Research Progress and Future Plan

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Master's Program

Pohang University of Science and Technology

Value Creating University
POSTECH
POHANG UNIVERSITY OF SCIENCE AND TECHNOLOGY

PAL 포항가속기연구소
POHANG ACCELERATOR LABORATORY

POLYTECHNIQUE MONTREAL

Contents

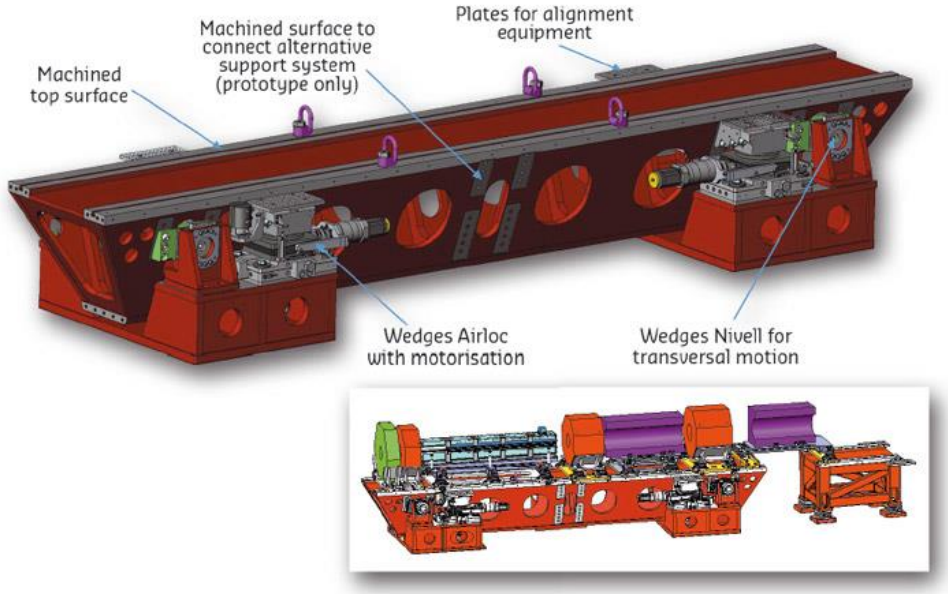
Studying the magnet girder

Participating in the USPAS 2026

- To study the mechanical engineering of the accelerator.
- Mechanical alignment and vibration.
- Precise survey and vibrational stability.

Mechanical behavior of the girder

- Robust structure for micron precision.
- Vibration measurement and attenuation.



Research opportunity

Motivation of the research

RESEARCH INTERNSHIP PROGRAM

SUMMER 2026

Polytechnique Montréal is one of Canada's leading research engineering universities. Founded in 1873, Polytechnique Montréal has the largest engineering student body in Quebec and is highly ranked for the number of Canada Research Chairs in Engineering and the scope of its research activities. The world needs creative and innovative engineers more than ever. Polytechnique is producing them, in Montreal, a city ranked among the top student cities in the world for the last 5 years!

RESEARCH INTERNSHIP PROGRAM

Every year, Polytechnique's research laboratories welcome over 250 students from other universities wishing to put into practice the technical and scientific knowledge acquired in their studies. The research conducted, supervised by a Polytechnique professor and respectful of all health and safety measures, emanates from a real societal or industrial need, and is carried out in the lab or *in situ*.

ELIGIBILITY CRITERIA

- Enrolled in one of Polytechnique Montréal's partner universities
- Be officially nominated by your home university before applying to this program. Do to so, please contact your International Relations Office or your Internship Office
- Completed at least two years of an engineering undergraduate program or be registred in a graduate program (Master or Ph.D.) according to the projects' university cycle requirements
- Enrolled in a full-time program and will continue to be enrolled after your internship
- Minimum GPA of 2.75 out of 4 (or equivalent)
- Meet the required skills for the internship
- Be fluent in English or in French (research intern must have a competency sufficient to succeed in a university-level engineering research project and to fully participate in the life of their host lab)

DURATION

The recommended duration of the internship is 4 months, with 5 possible starting dates between April and July. Once the admission to the program has been confirmed, no change in the duration or the dates can be made. Please confirm the research duration with your home university Program Coordinator before applying. Note that it is a full-time research internship in Montreal (7 hours a day, 35 hours a week).

Outstanding candidates may receive one of the 25 scholarships available annually!

Maximum amount of the scholarship: 6,000 CAD for 4 months (prorated at 1 500 CAD/month).

APPLICATION PROCEDURE

Follow the link below to browse the list of research projects offered by area(s) of expertise and/or university cycle, and apply by **January 15, 2026:**

polymtl.adv-pub.moveonca.com/rip

Note that an online conference call may be organized for final selection.

For any questions regarding your application, please contact:
Polytechnique Montréal International ▪ point@polymtl.ca

POLYTECHNIQUE MONTRÉAL

Current research

Summer plan

Discovery and motivation

- Good opportunity to acquire foundational technology for particle accelerators.
- Learning mechanical engineering in a short period time.
- Integration and application into the accelerator.

2026학년도부터 국제협력팀에서 **Non-Credit Program**을 통해 **연구참여, 리더십 등 다양한 주제의 "비학점 기반 국제교류 프로그램"**을 운영합니다.
기존에 개별 공지되었던 비학점 기반 국제교류 프로그램이 본 게시글을 통해 통합 모집되오니 **OneDrive 폴더 내 업데이트 되는 엑셀 파일 참고 바랍니다.**

★OneDrive 링크: [POSTECH] 2026 Non-Credit Program 참여자 모집

1. 선발인원: 2026학년도 00명

2. 파견기간: 2026.02.23 - 2027.02.21

3. 지원자격

가. 본교 학부 및 대학원 재학생 (휴학생 신청 불가)

- (학부) 8학기 / (대학원) 석사 4학기, 박사 8학기, 통합 10학기까지 파견 및 지원 가능

나. 주관기관에서 요구하는 자격을 충족하는 자

다. 파견 및 지원 직전 학기 학사경고 및 징계를 받지 않은 자

라. 본교 장학금 지급 규정의 자격 요건을 충족하는 자

Specific details

Motivation of the research Current research Summer plan

Université de Montréal

POLYTECHNIQUE MONTRÉAL
UNIVERSITÉ D'INGÉNIERIE

HEC MONTRÉAL

Family name (surname) of the professor
TUYSUZ

First name of the professor
Oguzhan

Engineering Department:

☐ Chemical ☐ Civil/Geol./Mining ☐ Electrical ☐ Maths/Industrial
☐ Computer/Software ☒ Mechanical ☐ Physics

Research Project Subject

MEC 06 - Analysis of Manufacturing Process and Machine Interaction

Main Tasks during the Internship
Select optimum cutting conditions
Design a machining process with high dimensional and surface quality
Measure machining forces and vibrations
Experiment, collect, analyze, and interpret machining process data.

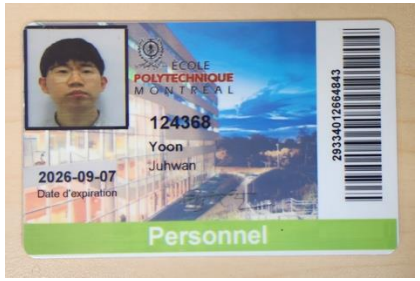
Experience or Skills Required for the Internship
Ability to design laboratory tests ,
Familiarity with research equipment (CNC machines, cutting tools, forces sensors, accelerometers, dynamometers etc.)
Familiarity with machining processes

University Cycle at Polytechnique:

Undergraduate / Licence,Postgraduate / Master,Doctorate / Doctorat

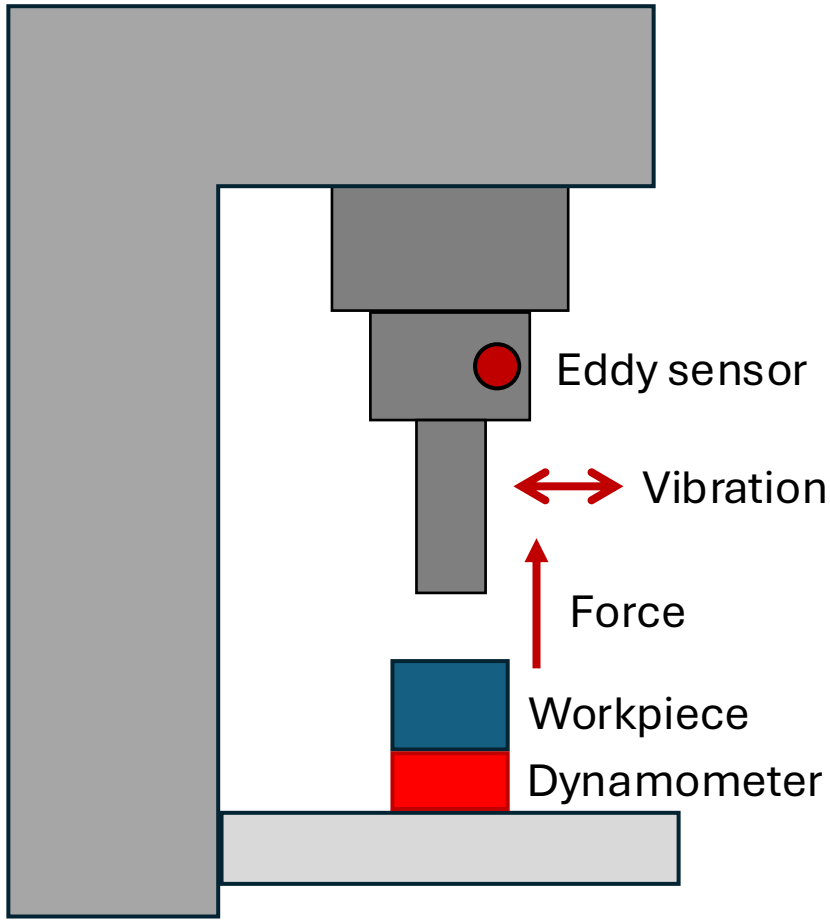
☐ 1st (undergrad) ☒ 2nd (master) ☐ 3rd (doctoral)
(should correspond to the current level of studies of the research intern)

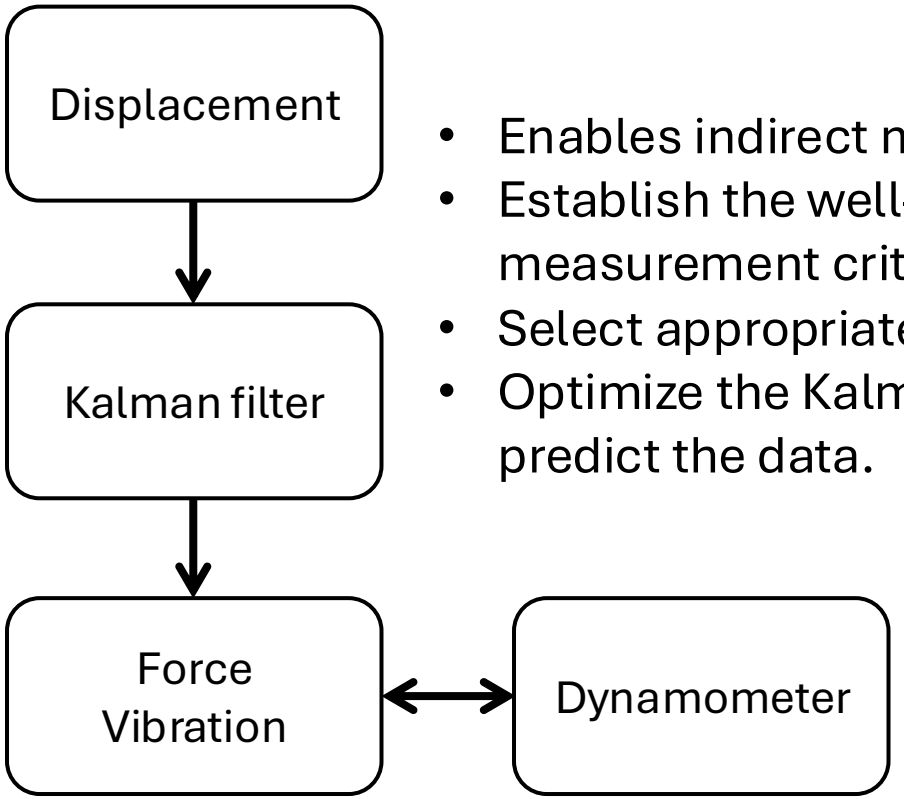
- Location: Montreal, Canada
- Duration: 120 days
- Funding: 6,000 CAD
- Dept. of mechanical engineering
- Position: Personnel (researcher)
- Duty: Analysis & Development



Research topic

Motivation of the research | **Current research** | Summer plan





- Enables indirect measurement.
- Establish the well-controlled measurement criteria.
- Select appropriate sensor.
- Optimize the Kalman filter to predict the data.

Experimental modal analysis

Inertia Damp Resilience External

$$[M]\{\ddot{x}\} + [C]\{\dot{x}\} + [K]\{x\} = F(t)$$

$x = \varphi q(t)$ $q(t)$: Modal coordinates

φ: Modal shape

$$[M]\varphi\ddot{q} + [C]\varphi\dot{q} + [K]\varphi q = F(t)$$
$$\varphi^T[M]\varphi\ddot{q} + \varphi^T[C]\varphi\dot{q} + \varphi^T[K]\varphi q = \varphi^T F(t)$$
$$[m]\ddot{q} + [c]\dot{q} + [k]q = \varphi^T F(t)$$

$\zeta = \frac{c}{2m\omega}$ ζ: Damping ratio

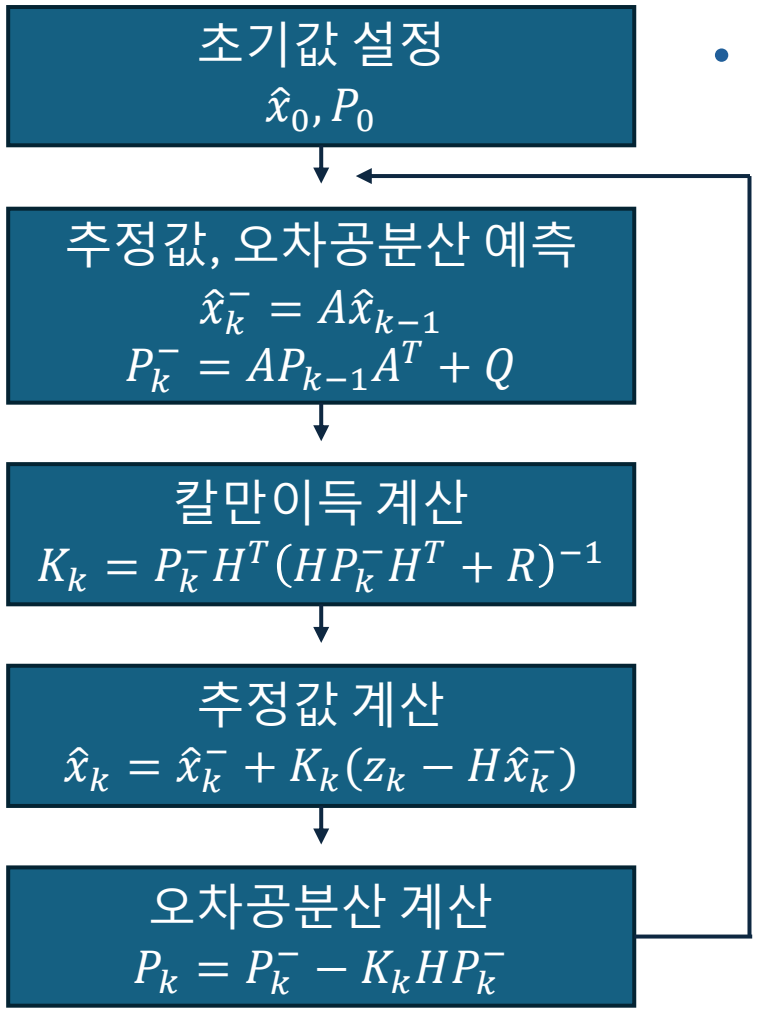
$\omega = \sqrt{\frac{k}{m}}$ ω: Natural frequency

$$\ddot{q} + 2\zeta\omega\dot{q} + \omega^2 q = \varphi^T F(t)$$

Measurement process

- Excitation: momentary impact load to the tool tip using an impact hammer.
- Measurement: vibration response (acceleration) generated by the tool via an accelerometer
- Analysis: natural frequency, damping ratio, and mode shape based on the collected signals

Kalman filter



- Balance between the ideal value and measured value with sensor noise.

x_0: Space state model (e.g. position, velocity)
P_0: Covariance (correlation between variables of interest)

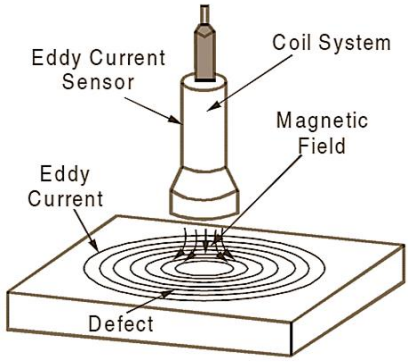
$\hat{x}_k^-$: Estimated value of next step via the system model A
P_k^-: Covariance enlarged by model noise Q

H: Mapping the sensor value to the system value of interest
R: Sensor error as covariance
$K_k \approx \frac{P_k}{P_k + R_k}$: Ratio of model noise to sensor noise (lower → model↑)

z_k: Observed value by sensor
$\hat{x}_k$: Final state reflecting the residual of sensor and model value
P_k: Reduced covariance based on the measurement reliability

Data analysis

Data acquisition → **Kalman filtering** → **Force & Vibration** → **Validation by dynamometer**



Eddy sensor

Types of Kalman filters

Extended Kalman filter

Unscented Kalman filter

Ensemble Kalman filter

Adaptive Extended Kalman filter

Dynamometer

Summer research timeline

Motivation of the research | Current research | **Summer plan**

Code setup

Prepare Python code for sensor data processing.

Jun.

Jul.

Kalman filter

Design an improved Kalman filter considering the experimental characteristics.

Data analysis

Check if measurement performance and error have been improved.

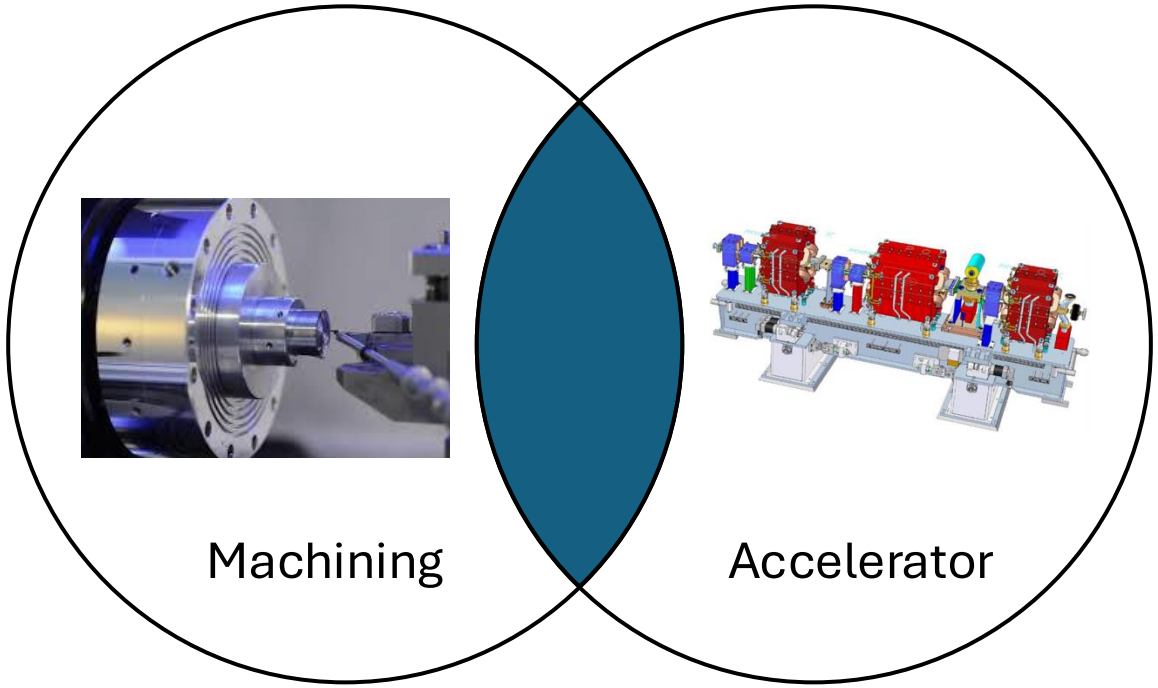
Aug.

Sep.

Magnet girder

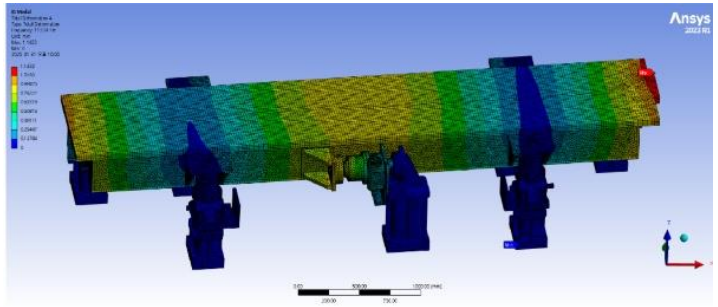
Research the girder related to vibration based on learned skills.

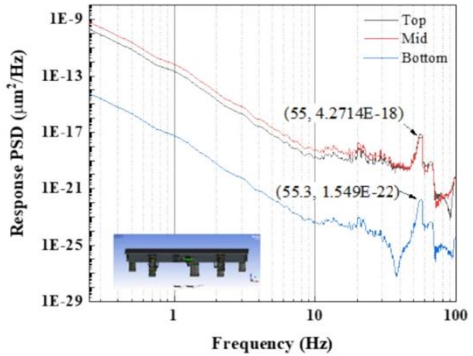
Connection to the magnet girder



Establish the Master's topic

- Accelerator body design and stability evaluation.
- Develop a method for measuring girder dynamics.
- Minimize the beam emittance from a mechanical engineering perspective.





Conclusion and summary

01 Starting new research

Short-term research project at Polytechnique Montreal

Acquiring mechanical engineering skills for magnet girder

02 Mechanical data analysis

Measurement of the dynamic system

Data processing with Kalman filter

03 Toward the magnet girder

Investigation of the mechanical behavior of the girder

Contribute to the stable beam operation with stiffness

QnA

Thank you for listening to the presentation.
Please feel free to ask any questions.