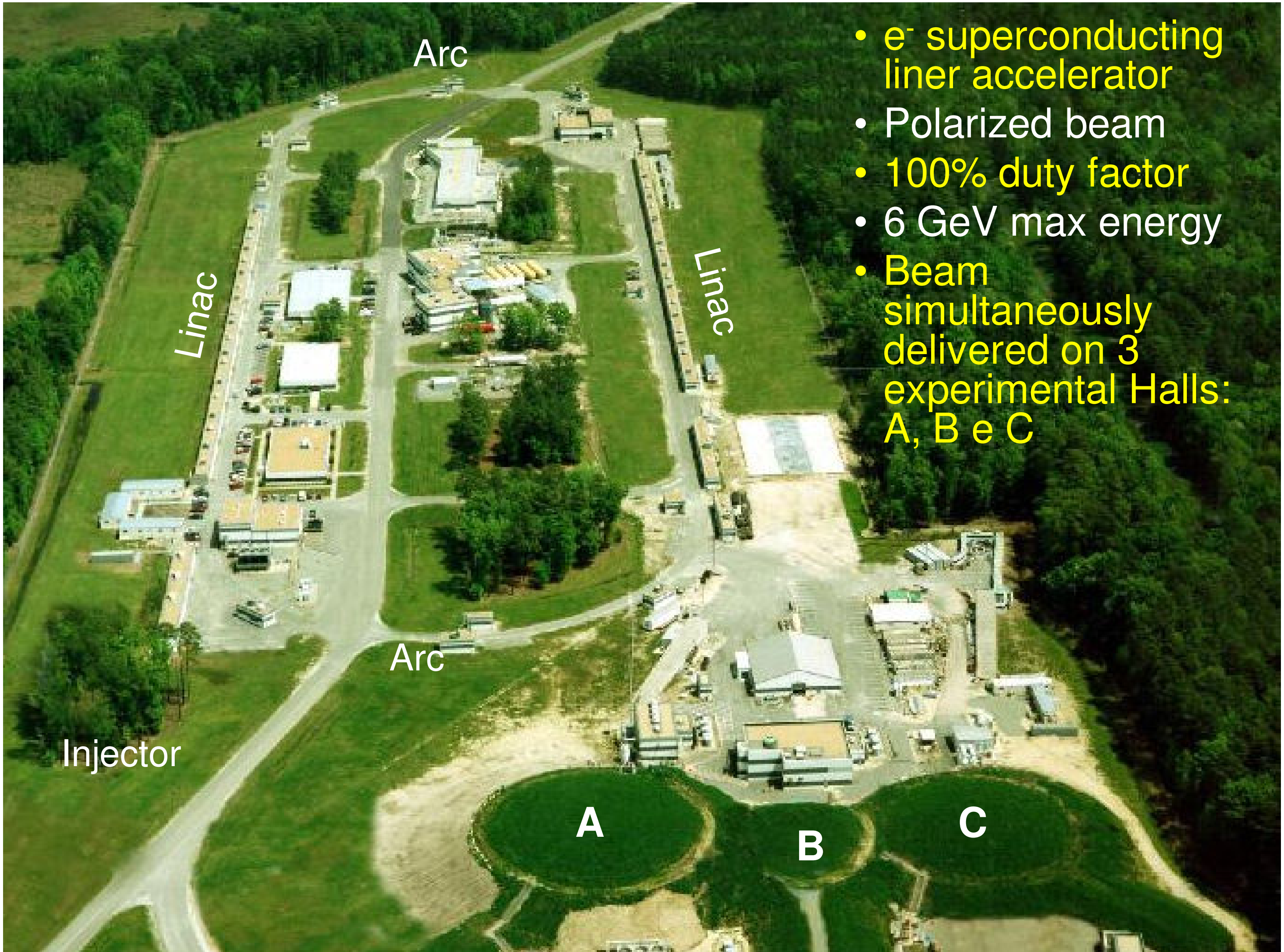
WG2 / RD51 Collaboration Meeting
CERN : 24/Nov/2009

Status of the Front Tracker development for the new SBS spectrometer at JLab

Evaristo Cisbani / INFN-Rome Sanità Group

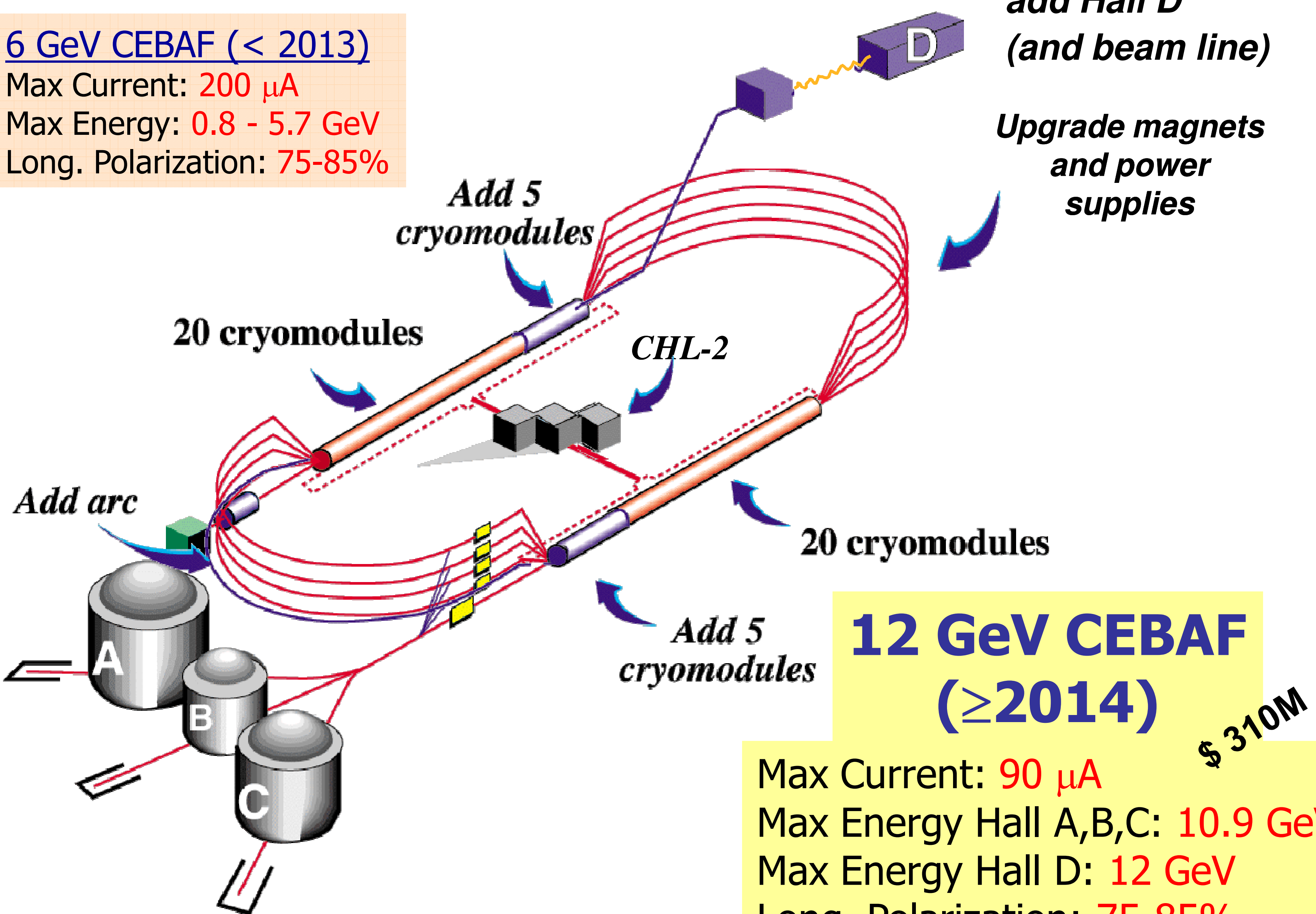
CEBAF accelerator today (2009)



- e⁻ superconducting liner accelerator
- Polarized beam
- 100% duty factor
- 6 GeV max energy
- Beam simultaneously delivered on 3 experimental Halls: A, B e C

CEBAF accelerator in 2014

<u>6 GeV CEBAF (< 2013)</u>
Max Current: 200 μA
Max Energy: 0.8 - 5.7 GeV
Long. Polarization: 75-85%



12 GeV CEBAF (≥2014)

Max Current: 90 μA
Max Energy Hall A,B,C: 10.9 GeV
Max Energy Hall D: 12 GeV
Long. Polarization: 75-85%

Asymptotic Freedom

Small Distance
High Energy

Perturbative QCD
DIS Scattering
Parton models

Confinement

Large Distance
Low Energy

Strong QCD
Spectroscopy
Phenomenological Models

+ Test Standard Model

$$\sigma \sim \mathbf{QED} \otimes \mathbf{QCD}$$

JLab offers:

- High luminosity
- Polarization (initial and final states)
- High beam stability
- Complementary Equipments
- Dedicated, optimized detectors

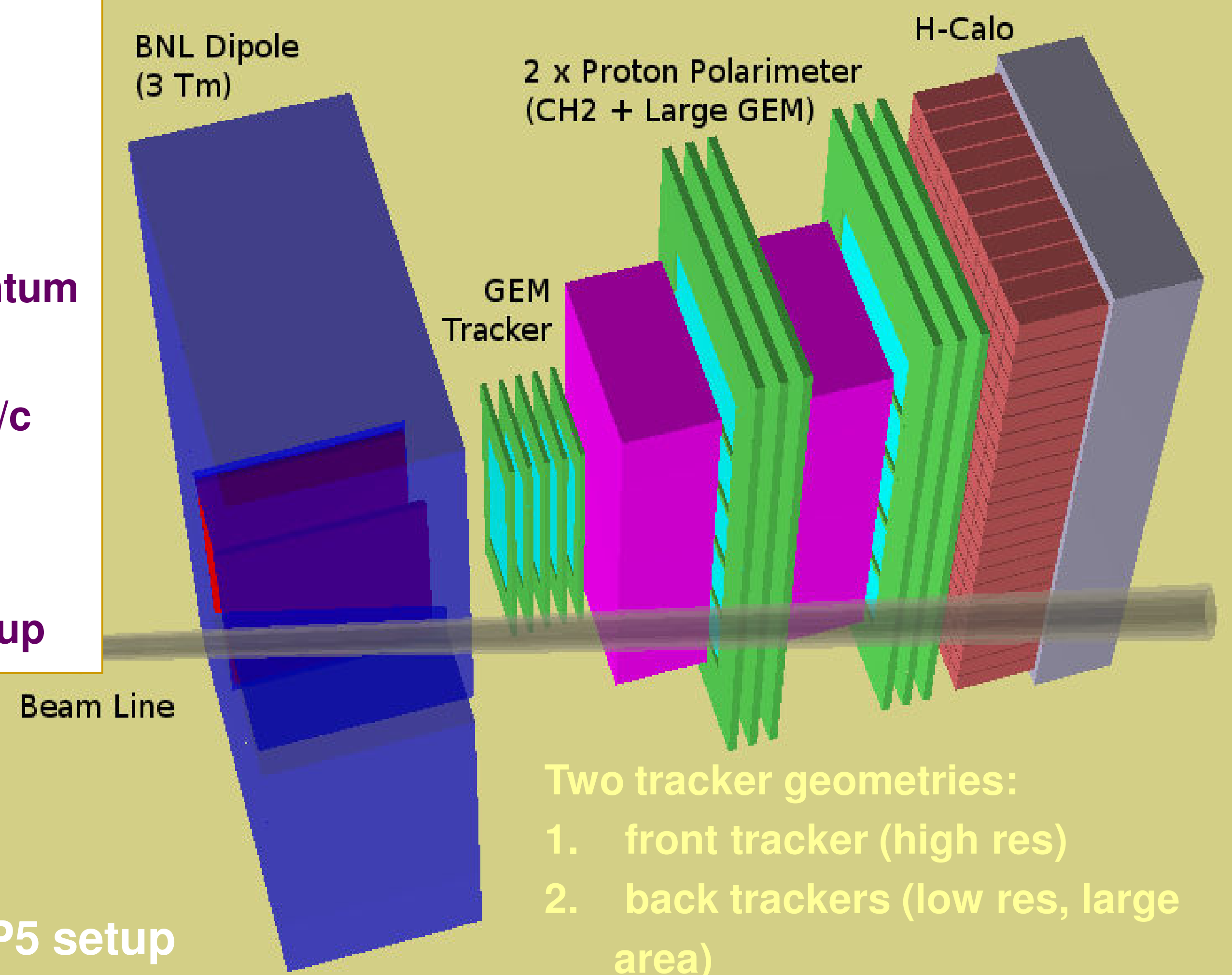
www.jlab.org

New SBS Spectrometer @ JLab 12 GeV

- **High Luminosity: 10^{38} /cm^2/s**
- **Support high background: 400 kHz/cm^2 (low energy photons mainly)**
- **Forward angle**
- **Large acceptance**
- **Good angular and momentum resolutions: 0.2 mrad, 0.5% @ 4-8 GeV/c**
- **Flexibility: use the same detectors in different experimental setup**

Ready in 2013
⇓
minimize development

hallaweb.jlab.org/12GeV/SuperBigBite/



GEP5 setup

Two tracker geometries:
1. **front tracker (high res)**
2. **back trackers (low res, large area)**

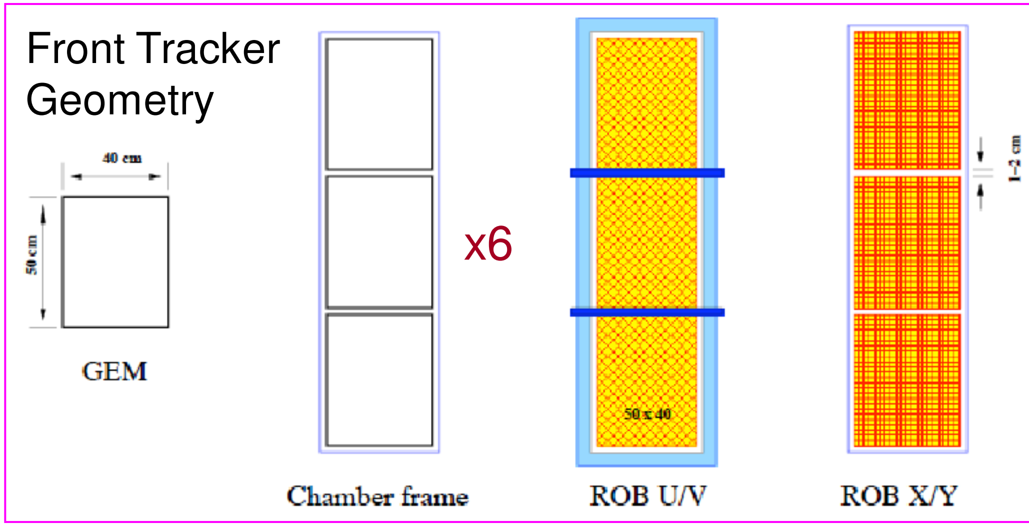
SBS Tracking Requirements

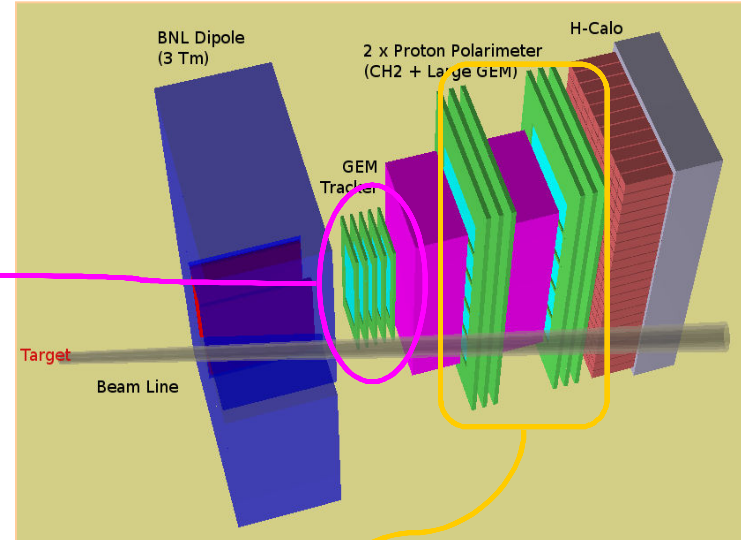
Requirements	Tracking Technology		
	Drift	**MPGD**	Silicon
High Rate (up to): **0.50 MHz/cm^2**	NO	**MHz/mm^2**	**MHz/mm^2**
High Resolution (down to): **<100 μm**	Achievable	**50 μm**	30 μm
Large Area: 40x150 and 50 x 200 cm^2 (+ minimize dead area)	YES	**Doable**	Very Expensive

… and modular: reuse in different geometrical configuration

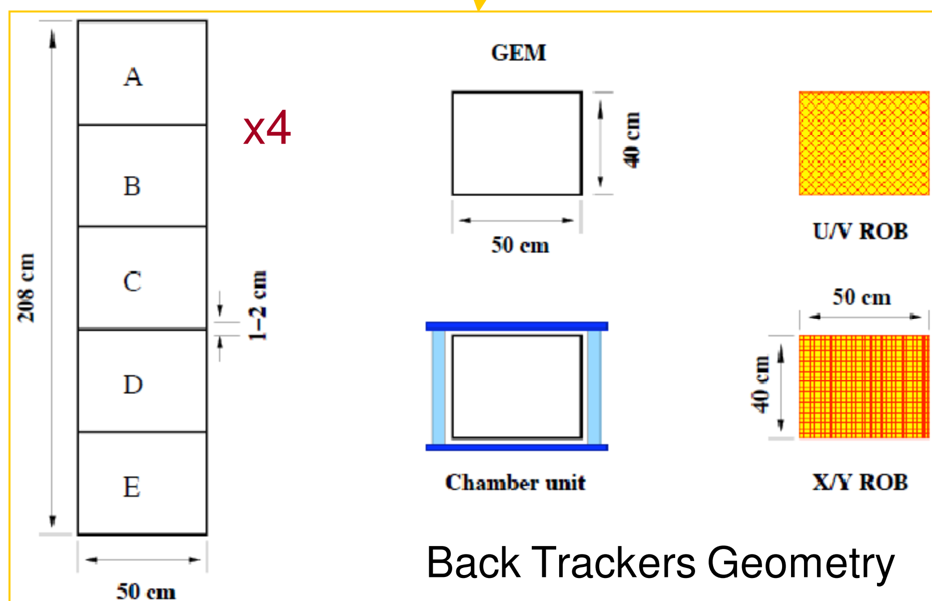
Flexibility in readout geometry ⇒ GEM

Large area GEM Chambers

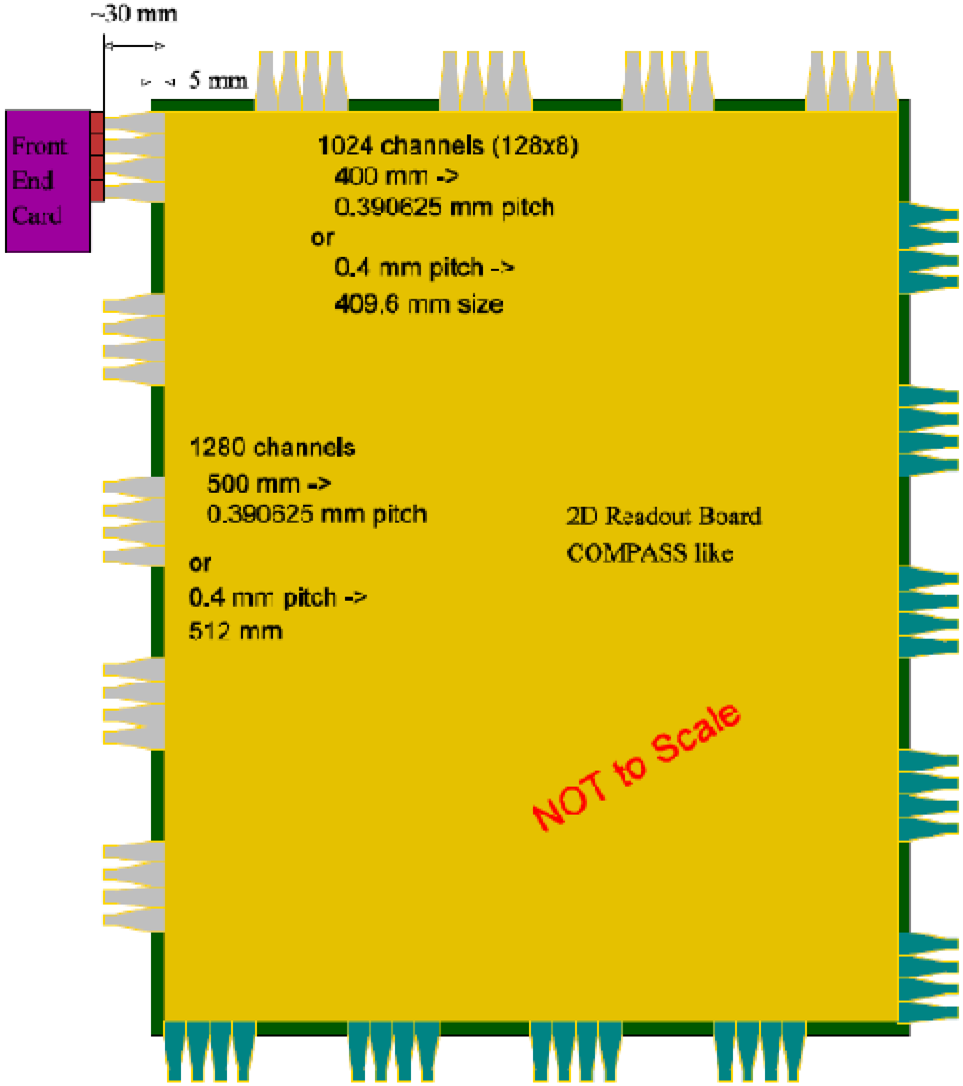




- ✓ **Single Module: 40x50 cm^2 "standard" 3-GEM foil**
- ✓ **Chamber combination of 3 or 5 adjacent modules**
- ✓ **Both x/y and u/v 2D (a la COMPASS) readout strips**
- ✓ **Electronics on the side (cyan) or beyond the dead areas (blue) at 90° degree**
- ✓ **About 50000 channels**



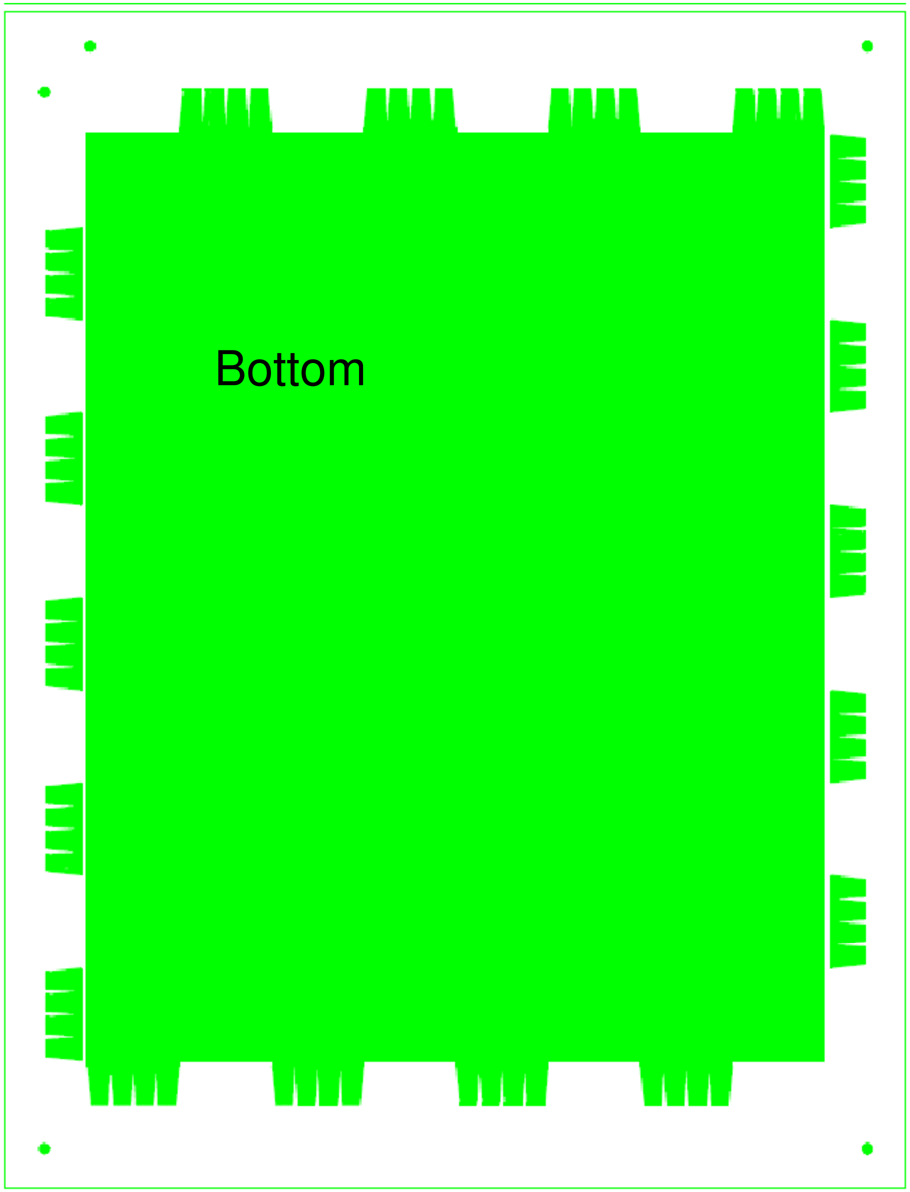
Readout Plane and ZIF extension

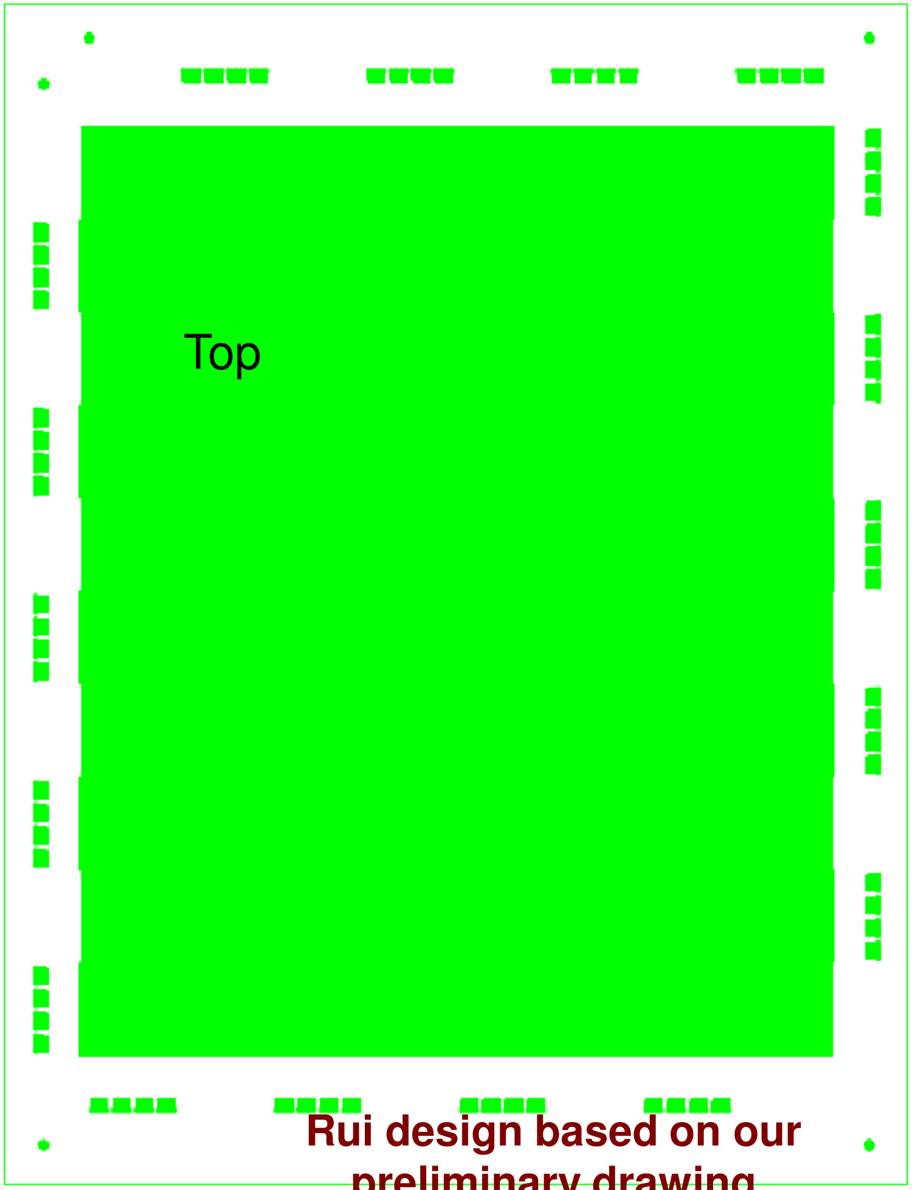


- Readout along all sides
  - not strictly required in x/y unless additional segmentation of the readout plane
  - unavoidable in diagonal u/v
- Extension feeds into ZIF connectors:
  - no soldering on the readout foil
  - permit safer bending
- Small frame width (8 mm);
  minimize dead are

- Require precise cutting around the ZIF terminals

Readout layers and ZIF extension

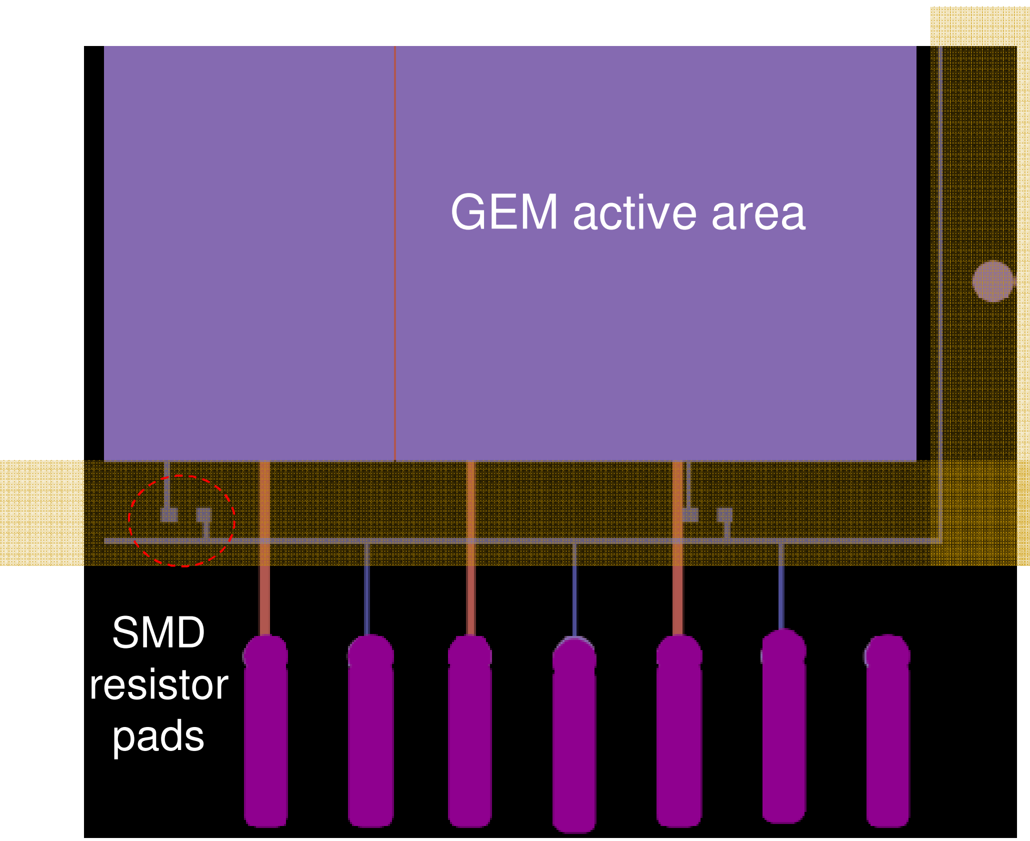


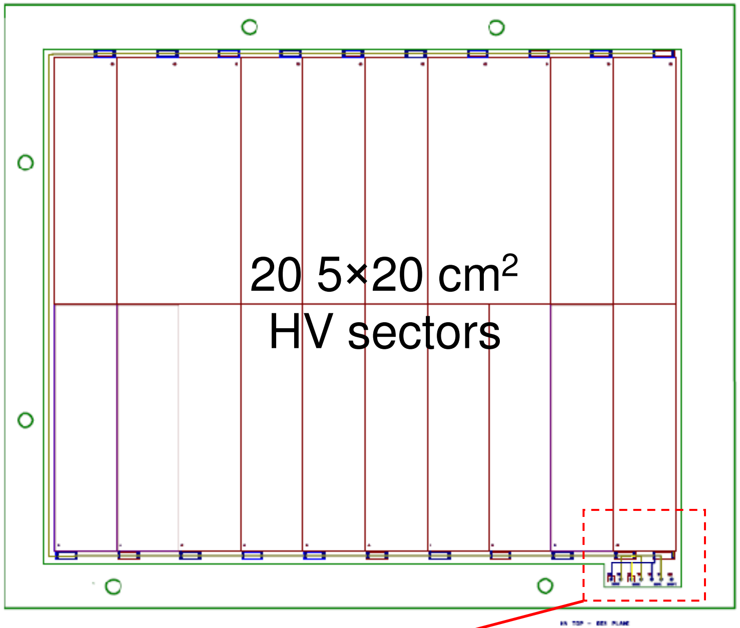


Rui design based on our preliminary drawing

Detail of the HV distribution

- 3 HV identical doublets + 1 for drift (same on all GEM foils); each doublet serves one GEM foil, unused will be cut.
- SMD protection resistors, under the permaglas frame



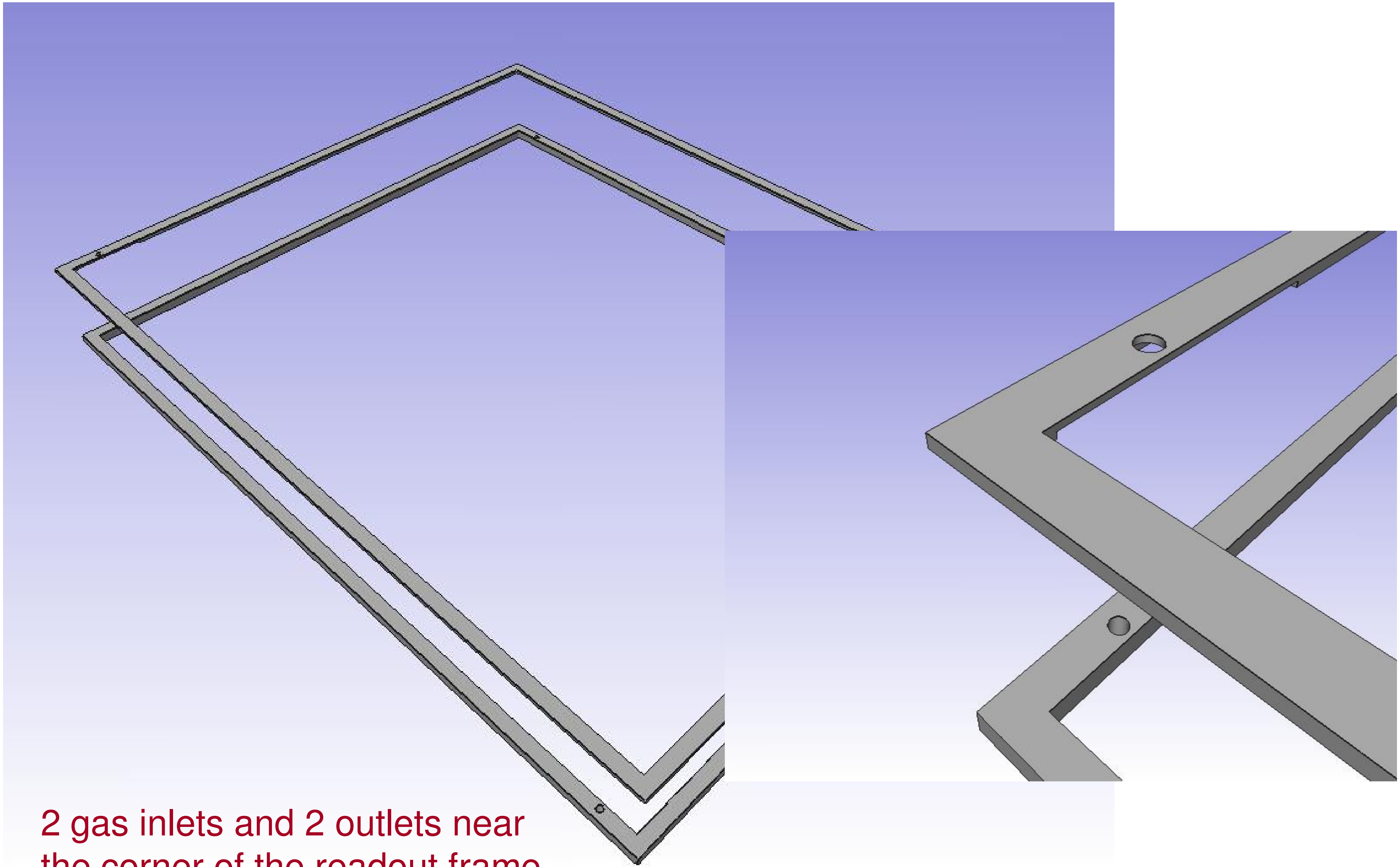


Permaglas frame

Plan to use the HV modules from Corradi/Murtas

Rui design based on our preliminary drawing

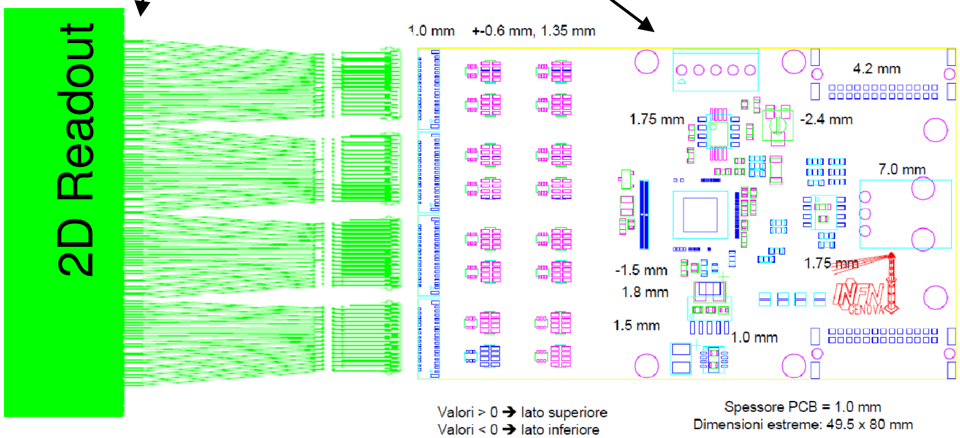
GAS distribution detail



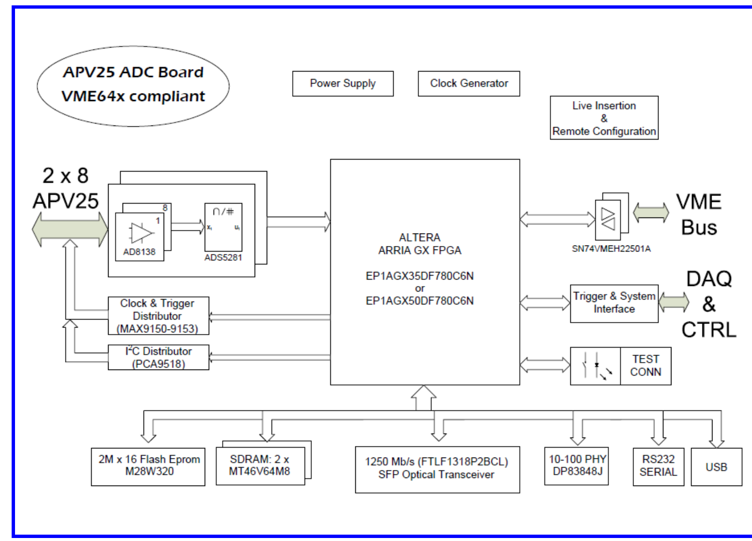
2 gas inlets and 2 outlets near the corner of the readout frame, serving all gaps.

Electronics Components

GEM ⇒ FEC ⇒ ADC+VME Controller ⇒ DAQ



Up to 10 m



Main features:

- Use APV25 chips (wire-bounded on standard PCB, no ceramics)
- ZIF connector on the GEM side (no soldering on readout foil)
- Minimum electronics components
- Compliant to JLab DAQ (use VME64x custom modules)

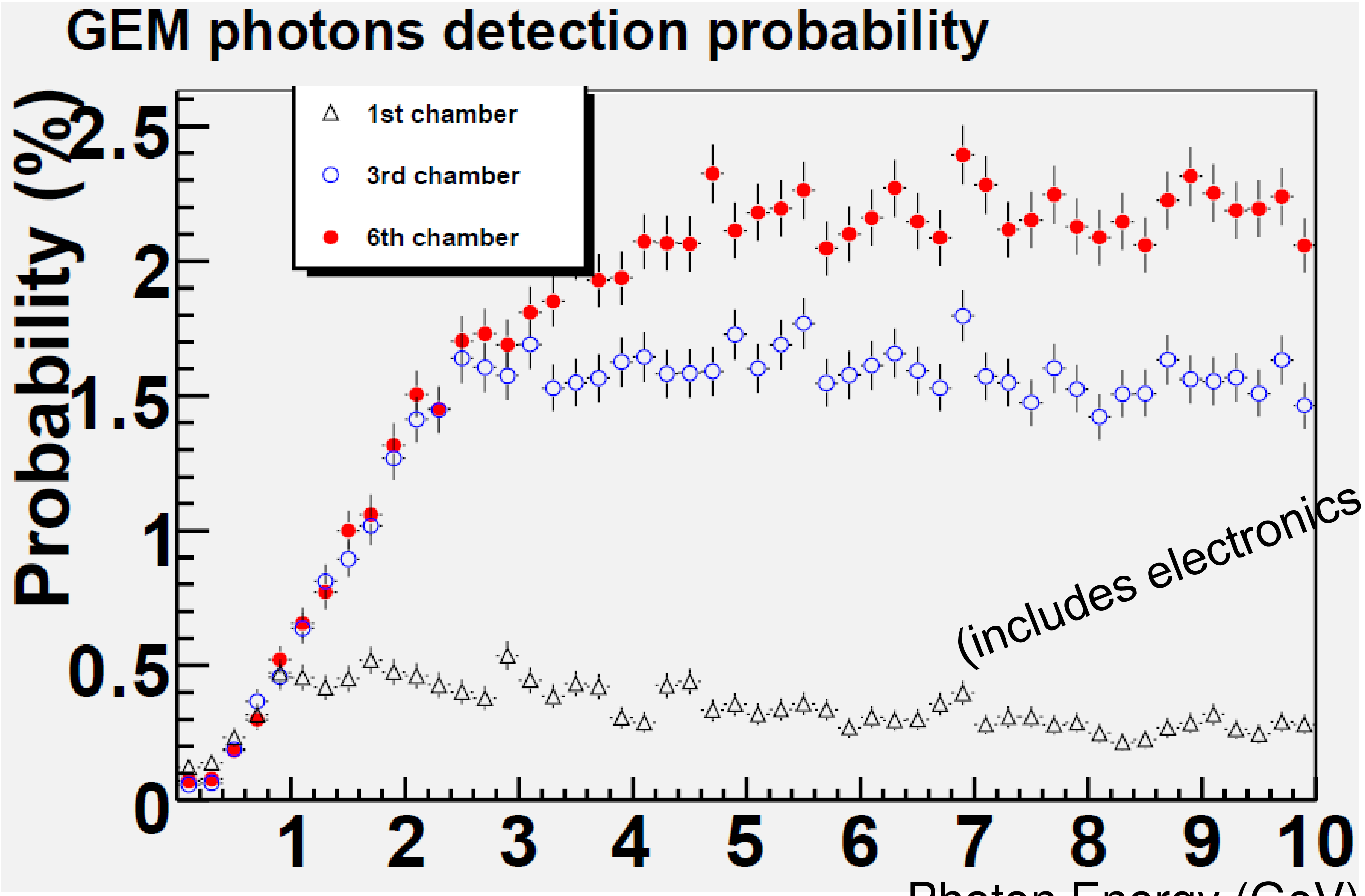
First Front-End Cards prototypes ready this week

Thanks to Michael Böhmer and Igor Konorov for very productive discussions on the design of the APV25 based FrontEnd card

MC: Photon detection probability

Photons are the main source of background

1st – 6th chambers distance ~60 cm



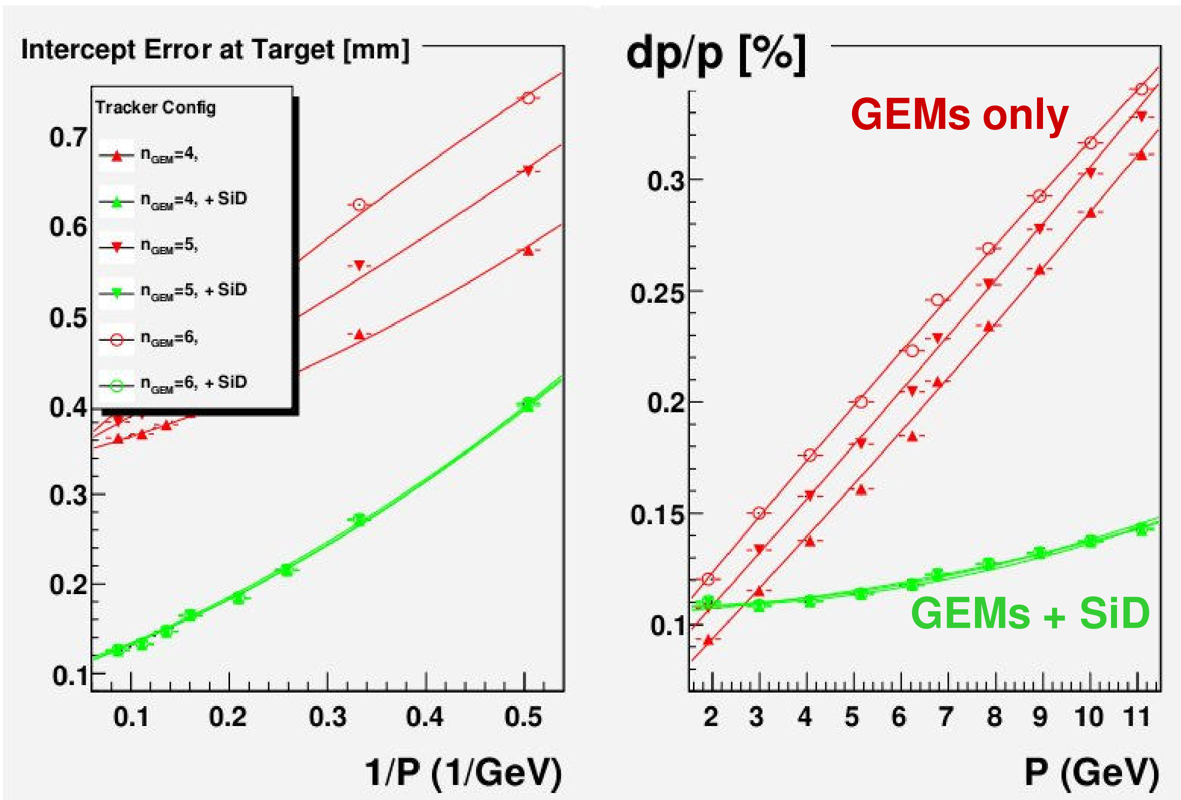
Photon Energy (GeV)

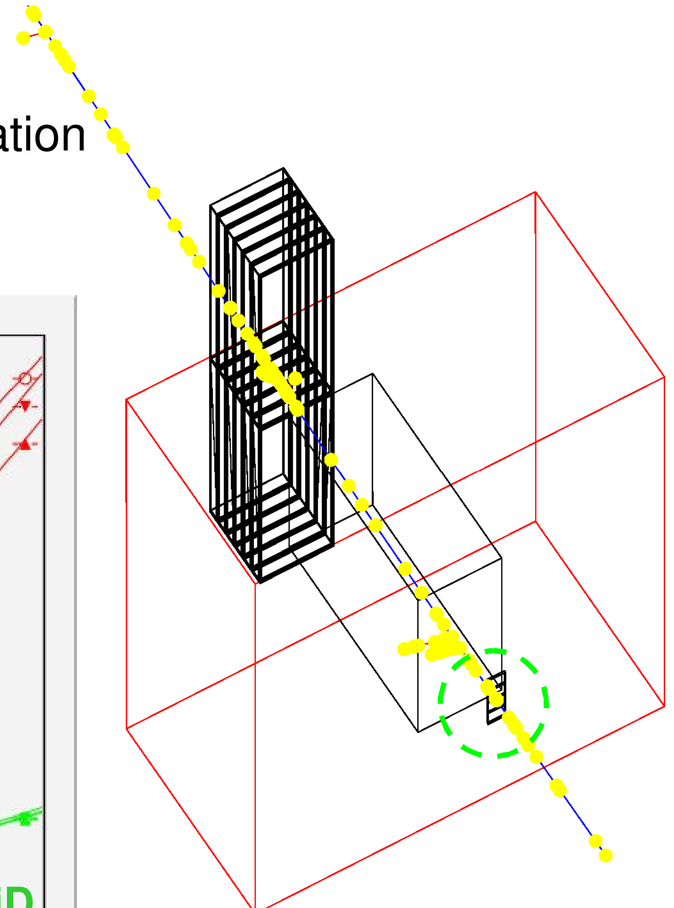
Air accounts for ~0.1%

SiD planes / Hybrid tracker

Add 2 small silicon detector planes (x/y, 50 μm pitch) in front of the magnet to increase the "tracking arm" (from 60 cm to ~180 cm)

Expected 10 times higher background but segmentation is 10 times higher ⇒ approx. same occupancy





Readout:
adapt GEM APV25 based electronics

Conclusions / Plan summary

- Design of the first x/y full scale 40x50 cm^2 prototype done (tanks to Rui) and ready for production
- Assembling tools almost completed (GEM stretcher similar to Bencivenni design, HV testing box, protocol …)
- First electronics prototypes available (except ZIF connectors)
- Expected to start testing module late February/ beginning of March
- Next step (while testing prototype): design the u/v readout foil and produce the corresponding module
- In parallel: development of the small Si-detector