



SHiP

Search for Hidden Particles

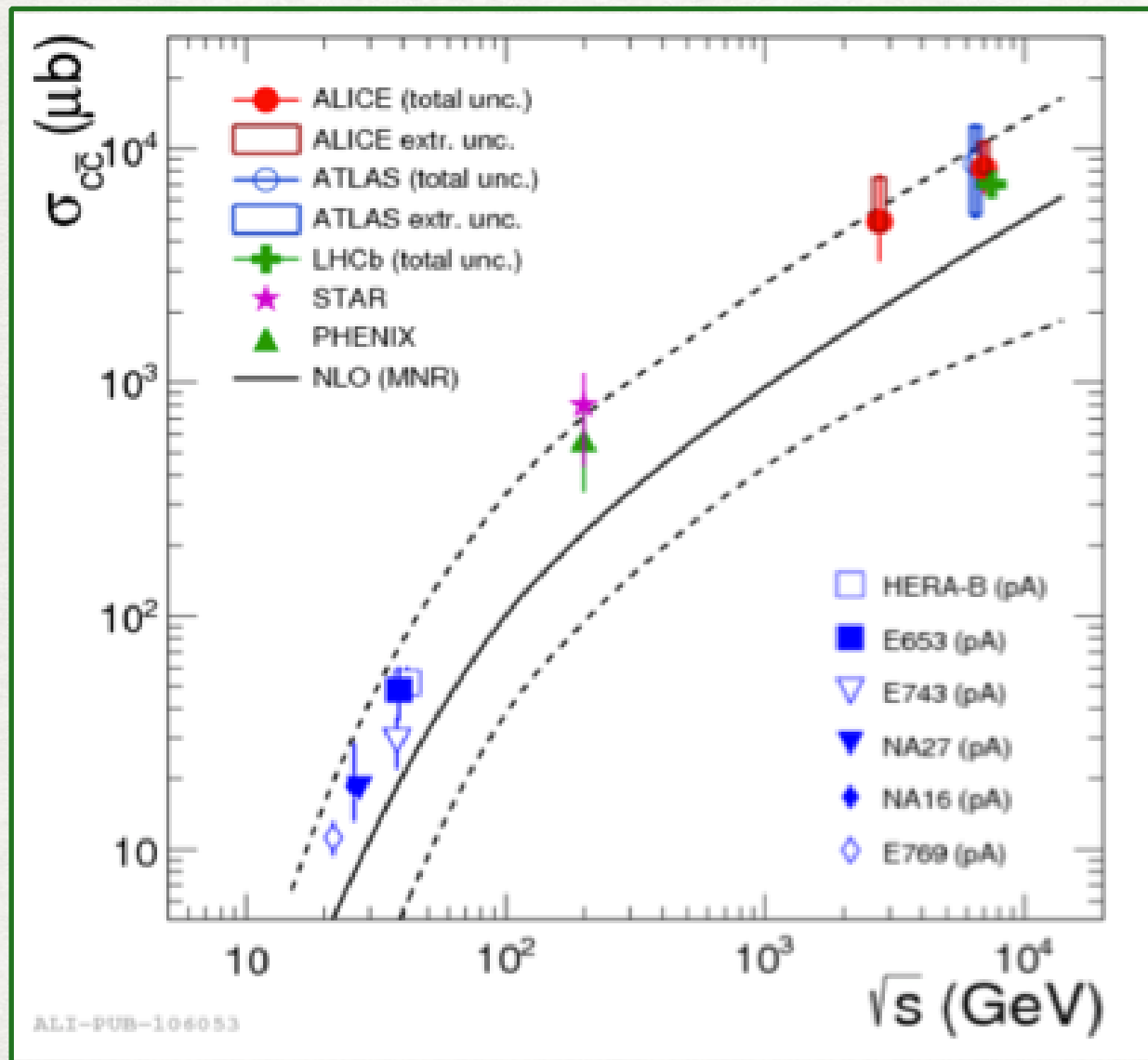
SHIP-CHARM

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SHiP-CHARM PROJECT: Motivation

- Charm production in **proton interactions** and in **hadron cascades** in the SHiP target important for Hidden Sector searches normalization and ν_τ cross-section measurement



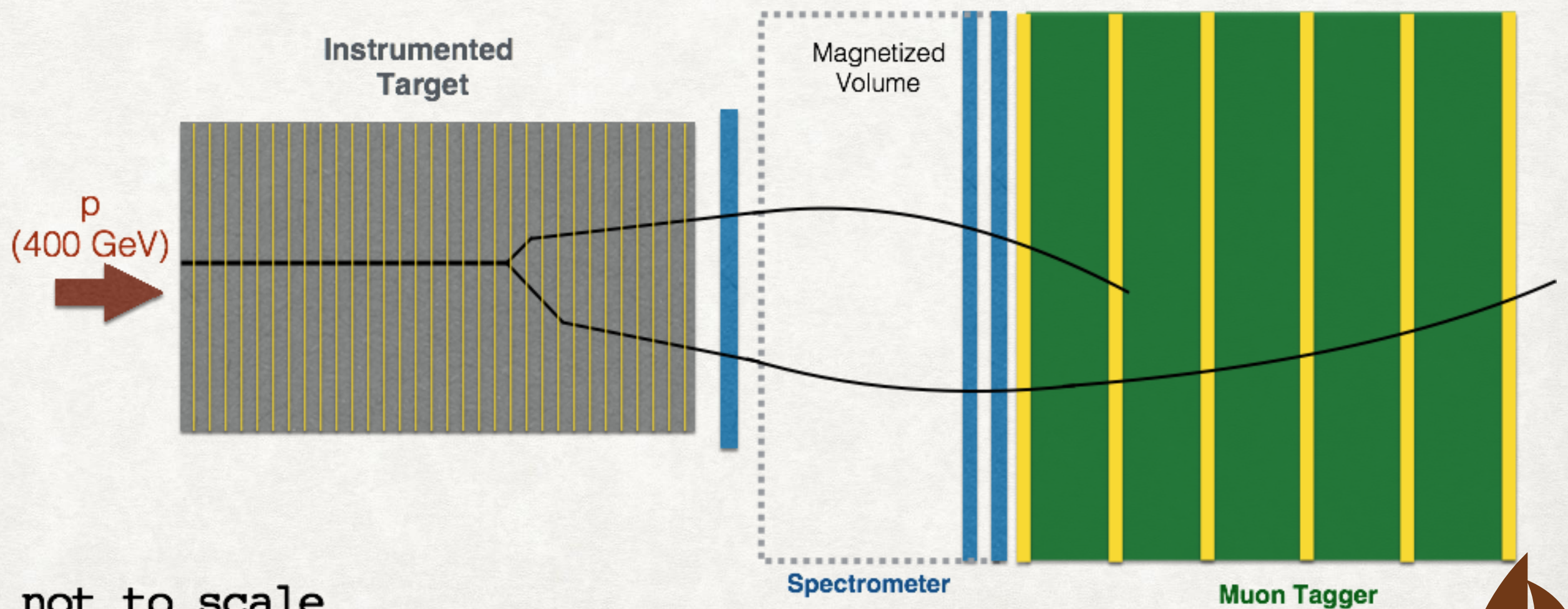
- Inclusive double-charm cross-section measured in NA27 using thin target

	exp NA27
$\sigma[\mu\text{b}]$	18.1 ± 1.7

- Missing information: charm production in **hadron cascades**
- Charm yield from cascade expected 2.3 times larger than prompt contribution

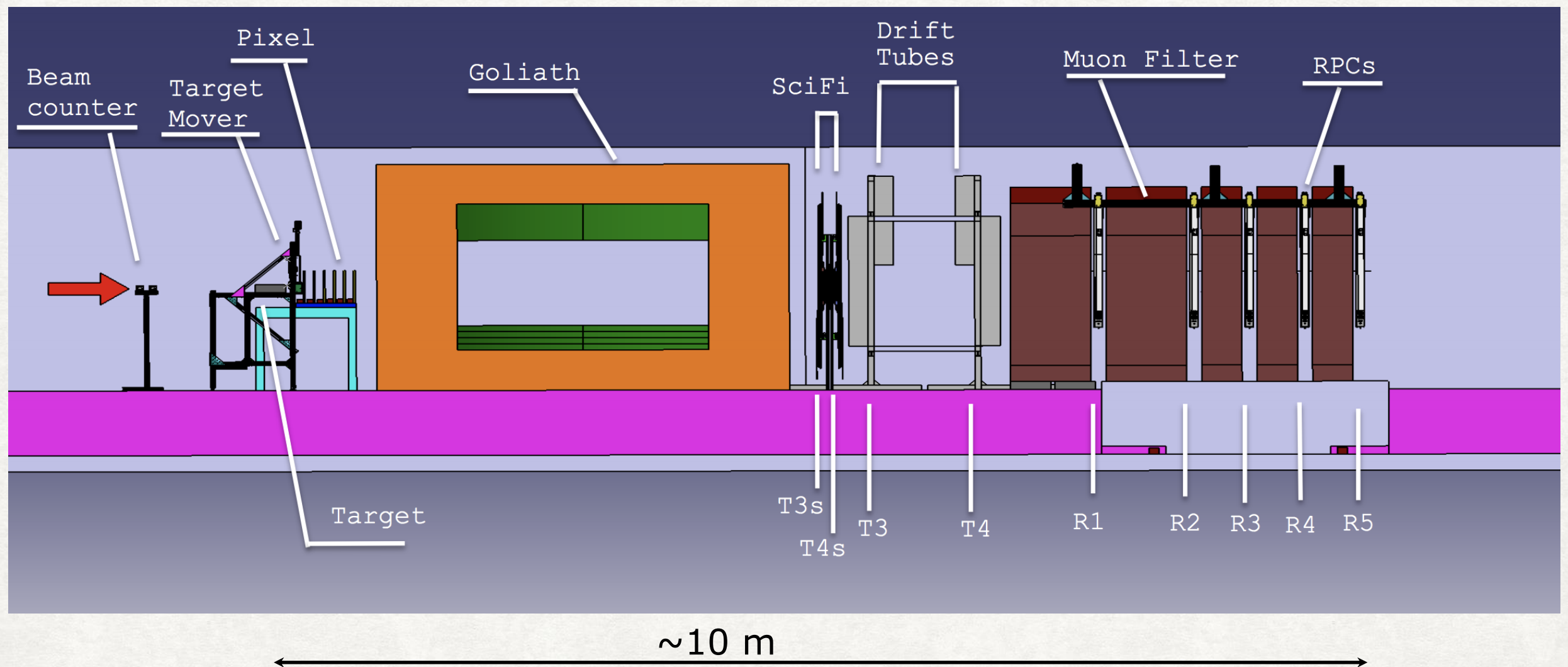
SHiP-CHARM PROJECT: Conceptual design

- ▶ **Double-differential** cross-section measurement ($d^2\sigma/dEd\theta$)
- ▶ Proton collisions in Mo/W target instrumented with **nuclear emulsions**
- ▶ **Nuclear emulsions** as tracking detector
 - identification of hadronic and leptonic charm decay modes
 - volume of sensitive layers \ll target volume
- ▶ Charm daughters charge and momentum by a dedicated **Spectrometer** based on silicon pixel detectors, Scintillator fibers and drift tubes
- ▶ Muon identification with a **Muon Tagger** based on RPC

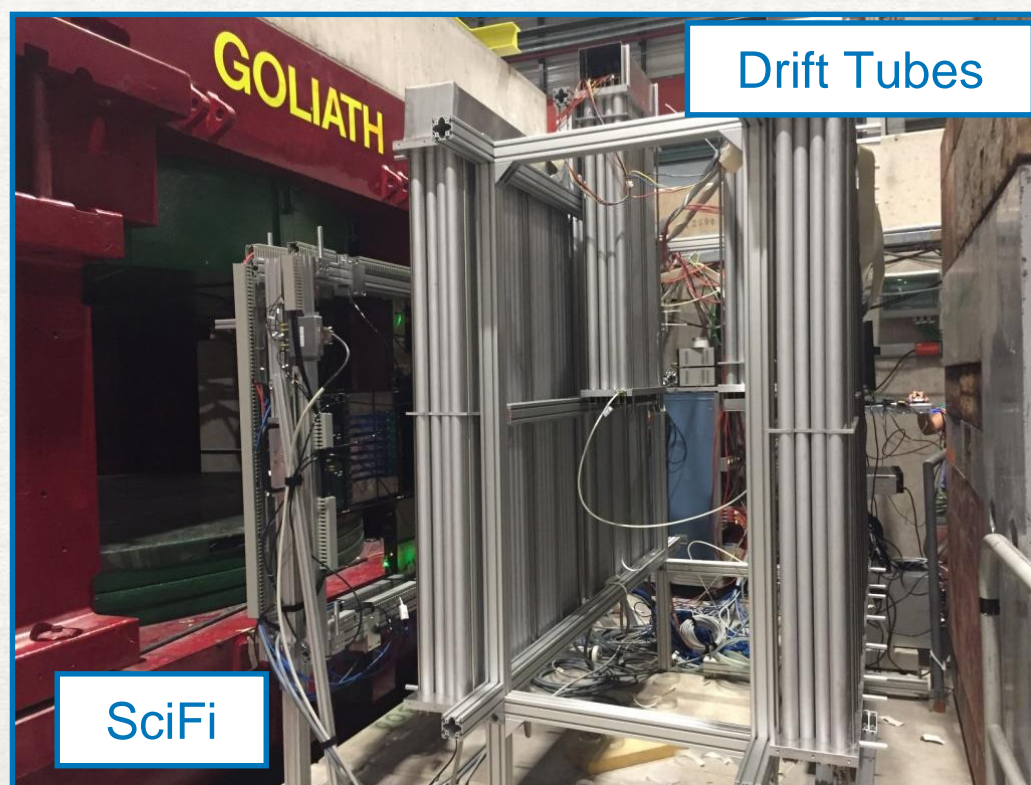
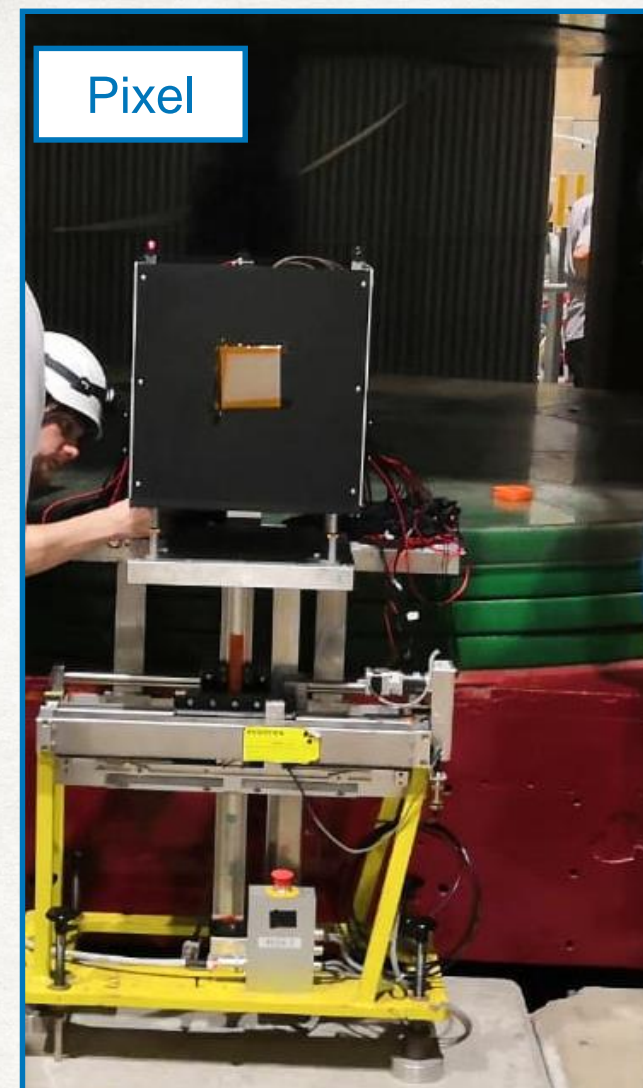
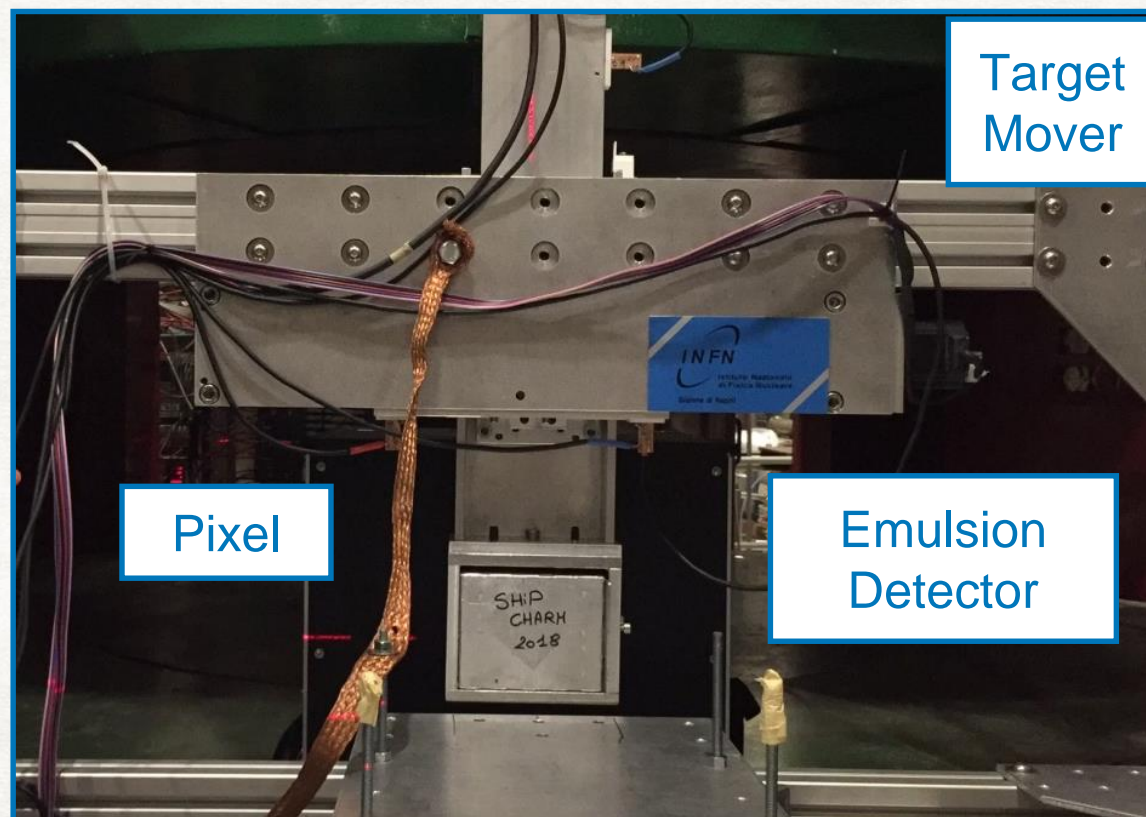


EXPERIMENTAL SETUP

- **Lead target**, $12 \times 10 \text{ cm}^2$ Pb blocks (few cm) interleaved with emulsion to identify charm topology
- **Spectrometer** to measure momentum and charge of the charm daughters
- **Muon tagger** to identify muons

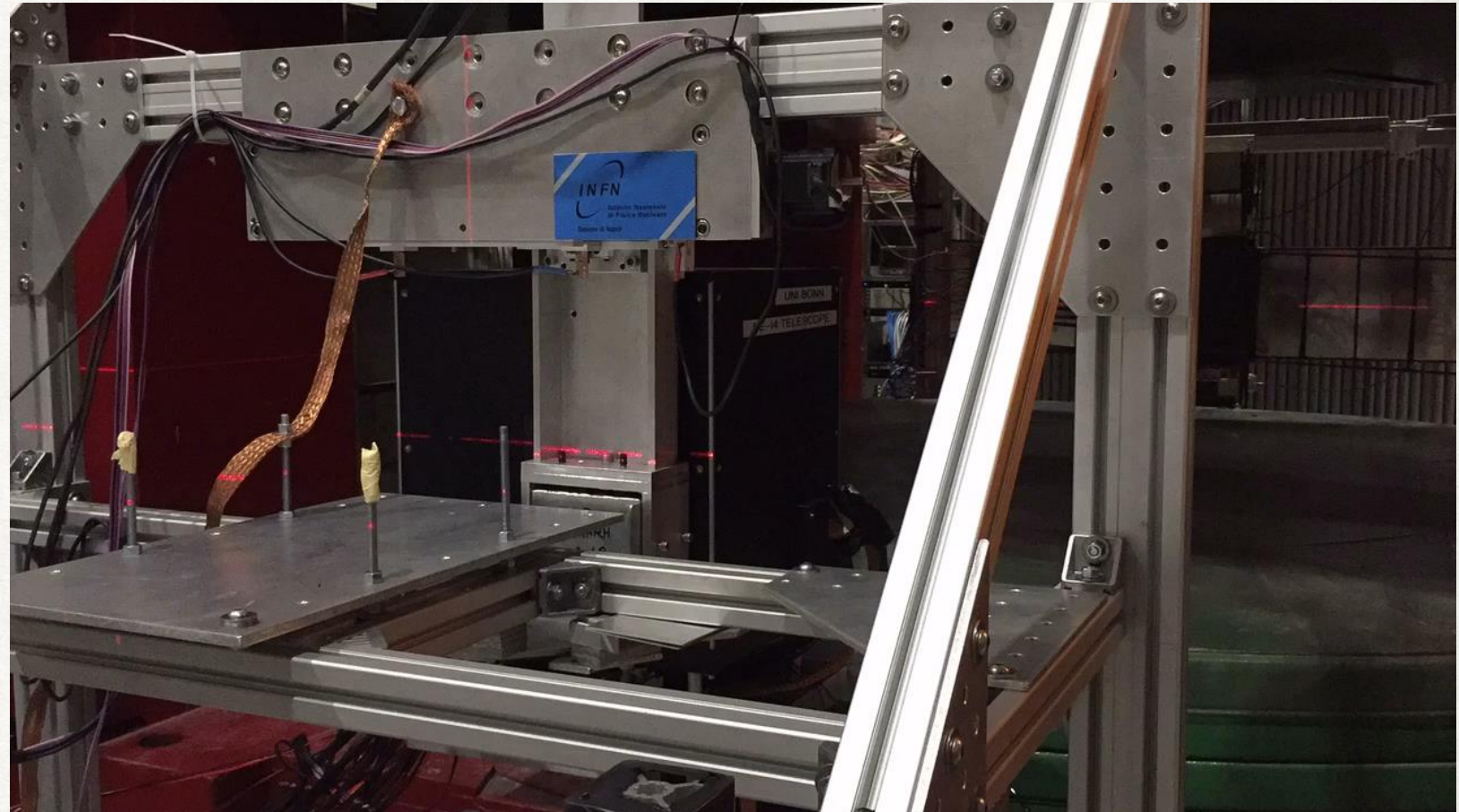
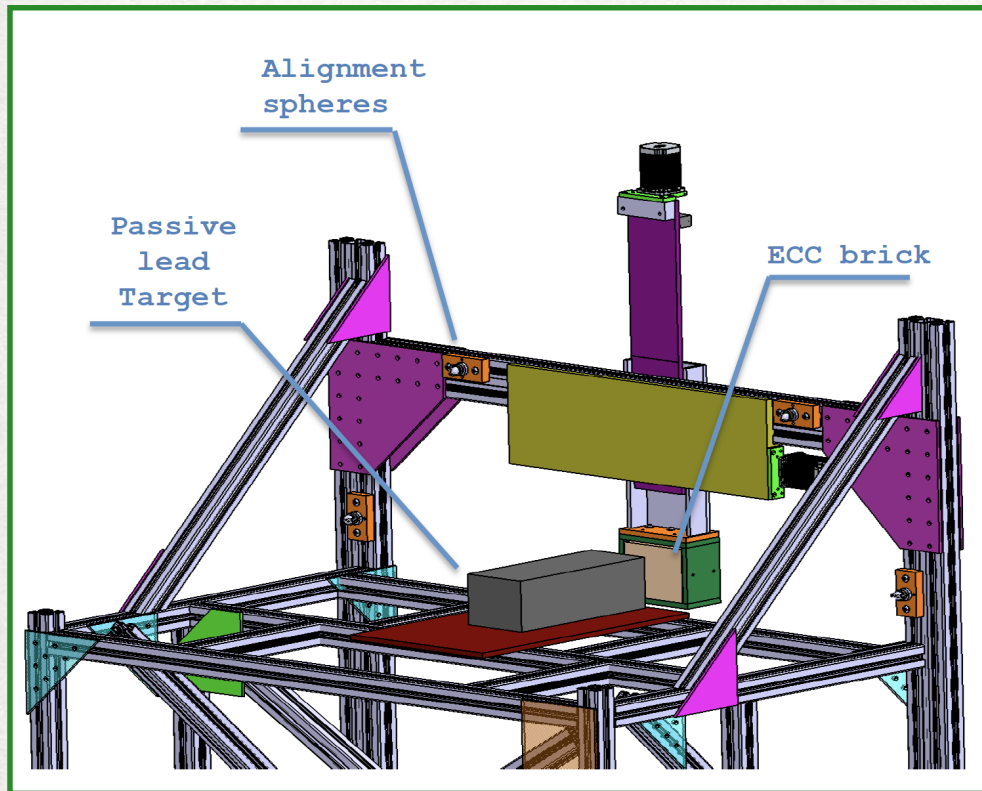


EXPERIMENTAL SETUP



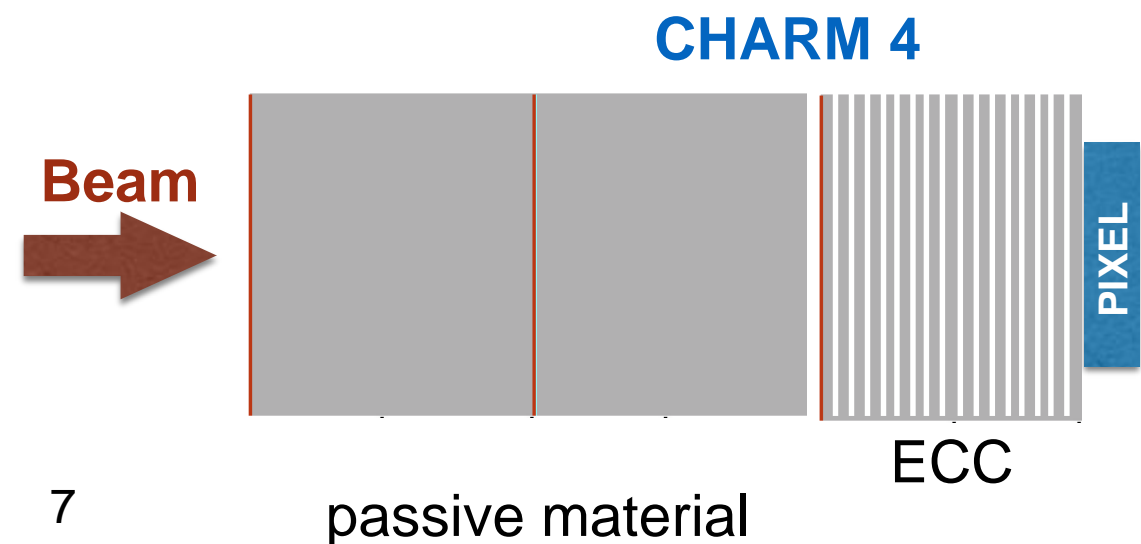
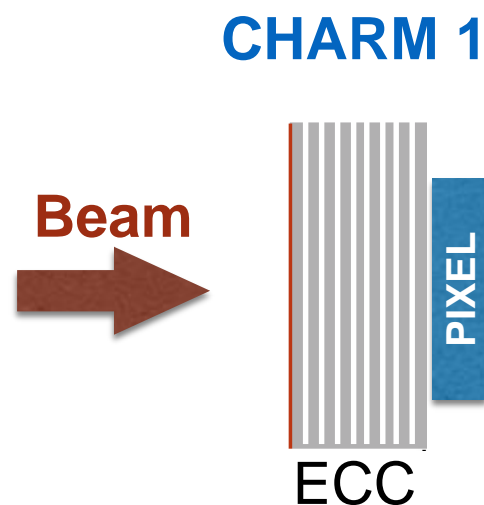
MOVING TABLE & ECC TARGET

- ▶ Target mover to have protons uniformly distributed on the emulsion films
- ▶ Design:
 - ▶ shift along x axis during the spill (26 mm/s)
 - ▶ Shift along y axis in the inter-spill



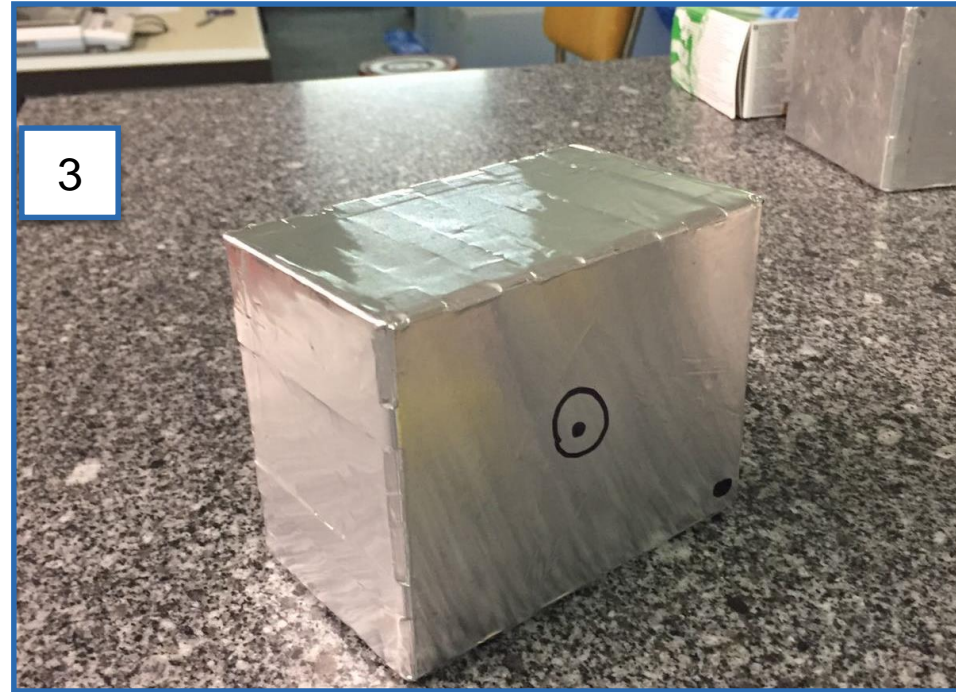
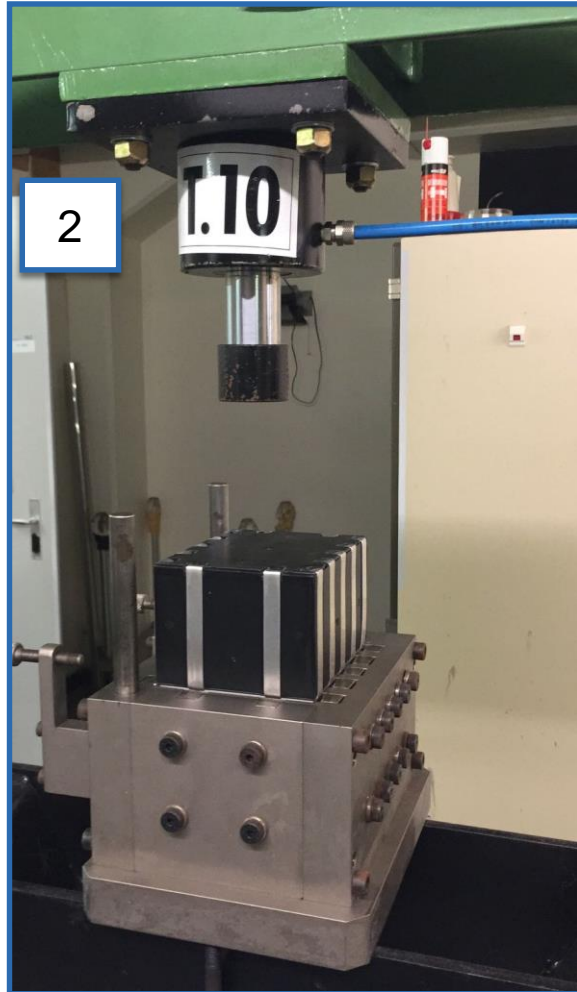
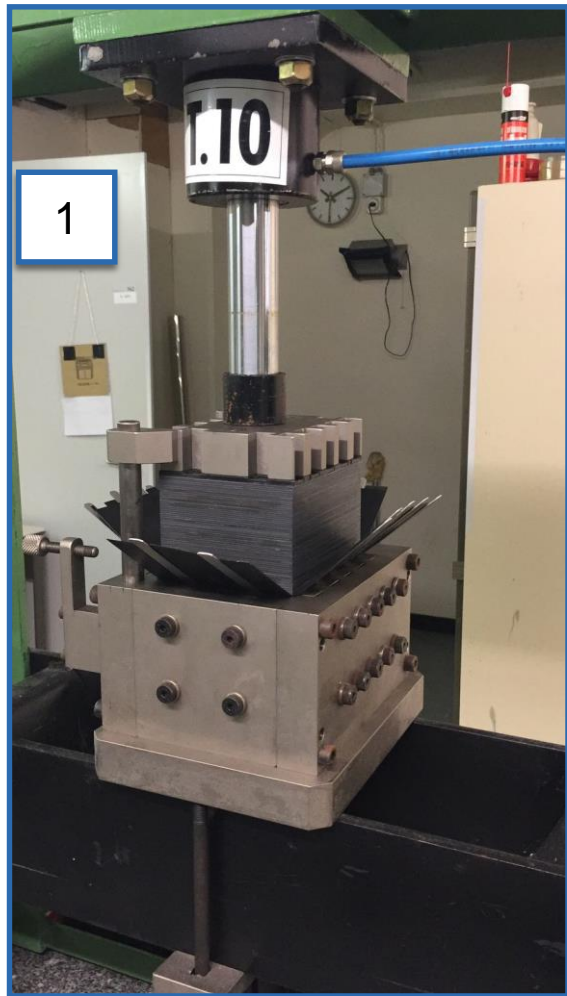
EXPOSURE SUMMARY

Configuration	# OF RUNS	Passive material	Emulsion Cloud Chamber	# Emulsion Films
CHARM 1	x6	-	28 mm lead + 29 emulsion films	174
CHARM 2	x6	28 mm lead	28 mm lead + 29 emulsion films	174
CHARM 3	x3	56 mm lead	56 mm lead + 57 emulsion films	171
CHARM 4	x3	2x56 mm lead	56 mm lead + 57 emulsion films	171
CHARM 5	x3	3x56 mm lead	56 mm lead + 57 emulsion films	171
CHARM 6	x3	4x56 mm lead	56 mm lead + 57 emulsion films	171
TOTAL	24			1032



BRICK ASSEMBLY

- Brick Assembly Machine (BAM) in dark room in CERN (Meyrin Site)



TIMELINE

- Sunday 22nd: tuning of the beam for vertical shift
- Tuesday 24th/Wednesday 25th:
 - deinstallation of mu-flux setup and installation of charm production setup
 - assembling of emulsion/lead bricks in dark room
- Thursday 26th: safety inspection, beam tuning (I), survey (I)
- Friday 27th: survey (II), test of sub-detectors
- Saturday 28th- Sunday 29th: no beam
- Monday 30th: tuning of the beam (II), data taking with emulsions
- Tuesday 31st: data taking with electronic detectors only, de-installation
- Wednesday 1st (morning): removal of detectors from experimental area
- Wednesday 1st - Sunday 5th: development of nuclear emulsion in dark room

BEAM REQUIREMENTS:

- 10^4 /spill
- 1 cm FWHM along y
- Vertical shift of 1 cm to center the holes in the Muon Filter



CONCLUSIONS

- 43 shifters/experts
- Charm cross section measurement completed
- Expected fully reconstructed charm-pairs: ~ 150
- A big THANK YOU to:
 - Our fabulous colleagues from RP and EN for their advice, help and enthusiasm
 - All shifters and experts for their enthusiasm and help to make this measurement possible!

Full data taking after LS2: ~ 1000 fully reconstructed charm pairs

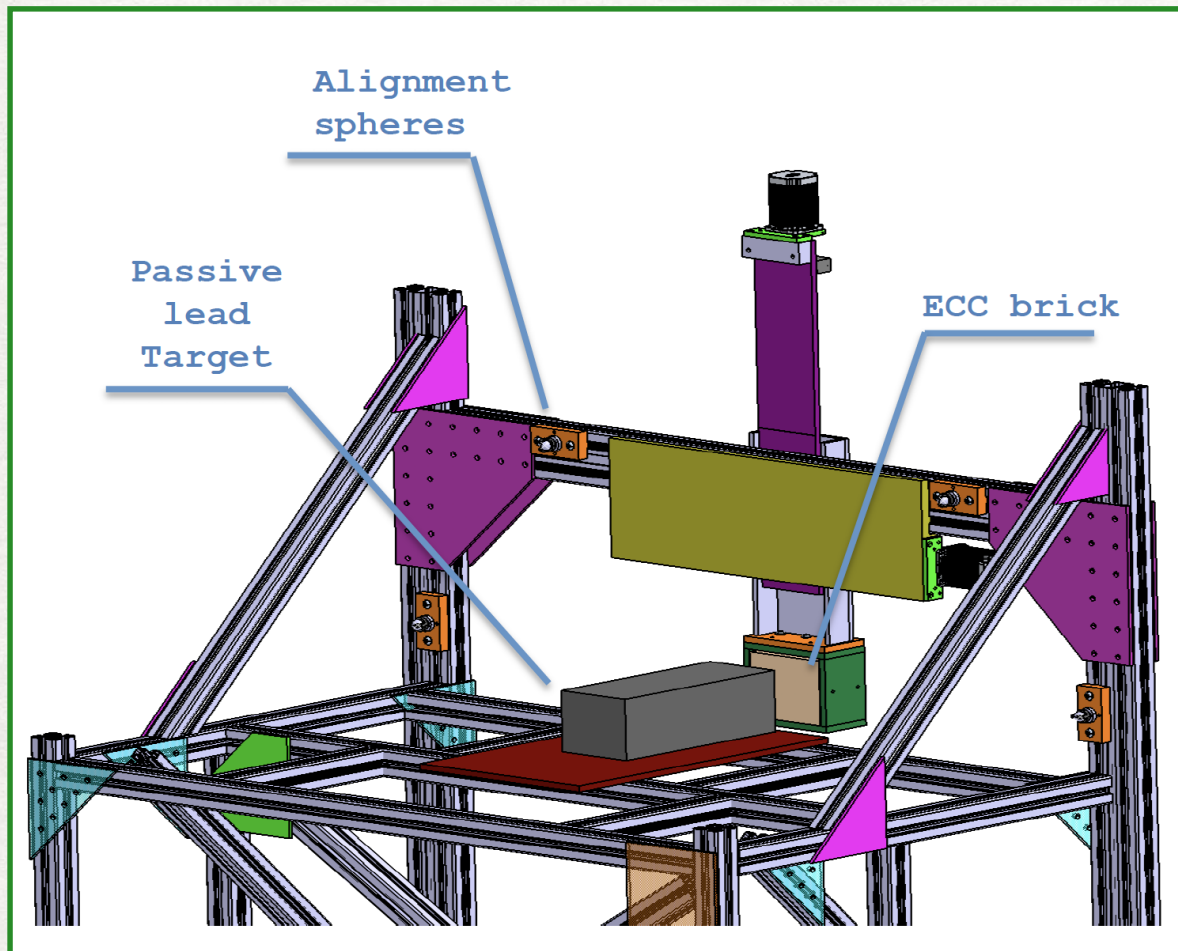


BACK-UP SLIDES



ECC TARGET

- ▶ Target mover to have protons uniformly distributed on the emulsion films
- ▶ Design:
 - ▶ shift along y axis during the spill
 - ▶ Shift along x axis in the inter-spill



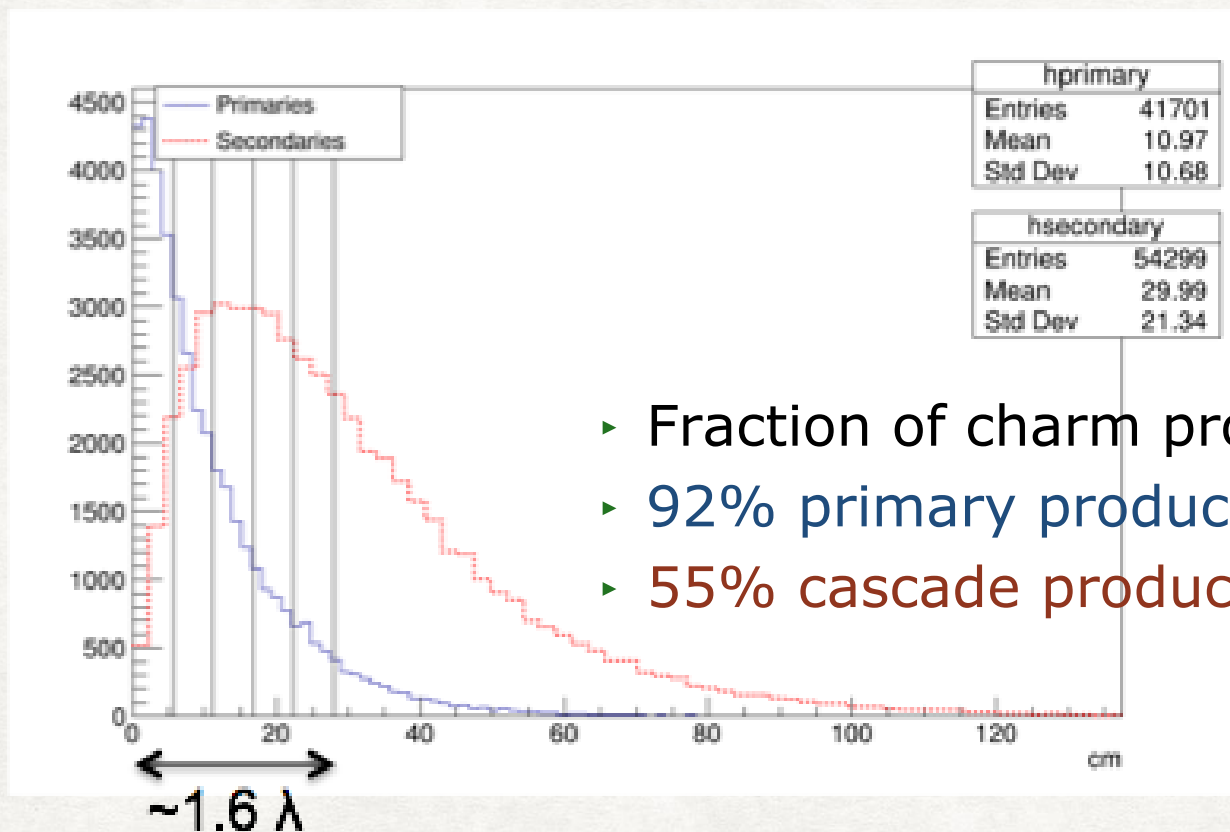
2018 EXPOSURE PLAN

- ▶ Maximum track density in emulsion films: $10^3/\text{mm}^2$
- ▶ Emulsion surface available in July 2018: 10 m^2
- ▶ ~20 ECC bricks exposed to proton beam with maximum intensity 10^4 pot/spill
- ▶ Fully reconstructed charm-pairs: ~150

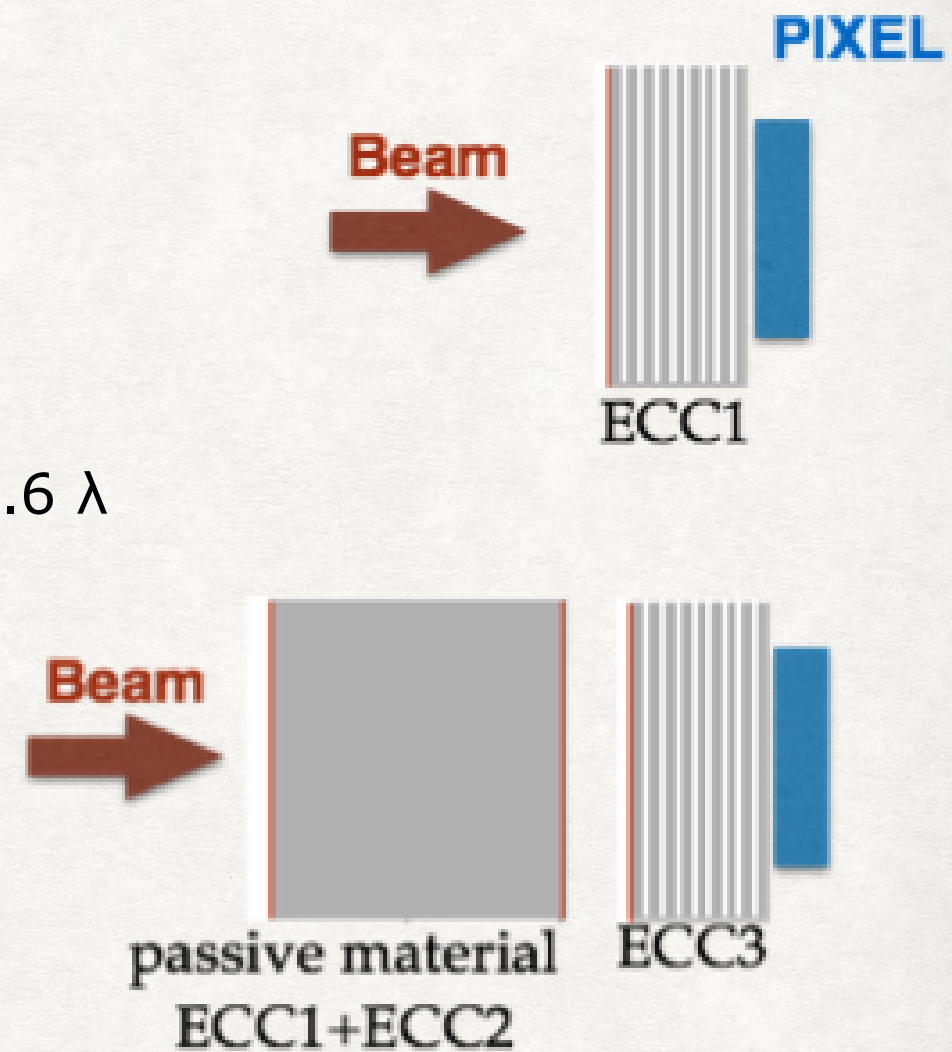
Full data taking after LS2: ~1000 fully reconstructed charm pairs

EXPOSURE CONFIGURATION

- ▶ Target material: lead
- ▶ Instrumentation of $\sim 1.6 \lambda$ to study charm production in **primary interactions** and **hadron cascades**



- ▶ Fraction of charm produced in $\sim 1.6 \lambda$
- ▶ 92% primary production
- ▶ 55% cascade production



- ▶ Instrumentation of $\sim 1.6 \lambda$ allows the study of a large fraction of charmed hadrons
- ▶ Six Emulsion Cloud Chambers (ECC)
- ▶ ECC is the most downstream target part to let charm daughters reach the spectrometer
- ▶ Target modules retained upstream of the ECC