19	09/12/19	16/12/19	23/12/19						
Monday	Beam based alignment (A015.1)	Beam based alignment (A015.1)	MD	JEDI Polar. (E002.7)	MD	CBM (D004.7)	MD	stochastic cooling (A001.9)	electron. cooling (A002.6)	PANDA Koala (D005)	Feiertag	Maintenance	Maintenance						
Tuesday																			
Wednesday																			
Thursday																			
Friday																			
Saturday																			
Sunday																			
unpol.deuterons			pol. deuterons			unpolarized protons			Cyc. BIG Karl										
COSY internal beam					JESSICA			COSY internal beam			Cyc. BIG Karl								

MEASUREMENT AT COSY



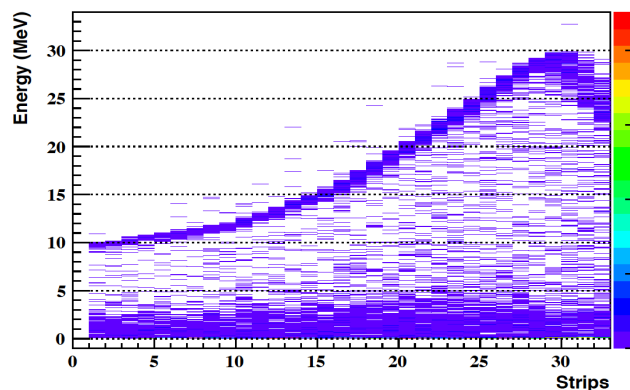
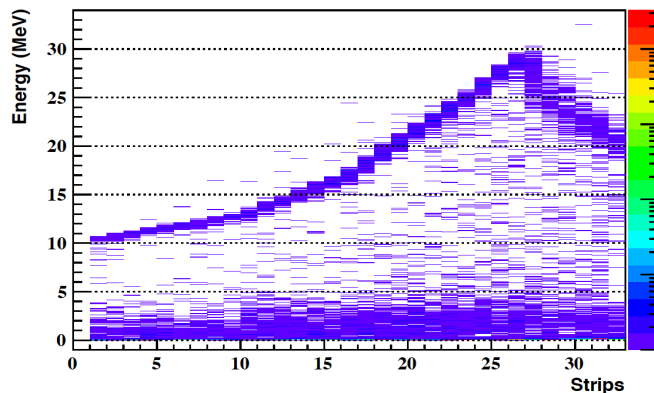
- Problems on Mar.
 - Vacuum of 10^{-6} mbar but 10^{-8} mbar expected
 - Beam without cooling
- Vacuum 10^{-7} mbar, beam with cooling (Aug.-Sep.)
- Pbeam: 3.0, 2.6 GeV/c, intensity: $\sim 2.5 \times 10^{10}$
- Hit rate: ~ 640 (recoil)/ ~ 1040 (scintillator)

“PUNCH THROUGH” EVENTS (AUG. 2019)

3.0 GeV/c

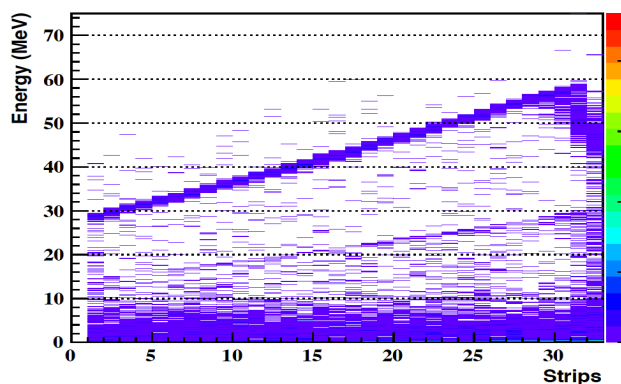
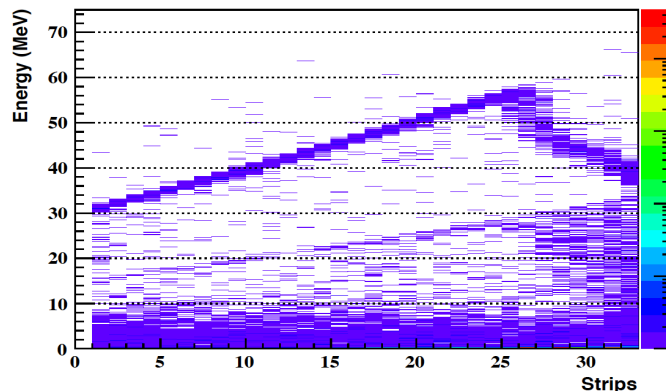
2.6 GeV/c

Ge1



- ~2.6 mm (5.2 mm)
- ~42.7 MeV

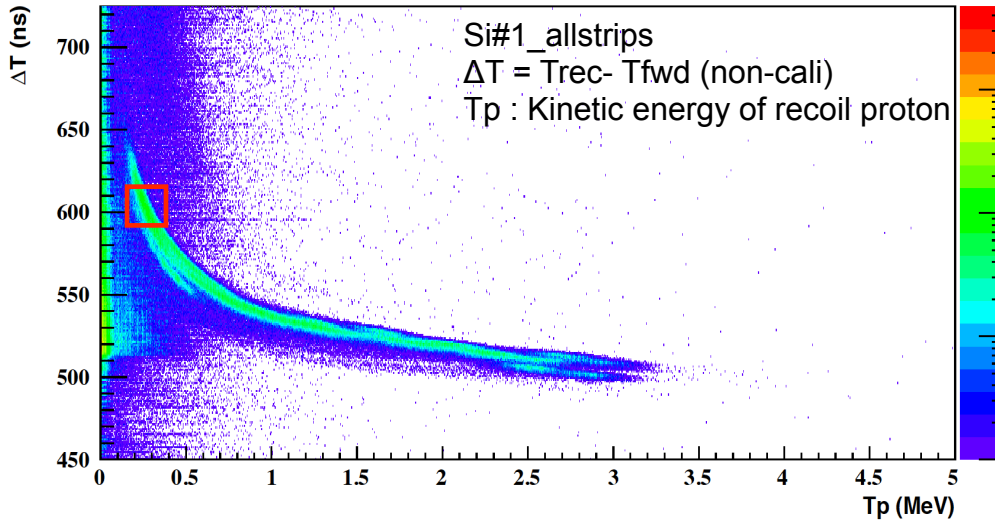
Ge2



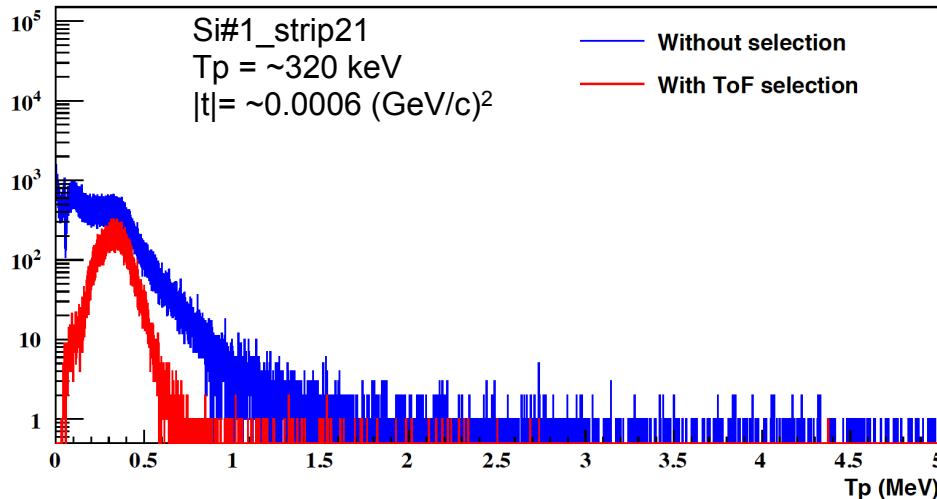
- ~8.9 mm (11.3 mm)
- ~66.6 MeV

- Sensitive thickness of Ge sensor is getting smaller
- New Ge detector to be built in future

ACHIEVEMENTS OF FULL SETUP



- Data sample of Aug. 2019
- $P_{lab} = 3$ GeV/c
- Distance between detector and target: 90.4 cm (instead of 101 cm before)



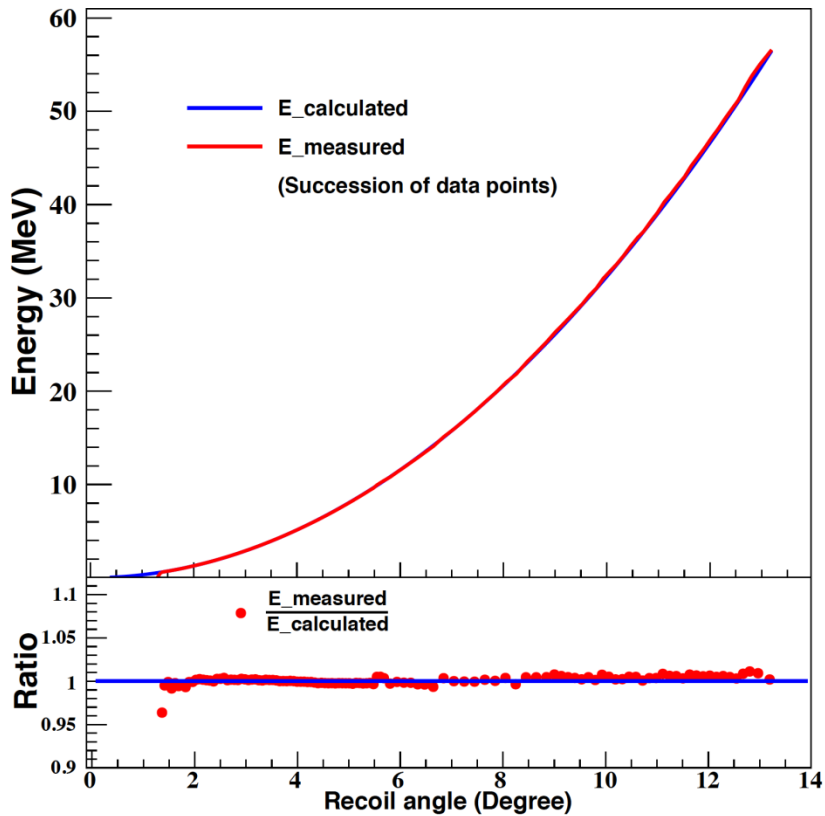
SUMMARY AND OUTLOOK

- Nearly 6 m linear space was gained
- KOALA full setup was installed and being commissioned at COSY
- Coincidence measurement works
- Ge detector is getting older with time

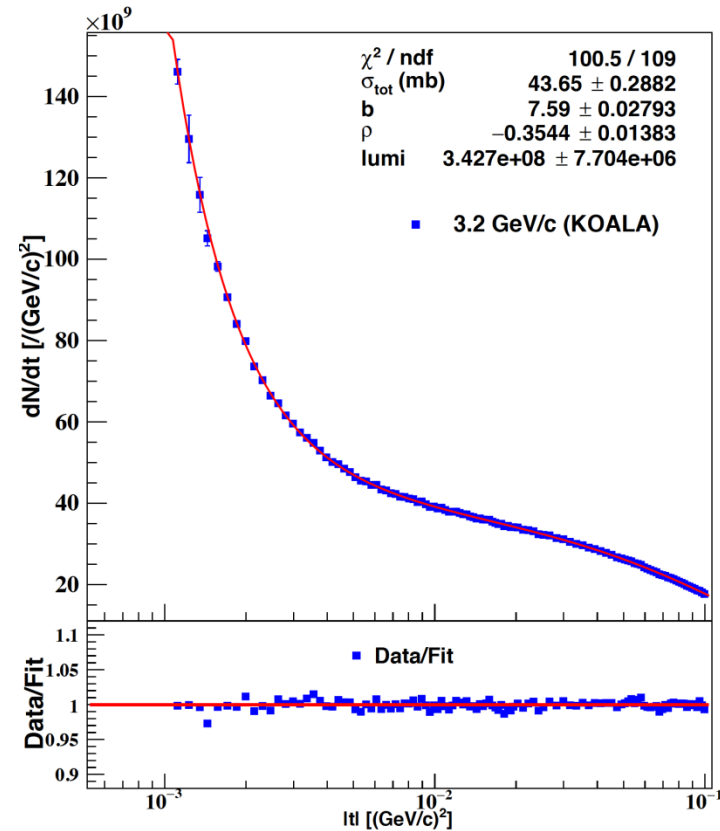
- Beam time on CW49 for data taking at 2.4, 2.2 and 2.0 GeV/c
- Data analysis for the systematic error evaluation
- New Ge detectors are required for future measurement

Thanks for your attention!

ACHIEVEMENTS OF RECOIL DETECTOR

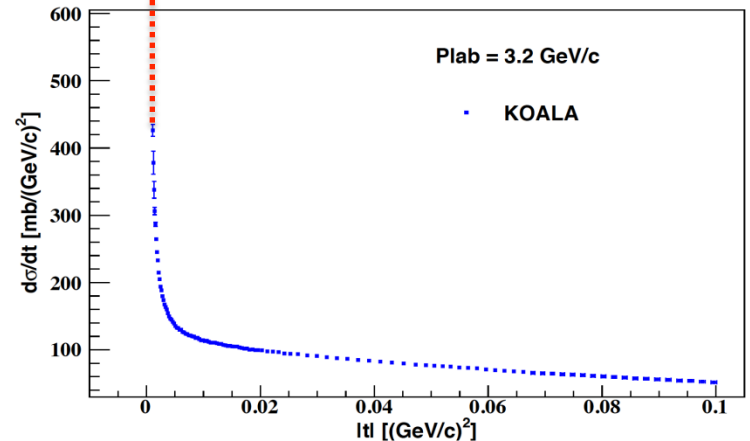
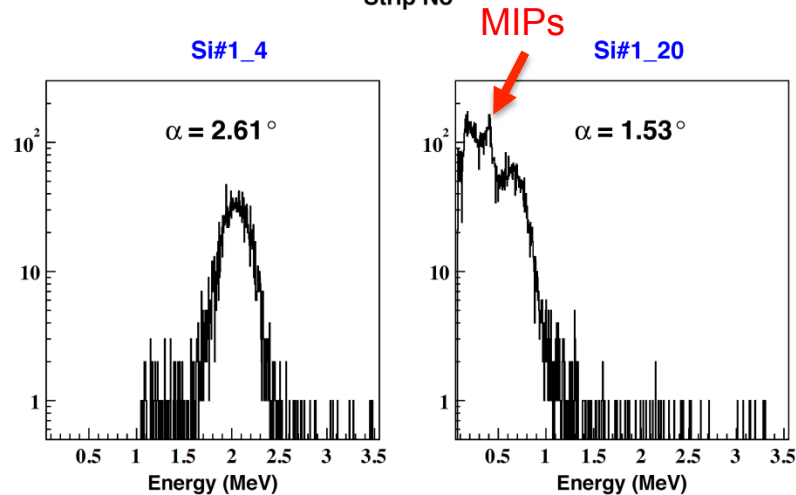
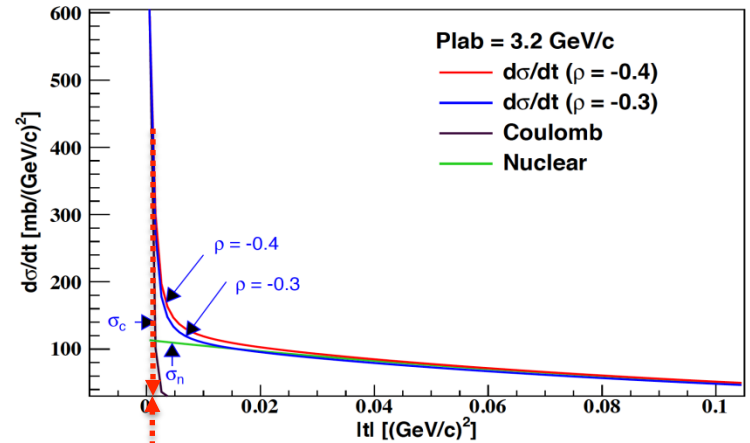
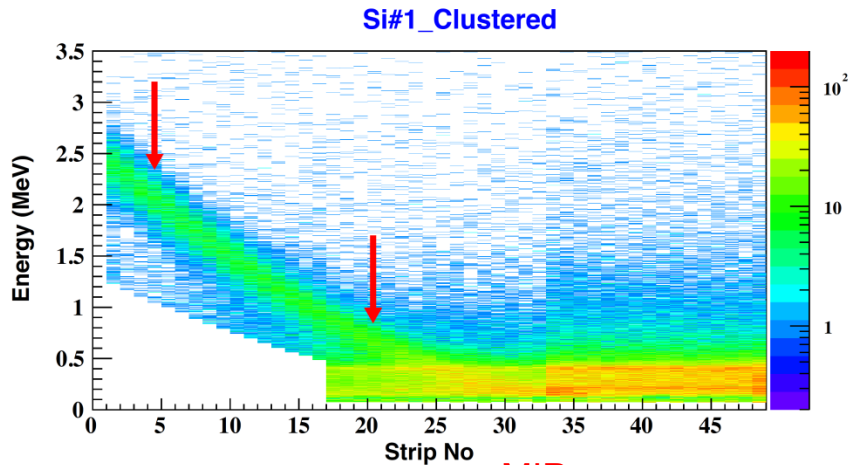


$\Delta E/E < 1\%$



Reconstructed t -spectrum

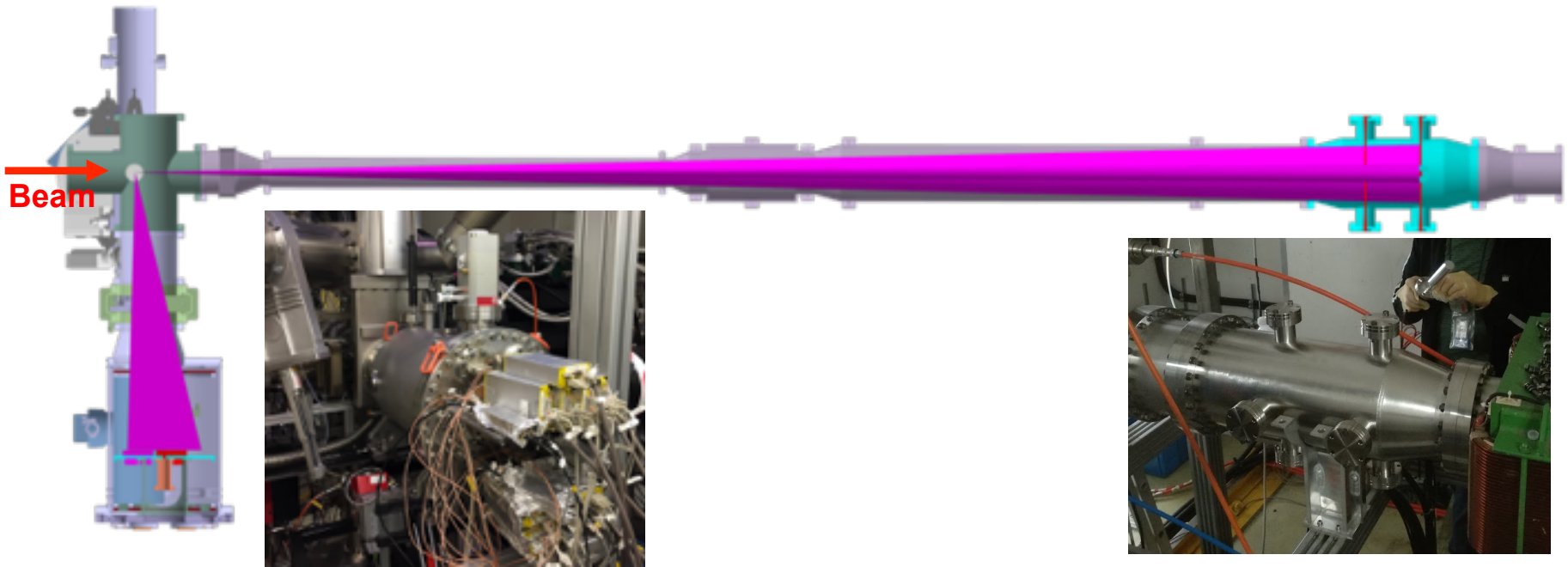
CHALLENGE OF RECOIL DETECTOR



Threshold: ~ 600 keV

$|t| \sim 0.001$ (GeV/c)²

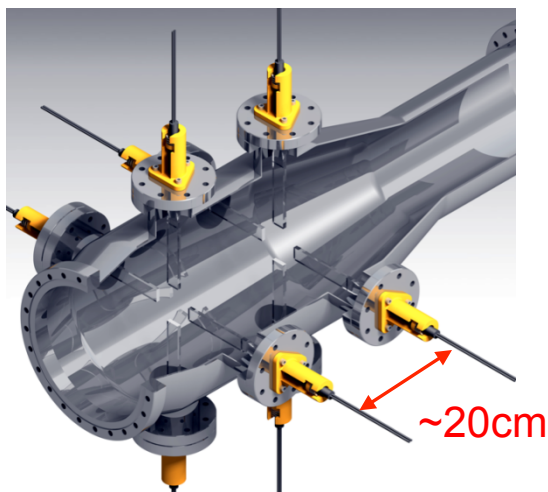
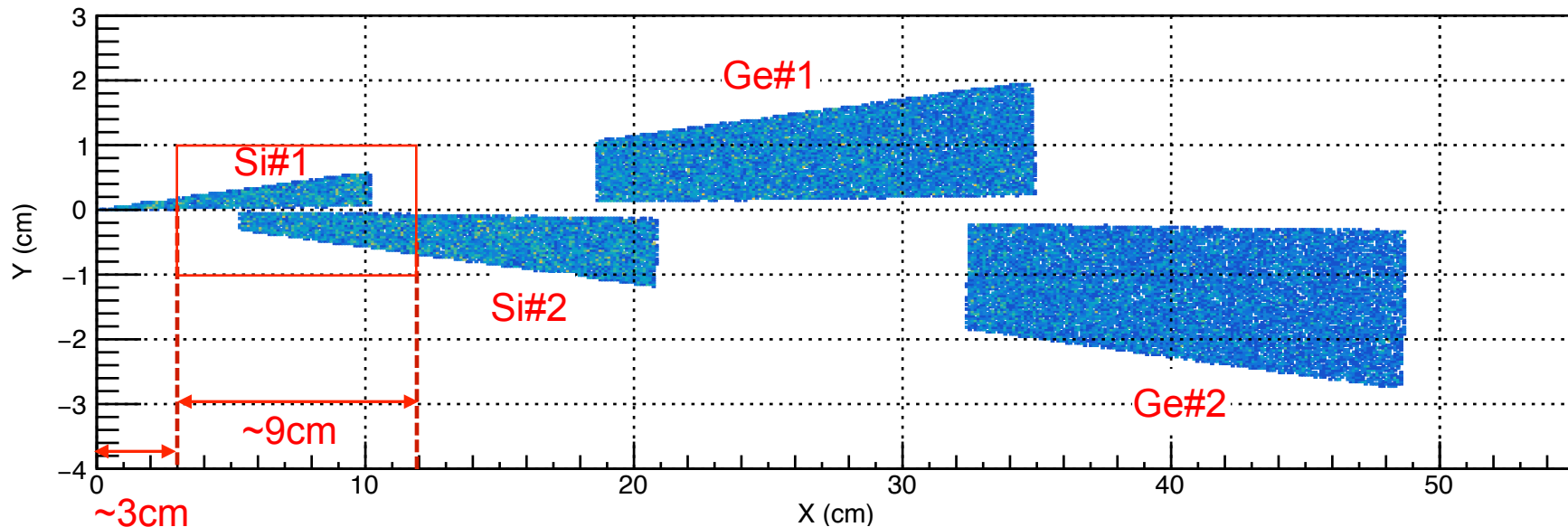
MEASUREMENT AT COSY



- Problems on Mar.
 - Vacuum of 10^{-6} mbar but 10^{-8} mbar expected
 - Beam without cooling
- Pbeam: 3.0, 2.6 GeV/c (Aug. 2019), 2.4, 2.2 and 2.0 GeV/c
- Beam intensity: $\sim 2.5 \times 10^{10}$
- Hit rate ~ 640 (recoil)/ ~ 1040 (scintillator)

FORWARD SCINTILLATOR DETECTOR

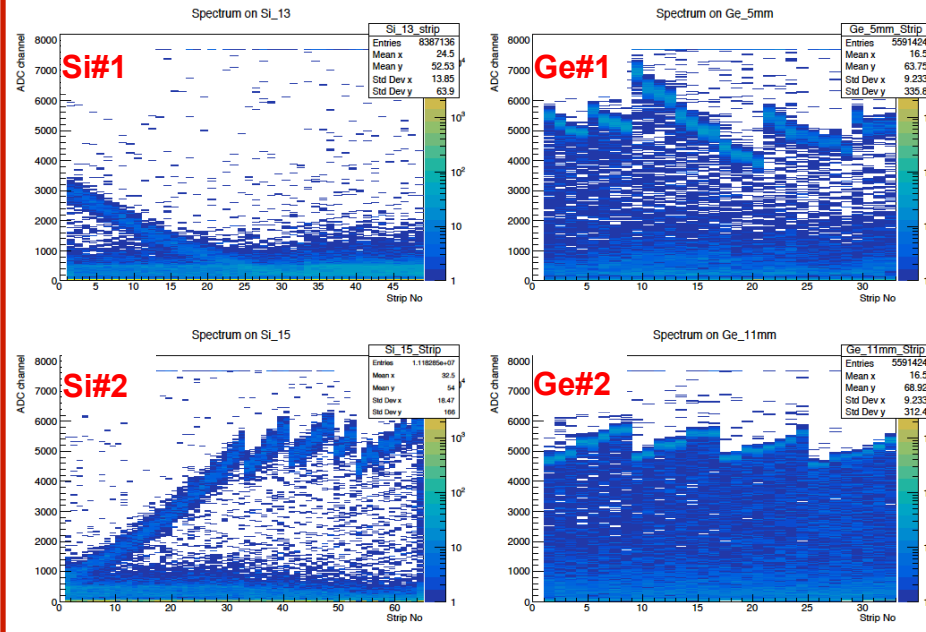
Distribution of the Correlated Scattering Proton in Fwd Detector Position @ 4.6m



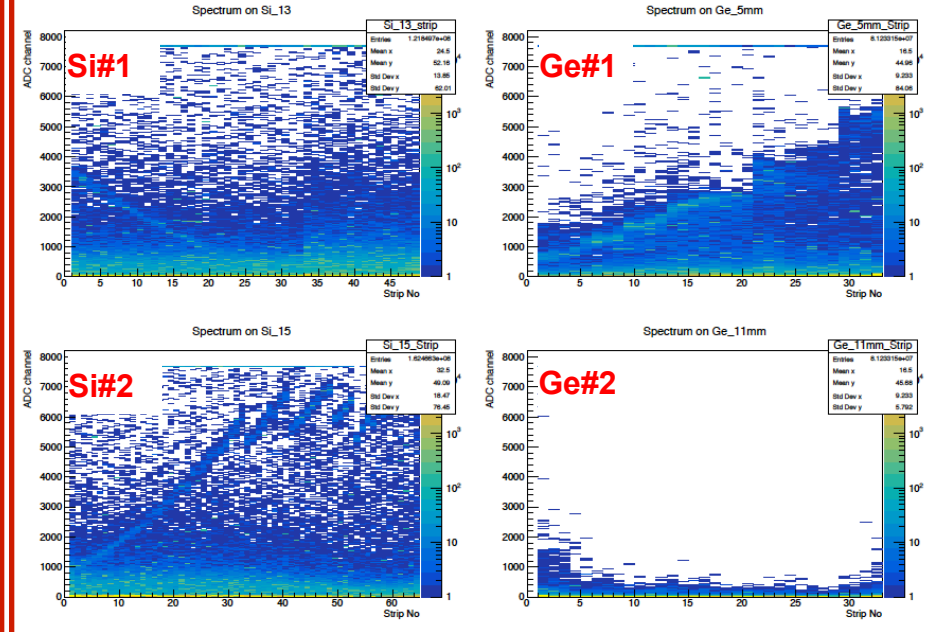
- Acceptance: $0.37^\circ < \theta < 1.2^\circ$
- Position: $z=4.6$ and 4.8 m
- Scintillator: $90 \times 20 \times 6$ (mm)
- Layout: 4x2 layers in 20 cm

CHALLENGE OF VACUUM (MAR. 2019)

Former test

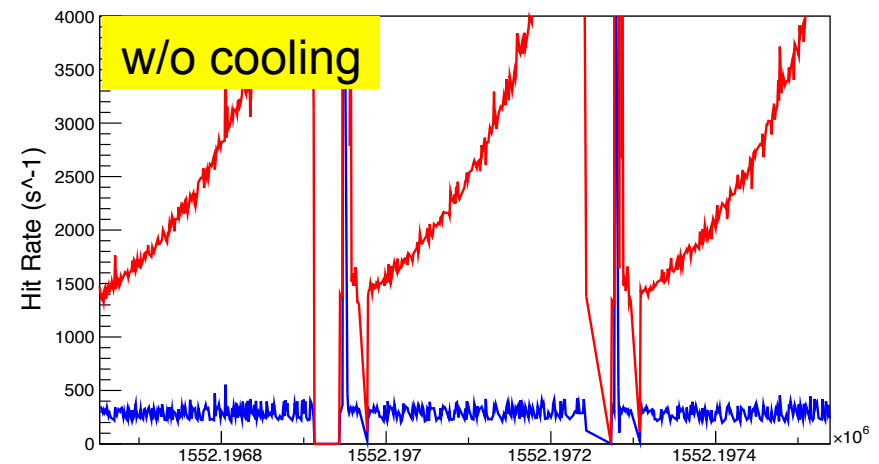
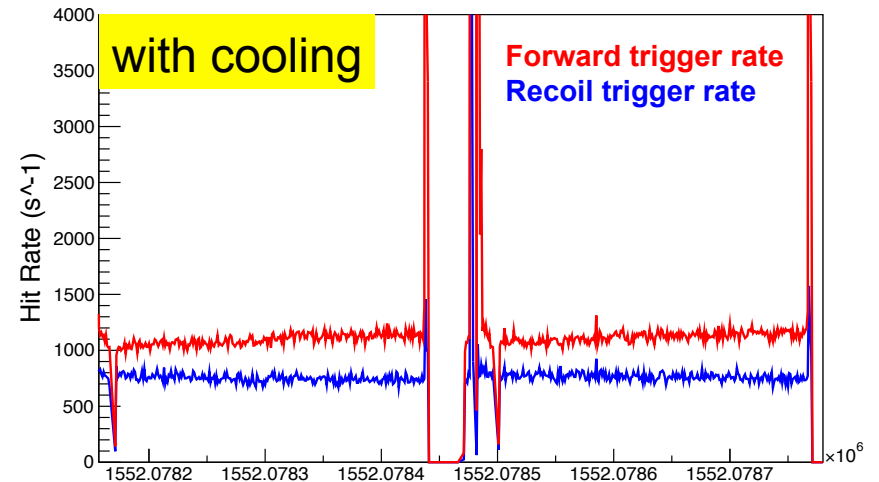
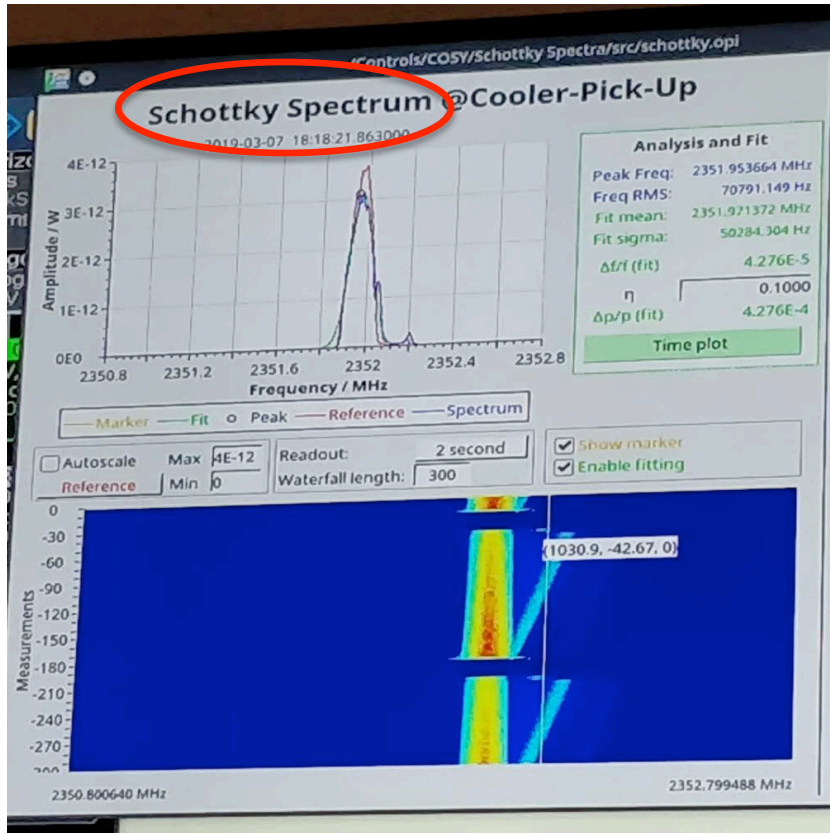


March test



- Vacuum of 10^{-6} mbar but 10^{-8} mbar expected
- High leakage current of Ge (no operation of Ge)
- Improve vacuum, e.g. more pumping power required

CHALLENGE OF BEAM (MAR. 2019)



- Beam cooling is mandatory

PUNCH THROUGH PROBLEM

- Sensitive thickness
 - Ge2, ~56 MeV, 8.86 mm < 11.38 mm (~66.6MeV)
 - Ge1, 28 MeV, 2.6 mm < 5.2 mm (~42.7MeV)
- Fully depleted in principle
 - Bias voltage:
 - 5 mm @ 300V
 - 11 mm @ 900V
- Reason for punch through scenario
 - Diffusion layer is getting thicker
 - Electrical field is not high enough

Recoil Angle [0°, 14.91°]

- Ge2, at 14.91°
 - 69 MeV @ 3.0 GeV/c
 - 63.3MeV @ 2.6 GeV/c
- Ge1 , at 10.67°
 - 35.4 MeV@3.0 GeV/c,
 - 32.3 MeV@2.6 GeV/c